Appendix B

Process Modeling Technical Memorandum

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TECHNICAL MEMORANDUM

DATE: February 22, 2021

Project No.: 964-50-20-01.006
SENT VIA: EMAIL

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SUBJECT: Sandy WWTP Secondary Process Evaluation

West Yost is completing a preliminary design for modifications to the City of Sandy Wastewater Treatment Plant (WWTP), located in Boring, Oregon. This Technical Memorandum (TM) has been developed to describe treatment process modeling that has been conducted to support the preliminary design effort. The analysis presented herein builds off the information and findings provided in the 2019 *City of Sandy Wastewater Facilities Plan* (Facilities Plan) (MurraySmith, 2019) and relies on WWTP steady-state BioWin models that were developed by MurraySmith to support the Facilities Plan and a State Point Analysis model of the secondary clarifiers that was developed by West Yost. These topics addressed in this TM are as follows:

- Summary of Findings
- Background
- Modeling Approach
- Key Model Inputs
- Key BioWin Modeling Parameters
- Modeling Results
- Conclusions
- Recommended Operations Summary

SUMMARY OF FINDINGS

Key findings from the analysis described herein are as follows:

- Optimization of the secondary process treatment system through mechanical upgrades and operational changes to the aeration basins is necessary to meet the current effluent limitations at the anticipated 2025 wet weather flows and load conditions.
- The key capacity limitation is the solids loading on the secondary clarifiers during peak flow conditions. Operating the aeration basin in a fully aerobic mode with an inlet step feed will maximize treatment capacity by lowering the solids loadings to the clarifiers.

- With the recommended changes, the steady-state BioWin modeling predicts the WWTP will be able to meet the effluent limitations following filtration. However, the State Point model predicts clarifier failure at flows exceeding 7.0 mgd[1], which about 2.0 mgd lower than the 2020 peak instantaneous flow condition.
- The steady-state modeling approach used for this analysis does provide a conservative assessment of the available capacity for handling peak flow conditions. However, the dynamic modeling needed to fully optimize the treatment process performance for short-term peak flow conditions is complex and requires a significant amount of process data that is not available.
- The addition of a third clarifier would eliminate performance concerns with the secondary clarifier system and would allow the aeration basins to be operated at a higher MLSS concentration, increasing overall performance of the secondary process. However, once the new satellite treatment system is constructed, the overall loadings to the plant will decrease. Therefore, it would not be prudent to construct a new secondary clarifier facility at this time.
- It may be possible to further lower MLSS concentrations during winter flow conditions by using the ASSB for contact stabilization. It may also be possible to reduce the aSRT during peak flow periods thereby lowering the MLSS concentration enough to avoid clarifier failure. Additional modeling analysis is needed to assess both possible strategies.

BACKGROUND

This section provides an overview of the WWTP facilities and the existing discharge requirements.

Overview of WWTP

The Sandy WWTP includes facilities for the following:

- Preliminary treatment through fine screening and grit removal
- Biological nitrogen removal activated sludge aeration basins: These basins consist of two anoxic zones (37,700 gallons each), one “swing” zone that can have aeration on or off (37,700 gallons), followed by a large aeration basin (257,400 gallons). Internal Mixed Liquor Recycle (IMLR) pumping is used to return nitrate-laden effluent from the aeration basin to the anoxic portion (i.e. head) of the secondary process where carbon is available from the influent to provide for denitrification.
- Secondary clarification: There are two clarifiers with diameters of 54 feet (Curran-McLeod, 1996), resulting in a total clarifier surface area of 4,580 square feet. The clarifiers produce Return Activated Sludge (RAS) for recycle to the aeration basins and Waste Activated Sludge (WAS) sent to further solids processing. RAS is used to maintain the desired microorganism population in the aeration basins. The WAS are the solids wasted from the system to maintain the desired microorganism population “age,” which is often characterized by the aerobic Solids Retention Time (aSRT).
- Sodium hydroxide (caustic) addition for alkalinity control to achieve adequate ammonia removal

[1] Assuming a Sludge Volume Index of 200 milliliters per gram or better.

- Cloth media filtration
- Ultraviolet (UV) disinfection
- WAS treatment in two cells of an Aerated Sludge Storage Basin (ASSB), the inner 90,000-gallon “donut hole” and the 180,000-gallon “ring”
- Digested solids dewatering with a belt filter press: Pressate from this system is equalized in a third cell of the ASSB before being returned to the activated sludge aeration basins.

Discharge Requirements

The WWTP is permitted by the Oregon Department of Environmental Quality for discharge of treated effluent to Tickle Creek between November 1 and April 30, when adequate stream dilution is available. Land application of treated effluent is also permitted year-round as irrigation water on a nearby plant nursery.

The surface water discharge is subject to concentration-based effluent limits for Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) as follows:

- Monthly average effluent limit of 10 milligrams per liter (mg/L)
- Weekly average effluent limit of 15 mg/L

The surface water discharge is also subject to daily maximum, weekly average and monthly average loads limits for BOD and TSS that are based on an average wet weather design flow of 1.5 million gallons per day (mgd).

Additional relevant effluent limits include the following:

- pH within the range of 6.0 to 9.0
- ammonia:
  - Daily maximum effluent limit of 10.9 mg/L as nitrogen
  - Monthly average effluent limit of 3.7 mg/L as nitrogen

MODELING APPROACH

This section presents an overview of the modeling approach used for this analysis, followed by a discussion of the specific scenarios evaluated through the BioWin and State Point modeling efforts.

Approach Overview

The modeling approach involved the following steps:

- The first step involved using BioWin modeling in concert with State Point modeling of the existing clarifiers to define the aeration basin modifications that can reasonably be implemented to optimize the available capacity of the existing secondary treatment facilities and achieve reliable nitrification (effluent ammonia concentration of 1 mg/L as N[2]) at the anticipated maximum month design conditions.
- The second step involved using the BioWin model of the preferred aeration basin configuration to determine the aSRT needed to achieve reliable nitrification.
- The third step involved using the BioWin model of the preferred aeration basin configuration to evaluate the system performance and aeration and caustic demands over the range of anticipated influent flow, load, and temperature conditions. An understanding of the range of operating conditions and aeration and caustic demands that could occur supports efficient design of the entire system.
- The final step involved using a State Point model of the existing clarifiers to evaluate the peak flow capacity of the secondary clarifiers given the range of aeration basin operating conditions.

BioWin Modeling Scenarios

As noted above, one of the goals of the modeling effort is to evaluate the operating conditions and aeration and caustic demands under the range of influent flow, load and temperature conditions anticipated over the life of the project. The City plans to finish construction of a satellite treatment facility around 2025. That project will result in the removal of a portion of the flow and load currently entering the WWTP. Therefore, the range of conditions expected for this project can be correlated to the influent flows and loads anticipated between 2020 and 2025, where the 2025 conditions represent the anticipated worst-case flow and load conditions for operation of the WWTP.

A summary of the modeling scenarios used to evaluate performance and demands over the 2020 and 2025 range is provided in Table 1. For the first two steps of the modeling evaluation, the anticipated maximum month design conditions are represented by the 2025 Wet Weather Design Treatment Performance and 2025 Dry Weather Design Treatment Performance modeling scenarios, which were defined by MurraySmith, were applied. The full range of scenarios shown in Table 1 were used in completing the third step of the evaluation.

[2] This target ammonia level was selected for this analysis because it demonstrates near-complete nitrification (conversion of ammonia to nitrate) is achievable under the conditions of interest.

<table>
<tr><th colspan="4">Table 1. Summary of BioWin Modeling Scenarios Evaluated</th></tr>
<tr><th>Scenario</th><th>Flow Condition</th><th>Load Condition</th><th>Temperature Condition</th></tr>
<tr><td colspan="4">Treatment Performance</td></tr>
<tr><td>2025 Wet Weather Design Treatment Performance(a,b)</td><td colspan="2">2025 Max Month Wet Weather</td><td>Minimum Wet Weather</td></tr>
<tr><td>2025 High Flow Treatment Performance</td><td>2025 Peak Weekly</td><td>2025 Max Month Wet Weather</td><td>Average Wet Weather</td></tr>
<tr><td>2025 Typical Wet Weather Treatment Performance(c)</td><td colspan="2">2025 Average Wet Weather</td><td>Average Wet Weather</td></tr>
<tr><td>2025 Dry Weather Design Treatment Performance(a)</td><td colspan="2">2025 Max Month Dry Weather</td><td>Average Dry Weather</td></tr>
<tr><td colspan="4">Aeration and Caustic Demands</td></tr>
<tr><td>2025 Peak Aeration Demand</td><td colspan="2">2025 Max Month Dry Weather</td><td>Maximum Dry Weather</td></tr>
<tr><td>2025 Peak Caustic Demand(b)</td><td colspan="2">2025 Max Month Wet Weather</td><td>Average Wet Weather</td></tr>
<tr><td>2025 Typical Dry Weather Demands</td><td colspan="2">2025 Average Dry Weather</td><td>Average Dry Weather</td></tr>
<tr><td>2025 Typical Wet Weather Demands(c)</td><td colspan="2">2025 Average Wet Weather</td><td>Average Wet Weather</td></tr>
<tr><td>2020 Typical Dry Weather Demands</td><td colspan="2">2020 Average Dry Weather</td><td>Average Dry Weather</td></tr>
<tr><td>2020 Typical Wet Weather Demands</td><td colspan="2" rowspan="2">2020 Average Wet Weather</td><td>Average Wet Weather</td></tr>
<tr><td>2020 Minimum Aeration Demand</td><td>Minimum Wet Weather</td></tr>
</table>

(a) The 2025 Wet and Dry Weather Design Treatment Performance scenarios were the modeling scenarios used in the models provided by MurraySmith.

(b) The 2025 Wet Weather Design Treatment Performance and 2025 Peak Caustic Demand conditions are evaluated using the same BioWin modeling scenario.

(c) The 2025 Typical Wet Weather Treatment Performance and Demands conditions are evaluated using the same BioWin modeling scenario.

State Point Modeling Scenarios

The steady-state BioWin models simulate secondary treatment performance under average conditions that are expected occur over an extended period (e.g. maximum month). However, the capacity of the secondary clarification process must consider the solids loading that would occur under the anticipated peak (daily or hourly) flow conditions. Therefore, a separate, State Point model was used to assess the secondary clarifier performance.

A State Point model considers the Mixed Liquor Suspended Solids (MLSS) concentrations entering the clarifier, the total flows to the clarifier, and the solids settleability characteristics to define what conditions would cause a failure of the clarification treatment process. For this analysis, the MLSS concentrations predicted by the BioWin models were used in combination with the peak design flows for the WWTP to assess performance. The combined peak flow/BioWin model MLSS values evaluated under this effort are summarized in Table 2.

Table 2. State Point Modeling Scenarios	
Secondary Effluent Flow	BioWin Modeling Condition
2025 Peak Instantons Flow (PIF)[a]	2025 High Flow Treatment Performance
2025 Peak Day Flow (PDF)	
2025 Peak Weekly Flow (PWF)	
2025 Max Month Wet Weather Flow (MMWWF)	2025 Wet Weather Design Treatment Performance
2025 Max Month Dry Weather Flow (MMDWF)	2025 Dry Weather Design Treatment Performance
(a). The Facilities Plan defines a "Peak Instantaneous Flow" (PIF) as "the highest peak WWTP flow attained during a 5-year peak day flow event."	

KEY MODEL INPUTS

This section addresses the key model inputs used in the modeling analysis. Additional BioWin model inputs, which were defined by MurraySmith and/or are BioWin default values, are included as Attachment 1.[3]

Influent Flows

The influent flow values used in the modeling analyses are based on the information provided in the Facilities Plan. The specific flow values used for this evaluation are summarized in Table 3.

Table 3. Assumed Influent Flows by Year, mgd		
Condition	Year 2020	Year 2025
Average Dry Weather Flow (ADWF)	1.12	1.18
Average Wet Weather Flow (AWWF)	1.85	1.95
MMDWF	--[a]	1.55
MMWWF	--	2.91
PWF	--	5.48
PDF	--	6.42
PIF	--	9.90
(a) Values shown only for conditions used to support the modeling analysis.		

[3] The model by MurraySmith included some non-default values for wastewater "fractions," which are site-specific parameters that define how the influent organic matter and nitrogen compounds divide into various components that are digested differently in the secondary process. No details have been provided regarding how the non-default values were derived.

Influent Loads

The Facilities Plan does not directly list influent loads of interest for the years 2020 and 2025, but it does provide per capita Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) loads and monthly average and maximum monthly load factors. This information can therefore be used to derive the load values of interest based on population estimates for 2020 and 2025. Influent BOD and TSS loads for average and maximum month dry and weather load conditions are presented in Table 4 for 2020 and 2025, based on this methodology.

Table 4. Influent BOD and TSS Loads Calculated from Facilities Plan Information, pounds per day (lb/day)

Condition	Parameter	Year 2020	Year 2025
Average Dry Weather Load (ADWL)	BOD	2,690	3,090
	TSS	2,590	2,970
Maximum Month Dry Weather Load (MMDWL)	BOD	3,930	4,510
	TSS	3,790	4,350
Average Wet Weather Load (AWWL)	BOD	2,610	3,000
	TSS	2,600	2,990
Maximum Month Wet Weather Load (MMWWL)	BOD	3,780	4,350
	TSS	4,280	4,930

The primary BioWin model inputs are the influent BOD, TSS, Volatile Suspended Solids (VSS), Total Kjeldahl Nitrogen (TKN), pH, and alkalinity concentrations and associated flows for the load condition of interest. The Facilities Plan includes minimum, average and maximum influent concentrations for these and other parameters based on nine dry weather (summer) samples. However, this information is not adequate to calculate values for all the modeling scenarios of interest without additional assessment of flows and loads for the plant. Therefore, the best information available for defining the influent flow characteristics are influent concentrations defined in MMDWL/MMDWF and MMWWL/MMWWF models provided by MurraySmith.

Accordingly, the influent loads under the average dry and average wet weather load modeling scenarios were estimated using the MMDWL/MMDWF and MMWWL/MMWWF influent concentrations defined in the MurraySmith modeling analysis and the corresponding modeling scenario flow condition (as defined in the Facilities Plan). The resulting average dry weather and average wet eater BOD and TSS loads are provided in Table 5.

Table 5. Influent BOD and TSS Loads Applied in the BioWin Analysis, lb/day

Condition	Parameter	Year 2020	Year 2025
ADWL	BOD	3,270	3,440
	TSS	3,160	3,330
AWWL	BOD	2,760	2,910
	TSS	3,130	3,300

(a) Values shown only for conditions used to support the modeling analysis.

Comparing the AWWL and ADWL presented in Tables 4 and 5 demonstrates that the average day loads are 10 to 20 percent higher than what was calculated in the Facilities Plan, except for AWWL BOD, which is about the same. However, as shown in Table 1, the average load modeling scenarios are not used to define the treatment capacity, so the capacity analysis will not be impacted by this conservative approach. However, the values are used to define typical operation conditions - primarily to define aeration and caustic requirements. Therefore, the applied conservatism in average load estimates will provide an overestimate of average aeration and caustic requirements.

Temperatures

The process temperatures assumed for the secondary process modeling are based on information in the Facilities Plan and the BioWin model provided by MurraySmith. The process temperatures of interest are summarized in Table 6.

Table 6. Assumed Process Temperatures, degrees Celsius

Condition	Value
Minimum Wet Weather	11
Average Wet Weather	15
Average Dry Weather	18
Maximum Dry Weather	22

Sludge Volume Index (SVI)

SVI is a common measurement of how well a mixed liquor settles. SVI data was not readily available for the WWTP, so a reasonably conservative SVI of 200 milliliters per gram (mL/g) was assumed for the analysis. The 200 mL/g is a reasonably conservative assumption for mixed liquor produced by a reactor that has an anoxic selector. However, a reactor operating with extended aeration and no selector (which is recommended, as discussed later in this TM) could have poorer sludge settleability performance (higher SVI).

Ongoing collection of SVI data following implementation of the recommended process modifications will be essential to understanding performance and inform process decisions. Monitoring should occur at least twice per week. If this data indicates significantly higher SVIs than 200 mL/g, the results of this analysis should be revisited.

KEY BIOWIN MODELING PARAMETERS

IMLR Flow

The Facilities Plan indicates that there are two IMLR pumps (one per train), each with a capacity of 750 gallons per minute (gpm). These are constant speed pumps. Therefore, when being applied, the total IMLR flows were set at 1,500 gpm or 2.16 mgd (1.08 mgd per train).

An IMLR flow of 200 to 300 percent of the influent flow is typically desired to optimize denitrification performance. However, at the 2025 MMDWF and ADWF, the IMLR flow would be about 150 and 180 percent of the influent flow, respectively.

RAS Flow

The WWTP has three RAS pumps, each with a capacity 600 gpm capacity. Therefore, the maximum possible RAS flow rate is 1,800 gpm or 2.6 mgd. A typical target RAS flow rate is 50 to 75 percent of the influent flow. BioWin models are typically developed with a combined RAS/WAS output from the secondary clarifiers. For this analysis, the combined RAS/WAS flow was assumed to be 100 percent of secondary influent flow for all the scenarios except the 2025 High Flow Treatment Performance scenario. For that scenario, a combined RAS/WAS flow of 47 percent of secondary influent flow is assumed, equating to 2.6 mgd or 1,800 gpm.

WAS Flow

WAS flow rates are adjusted in each modeling scenario to achieve the desired aSRT and MLSS concentrations.

Caustic Flow

The caustic flow rates are adjusted in each modeling scenario to achieve two goals: a desired effluent ammonia-N concentration of 1 mg/L (as Nitrogen) and a minimum pH in the aeration basins of 6.3. The modeling also assumes, a concentration of 1.25×10^4 milliequivalents per liter, which is the value included in in the model provided by MurraySmith.

Aeration Settings

Aerated basins have been assumed to operate with Dissolved Oxygen (DO) setpoints of 2 mg/L. The alpha and beta factors established in the model provided by MurraySmith were also applied for this analysis. These are a beta value of 0.95 for all basins and alpha values of either 0.30 or 0.35, where 0.30 was used for the initial aerated zone (swing zone) and 0.35 for the main aerated zone(s).[4]

MODELING RESULTS

Recommended Aeration Basin Configuration

In the first step of the analysis, it was determined that the existing configuration of the aeration basins does not provide enough capacity to treat the 2025 maximum month wet weather flow and load conditions. Specifically, the MLSS concentrations that the MurraySmith MMWWL/MMWWF model predicted as being necessary to provide efficient ammonia removal resulted in a clarifier failure in the State Point model under peak flow conditions. Therefore, BioWin modeling was used to evaluate possible aeration basin modifications that could be implemented to improve system performance by lowering the MLSS concentrations during the peak flow conditions, thus reducing the solids loads to the clarifiers.

[4] Typical alpha factors for fine bubble diffusers range from 0.5 to 0.6 and coarse bubble from 0.7 to 0.8. However, several factors can impact alpha factors. It is unclear how the alpha values applied in the model provided by MurraySmith were defined. If the alpha factors applied in the model are lower than actual values, the model will overpredict total aeration demands.

Based on this analysis, the following specific modifications are recommended to improve system performance[5]:

- Split the main aerobic tank in each treatment train into two zones of approximate equal volumes. This will result in each basin being divided into five zones total. Splitting the tank improves performance with respect to ammonia removal, allowing the system to be operated at a slightly lower aSRT to achieve the same nitrification performance.
- Operate the system as an extended aerated system in the wet weather period. This involves aerating all zones and eliminating the IMLR flow. This strategy will allow the system to operate at lower MLSS concentrations while still achieving the same aSRT. The potential trade-off for this operational strategy is increased caustic demand because there is no alkalinity recovery from the denitrification process. However, it was determined that the reduced aerated Hydraulic Residence Time (HRT) driven by two anoxic basins and the IMLR flow resulted in inhibition of the nitrification process. Therefore, the modeling showed higher caustic demands with the anoxic selectors in operation because caustic was needed to reduce pH inhibition to offset the inhibition being caused by low HRT. Indeed, the overall caustic use under the extended aeration mode was lower than what would be required if operating the system for denitrification.
- Operate the system in step-feed mode during wet-weather flow periods[6]. The step-feed operation would entail directing a portion of the secondary influent to the fourth zone of the reactor (sending around the three initial zones). The step-feed operation allows for a lower HRT through the initial treatment zones, which improves the performance of the initial zones without increasing solids loading to the secondary clarifiers. Most of the modeled scenarios showed an optimum split of 50 percent entering the head of the system and 50 percent sent directly to the main aeration basin. Some of the modeled scenarios also showed benefit with a 33 percent/67 percent split. Therefore, it is recommended that the WWTP have the flexibility to achieve a range of split flows.

Table 7 summarizes the assume operations for the wet weather and dry weather model scenarios.

Table 7. Recommended Aeration Basin Operations

Scenario	Aeration Condition	Step-Feed Condition
Wet Weather Operations	All aerated	50%/50% - 33%/67% Split
Dry Weather Operations	2 anoxic zones	100% direct feed

[5] The modeling was also used to evaluate whether feeding caustic to the RAS line (versus to the head of the basin) had any impact on operations. This approach was recommended to support some of the basin modifications needed to improve performance. The analysis demonstrated there was no difference in performance between these two feed locations.

[6] A contact stabilization approach, which is similar to step-feed was also evaluated. With contact stabilization the RAS is initially subject to aerated treatment for a few hours before being blended with secondary effluent downstream of the process. However, it was determined that the volume of the basins available for treatment after a portion of the basin is allocated to RAS treatment was not large enough to provide sufficient HRT to achieve the desired process treatment performance.

Recommended aSRT

The second step of the analysis demonstrated that, with the recommended basin configuration, an aSRT of at least 6.5 days is required under the 2025 Wet Weather Design Treatment Performance modeling scenario conditions and an aSRT of at least 4.0 days under the 2025 Dry Weather Design Treatment Performance modeling scenario conditions. These aSRT values were used in completing the modeling under third step in the analysis discussed in the next section of this TM.

Treatment Performance, Aeration Demands, and Caustic Demands

The third step in the analysis involved evaluating the system performance and aeration and caustic demands over the range of anticipated influent flow, load, and temperature conditions. As indicated in Table 1, nine different scenarios were modeled for this analysis. Flow schematics and major input/output parameters associated with these model scenarios are provided with the BioWin reports in Attachments 2 through 10. A summary of the output parameters is provided below.

Treatment Performance

A summary of the key performance results from the BioWin model scenarios is provided in Table 8.

Table 8. Summary of Performance Modeling Results

Scenario	aSRT, days	MLSS, mg/L	Effluent Quality, mg/L					
			Ammonia-N	Nitrate-N plus Nitrite-N	Total BOD	Soluble BOD	TSS
2025 Wet Weather Design Treatment Performance	6.5	3,000	0.93	20	7	1	15[(a)]
2025 High Flow Treatment Performance	6.5	1,900	1.0	9	17[(a)]	1	35[(a)]
2025 Typical Wet Weather Treatment Performance	6.5	2,100	0.27	21	4	1	8
2025 Dry Weather Design Treatment Performance	4.0	2,900	0.16	12	4	1	6

mg/L = milligrams per liter

(a) Effluent BOD and TSS values above the effluent limits of 10 and 15 mg/L occur because the BioWin modeling predicts capacity limitations in the secondary clarifiers. These concentrations will be lowered through downstream filtration.

The following conclusions can be drawn from the results in Table 8:

- MLSS concentrations vary from about 1,900 mg/L to 3,000 mg/L. An analysis of the secondary clarifiers' ability to manage these MLSS concentrations is provided in the State Point Modeling Results section of this TM.
- The target effluent ammonia-nitrogen concentration of 1 mg/L was achieved in all modeling scenarios.
- Significant BOD removal is achieved under all conditions. With the exception of the High Flow Treatment Performance scenario, the predicted effluent BOD concentrations are well below permitted limits.
- Although the effluent BOD concentration predicted under the 2025 High Flow Treatment Performance scenario slightly exceeds the weekly effluent limit of 15 mg/L, the low soluble BOD concentrations confirms high BOD removal performance in the aeration basins. The elevated effluent BOD is caused by the BioWin model predicting capacity limitations in the clarification process. Nevertheless, with the anticipated removal of particulate BOD in the filtration process, the BOD effluent limitation will likely be achievable.
- Significant TSS removal is also achieved under all conditions. Under all dry weather and average wet weather conditions, the effluent TSS concentrations are below the permitted limits.
- The TSS concentration of 15 mg/L under the 2025 Wet Weather Design Treatment Performance scenario equals the weekly effluent limit of 15 mg/L. The TSS concentration of 35 mg/L under the 2025 High Flow Treatment Performance scenario is well above the weekly effluent limit. As noted above, the BioWin model predicts capacity limitations in the clarification process. With the anticipated removal of particulate BOD in the filtration process, the TSS effluent limitation will likely be achievable.
- As noted previously, steady state models are intended to analyze long-term operating conditions. Using a steady-state model to evaluate the peak flow conditions may be under-predicting the system performance for this short-term condition. Dynamic modeling, which requires significantly more data than is currently available, is needed to better understand the system performance under short-term peak flow conditions.

Air Flow Demands

The required daily average air flows in the secondary aeration process for the modeling scenarios of interest are presented in Table 9. As noted previously, the predicted air demands under the average conditions shown in the table may be higher than actual demands due to the procedures used to estimate the average loads for this analysis.

Table 9. Air Flow Demand Results, standard cubic feet per minute

Scenario	Air Flow Demands by Zone					
	Total (both trains)	Anoxic 1 (per train)	Anoxic 2 (per train)	Swing (per train)	Aerobic 1 (per train)	Aerobic 2 (per train)
2025 Peak Aeration Demand	2,980	0	0	330	730	430
2025 Typical Dry Weather Demands	2,120	0	0	220	490	350
2025 Typical Wet Weather Demands	1,860	180	130	110	320	190
2020 Typical Dry Weather Demands	1,980	0	0	200	460	330
2020 Typical Wet Weather Demands	1,760	170	130	100	300	180
2020 Minimum Aeration Demands	1,680	160	110	100	280	190

Determining diurnal maximum and minimum air flow needs would require dynamic modeling, which was not possible with currently available data. Therefore, maximum and minimum air flows need to be estimated by assuming certain "peaking factors" relative to the steady-state (average) conditions. A factor of 25 percent is recommended to be added or subtracted from the maximum and minimum values, respectively, to determine an approximate diurnal range of air flow demands. Using these factors and the minimum and maximum total values from Table 9, the approximate range of total air flow demands between 2020 and 2025 is 1,300 to 3,700 standard cubic feet per minute.

It should be noted that part of the upgrades recommended involve installing fine bubble diffusers in all the zones of the basin. Therefore, the alpha factors assumed in the modeling may not accurately reflect the design conditions. However, there was not enough information provided in the Facilities Plan to determine how the alpha factors were selected for the models provided by MurraySmith, so they were not adjusted for this analysis. If anything, the actual alpha factors are likely higher than the values used herein. In that case, the aeration demands predicted here would be higher than actual demands.

Caustic Demands

The required caustic flows to achieve the desired effluent quality are presented in Table 10. Assuming a typical caustic tote size of 300 gallons, these flow rates equate to a little under two totes per week under average dry weather (summer) conditions but one tote per day for average wet weather (winter) conditions. As noted previously, the caustic demands under the average conditions may be higher than actual demands by 10 to 20 percent due to the procedures used to estimate average loads for this analysis.

Table 10. Caustic Flow Results, gallons per day

Scenario	Sodium Hydroxide Flow
2025 Peak Caustic Demand	440
2025 Typical Dry Weather Demands	70
2025 Typical Wet Weather Demands	330
2020 Typical Dry Weather Demands	60
2020 Typical Wet Weather Demands	300

Although not shown in the table, the 2025 High Flow Treatment Performance modeling scenario shows caustic demands more than three times higher than the Peak Caustic Demand modeling scenario. However, as noted previously, a steady state model is not appropriate for evaluating a short-term peak condition. Nevertheless, the modeling does indicate that the caustic demands during short-term peak flow conditions could be substantially higher than the values shown in Table 10, making it difficult to keep up with demands. Accordingly, the WWTP may experience reduced performance for ammonia removal during peak flow events. Additional evaluation using dynamic modeling is needed to better assess these conditions.

State Point Modeling Results

A summary of the results of the State Point modeling is shown in Table 11. As indicated, all the scenarios evaluated passed with the exception of the peak hour flow scenario. This means that the State Point modeling demonstrates that clarifier failure would not occur assuming the SVI is 200 mL/g or less under peak day and peak week flow conditions. (This does not mean the clarifier will not exhibit performance issues under peak flow conditions; it just means that the sludge blanket will overtop the weirs.)

Table 11. Summary of State Point Analysis Results

Secondary Effluent Flow Condition	Secondary Effluent Flow, mgd	RAS Flow		MLSS, mg/L	Pass/Fail?
		Mgd	as percent of influent		
2025 PIF	9.9	2.6	26	1,900	Fail
Allowable Peak Flow	7.0	2.6	37		Pass
2025 PDF	6.42	2.6	40		Pass
2025 PWF	5.48	2.6	47		Pass
2025 MMWWF	2.91	1.5	50	3,000	Pass
2025 MMDWF	1.55	0.8	50	2,900	Pass

A sixth scenario was also assessed to determine what the peak flow is that could be treated without failure given the predicted High Flow Treatment Performance scenario MLSS concentration of 1,900 mg/L. As shown in Table 11, it appears that a flow up to 7.0 mgd could be treated at the MLSS concentration. Therefore, it may be necessary to make further process modifications to provide reliable treatment at the peak flow conditions.

CONCLUSIONS

Modification of the configuration and operation of the aeration basins is recommended to increase the treatment capacity.

Even with the recommended modifications, the modeling predicts clarifier capacity limitations at PIF conditions. However, the steady-state modeling approach used for this analysis does provide a conservative assessment of the available capacity for handling peak flow conditions. Nevertheless, the dynamic modeling needed to fully optimize the treatment process performance for short-term peak flow conditions is more complex and requires a significant amount of process data that is not available

The addition of a third clarifier would eliminate any performance concerns with the secondary clarifier system and would allow the aeration basins to be operated at a higher MLSS concentration, increasing overall performance of the secondary process. However, once the new satellite treatment system is constructed, the overall loadings to the plant will decrease. Therefore, it would not be prudent to construct a new clarifier facility at this time.

It may be possible to further lower MLSS concentrations in peak flow conditions by using the ASSB for contact stabilization. This approach would require additional evaluation. It may be possible to reduce the aSRT and MLSS concentration enough to avoid clarifier failure at the PIF conditions. Under this scenario, BOD and TSS limits can most likely be met, but there could be challenges associated with meeting ammonia discharge limits. Additional evaluation is needed to assess whether a strategy that provides for reduced ammonia treatment performance (with a lower SRT) during peak flows periods would allow for compliance.

RECOMMENDED OPERATIONS SUMMARY

Recommended operations under general conditions during the year (peak flow, wet weather and dry weather) are summarized in Table 12, based on the analysis detailed in the rest of this TM.

Table 12. Recommended Operational Conditions

<table>
<tr><th>Scenario</th><th>Anoxic Basin Operation</th><th>aSRT, days</th><th>Recommended Maximum MLSS, mg/L</th><th>Influent Flow Split, percent to Head of Basin/ Zone 4</th><th>IMLR Pumps Running?</th><th>RAS Flow, percent of Influent</th></tr>
<tr><td>Peak Flow Operations</td><td rowspan="2">All aerated</td><td rowspan="2">6.5</td><td>1,900</td><td>50/50</td><td rowspan="2">No</td><td>Up to 2.6 mgd</td></tr>
<tr><td>Wet Weather Operations</td><td rowspan="2">3,000</td><td>50/50 – 66/33</td><td>50 to 100</td></tr>
<tr><td>Dry Weather Operations</td><td>Two anoxic zones</td><td>4.0</td><td>100/0</td><td>Yes</td><td>50 to 100</td></tr>
</table>

REFERENCES

Curran-McLeod, Inc. Consulting Engineers. January 1996. Record Drawings. *City of Sandy Wastewater Treatment Facility Improvements*.

MurraySmith. October 2019. *City of Sandy Wastewater System Facilities Plan*.

Attachment 1

BioWin Report with Information Common to All Models

Information Common to All BioWin Scenarios

This attachment includes information that is common to the other attachments.

Configuration information for all Digester - Aerobic units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Donut Hole	0.0900	802.0834	15.000	182
Ring	0.1800	1604.1668	15.000	364

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Donut Hole	2.0
Ring	2.0

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Donut Hole	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Ring	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0

Configuration information for all Bioreactor units

Aeration equipment parameters

Element name	k1 in C = k1(PC)^ 0.25 + k2	k2 in C = k1(PC)^ 0.25 + k2	Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	Area of one diffuser	Diffuser mounting height	Min. air flow rate per diffuser ft3/min (20C, 1 atm)	Max. air flow rate per diffuser ft3/min (20C, 1 atm)	'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2	'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2
Anoxic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Anoxic 2	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Swing	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Aerobic 1	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Anoxic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Anoxic 2B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Swing B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Aerobic 1B	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Bioreactor26	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0
Bioreactor44	1.2400	0.8960	0.8880	0.4413	0.2500	0.2943	5.8858	2.9999	0	0

Configuration information for all Influent - BOD units

Element name	Influent - BOD49
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.1410
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1418
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.6770
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0650
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fcel - Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5000
Fna - Ammonia [gNH3-N/gTKN]	0.7353
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0200
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0700
Fpo4 - Phosphate [gPO4-P/gTP]	0.4717
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0220
Fsr - Reduced sulfur [H2S] [gS/gS]	0
FZbh - Ordinary heterotrophic COD fraction [gCOD/g of total COD]	0.0200
FZbm - Methylotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZao - Ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZno - Nitrite oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZaao - Anaerobic ammonia oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZppa - Phosphorus accumulating COD fraction [gCOD/g of total COD]	1.000E-4
FZpa - Propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZam - Acetoclastic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZhm - Hydrogenotrophic methanogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZso - Sulfur oxidizing COD fraction [gCOD/g of total COD]	1.000E-4
FZsrpa - Sulfur reducing propionic acetogenic COD fraction [gCOD/g of total COD]	1.000E-4
FZsra - Sulfur reducing acetotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZsrh - Sulfur reducing hydrogenotrophic COD fraction [gCOD/g of total COD]	1.000E-4
FZe - Endogenous products COD fraction [gCOD/g of total COD]	0

Configuration information for all Clarifier - Model units

Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]	Number of layers	Top feed layer	Feed Layers
Model clarifier5	0.2570	2290.0000	15.000	10	6	1
Model clarifier70	0.2570	2290.0000	15.000	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Average Temperature	Reactive
Model clarifier5	Uses global setting	No
Model clarifier70	Uses global setting	No

Configuration information for all Separator - Grit tank units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Separator - Grit tank85	4.000E-3	89.1204	6.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Grit tank85	Flowrate [Under]	0.0002642

Element name	Percent removal	Blanket fraction
Separator - Grit tank85	65.00	0.10

Configuration information for all Separator - Dewatering unit units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Separator - Dewatering unit83	Fraction	0.03

Element name	Percent removal
Separator - Dewatering unit83	90.00

Global Parameters

Common

Name	Default	Value	
Hydrolysis rate [1/d]	2.1000	2.1000	1.0290
Hydrolysis half sat. [-]	0.0600	0.0600	1.0000
External organics hydrolysis rate [1/d]	2.1000	2.1000	1.0290
External organics hydrolysis half sat. [-]	0.0600	0.0600	1.0000
Anoxic hydrolysis factor [-]	0.2800	0.2800	1.0000
Anaerobic hydrolysis factor (AS) [-]	0.0400	0.0400	1.0000
Anaerobic hydrolysis factor (AD) [-]	0.5000	0.5000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.1500	0.1500	1.0290
Ammonification rate [L/(mgCOD d)]	0.0800	0.0800	1.0290
Assimilative nitrate/nitrite reduction rate [1/d]	0.5000	0.5000	1.0000
Endogenous products decay rate [1/d]	0	0	1.0000

Ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9000	0.9000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.7000	0.7000	1.0000
Byproduct NH4 logistic slope [-]	50.0000	50.0000	1.0000
Byproduct NH4 inflection point [mgN/L]	1.4000	1.4000	1.0000
Denite DO half sat. [mg/L]	0.1000	0.1000	1.0000
Denite HNO2 half sat. [mgN/L]	5.000E-6	5.000E-6	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiHNO2 [mmol/L]	5.000E-3	5.000E-3	1.0000

Nitrite oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.7000	0.7000	1.0600
Substrate (NO2) half sat. [mgN/L]	0.1000	0.1000	1.0000
Aerobic decay rate [1/d]	0.1700	0.1700	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0800	0.0800	1.0290
KiNH3 [mmol/L]	0.0750	0.0750	1.0000

Anaerobic ammonia oxidizing

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2000	0.2000	1.1000
Substrate (NH4) half sat. [mgN/L]	2.0000	2.0000	1.0000
Substrate (NO2) half sat. [mgN/L]	1.0000	1.0000	1.0000
Aerobic decay rate [1/d]	0.0190	0.0190	1.0290
Anoxic/anaerobic decay rate [1/d]	9.500E-3	9.500E-3	1.0290
Ki Nitrite [mgN/L]	1000.0000	1000.0000	1.0000
Nitrite sensitivity constant [L / (d mgN)]	0.0160	0.0160	1.0000

Ordinary heterotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	3.2000	3.2000	1.0290
Substrate half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.6200	0.6200	1.0290
Anoxic decay rate [1/d]	0.2330	0.2330	1.0290
Anaerobic decay rate [1/d]	0.1310	0.1310	1.0290
Fermentation rate [1/d]	1.6000	1.6000	1.0290
Fermentation half sat. [mgCOD/L]	5.0000	5.0000	1.0000
Fermentation growth factor (AS) [-]	0.2500	0.2500	1.0000
Free nitrous acid inhibition [mol/L]	1.000E-7	1.000E-7	1.0000

Heterotrophic on industrial COD

Name	Default	Value	
Maximum specific growth rate on Ind #1 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #1) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #1 [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #1 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #2 COD [1/d]	1.5000	1.5000	1.0290
Substrate (Ind #2) half sat. [mgCOD/L]	30.0000	30.0000	1.0000
Inhibition coefficient for Ind #2 [mgCOD/L]	3000.0000	3000.0000	1.0000
Anaerobic growth factor for Ind #2 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on Ind #3 COD [1/d]	4.3000	4.3000	1.0290
Substrate (Ind #3) half sat. [mgCOD/L]	1.0000	1.0000	1.0000
Inhibition coefficient for Ind #3 COD [mgCOD/L]	60.0000	60.0000	1.0000
Anaerobic growth factor for Ind #3 [mgCOD/L]	0.0500	0.0500	1.0000
Maximum specific growth rate on adsorbed hydrocarbon COD [1/d]	2.0000	2.0000	1.0290
Substrate (adsorbed hydrocarbon) half sat. [-]	0.1500	0.1500	1.0000
Anaerobic growth factor for adsorbed hydrocarbons [mgCOD/L]	0.0100	0.0100	1.0000
Adsorption rate of soluble hydrocarbons [l/(mgCOD d)]	0.2000	0.2000	1.0000

Methylotrophic

Name	Default	Value	
Max. spec. growth rate [1/d]	1.3000	1.3000	1.0720
Methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Denite N2 producers (NO3 or NO2) [-]	0.5000	0.5000	1.0000
Aerobic decay rate [1/d]	0.0400	0.0400	1.0290
Anoxic/anaerobic decay rate [1/d]	0.0300	0.0300	1.0290
Free nitrous acid inhibition [mmol/L]	1.000E-7	1.000E-7	1.0000

Phosphorus accumulating

Name	Default	Value	
Max. spec. growth rate [1/d]	0.9500	0.9500	1.0000
Max. spec. growth rate, P-limited [1/d]	0.4200	0.4200	1.0000
Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)]	0.1000	0.1000	1.0000
Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)]	0.0500	0.0500	1.0000
Magnesium half sat. [mgMg/L]	0.1000	0.1000	1.0000
Cation half sat. [mmol/L]	0.1000	0.1000	1.0000
Calcium half sat. [mgCa/L]	0.1000	0.1000	1.0000
Aerobic/anoxic decay rate [1/d]	0.1000	0.1000	1.0000
Aerobic/anoxic maintenance rate [1/d]	0	0	1.0000
Anaerobic decay rate [1/d]	0.0400	0.0400	1.0000
Anaerobic maintenance rate [1/d]	0	0	1.0000
Sequestration rate [1/d]	4.5000	4.5000	1.0000
Anoxic growth factor [-]	0.3300	0.3300	1.0000

Propionic acetogenic

Name	Default	Value	
Max. spec. growth rate [1/d]	0.2500	0.2500	1.0290
Substrate half sat. [mgCOD/L]	10.0000	10.0000	1.0000
Acetate inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Anaerobic decay rate [1/d]	0.0500	0.0500	1.0290
Aerobic/anoxic decay rate [1/d]	0.5200	0.5200	1.0290

Methanogenic

Name	Default	Value	
Acetoclastic max. spec. growth rate [1/d]	0.3000	0.3000	1.0290
H2-utilizing max. spec. growth rate [1/d]	1.4000	1.4000	1.0290
Acetoclastic substrate half sat. [mgCOD/L]	100.0000	100.0000	1.0000
Acetoclastic methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.1000	0.1000	1.0000
H2-utilizing substrate half sat. [mgCOD/L]	1.0000	1.0000	1.0000
H2-utilizing methanol half sat. [mgCOD/L]	0.5000	0.5000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.0000	10000.0000	1.0000
Acetoclastic anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
Acetoclastic aerobic/anoxic decay rate [1/d]	0.6000	0.6000	1.0290
H2-utilizing anaerobic decay rate [1/d]	0.1300	0.1300	1.0290
H2-utilizing aerobic/anoxic decay rate [1/d]	2.8000	2.8000	1.0290

Sulfur oxidizing

Name	Default	Value	
Maximum specific growth rate (sulfide) [1/d]	0.7500	0.7500	1.0290
Maximum specific growth rate (sulfur) [1/d]	0.1000	0.1000	1.0290
Substrate (H2S) half sat. [mgS/L]	1.0000	1.0000	1.0000
Substrate (sulfur) half sat. [mgS/L]	1.0000	1.0000	1.0000
Anoxic growth factor [-]	0.5000	0.5000	1.0000
Decay rate [1/d]	0.0400	0.0400	1.0290

Sulfur reducing

Name	Default	Value	
Propionic max. spec. growth rate [1/d]	0.5830	0.5830	1.0350
Propionic acid half sat. [mgCOD/L]	295.0000	295.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	185.0000	185.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	2.4700	2.4700	1.0000
Decay rate [1/d]	0.0185	0.0185	1.0350
Acetotrophic max. spec. growth rate [1/d]	0.6120	0.6120	1.0350
Acetic acid half sat. [mgCOD/L]	24.0000	24.0000	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	164.0000	164.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Decay rate [1/d]	0.0275	0.0275	1.0350
Hydrogenotrophic max. spec. growth rate with SO4= [1/d]	2.8000	2.8000	1.0350
Hydrogenotrophic max. spec. growth rate with S [1/d]	0.1000	0.1000	1.0350
Hydrogen half sat. [mgCOD/L]	0.0700	0.0700	1.0000
Hydrogen sulfide inhibition coefficient [mgS/L]	550.0000	550.0000	1.0000
Sulfate (SO4=) half sat. [mgS/L]	6.4100	6.4100	1.0000
Sulfur (S) half sat. [mgS/L]	50.0000	50.0000	1.0000
Decay rate [1/d]	0.0600	0.0600	1.0350

pH

Name	Default	Value
Ordinary heterotrophic low pH limit [-]	4.0000	4.0000
Ordinary heterotrophic high pH limit [-]	10.0000	10.0000
Methylotrophic low pH limit [-]	4.0000	4.0000
Methylotrophic high pH limit [-]	10.0000	10.0000
Autotrophic low pH limit [-]	5.5000	5.5000
Autotrophic high pH limit [-]	9.5000	9.5000
Phosphorus accumulating low pH limit [-]	4.0000	4.0000
Phosphorus accumulating high pH limit [-]	10.0000	10.0000
Ordinary heterotrophic low pH limit (anaerobic) [-]	5.5000	5.5000

Ordinary heterotrophic high pH limit (anaerobic) [-]	8.5000	8.5000
Propionic acetogenic low pH limit [-]	4.0000	4.0000
Propionic acetogenic high pH limit [-]	10.0000	10.0000
Acetoclastic methanogenic low pH limit [-]	5.0000	5.0000
Acetoclastic methanogenic high pH limit [-]	9.0000	9.0000
H2-utilizing methanogenic low pH limit [-]	5.0000	5.0000
H2-utilizing methanogenic high pH limit [-]	9.0000	9.0000

Switches

Name	Default	Value
Ordinary heterotrophic DO half sat. [mgO2/L]	0.1500	0.0500
Phosphorus accumulating DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic/anaerobic NOx half sat. [mgN/L]	0.1500	0.1500
Ammonia oxidizing DO half sat. [mgO2/L]	0.2500	0.2500
Nitrite oxidizing DO half sat. [mgO2/L]	0.5000	0.5000
Anaerobic ammonia oxidizing DO half sat. [mgO2/L]	0.0100	0.0100
Sulfur oxidizing sulfate pathway DO half sat. [mgO2/L]	0.2500	0.2500
Sulfur oxidizing sulfur pathway DO half sat. [mgO2/L]	0.0500	0.0500
Anoxic NO3(->NO2) half sat. [mgN/L]	0.1000	0.1000
Anoxic NO3(->N2) half sat. [mgN/L]	0.0500	0.0500
Anoxic NO2(->N2) half sat. (mgN/L)	0.0100	0.0100
NH3 nutrient half sat. [mgN/L]	5.000E-3	5.000E-3
PolyP half sat. [mgP/mgCOD]	0.0100	0.0100
VFA sequestration half sat. [mgCOD/L]	5.0000	5.0000
P uptake half sat. [mgP/L]	0.1500	0.1500
P nutrient half sat. [mgP/L]	1.000E-3	1.000E-3
Autotrophic CO2 half sat. [mmol/L]	0.1000	0.1000
H2 low/high half sat. [mgCOD/L]	1.0000	1.0000
Propionic acetogenic H2 inhibition [mgCOD/L]	5.0000	5.0000
Synthesis anion/cation half sat. [meq/L]	0.0100	0.0100

Common

Name	Default	Value
Biomass/Endog Ca content (gCa/gCOD)	3.912E-3	3.912E-3
Biomass/Endog Mg content (gMg/gCOD)	3.912E-3	3.912E-3
Biomass/Endog other cations content (mol/gCOD)	5.115E-4	5.115E-4
Biomass/Endog other Anions content (mol/gCOD)	1.410E-4	1.410E-4
N in endogenous residue [mgN/mgCOD]	0.0700	0.0700
P in endogenous residue [mgP/mgCOD]	0.0220	0.0220
Ca content of slowly biodegradabe (gCa/gCOD)	3.912E-3	3.912E-3
Mg content of slowly biodegradabe (gMg/gCOD)	3.700E-4	3.700E-4
Endogenous residue COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.6327	1.4200
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.4200
Cellulose COD:VSS ratio [mgCOD/mgVSS]	1.4000	1.4000
External organic COD:VSS ratio [mgCOD/mgVSS]	1.6000	1.6000
Molecular weight of other anions [mg/mmol]	35.5000	35.5000
Molecular weight of other cations [mg/mmol]	39.0983	39.1000

Ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1500	0.1500
Denite NO2 fraction as TEA [-]	0.5000	0.5000
Byproduct NH4 fraction to N2O [-]	2.500E-3	2.500E-3
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Nitrite oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.0900	0.0900
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Anaerobic ammonia oxidizing

Name	Default	Value
Yield [mgCOD/mgN]	0.1140	0.1140
Nitrate production [mgN/mgBiomassCOD]	2.2800	2.2800
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Ordinary heterotrophic

Name	Default	Value
Yield (aerobic) [-]	0.6660	0.6660
Yield (fermentation, low H2) [-]	0.1000	0.1000
Yield (fermentation, high H2) [-]	0.1000	0.1000
H2 yield (fermentation low H2) [-]	0.3500	0.3500
H2 yield (fermentation high H2) [-]	0	0
Propionate yield (fermentation, low H2) [-]	0	0
Propionate yield (fermentation, high H2) [-]	0.7000	0.7000
CO2 yield (fermentation, low H2) [-]	0.7000	0.7000
CO2 yield (fermentation, high H2) [-]	0	0
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Endogenous fraction - aerobic [-]	0.0800	0.0800
Endogenous fraction - anoxic [-]	0.1030	0.1030
Endogenous fraction - anaerobic [-]	0.1840	0.1840
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield (anoxic) [-]	0.5400	0.5400
Yield propionic (aerobic) [-]	0.6400	0.6400
Yield propionic (anoxic) [-]	0.4600	0.4600
Yield acetic (aerobic) [-]	0.6000	0.6000
Yield acetic (anoxic) [-]	0.4300	0.4300
Yield methanol (aerobic) [-]	0.5000	0.5000
Adsorp. max. [-]	1.0000	1.0000
Max fraction to N2O at high FNA over nitrate [-]	0.0500	0.0500
Max fraction to N2O at high FNA over nitrite [-]	0.1000	0.1000

Ordinary heterotrophic on industrial COD

Name	Default	Value
Yield Ind #1 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #1 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #1 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #1 COD [gCOD/Mol]	224.0000	224.0000
Yield Ind #2 COD (Aerobic) [-]	0.5000	0.5000
Yield Ind #2 COD (Anoxic) [-]	0.4000	0.4000
Yield Ind #2 COD (Anaerobic) [-]	0.0500	0.0500
COD:Mole ratio - Ind #2 COD [gCOD/Mol]	240.0000	240.0000
Yield on Ind #3 COD (Aerobic) [-]	0.5000	0.5000
Yield on Ind #3 COD (Anoxic) [-]	0.4000	0.4000
Yield on Ind #3 COD (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Ind #3 COD [gCOD/Mol]	288.0000	288.0000
Yield enmeshed hydrocarbons (Aerobic) [-]	0.5000	0.5000
Yield enmeshed hydrocarbons (Anoxic) [-]	0.4000	0.4000
Yield enmeshed hydrocarbons (Anaerobic) [-]	0.0400	0.0400
COD:Mole ratio - Hydrocarbon COD [gCOD/Mol]	336.0000	336.0000
Hydrocarbon COD:VSS ratio [mgCOD/mgVSS]	3.2000	3.2000
Max. hydrocarbon adsorp. ratio [-]	1.0000	1.0000
Yield of Ind #1 on Ind #3 COD (Aerobic) [-]	0	0
Yield of Ind #1 on Ind #3 COD (Anoxic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Aerobic) [-]	0	0
Hydrocarbon Yield on Ind #3 COD (Anoxic) [-]	0	0

Methylotrophic

Name	Default	Value
Yield (anoxic) [-]	0.4000	0.4000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Max fraction to N2O at high FNA over nitrate [-]	0.1000	0.1000
Max fraction to N2O at high FNA over nitrite [-]	0.1500	0.1500

Phosphorus accumulating

Name	Default	Value
Yield (aerobic) [-]	0.6390	0.6390
Yield (anoxic) [-]	0.5200	0.5200
Aerobic P/PHA uptake [mgP/mgCOD]	0.9300	0.9300
Anoxic P/PHA uptake [mgP/mgCOD]	0.3500	0.3500
Yield of PHA on Ac sequestration [-]	0.8890	0.8890
N in biomass [mgN/mgCOD]	0.0700	0.0700
N in sol. inert [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous part. [-]	0.2500	0.2500
Inert fraction of endogenous sol. [-]	0.2000	0.2000
P/Ac release ratio [mgP/mgCOD]	0.5100	0.5100
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
Yield of low PP [-]	0.9400	0.9400
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.3000	0.3000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.1500	0.1500
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.0500	0.0500

Propionic acetogenic

Name	Default	Value
Yield [-]	0.1000	0.1000
H2 yield [-]	0.4000	0.4000
CO2 yield [-]	1.0000	1.0000
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Methanogenic

Name	Default	Value
Acetoclastic yield [-]	0.1000	0.1000
Acetoclastic yield on methanol[-]	0.1000	0.1000
H2-utilizing yield [-]	0.1000	0.1000
H2-utilizing yield on methanol [-]	0.1000	0.1000
N in acetoclastic biomass [mgN/mgCOD]	0.0700	0.0700
N in H2-utilizing biomass [mgN/mgCOD]	0.0700	0.0700
P in acetoclastic biomass [mgP/mgCOD]	0.0220	0.0220
P in H2-utilizing biomass [mgP/mgCOD]	0.0220	0.0220
Acetoclastic fraction to endog. residue [-]	0.0800	0.0800
H2-utilizing fraction to endog. residue [-]	0.0800	0.0800
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur oxidizing

Name	Default	Value
Yield (aerobic) [mgCOD/mgS]	0.5000	0.5000
Yield (Anoxic) [mgCOD/mgS]	0.3500	0.3500
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

Sulfur reducing

Name	Default	Value
Yield [mgCOD/mg H2 COD]	0.0712	0.0712
Yield [mgCOD/mg Ac COD]	0.0470	0.0470
Yield [mgCOD/mg Pr COD]	0.0384	0.0384
N in biomass [mgN/mgCOD]	0.0700	0.0700
P in biomass [mgP/mgCOD]	0.0220	0.0220
Fraction to endogenous residue [-]	0.0800	0.0800
COD:VSS ratio [mgCOD/mgVSS]	1.4200	1.4200

General

Name	Default	Value
Tank head loss per metre of length (from flow) [m/m]	2.500E-3	2.500E-3
BOD calculation rate constant for Xsc degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xsp (and hydrocarbon) degradation [/d]	0.5000	0.5000
BOD calculation rate constant for Xeo degradation [/d]	0.5000	0.5000

Heating fuel/Chemical Costs

Name	Default	Value
Methanol [$/gal]	1.6656	1.6656
Ferric chloride [$/lb Fe]	0.5307	0.5307
Ferric sulfate [$/lb Fe]	0.3583	0.3583
Ferrous chloride [$/lb Fe]	0.2767	0.2767
Ferrous sulfate [$/lb Fe]	1.0750	1.0750
Aluminum sulfate [$/lb Al]	0.7666	0.7666
Aluminum chloride [$/lb Al]	0.8981	0.8981
Poly Aluminum Chloride (PAC) [$/lb Al]	0.5307	0.5307
Natural gas [$/MMBTU]	3.1652	3.1652
Heating oil [$/gal]	1.8927	1.8927
Diesel [$/gal]	2.6498	2.6498
Custom fuel [$/gal]	3.7854	3.7854
Biogas sale price [$/MMBTU]	2.1101	2.1101

Anaerobic digester

Name	Default	Value
Bubble rise velocity (anaerobic digester) [cm/s]	23.9000	23.9000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.3500	0.3500
Anaerobic digester gas hold-up factor []	1.0000	1.0000

Combined Heat and Power (CHP) engine

Name	Default	Value
Methane heat of combustion [kJ/mole]	800.0000	800.0000
Hydrogen heat of combustion [kJ/mole]	240.0000	240.0000
CHP engine heat price [$/kWh]	0	0
CHP engine power price [$/kWh]	0.1500	0.1500

Calorific values of heating fuels

Name	Default	Value
Calorific value of natural gas [BTU/lb]	20636	20636
Calorific value of heating fuel oil [BTU/lb]	18057	18057
Calorific value of diesel [BTU/lb]	19776	19776
Calorific value of custom fuel [BTU/lb]	13758	13758

Density of liquid heating fuels

Name	Default	Value
Density of heating fuel oil [lb/ft3]	56	56
Density of diesel [lb/ft3]	55	55
Density of custom fuel [lb/ft3]	49	49

Mass transfer

Name	Default	Value	
Kl for H2 [m/d]	17.0000	17.0000	1.0240
Kl for CO2 [m/d]	10.0000	10.0000	1.0240
Kl for NH3 [m/d]	1.0000	1.0000	1.0240
Kl for CH4 [m/d]	8.0000	8.0000	1.0240
Kl for N2 [m/d]	15.0000	15.0000	1.0240
Kl for N2O [m/d]	8.0000	8.0000	1.0240
Kl for H2S [m/d]	1.0000	1.0000	1.0240
Kl for Ind #1 COD [m/d]	0	0	1.0240
Kl for Ind #2 COD [m/d]	0.5000	0.5000	1.0240
Kl for Ind #3 COD [m/d]	0	0	1.0240
Kl for O2 [m/d]	13.0000	13.0000	1.0240

Henry's law constants

Name	Default	Value	
CO2 [M/atm]	3.4000E-2	3.4000E-2	2400.0000
O2 [M/atm]	1.3000E-3	1.3000E-3	1500.0000
N2 [M/atm]	6.5000E-4	6.5000E-4	1300.0000
N2O [M/atm]	2.5000E-2	2.5000E-2	2600.0000
NH3 [M/atm]	5.8000E+1	5.8000E+1	4100.0000
CH4 [M/atm]	1.4000E-3	1.4000E-3	1600.0000
H2 [M/atm]	7.8000E-4	7.8000E-4	500.0000
H2S [M/Atm]	1.0000E-1	1.0000E-1	2200.0000
Ind 1 [M/Atm]	1.9000E+3	1.9000E+3	7300.0000
Ind 2 [M/Atm]	1.8000E-1	1.8000E-1	2200.0000
Ind 3 [M/Atm]	1.5000E-1	1.5000E-1	1900.0000

Properties constants

Name	Default	Value
K in Viscosity = K e ^(Ea/RT) [Pa s]	6.849E-7	6.849E-7
Ea in Viscosity = K e ^(Ea/RT) [j/mol]	1.780E+4	1.780E+4
Y in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [-]	1.0000	1.0000
A in ML Viscosity = H2O viscosity * (1+A*MLSS^Y) [m3/g]	1.000E-7	1.000E-7
A in ML Density = H2O density + A*MLSS [(kg/m3)/(g/m3)]	3.248E-4	3.248E-4
A in Antoine equn. [T in K, P in Bar {NIST}]	5.2000	5.2039
B in Antoine equn. [T in K, P in Bar {NIST}]	1734.0000	1733.9260
C in Antoine equn. [T in K, P in Bar {NIST}]	-39.5000	-39.4800

Metal salt solution densities

Name	Default	Value
Ferric chloride solution density [kg/m3]	3820.0000	3820.0000
Ferric sulfate solution density [kg/m3]	4800.0000	4800.0000
Ferrous chloride solution density [kg/m3]	3160.0000	3160.0000
Ferrous sulfate solution density [kg/m3]	1150.0000	1150.0000
Aluminum sulfate solution density [kg/m3]	1950.0000	1950.0000
Aluminum chloride solution density [kg/m3]	2480.0000	2480.0000

Mineral precipitation rates

Name	Default	Value	
Vivianite precipitation rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite redissolution rate [L/(mol d)]	1.000E+5	1.000E+5	1.0240
Vivianite half sat. [mgTSS/L]	0.0100	0.0100	1.0000
FeS precipitation rate [L/(mol d)]	1000.0000	1000.0000	1.0240
FeS redissolution rate [L/(mol d)]	10.0000	10.0000	1.0240
FeS half sat. [mgTSS/L]	0.1000	0.1000	1.0000
Struvite precipitation rate [L^2/(mol^2 d)]	3.000E+10	3.000E+10	1.0240
Struvite redissolution rate [L^2/(mol^2 d)]	3.000E+11	3.000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
Brushite precipitation rate [L/(mol d)]	1.000E+6	1.000E+6	1.0000
Brushite redissolution rate [L/(mol d)]	10000.0000	10000.0000	1.0000
Brushite half sat. [mgTSS/L]	1.0000	1.0000	1.0000
HAP precipitation rate [g/d]	5.000E-4	5.000E-4	1.0000

Mineral precipitation constants

Name	Default	Value
Vivianite solubility product [mol/L]^5	1.710E-36	1.710E-36
FeS solubility product [mol/L]^2	4.258E-4	4.258E-4
Struvite solubility product [mol/L]^3	6.918E-14	6.918E-14
Brushite solubility product [mol/L]^2	2.490E-7	2.490E-7

Fe rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HFO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HFO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HFO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	2.000E-11	2.000E-11	1.0000
H+ competition for HFO(H) protonation sites [L/(mmol . d)]	1000.0000	1000.0000	1.0000
H+ competition for HFO(L) protonation sites [L/(mmol . d)]	100.0000	100.0000	1.0000

Fe constants

Name	Default	Value
Ferric active site factor(high) [{mol Sites}/{mol HFO(H)}]	4.0000	2.0000
Ferric active site factor(low) [{mol Sites}/{mol HFO(L)}]	2.4000	1.2000
H+ competition level for Fe(OH)3 [mol/L]	7.000E-7	7.000E-7
Equilibrium constant for FeOH3-H2PO4- [{mf HFO(H).H2PO4}/({mol H2PO4-}{mf HFO(H)}^2)]	2.000E-9	2.000E-9
Colloidal COD removed with Ferric [gCOD/Fe active site]	80.0000	130.0000
Minimum residual P level with iron addition [mgP/L]	0.0150	0.0150
HFO(H) with H2PO4- P release factor	10000.0000	10000.0000
HFO(L) with H2PO4- P release factor	10000.0000	10000.0000

Fe RedOx rates

Name	Default	Value	
Iron reduction using acetic acid	1.000E-7	1.000E-7	1.0000
Half Sat. acetic acid	0.5000	0.5000	1.0000
Iron reduction using propionic acid	1.000E-7	1.000E-7	1.0000
Half Sat. propionic acid	0.5000	0.5000	1.0000
Iron reduction using dissolved hydrogen gas	1.000E-7	1.000E-7	1.0000
Half Sat. dissolved hydrogen gas	0.5000	0.5000	1.0000
Iron reduction using hydrogen sulfide	5.000E-5	5.000E-5	1.0000
Half Sat. hydrogen sulfide	0.5000	0.5000	1.0000
Iron oxidation rate (aerobic)	1.000E-3	1.000E-3	1.0000
Abiotic iron reduction using acetic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using propionic acid	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using dissolved hydrogen gas	2.000E-5	2.000E-5	1.0000
Abiotic iron reduction using hydrogen sulfide	2.000E-5	2.000E-5	1.0000
Abiotic iron oxidation rate (aerobic)	1.0000	1.0000	1.0000

CEPT rates

Name	Default	Value	
HFO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HFO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000
HAO colloidal adsorption rate	1.0000	1.0000	1.0000
Residual Xsc for adsorption to HAO	5.0000	5.0000	1.0000
Slope for Xsc residual	1.0000	1.0000	1.0000

Al rates

Name	Default	Value	
A in aging rate = A * exp(-G/B) [1/d)]	16.1550	16.1550	1.0000
B in aging rate = A * exp(-G/B) [1/s)]	57.3000	57.3000	1.0000
HAO(L) aging rate factor	2.500E-4	2.500E-4	1.0000
HAO(H) with H2PO4- bound aging factor []	1.000E-5	1.000E-5	1.0000
HAO(L) with H2PO4- bound aging factor []	0.4000	0.4000	1.0000
H2PO4- coprecipitation rate [mol/(L d)]	1.500E-9	1.500E-9	1.0000
H2PO4- Adsorption rate [mol /(L d)]	1.000E-9	1.000E-9	1.0000

Al constants

Name	Default	Value
Al active site factor(high) [{mol Sites}/{mol HAO(H)}]	3.0000	3.0000
Al active site factor(low) [{mol Sites}/{mol HAO(L)}]	1.5000	1.5000
Equilibrium constant for AlOH3-H2PO4- [{mf HAO(H).H2PO4}/({mol H2PO4-}{mf HAO(H)}^2)]	8.000E-10	8.000E-10
Colloidal COD removed with Al [gCOD/Al active site]	30.0000	30.0000
Minimum residual P level with Al addition [mgP/L]	0.0150	0.0150
HAO(H) with H2PO4- P release factor	10000.0000	10000.0000
HAO(L) with H2PO4- P release factor	10000.0000	10000.0000

Pipe and pump parameters

Name	Default	Value
Static head [ft]	0.8202	0.8202
Pipe length (headloss calc.s) [ft]	164.0420	164.0420
Pipe inside diameter [in]	19.68504	19.68504
K(fittings) - Total minor losses K	5.0000	5.0000
Pipe roughness [in]	0.00787	0.00787
'A' in overall pump efficiency = A + B*Q + C*(Q^2)[-]	0.8500	0.8500
'B' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)]	0	0
'C' in overall pump efficiency = A + B*Q + C*(Q^2)[[-]/(mgd)^2]	0	0

Fittings and loss coefficients ('K' values)

Name	Default	Value
Pipe entrance (bellmouth)	0.0500	1.0000
90° bend	0.7500	5.0000
45° bend	0.3000	2.0000
Butterfly value (open)	0.3000	1.0000
Non-return value	1.0000	0
Outlet (bellmouth)	0.2000	1.0000

Aeration

Name	Default	Value
Surface pressure [kPa]	101.3250	101.3250
Fractional effective saturation depth (Fed) [-]	0.3250	0.3250
Supply gas CO2 content [vol. %]	0.0400	0.0350
Supply gas O2 [vol. %]	20.9500	20.9500
Off-gas CO2 [vol. %]	2.0000	2.0000
Off-gas O2 [vol. %]	18.8000	18.8000
Off-gas H2 [vol. %]	0	0
Off-gas NH3 [vol. %]	0	0
Off-gas CH4 [vol. %]	0	0
Off-gas N2O [vol. %]	0	0
Surface turbulence factor [-]	2.0000	2.0000
Set point controller gain []	1.0000	1.0000

MABR Membrane effective diffusivities

Name	Default	Value	
O2 [m2/s]	2.500E-9	2.500E-9	1.0000
N2 [m2/s]	1.900E-9	1.900E-9	1.0000
CO2 [m2/s]	1.960E-9	1.960E-9	1.0000
H2 [m2/s]	5.850E-9	5.850E-9	1.0000
CH4 [m2/s]	1.963E-9	1.963E-9	1.0000
NH3 [m2/s]	2.000E-9	2.000E-9	1.0000
N2O [m2/s]	1.607E-9	1.607E-9	1.0000
H2S [m2/s]	1.530E-9	1.530E-9	1.0000
Ind 1 [m2/s]	7.240E-10	7.240E-10	1.0000
Ind 2 [m2/s]	8.900E-10	8.900E-10	1.0000
Ind 3 [m2/s]	7.960E-10	7.960E-10	1.0000

MABR Membrane transfer factors

Name	Default	Value	
O2 []	1.0000	1.0000	1.0000
N2 []	1.0000	1.0000	1.0000
CO2 []	1.0000	1.0000	1.0000
H2 []	1.0000	1.0000	1.0000
CH4 []	1.0000	1.0000	1.0000
NH3 []	1.0000	1.0000	1.0000
N2O []	1.0000	1.0000	1.0000
H2S []	1.0000	1.0000	1.0000
Ind 1 []	1.0000	1.0000	1.0000
Ind 2 []	1.0000	1.0000	1.0000
Ind 3 []	1.0000	1.0000	1.0000

Blower

Name	Default	Value
Intake filter pressure drop [psi]	0.5076	0.5076
Pressure drop through distribution system (piping/valves) [psi]	0.4351	0.4351
Adiabatic/polytropic compression exponent (1.4 for adiabatic)	1.4000	1.4000
'A' in blower efficiency = A + B*Qa + C*(Qa^2)[-]	0.7500	0.7500
'B' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))]	0	0
'C' in blower efficiency = A + B*Qa + C*(Qa^2)[[-]/(ft3/min (20C, 1 atm))^2]	0	0

Diffuser

Name	Default	Value
k1 in C = k1(PC)^0.25 + k2	1.2400	1.2400
k2 in C = k1(PC)^0.25 + k2	0.8960	0.8960
Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)]	0.8880	0.8880
Area of one diffuser [ft2]	0.4413	0.4413
Diffuser mounting height [ft]	0.8202	0.8202
Min. air flow rate per diffuser ft3/min (20C, 1 atm)	0.2943	0.2943
Max. air flow rate per diffuser ft3/min (20C, 1 atm)	5.8858	5.8858
'A' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2 [psi]	0.4351	0.4351
'B' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))]	0	0
'C' in diffuser pressure drop = A + B*(Qa/Diff) + C*(Qa/Diff)^2[psi/(ft3/min (20C, 1 atm))^2]	0	0

Surface aerators

Name	Default	Value
Surface aerator Std. oxygen transfer rate [lb O /(hp hr)]	2.46697	2.46697

Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.387	0.355
Vesilind hindered zone settling parameter (K) [L/g]	0.370	0.336
Clarification switching function [mg/L]	100.000	100.000
Specified TSS conc.for height calc. [mg/L]	2500.000	2500.000
Maximum compactability constant [mg/L]	15000.000	15000.000
Maximum compactability slope [L/mg]	0.010	0.010

Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.934	0.934
Maximum (practical) settling velocity (Vo') [ft/min]	0.615	0.615
Hindered zone settling parameter (Kh) [L/g]	0.400	0.400
Flocculent zone settling parameter (Kf) [L/g]	2.500	2.500
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	1.000E-3	1.000E-3
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

Emission factors

Name	Default	Value
Carbon dioxide equivalence of nitrous oxide	296.0000	296.0000
Carbon dioxide equivalence of methane	23.0000	23.0000

Biofilm general

Name	Default	Value	
Attachment rate [g / (m2 d)]	8.0000	80.0000	1.0000
Attachment TSS half sat. [mg/L]	100.0000	100.0000	1.0000
Detachment rate [g/(m3 d)]	8000.0000	8.000E+4	1.0000
Solids movement factor []	10.0000	10.0000	1.0000
Diffusion neta []	0.8000	0.8000	1.0000
Thin film limit [mm]	0.5000	0.5000	1.0000
Thick film limit [mm]	3.0000	3.0000	1.0000
Assumed Film thickness for tank volume correction (temp independent) [mm]	1.2500	0.7500	1.0000
Film surface area to media area ratio - Max.[ ]	1.0000	1.0000	1.0000
Minimum biofilm conc. for streamer formation [gTSS/m2]	4.0000	4.0000	1.0000

Maximum biofilm concentrations [mg/L]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Methylotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Ammonia oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Nitrite oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Anaerobic ammonia oxidizing	5.000E+4	5.000E+4	1.0000
Biomass - Phosphorus accumulating	5.000E+4	5.000E+4	1.0000
Biomass - Propionic acetogenic	5.000E+4	5.000E+4	1.0000
Biomass - Acetoclastic methanogenic	5.000E+4	5.000E+4	1.0000
Biomass - Hydrogenotrophic methanogenic	5.000E+4	5.000E+4	1.0000
Biomass - Endogenous products	3.000E+4	3.000E+4	1.0000
CODp - Slowly degradable particulate	5000.0000	5000.0000	1.0000
CODp - Slowly degradable colloidal	4000.0000	4000.0000	1.0000
CODp - Degradable external organics	5000.0000	5000.0000	1.0000
CODp - Undegradable non-cellulose	5000.0000	5000.0000	1.0000
CODp - Undegradable cellulose	5000.0000	5000.0000	1.0000
N - Particulate degradable organic	0	0	1.0000
P - Particulate degradable organic	0	0	1.0000
N - Particulate degradable external organics	0	0	1.0000
P - Particulate degradable external organics	0	0	1.0000
N - Particulate undegradable	0	0	1.0000
P - Particulate undegradable	0	0	1.0000
CODp - Stored PHA	5000.0000	5000.0000	1.0000
P - Releasable stored polyP	1.150E+6	1.150E+6	1.0000
P - Unreleasable stored polyP	1.150E+6	1.150E+6	1.0000
CODs - Complex readily degradable	0	0	1.0000
CODs - Acetate	0	0	1.0000
CODs - Propionate	0	0	1.0000
CODs - Methanol	0	0	1.0000
Gas - Dissolved hydrogen	0	0	1.0000
Gas - Dissolved methane	0	0	1.0000
N - Ammonia	0	0	1.0000
N - Soluble degradable organic	0	0	1.0000

Gas - Dissolved nitrous oxide	0	0	1.0000
N - Nitrite	0	0	1.0000
N - Nitrate	0	0	1.0000
Gas - Dissolved nitrogen	0	0	1.0000
P - Soluble phosphate	0	0	1.0000
CODs - Undegradable	0	0	1.0000
N - Soluble undegradable organic	0	0	1.0000
Influent inorganic suspended solids	1.300E+6	1.300E+6	1.0000
Precipitate - Struvite	8.500E+5	8.500E+5	1.0000
Precipitate - Brushite	1.165E+6	1.165E+6	1.0000
Precipitate - Hydroxy - apatite	1.600E+6	1.600E+6	1.0000
Precipitate - Vivianite	1.340E+6	1.340E+6	1.0000
HFO - High surface	5.000E+4	5.000E+4	1.0000
HFO - Low surface	5.000E+4	5.000E+4	1.0000
HFO - High with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HFO - Low with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HFO - Aged	5.000E+4	5.000E+4	1.0000
HFO - Low with H+ adsorbed	5.000E+4	5.000E+4	1.0000
HFO - High with H+ adsorbed	5.000E+4	5.000E+4	1.0000
HAO - High surface	5.000E+4	5.000E+4	1.0000
HAO - Low surface	5.000E+4	5.000E+4	1.0000
HAO - High with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HAO - Low with H2PO4- adsorbed	5.000E+4	5.000E+4	1.0000
HAO - Aged	5.000E+4	5.000E+4	1.0000
P - Bound on aged HMO	5.000E+4	5.000E+4	1.0000
Metal soluble - Magnesium	0	0	1.0000
Metal soluble - Calcium	0	0	1.0000
Metal soluble - Ferric	0	0	1.0000
Metal soluble - Ferrous	0	0	1.0000
Metal soluble - Aluminum	0	0	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Gas - Dissolved total CO2	0	0	1.0000
User defined - UD1	0	0	1.0000
User defined - UD2	0	0	1.0000

User defined - UD3	5.000E+4	5.000E+4	1.0000
User defined - UD4	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur oxidizing	1.000E+5	1.000E+5	1.0000
Biomass - Sulfur reducing propionic acetogenic	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur reducing acetotrophic	5.000E+4	5.000E+4	1.0000
Biomass - Sulfur reducing hydrogenotrophic	1.000E+5	1.000E+5	1.0000
Gas - Dissolved total sulfides	0	0	1.0000
S - Soluble sulfate	0	0	1.0000
S - Particulate elemental sulfur	5.000E+4	5.000E+4	1.0000
Precipitate - Ferrous sulfide	5.000E+4	5.000E+4	1.0000
CODp - Adsorbed hydrocarbon	5.000E+4	5.000E+4	1.0000
CODs - Degradable volatile ind. #1	0	0	1.0000
CODs - Degradable volatile ind. #2	0	0	1.0000
CODs - Degradable volatile ind. #3	0	0	1.0000
CODs - Soluble hydrocarbon	0	0	1.0000
Gas - Dissolved oxygen	0	0	1.0000

Effective diffusivities [m2/s]

Name	Default	Value	
Biomass - Ordinary heterotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Methylotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Ammonia oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Nitrite oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Anaerobic ammonia oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Phosphorus accumulating	5.000E-14	5.000E-14	1.0290
Biomass - Propionic acetogenic	5.000E-14	5.000E-14	1.0290
Biomass - Acetoclastic methanogenic	5.000E-14	5.000E-14	1.0290
Biomass - Hydrogenotrophic methanogenic	5.000E-14	5.000E-14	1.0290
Biomass - Endogenous products	5.000E-14	5.000E-14	1.0290
CODp - Slowly degradable particulate	5.000E-14	5.000E-14	1.0290
CODp - Slowly degradable colloidal	5.000E-10	5.000E-10	1.0290
CODp - Degradable external organics	5.000E-14	5.000E-14	1.0290

CODp - Undegradable non-cellulose	5.000E-14	5.000E-14	1.0290
CODp - Undegradable cellulose	5.000E-14	5.000E-14	1.0290
N - Particulate degradable organic	5.000E-14	5.000E-14	1.0290
P - Particulate degradable organic	5.000E-14	5.000E-14	1.0290
N - Particulate degradable external organics	5.000E-14	5.000E-14	1.0290
P - Particulate degradable external organics	5.000E-14	5.000E-14	1.0290
N - Particulate undegradable	5.000E-14	5.000E-14	1.0290
P - Particulate undegradable	5.000E-14	5.000E-14	1.0290
CODp - Stored PHA	5.000E-14	5.000E-14	1.0290
P - Releasable stored polyP	5.000E-14	5.000E-14	1.0290
P - Unreleasable stored polyP	5.000E-14	5.000E-14	1.0290
CODs - Complex readily degradable	6.900E-10	6.900E-10	1.0290
CODs - Acetate	1.240E-9	1.240E-9	1.0290
CODs - Propionate	8.300E-10	8.300E-10	1.0290
CODs - Methanol	1.600E-9	1.600E-9	1.0290
Gas - Dissolved hydrogen	5.850E-9	5.850E-9	1.0290
Gas - Dissolved methane	1.963E-9	1.963E-9	1.0290
N - Ammonia	2.000E-9	2.000E-9	1.0290
N - Soluble degradable organic	1.370E-9	1.370E-9	1.0290
Gas - Dissolved nitrous oxide	1.607E-9	1.607E-9	1.0290
N - Nitrite	2.980E-9	2.980E-9	1.0290
N - Nitrate	2.980E-9	2.980E-9	1.0290
Gas - Dissolved nitrogen	1.900E-9	1.900E-9	1.0290
P - Soluble phosphate	2.000E-9	2.000E-9	1.0290
CODs - Undegradable	6.900E-10	6.900E-10	1.0290
N - Soluble undegradable organic	6.850E-10	6.850E-10	1.0290
Influent inorganic suspended solids	5.000E-14	5.000E-14	1.0290
Precipitate - Struvite	5.000E-14	5.000E-14	1.0290
Precipitate - Brushite	5.000E-14	5.000E-14	1.0290
Precipitate - Hydroxy - apatite	5.000E-14	5.000E-14	1.0290
Precipitate - Vivianite	5.000E-14	5.000E-14	1.0290
HFO - High surface	5.000E-14	5.000E-14	1.0290
HFO - Low surface	5.000E-14	5.000E-14	1.0290
HFO - High with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HFO - Low with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290

HFO - Aged	5.000E-14	5.000E-14	1.0290
HFO - Low with H+ adsorbed	5.000E-14	5.000E-14	1.0290
HFO - High with H+ adsorbed	5.000E-14	5.000E-14	1.0290
HAO - High surface	5.000E-14	5.000E-14	1.0290
HAO - Low surface	5.000E-14	5.000E-14	1.0290
HAO - High with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HAO - Low with H2PO4- adsorbed	5.000E-14	5.000E-14	1.0290
HAO - Aged	5.000E-14	5.000E-14	1.0290
P - Bound on aged HMO	5.000E-14	5.000E-14	1.0290
Metal soluble - Magnesium	7.200E-10	7.200E-10	1.0290
Metal soluble - Calcium	7.200E-10	7.200E-10	1.0290
Metal soluble - Ferric	4.800E-10	4.800E-10	1.0290
Metal soluble - Ferrous	4.800E-10	4.800E-10	1.0290
Metal soluble - Aluminum	4.800E-10	4.800E-10	1.0290
Other Cations (strong bases)	1.440E-9	1.440E-9	1.0290
Other Anions (strong acids)	1.440E-9	1.440E-9	1.0290
Gas - Dissolved total CO2	1.960E-9	1.960E-9	1.0290
User defined - UD1	6.900E-10	6.900E-10	1.0290
User defined - UD2	6.900E-10	6.900E-10	1.0290
User defined - UD3	5.000E-14	5.000E-14	1.0290
User defined - UD4	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur oxidizing	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing propionic acetogenic	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing acetotrophic	5.000E-14	5.000E-14	1.0290
Biomass - Sulfur reducing hydrogenotrophic	5.000E-14	5.000E-14	1.0290
Gas - Dissolved total sulfides	1.530E-9	1.530E-9	1.0290
S - Soluble sulfate	2.130E-10	2.130E-10	1.0290
S - Particulate elemental sulfur	5.000E-14	5.000E-14	1.0290
Precipitate - Ferrous sulfide	5.000E-14	5.000E-14	1.0290
CODp - Adsorbed hydrocarbon	5.000E-14	5.000E-14	1.0290
CODs - Degradable volatile ind. #1	7.240E-10	7.240E-10	1.0290
CODs - Degradable volatile ind. #2	8.900E-10	8.900E-10	1.0290
CODs - Degradable volatile ind. #3	7.960E-10	7.960E-10	1.0290
CODs - Soluble hydrocarbon	7.120E-10	7.120E-10	1.0290
Gas - Dissolved oxygen	2.500E-9	2.500E-9	1.0290

EPS Strength coefficients [ ]

Name	Default	Value	
Biomass - Ordinary heterotrophic	1.0000	1.0000	1.0000
Biomass - Methylotrophic	1.0000	1.0000	1.0000
Biomass - Ammonia oxidizing	5.0000	5.0000	1.0000
Biomass - Nitrite oxidizing	25.0000	25.0000	1.0000
Biomass - Anaerobic ammonia oxidizing	10.0000	10.0000	1.0000
Biomass - Phosphorus accumulating	1.0000	1.0000	1.0000
Biomass - Propionic acetogenic	1.0000	1.0000	1.0000
Biomass - Acetoclastic methanogenic	1.0000	1.0000	1.0000
Biomass - Hydrogenotrophic methanogenic	1.0000	1.0000	1.0000
Biomass - Endogenous products	1.0000	1.0000	1.0000
CODp - Slowly degradable particulate	1.0000	1.0000	1.0000
CODp - Slowly degradable colloidal	1.0000	1.0000	1.0000
CODp - Degradable external organics	1.0000	1.0000	1.0000
CODp - Undegradable non-cellulose	1.0000	1.0000	1.0000
CODp - Undegradable cellulose	1.0000	1.0000	1.0000
N - Particulate degradable organic	1.0000	1.0000	1.0000
P - Particulate degradable organic	1.0000	1.0000	1.0000
N - Particulate degradable external organics	1.0000	1.0000	1.0000
P - Particulate degradable external organics	1.0000	1.0000	1.0000
N - Particulate undegradable	1.0000	1.0000	1.0000
P - Particulate undegradable	1.0000	1.0000	1.0000
CODp - Stored PHA	1.0000	1.0000	1.0000
P - Releasable stored polyP	1.0000	1.0000	1.0000
P - Unreleasable stored polyP	1.0000	1.0000	1.0000
CODs - Complex readily degradable	0	0	1.0000
CODs - Acetate	0	0	1.0000
CODs - Propionate	0	0	1.0000
CODs - Methanol	0	0	1.0000
Gas - Dissolved hydrogen	0	0	1.0000
Gas - Dissolved methane	0	0	1.0000
N - Ammonia	0	0	1.0000
N - Soluble degradable organic	0	0	1.0000

Gas - Dissolved nitrous oxide	0	0	1.0000
N - Nitrite	0	0	1.0000
N - Nitrate	0	0	1.0000
Gas - Dissolved nitrogen	0	0	1.0000
P - Soluble phosphate	0	0	1.0000
CODs - Undegradable	0	0	1.0000
N - Soluble undegradable organic	0	0	1.0000
Influent inorganic suspended solids	0.3300	0.3300	1.0000
Precipitate - Struvite	1.0000	1.0000	1.0000
Precipitate - Brushite	1.0000	1.0000	1.0000
Precipitate - Hydroxy - apatite	1.0000	1.0000	1.0000
Precipitate - Vivianite	1.0000	1.0000	1.0000
HFO - High surface	1.0000	1.0000	1.0000
HFO - Low surface	1.0000	1.0000	1.0000
HFO - High with H2PO4- adsorbed	1.0000	1.0000	1.0000
HFO - Low with H2PO4- adsorbed	1.0000	1.0000	1.0000
HFO - Aged	1.0000	1.0000	1.0000
HFO - Low with H+ adsorbed	1.0000	1.0000	1.0000
HFO - High with H+ adsorbed	1.0000	1.0000	1.0000
HAO - High surface	1.0000	1.0000	1.0000
HAO - Low surface	1.0000	1.0000	1.0000
HAO - High with H2PO4- adsorbed	1.0000	1.0000	1.0000
HAO - Low with H2PO4- adsorbed	1.0000	1.0000	1.0000
HAO - Aged	1.0000	1.0000	1.0000
P - Bound on aged HMO	1.0000	1.0000	1.0000
Metal soluble - Magnesium	0	0	1.0000
Metal soluble - Calcium	0	0	1.0000
Metal soluble - Ferric	0	0	1.0000
Metal soluble - Ferrous	0	0	1.0000
Metal soluble - Aluminum	0	0	1.0000
Other Cations (strong bases)	0	0	1.0000
Other Anions (strong acids)	0	0	1.0000
Gas - Dissolved total CO2	0	0	1.0000
User defined - UD1	0	0	1.0000
User defined - UD2	0	0	1.0000

User defined - UD3	1.0000	1.0000	1.0000
User defined - UD4	1.0000	1.0000	1.0000
Biomass - Sulfur oxidizing	1.0000	1.0000	1.0000
Biomass - Sulfur reducing propionic acetogenic	1.0000	1.0000	1.0000
Biomass - Sulfur reducing acetotrophic	1.0000	1.0000	1.0000
Biomass - Sulfur reducing hydrogenotrophic	1.0000	1.0000	1.0000
Gas - Dissolved total sulfides	0	0	1.0000
S - Soluble sulfate	0	0	1.0000
S - Particulate elemental sulfur	1.0000	1.0000	1.0000
Precipitate - Ferrous sulfide	1.0000	1.0000	1.0000
CODp - Adsorbed hydrocarbon	1.0000	1.0000	1.0000
CODs - Degradable volatile ind. #1	0	0	1.0000
CODs - Degradable volatile ind. #2	0	0	1.0000
CODs - Degradable volatile ind. #3	0	0	1.0000
CODs - Soluble hydrocarbon	0	0	1.0000
Gas - Dissolved oxygen	0	0	1.0000

Attachment 2

BioWin Report for 2025 Wet Weather Design Treatment Performance Scenario

2025 Wet Weather Design
Treatment Performance Scenario

BioWin user and configuration data

Project details

Project name: Unknown **Project ref.: BW1**

Plant name: Unknown **User name: Charles Hardy**

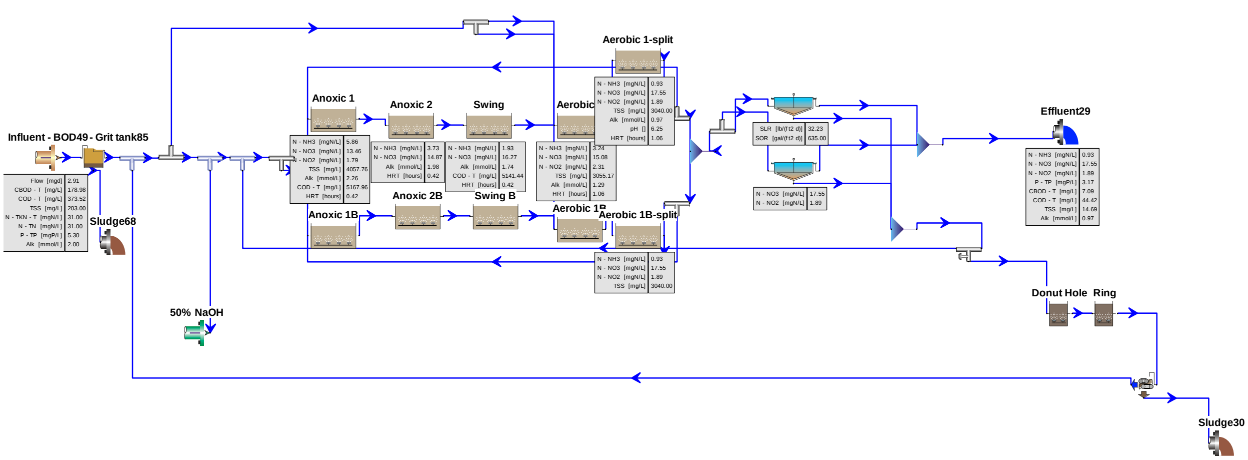
Created: 5/18/2018 **Saved: 2/20/2021**

Steady state solution

Target SRT: 6.50 days **SRT #1: 6.50 days**

Temperature: 11.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	63
Anoxic 2	0.0377	278.7476	18.080	63
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	63
Anoxic 2B	0.0377	278.7476	18.080	63
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Aerobic 1-split	0.1287	951.5868	18.080	216
Aerobic 1B-split	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	2.0
Anoxic 2	2.0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	2.0
Anoxic 2B	2.0
Swing B	2.0
Aerobic 1B	2.0
Aerobic 1-split	2.0
Aerobic 1B-split	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	2.91
BOD - Total Carbonaceous mgBOD/L	179.00
Volatile suspended solids mg/L	188.00
Total suspended solids mg/L	203.00
N - Total Kjeldahl Nitrogen mgN/L	31.00
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	0
Splitter12	Flowrate [Side]	0
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0630438437094213
Splitter32	Fraction	0.50
Splitter51	Fraction	0.50
Splitter62	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.00044

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	178.98	106.91	203.00	188.00	7.10	2.00	31.00	22.79	0	0	-----	-----	-----	-----
Anoxic 1B	1673.89	28.80	4057.76	3626.54	6.76	2.26	308.29	5.86	1.79	13.46	247.63	21.47	66.62	88.13
Anoxic 2B	1664.84	26.30	4050.45	3618.66	6.59	1.98	306.38	3.73	2.18	14.87	181.79	16.31	51.86	66.97
Swing B	1656.42	25.90	4042.10	3609.91	6.51	1.74	304.75	1.93	2.31	16.27	164.80	14.95	47.53	61.39
Aerobic 1B	1257.85	27.07	3055.17	2729.77	6.38	1.29	231.74	3.24	2.31	15.08	449.07	45.27	41.68	171.55
Model clarifier5	7.09	25.83	14.69	13.12	6.25	0.97	3.23	0.93	1.89	17.55	-----	-----	-----	-----
Model clarifier5 (U)	2476.70	25.83	6063.53	5413.30	6.25	0.97	455.67	0.93	1.89	17.55	-----	-----	-----	-----
Model clarifier70	7.09	25.83	14.69	13.12	6.25	0.97	3.23	0.93	1.89	17.55	-----	-----	-----	-----
Model clarifier70 (U)	2476.70	25.83	6063.53	5413.30	6.25	0.97	455.67	0.93	1.89	17.55	-----	-----	-----	-----
Effluent29	7.09	25.83	14.69	13.12	6.25	0.97	3.23	0.93	1.89	17.55	-----	-----	-----	-----

Attachment 3

BioWin Model Report for 2025 High Flow Treatment Performance Scenario

2025 High Flow Treatment Performance Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Charles Hardy

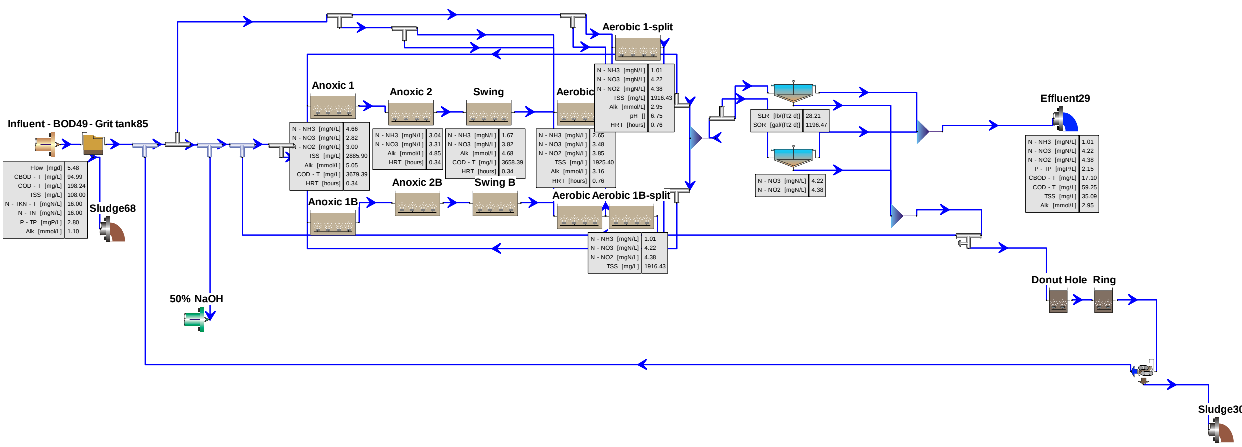
Created: 5/18/2018 Saved: 2/17/2021

Steady state solution

Target SRT: 6.50 days SRT #1: 6.50 days

Temperature: 15.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	63
Anoxic 2	0.0377	278.7476	18.080	63
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	63
Anoxic 2B	0.0377	278.7476	18.080	63
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Aerobic 1-split	0.1287	951.5868	18.080	216
Aerobic 1B-split	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	2.0
Anoxic 2	2.0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	2.0
Anoxic 2B	2.0
Swing B	2.0
Aerobic 1B	2.0
Aerobic 1-split	2.0
Aerobic 1B-split	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	5.48
BOD - Total Carbonaceous mgBOD/L	95.00
Volatile suspended solids mg/L	100.00
Total suspended solids mg/L	108.00
N - Total Kjeldahl Nitrogen mgN/L	16.00
P - Total P mgP/L	2.80
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	1.10
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flowrate [Under]	1.3
Model clarifier70	Flowrate [Under]	1.3

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	0
Splitter12	Flowrate [Side]	0
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0429360572882485
Splitter32	Fraction	0.50
Splitter51	Fraction	0.50
Splitter62	Fraction	0.50
Splitter63	Fraction	1.00
Splitter65	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.0014

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	94.99	56.42	108.00	100.00	7.10	1.10	16.00	11.76	0	0	-----	-----	-----	-----
Anoxic 1B	1310.21	17.95	2885.90	2583.33	8.04	5.05	220.96	4.66	3.00	2.82	223.01	19.47	58.87	80.30
Anoxic 2B	1303.05	15.30	2880.71	2577.57	7.13	4.85	219.63	3.04	3.75	3.31	161.34	14.61	46.43	60.24
Swing B	1296.44	14.78	2874.36	2570.78	6.99	4.68	218.50	1.67	4.30	3.82	146.37	13.40	42.59	55.25
Aerobic 1B	872.85	16.17	1925.40	1723.05	6.81	3.16	147.60	2.65	3.85	3.48	360.27	37.06	33.62	141.07
Aerobic 1B-split	863.03	14.78	1916.43	1713.47	6.75	2.95	146.22	1.01	4.38	4.22	269.08	28.60	26.63	108.86
Model clarifier5	17.10	14.78	35.09	31.37	6.75	2.95	4.57	1.01	4.38	4.22	-----	-----	-----	-----
Model clarifier5 (U)	2645.95	14.78	5881.61	5258.72	6.75	2.95	444.78	1.01	4.38	4.22	-----	-----	-----	-----
Model clarifier70	17.10	14.78	35.09	31.37	6.75	2.95	4.57	1.01	4.38	4.22	-----	-----	-----	-----
Model clarifier70 (U)	2645.95	14.78	5881.61	5258.72	6.75	2.95	444.78	1.01	4.38	4.22	-----	-----	-----	-----
Effluent29	17.10	14.78	35.09	31.37	6.75	2.95	4.57	1.01	4.38	4.22	-----	-----	-----	-----

Attachment 4

BioWin Model Report for 2025 Typical Wet Weather Treatment Scenario

2025 Typical Wet Weather
Treatment Performance Scenario

BioWin user and configuration data

Project details

Project name: Unknown **Project ref.: BW1**

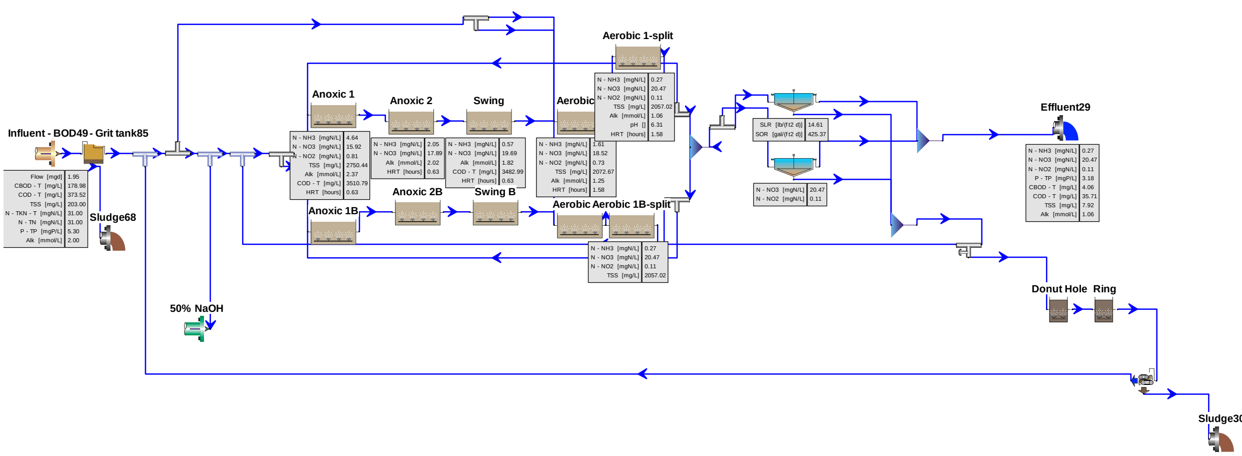
Plant name: Unknown **User name: Charles Hardy**

Created: 5/18/2018 **Saved: 2/19/2021**

Target SRT: 6.50 days **SRT: **** days**

Temperature: 15.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	63
Anoxic 2	0.0377	278.7476	18.080	63
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	63
Anoxic 2B	0.0377	278.7476	18.080	63
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Aerobic 1-split	0.1287	951.5868	18.080	216
Aerobic 1B-split	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	2.0
Anoxic 2	2.0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	2.0
Anoxic 2B	2.0
Swing B	2.0
Aerobic 1B	2.0
Aerobic 1-split	2.0
Aerobic 1B-split	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.95
BOD - Total Carbonaceous mgBOD/L	179.00
Volatile suspended solids mg/L	188.00
Total suspended solids mg/L	203.00
N - Total Kjeldahl Nitrogen mgN/L	31.00
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	0
Splitter12	Flowrate [Side]	0
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0630890163005043
Splitter32	Fraction	0.50
Splitter51	Fraction	0.50
Splitter62	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.00033

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	178.98	106.91	203.00	188.00	7.10	2.00	31.00	22.79	0	0	-----	-----	-----	-----
Anoxic 1B	1082.74	28.65	2750.44	2457.43	6.80	2.37	208.49	4.64	0.81	15.92	184.33	16.44	51.19	67.81
Anoxic 2B	1073.16	26.22	2742.53	2448.95	6.61	2.02	206.15	2.05	1.06	17.89	133.45	12.34	39.23	50.90
Swing B	1064.38	25.81	2733.78	2439.86	6.54	1.82	204.78	0.57	0.55	19.69	105.59	10.03	31.87	41.34
Aerobic 1B	813.05	26.96	2072.67	1850.98	6.38	1.25	156.14	1.61	0.73	18.52	320.92	33.44	30.82	127.29
Aerobic 1B-split	797.16	25.70	2057.02	1835.02	6.31	1.06	154.64	0.27	0.11	20.47	190.13	21.01	19.56	79.97
Model clarifier5	4.06	25.70	7.92	7.06	6.31	1.06	2.07	0.27	0.11	20.47	-----	-----	-----	-----
Model clarifier5 (U)	1589.52	25.70	4104.20	3661.26	6.31	1.06	307.06	0.27	0.11	20.47	-----	-----	-----	-----
Model clarifier70	4.06	25.70	7.92	7.06	6.31	1.06	2.07	0.27	0.11	20.47	-----	-----	-----	-----
Model clarifier70 (U)	1589.52	25.70	4104.20	3661.26	6.31	1.06	307.06	0.27	0.11	20.47	-----	-----	-----	-----
Effluent29	4.06	25.70	7.92	7.06	6.31	1.06	2.07	0.27	0.11	20.47	-----	-----	-----	-----

Attachment 5

BioWin Model Report for 2025 Dry Weather Treatment Performance Scenario

2025 Dry Weather Design
Treatment Performance Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

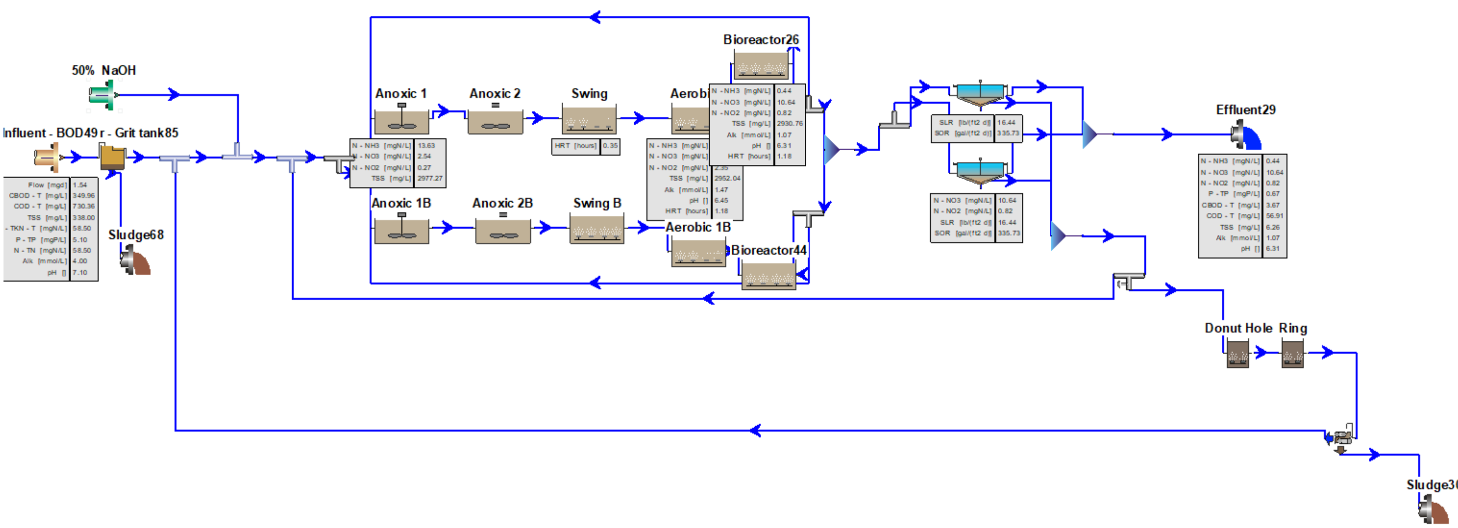
Plant name: Unknown User name: Charles Hardy

Created: 5/18/2018 Saved: 2/17/2021

Target SRT: 4.00 days SRT: ** days**

Temperature: 18.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Bioreactor26	0.1287	951.5868	18.080	216
Bioreactor44	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0
Bioreactor26	2.0
Bioreactor44	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.54
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.50
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	1.08
Splitter12	Flowrate [Side]	1.08
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0737749999077813
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.0001

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----
Anoxic 1B	1250.80	63.76	2977.27	2642.02	6.86	2.61	229.86	13.63	0.27	2.54	0	0	0	0
Anoxic 2B	1246.36	52.16	2981.50	2646.11	6.89	2.78	229.86	13.82	0.10	0.63	0	0	0	0
Swing B	1239.23	50.39	2974.94	2638.89	6.71	2.43	227.66	10.94	0.91	1.92	285.67	20.13	58.19	100.05
Aerobic 1B	1215.98	49.42	2952.04	2614.24	6.45	1.47	221.35	3.46	2.35	6.52	659.60	56.65	52.74	241.35
Bioreactor 44	1195.05	49.06	2930.76	2592.01	6.31	1.07	218.54	0.44	0.82	10.64	467.68	41.74	38.87	177.85
Model clarifier5	3.67	49.06	6.26	5.54	6.31	1.07	2.67	0.44	0.82	10.64	-----	-----	-----	-----
Model clarifier5 (U)	2384.60	49.06	5850.75	5174.50	6.31	1.07	434.07	0.44	0.82	10.64	-----	-----	-----	-----
Model clarifier70	3.67	49.06	6.26	5.54	6.31	1.07	2.67	0.44	0.82	10.64	-----	-----	-----	-----
Model clarifier70 (U)	2384.60	49.06	5850.75	5174.50	6.31	1.07	434.07	0.44	0.82	10.64	-----	-----	-----	-----
Effluent29	3.67	49.06	6.26	5.54	6.31	1.07	2.67	0.44	0.82	10.64	-----	-----	-----	-----

Attachment 6

BioWin Model Report for 2025 Peak Aeration Demand Scenario

2025 Peak Aeration Demand Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Charles Hardy

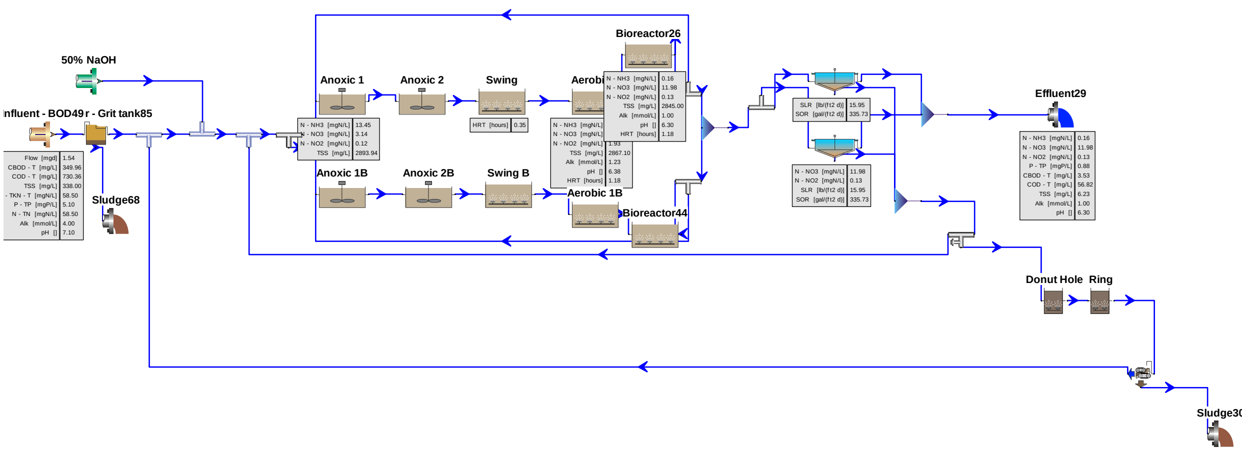
Created: 5/18/2018 Saved: 2/17/2021

Steady state solution

Target SRT: 4.00 days SRT #0: 4.03 days

Temperature: 22.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Bioreactor26	0.1287	951.5868	18.080	216
Bioreactor44	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0
Bioreactor26	2.0
Bioreactor44	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.54
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.50
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	1.08
Splitter12	Flowrate [Side]	1.08
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0737749999077813
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.0001

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----
Anoxic 1B	1177.35	62.99	2893.94	2566.35	6.87	2.57	222.74	13.45	0.12	3.14	0	0	0	0
Anoxic 2B	1172.78	51.81	2897.65	2569.92	6.89	2.74	222.73	13.62	0.08	1.04	0	0	0	0
Swing B	1165.35	50.26	2890.72	2562.30	6.69	2.30	219.92	10.07	1.08	2.76	333.69	22.92	67.05	114.85
Aerobic 1B	1141.43	49.35	2867.10	2536.97	6.38	1.23	212.85	1.88	1.93	8.71	727.14	61.26	57.04	263.18
Bioreactor 44	1119.91	49.01	2845.00	2514.12	6.30	1.00	211.14	0.16	0.13	11.98	427.07	38.19	35.56	164.06
Model clarifier5	3.53	49.01	6.23	5.51	6.30	1.00	2.39	0.16	0.13	11.98	-----	-----	-----	-----
Model clarifier5 (U)	2234.56	49.01	5679.39	5018.87	6.30	1.00	419.57	0.16	0.13	11.98	-----	-----	-----	-----
Model clarifier70	3.53	49.01	6.23	5.51	6.30	1.00	2.39	0.16	0.13	11.98	-----	-----	-----	-----
Model clarifier70 (U)	2234.56	49.01	5679.39	5018.87	6.30	1.00	419.57	0.16	0.13	11.98	-----	-----	-----	-----
Effluent29	3.53	49.01	6.23	5.51	6.30	1.00	2.39	0.16	0.13	11.98	-----	-----	-----	-----

Attachment 7

BioWin Model Report for 2025 Typical Dry Weather Demands Scenario

2025 Typical Dry Weather Demands Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Charles Hardy

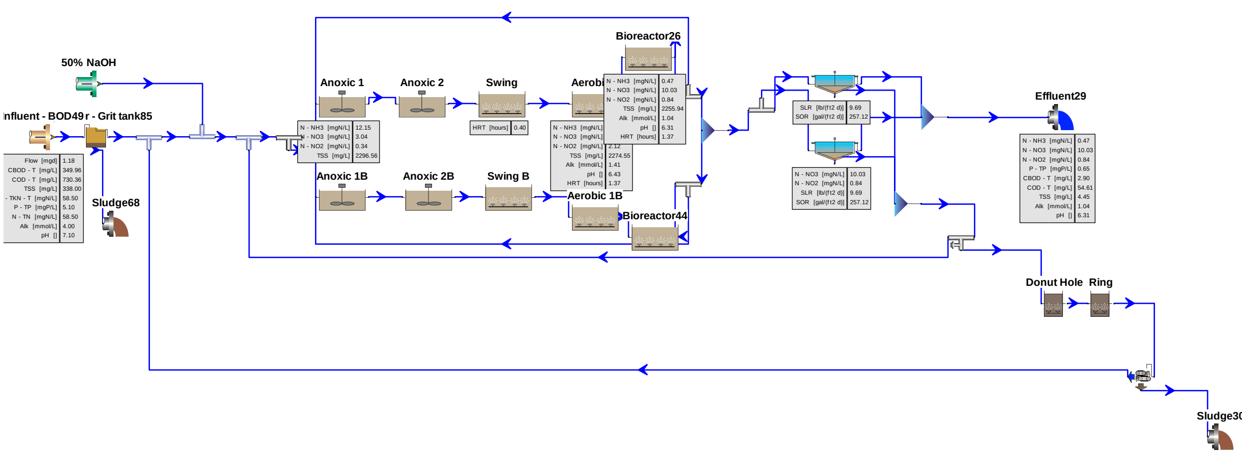
Created: 5/18/2018 Saved: 2/18/2021

Steady state solution

Target SRT: 4.00 days SRT #0: 4.03 days

Temperature: 18.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Bioreactor26	0.1287	951.5868	18.080	216
Bioreactor44	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0
Bioreactor26	2.0
Bioreactor44	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.18
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.50
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	1.08
Splitter12	Flowrate [Side]	1.08
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0737749999077813
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	7E-5

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----
Anoxic 1B	967.17	63.36	2296.56	2038.58	6.80	2.40	178.85	12.15	0.34	3.04	0	0	0	0
Anoxic 2B	962.95	52.21	2300.61	2042.46	6.83	2.56	178.85	12.31	0.18	1.18	0	0	0	0
Swing B	956.52	50.51	2294.86	2036.11	6.67	2.25	176.93	9.75	0.89	2.31	215.11	15.65	44.74	77.77
Aerobic 1B	935.74	49.44	2274.55	2014.24	6.43	1.41	171.41	3.18	2.12	6.36	487.15	43.28	40.30	184.41
Bioreactor 44	917.38	49.03	2255.94	1994.85	6.31	1.04	168.82	0.47	0.84	10.03	345.78	31.93	29.72	136.02
Model clarifier5	2.90	49.03	4.45	3.94	6.31	1.04	2.56	0.47	0.84	10.03	-----	-----	-----	-----
Model clarifier5 (U)	1830.00	49.03	4502.83	3981.70	6.31	1.04	334.73	0.47	0.84	10.03	-----	-----	-----	-----
Model clarifier70	2.90	49.03	4.45	3.94	6.31	1.04	2.56	0.47	0.84	10.03	-----	-----	-----	-----
Model clarifier70 (U)	1830.00	49.03	4502.83	3981.70	6.31	1.04	334.73	0.47	0.84	10.03	-----	-----	-----	-----
Effluent29	2.90	49.03	4.45	3.94	6.31	1.04	2.56	0.47	0.84	10.03	-----	-----	-----	-----

Attachment 8

BioWin Model Report for 2020 Typical Dry Weather Demands Scenario

2020 Typical Dry Weather Demands Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Charles Hardy

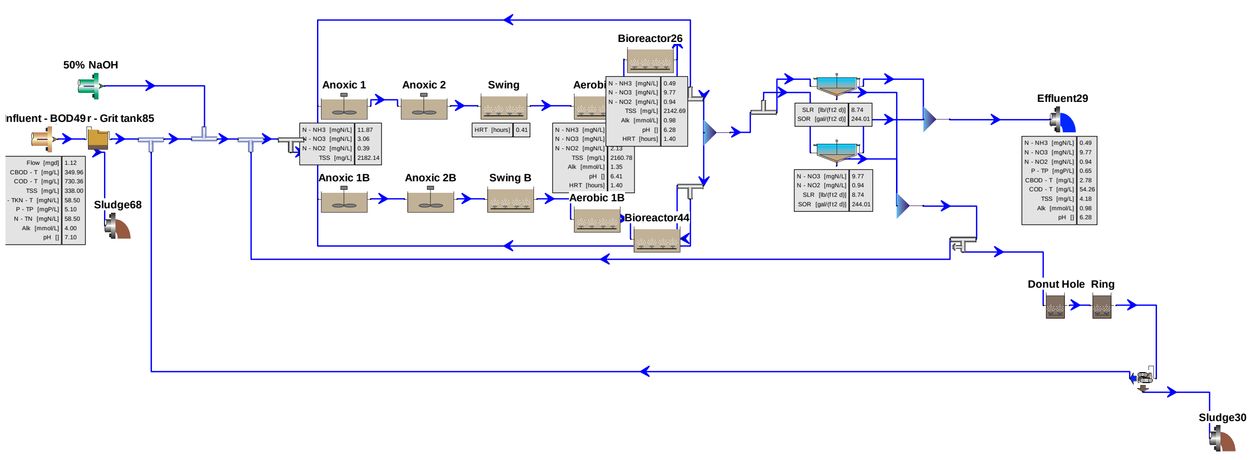
Created: 5/18/2018 Saved: 2/18/2021

Steady state solution

Target SRT: 4.00 days SRT #0: 4.03 days

Temperature: 18.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	Un-aerated
Anoxic 2	0.0377	278.7476	18.080	Un-aerated
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	Un-aerated
Anoxic 2B	0.0377	278.7476	18.080	Un-aerated
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Bioreactor26	0.1287	951.5868	18.080	216
Bioreactor44	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	0
Anoxic 2	0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	0
Anoxic 2B	0
Swing B	2.0
Aerobic 1B	2.0
Bioreactor26	2.0
Bioreactor44	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.12
BOD - Total Carbonaceous mgBOD/L	350.00
Volatile suspended solids mg/L	302.00
Total suspended solids mg/L	338.00
N - Total Kjeldahl Nitrogen mgN/L	58.50
P - Total P mgP/L	5.10
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	4.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	1.08
Splitter12	Flowrate [Side]	1.08
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0737749999077813
Splitter32	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	6E-5

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	349.96	302.19	338.00	302.00	7.10	4.00	58.50	43.02	0	0	-----	-----	-----	-----
Anoxic 1B	919.55	63.29	2182.14	1937.13	6.77	2.30	170.27	11.87	0.39	3.06	0	0	0	0
Anoxic 2B	915.39	52.24	2186.16	1940.99	6.80	2.46	170.27	12.03	0.21	1.22	0	0	0	0
Swing B	909.11	50.54	2180.58	1934.82	6.65	2.16	168.40	9.54	0.91	2.32	203.25	14.88	42.43	73.95
Aerobic 1B	888.81	49.44	2160.78	1913.49	6.41	1.35	163.06	3.17	2.13	6.21	457.99	40.97	38.15	174.57
Bioreactor 44	870.95	49.02	2142.69	1894.66	6.28	0.98	160.49	0.49	0.94	9.77	326.50	30.34	28.25	129.26
Model clarifier5	2.78	49.02	4.18	3.70	6.28	0.98	2.57	0.49	0.94	9.77	-----	-----	-----	-----
Model clarifier5 (U)	1737.25	49.02	4276.59	3781.54	6.28	0.98	318.07	0.49	0.94	9.77	-----	-----	-----	-----
Model clarifier70	2.78	49.02	4.18	3.70	6.28	0.98	2.57	0.49	0.94	9.77	-----	-----	-----	-----
Model clarifier70 (U)	1737.25	49.02	4276.59	3781.54	6.28	0.98	318.07	0.49	0.94	9.77	-----	-----	-----	-----
Effluent29	2.78	49.02	4.18	3.70	6.28	0.98	2.57	0.49	0.94	9.77	-----	-----	-----	-----

Attachment 9

BioWin Model Report for 2020 Typical Wet Weather Demands Scenario

2020 Typical Wet Weather Demands Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

Plant name: Unknown User name: Charles Hardy

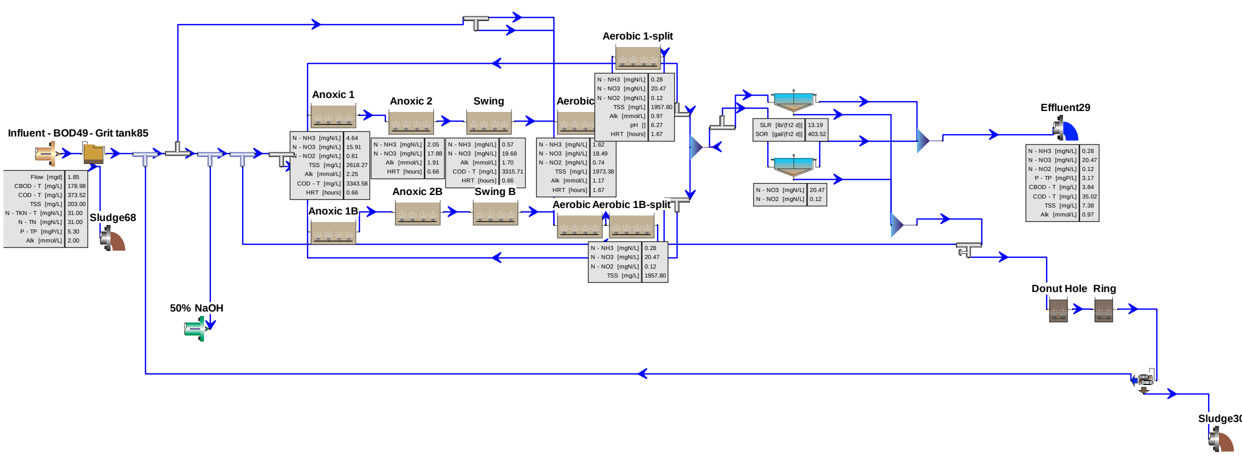
Created: 5/18/2018 Saved: 2/19/2021

Steady state solution

Target SRT: 6.50 days SRT #1: 6.50 days

Temperature: 15.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	63
Anoxic 2	0.0377	278.7476	18.080	63
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	63
Anoxic 2B	0.0377	278.7476	18.080	63
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Aerobic 1-split	0.1287	951.5868	18.080	216
Aerobic 1B-split	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	2.0
Anoxic 2	2.0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	2.0
Anoxic 2B	2.0
Swing B	2.0
Aerobic 1B	2.0
Aerobic 1-split	2.0
Aerobic 1B-split	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.85
BOD - Total Carbonaceous mgBOD/L	179.00
Volatile suspended solids mg/L	188.00
Total suspended solids mg/L	203.00
N - Total Kjeldahl Nitrogen mgN/L	31.00
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	0
Splitter12	Flowrate [Side]	0
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0630961423998037
Splitter32	Fraction	0.50
Splitter51	Fraction	0.50
Splitter62	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.0003

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD 49	178.98	106.91	203.00	188.00	7.10	2.00	31.00	22.79	0	0	-----	-----	-----	-----
Anoxic 1B	1029.98	28.66	2618.27	2339.42	6.77	2.25	198.67	4.64	0.81	15.91	174.17	15.64	48.68	64.48
Anoxic 2B	1020.36	26.23	2610.32	2330.90	6.58	1.91	196.34	2.05	1.07	17.88	125.91	11.72	37.26	48.34
Swing B	1011.57	25.80	2601.57	2321.81	6.51	1.70	194.95	0.57	0.55	19.68	99.51	9.51	30.23	39.22
Aerobic 1B	773.37	26.96	1973.38	1762.31	6.35	1.17	148.78	1.62	0.74	18.49	302.64	31.75	29.26	120.84
Aerobic 1B-split	757.54	25.69	1957.80	1746.44	6.27	0.97	147.26	0.28	0.12	20.47	179.26	19.94	18.57	75.90
Model clarifier5	3.84	25.69	7.38	6.58	6.27	0.97	2.04	0.28	0.12	20.47	-----	-----	-----	-----
Model clarifier5 (U)	1510.48	25.69	3906.26	3484.55	6.27	0.97	292.33	0.28	0.12	20.47	-----	-----	-----	-----
Model clarifier70	3.84	25.69	7.38	6.58	6.27	0.97	2.04	0.28	0.12	20.47	-----	-----	-----	-----
Model clarifier70 (U)	1510.48	25.69	3906.26	3484.55	6.27	0.97	292.33	0.28	0.12	20.47	-----	-----	-----	-----
Effluent29	3.84	25.69	7.38	6.58	6.27	0.97	2.04	0.28	0.12	20.47	-----	-----	-----	-----

Attachment 10

BioWin Model Report for 2020 Minimum Aeration Demand Scenario

2020 Minimum Aeration Demand Scenario

BioWin user and configuration data

Project details

Project name: Unknown Project ref.: BW1

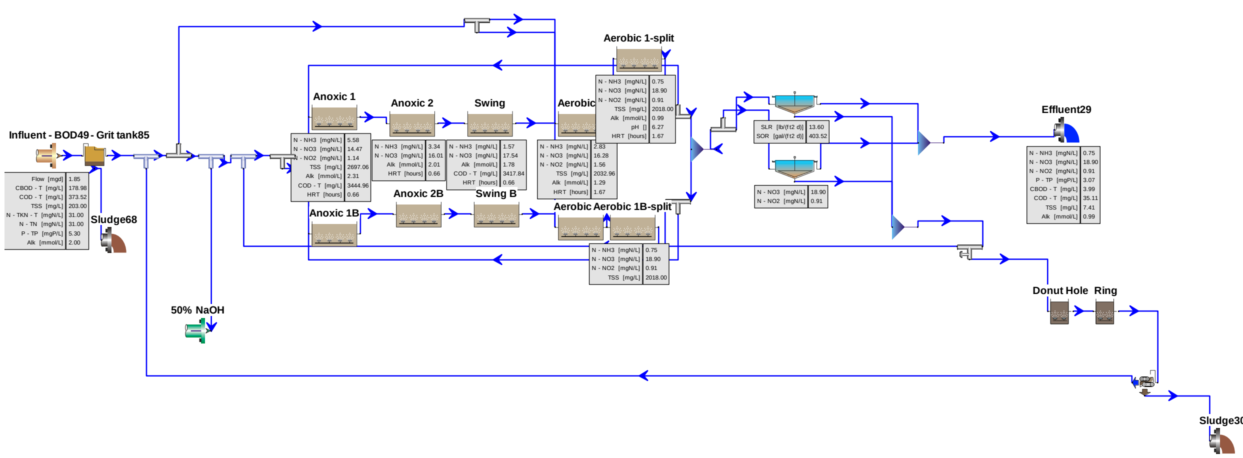
Plant name: Unknown User name: Charles Hardy

Created: 5/18/2018 Saved: 2/19/2021

Target SRT: 6.50 days SRT: **** days

Temperature: 11.0°C

Flowsheet



Configuration information for all Bioreactor units

Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Anoxic 1	0.0377	278.7476	18.080	63
Anoxic 2	0.0377	278.7476	18.080	63
Swing	0.0377	278.7476	18.080	63
Aerobic 1	0.1287	951.5868	18.080	216
Anoxic 1B	0.0377	278.7476	18.080	63
Anoxic 2B	0.0377	278.7476	18.080	63
Swing B	0.0377	278.7476	18.080	63
Aerobic 1B	0.1287	951.5868	18.080	216
Aerobic 1-split	0.1287	951.5868	18.080	216
Aerobic 1B-split	0.1287	951.5868	18.080	216

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Anoxic 1	2.0
Anoxic 2	2.0
Swing	2.0
Aerobic 1	2.0
Anoxic 1B	2.0
Anoxic 2B	2.0
Swing B	2.0
Aerobic 1B	2.0
Aerobic 1-split	2.0
Aerobic 1B-split	2.0

Configuration information for all Influent - BOD units

Operating data Average (flow/time weighted as required)

Element name	Influent - BOD49
Flow	1.85
BOD - Total Carbonaceous mgBOD/L	179.00
Volatile suspended solids mg/L	188.00
Total suspended solids mg/L	203.00
N - Total Kjeldahl Nitrogen mgN/L	31.00
P - Total P mgP/L	5.30
S - Total S mgS/L	0
N - Nitrate mgN/L	0
pH	7.10
Alkalinity mmol/L	2.00
Metal soluble - Calcium mg/L	11.10
Metal soluble - Magnesium mg/L	3.20
Gas - Dissolved oxygen mg/L	0

Configuration information for all Clarifier - Model units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier5	Flow paced	50.00 %
Model clarifier70	Flow paced	50.00 %

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Splitter11	Flowrate [Side]	0
Splitter12	Flowrate [Side]	0
Splitter13	Fraction	0.50
Splitter40	Flowrate [Side]	0.0630739136240442
Splitter32	Fraction	0.50
Splitter51	Fraction	0.50
Splitter62	Fraction	0.50

Configuration information for all Influent - State variable units

Operating data Average (flow/time weighted as required)

Element name	50% NaOH
Other Cations (strong bases) [meq/L]	12500.00
Flow	0.00029

BioWin Album

Album page - Page 12

Elements	Liquid volume [Mil. Gal]
Anoxic 1	0.04
Anoxic 2	0.04
Swing	0.04
Aerobic 1	0.13
Anoxic 1B	0.04
Anoxic 2B	0.04
Swing B	0.04
Aerobic 1B	0.13

Album page - New Plant Summary

Elements	BOD - Total Carbonaceous [mg/L]	COD - Filtered [mg/L]	Total suspended solids [mg/L]	Volatile suspended solids [mg/L]	pH []	Alkalinity [mmol/L]	N - Total Kjeldahl Nitrogen [mgN/L]	N - Ammonia [mgN/L]	N - Nitrite [mgN/L]	N - Nitrate [mgN/L]	Air flow rate [ft3/min (20C, 1 atm)]	OTR [lb/hr]	OUR - Total [mgO/L/hr]	SOTR [lb/hr]
Influent - BOD49	178.98	106.91	203.00	188.00	7.10	2.00	31.00	22.79	0	0	-----	-----	-----	-----
Anoxic 1B	1098.26	28.82	2697.06	2410.72	6.77	2.31	206.22	5.58	1.14	14.47	155.08	14.17	44.01	58.16
Aerobic 1B-split	809.67	25.74	2018.00	1800.87	6.27	0.99	152.81	0.75	0.91	18.90	192.84	21.37	19.90	80.98
Anoxic 2B	1088.90	26.29	2689.46	2402.52	6.60	2.01	204.24	3.34	1.47	16.01	113.44	10.73	34.11	44.06
Swing B	1080.37	25.85	2681.02	2393.70	6.52	1.78	202.61	1.57	1.47	17.54	100.02	9.60	30.51	39.40
Aerobic 1B	825.05	27.05	2032.96	1816.27	6.39	1.29	154.95	2.83	1.56	16.28	279.45	29.71	27.36	112.58
Model clarifier5	3.99	25.74	7.41	6.61	6.27	0.99	2.51	0.75	0.91	18.90	-----	-----	-----	-----
Model clarifier5 (U)	1614.53	25.74	4026.56	3593.32	6.27	0.99	302.95	0.75	0.91	18.90	-----	-----	-----	-----
Model clarifier70	3.99	25.74	7.41	6.61	6.27	0.99	2.51	0.75	0.91	18.90	-----	-----	-----	-----
Model clarifier70 (U)	1614.53	25.74	4026.56	3593.32	6.27	0.99	302.95	0.75	0.91	18.90	-----	-----	-----	-----
Effluent29	3.99	25.74	7.41	6.61	6.27	0.99	2.51	0.75	0.91	18.90	-----	-----	-----	-----

Appendix C

Opinion of Probable Construction Cost (OPCC)

Project:	City of Sandy - WWTP PreDesign Evaluation
Client:	City of Sandy
Project no.	964-50-20-01
Prepared by:	Ruby Lang, TAG, and Landis
Checked by:	Bill Schilling
Title	Preliminary Cost Estimate
Date	2/16/2021

WEST YOST
Water. Engineered.

PreDesign Project Summary

Area No.	Area Description	Opinion of Probable Construction Cost (OPCC)		
		2020 PDR	Modified Pre-Design	Delta Cost
100	Headworks	$714,000	$261,971	($452,029)
150	Equalization Basin		$112,292	$112,292
200	Aeration Basins & Blowers	$607,100	$1,392,993	$785,893
210	Secondary Clarifiers	$350,000	$125,519	($224,481)
220	RAS/WAS Pump Station		$80,170	$80,170
300	Filter & UV Disinfection System	$690,000	$1,221,791	$531,791
600	Aerated Sludge Storage Basin (ASSB)	$118,700	$556,873	$438,173
800	Chemical Storage & Metering Facilities	$496,000	$374,668	($121,332)
900	Waste Pump Station & Stormwater Control	$65,000	$273,983	$208,983
910	Site Improvements	$0	$510,985	$510,985
	TOTAL - With Filter & UV	$3,040,800	$4,911,245	$1,870,445
	TOTAL - Without Filter & UV	$2,350,800	$3,689,454	$1,338,654

Area 100 - Headworks

Division	Spec #	Item #	Item Description	Qty	Unit	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total Cost	Source	Notes
Div 5			METALS									
			Bridge Crane and Support Structure	1	EA	$ 9,700.00	$ 9,700.00	$ 7,000.00	$ 7,000.00	$ 16,700.00		
			Overflow Notch	1	EA	$ 1,380.00	$ 1,380.00	$ 2,100.00	$ 2,100.00	$ 3,480.00		
Subtotal			**Division 2 Existing Conditions**							**$ 20,180**		
Div 11			EQUIPMENT									
			Grit pump, suction pipe, and paddle mixer	1	EA	$ 109,304	$ 109,304	$ 54,652	$ 54,652.00	$ 163,956	Smith & Loveless	
Subtotal			**Division 11 Equipment**							**$ 164,000**		
Div 15			MECHANICAL									
			Discharge Piping 4" DI	20	FT	$ 83	$ 1,655	$ 41	$ 827.50	$ 2,483	RSMeans	
			Discharge Piping 4" DI 90-degree Elbows	4	EA	$ 182	$ 728	$ 91	$ 364.00	$ 1,092	RSMeans	
			Discharge Piping 4" DI Reducer	1	EA	$ 270	$ 270	$ 135	$ 135.00	$ 405	RSMeans	
Subtotal			**Division 15 Mechanical**							**$ 4,000**		
Div 16			ELECTRICAL									
			Hoist Electrical Connection	1	EA	$ 1,005	$ 1,005	$ 1,890	$ 1,890.00	$ 2,895		
			Circuit Breaker for Hoist	1	EA	$ 300	$ 300	$ 840	$ 840.00	$ 1,140		
			Disconnect/Reconnect Grit Motor Conductors	1	EA	$ -	$ -	$ 840	$ 840.00	$ 840		
			Fanick 50, GE90 Reprogram (TAG number)	1	EA	$ 1,000	$ 1,000	$ -	$ -	$ 1,000		
Subtotal			**Division 16 Electrical**							**$ 5,875**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 194,100**		
			Subcontractor Markup						0.05	4,852.50		
			Subtotal - Direct Costs + Subcontractor Markups							**198,952.50**		
			Insurance & Bonds						0.03	$ 5,969		
			Mob/Demob						0.05	$ 9,948		
			OH&P						0.065	$ 12,932		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 227,801**		
			Contingency						0.15	$ 34,170		
			Total Construction Costs							**$ 261,971**		

Area 110 - Equalization Basin												
Division	**Spec #**	**Item #**	**Item Description**	**Qty**	**Unit**	**Materials**		**Installation**		**Total Cost**	**Source**	**Notes**
						$/Unit	**Total**	**$/Unit**	**Total**			
Div 11			**EQUIPMENT**									
			Floating Aerators	3		$ 10,000	$ 30,000	$ 5,000	$ 15,000.00	$ 45,000.00	Aerator Solutions	
			Weir Gate	1	EA	$ 8,000.00	$ 8,000.00	$ 4,000.00	$ 4,000.00	$ 12,000.00	Golden Harvest, Inc.	
Subtotal			**Division 11 Equipment**							**$ 57,000**		
Div 16			**ELECTRICAL**									
			EQ Basin Level Transducer and Aerators	1	LS	$ 1,000.00	$ 1,000.00	$ 6,500.00	$ 6,500.00	$ 7,500		
			EQ Basin Waterpilot 200ft Cable (TAG number)	1	LS	$ 1,000.00	$ 1,000.00	$ 1,300.00	$ 1,300.00	$ 2,300		
			EQ Basin Waterpilot AB Left Channel (TAG number)	1	LS	$ 1,000.00	$ 1,000.00	$ 1,250.00	$ 1,250.00	$ 2,250		
			EQ Basin Waterpilot AB Right Channel (TAG number)	1	LS	$ -	$ -	$ 1,250.00	$ 1,250.00	$ 1,250		
			Flo-Dar (TAG number)	1	EA	$ 1,000.00	$ 1,000.00	$ 8,900.00	$ 8,900.00	$ 9,900.00		
			Instrumentation Calibration and Comm (TAG number)	1	LS	$ -	$ -	$ 1,800.00	$ 1,800.00	$ 1,800.00		
			Flow Meter Transmitter Conduit/Cable	1	EA	$ 541.28	$ 541.28	$ 619.00	$ 619.00	$ 1,160.28		
Subtotal			**Division 16 Electrical**							**$ 26,160**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 83,200**		
			Subcontractor Markup						0.05	2,080.00		
			Subtotal - Direct Costs + Subcontractor Markups							**85,280.00**		
			Insurance & Bonds						0.03	$ 2,558		
			Mob/Demob						0.05	$ 4,264		
			OH&P						0.065	$ 5,543		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 97,646**		
			Contingency						0.15	$ 14,647		
			Total Construction Costs							**$ 112,292**		

Area 200 - Aeration Basin + Blowers												
Division	**Spec #**	**Item #**	**Item Description**	**Qty**	**Unit**	**Materials**		**Installation**		**Total Cost**	**Source**	**Notes**
						$/Unit	**Total**	**$/Unit**	**Total**			
Div 3			**CONCRETE**									
			Concrete Baffle Wall	2	EA	$ 24,000.00	$ 48,000.00		$ -	$ 48,000.00		
Subtotal			**Division 3 Concrete**							**$ 48,000.00**		
Div 11			**EQUIPMENT**									
			Plug Valves (8-inch dia.)	4	EA	$ 1,500.00	$ 6,000.00	$ 750.00	$ 3,000.00	$ 9,000.00	Valmatic	
			Plug Valve Actuators	4	EA	$ 7,500.00	$ 30,000.00	$ 3,750.00	$ 15,000.00	$ 45,000.00	TAG	
			Butterfly Valves 6" with motorized actuator	4	EA	$ 9,000.00	$ 36,000.00	$ 4,500.00	$ 18,000.00	$ 54,000.00	DeZurik	
			Butterfly Valves 8" with motorized actuator	2	EA	$ 10,000.00	$ 20,000.00	$ 5,000.00	$ 10,000.00	$ 30,000.00	DeZurik	
			Gates with motorized actuators	6	EA	$ 15,000.00	$ 90,000.00	$ 7,500.00	$ 45,000.00	$ 135,000.00	Golden Harvest, Inc.	
			Gates with manual operators	10	EA	$ 8,000.00	$ 80,000.00	$ 4,000.00	$ 40,000.00	$ 120,000.00	Golden Harvest, Inc.	
			Diffusers	1	LS	$ 95,000.00	$ 95,000.00	$ 47,500.00	$ 47,500.00	$ 142,500.00	Sanitaire	
Subtotal			**Division 11 Equipment**							**$ 536,000.00**		
Div 13			**SPECIAL CONSTRUCTION**									
			FRP Baffle Zone 2 Inlet	2	EA	$ 1,500.00	$ 3,000.00	$ 1,500.00	$ 3,000.00	$ 6,000.00		
							$ -	$ -	$ -	$ -		
Subtotal			**Division 13 Special Construction**							**$ 6,000.00**		
Div 15			**MECHANICAL**									
			Steel Air Piping 10"	150	LF	$ 65.00	$ 9,750.00	$ 32.50	$ 4,875.00	$ 14,625.00	https://brismet.com/wp-content/uploads/2012/01/B-PRICESHEET1211PDF.pdf	
			DI RAS Piping 8"	10	LF	$ 50.00	$ 500.00	$ 25.00	$ 250.00	$ 750.00	RS Means: 331413152060, costs for recent project & other research	
			DI IMLR Piping 8"	150	LF	$ 50.00	$ 7,500.00	$ 25.00	$ 3,750.00	$ 11,250.00	RS Means: 331413152060, costs for recent project & other research	
			DI IMLR Piping 18"	250	LF	$ 145.37	$ 36,342.50	$ 72.69	$ 18,171.25	$ 54,513.75	RS Means: 331413152170, costs for recent project & other research	
			Pipe Fittings	53	EA	$ 350.00	$ 18,550.00	$ 175.00	$ 9,275.00	$ 27,825.00	RS Means: 331413158040, costs for recent project & other research	
Subtotal			**Division 15 Mechanical**							**$ 109,000.00**		
Div 16			**ELECTRICAL**									
			Flow Meter Transmitter Conduit/Cable	6	EA	$ 541.28	$ 3,247.68	$ 619.00	$ 3,714.00	$ 6,961.68		
			DO Sensors Conduit/Cable	4	EA	$ 822.75	$ 3,291.00	$ 4,583.25	$ 18,333.00	$ 21,624.00		
			Level Transducers Conduit/Cable	2	EA	$ 1,364.50	$ 2,729.00	$ 1,536.00	$ 3,072.00	$ 5,801.00		
			Motorized Valves Conduit/Cable	8	EA	$ 1,569.83	$ 12,558.64	$ 1,097.00	$ 8,776.00	$ 21,334.64		
			Motorized Actuators Conduit/Cable	2	EA	$ 1,584.50	$ 3,169.00	$ 2,279.00	$ 4,558.00	$ 7,727.00		
			Motorized Slide Gates Conduit/Cable	6	EA	$ 1,565.75	$ 9,394.50	$ 1,540.00	$ 9,240.00	$ 18,634.50		
			Instrumentation Marshaling Panels Install/Conduit/Cable	2	EA	$ 1,048.00	$ 2,096.00	$ 1,260.00	$ 2,520.00	$ 4,616.00		
			Blower Conductor Replacement	4	EA	$ 346.45	$ 1,385.80	$ 1,680.00	$ 6,720.00	$ 8,105.80		
			Conduit work at Blowers	1	EA	$ -	$ -	$ 1,500.00	$ 1,500.00	$ 1,500.00		
			Arc Flash Breakers in Service	1	EA	$ -	$ -	$ 40,000.00	$ 40,000.00	$ 40,000.00		
			MCC, VFDs and Active Harmonic Filter (TAG number)	1	EA	$ 129,705.00	$ 129,705.00	$ 9,600.00	$ 9,600.00	$ 139,305.00		
			Blower PLC, Analog Cards ADDED	2	EA	$ 1,320.00	$ 2,640.00	$ 1,180.00	$ 2,360.00	$ 5,000.00		
			SC200 (TAG number)	2	EA	$ 2,760.00	$ 5,520.00	$ 400.00	$ 800.00	$ 6,320.00		
			DO Sensers (TAG number)	4	EA	$ 2,583.75	$ 10,335.00	$ 200.00	$ 800.00	$ 11,135.00		
			Wands (TAG number)	4	EA	$ 840.00	$ 3,360.00	$ -	$ -	$ 3,360.00		
			DO Cable Extension (TAG number)	4	EA	$ 225.00	$ 900.00	$ 200.00	$ 800.00	$ 1,700.00		
			Breather 'E+H-PS' Boxes (TAG number)	3	EA	$ 100.00	$ 300.00	$ 116.67	$ 350.01	$ 650.01		
			Instrumentation Calibration and Comm (TAG number)	1	EA	$ -	$ -	$ 3,990.00	$ 3,990.00	$ 3,990.00		
			MASS AFM (TAG number)	6	EA	$ 3,830.00	$ 22,980.00	$ 400.00	$ 2,400.00	$ 25,380.00		
Subtotal			**Division 16 Electrical**							**$ 333,144.63**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 1,032,100**		
			Subcontractor Markup						0.05	25,802.50		
			Subtotal - Direct Costs + Subcontractor Markups							**1,057,902.50**		
			Insurance & Bonds						0.03	$ 31,737		
			Mob/Demob						0.05	$ 52,895		
			OH&P						0.065	$ 68,764		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 1,211,298**		
			Contingency						0.15	$ 181,695		
			Total Construction Costs							**$ 1,392,993**		

Area 210 - Secondary Clarification and Sludge Pumping												
Division	**Spec #**	**Item #**	**Item Description**	**Qty**	**Unit**	**Materials**		**Installation**		**Total Cost**	**Source**	**Notes**
						$/Unit	**Total**	**$/Unit**	**Total**			
Div 11			**EQUIPMENT**									
			Mechanism & Scum Collection Rehab (Re-Build It)	1	EA	$ 34,121	$ 34,121	$ 28,934	$ 28,934.00	$ 63,055	Rebuild-it	
			Add Scum Box	1	EA	$ 10,000	$ 10,000	$ 5,000	$ 5,000.00	$ 15,000		
Subtotal			**Division 11 Equipment**							**$ 78,000**		
Div 13			**SPECIAL CONSTRUCTION**									
			Replace/Adjust Weir Plates	2	EA	$ 5,000	$ 10,000	$ 2,500	$ 5,000.00	$ 15,000	Base on cost from recent similar project	
							$ -		$ -	$ -		
Subtotal			**Division 13 Special Construction**							**$ 15,000**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 93,000**		
			Subcontractor Markup						0.05	2,325.00		
			Subtotal - Direct Costs + Subcontractor Markups							**95,325.00**		
			Insurance & Bonds						0.03	$ 2,860		
			Mob/Demob						0.05	$ 4,766		
			OH&P						0.065	$ 6,196		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 109,147**		
			Contingency						0.15	$ 16,372		
			Total Construction Costs							**$ 125,519**		

Area 220 - RAS/WAS Pump Station

Division	Spec #	Item #	Item Description	Qty	Unit	Materials		Installation		Total Cost	Source	Notes
						$/Unit	Total	$/Unit	Total			
Div 11			**EQUIPMENT**									
			RAS Pumps 20 hp Moter	2	EA	$ 2,500	$ 5,000	$ 1,250	$ 2,500.00	$ 7,500	Pump Tech Inc.	
			Ventilation Fan	1	EA	$ 2,500	$ 2,500	$ 1,250	$ 1,250.00	$ 3,750		
Subtotal			**Division 11 Equipment**							**$ 11,000**		
Div 15			**MECHANICAL**									
			Piping	50	FT	$ 50	$ 2,500	$ 25	$ 1,250.00	$ 3,750		
							$ -		$ -	$ -		
Subtotal			**Division 15 Mechanical**							**$ 4,000**		
Div 16			**ELECTRICAL**									
			VFDs (TAG number)	2	EA	$ -	$ -	$ 8,900	$ 17,800.00	$ 17,800		
			VFDs Setup and Startup (TAG number)	2	EA	$ 570	$ 1,140	$ -	$ -	$ 1,140		
			VFD Conductors	2	EA	$ 409	$ 817	$ 1,050	$ 2,100.00	$ 2,917		
			480V Power Panel	1	EA	$ 5,699	$ 5,699	$ 2,940	$ 2,940.00	$ 8,639		
			Refeed 45kVA transformer	1	EA	$ 717	$ 717	$ 2,520	$ 2,520.00	$ 3,237		
			Exhaust Fan	1	EA	$ 250	$ 250	$ 500	$ 500.00	$ 750		
			New Circuit Breakers in MCC-A	1	EA	$ 1,500	$ 1,500	$ 2,100	$ 2,100.00	$ 3,600		
			Demo and Install VFDs	1	EA	$ -	$ -	$ 3,360	$ 3,360.00	$ 3,360		
			PLC additional Parts (TAG number)	1	EA	$ 1,800	$ 1,800	$ 1,180	$ 1,180.00	$ 2,980		
Subtotal			**Division 16 Electrical**							**$ 44,423**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 59,400**		
			Subcontractor Markup						0.05	1,485.00		
			Subtotal - Direct Costs + Subcontractor Markups							**60,885.00**		
			Insurance & Bonds						0.03	$ 1,827		
			Mob/Demob						0.05	$ 3,044		
			OH&P						0.065	$ 3,958		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 69,713**		
			Contingency						0.15	$ 10,457		
			Total Construction Costs							**$ 80,170**		

Area 300 - Filters & UV Disinfection

Division	Spec #	Item #	Item Description	Qty	Unit	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total Cost	Source	Notes
Div 2			**EXISTING CONDITIONS**									
			Concrete Pad for UV/Filter System	16.66666667	CY	$ 600.00	$ 10,000.00		$ -	$ 10,000.00		
							$ -		$ -	$ -		
Subtotal			**Division 2 Existing Conditions**							**$ 10,000.00**		
Div 5			**METALS**									
			Replace Cathodic Protection System, Recoat Steel	1	LS	$ -	$ -	$ 50,000.00	$ 50,000.00	$ 50,000.00	ACE, includes materials	
							$ -		$ -	$ -		
Subtotal			**Division 2 Existing Conditions**							**$ 50,000.00**		
Div 11			**EQUIPMENT**									
			Filter package (including set up and freight)	1	EA	$ 319,000.00	$ 319,000.00	$ 159,500.00	$ 159,500.00	$ 478,500.00	AquaDisk Filter	Includes control panel
			UV System	1	EA	$ 87,500.00	$ 87,500.00	$ 43,750.00	$ 43,750.00	$ 131,250.00	Trojan UVFit	Includes control panel
			Feed Pumps	2	EA	$ 25,000.00	$ 50,000.00	$ 12,500.00	$ 25,000.00	$ 75,000.00	Estimated based on recent previous projects	
			Flowmeter	1	EA	$ 2,500.00	$ 2,500.00	$ 1,250.00	$ 1,250.00	$ 3,750.00	Estimated based on recent previous projects	
Subtotal			**Division 11 Equipment**							**$ 689,000**		
Div 15			**MECHANICAL**									
			Filter/UV inlet/outlet piping - 12" DI	100	FT	$ 50.00	$ 5,000.00	$ 25.00	$ 2,500.00	$ 7,500.00		
			Pipe Fittings	20	EA	$ 350.00	$ 7,000.00	$ 175.00	$ 3,500.00	$ 10,500.00		
Subtotal			**Division 15 Mechanical**							**$ 18,000.00**		
Div 16			**ELECTRICAL**									
			100Amp feed to UV Control Panel	1	EA	$ 1,713.00	$ 1,713.00	$ 3,780.00	$ 3,780.00	$ 5,493.00		
			Controls feed to UV Control Panel	1	EA	$ 828.00	$ 828.00	$ 2,520.00	$ 2,520.00	$ 3,348.00		
			Feed to Filter Panel (West Yost)	1	EA	$ 1,713.00	$ 1,713.00	$ 3,780.00	$ 3,780.00	$ 5,493.00		
			Controls feed to Filter Panel (West Yost)	1	EA	$ 828.00	$ 828.00	$ 2,520.00	$ 2,520.00	$ 3,348.00		
			Power for Instrumentation Devices	1	LS	$ 1,000.00	$ 1,000.00	$ 4,000.00	$ 4,000.00	$ 5,000.00		
			Controls for Instrumentation Devices	1	LS	$ 1,000.00	$ 1,000.00	$ 4,000.00	$ 4,000.00	$ 5,000.00		
			PLC GE Equipment & Installation	1	LS	$ 3,750.00	$ 3,750.00	$ 2,360.00	$ 2,360.00	$ 6,110.00		
Subtotal			**Division 16 Electrical**							**$ 33,792.00**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 800,800**		
			Subcontractor Markup						0.05	20,020.00		
			Subtotal - Direct Costs + Subcontractor Markups							**820,820.00**		
			Insurance & Bonds						0.03	$ 24,625		
			Mob/Demob						0.05	$ 41,041		
			OH&P						0.065	$ 53,353		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 939,839**		
			Contingency						0.30	$ 281,952		
			Total Construction Costs							**$ 1,221,791**		

Area 600- Aerated Sludge Storage Basin (ASSB)

Division	Spec #	Item #	Item Description	Qty	Unit	Materials		Installation		Total Cost	Source	Notes
						$/Unit	Total	$/Unit	Total			
Div 5			**METALS**									
			Existing Walkway, sandblast, repair, paint	1	EA	$ 72,500	$ 72,500	$ -	$ -	$ 72,500		
							$ -		$ -	$ -		
Subtotal			**Division 5 Metals**							**$ 72,500**		
Div 11			**EQUIPMENT**									
			Diffusers	1	LS	$ 65,000	$ 65,000	$ 32,500	$ 32,500.00	$ 97,500	Sanitaire	
			Move Decant Pumps	2	EA	$ 2,500	$ 5,000	$ 2,400	$ 4,800.00	$ 9,800	Assume 50 ft of new pipe @ $30/ft & 64 hrs of labor @$75/hr	
			Demo air piping & diffusers	1	LS		$ -	$ 4,800	$ 4,800.00	$ 4,800	Assume 2 days, 4 workers, 8 hrs/day ea @ $75/hr	
			Positive Displacement Blower	1	EA	$ 35,000	$ 35,000	$ 17,500	$ 17,500.00	$ 52,500	cost from recent similar project	
			Motorized Butterfly Valve	4	EA	$ 9,000	$ 36,000	$ 4,500	$ 18,000.00	$ 54,000	Dezurik	
Subtotal			**Division 11 Equipment**							**$ 219,000**		
Div 16			**ELECTRICAL**									
			Blower #3 Circuit	1	EA	$ 102	$ 102	$ 1,890	$ 1,890.00	$ 1,992		
			Instrumentation Cable and Conduit	1	EA	$ 309	$ 309	$ 1,680	$ 1,680.00	$ 1,989		
			Install VFDs	1	LS	$ -	$ -	$ 2,520	$ 2,520.00	$ 2,520		
			Blower #3 VFD (TAG number)	1	EA	$ -	$ -	$ 9,000	$ 9,000.00	$ 9,000		
			VFD Setup and Startup (TAG number)	1	EA	$ 1,140	$ 1,140	$ -	$ -	$ 1,140		
			SC200 (TAG number)	2	EA	$ 2,760.00	$ 5,520.00	$ 400.00	$ 800.00	$ 6,320.00		
			DO Sensers (TAG number)	4	EA	$ 2,583.75	$ 10,335.00	$ 400.00	$ 1,600.00	$ 11,935.00		
			Wands (TAG number)	4	EA	$ 840.00	$ 3,360.00	$ 200.00	$ 800.00	$ 4,160.00		
			DO Cable Extension (TAG number)	4	EA	$ 225.00	$ 900.00	$ -	$ -	$ 900.00		
			DO Sensors Conduit/Cable	4	EA	$ 822.75	$ 3,291.00	$ 4,583.25	$ 18,333.00	$ 21,624.00		
			MASS AFM (TAG number)	4	EA	$ 400.00	$ 1,600.00	$ 3,830.00	$ 15,320.00	$ 16,920.00		
			Flow Meter Transmitter Conduit/Cable	4	EA	$ 541.28	$ 2,165.12	$ 619.00	$ 2,476.00	$ 4,641.12		
			Motorized Valves Conduit/Cable	4	EA	$ 1,569.83	$ 6,279.32	$ 1,097.00	$ 4,388.00	$ 10,667.32		
			New ASSB GE PLC Remote Panel & Installation	1	LS	$ 23,788.00	$ 23,788.00	$ 2,360.00	$ 2,360.00	$ 26,148.00		
			PLC Programming for new I/O	1	LS	$ -	$ -	$ 1,180.00	$ 1,180.00	$ 1,180.00		
Subtotal			**Division 16 Electrical**							**$ 121,136**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 412,600**		
			Subcontractor Markup						0.05	10,315.00		
			Subtotal - Direct Costs + Subcontractor Markups							**422,915.00**		
			Insurance & Bonds						0.03	$ 12,687		
			Mob/Demob						0.05	$ 21,146		
			OH&P						0.065	$ 27,489		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 484,238**		
			Contingency						0.15	$ 72,636		
			Total Construction Costs							**$ 556,873**		

Area 800 - Chemical Storage & Metering

Division	Spec #	Item #	Item Description	Qty	Unit	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total Cost	Source	Notes
Div 3			**CONCRETE**									
			16' x 24' Concrete Pad for Chem Storage	1	EA	$ 23,000	$ 23,000	$ -	$ -	$ 23,000		
							$ -		$ -	$ -		
Subtotal			**Division 3 Concrete**							**$ 23,000**		
Div 11			**EQUIPMENT**									
			Chemical feed pump Skid (NaOCl)	1	EA	$ 32,315	$ 32,315	$ 16,157	$ 16,157.27	$ 48,472	US Blue Book	
			Chemical feed pump Skid (hypo)	1	EA	$ 40,477	$ 40,477	$ 20,239	$ 20,238.52	$ 60,716	US Blue Book	
			Shower with eye flush	1	EA	$ 850	$ 850	$ 425	$ 425.00	$ 1,275	Cintas Corporation	
			Thermo Mixing valves for Shower	1	EA	$ 700	$ 700	$ 350	$ 350.00	$ 1,050	Cintas Corporation	
			Temp gage for shower	1	EA	$ 1,400	$ 1,400	$ 700	$ 700.00	$ 2,100	Cintas Corporation	
			6500 Gal Polymer Tank (NaOCl)	1	EA	$ 28,836	$ 28,836	$ 14,418	$ 14,417.78	$ 43,253	Harrington Industrial Plastics LLC	
			Tank Mixer	1	EA	$ 10,000	$ 10,000	$ 5,000	$ 5,000.00	$ 15,000	Harrington Industrial Plastics LLC	
Subtotal			**Division 11 Equipment**							**$ 172,000**		
Div 13			**SPECIAL CONSTRUCTION**									
			6'x10' FRP Building	1	EA	$ 55,191	$ 55,191	$ 2,760	$ 2,759.55	$ 57,951	Plasti-Fab	Estimated to be $800 in freight PP&A
							$ -		$ -	$ -		
Subtotal			**Division 13 Special Construction**							**$ 57,951**		
Div 15			**MECHANICAL**									
			Chemical Piping	100	FT	$ 25	$ 2,500	$ 13	$ 1,250.00	$ 3,750		
							$ -		$ -	$ -		
Subtotal			**Division 15 Mechanical**							**$ 4,000**		
Div 16			**ELECTRICAL**									
			Branch Circuiting	1	LS	$ 710	$ 710	$ 1,680.00	$ 1,680.00	$ 2,390		
			Visual/Audible Alarms	1	LS	$ 500	$ 500	$ 2,000.00	$ 2,000.00	$ 2,500		
			Chlorine Gas Detector and Calibration Kit (TAG number)	1	EA	$ 3,100	$ 3,100	$ 4,000.00	$ 4,000.00	$ 7,100		
			Go, No-Go Lights Indicators (TAG number)	1	EA	$ 400	$ 400	$ 500.00	$ 500.00	$ 900		
			CAT 6 Cables/Coduit	1	LS	$ -	$ -	$ 5,676	$ 5,676.00	$ 5,676		
			Water Heater	1	EA	$ 416	$ 416	$ 1,680	$ 1,680.00	$ 2,096		
Subtotal			**Division 16 Electrical**							**$ 20,662**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 277,600**		
			Subcontractor Markup						0.05	6,940.00		
			Subtotal - Direct Costs + Subcontractor Markups							**284,540.00**		
			Insurance & Bonds						0.03	$ 8,536		
			Mob/Demob						0.05	$ 14,227		
			OH&P						0.065	$ 18,495		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 325,798**		
			Contingency						0.15	$ 48,870		
			Total Construction Costs							**$ 374,668**		

Area 900 - Waste Pump Station & Stormwater Control

Division	Spec #	Item #	Item Description	Qty	Unit	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total Cost	Source	Notes
Div 2			EXISTING CONDITIONS									
			New Manholes	3	EA	$ 5,000	$ 15,000	$ 2,500	$ 7,500.00	$ 22,500	recent similar projects	
			Storm Drain Piping	20	FT	$ 50	$ 1,000	$ 25	$ 500.00	$ 1,500	recent similar projects	
			Waste PS Force Main	150	FT	$ 50	$ 7,500	$ 25	$ 3,750.00	$ 11,250	recent similar projects	
Subtotal			**Division 2 Existing Conditions**							**$ 35,250**		
Div 11			EQUIPMENT									
			New Pumps (two in total)	1	LS	$ 55,000	$ 55,000	$ 27,500	$ 27,500.00	$ 82,500	Flygt, includes control panel	
			New Valve Vault	1	EA	$ 35,000	$ 35,000	$ 17,500	$ 17,500.00	$ 52,500	Flygt	
			New Piping	40	FT	$ 50	$ 2,000	$ 25	$ 1,000.00	$ 3,000	recent similar projects	
Subtotal			**Division 11 Equipment**							**$ 138,000**		
Div 16			ELECTRICAL									
			Stormwater Pump Connection	2	EA	$ 200	$ 400	$ 840	$ 1,680.00	$ 2,080		
			Stormwater Pump Controls Connection	2	EA	$ 200	$ 400	$ 840	$ 1,680.00	$ 2,080		
			Stormwater VFDs (TAG number) 10HP	2	EA	$ 1,600	$ 3,200	$ 9,000	$ 18,000.00	$ 21,200		
			Stormwater VFDs Setup and Startup (TAG number)	2	EA	$ -	$ -	$ 570	$ 1,140.00	$ 1,140		
			Stormwater Instrumentation (TAG number)	1	EA	$ 1,200	$ 1,200	$ 2,000	$ 2,000.00	$ 3,200		
Subtotal			**Division 16 Electrical**							**$ 29,700**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 203,000**		
			Subcontractor Markup						0.05	5,075.00		
			Subtotal - Direct Costs + Subcontractor Markups							**208,075.00**		
			Insurance & Bonds						0.03	$ 6,242		
			Mob/Demob						0.05	$ 10,404		
			OH&P						0.065	$ 13,525		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 238,246**		
			Contingency						0.15	$ 35,737		
			Total Construction Costs							**$ 273,983**		

Division	Spec #	Item #	Item Description	Qty	Unit	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Total Cost	Source	Notes
Area 910 - Site Improvements												
Div 16			**ELECTRICAL**									
			CAT6 Infrastructure Cabling	1	LS	$ 2,991	$ 2,991	$ 9,240.00	$ 9,240.00	$ 12,231		
			480V Power Feed to RAS Bldg	1	LS	$ 6,192	$ 6,192	$ 5,250.00	$ 5,250.00	$ 11,442		
			Replace and Add LED Lighting	1	LS	$ 30,894	$ 30,894	$ 19,320.00	$ 19,320.00	$ 50,214		
			Camera Infrastructure	1	LS	$ 790	$ 790	$ 5,040.00	$ 5,040.00	$ 5,830		
			Spare Valves & instruments	1	LS	$ 20,000	$ 20,000	$ -	$ -	$ 20,000		
			Cameras	1	LS	$ -	$ -	$ 4,800.00	$ 4,800.00	$ 4,800		
			Camera Setup and Programming	1	LS	$ 2,100	$ 2,100	$ -	$ -	$ 2,100		
			Elec connection to exhaust fan in Dewatering Bldg	1	LS	$ 200	$ 200	$ 800	$ 800.00	$ 1,000		
			PC, PLC/SCADA SOFTWARE AND PROGRAMMING	1	LS	$ 82,000	$ 82,000	$ -	$ -	$ 82,000		
			PLC System Upgrade (1 to 1 Swap of existing)	1	LS	$ 189,000	$ 189,000	$ -	$ -	$ 189,000		
Subtotal			**Division 16 Electrical**							**$ 378,617**		
										Alt 1 Cost		
			Subtotal - Direct Costs							**$ 378,600**		
			Subcontractor Markup						0.05	9,465.00		
			Subtotal - Direct Costs + Subcontractor Markups							**388,065.00**		
			Insurance & Bonds						0.03	$ 11,642		
			Mob/Demob						0.05	$ 19,403		
			OH&P						0.065	$ 25,224		
			Subtotal - Direct Costs + Subcontractor Markup +							**$ 444,334**		
			Contingency						0.15	$ 66,650		
			Total Construction Costs							**$ 510,985**		

Appendix D

Control System Evaluation Technical Memorandum

The Automation Group
INTEGRATION · SCADA · CONTROLS · INSTRUMENTATION

Innovative Solutions

Sandy WWTP Condition Assessment Improvements Project Control System Evaluation Technical Memorandum

Feb. 2021

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9. Selection of GE Based on Minimal Replacement Cost
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    a. Direct I/O Digital & Analog
    b. ProfiNet Communications to I/O devices (VFDs, Valves, Remotes, Dialer)
    c. Recommendation
    d. Total Cost Comparison For PLC/SCADA System

1. Introduction

Several components of the control system at the City of Sandy Wastewater Treatment Plant (WWTP) will be upgraded as part of the Condition Assessment Improvements Project. This technical memorandum (TM) summarizes various alternatives for upgraded each component, evaluates the alternatives, identifies a preferred alternative recommended for implementation.

2. PLC Architecture Evaluation

The PLCs are being Evaluated by the following table below. The Plant Currently has GE 90-30 PLC that were installed when the Plant was built. The objective of this project is to replace the entire PLC system based on the installed life cycle and re write the logic to enhance the process control with the added/upgraded processes.

2a)

	GE RX3i	Rockwell/AB Compact Logic
Cost Installed & Programmed	$175,000	$152,000
Market Share in Oregon	3%	80%
Availability	Kirkland Washington	4 Locations in Oregon – Portland location has the Largest Stock
Alarming Functions	Via Cimplicity Alarm Manager	Check box to subscribe to Processor Based Alarms with No extra Programming
Integration Capabilities to External Drives & Intellicenter MCC	Via Prosoft 5201-DFNT-EGD Module. Requires additional programming $2,500 + $5,000 Programming	Direct via Ethernet/IP – Hangs on the Comm Tree with No Extra Programming

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3. HMI/SCADA Selection

The HMI/SCADA is being Evaluated by the following table below. The Plant is Currently using a Cimplicity 9.5 application on a PC that is being shared with the Water System and Distribution/Collections. The upgrade plan will be to split the Wastewater Treatment Plant from the rest of the systems so that a single failure does not affect the rest of the City and Vice versa. The following evaluation is for a new Windows PC to run the HMI/SCADA System.

3a)

	GE Cimplicity	Rockwell Factory Talk View
Cost Installed & Programmed	$81,700	$73,150
Connection to PLC	Ethernet	Ethernet
Connections for Events & Alarms	Programmed for each	Subscribed from PLC with a Checkbox – No Programming
PC Requirements	Windows 10	Windows 10
Connection to Dialer Systems	Hardware Dialer = Converter Module for Modbus or Ethernet/IP $2,500 Software Dialer = PC	Hardware Dialer = Direct via Ethernet/IP $0 Software Dialer = PC
License Type	TAG Based, Unlimited Screens	Screen Based, unlimited TAGS

4. CAT6 vs Fiber Evaluation

The Preliminary Report indicated Ethernet connections via Fiber using the existing raceways through the vaults. Due to the distances, fiber is not needed as the Ethernet max distances between devices will not be exceeded. Depending on how the conduits were run and their bending radiuses, we cannot be assured that the fiber max bending radiuses would not be exceeded. By using copper CAT6 Shielded to each location, we can ensure that it will be physically possible to install. In addition to the PLC Communication Ethernet Cable, we are planning to share that same conduit with the Camera system Ethernet and this will allow the conduit to be used for multiple systems.

5. Dialers

The Preliminary Report indicated a software dialer to be used. We do not recommend using a software dialer as it is dependent on the PC to be operational 100% of the time. Due to the volatility of the Windows OS we have experienced alarm failures due to the PC either shutting down unexpectedly, or during patches/upgrades in which time you will not get important needed alarms. By connecting your Alarm Dialer system directly to the PLC, you do not have to worry about not getting your alarms. Both PLC & HMI Manufactures that are being evaluated have the same costing for the Alarm Dialer. Additionally, the GE system will need a converter installed to talk to the Dialer.

5a)

	Hardware Dialer w/Programming	Software Dialer w/Programming
Cost	$8,000	$7,000
Added Cost for GE Converter to Modbus or Ethernet/IP	$2,500	$0

6. Reporting Software

Reporting Software will be the same cost for both Manufactures as it will be installed on a Separate PC running Server Software for the Historian and both systems use the same Dream Reports for Generating State Reports. Anticipated costing for the Reporting System Fully programmed will be **$31,000**

7. Secure Remote Connection

TAG is recommending a Tosi Box Solution for Operators to make a Secure Remote Connection to the Plant. This type of system uses a two-part authentication (Physical USB Key & Username/Password) to ensure a secure connection. The Plant will need a good internet connection to allow good refresh rates. This system will work with both evaluated systems and meets the latest IOT requirements for a secure connection.

8. Selection and Basis

With over 30 Years of Experience using both Systems we are recommending that the Plant be upgraded using the Rockwell/Allen Bradley PLC/HMI SCADA Solution based on the following : Rockwell integration will be seamless between the MCCs and Dialer System using native Ethernet/IP protocol as a direct link eliminating additional code at implementation also for future coding allowing for a lower cost for upgrades. The availability of parts is local to the Portland area with additional locations in Oregon. Programming and integrator support is another factor as we have done a study on the major Integrators in Oregon and Washington and 90% of all Programmers know Rockwell/Allen Bradly with only 30% knowing GE which is based on the market share in Oregon for Water and Wastewater Facilities. The final factor is the pricing is lower based on additional work needed for programming the GE PLC and HMI for tasks like Alarming and communications to remote devices like the Smart MCCs and VFD Systems.

--March. 2021--

9. Selection Of GE Based On Minimal Replacement Cost

After owner review, the decision was made to ~~not~~ keep as much of the existing system as possible and only replace the components needed to bring the system to the currently supported platform of GE. The existing serial SCADA network will still need to be upgraded to a ProfiNet (Cat6) cabling system between processors and the new SCADA PC. All the existing Processors will be upgraded to the GE RX3i and will have a duel port ProfiNet card with new Power Supplies for all chassis. The RX3i CPU uses a high-speed buss and will require that the main chassis backplane be replaced. The extended racks can stay the way they are now as the new main chassis backplane also has a serial bus so that the older cards can be used but will require a bus extender be added in the main chassis last slot. The new Main Chassis are now a 12-slot vs the 10-slot for the 90-30 so we will have room for the bus extender.

10. Cost Evaluation – Card I/O Vs Comms

We have two options for connecting the new devices to the PLC/SCADA System, Digital and Analog direct I/O wired from each device to the PLC Cards or Extending the Profinet Network to Smart Communication modules connected to the devices.

10a) Direct I/O approach

This method would require additional Digital I/O modules and terminal blocks to be installed in the PLC to accommodate the new devices and larger conduit and wire than the ProfiNet as each device will need its own cabling. Below is a ROM for added cards, terminals, larger conduits and labor but does not include the cost of the CPUs, Bases, Power Supplies and SCADA Network cards as we are only evaluating the cost for Hardwire I/O vs Comms I/O. The Direct I/O approach will also have additional design cost for individual wiring diagrams and additional card breakout.

	Cards	Terminals/Wire	Labor for card terminal wiring	Larger Conduits & Wire
Control Room (Dialer)	$1,200	$300	$1,200	NA
Dewatering	NA	NA	NA	NA
UV	NA	NA	NA	NA
RAS	Existing I/O	NA	NA	$5,000
Blower/Basin	$6,400	$700	$3,500	$30,000
ASSB VFD	$3,300	$500	$1,900	$5,000

10b) ProfiNet Communication

This method would require a communication card in all the devices to allow them to talk directly to the CPU via ProfiNet. The PLC will also require an Ethernet switch to star connect the remote cards and additional programming will be required for the interface. One advantage is that if you needed extra data from the smart devices in the future you would not need to install more wiring as it would only require some additional programming.

	Ethernet Switch	ProfiNet Comm Card	Added Programming for Network Card & Ethernet Switch Install
Control Room (Dialer)	$600	$800	$1,800
Dewatering	NA	NA	NA
UV	NA	NA	NA
RAS	$600	$1,600	$1,800
Blower/Basin	$2,900	$9,000	$2,900
ASSB VFD	$600	$800	$1,600

10c) Recommendation

Based on the added cost of the larger conduits and additional Cards with Wiring, we recommend that Profinet be used where possible for I/O communications from Drives, Valves, Remote Rack and Dialer.

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10d) Total Cost Comparison for PLC/SCADA System

Below is a total cost comparison of the PLC/SCADA System with above communication differences. The PLC cost below is based on the new approach of only replacing what is needed to incorporate the new RX3i Processors. We have removed the Reporting Package as discussed in the Design Meeting and will be using Cimplicity Historical Trends.

	Direct I/O Approach	ProfiNet Comms Approach
PLC Hardware Upgraded (CPU, Power Supplies, Chassis) & Programming	$149,000	$149,000
Hardware Dialer & Programming	$10,000	$10,000
Added Items for Direct Approach (10a)	$59,000	NA
Added Items for Communication Approach (10b)	NA	$25,000
PC, PLC/SCADA Software and Programming	$82,000	$82,000
TosiBox Remote Monitoring	$5,000	$5,000
Total	$305,000	$271,000

Appendix E

Wish List Improvements

Project: City of Sandy - WWTP PreDesign Evaluation
Client: City of Sandy
Project no. 964-50-20-01
Prepared by: West Yost, TAG, Landis
Title Wishlist Collected from Site Visit on 01/29/2021
Date 2/16/2021

WEST YOST
Water. Engineered.

Key	
Should be added to scope	
Consider if project budget allows	
Purely a wishlist item	
Process Area Number	**Process Area**
100	Headworks
150	Equalization Basin
200	Aeration Basins & Blowers
210	Secondary Clarifiers
220	RAS/WAS Pump Station
300	Filter & UV Disinfection System
600	Aerated Sludge Storage Basin (ASSB)
800	Chemical Storage & Metering Facilities
900	Waste Pump Station & Stormwater Control
910	Site Improvements

Process Area (by Number)	Wish List Item
100	Cut notch in concrete for overflow
200	Anchor clips on grating for aeration basin
200	Gate on overflow cut out on utility pump station
200	A way to measure flow going into each clarifier
210	Scum pump station improvements
210	Clarifier Underbrush
210	Double beach on skimmer
300	Filter expansion - Additional filter system to increase capacity
300	Outflow from filters - add a 90-degree Joint pointing down for entrance
300	UV expansion
300	Sandblast/wire brush rust on building steel frame & paint; repair cathodic sys
700	Hypo - 3 pump system - feed independently to RAS and utility
700	temped water for all eye washes
700	Duct fan
900	Pump in outfall stormwater manhole
910	The right tools for opening all of the electrical manholes
910	Better lighting throughout the plant
910	Alarms and cameras
910	For Solids: new gate on discharge pipe, trash pump in manhole
910	Historian Computer
910	Dream Reports
910	Rockwell SCADA