ST. GEORGE WATER POLLUTION CONTROL PLANT OPTIMIZATION STUDY

TECHNICAL MEMORANDUM

TREATMENT PROCESS MODELING

January 2012
Our File: 110-003

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GUELPH – OWEN SOUND – KITCHENER – LISTOWEL – EXETER

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Gamsby and Mannerow

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1.0 INTRODUCTION

Gamsby and Mannerow Ltd. (G&M) together with process specialists from Conestoga-Rovers and Associates (CRA), University of Western Ontario (UWO), and Huber Environmental Consulting (HEC) were retained by the St. George Landowners' Group to complete an Optimization Study of the St. George Water Pollution Control Plant (WPCP). This Technical Memorandum presents the results of computer-based treatment process modeling that was undertaken as part of the assignment. This Memo will form part of the final Optimization Study document with other Technical Memoranda prepared by the project team covering other aspects of the overall Study.

The St. George WPCP is located at 43 Victor Boulevard in the Village of St. George and serves the community of St. George by means of a gravity collection system. The plant serves an estimated population of 2,300 people. The community is primarily residential and consequently the waste stream from the community is considered to be typical municipal domestic wastewater. The plant is owned by The County of Brant and operated under contract by the Ontario Clean Water Agency (OCWA).

2.0 DESCRIPTION OF EXISTING TREATMENT PLANT

The St. George WPCP is an extended aeration activated sludge plant with a rated hydraulic capacity of 1,300 m^3/d and a design peak flow rate of 3,412 m^3/d. The plant operates under Ministry of Environment Certificate of Approval No. 9415-6CQKH5 dated June 24, 2005.

The original plant was constructed in 1981 as a package extended aeration plant with a rated hydraulic capacity of 1,063 m^3/d. Main plant processes include grit removal, comminution, aeration, coagulant feed system for phosphorous removal, secondary clarification, disinfection by chlorine, tertiary media filtration, and sludge digestion. The plant also includes a back-up diesel generator. The effluent receiving stream is an unnamed tributary of Fairchild Creek. The plant was rerated in 2005 to a capacity of 1,300 m^3/d, as a result of upgrades that included new fine bubble diffusers, a third positive displacement air blower, inlet channel grinder, conversion from gas chlorination to liquid sodium hypochlorite, dechlorination facilities, and a larger aerobic digestion facility. The original aerobic digester was converted to a sludge holding tank.

A Process Capacity Assessment conducted by G&M in 2009 concluded that based on historical data, the existing plant (without any improvements) can achieve reasonable effluent quality at flows up to an average processing capacity of 1,000 m^3/d. The plant is currently running at 86% of the estimated capacity (66% of the rated capacity); therefore, there is limited remaining capacity to meet future servicing requirements for the St. George catchment area (estimated to be ~ 4,000 m^3/day). Consequently, one of the primary objectives of the overall Optimization Study is to evaluate feasible interim upgrades to restore plant capacity to 1,300 m^3/d and ultimate plant expansion configurations. Detailed process modeling was therefore conducted to evaluate various alternatives for optimization of the existing plant, and to evaluate alternatives for plant expansion to accommodate ultimate design flows.

3.0 MODEL DEVELOPMENT

3.1 GENERAL

A detailed sampling program was conducted in April 2010 at the plant that generally involved sampling and analysis of wastewater at several locations throughout the treatment process for a comprehensive list of parameters. The program included daily sampling for 30 days plus discrete hourly sampling for a 72-hour period. Results from the sampling program are presented in a separate Technical Memorandum.

Analytical data from the sampling program was used for calibration and modeling using BioWin® (3.0) software developed by Envirosim Associates Ltd. (Burlington, ON, Canada). The St. George WPCP was modeled using basic reactors available in BioWin® (i.e. influent, aerobic reactor, ideal clarifier, aerobic digester, clarifiers, effluent, chemical feed system, and sludge wastage effluent). An overall plant process flow schematic used for process modeling is shown below in Figure 1. Although the plant does not operate at a fixed solids retention time (SRT), with sludge wastage controlled primarily by both the quantity of sludge in the aerobic digester and aeration tank mixed-liquor suspended solids (MLSS), the SRT was estimated manually at around 28 days. Part of the model calibration involved testing SRTs in the range of 15 to 25 days.

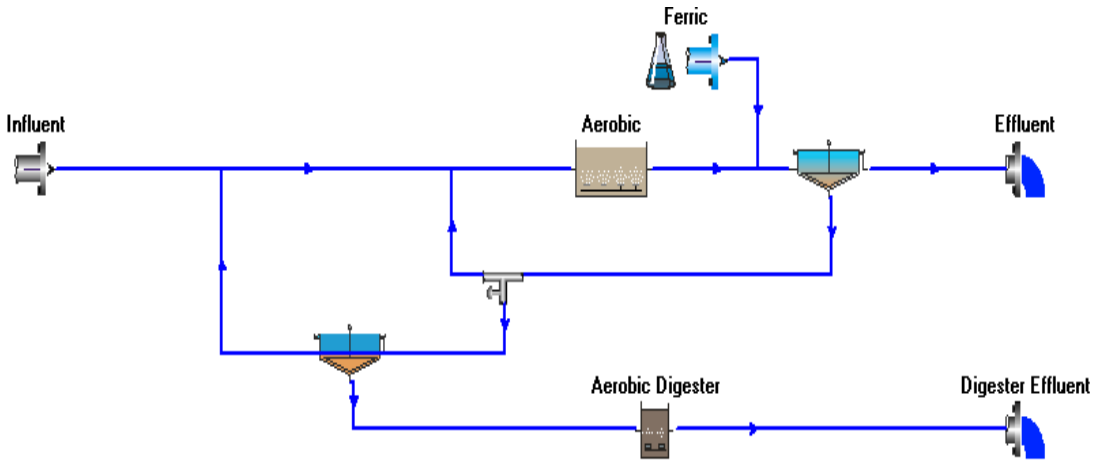

Figure 1. BioWin® Schematic Flow Diagram of St. George WPCP Model

3.2 MODEL CALIBRATION

Plant historical records along with data obtained from the detailed sampling program, as discussed above, were analyzed and used for BioWin model calibration. The purpose of the calibration was to confirm the existing data for consistency, establish details of wastewater characteristics, and confirm biological growth and decay parameters. The model was calibrated for various COD fractionations to represent the actual influent wastewater characteristics at the St. George WPCP. The calibration was then validated by matching steady state simulation predictions with averages of plant historical operating records.

Model calibration focused primarily on matching the clarifier effluent characteristics since filtration in the model only removes particulate contaminants, as well as the various biomass concentrations (as TSS) in the aeration tank and return activated sludge (RAS) primarily due to lack of reliable information on the sludge holding tank (thickener) decant and thickened waste activated sludge (WAS) going to the aerobic digester. In addition, thickener performance in terms of solids capture and flow rates was set to match the hauled sludge average daily flow rates for 2010 of 3.97 m^3/d. Plant records indicate that historically about 17.8 kg $Fe^{2+/}$d (iron in the form of ferric chloride) were added at the end of the aeration tank for phosphorus removal. With such a high chemical dose, not only is the effluent soluble phosphorus (P) too low (0.01 mg/L modeled versus 0.1 to 0.3 observed) but also the volatile fraction of biomass was unrealistically low at 47 percent. Thus, in all calibration scenarios, the ferric chloride dose was set at 21 kg/d, corresponding to an iron dose of 7.2 kg $Fe^{2+/}$d, about 40 percent of the plant's dose. This suggests that the chemical dispersion and mixing with the wastewater may not be complete.

It was also apparent from analysis of the April 2010 monitoring data that about 15 percent to 20 percent of influent Total Kjeldahl Nitrogen (TKN) is lost through nitrification/denitrification. This prompted thorough evaluation of the oxidation-reduction potential (ORP) and dissolved oxygen (DO) data. Recognizing that denitrification can occur at DO concentrations of <0.5 mg/L and ORP <50 mV, the DO and ORP at the aeration tank inlet, outlet and average (of both locations) were analyzed. On average, the DO was less than 0.5 mg/L, 46 percent of the time (43 percent at the inlet and 51 percent at the outlet). Similarly average ORP was less than 50 mV, 37 percent of the time (36 percent at the inlet and 38 percent at the outlet). Thus the modeling effort evaluated two scenarios:

Scenario A: straight aerobic bioreactor without denitrification, and
Scenario B: an aerobic bioreactor with anoxic condition for denitrification (i.e. DO of 0 mg/L, 50 percent of the time, with an overall cycle time of 10 hours).

Detailed calibration tables and modeling results for the existing plant are appended to this report as follows.

Appendix "A" Calibration Tables for Scenario A
Appendix "B" Modeling Results for Scenario A
Appendix "C" Calibration Tables for Scenario B
Appendix "D" Modeling Results for Scenario B

It is noted that in order to ensure proper fractionation since the influent specifier in BioWin calculates volatile suspended solids (VSS) and BOD from the COD fractionation, both sets of calibration tables show the comparison between modeled influent and measured influent

characteristics as appendix tables "1" (i.e. Tables A-1 in Appendix "A" and B-1 in Appendix "C' are identical). Scrutiny of the summarized data in Appendices "B" and "D" reveals the following:

- The calibrated model at an SRT of 24 days matches the effluent characteristics very well (excluding nitrates without denitrification) with all parameters well within the average $\pm$ standard deviation of the experimental data.
- The various biomass streams such as RAS and sludge holding tank decant were also well predicted. Even the thickened WAS TSS of 20,600 mg/L closely matches the one measured sample on July 29, 2010 of 22,000 mg/L.
- Upon comparing the calibration with and without denitrification, it is apparent that the only major difference is effluent nitrates which decreased by about 10 percent to 27 mg/L as opposed to the 15 percent estimated based on mass balances. This is due to continuous sludge decant assumed in the model which supplies organic nitrogen (N) and ammonia (NH_3) continuously as opposed to actual operating practice at the plant which involves manually controlled decant weekday mornings for a period of 2 to 3 hours.
- The volatile fraction of biomass predicted by the model is 60 percent lower than the measured 70 percent. This is primarily due to the long SRT contributing additional inserts due to biomass decay, which increase the concentration of inert volatile solids in the system. Consequently, due to under-prediction of VSS, the model under-predicted the total COD of various sludge streams, and also TKN in the aeration tank.
- The estimated WAS flow rate of 14 m^3/d does not agree with the 24 m^3/d (720 m^3/month) indicated by plant records.
- The model is predicting that the 280-m^3 aerobic digester would achieve 20 percent volatile solids destruction efficiency. The limited experimental data shows no significant difference between the thickened WAS and digested sludge characteristics during the sampling period of April 2010.

3.3 MODEL VERIFICATION

The available historical data include influent and final effluent general characteristics as well as operational data. Results of model verification data for 2007 to 2009 are presented in Table 1. It is noted that the model effluent represents the clarifier effluent characteristics. The calibrated model with denitrification was used for verification of historical performance. As apparent from Table 1 for 2007, although the model predicted MLSS and sludge wastage accurately, effluent NH_3 was significantly under-predicted while nitrates (NO_3^-) and nitrites (NO_2^-) were significantly over-predicted. It is noted that effluent NH_3 in 2007 was significantly above the averages for 2008 and 2009.

The variability, as reflected by the coefficient of variation (i.e. standard deviation divided by mean), was 217 percent for effluent NH_3 and 61 percent for effluent nitrates-plus-nitrites in 2007. For 2008 and 2009, there is a major discrepancy between the aeration tank MLSS and sludge haulage data, and accordingly each of the two parameters was fitted separately. In general, effluent NH_3, nitrates-plus-nitrites, and BOD were accurately predicted for 2008 and 2009. The model over prediction of effluent TSS is due to lack of filtration and is expected. However, it is evident that the solids balance is an underlying problem, as the MLSS and handled sludge volume varied by close to 100 percent with fitting each parameter individually. It is noteworthy that the sludge haulage in 2008 and 2009 were much greater (30 percent to 70 percent) than 2007 and 2010 despite same influent characteristics.

In order to validate the historical 2007 to 2009 data, a calibrated settling velocity, adjusted using the experimental sludge volume index shown below in Table 2 as a function of the maximum zone settling velocity (V_o) and settling coefficient K as shown in equations (1) and (2) [Ozinsky and Ekama, 1995] , was used to estimate settling parameters.

$$V_o = 8.53094\ e^{-0.00165(SVI)} \qquad (1)$$

$$K = 0.20036 + 0.00091\ (SVI) \qquad (2)$$

Table 2 generally shows the annual average SVIs for 2007-2010, and clearly indicate that 2008 and 2009 were both characterized by poor settling, which may rationalize the relatively higher hauled sludge volumes yet contradicts the observed high MLSS concentrations.

Table 1. Model Verification Data

Parameter	April 2007		April 2008			April 2009		
	Exp.	Calibrated Model Prediction	Exp.	Calibrated Model Prediction		Exp.	Calibrated Model Prediction	
				(a)	(b)		(a)	(b)
Influent								
Flow (m^3/d)	855	**855**	985	**985**	**985**	984	**984**	**984**
TSS (mg/L)	225±62*	**188**	162±102	**145**	**145**	119±130	**140**	**140**
BOD (mg/L)	134±19	**155**	131±102	**133**	**133**	148±69	**156**	**156**
TKN (mg/L)	35±4	**35**	22±7	**22**	**22**	26±4	**26**	**26**
TP (mg/L)	6±1	**6**	4±1	**4**	**4**	4±1	**4**	**4**
pH	8	**8**	8	**8**	**8**	8	**8**	**8**
Operational								
MLSS (mg/L)	4349±1331	**4297**	4680±659	**4283**	**2561**	476±366	**4639**	**2543**
SRT (day)	-	**22**	-	**27**	**15**	-	**27**	**14**
Thickener Solids Capture Efficiency (%)	-	**65**	-	**65**	**65**	-	**65**	**65**
Sludge Haulage Flow Rate (m^3/d)	4.7	**4.6**	6.1	**3.5**	**6.2**	6.9	**3.4**	**6.7**
Effluent								
TSS (mg/L)	3.3±2.8	**3.7**	1.9±0.5	**5.3**	**4.9**	1.9±0.9	**5.2**	**4.8**
BOD (mg/L)	12±7.1	**1.4**	3.5±0.7	**1.5**	**1.9**	2.0±0.1	**1.7**	**2.0**
NH_3 (mg/L)	2.4±5.2	**0.4**	0.4±0.4	**0.3**	**0.4**	0.2±0.1	**0.4**	**0.4**
NO_2 + NO_3 (mg/L)	12.7±7.8	**23.6**	16.5±3.7	**12.8**	**11.7**	16.9±4.1	**15.4**	**14.3**
pH	7.2	**6.8**	7.1	**7.0**	**7.0**	7.4	**6.9**	**6.9**

Notes:
*Average ± STD

Model calibration and verification against actual historical operating data (Exp.) involved efforts to match aeration tank MLSS concentration and sludge haulage quantities as closely as possible between the model and actual operating data. This was achieved for 2007 data as indicated in the above table at an SRT of 22 days. However, there was a discrepancy when comparing operating data for 2008 and 2009. Consequently, two different calibration scenarios were tested, one with an SRT of 27 days which predicted MLSS well but underestimated sludge haulage flow by ~ 50

percent, and another scenario with an SRT of 14 to 15 days which predicted sludge haulage flow well but underestimated MLSS by ~ 50 percent.

Table 2. Average Settling Parameters for the Month of April (2007 to 2010)

Year	Vo (m/day)	K (m^3/kg)	SVI
2007	181.5	0.3	73
2008	152.6	0.4	178
2009	155.7	0.4	166
2010	183.9	0.3	65

3.4 MODEL CALIBRATION SUMMARY

Based on the above observations, the calibrated model can be used to model various upgrade scenarios. Particular attention should be paid to using the model for **inorganic** solids determination resulting from chemical addition. Any upgrades to the sludge management system must be based on sludge quantities across a relatively wide range of SRTs as the plant has experienced sludge bulking in the past, not necessarily the long SRT that the plant is currently operating at. The aerobic digester performance could not be modeled well, indicating that the effective digester volume may be less than 240 m^3 since the digester is filled intermittently and is not operating as a fixed volume reactor.

4.0 PROCESS MODELING RESULTS

The calibrated model was used to determine the maximum capacity of the existing plant. Given the condition of the existing filters, it was determined that the maximum solids concentration to the filters would be 10 mg/L. The existing plant was modelled at flow rates of 1,000 m^3/d and 1,100 m^3/d, and the results are summarized in Table 3. As shown in Table 3, the maximum capacity for the existing plant is 1,100 $m^{3/}$d as shown by effluent TSS concentration of >10 mg/L. The results of process modeling verified that the maximum capacity for the existing plant is 1,100 m^3/d above which the solids loading rate to the clarifier increases and results in high (<10 mg/L) TSS in the effluent, thus strongly compromising the ability to meet the effluent TSS criteria.

The calibrated model was also used to simulate the performance of a retrofitted plant with a Biological Nutrient Removal (BNR) process (Alternative 1) as well as a newly built BNR plant (Alternative 2). The results of process modeling were used to size the process units, estimate the sludge production rate and storage capacity, and chemical dose. Modeling results can also be used as a basis for rough budget estimates for full scale implementation.

Both the liquid and solids processes at the St. George WPCP were modeled for the retrofitted plant with the Modified Ludzack Ettinger (MLE) or Anoxic-Aerobic (AO) Process (Alternative 1) as well as the newly built MLE plant (Alternative 2). The components involved in the retrofitted plant included an addition of a new 350 m^3 anoxic tank and a Waste Activated Sludge (WAS) thickener to the existing plant. The newly built MLE plant included rectangular anoxic and aerobic tanks, circular clarifier, WAS thickener, and the existing aerobic sludge digester. An overall process flow schematic used for modeling of the MLE process for the St. George WPCP is provided in Figure 2.

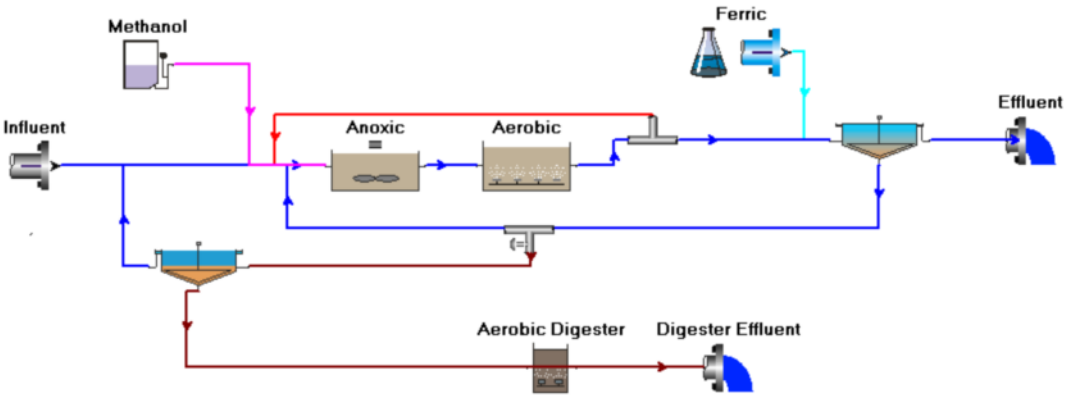

Figure 2. BioWin® Schematic Flow Diagram of Proposed MLE Process for the St. George WPCP

The design raw wastewater characteristics, which represent the average observed during the April 2010 sampling program (described elsewhere), were as follows:

TCOD = 300 mg/L
SCOD = 85 mg/L
BOD-5 = 140 mg/L
SBOD-5 = 45 mg/L
VSS = 135 mg/L
TSS = 155 mg/L
TKN = 38 mg/L
STKN = 32 mg/L
TP = 4.7 mg/L
SP = 3.4 mg/L
Alkalinity (as $CaCO_3$) = 400 mg/L

The modeling effort evaluated three scenarios for Alternative 1 at flow rates of 1,100 m^3/d, 1,300 m^3/d, and 1,500 m^3/d, and three scenarios for Alternative 2 at flow rates of 1,600 m^3/d, 2,600 m^3/d and 3,600 m^3/d. Sensitivity analysis was conducted to determine the maximum plant capacity for Alternative 1. The process modeling for Alternative 1 was conducted at the average design concentrations while both average and the 90th percentile concentrations were considered in modeling of Alternative 2. The 90th percentile concentrations are summarized in Table A-1. For both alternatives, methanol was added as a carbon source to achieve higher levels of denitrification. Detailed process modeling results are discussed in Sections 4.1 for Alternative 1 and Section 4.2 for Alternative 2. The detailed modeling reports for the flow rates of 1,500 m^3/d (retrofitted plant) and 3,600 m^3/d (new plant) are attached in Appendix "E". Tables 4a and 4b summarize the effluent quality and sludge management for the retrofitted plant at average design concentrations (Alternative 1), respectively. Tables 5a and 5b present the effluent quality management results for the maximum capacity of the existing plant after conversion to BNR Alternative 1 at average and 90th percentile design concentrations, respectively. Tables 6a and 6b, and 7a and 7b summarize the effluent quality and sludge management results for Alternative 2 at the average and 90th percentile concentrations, respectively.

4.1 ALTERNATIVE 1

4.1.1 Effluent Quality

As noted above, the model-predicted effluent characteristics are presented in Table 4a for Alternative 1. The plant will produce an effluent quality which meets all of the effluent quality criteria stipulated in the current Ministry of the Environment (MOE) Certificate of Approval (C of A) 9415-6CQKH5. For all scenarios presented in Table 4a (plant flow rates of 1,100 m^3/d, 1300 m^3/d, and 1500 m^3/d), clarified effluent NH_3 concentration is < 0.6 mg/L, TP < 0.2 mg/L, TN < 10 mg/L, and TSS and BOD concentrations are < 5 mg/L.

4.1.2 Conceptual Design Considerations

Sludge Production

By retrofitting an existing plant with the MLE process, the biological processing capacity of the plant increases as a result of the introduction of an anoxic tank, reduced sludge yield, and improved sludge settling characteristics. Considering that the overall sludge management capability at the plant is limited, application of the MLE process to reduce the sludge yield is an attractive alternative for the St. George WPCP. Based on plant records, the St. George WPCP currently produces approximately 720 m^3/month (24 m^3/d) WAS at the plant hydraulic flow rate of 830 m^3/d as indicated by the operator in a teleconference. The results of modeling in terms of sludge management are presented in Table 4b for Alternative 1 and Tables 5b and 6b for Alternative 2 at average design and 90th percentile concentrations. Process modeling for the retrofitted plant (Alternative 1) operating at an SRT of 15 days treating 1,100 m^3/d, 1,300 m^3/d, and 1,500 m^3/d at 15^{o}C, indicated that the plant will produce approximately 6.54 m^3/d of WAS which is significantly less than the WAS generation for the current plant. It should be noted that under current conditions, the calibrated model estimates that the total dry solids production of the Extended Aeration plant, prior to thickening and digestion, based on a WAS flow of 14 m^3/d and WAS solids concentration of 8,740 mg/L (Tables A-4a and B-4a) is 122 kgTSS/d, corresponding to an overall yield of 1.14 kgTSS/kgBOD-5. The same calculations for the MLE process using the WAS flows and solids concentrations depicted in Table 4b, result in sludge production rate of 140 kg TSS/d to 190 kg TSS/d and overall biological sludge yields of 0.90 kgTSS/kgBOD-5, 0.91 kgTSS/kgBOD-5, and 1.15 kgTSS/kgBOD-5 for the 1,100 m^3/d, 1,300 m^3/d, and 1,500 m^3/d, representing an average reduction of 14%, relative to the Extended Aeration plant. It must be asserted that the above yield calculations for the BNR are solely based on the wastewater BOD and do not include the methanol.

It is concluded that the sludge production and hauled sludge average daily flow rates decrease by converting the Extended Aeration Activated Sludge (EAAS) plant to the MLE process which is beneficial to the operation of the plant in terms of longer sludge storage time and lower sludge haulage costs. As presented in Table 4b the retention time in the aerobic digester will be 43 days for Alternative 1 which corresponds to one truckload per week.

In order to address constraints in sludge processing capability of the current sludge management system at St. George WPCP and to reduce haulage rate of digested sludge to Paris WPCP, sludge thickening through application of Dissolved Air Flotation (DAF) technology is proposed. Application of DAF at St. George WPCP is an economically attractive solution to reduce the overall WAS quantity and volume, while extending the retention time in the aerobic digester in

the existing sludge management system. A DAF unit could be installed between the secondary clarifier and the aerobic digester. Thickened sludge entrained by rising air bubbles would be removed from the top of the DAF and transferred to the digester while clarified underflow could be returned to the plant influent stream.

Chemical Dose

The estimated chemical doses for the retrofitted plant are 8.31 kg $Fe^{3+/}$d, 10.85 kg $Fe^{3+/}$d, and 12.87kg $Fe^{3+/}$d at the plant flow rates of 1,100 m^3/d, 1,300 m^3/d, and 1,500 m^3/d, respectively. The ferric chloride dose for Alternative 1 (retrofitted plant) is 13 to 26 percent lower than the flow pro-rated dose of 11.3 kg $Fe^{3+/}$d to 14.8 kg $Fe^{3+/}$d based on the ***modeled*** ferric chloride dose of 7.2 kg $Fe^{3+/}$d at a flow rate of 830 m^3/d. The conversion of the existing EAAS plant to the MLE process will reduce the chemical consumption and the associated costs due to enhanced biological phosphorous removal resulting in higher P content of biomass despite the reduced sludge yield.

Methanol doses for the various flows of Alternative 1 are 40 L/d, 50 L/d, and 60 L/d at plant flow rates of 1,100 m^3/d, 1,300 m^3/d, and 1,500 m^3/d, respectively.

Maximum Plant Capacity

Sensitivity analysis was conducted to determine the plant maximum capacity by retrofitting the existing plant to a BNR process in Alternative 1 which includes addition of a 350 m^3 anoxic tank and a DAF system. Biological process modeling indicated that the treatment capacity at the plant can increase to 2,000 m^3/d for Alternative 1. Clarifier effluent TSS concentration > 10 mg/L was selected as the criteria to determine the maximum plant capacity. The effluent quality at the ultimate plant capacity for Alternative 1 (2,000 m^3/d) is presented in Tables 5a and 5b for the average and 90th percentile conditions. As apparent from Tables 5a and 5b, the clarifier effluent TSS concentration at 2,000 m^3/d is 10 and 10.1 mg/L at the average and 90th percentile conditions. Flow rates higher than 2,000 m^3/d resulted in clarifier effluent TSS concentrations exceeding the 10 mg/L criteria. Therefore, to further increase the plant processing capacity, Alternative 2 will need to be considered which includes building new rectangular anoxic and aerobic tanks and a circular clarifier.

4.2 ALTERNATIVE 2

As noted above, the process modeling for Alternative 2 (at plant flow rates of 1,600 m^3/d, 2,600 m^3/d and 3,600 m^3/d) was conducted at the average design concentrations as defined in Section 4.0 as well as the 90th percentile concentrations (Table A-1). Tables 6a and 6b present the effluent quality and sludge management results for Alternative 2 at average design concentrations, respectively, while Tables 7a and 7b summarize the effluent quality and sludge management results for Alternative 2 at 90th percentile concentrations, respectively. The tank sizes for the new plants are also specified in Tables 6a and 7a for the plant flow rate of 1,600 m^3/d, 2,600 m^3/d, and 3,600 m^3/d. The components involved in the new plant at 1,600 m^3/d included an addition of a 250 m^3 anoxic tank, a 1000 m^3 aerobic tank, a 110 m^2 circular clarifier, a new Waste Activated Sludge (WAS) thickener, and the existing aerobic digester. The new plant at 2,600 m^3/d included a 350 m^3 anoxic tank, a 1,400 m^3 aerobic tank, a 110 m^2 circular clarifier, a WAS thickener and uses the existing aerobic sludge digester. The tank sizes for the flow rate of 3,600 m^3/d include a 700 m^3 anoxic tank (two- 350 m^3 tanks), 2,310 m^3 aerobic tank (830 m^3

existing aerobic tank + 80 m^3 existing sludge storage tank + 1,400 m^3 new aerobic tank), a 199 m^2 clarifier (89 m^2 existing clarifier + 110 m^2 new clarifier), a WAS thickener and the existing aerobic sludge digester. Detailed process modeling results are discussed below.

4.2.1 Effluent Quality

As noted above, the model-predicted effluent characteristics are presented in Tables 6a and 7a for Alternative 2 at average and 90th percentile concentrations, respectively. The plant will produce an effluent quality which meets all of the effluent quality criteria stipulated in the current Ministry of the Environment (MOE) Certificate of Approval (C of A) 9415-6CQKH5. For all scenarios at both average and 90th percentile conditions, clarified effluent NH_3 concentration is < 0.6 mg/L, TP < 0.2 mg/L, TN < 10 mg/L, and TSS and BOD concentrations are < 5 mg/L.

4.2.2 Conceptual Design Considerations

Sludge Production

The sludge generation rates for Alternative 2 are 9.2 m^3/d, 11 m^3/d and 21 m^3/d at the plant flow rates of 1,600 m^3/d (both average and 90th percentile), 2,600 m^3/d (both average and 90th percentile) and 3,600 m^3/d (both average and 90th percentile). As presented in Tables 6b and 7b, the retention time in the aerobic digester will be 30, 25, and 13 days for Alternative 2 at 1,600 m^3/d, 2,600 m^3/d, and 3,600 m^3/d, at both average and 90th percentile concentrations, respectively. This corresponds to two truckloads per week at 1,600 m^3/d and 2,600 m^3/d, and four truckloads per week at 3,600 m^3/d for Alternative 2 at both average and 90th percentile concentrations. Similar to Alternative 1, the application of DAF technology is proposed to reduce the overall WAS quantity and volume, while extending the retention time in the aerobic digester in the existing sludge management system. A DAF unit could be installed between the secondary clarifier and the aerobic digester. Thickened sludge entrained by rising air bubbles would be removed from the top of the DAF and transferred to the digester while clarified underflow could be returned to the plant influent stream.

Chemical Dose

For Alternative 2 (new plant), the chemical dose is estimated to be 11.6 kg Fe/d to 16 kg Fe/d at the plant flow rate of 1,600 m^3/d at the average and 90th percentile conditions, respectively. As apparent from Tables 6a and 7a, 29 Fe^{2+}/d is required at the average conditions for plant flow rates of 2,600 m^3/d and 3,600 m^3/d while 31 kg Fe^{2+}/d to 34 kg Fe^{2+}/d is required at the 90th percentile conditions for the plant flow rates of 2,600 m^3/d and 3,600 m^3/d, respectively. The conversion of the existing EAAS plant to the MLE process will reduce the chemical consumption and the associated costs due to enhanced biological phosphorous removal resulting in higher P content of biomass despite the reduced sludge yield.

Methanol doses at the plant flow rate of 1,600 m^3/d are 120 L/d and 140 L/d for the average and 90th percentile conditions, respectively. At the plant flow rate of 2600 m^3/d, 160 L/d and 200 L/d of methanol is required at average and 90th percentile conditions, respectively, while 250 L/d of methanol are required at the plant flow rate of 3,600 m^3/d for both average and 90th percentile conditions to achieve high levels of denitrification.

5.0 SUMMARY

Historical plant data for St. George Water Pollution Control Plant (WPCP) were reviewed and modeled using a process modeling software. A process model was developed for the retrofitted existing plant with the MLE process (Alternative 1) as well as a newly built MLE plant (Alternative 2). The results of process modeling indicated that the maximum biological processing capacity of the existing plant is 1,100 m^3/d, above which the solids loading rate to the clarifier increases and results in high (>10 mg/L) effluent TSS concentrations. By retrofitting the existing EAAS process with the MLE process, the biological processing capacity can increase to a maximum of 2,000 m^3/d with the addition of a new 350 m^3 anoxic tank. To further increase the plant capacity, Alternative 2 is proposed. The biological processing capacity can increase to 3,600 m^3/d by building a new MLE plant. For both alternatives, the plant will produce a clarified effluent with NH_3 < 0.6 mg/L, TP < 0.2 mg/L, TN < 10 mg/L, and TSS and BOD concentrations < 5 mg/L. Lower sludge yield and consequently lower sludge production for the MLE process makes it an economical alternative to address the sludge processing capacity limitations both on site as well as at the Paris WPCP. In addition, the chemical (ferric) dose at the plant will decrease by converting the existing plant to MLE process.

In order to reduce the overall WAS quantity and extend the retention time in the existing aerobic digester, application of a DAF unit is proposed for WAS thickening. It should be noted that Alternative 2 is superior to Alternative 1 in terms of ease of maintenance/repairs and flexibility of operation. Furthermore, retrofitting the existing plant to an MLE process, as described by Alternative 1, may pose some operational difficulties during construction as the existing plant will stay in operation while the modifications are done for conversion to the MLE process. Also, the effluent from the existing plant may exceed effluent quality criteria during the construction period for Alternative 1. Thus for Alternative 1, a temporary treatment system may be required during construction. Alternative 2 will allow the existing plant to be in operation while the new MLE plant is constructed. Process design for Alternative 2 includes two treatment trains, thus allowing the existing plant to be used when the portion (or all) of the new plant is removed from service for preventative maintenance purposes.

All of which is respectfully submitted.

GAMSBY AND MANNEROW LIMITED

Per: Per:

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POLLUTION CONTROL PROCESS CONSULTING

Per:

Dr. George Nakhla, PhD, P. Eng., P.E. (Michigan)

REFERENCES

Ozinsky, A.E., and Ekama, G.A. (1995) Secondary Settling Tank Modeling and Design Part 2: Linking Sludge Settleability Measures. Water SA, Vol. 21, 4, 333.

Table 3. Process Modeling Results for the Existing Plant

Flow	SRT	Temp	Influent			Unit Processes		Operational			Clarifier Effluent					
			COD	TKN	TP	Aerobic Vol.	Clarifier Area	Ferric Dose	MLSS	MLVSS	cBOD	NH_3	NO_3	TN	TSS	TP
m^3/d	d	(ºC)	mg/L	mg/L	mg/L	m^3	m^2	kg/d	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
830	24	15	300	38	4.7	830	89	7.2	3,450	1,970	1.8	0.35	30	33	7	0.47
1,000	24	15	300	38	4.7	830	89	9.4	4,150	2,130	2.3	0.42	30	33	9.4	0.42
1,100	24	15	300	38	4.7	830	89	10.1	4,480	2,530	2.4	0.35	30	33	10.9	0.49

Table 4a. Process Modeling Results for Alternative 1 (Average Conditions) – Effluent Quality

Scenario	Flow	SRT	Temp	Influent			Unit Processes			Operational				Clarifier Effluent							Filtered Effluent [2]						
				COD	TKN	TP	Anoxic Vol. [1]	Aerobic Vol.	Clarifier Area	Ferric Dose	Methanol Dose	MLSS	MLVSS	cBOD	NH_3	NO_3	TN	TSS	TP	SP	cBOD	NH_3	NO_3	TN	TSS	TP	SP
	m^3/d	d	(ºC)	mg/L	mg/L	mg/L	m^3	m^3	m^2	kg/d	L/d	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	1,100	15	15	300	38	4.7	350	830	89	8.3	40	2,532	1,580	1.9	0.47	5.06	7.91	4.4	0.22	0.03	1.6	0.47	5.06	7.83	1--5	0.16	0.03
2	1,300	15	15	300	38	4.7	350	830	89	10.8	50	2,993	1,837	2.1	0.48	5.02	7.93	5.5	0.23	0.01	1.6	0.48	5.02	7.8	1--5	0.12	0.01
3	1,500	15	15	300	38	4.7	350	830	89	12.9	60	3,442	2,107	2.4	0.55	4.97	8.03	6.6	0.28	0.01	1.7	0.55	4.97	7.84	1--5	0.13	0.01

Table 4b. Process Modeling Results for Alternative 1 (Average Conditions) – Sludge Management

Scenario	Flow	WAS Thickener Vol.	Aerobic Digester Vol.	WAS flow	WAS Conc.	Thickener Solid Capture Efficiency	Thickened WAS Conc.	Digested Sludge Conc.	Digested Sludge Flow	Retention Time in Digester	Storage Capacity
	m^3/d	m^3	m^3	m^3/d	mg/L	%	%	%	m^3/d	d	Truck/week [3]
1	1,100	112	278	23.7	5,910	85	1.8	1.5	6.5	43	1
2	1,300	112	278	23.7	6,980	85	2.1	1.8	6.5	43	1
3	1,500	112	278	23.7	8,024	85	2.4	2	6.5	43	1

Notes
(1) SWD of 4.5 m to 5 m.
(2) The filtered effluent BOD, TN, and TP are calculated based on the BOD, N, and P content of Biomass from BioWin as 20%, 5.2%, and 4.1% of TSS, respectively.
(3) Assumed a Truck Capacity of 30,000 L (8,000 US gal.).

Table 5a. Process Modeling Results for Alternative 1 at Max. Plant Capacity (Average Conditions) – Effluent Quality

Flow	SRT	Temp	Influent			Unit Processes			Operational				Clarifier Effluent							Filtered Effluent [2]						
			COD	TKN	TP	Anoxic Vol. [1]	Aerobic Vol.	Clarifier Area	Ferric Dose	Methanol Dose	MLSS	MLVSS	cBOD	NH_3	NO_3	TN	TSS	TP	SP	cBOD	NH_3	NO_3	TN	TSS	TP	SP
m^3/d	d	(ºC)	mg/L	mg/L	mg/L	m^3	m^3	m^2	kg/d	L/d	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2,000	15	15	300	38	4.7	350	830	89	18	100	4,555	2,791	3.2	0.56	4.91	8.15	10	0.41	0.01	1.8	0.56	4.91	7.8	1--5	0.13	0.01

Table 5b. Process Modeling Results for Alternative 1 at Max. Plant Capacity (90th Percentile Conditions) – Effluent Quality

Flow	SRT	Temp	Influent			Unit Processes			Operational				Clarifier Effluent							Filtered Effluent (2)						
			COD	TKN	TP	Anoxic Vol. (1)	Aerobic Vol.	Clarifier Area	Ferric Dose	Methanol Dose	MLSS	MLVSS	cBOD	NH_3	NO_3	TN	TSS	TP	SP	cBOD	NH_3	NO_3	TN	TSS	TP	SP
m^3/d	d	(ºC)	mg/L	mg/L	mg/L	m^3	m^3	m^2	kg/d	L/d	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2,000	11	15	460	46	6.2	350	830	89	20.2	150	4,736	3,252	3.5	0.65	5.57	9.07	10.1	0.39	0.01	1.9	0.65	5.57	8.65	1--5	0.12	0.01

Notes
(1) SWD of 4.5 m to 5 m.
(2) The filtered effluent BOD, TN, and TP are calculated based on the BOD, N, and P content of Biomass from BioWin as 20% to 2 %, 5.3% to 5.9%, and 3.8% to 4% of TSS, respectively.

Table 6a. Process Modeling Results for Alternative 2 (Average Conditions) – Effluent Quality

Scenario	Flow	SRT	Temp	Influent			Unit Processes			Operational				Clarifier Effluent							Filtered Effluent (2)						
				COD	TKN	TP	Anoxic Vol. (1)	Aerobic Vol. (1)	Clarifier Area	Ferric Dose	Methanol Dose	MLSS	MLVSS	cBOD	NH_3	NO_3	TN	TSS	TP	SP	cBOD	NH_3	NO_3	TN	TSS	TP	SP
	m^3/d	d	(C)	mg/L	mg/L	mg/L	m^3	m^3	m^2	kg/d	L/d	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
4	1,600	15	15	300	38	4.7	250	1,000	110	11.6	120	3,290	2,164	2.3	0.45	4.7	7.6	5.6	0.25	0.02	1.7	0.45	4.7	7.4	1--5	0.15	0.02
5	2,600	15	15	300	38	4.7	350	1,400	110	29	160	3,880	2,395	3.4	0.5	5	8.2	10.4	0.39	0.01	1.8	0.5	5	7.8	1--5	0.12	0.01
6	3,600	15	15	300	38	4.7	700	2,310	200	29	250	3,135	2,011	2.7	0.5	4.7	7.7	7.3	0.29	0.01	1.8	0.5	4.7	7.5	1--5	0.12	0.01

Table 6b. Process Modeling Results for Alternative 2 (Average Conditions) – Sludge Management

Scenario	Flow	WAS Thickener Vol.	Aerobic Digester Vol.	WAS flow	WAS Conc.	Thickener Solid capture Efficiency	Thickened WAS Conc.	Digested Sludge Conc.	Digested Sludge Flow	Retention Time in Digester	Storage Capacity (1)
	m^3/d	m^3	m^3	m^3/d	mg/L	%	%	%	m^3/d	d	Truck/week
4	1,600	112	278	33.3	6,575	85	2	1.6	9.2	30	2
5	2,600	112	278	40	9,045	85	2.8	2.3	11	25	2
6	3,600	112	278	77	6,259	85	1.9	1.7	21.2	13	4

Table 7a. Process Modeling Results for Alternative 2 (90th Percentile Conditions) – Effluent Quality

Scenario	Flow	SRT	Temp	Influent			Unit Processes			Operational				Clarifier Effluent							Filtered Effluent (2)						
				COD	TKN	TP	Anoxic Vol. (1)	Aerobic Vol. (1)	Clarifier Area	Ferric Dose	Methanol Dose	MLSS	MLVSS	cBOD	NH_3	NO_3	TN	TSS	TP	SP	cBOD	NH_3	NO_3	TN	TSS	TP	SP
	m^3/d	d	(ºC)	mg/L	mg/L	mg/L	m^3	m^3	m^2	kg/d	L/d	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
4	1,600	15	15	460	46	6.2	250	1,000	110	16	140	4,482	3,107	2.4	0.5	5.47	8.5	5.8	0.23	0.01	1.7	0.5	5.47	8.3	1--5	0.12	0.01
5	2,600	15	15	460	46	6.2	350	1,400	110	31	200	5,556	3,490	3.4	0.5	5.57	8.91	11.3	0.39	0.01	0.9	0.5	5.57	8.17	1--5	0.11	0.01
6	3,600	15	15	460	46	6.2	700	2,310	200	34	250	4,500	2,857	2.5	0.45	5.53	8.61	7.8	0.29	0.01	1.6	0.45	5.53	8.35	1--5	0.11	0.01

Table 7b. Process Modeling Results for Alternative 2 (90th Percentile Conditions) – Sludge Management

Scenario	Flow	WAS Thickener Vol.	Aerobic Digester Vol.	WAS flow	WAS Conc.	Thickener Solid Capture Efficiency	Thickened WAS Conc.	Digested Sludge Conc.	Digested Sludge Flow	Retention Time in Digester	Storage Capacity (3)
	m^3/d	m^3	m^3	m^3/d	mg/L	%	%	%	m^3/d	d	Truck/week
4	1.600	112	278	33.3	8,951	85	2.8	2.2	9.2	30	2
5	2.600	112	278	40	12,950	85	4	3.4	11	25	2
6	3.600	112	278	77	8,986	85	2.7	2.4	21.2	13	4

Notes
(1) SWD of 4.5m to 5 m.
(2) The filtered effluent BOD, TN, and TP are calculated based on the BOD, N, and P content of Biomass from BioWin as 20% to 24 %, 5.3% to 6 %, and 3.4% to 3.8% of TSS, respectively.
(3) Assumed a Truck Capacity of 30,000 L (8,000 US gal.).

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APPENDIX "A"

CALIBRATION TABLES
FOR SCENARIO A

St. George WPCP Modeling Report (A- Without Denitrification)

Table A-1. Characteristics of Raw Sewage

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
Flow (m^3/d)	827 ± 91	914	756	**827**
TSS (mg/L)	169 ± 104	311	46	**147**
VSS (mg/L)	152 ± 93	281	39	**130**
TBOD (mg/L)	129 ± 69	206	67	**131**
SBOD (mg/L)	40 ± 16	63	18	**41**
TCOD (mg/L)	288 ± 122	461	159	**288**
SCOD (mg/L)	76 ± 33	115	43	**80**
TKN (mg/L)	38 ± 13	46	29	**38**
STKN (mg/L)	30 ± 10	40	23	**32**
Ammonia (mg/L)	25.6 ± 4.6	32	21	**25.6**
Nitrite (mg/L)	0.10 ± 0.14	0.23	0.02	**0**
Nitrate (mg/L)	0.20	0.2	0.2	**0.2**
Nitrate and Nitrite (mg/L)	0.30 ± 0.28	0.46	0.14	**0.2**
TP (mg/L)	4.7 ± 1.7	6.2	3.3	**4.7**
SP (mg/L)	3.4 ± 1.1	4.3	2.7	**3.4**
Alk. ($mgCaCO_3/L$)	403 ± 36	429	371	**403**
Oil and Grease	13.3 ± 6.2	23.0	6.7	**-**
pH	7.6 ± 0.2	7.8	7.3	**7.6**
Temp (^oC)	13.6 ± 1.1	14.3	12.3	**13**

Table A-2. Characteristics of Aeration Tank Effluent

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	3670 ± 576	4310	2990	**3447**
VSS (mg/L)	2727 ± 433	3200	2190	**1967**
TBOD (mg/L)	878 ± 169	1010	628	**432**
SBOD (mg/L)	3.8 ± 5.0	5.0	3.0	**1.0**
TCOD (mg/L)	3103 ± 1143	4410	1880	**2961**
SCOD (mg/L)	231 ± 105	353	123	**23**
TKN (mg/L)	221 ± 58	280	148	**164**
STKN (mg/L)	35 ± 9	44	24	**3**
Ammonia (mg/L)	4.9 ± 2.6	7.7	2.3	**0.4**
Nitrite (mg/L)	1.9 ± 0.9	3.1	0.6	**0.1**
Nitrate (mg/L)	2.2 ± 1.3	3.8	1.0	**30**
Nitrate and Nitrite (mg/L)	3.7 ± 1.8	5.9	1.1	**30.1**
TP (mg/L)	73 ± 40	104	1.3	**152**
SP (mg/L)	1.0 ± 0.7	1.9	0.3	**2**
Alk. ($mgCaCO_3/L$)	424 ± 61	508	347	**530**
Oil and Grease	9.8 ± 1.1	10.7	9.0	**---**
pH	7.2 ± 0.2	7.4	7.0	**6.9**
Temp (^oC)	13.1 ± 0.9	14.0	12.1	**13**

Table A-3. Characteristics of Clarifier Effluent

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	6.6 ± 3.3	10.1	4.0	**6.9**
VSS (mg/L)	5.7 ± 4.7	7.1	2.0	**4.0**
TBOD (mg/L)	3.9 ± 1.9	5.0	3.0	**1.8**
SBOD (mg/L)	3.0 ± 0.8	4.0	2.0	**1.0**
TCOD (mg/L)	26.3 ± 5.5	31.0	22.8	**28.8**
SCOD (mg/L)	22.6 ± 3.5	26.5	18.5	**22.9**
TKN (mg/L)	2.0 ± 1.3	2.8	1.3	**2.8**
STKN (mg/L)	1.3 ± 1.0	2.3	0.7	**2.5**
Ammonia (mg/L)	0.6 ± 1.1	1.1	0.1	**0.4**
Nitrite (mg/L)	0.6 ± 1.1	2.2	0.0	**0.7**
Nitrate (mg/L)	22.3 ± 4.3	26.1	16.8	**30**
Nitrate and Nitrite (mg/L)	23.2 ± 4.4	26.1	18.0	**30.7**
TP (mg/L)	0.4 ± 0.2	0.4	0.2	**0.4**
SP (mg/L)	0.1 ± 0.2	0.2	0.1	**0.1**
Alk. ($mgCaCO_3/L$)	196 ± 15	210	181	**189**
Oil and Grease	1.5 ± 0.9	2.0	0.9	**---**
pH	7.3	7.3	7.3	**6.8**
Temp (^oC)	11.8	11.8	11.8	**13**

Table A-4a. Characteristics of RAS/WAS

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	9692 ± 3642	15400	5740	**8739**
VSS (mg/L)	7223 ± 2744	11520	4140	**4965**
TCOD (mg/L)	9496 ± 5774	13900	4210	**7440**
SCOD (mg/L)	834 ± 602	1815	255	**1088**

Table A-4b. Characteristics of Sludge Tank Decant

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	1933 ± 2832	4580	43	**4220**
VSS (mg/L)	1435 ± 2068	3380	31	**2398**
TCOD (mg/L)	1486 ± 1773	3540	276	**3605**
SCOD (mg/L)	740 ± 568	1473	204	**526**

Note: Two Decant samples on July 29th, 2010 indicated the following characteristics (mg/L): TCOD = 5,000, SCOD = 656-671, TSS = 3,000-5,700, VSS= 2,200-3,900, TKN=320-390, NH_4-N = 69-71

Table A-4c. Characteristics of Digester Effluent

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	23652 ± 1434	25000	22000	**18133**
VSS (mg/L)	16190 ± 928	17000	15000	**9439**

Note: A mixed thickened sludge sample on July 29th, 2010 indicated the following characteristics (mg/L): TCOD=27,000, SCOD = 1,080,TSS = 22,000,VSS= 15,000,TKN=1,300,NH_4-N = 130

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APPENDIX "B"

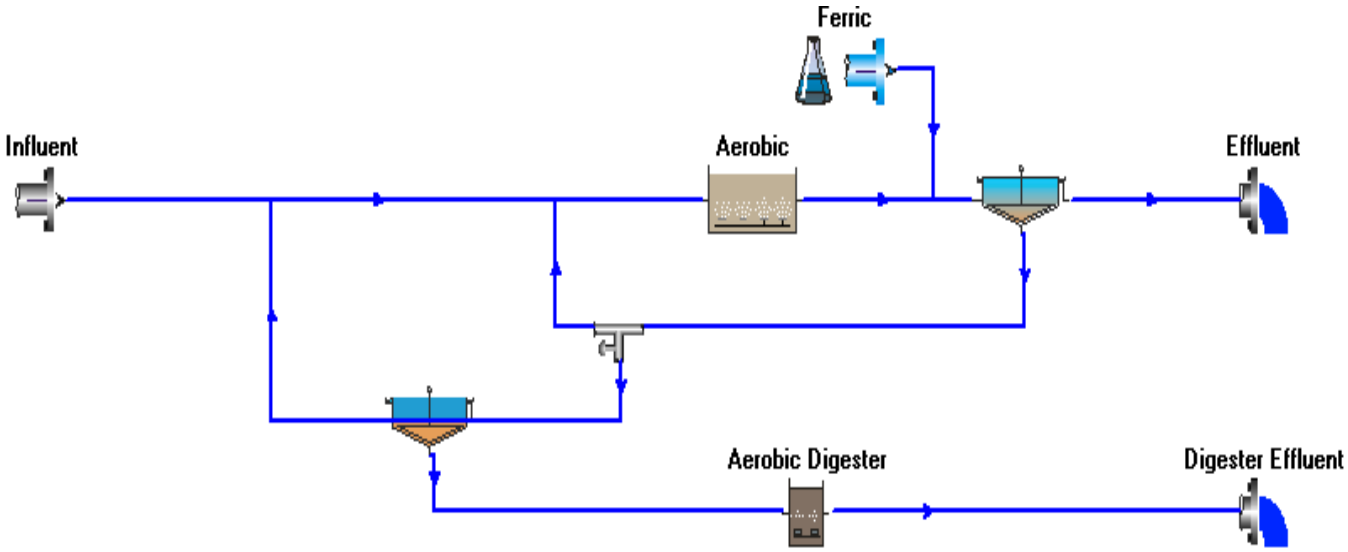
MODELING RESULTS
FOR SCENARIO A

St. George WPCP Modeling Report (A- Without Denitrification)

WPCP-final calibration (13°C)

Flow	827.00	m3/d
Total COD	288.00	mg/L
Total Kjeldahl Nitrogen	38.00	mgN/L
Total P	4.70	mgP/L
Inorganic S.S.	17.00	mg/L
Volatile suspended solids	129.93	mgVSS/L
Total suspended solids	146.96	mgTSS/L
Total Carbonaceous BOD	131.45	mg/L
pH	7.60	

Solids retention time (SRT) = 24 days
Temperature = 13 °C

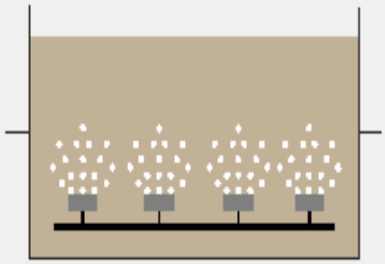


Influent Characteristics

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	129.93	107.45	
Total suspended...	146.96	121.53	
Particulate COD	207.86	171.90	
Filtered COD	80.14	66.28	
Total COD	288.00	238.18	
Soluble PO4-P	3.40	2.81	
Total P	4.70	3.89	
Filtered TKN	31.52	26.07	
Particulate TKN	6.48	5.36	
Total Kjeldahl Nit...	38.00	31.43	
Filtered Carbona...	41.35	34.20	
Total Carbonace...	131.45	108.71	
Nitrite + Nitrate	0.20	0.17	
Total N	38.20	31.59	
Total inorganic N	25.81	21.35	
Alkalinity	8.06	6.67	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	4.99	4.13	
Total precipitate...	0	0	
Total inorganic s...	17.02	14.08	
Ammonia N	25.61	21.18	
Nitrate N	0.20	0.17	

Aerobic

Name: Aerobic		Type: Bioreactor
Volume:	851.84	m3
Area:	193.60	m2
Depth:	4.40	m
Diffuser coverage:	15.00	%
Number of diffusers:	708	
Diffuser unit area:	0.0410	m2

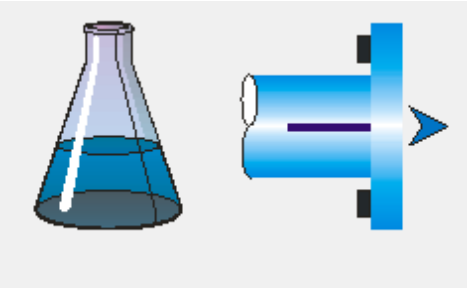


Hydraulic residence time	15.0	hours
Ammonia N	0.35	mgN/L
Nitrate N	30.01	mgN/L
Nitrite N	0.07	mgN/L
Soluble PO4-P	2.01	mgP/L
Volatile suspended solids	1967	mgVSS/L
Total suspended solids	3447	mgTSS/L
Dissolved oxygen	2.00	mg/L
pH	6.89	

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	1967.10	2679.47	
Total suspended...	3447.14	4695.50	
Particulate COD	2938.36	4002.47	
Filtered COD	22.97	31.29	
Total COD	2961.33	4033.76	
Soluble PO4-P	2.01	2.74	
Total P	152.38	207.57	
Filtered TKN	2.51	3.41	
Particulate TKN	161.14	219.49	
Total Kjeldahl Nit...	163.64	222.91	
Filtered Carbona...	0.97	1.32	
Total Carbonace...	431.82	588.20	
Nitrite + Nitrate	30.08	40.97	
Total N	193.72	263.88	
Total inorganic N	30.43	41.45	
Alkalinity	10.63	14.48	mmol/L and kmol/d
pH	6.89		
Volatile fatty acids	0.01	0.01	
Total precipitate...	808.27	1100.98	
Total inorganic s...	1480.04	2016.03	
Ammonia N	0.35	0.48	
Nitrate N	30.01	40.87	

Parameter	Value	Units
Hydraulic residence time	15.0	hours
Flow	1362.14	m3/d
MLSS	3447.14	mg/L
Total solids mass	2936.41	kg
Total readily biodegradable ...	1.30	mg/L
Total oxygen uptake rate	12.78	mgO/L/hr
Carbonaceous OUR	7.36	mgO/L/hr
Nitrogenous OUR	5.41	mgO/L/hr
Net. ammonia removal rate	1.02	mgN/L/hr
Nitrate production rate	1.26	mgN/L/hr
Nitrite production rate	1.30	mgN/L/hr
Nitrate removal rate	0.06	mgN/L/hr
Nitrite removal rate	1.30	mgN/L/hr
Net. nitrate production rate	1.21	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas productio...	0.09	mgN/L/hr
Spec. dissolved N2 gas pro...	0.05	mgN/gVSS/hr
Spec. dissolved N2 gas pro...	0.19	mgN/gVASS/hr
OTE	14.61	%
OTR	10.95	kg/hr
SOTE	44.61	%
SOTR	32.69	kg/hr
Air supply rate	268.98	m3/hr (20C, 101.325 kP...
Air flow rate / diffuser	0.38	m3/hr (20C, 101.325 kP...
# of diffusers	708.00	
Off gas flow rate (dry)	261.53	m3/hr
Oxygen content	17.96	%
Carbon dioxide content	2.73	%
Ammonia content	0.00	%
Actual DO sat. conc.	10.07	mg/L

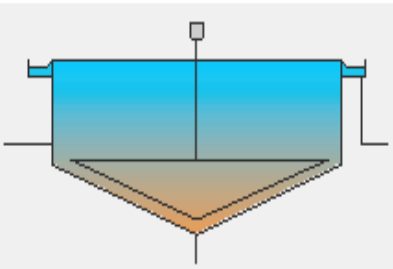
Ferric addition



Flow	1000.00	L/d
Ferric		
Chemical dose	21.00	kg/d
Metal dose	7.23	kg/d
Total suspended solids	0	mgTSS/L
pH	2.00	

Clarifier

Name: Model clarifier19	Type: Model clarifier	
Volume:	327.94	m3
Area:	86.30	m2
Depth:	3.80	m



Flow	824.14	m3/d
Surface overflow rate	9.55	m3/(m2 d)
Solids loading rate	54.64	kg/(m2 d)
Total suspended solids	6.98	mgTSS/L
Total COD	29	mg/L
pH	6.79	
Flow (U)	539.00	m3/d
Total suspended solids (U)	8738.55	mgTSS/L

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	3.97	3.27	
Total suspended...	6.98	5.75	
Particulate COD	5.93	4.88	
Filtered COD	22.95	18.92	
Total COD	28.88	23.80	
Soluble PO4-P	0.17	0.14	
Total P	0.47	0.39	
Filtered TKN	2.51	2.06	
Particulate TKN	0.33	0.27	
Total Kjeldahl Nit...	2.83	2.33	
Filtered Carbona...	0.97	0.80	
Total Carbonace...	1.84	1.52	
Nitrite + Nitrate	30.06	24.77	
Total N	32.89	27.10	
Total inorganic N	30.40	25.06	
Alkalinity	3.78	3.12	mmol/L and kmol/d
pH	6.79		
Volatile fatty acids	0.01	0.00	
Total precipitate...	1.66	1.37	
Total inorganic s...	3.02	2.49	
Ammonia N	0.35	0.29	
Nitrate N	29.98	24.71	

Parameter	Value	Units
Hydraulic residence time	5.77	hours
Effluent flow	824.14	m3/d
Return activated sludge flow	539.00	m3/d
Height of specified concentr...	0.45	m
Return activated sludge TSS	8738.55	mg/L
Effluent solids	6.98	mg/L
Solids loading rate	54.64	kg/(m2 d)
Surface overflow rate	9.55	m3/(m2 d)
Total solids mass	391.34	kg

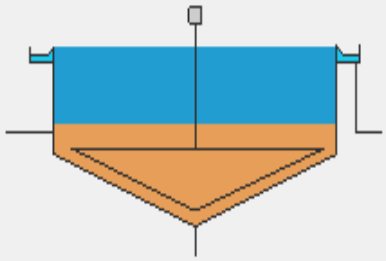
RAS from the clarifier

Flow of 539.00 m3/d from Model clarifier19

Variable	Concentration mg/L	Mass rate kg/d
Total COD	7439.62	4009.96
Total Carbonaceous BOD	1088.47	586.68
Total Kjeldahl Nitrogen	409.23	220.57
Total P	384.37	207.18
Volatile suspended solids	4965.12	2676.20
Total suspended solids	8738.55	4710.08

WAS Thickener

Name: WAS Thickener	Type: Ideal clarifier	
Volume:	112.00	m3
Area:	28.00	m2
Depth:	4.00	m



Flow	10.15	m3/d
Surface overflow rate	0.36	m3/(m2 d)
Solids loading rate	4.37	kg/(m2 d)
Total suspended solids	4220.73	mgTSS/L
Total COD	3605.2	mg/L
pH	6.79	

Flow (U)	3.86	m3/d
Total suspended solids (U)	20627.56	mgTSS/L

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	2398.16	24.33	
Total suspended...	4220.73	42.82	
Particulate COD	3582.25	36.34	
Filtered COD	22.95	0.23	
Total COD	3605.21	36.58	
Soluble PO4-P	0.17	0.00	
Total P	185.74	1.88	
Filtered TKN	2.51	0.03	
Particulate TKN	196.45	1.99	
Total Kjeldahl Nit...	198.95	2.02	
Filtered Carbona...	0.97	0.01	
Total Carbonace...	526.23	5.34	
Nitrite + Nitrate	30.06	0.30	
Total N	229.01	2.32	
Total inorganic N	30.40	0.31	
Alkalinity	11.77	0.12	mmol/L and kmol/d
pH	6.79		
Volatile fatty acids	0.01	0.00	
Total precipitate...	1003.59	10.18	
Total inorganic s...	1822.57	18.49	
Ammonia N	0.35	0.00	
Nitrate N	29.98	0.30	

Parameter	Value	Units
Hydraulic residence time	191.98	hours
Effluent flow	10.15	m3/d
Return activated sludge flow	3.86	m3/d
Height of specified concentr...	0.80	m
Return activated sludge TSS	20627.56	mg/L
Effluent solids	4220.73	mg/L
Solids loading rate	4.37	kg/(m2 d)
Surface overflow rate	0.36	m3/(m2 d)
Total solids mass	840.23	kg
Percent removal	65.00	%

RAS from the Thickener

Flow of 10.15 m3/d from WAS Thickener

Variable	Concentration mg/L	Mass rate kg/d
Total COD	3605.21	36.58
Total Carbonaceous BOD	526.23	5.34
Total Kjeldahl Nitrogen	198.95	2.02
Total P	185.74	1.88
Volatile suspended solids	2398.16	24.33
Total suspended solids	4220.73	42.82

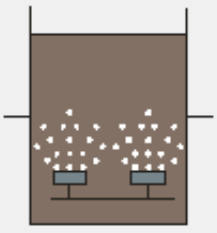
WAS from the Thickener to the Aerobic Digester

Flow of 3.86 m3/d from WAS Thickener

Variable	Concentration mg/L	Mass rate kg/d
Total COD	17530.20	67.59
Total Carbonaceous BOD	2568.03	9.90
Total Kjeldahl Nitrogen	962.59	3.71
Total P	907.09	3.50
Volatile suspended solids	11720.31	45.19
Total suspended solids	20627.56	79.53

Aerobic Digester

Name: Aerobic Digester		Type: Aerobic Digester
Volume:	278.00	m3
Area:	63.18	m2
Depth:	4.40	m
Diffuser coverage:	10.00	%
Number of diffusers:	154	
Diffuser unit area:	0.0410	m2



		Hydraulic residence time	1730.6	hours
		Ammonia N	0.12	mgN/L
		Nitrate N	47.43	mgN/L
		Nitrite N	0.06	mgN/L
		Soluble PO4-P	73.74	mgP/L
		Volatile suspended solids	9440	mgVSS/L
		Total suspended solids	18134	mgTSS/L
		Dissolved oxygen	0.10	mg/L
		pH	6.04	
Total oxygen uptake rate	2.17	mgO/L/hr		
OTR	0.60	kg/hr		
Off gas flow rate (dry)	8.51	m3/hr		

Power dissipation

Mech. mixing	5.00 W/m3
Air / flow	0.44 W/m3
Velocity gradient	67.78 /s

Local temperature = 13°C

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	9439.85	36.39	
Total suspended...	18133.79	69.91	
Particulate COD	14248.08	54.93	
Filtered COD	22.48	0.09	
Total COD	14270.57	55.02	
Soluble PO4-P	73.74	0.28	
Total P	907.09	3.50	
Filtered TKN	1.75	0.01	
Particulate TKN	735.24	2.83	
Total Kjeldahl Nit...	737.00	2.84	
Filtered Carbona...	0.52	0.00	
Total Carbonace...	228.48	0.88	
Nitrite + Nitrate	47.49	0.18	
Total N	784.49	3.02	
Total inorganic N	47.61	0.18	
Alkalinity	-999.00	-3.85	mmol/L and kmol/d
pH	6.04		
Volatile fatty acids	0.00	0.00	
Total precipitate...	4880.01	18.81	
Total inorganic s...	8693.94	33.52	
Ammonia N	0.12	0.00	
Nitrate N	47.43	0.18	

Parameter	Value	Units
Hydraulic residence time	1730.6	hours
Flow	3.86	m3/d
MLSS	18133.79	mg/L
Total solids mass	5041.19	kg
Total readily biodegradable ...	0.73	mg/L
Total oxygen uptake rate	2.17	mgO/L/hr
Carbonaceous OUR	1.47	mgO/L/hr
Nitrogenous OUR	0.70	mgO/L/hr
Net. ammonia removal rate	0.00	mgN/L/hr
Nitrate production rate	0.23	mgN/L/hr
Nitrite production rate	0.36	mgN/L/hr
Nitrate removal rate	0.22	mgN/L/hr
Nitrite removal rate	0.36	mgN/L/hr
Net. nitrate production rate	0.01	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas productio...	0.12	mgN/L/hr
Spec. dissolved N2 gas pro...	0.01	mgN/gVSS/hr
Spec. dissolved N2 gas pro...	0.46	mgN/gVASS/hr
OTE	24.74	%
OTR	0.60	kg/hr
SOTE	61.13	%
SOTR	1.45	kg/hr
Air supply rate	8.73	m3/hr (20C, 101.325 kP...
Air flow rate / diffuser	0.06	m3/hr (20C, 101.325 kP...
# of diffusers	154.00	
Off gas flow rate (dry)	8.51	m3/hr
Oxygen content	15.79	%
Carbon dioxide content	4.73	%
Ammonia content	0.00	%
Actual DO sat. conc.	10.07	mg/L

Effluent Digester

Flow	3.86	m3/d
Ammonia N	0.12	mgN/L
Nitrate N	47.43	mgN/L
Nitrite N	0.06	mgN/L
Filtered TKN	1.75	mgN/L
Total N	784.49	mgN/L
Total P	907.09	mgP/L
Total suspended solids	18133.8	mgTSS/L
Total COD	14270.6	mg/L
Total Carbonaceous BOD	228.48	mg/L
pH	6.04	

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	9439.85	36.39	
Total suspended...	18133.79	69.91	
Particulate COD	14248.08	54.93	
Filtered COD	22.48	0.09	
Total COD	14270.57	55.02	
Soluble PO4-P	73.74	0.28	
Total P	907.09	3.50	
Filtered TKN	1.75	0.01	
Particulate TKN	735.24	2.83	
Total Kjeldahl Nit...	737.00	2.84	
Filtered Carbona...	0.52	0.00	
Total Carbonace...	228.48	0.88	
Nitrite + Nitrate	47.49	0.18	
Total N	784.49	3.02	
Total inorganic N	47.61	0.18	
Alkalinity	-999.00	-3.85	mmol/L and kmol/d
pH	6.04		
Volatile fatty acids	0.00	0.00	
Total precipitate...	4880.01	18.81	
Total inorganic s...	8693.94	33.52	
Ammonia N	0.12	0.00	
Nitrate N	47.43	0.18	

Final Effluent Characteristics

Flow	824.14	m3/d
Ammonia N	0.35	mgN/L
Nitrate N	29.98	mgN/L
Nitrite N	0.07	mgN/L
Filtered TKN	2.51	mgN/L
Total N	32.89	mgN/L
Total P	0.47	mgP/L
Total suspended solids	7.0	mgTSS/L
Total COD	28.9	mg/L
Total Carbonaceous BOD	1.84	mg/L
pH	6.79	

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	3.97	3.27	
Total suspended...	6.98	5.75	
Particulate COD	5.93	4.88	
Filtered COD	22.95	18.92	
Total COD	28.88	23.80	
Soluble PO4-P	0.17	0.14	
Total P	0.47	0.39	
Filtered TKN	2.51	2.06	
Particulate TKN	0.33	0.27	
Total Kjeldahl Nit...	2.83	2.33	
Filtered Carbona...	0.97	0.80	
Total Carbonace...	1.84	1.52	
Nitrite + Nitrate	30.06	24.77	
Total N	32.89	27.10	
Total inorganic N	30.40	25.06	
Alkalinity	3.78	3.12	mmol/L and kmol/d
pH	6.79		
Volatile fatty acids	0.01	0.00	
Total precipitate...	1.66	1.37	
Total inorganic s...	3.02	2.49	
Ammonia N	0.35	0.29	
Nitrate N	29.98	24.71	

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APPENDIX "C"

CALIBRATION TABLES
FOR SCENARIO B

St. George WPCP Modeling Report (B-With Denitrification)

Table B-1. Characteristics of Raw Sewage

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
Flow (m^3/d)	827 ± 91	914	756	**827**
TSS (mg/L)	169 ± 104	311	46	**147**
VSS (mg/L)	152 ± 93	281	39	**130**
TBOD (mg/L)	129 ± 69	206	67	**131**
SBOD (mg/L)	40 ± 16	63	18	**41**
TCOD (mg/L)	288 ± 122	461	159	**288**
SCOD (mg/L)	76 ± 33	115	43	**80**
TKN (mg/L)	38 ± 13	46	29	**38**
STKN (mg/L)	30 ± 10	40	23	**32**
Ammonia (mg/L)	25.6 ± 4.6	32	21	**25.6**
Nitrite (mg/L)	0.10 ± 0.14	0.23	0.02	**0**
Nitrate (mg/L)	0.20	0.2	0.2	**0.2**
Nitrate and Nitrite (mg/L)	0.30 ± 0.28	0.46	0.14	**0.2**
TP (mg/L)	4.7 ± 1.7	6.2	3.3	**4.7**
SP (mg/L)	3.4 ± 1.1	4.3	2.7	**3.4**
Alk. ($mgCaCo_3/L$)	403 ± 36	429	371	**403**
Oil and Grease	13.3 ± 6.2	23.0	6.7	**-**
pH	7.6 ± 0.2	7.8	7.3	**7.6**
Temp (^oC)	13.6 ± 1.1	14.3	12.3	**13**

Table B-2. Characteristics of Aeration Tank Effluent

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	3670 ± 576	4310	2990	**3444**
VSS (mg/L)	2727 ± 433	3200	2190	**1964**
TBOD (mg/L)	878 ± 169	1010	628	**441**
SBOD (mg/L)	3.8 ± 5.0	5.0	3.0	**1.0**
TCOD (mg/L)	3103 ± 1143	4410	1880	**2959**
SCOD (mg/L)	231 ± 105	353	123	**23**
TKN (mg/L)	221 ± 58	280	148	**164**
STKN (mg/L)	35 ± 9	44	24	**3**
Ammonia (mg/L)	4.9 ± 2.6	7.7	2.3	**0.4**
Nitrite (mg/L)	1.9 ± 0.9	3.1	0.6	**0.1**
Nitrate (mg/L)	2.2 ± 1.3	3.8	1.0	**27.4**
Nitrate and Nitrite (mg/L)	3.7 ± 1.8	5.9	1.1	**27.5**
TP (mg/L)	73 ± 40	104	1.3	**152**
SP (mg/L)	1.0 ± 0.7	1.9	0.3	**2**
Alk. ($mgCaCo_3/L$)	424 ± 61	508	347	**530**
Oil and Grease	9.8 ± 1.1	10.7	9.0	**---**
pH	7.2 ± 0.2	7.4	7.0	**6.9**
Temp (^oC)	13.1 ± 0.9	14.0	12.1	**13**

Table B-3. Characteristics of Clarifier Effluent

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	6.6 ± 3.3	10.1	4.0	**6.9**
VSS (mg/L)	5.7 ± 4.7	7.1	2.0	**4.0**
TBOD (mg/L)	3.9 ± 1.9	5.0	3.0	**1.8**
SBOD (mg/L)	3.0 ± 0.8	4.0	2.0	**1.0**
TCOD (mg/L)	26.3 ± 5.5	31.0	22.8	**28.8**
SCOD (mg/L)	22.6 ± 3.5	26.5	18.5	**22.9**
TKN (mg/L)	2.0 ± 1.3	2.8	1.3	**2.8**
STKN (mg/L)	1.3 ± 1.0	2.3	0.7	**2.5**
Ammonia (mg/L)	0.6 ± 1.1	1.1	0.1	**0.4**
Nitrite (mg/L)	0.6 ± 1.1	2.2	0.0	**0.1**
Nitrate (mg/L)	22.3 ± 4.3	26.1	16.8	**27.4**
Nitrate and Nitrite (mg/L)	23.2 ± 4.4	26.1	18.0	**27.5**
TP (mg/L)	0.4 ± 0.2	0.4	0.2	**0.4**
SP (mg/L)	0.1 ± 0.2	0.2	0.1	**0.1**
Alk. ($mgCaCo_3/L$)	196 ± 15	210	181	**189**
Oil and Grease	1.5 ± 0.9	2.0	0.9	**---**
pH	7.3	7.3	7.3	**6.8**
Temp (^oC)	11.8	11.8	11.8	**13**

Table B-4a. Characteristics of RAS/WAS

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	9692 ± 3642	15400	5740	**8732**
VSS (mg/L)	7223 ± 2744	11520	4140	**4960**
TCOD (mg/L)	9496 ± 5774	13900	4210	**7432**
SCOD (mg/L)	834 ± 602	1815	255	**1113**

Table B-4b. Characteristics of Sludge Tank Decant

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	1933 ± 2832	4580	43	**4218**
VSS (mg/L)	1435 ± 2068	3380	31	**2396**
TCOD (mg/L)	1486 ± 1773	3540	276	**3601**
SCOD (mg/L)	740 ± 568	1473	204	**526**

Note: Two Decant samples on July 29th, 2010 indicated the following characteristics (mg/L): TCOD=5,000, SCOD = 656-671,TSS = 3,000-5,700,VSS= 2,200-3,900,TKN=320-390,NH_4-N = 69-71

Table B-4c. Characteristics of Digester Effluent

	Average ± STD	90th Percentile	10th Percentile	Calibrated Model Prediction
TSS (mg/L)	23652 ± 1434	25000	22000	**18058**
VSS (mg/L)	16190 ± 928	17000	15000	**9384**

Note: A mixed thickened sludge sample July 29th, 2010 indicated the following characteristics (mg/L): TCOD=27,000, SCOD = 1,080, TSS = 22,000, VSS= 15,000, TKN=1, 300, NH_4-N = 130

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APPENDIX "D"

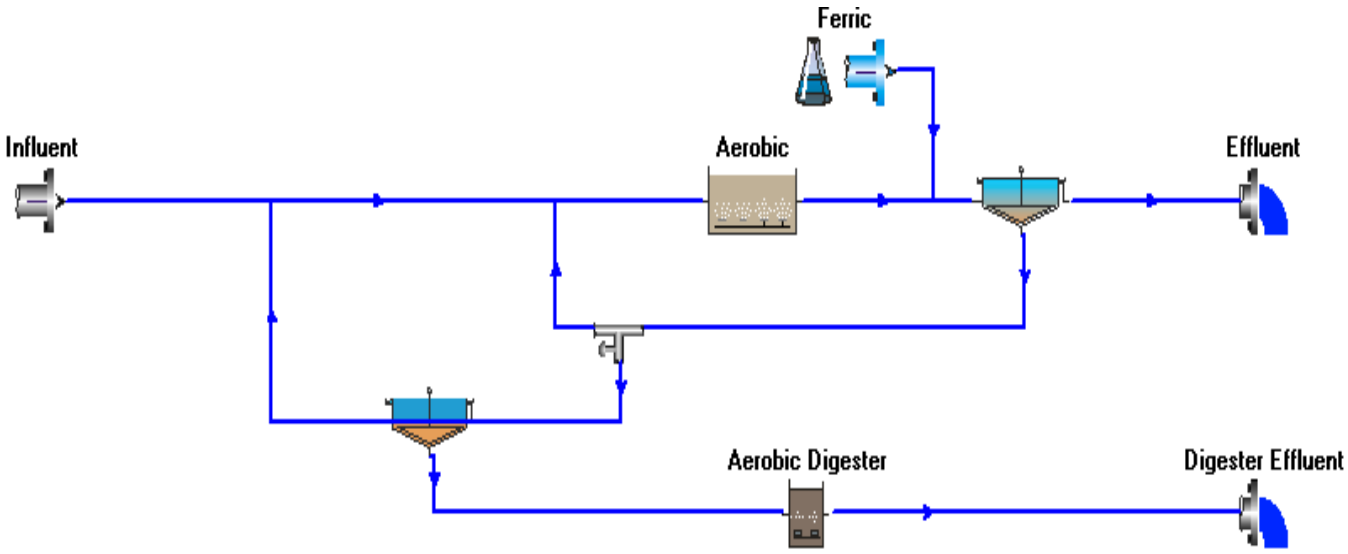
MODELING RESULTS
FOR SCENARIO B

St. George WPCP Modeling Report (B-With Denitrification)

WPCP-final calibration (13°C)

Flow	827.00	m3/d
Total COD	288.00	mg/L
Total Kjeldahl Nitrogen	38.00	mgN/L
Total P	4.70	mgP/L
Inorganic S.S.	17.00	mg/L
Volatile suspended solids	129.93	mgVSS/L
Total suspended solids	146.96	mgTSS/L
Total Carbonaceous BOD	131.45	mg/L
pH	7.60	

Solids retention time (SRT) = 24 days
Temperature = 13 C

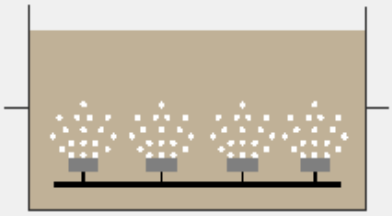


Influent Characteristics

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	129.93	107.45	
Total suspended...	146.96	121.53	
Particulate COD	207.86	171.90	
Filtered COD	80.14	66.28	
Total COD	288.00	238.18	
Soluble PO4-P	3.40	2.81	
Total P	4.70	3.89	
Filtered TKN	31.52	26.07	
Particulate TKN	6.48	5.36	
Total Kjeldahl Nit...	38.00	31.43	
Filtered Carbona...	41.35	34.20	
Total Carbonace...	131.45	108.71	
Nitrite + Nitrate	0.20	0.17	
Total N	38.20	31.59	
Total inorganic N	25.81	21.35	
Alkalinity	8.06	6.67	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	4.99	4.13	
Total precipitate...	0	0	
Total inorganic s...	17.02	14.08	
Ammonia N	25.61	21.18	
Nitrate N	0.20	0.17	

Aerobic

Name: Aerobic	Type: Bioreactor	
Volume:	851.84	m3
Area:	193.60	m2
Depth:	4.40	m
Diffuser coverage:	15.00	%
Number of diffusers:	708	
Diffuser unit area:	0.0410	m2

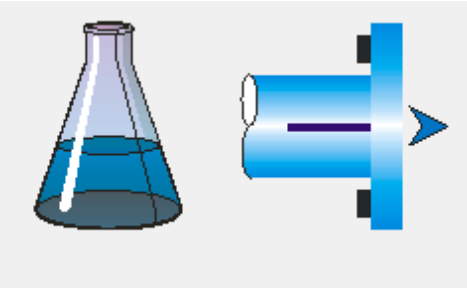


Hydraulic residence time	15.0	hours
Ammonia N	0.44	mgN/L
Nitrate N	27.41	mgN/L
Nitrite N	0.12	mgN/L
Soluble PO4-P	2.01	mgP/L
Volatile suspended solids	1965	mgVSS/L
Total suspended solids	3445	mgTSS/L
Dissolved oxygen	0.56	mg/L
pH	6.89	

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	1964.98	2676.59	
Total suspended...	3444.74	4692.24	
Particulate COD	2935.53	3998.61	
Filtered COD	22.98	31.30	
Total COD	2958.51	4029.91	
Soluble PO4-P	2.01	2.74	
Total P	152.31	207.46	
Filtered TKN	2.57	3.50	
Particulate TKN	160.90	219.17	
Total Kjeldahl Nit...	163.47	222.67	
Filtered Carbona...	0.98	1.33	
Total Carbonace...	441.74	601.72	
Nitrite + Nitrate	27.54	37.51	
Total N	191.01	260.18	
Total inorganic N	27.98	38.12	
Alkalinity	10.82	14.74	mmol/L and kmol/d
pH	6.89		
Volatile fatty acids	0.01	0.01	
Total precipitate...	808.29	1101.01	
Total inorganic s...	1479.76	2015.65	
Ammonia N	0.44	0.61	
Nitrate N	27.41	37.34	

Parameter	Value	Units
Hydraulic residence time	15.0	hours
Flow	1362.14	m3/d
MLSS	3444.74	mg/L
Total solids mass	2934.37	kg
Total readily biodegradable ...	1.31	mg/L
Total oxygen uptake rate	12.47	mgO/L/hr
Carbonaceous OUR	7.05	mgO/L/hr
Nitrogenous OUR	5.43	mgO/L/hr
Net. ammonia removal rate	1.02	mgN/L/hr
Nitrate production rate	1.29	mgN/L/hr
Nitrite production rate	1.43	mgN/L/hr
Nitrate removal rate	0.19	mgN/L/hr
Nitrite removal rate	1.42	mgN/L/hr
Net. nitrate production rate	1.10	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas productio...	0.13	mgN/L/hr
Spec. dissolved N2 gas pro...	0.07	mgN/gVSS/hr
Spec. dissolved N2 gas pro...	0.26	mgN/gVASS/hr
OTE	17.96	%
OTR	10.65	kg/hr
SOTE	46.54	%
SOTR	26.96	kg/hr
Air supply rate	212.67	m3/hr (20C, 101.325 kP...
Air flow rate / diffuser	0.30	m3/hr (20C, 101.325 kP...
# of diffusers	708.00	
Off gas flow rate (dry)	206.68	m3/hr
Oxygen content	17.26	%
Carbon dioxide content	3.36	%
Ammonia content	0.00	%
Actual DO sat. conc.	10.07	mg/L

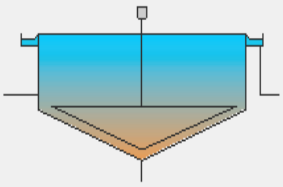
Ferric addition



Flow	1000.00	L/d
Ferric		
Chemical dose	21.00	kg/d
Metal dose	7.23	kg/d
Total suspended solids	0	mgTSS/L
pH	2.00	

Clarifier

Name: Model clarifier19	Type: Model clarifier	
Volume:	327.94	m3
Area:	86.30	m2
Depth:	3.80	m



Flow	824.14	m3/d
Surface overflow rate	9.55	m3/(m2 d)
Solids loading rate	54.64	kg/(m2 d)
Total suspended solids	6.98	mgTSS/L
Total COD	29	mg/L
pH	6.79	
Flow (U)	539.00	m3/d
Total suspended solids (U)	8738.55	mgTSS/L

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	3.97	3.27	
Total suspended...	6.98	5.75	
Particulate COD	5.92	4.88	
Filtered COD	22.96	18.92	
Total COD	28.89	23.81	
Soluble PO4-P	0.17	0.14	
Total P	0.47	0.39	
Filtered TKN	2.57	2.12	
Particulate TKN	0.32	0.27	
Total Kjeldahl Nit...	2.89	2.38	
Filtered Carbona...	0.98	0.81	
Total Carbonace...	1.87	1.54	
Nitrite + Nitrate	27.52	22.68	
Total N	30.41	25.06	
Total inorganic N	27.96	23.04	
Alkalinity	3.97	3.27	mmol/L and kmol/d
pH	6.80		
Volatile fatty acids	0.01	0.00	
Total precipitate...	1.66	1.37	
Total inorganic s...	3.02	2.49	
Ammonia N	0.44	0.37	
Nitrate N	27.39	22.58	

Parameter	Value	Units
Hydraulic residence time	5.77	hours
Effluent flow	824.14	m3/d
Return activated sludge flow	539.00	m3/d
Height of specified concentr...	0.45	m
Return activated sludge TSS	8732.50	mg/L
Effluent solids	6.98	mg/L
Solids loading rate	54.61	kg/(m2 d)
Surface overflow rate	9.55	m3/(m2 d)
Total solids mass	391.06	kg

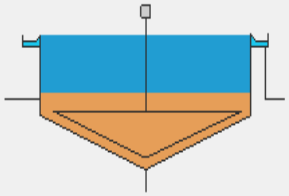
RAS from the clarifier

Flow of 539.00 m3/d from Model clarifier19

Variable	Concentration mg/L	Mass rate kg/d
Total COD	7432.48	4006.11
Total Carbonaceous BOD	1113.51	600.18
Total Kjeldahl Nitrogen	408.69	220.28
Total P	384.18	207.07
Volatile suspended solids	4959.78	2673.32
Total suspended solids	8732.50	4706.82

WAS Thickener

Name: WAS Thickener	Type: Ideal clarifier	
Volume:	112.00	m3
Area:	28.00	m2
Depth:	4.00	m



Flow	10.15	m3/d
Surface overflow rate	0.36	m3/(m2 d)
Solids loading rate	4.37	kg/(m2 d)
Total suspended solids	4217.80	mgTSS/L
Total COD	3601.8	mg/L
pH	6.80	
Flow (U)	3.86	m3/d
Total suspended solids (U)	20613.28	mgTSS/L

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	2395.57	24.30	
Total suspended...	4217.80	42.79	
Particulate COD	3578.80	36.31	
Filtered COD	22.96	0.23	
Total COD	3601.76	36.54	
Soluble PO4-P	0.17	0.00	
Total P	185.65	1.88	
Filtered TKN	2.57	0.03	
Particulate TKN	196.16	1.99	
Total Kjeldahl Nit...	198.72	2.02	
Filtered Carbona...	0.98	0.01	
Total Carbonace...	538.33	5.46	
Nitrite + Nitrate	27.52	0.28	
Total N	226.24	2.30	
Total inorganic N	27.96	0.28	
Alkalinity	11.96	0.12	mmol/L and kmol/d
pH	6.80		
Volatile fatty acids	0.01	0.00	
Total precipitate...	1003.61	10.18	
Total inorganic s...	1822.23	18.49	
Ammonia N	0.44	0.00	
Nitrate N	27.39	0.28	

Parameter	Value	Units
Hydraulic residence time	191.98	hours
Effluent flow	10.15	m3/d
Return activated sludge flow	3.86	m3/d
Height of specified concentr...	0.80	m
Return activated sludge TSS	20613.28	mg/L
Effluent solids	4217.80	mg/L
Solids loading rate	4.37	kg/(m2 d)
Surface overflow rate	0.36	m3/(m2 d)
Total solids mass	839.65	kg
Percent removal	65.00	%

RAS from the Thickener

Flow of 10.15 m3/d from WAS Thickener

Variable	Concentration mg/L	Mass ra
Total COD	3601.76	36.54
Total Carbonaceous BOD	538.33	5.46
Total Kjeldahl Nitrogen	198.72	2.02
Total P	185.65	1.88
Volatile suspended solids	2395.57	24.30
Total suspended solids	4217.80	42.79

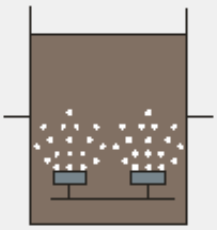
WAS from the Thickener to the Aerobic Digester

Flow of 3.86 m3/d from WAS Thickener

Variable	Concentration mg/L	Mass rate kg/d
Total COD	17513.32	67.52
Total Carbonaceous BOD	2627.13	10.13
Total Kjeldahl Nitrogen	961.23	3.71
Total P	906.64	3.50
Volatile suspended solids	11707.69	45.14
Total suspended solids	20613.28	79.47

Aerobic Digester

Name: Aerobic Digester		Type: Aerobic Digester
Volume:	278.00	m3
Area:	63.18	m2
Depth:	4.40	m
Diffuser coverage:	10.00	%
Number of diffusers:	154	
Diffuser unit area:	0.0410	m2



Hydraulic residence time	1730.6	hours
Ammonia N	0.11	mgN/L
Nitrate N	51.32	mgN/L
Nitrite N	0.06	mgN/L
Soluble PO4-P	76.81	mgP/L
Volatile suspended solids	9384	mgVSS/L
Total suspended solids	18058	mgTSS/L
Dissolved oxygen	0.10	mg/L
pH	5.96	

Total oxygen uptake rate	2.22	mgO/L/hr
OTR	0.62	kg/hr
Off gas flow rate (dry)	8.76	m3/hr

Local temperature = 13°C

Power dissipation

Mech. mixing	5.00 W/m3
Air / flow	0.46 W/m3
Velocity gradient	67.86 /s

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	9383.51	36.18	
Total suspended...	18058.10	69.62	
Particulate COD	14168.07	54.62	
Filtered COD	22.50	0.09	
Total COD	14190.57	54.71	
Soluble PO4-P	76.81	0.30	
Total P	906.64	3.50	
Filtered TKN	1.75	0.01	
Particulate TKN	729.61	2.81	
Total Kjeldahl Nit...	731.36	2.82	
Filtered Carbona...	0.52	0.00	
Total Carbonace...	235.94	0.91	
Nitrite + Nitrate	51.38	0.20	
Total N	782.74	3.02	
Total inorganic N	51.49	0.20	
Alkalinity	-999.00	-3.85	mmol/L and kmol/d
pH	5.96		
Volatile fatty acids	0.00	0.00	
Total precipitate...	4865.69	18.76	
Total inorganic s...	8674.59	33.44	
Ammonia N	0.11	0.00	
Nitrate N	51.32	0.20	

Parameter	Value	Units
Hydraulic residence time	1730.6	hours
Flow	3.86	m3/d
MLSS	18058.10	mg/L
Total solids mass	5020.15	kg
Total readily biodegradable ...	0.74	mg/L
Total oxygen uptake rate	2.22	mgO/L/hr
Carbonaceous OUR	1.50	mgO/L/hr
Nitrogenous OUR	0.71	mgO/L/hr
Net. ammonia removal rate	0.00	mgN/L/hr
Nitrate production rate	0.24	mgN/L/hr
Nitrite production rate	0.36	mgN/L/hr
Nitrate removal rate	0.23	mgN/L/hr
Nitrite removal rate	0.36	mgN/L/hr
Net. nitrate production rate	0.01	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas productio...	0.12	mgN/L/hr
Spec. dissolved N2 gas pro...	0.01	mgN/gVSS/hr
Spec. dissolved N2 gas pro...	0.44	mgN/gVASS/hr
OTE	24.60	%
OTR	0.62	kg/hr
SOTE	60.81	%
SOTR	1.49	kg/hr
Air supply rate	8.99	m3/hr (20C, 101.325 kP...
Air flow rate / diffuser	0.06	m3/hr (20C, 101.325 kP...
# of diffusers	154.00	
Off gas flow rate (dry)	8.76	m3/hr
Oxygen content	15.83	%
Carbon dioxide content	4.69	%
Ammonia content	0.00	%
Actual DO sat. conc.	10.07	mg/L

Effluent Digester

Flow	3.86	m3/d
Ammonia N	0.11	mgN/L
Nitrate N	51.32	mgN/L
Nitrite N	0.06	mgN/L
Filtered TKN	1.75	mgN/L
Total N	782.74	mgN/L
Total P	906.64	mgP/L
Total suspended solids	18058.1	mgTSS/L
Total COD	14190.6	mg/L
Total Carbonaceous BOD	235.94	mg/L
pH	5.96	

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	9383.51	36.18	
Total suspended...	18058.10	69.62	
Particulate COD	14168.07	54.62	
Filtered COD	22.50	0.09	
Total COD	14190.57	54.71	
Soluble PO4-P	76.81	0.30	
Total P	906.64	3.50	
Filtered TKN	1.75	0.01	
Particulate TKN	729.61	2.81	
Total Kjeldahl Nit...	731.36	2.82	
Filtered Carbona...	0.52	0.00	
Total Carbonace...	235.94	0.91	
Nitrite + Nitrate	51.38	0.20	
Total N	782.74	3.02	
Total inorganic N	51.49	0.20	
Alkalinity	-999.00	-3.85	mmol/L and kmol/d
pH	5.96		
Volatile fatty acids	0.00	0.00	
Total precipitate...	4865.69	18.76	
Total inorganic s...	8674.59	33.44	
Ammonia N	0.11	0.00	
Nitrate N	51.32	0.20	

Final Effluent Characteristics

Flow	824.14	m3/d
Ammonia N	0.44	mgN/L
Nitrate N	27.39	mgN/L
Nitrite N	0.12	mgN/L
Filtered TKN	2.57	mgN/L
Total N	30.41	mgN/L
Total P	0.47	mgP/L
Total suspended solids	7.0	mgTSS/L
Total COD	28.9	mg/L
Total Carbonaceous BOD	1.87	mg/L
pH	6.80	

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspend...	3.97	3.27	
Total suspended...	6.98	5.75	
Particulate COD	5.92	4.88	
Filtered COD	22.96	18.92	
Total COD	28.89	23.81	
Soluble PO4-P	0.17	0.14	
Total P	0.47	0.39	
Filtered TKN	2.57	2.12	
Particulate TKN	0.32	0.27	
Total Kjeldahl Nit...	2.89	2.38	
Filtered Carbona...	0.98	0.81	
Total Carbonace...	1.87	1.54	
Nitrite + Nitrate	27.52	22.68	
Total N	30.41	25.06	
Total inorganic N	27.96	23.04	
Alkalinity	3.97	3.27	mmol/L and kmol/d
pH	6.80		
Volatile fatty acids	0.01	0.00	
Total precipitate...	1.66	1.37	
Total inorganic s...	3.02	2.49	
Ammonia N	0.44	0.37	
Nitrate N	27.39	22.58	

ST. GEORGE WATER POLLUTION CONTROL PLANT
OPTIMIZATION STUDY

TECHNICAL MEMORANDUM
TREATMENT PROCESS MODELING

APPENDIX "E"

PROCESS MODELING RESULTS

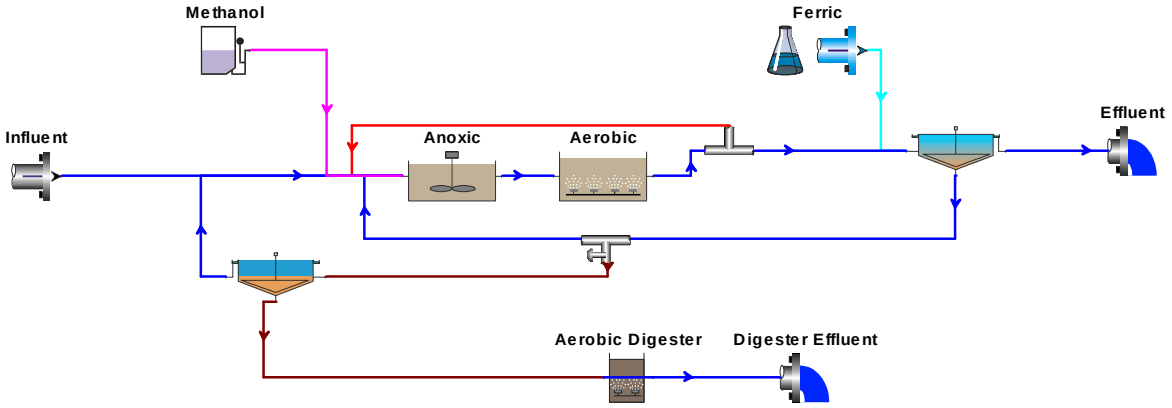
Detailed Modeling Report for a Flowrate of 1,500 m^3/d (Retrofitted Plant)
BioWin user and configuration data

Project details
Project name: Unknown Project ref.: BW3
Plant name: Unknown **User name: dold**

Created: 3/1/2001 **Saved: 12/1/2010**

Steady state solution
Target SRT: 15 SRT: 15.00
Temperature: 15.0

Flowsheet



Configuration information for all Aerobic Digester units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]	# of diffusers
Aerobic Digester	278.0000	63.1818	4.400	154

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Aerobic Digester	0.1

Element name	Average Temperature [deg. C]
Aerobic Digester	13.0

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	% of tank area covered by diffusers [%]
Aerobic Digester	2.5656	0.0432	0.8200	0.0410	10.0000

Configuration information for all Bioreactor units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]	# of diffusers
Aerobic	830.0000	184.4444	4.500	675
Anoxic	350.0000	77.7778	4.500	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Aerobic	2.0
Anoxic	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	% of tank area covered by diffusers [%]
Aerobic	2.5656	0.0432	0.8200	0.0410	15.0000
Anoxic	2.5656	0.0432	0.8200	0.0410	10.0000

Element name	Alpha (surf) OR Alpha F (diff) [-]	Beta [-]	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
Aerobic	0.5000	0.9500	101.3250	0.3250

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Surface turbulence factor [-]
Aerobic	0.0350	20.9500	2.0000	18.8000	0	0	0	2.0000

Configuration information for all Methanol units

Operating data Average (flow/time weighted as required)

Element name	Methanol
Non-polyP heterotrophs mgCOD/L	0
Anoxic methanol utilizers mgCOD/L	0
Ammonia oxidizing biomass mgCOD/L	0
Nitrite oxidizing biomass mgCOD/L	0
Anaerobic ammonia oxidizers mgCOD/L	0
PolyP heterotrophs mgCOD/L	0
Propionic acetogens mgCOD/L	0
Acetoclastic methanogens mgCOD/L	0
Hydrogenotrophic methanogens mgCOD/L	0
Endogenous products mgCOD/L	0
Slowly bio. COD (part.) mgCOD/L	0
Slowly bio. COD (colloid.) mgCOD/L	0
Part. inert. COD mgCOD/L	0
Part. bio. org. N mgN/L	0
Part. bio. org. P mgP/L	0
Part. inert N mgN/L	0
Part. inert P mgP/L	0
Stored PHA mgCOD/L	0

Releasable stored polyP mgP/L	0
Fixed stored polyP mgP/L	0
PolyP bound cations mg/L	0
Readily bio. COD (complex) mgCOD/L	0
Acetate mgCOD/L	0
Propionate mgCOD/L	0
Methanol mgCOD/L	1188000.00
Dissolved H2 mgCOD/L	0
Dissolved methane mg/L	0
Ammonia N mgN/L	0
Sol. bio. org. N mgN/L	0
Nitrite N mgN/L	0
Nitrate N mgN/L	0
Dissolved nitrogen gas mgN/L	0
PO4-P (Sol. & Me Complexed) mgP/L	0
Sol. inert COD mgCOD/L	0
Sol. inert TKN mgN/L	0
Inorganic S.S. mgISS/L	0
Struvite mgISS/L	0
Hydroxy-dicalcium-phosphate mgISS/L	0
Hydroxy-apatite mgISS/L	0
Magnesium mg/L	0
Calcium mg/L	0
Metal mg/L	0
Other Cations (strong bases) meq/L	0
Other Anions (strong acids) meq/L	0
Total CO2 mmol/L	0
User defined 1 mg/L	0
User defined 2 mg/L	0
User defined 3 mgVSS/L	0
User defined 4 mgISS/L	0
Dissolved oxygen mg/L	0
Flow	0.06

Configuration information for all Model clarifier units

Physical data

Element name	Volume[m3]	Area[m2]	Depth[m]	Number of layers	Top feed layer	Feed Layers
Model clarifier19	338.2000	89.0000	3.800	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier19	Flowrate [Under]	1125

Element name	Average Temperature	Reactive
Model clarifier19	Uses global setting	No

Local settling parameters

Element name	Maximum Vesilind settling velocity (Vo)	Vesilind hindered zone settling parameter (K) [L/g]	Clarification switching function [mg/L]	Specified TSS conc.for height calc. [mg/L]	Maximum compactability constant [mg/L]
Model clarifier19	183.0000	0.0003	100.0000	2500.0000	15000.0000

Configuration information for all Effluent units

Configuration information for all Ideal clarifier units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]
WAS Thickener	112.0000	28.0000	4.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
WAS Thickener	Ratio	0.38

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
WAS Thickener	Uses global setting	No	85.00	0.20

Configuration information for all COD Influent units

Operating data Average (flow/time weighted as required)

Element name	Influent
Time	0
Flow	1500
Total COD mgCOD/L	300.00
Total Kjeldahl Nitrogen mgN/L	38.00
Total P mgP/L	4.70
Nitrate N mgN/L	0.20
pH	7.60
Alkalinity mmol/L	8.06
Inorganic S.S. mgISS/L	17.00
Calcium mg/L	50.00
Magnesium mg/L	20.00
Dissolved oxygen mg/L	0

Element name	Influent
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.0990
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1750
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8500
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0750
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.6740
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]	0.0350
Fpo4 - Phosphate [gPO4-P/gTP]	0.7230
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0110
FZbh - Non-poly-P heterotrophs [gCOD/g of total COD]	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.0001
FZaob - Ammonia oxidizers [gCOD/g of total COD]	0.0001
FZnob - Nitrite oxidizers [gCOD/g of total COD]	0.0001
FZamob - Anaerobic ammonia oxidizers [gCOD/g of total COD]	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.0001

FZbam - Acetoclastic methanogens	[gCOD/g of total COD]	0.0001
FZbhm - H2-utilizing methanogens	[gCOD/g of total COD]	0.0001

Configuration information for all Metal addition units

Operating data Average (flow/time weighted as required)

Element name	Ferric
Non-polyP heterotrophs mgCOD/L	0
Anoxic methanol utilizers mgCOD/L	0
Ammonia oxidizing biomass mgCOD/L	0
Nitrite oxidizing biomass mgCOD/L	0
Anaerobic ammonia oxidizers mgCOD/L	0
PolyP heterotrophs mgCOD/L	0
Propionic acetogens mgCOD/L	0
Acetoclastic methanogens mgCOD/L	0
Hydrogenotrophic methanogens mgCOD/L	0
Endogenous products mgCOD/L	0
Slowly bio. COD (part.) mgCOD/L	0
Slowly bio. COD (colloid.) mgCOD/L	0
Part. inert. COD mgCOD/L	0
Part. bio. org. N mgN/L	0
Part. bio. org. P mgP/L	0
Part. inert N mgN/L	0
Part. inert P mgP/L	0
Stored PHA mgCOD/L	0
Releasable stored polyP mgP/L	0
Fixed stored polyP mgP/L	0
PolyP bound cations mg/L	0
Readily bio. COD (complex) mgCOD/L	0
Acetate mgCOD/L	0
Propionate mgCOD/L	0
Methanol mgCOD/L	0
Dissolved H2 mgCOD/L	0
Dissolved methane mg/L	0
Ammonia N mgN/L	0
Sol. bio. org. N mgN/L	0
Nitrite N mgN/L	0
Nitrate N mgN/L	0
Dissolved nitrogen gas mgN/L	0
PO4-P (Sol. & Me Complexed) mgP/L	0
Sol. inert COD mgCOD/L	0
Sol. inert TKN mgN/L	0
Inorganic S.S. mgISS/L	0
Struvite mgISS/L	0
Hydroxy-dicalcium-phosphate mgISS/L	0
Hydroxy-apatite mgISS/L	0
Magnesium mg/L	0
Calcium mg/L	0
Metal mg/L	7230.23
Other Cations (strong bases) meq/L	5.00
Other Anions (strong acids) meq/L	407.79
Total CO2 mmol/L	7.00
User defined 1 mg/L	0
User defined 2 mg/L	0
User defined 3 mgVSS/L	0
User defined 4 mgISS/L	0
Dissolved oxygen mg/L	0
Flow	1.78

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
WAS splitter	Flowrate [Side]	23.738051228474

Splitter21	Flowrate [Side]	6000

BioWin Album

Album page - Influent

Influent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	135.35	203.02	
Total suspended solids	152.37	228.56	
Particulate COD	216.52	324.78	
Filtered COD	83.48	125.22	
Total COD	300.00	450.00	
Soluble PO4-P	3.40	5.10	
Total P	4.70	7.05	
Filtered TKN	31.49	47.24	
Particulate TKN	6.51	9.76	
Total Kjeldahl Nitrogen	38.00	57.00	
Filtered Carbonaceous BOD	43.07	64.61	
Total Carbonaceous BOD	136.93	205.39	
Nitrite + Nitrate	0.20	0.30	
Total N	38.20	57.30	
Total inorganic N	25.81	38.72	
Alkalinity	8.06	12.09	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	5.20	7.80	
Total precipitated solids	0	0	
Total inorganic suspended solids	17.03	25.54	
Ammonia N	25.61	38.42	
Nitrate N	0.20	0.30	

Parameters	Value	Units

Album page - Anoxic

Anoxic			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	2118.46	18258.01	
Total suspended solids	3453.26	29761.99	
Particulate COD	3150.81	27155.30	
Filtered COD	30.35	261.57	
Total COD	3181.16	27416.87	
Soluble PO4-P	0.02	0.15	
Total P	141.38	1218.50	
Filtered TKN	7.58	65.31	
Particulate TKN	177.05	1525.92	
Total Kjeldahl Nitrogen	184.63	1591.24	
Filtered Carbonaceous BOD	4.45	38.34	
Total Carbonaceous BOD	709.92	6118.48	
Nitrite + Nitrate	0.11	0.97	
Total N	184.74	1592.21	
Total inorganic N	5.74	49.48	
Alkalinity	12.11	104.34	mmol/L and kmol/d
pH	7.18		
Volatile fatty acids	1.53	13.20	
Total precipitated solids	707.13	6094.43	
Total inorganic suspended solids	1334.80	11503.98	
Ammonia N	5.63	48.51	
Nitrate N	0.08	0.73	

Parameters	Value	Units
Hydraulic residence time	1.0	hours

Flow	8618.52	m3/d
MLSS	3453.26	mg/L
Total solids mass	1208.64	kg
Total readily biodegradable COD	6.03	mg/L
Total oxygen uptake rate	0.00	mgO/L/hr
Carbonaceous OUR	0.00	mgO/L/hr
Nitrogenous OUR	0.00	mgO/L/hr
Net. ammonia removal rate	-0.74	mgN/L/hr
Nitrate production rate	0.00	mgN/L/hr
Nitrite production rate	4.17	mgN/L/hr
Nitrate removal rate	4.17	mgN/L/hr
Nitrite removal rate	4.25	mgN/L/hr
Net. nitrate production rate	-4.17	mgN/L/hr
Net. nitrite production rate	-0.09	mgN/L/hr
Dissolved N2 gas production rate	4.25	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	2.01	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	5.30	mgN/gVASS/hr
OTE	100.00	%
OTR	0	kg/hr
SOTE	100.00	%
SOTR	0	kg/hr
Air supply rate	0	m3/hr (20C, 101.325 kPa or 1 atm)
Air flow rate / diffuser	0	m3/hr (20C, 101.325 kPa or 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	0.99	m3/hr
Oxygen content	0	%
Carbon dioxide content	68.12	%
Ammonia content	0.01	%
Actual DO sat. conc.	9.65	mg/L
Velocity gradient	67.97	1/s

Album page - Aerobic

Aerobic			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	2106.68	18156.51	
Total suspended solids	3441.95	29664.53	
Particulate COD	3130.74	26982.37	
Filtered COD	24.23	208.87	
Total COD	3154.98	27191.23	
Soluble PO4-P	0.01	0.11	
Total P	141.38	1218.50	
Filtered TKN	2.59	22.32	
Particulate TKN	176.90	1524.61	
Total Kjeldahl Nitrogen	179.49	1546.93	
Filtered Carbonaceous BOD	1.13	9.74	
Total Carbonaceous BOD	694.46	5985.23	
Nitrite + Nitrate	5.11	44.05	
Total N	184.60	1590.98	
Total inorganic N	5.66	48.78	
Alkalinity	11.39	98.14	mmol/L and kmol/d
pH	7.07		
Volatile fatty acids	0.02	0.18	
Total precipitated solids	707.01	6093.39	
Total inorganic suspended solids	1335.27	11508.03	
Ammonia N	0.55	4.72	
Nitrate N	4.98	42.89	

Parameters	Value	Units
Hydraulic residence time	2.3	hours
Flow	8618.52	m3/d
MLSS	3441.95	mg/L
Total solids mass	2856.82	kg
Total readily biodegradable COD	1.59	mg/L
Total oxygen uptake rate	20.67	mgO/L/hr
Carbonaceous OUR	11.05	mgO/L/hr
Nitrogenous OUR	9.62	mgO/L/hr

Net. ammonia removal rate	2.20	mgN/L/hr
Nitrate production rate	2.20	mgN/L/hr
Nitrite production rate	2.31	mgN/L/hr
Nitrate removal rate	0.08	mgN/L/hr
Nitrite removal rate	2.26	mgN/L/hr
Net. nitrate production rate	2.12	mgN/L/hr
Net. nitrite production rate	0.05	mgN/L/hr
Dissolved N2 gas production rate	0.06	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.03	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.08	mgN/gVASS/hr
OTE	13.26	%
OTR	17.87	kg/hr
SOTE	40.81	%
SOTR	53.77	kg/hr
Air supply rate	483.65	m3/hr (20C, 101.325 kPa or 1 atm)
Air flow rate / diffuser	0.72	m3/hr (20C, 101.325 kPa or 1 atm)
# of diffusers	675.00	
Off gas flow rate (dry)	474.78	m3/hr
Oxygen content	18.20	%
Carbon dioxide content	2.33	%
Ammonia content	0.00	%
Actual DO sat. conc.	9.65	mg/L
Velocity gradient	110.49	1/s

Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	4.03	6.03	
Total suspended solids	6.60	9.87	
Particulate COD	5.99	8.95	
Filtered COD	24.22	36.21	
Total COD	30.21	45.17	
Soluble PO4-P	0.01	0.01	
Total P	0.28	0.42	
Filtered TKN	2.59	3.87	
Particulate TKN	0.34	0.51	
Total Kjeldahl Nitrogen	2.93	4.38	
Filtered Carbonaceous BOD	1.13	1.69	
Total Carbonaceous BOD	2.46	3.67	
Nitrite + Nitrate	5.11	7.64	
Total N	8.03	12.01	
Total inorganic N	5.66	8.46	
Alkalinity	5.58	8.34	mmol/L and kmol/d
pH	6.96		
Volatile fatty acids	0.02	0.03	
Total precipitated solids	1.37	2.05	
Total inorganic suspended solids	2.57	3.85	
Ammonia N	0.55	0.82	
Nitrate N	4.97	7.44	
Parameters	Value	Units	

Album page - Digester effluent

Digester Effluent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	11255.04	73.57	
Total suspended solids	20656.77	135.02	
Particulate COD	16936.57	110.71	
Filtered COD	23.55	0.15	
Total COD	16960.12	110.86	
Soluble PO4-P	92.20	0.60	

Total P	1014.64	6.63	
Filtered TKN	1.82	0.01	
Particulate TKN	890.30	5.82	
Total Kjeldahl Nitrogen	892.12	5.83	
Filtered Carbonaceous BOD	0.55	0.00	
Total Carbonaceous BOD	1041.79	6.81	
Nitrite + Nitrate	18.81	0.12	
Total N	910.93	5.95	
Total inorganic N	18.94	0.12	
Alkalinity	-999.00	-6.53	mmol/L and kmol/d
pH	6.37		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	5207.08	34.04	
Total inorganic suspended solids	9401.73	61.46	
Ammonia N	0.13	0.00	
Nitrate N	18.75	0.12	

Parameters	Value	Units

Album page - Clarifier

Model clarifier19			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	4.03	6.03	
Total suspended solids	6.60	9.87	
Particulate COD	5.99	8.95	
Filtered COD	24.22	36.21	
Total COD	30.21	45.17	
Soluble PO4-P	0.01	0.01	
Total P	0.28	0.42	
Filtered TKN	2.59	3.87	
Particulate TKN	0.34	0.51	
Total Kjeldahl Nitrogen	2.93	4.38	
Filtered Carbonaceous BOD	1.13	1.69	
Total Carbonaceous BOD	2.46	3.67	
Nitrite + Nitrate	5.11	7.64	
Total N	8.03	12.01	
Total inorganic N	5.66	8.46	
Alkalinity	5.58	8.34	mmol/L and kmol/d
pH	6.96		
Volatile fatty acids	0.02	0.03	
Total precipitated solids	1.37	2.05	
Total inorganic suspended solids	2.57	3.85	
Ammonia N	0.55	0.82	
Nitrate N	4.97	7.44	

Parameters	Value	Units
Hydraulic residence time	3.10	hours
Effluent flow	1495.30	m3/d
Return activated sludge flow	1125.00	m3/d
Height of specified concentration	0.45	m
Return activated sludge TSS	8024.54	mg/L
Effluent solids	6.60	mg/L
Solids loading rate	101.54	kg/(m2 d)
Surface overflow rate	16.80	m3/(m2 d)
Total solids mass	371.81	kg

Album page - Thickener

WAS Thickener

Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	1013.91	17.44	
Total suspended solids	1661.08	28.57	
Particulate COD	1506.77	25.92	
Filtered COD	24.22	0.42	
Total COD	1530.99	26.34	
Soluble PO4-P	0.01	0.00	
Total P	68.05	1.17	
Filtered TKN	2.59	0.04	
Particulate TKN	85.14	1.46	
Total Kjeldahl Nitrogen	87.73	1.51	
Filtered Carbonaceous BOD	1.13	0.02	
Total Carbonaceous BOD	334.82	5.76	
Nitrite + Nitrate	5.11	0.09	
Total N	92.83	1.60	
Total inorganic N	5.66	0.10	
Alkalinity	8.23	0.14	mmol/L and kmol/d
pH	6.96		
Volatile fatty acids	0.02	0.00	
Total precipitated solids	344.80	5.93	
Total inorganic suspended solids	647.17	11.13	
Ammonia N	0.55	0.01	
Nitrate N	4.97	0.09	

Parameters	Value	Units
Hydraulic residence time	113.24	hours
Effluent flow	17.20	m3/d
Return activated sludge flow	6.54	m3/d
Height of specified concentration	0.80	m
Return activated sludge TSS	24770.48	mg/L
Effluent solids	1661.08	mg/L
Solids loading rate	6.80	kg/(m2 d)
Surface overflow rate	0.61	m3/(m2 d)
Total solids mass	703.69	kg
Percent removal	85.00	%

Album page - Aerobic Digester

Aerobic Digester			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	11255.04	73.57	
Total suspended solids	20657.02	135.03	
Particulate COD	16936.57	110.71	
Filtered COD	23.55	0.15	
Total COD	16960.12	110.86	
Soluble PO4-P	92.17	0.60	
Total P	1014.64	6.63	
Filtered TKN	1.82	0.01	
Particulate TKN	890.30	5.82	
Total Kjeldahl Nitrogen	892.12	5.83	
Filtered Carbonaceous BOD	0.55	0.00	
Total Carbonaceous BOD	1041.79	6.81	
Nitrite + Nitrate	18.81	0.12	
Total N	910.93	5.95	
Total inorganic N	18.94	0.12	
Alkalinity	-999.00	-6.53	mmol/L and kmol/d
pH	6.39		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	5207.32	34.04	
Total inorganic suspended solids	9401.98	61.46	
Ammonia N	0.13	0.00	
Nitrate N	18.75	0.12	

Parameters	Value	Units
Hydraulic residence time	1020.7	hours
Flow	6.54	m3/d

MLSS	20657.02	mg/L
Total solids mass	5742.65	kg
Total readily biodegradable COD	0.78	mg/L
Total oxygen uptake rate	6.23	mgO/L/hr
Carbonaceous OUR	4.21	mgO/L/hr
Nitrogenous OUR	2.01	mgO/L/hr
Net. ammonia removal rate	0.00	mgN/L/hr
Nitrate production rate	0.65	mgN/L/hr
Nitrite production rate	1.03	mgN/L/hr
Nitrate removal rate	0.63	mgN/L/hr
Nitrite removal rate	1.03	mgN/L/hr
Net. nitrate production rate	0.01	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas production rate	0.36	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.03	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.29	mgN/gVASS/hr
OTE	19.62	%
OTR	1.73	kg/hr
SOTE	48.48	%
SOTR	4.18	kg/hr
Air supply rate	31.65	m3/hr (20C, 101.325 kPa or 1 atm)
Air flow rate / diffuser	0.21	m3/hr (20C, 101.325 kPa or 1 atm)
# of diffusers	154.00	
Off gas flow rate (dry)	30.84	m3/hr
Oxygen content	16.87	%
Carbon dioxide content	3.72	%
Ammonia content	0.00	%
Actual DO sat. conc.	10.07	mg/L
Velocity gradient	74.67	1/s
VSS destruction	25.56	%

Album page – Digester Effluent

Digester Effluent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	11255.04	73.57	
Total suspended solids	20656.77	135.02	
Particulate COD	16936.57	110.71	
Filtered COD	23.55	0.15	
Total COD	16960.12	110.86	
Soluble PO4-P	92.20	0.60	
Total P	1014.64	6.63	
Filtered TKN	1.82	0.01	
Particulate TKN	890.30	5.82	
Total Kjeldahl Nitrogen	892.12	5.83	
Filtered Carbonaceous BOD	0.55	0.00	
Total Carbonaceous BOD	1041.79	6.81	
Nitrite + Nitrate	18.81	0.12	
Total N	910.93	5.95	
Total inorganic N	18.94	0.12	
Alkalinity	-999.00	-6.53	mmol/L and kmol/d
pH	6.37		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	5207.08	34.04	
Total inorganic suspended solids	9401.73	61.46	
Ammonia N	0.13	0.00	
Nitrate N	18.75	0.12	
Parameters	Value	Units	

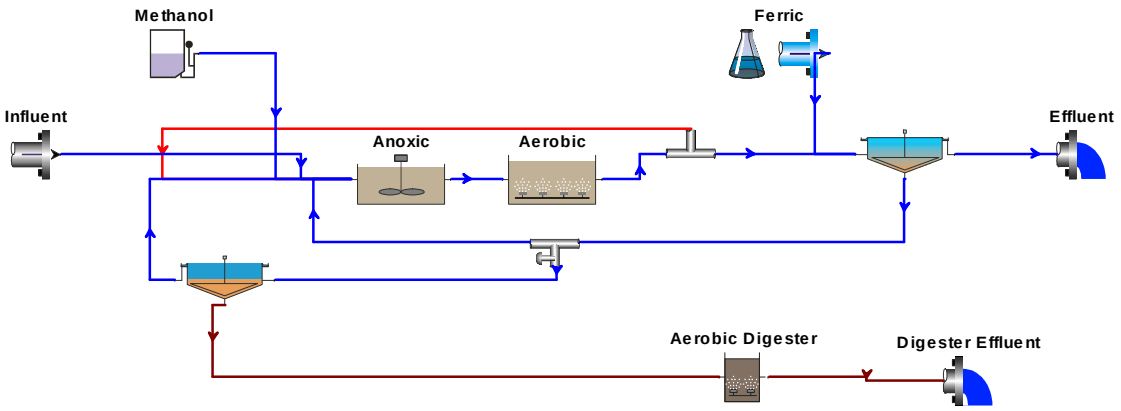
Detailed Modeling Report for a Flowrate of 3,600 m^3/d (New Plant)
BioWin user and configuration data

Project details
Project name: Unknown Project ref.: BW3
Plant name: Unknown **User name: dold**

Created: 3/1/2001 **Saved: 12/1/2010**

Target SRT: 15 SRT: **
Temperature: 15.0

Flowsheet



Configuration information for all Aerobic Digester units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]	# of diffusers
Aerobic Digester	278.0000	63.1818	4.400	154

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Aerobic Digester	0.1

Element name	Average Temperature [deg. C]
Aerobic Digester	13.0

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	% of tank area covered by diffusers [%]
Aerobic Digester	2.5656	0.0432	0.8200	0.0410	10.0000

Configuration information for all Bioreactor units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]	# of diffusers
Aerobic	2310.0000	513.3333	4.500	1878
Anoxic	700.0000	155.5556	4.500	Un-aerated

Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint [mg/L]
Aerobic	2.0
Anoxic	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	% of tank area covered by diffusers [%]
Aerobic	2.5656	0.0432	0.8200	0.0410	15.0000
Anoxic	2.5656	0.0432	0.8200	0.0410	10.0000

Element name	Alpha (surf) OR Alpha F (diff) [-]	Beta [-]	Surface pressure [kPa]	Fractional effective saturation depth (Fed) [-]
Aerobic	0.5000	0.9500	101.3250	0.3250

Element name	Supply gas CO2 content [vol. %]	Supply gas O2 [vol. %]	Off-gas CO2 [vol. %]	Off-gas O2 [vol. %]	Off-gas H2 [vol. %]	Off-gas NH3 [vol. %]	Off-gas CH4 [vol. %]	Surface turbulence factor [-]
Aerobic	0.0350	20.9500	2.0000	18.8000	0	0	0	2.0000

Configuration information for all Methanol units

Operating data Average (flow/time weighted as required)

Element name	Methanol
Non-polyP heterotrophs mgCOD/L	0
Anoxic methanol utilizers mgCOD/L	0
Ammonia oxidizing biomass mgCOD/L	0
Nitrite oxidizing biomass mgCOD/L	0
Anaerobic ammonia oxidizers mgCOD/L	0
PolyP heterotrophs mgCOD/L	0
Propionic acetogens mgCOD/L	0
Acetoclastic methanogens mgCOD/L	0
Hydrogenotrophic methanogens mgCOD/L	0
Endogenous products mgCOD/L	0
Slowly bio. COD (part.) mgCOD/L	0
Slowly bio. COD (colloid.) mgCOD/L	0
Part. inert. COD mgCOD/L	0
Part. bio. org. N mgN/L	0
Part. bio. org. P mgP/L	0
Part. inert N mgN/L	0
Part. inert P mgP/L	0
Stored PHA mgCOD/L	0

Releasable stored polyP mgP/L	0
Fixed stored polyP mgP/L	0
PolyP bound cations mg/L	0
Readily bio. COD (complex) mgCOD/L	0
Acetate mgCOD/L	0
Propionate mgCOD/L	0
Methanol mgCOD/L	1188000.00
Dissolved H2 mgCOD/L	0
Dissolved methane mg/L	0
Ammonia N mgN/L	0
Sol. bio. org. N mgN/L	0
Nitrite N mgN/L	0
Nitrate N mgN/L	0
Dissolved nitrogen gas mgN/L	0
PO4-P (Sol. & Me Complexed) mgP/L	0
Sol. inert COD mgCOD/L	0
Sol. inert TKN mgN/L	0
Inorganic S.S. mgISS/L	0
Struvite mgISS/L	0
Hydroxy-dicalcium-phosphate mgISS/L	0
Hydroxy-apatite mgISS/L	0
Magnesium mg/L	0
Calcium mg/L	0
Metal mg/L	0
Other Cations (strong bases) meq/L	0
Other Anions (strong acids) meq/L	0
Total CO2 mmol/L	0
User defined 1 mg/L	0
User defined 2 mg/L	0
User defined 3 mgVSS/L	0
User defined 4 mgISS/L	0
Dissolved oxygen mg/L	0
Flow	0.25

Configuration information for all Model clarifier units

Physical data

Element name	Volume[m3]	Area[m2]	Depth[m]	Number of layers	Top feed layer	Feed Layers
Model clarifier19	744.8000	196.0000	3.800	10	6	1

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
Model clarifier19	Flowrate [Under]	3600

Element name	Average Temperature	Reactive
Model clarifier19	Uses global setting	No

Local settling parameters

Element name	Maximum Vesilind settling velocity (Vo)	Vesilind hindered zone settling parameter (K) [L/g]	Clarification switching function [mg/L]	Specified TSS conc.for height calc. [mg/L]	Maximum compactability constant [mg/L]
Model clarifier19	183.0000	0.0003	100.0000	2500.0000	15000.0000

Configuration information for all Effluent units

Configuration information for all Ideal clarifier units

Physical data

Element name	Volume [m3]	Area [m2]	Depth [m]
WAS Thickener	112.0000	28.0000	4.000

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
WAS Thickener	Ratio	0.38

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
WAS Thickener	Uses global setting	No	85.00	0.20

Configuration information for all COD Influent units

Operating data Average (flow/time weighted as required)

Element name	Influent
Time	0
Flow	3600
Total COD mgCOD/L	300.00
Total Kjeldahl Nitrogen mgN/L	38.00
Total P mgP/L	4.70
Nitrate N mgN/L	0.20
pH	7.60
Alkalinity mmol/L	8.06
Inorganic S.S. mgISS/L	17.00
Calcium mg/L	50.00
Magnesium mg/L	20.00
Dissolved oxygen mg/L	0

Element name	Influent
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.0990
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1750
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8500
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0750
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.6740
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]	0.0350
Fpo4 - Phosphate [gPO4-P/gTP]	0.7230
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.0110
FZbh - Non-poly-P heterotrophs [gCOD/g of total COD]	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.0001
FZaob - Ammonia oxidizers [gCOD/g of total COD]	0.0001
FZnob - Nitrite oxidizers [gCOD/g of total COD]	0.0001
FZamob - Anaerobic ammonia oxidizers [gCOD/g of total COD]	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.0001
FZbam - Acetoclastic methanogens [gCOD/g of total COD]	0.0001
FZbhm - H2-utilizing methanogens [gCOD/g of total COD]	0.0001

Configuration information for all Metal addition units

Operating data Average (flow/time weighted as required)

Element name	Ferric
Non-polyP heterotrophs mgCOD/L	0
Anoxic methanol utilizers mgCOD/L	0
Ammonia oxidizing biomass mgCOD/L	0
Nitrite oxidizing biomass mgCOD/L	0
Anaerobic ammonia oxidizers mgCOD/L	0
PolyP heterotrophs mgCOD/L	0
Propionic acetogens mgCOD/L	0
Acetoclastic methanogens mgCOD/L	0
Hydrogenotrophic methanogens mgCOD/L	0
Endogenous products mgCOD/L	0
Slowly bio. COD (part.) mgCOD/L	0
Slowly bio. COD (colloid.) mgCOD/L	0
Part. inert. COD mgCOD/L	0
Part. bio. org. N mgN/L	0
Part. bio. org. P mgP/L	0
Part. inert N mgN/L	0
Part. inert P mgP/L	0
Stored PHA mgCOD/L	0
Releasable stored polyP mgP/L	0
Fixed stored polyP mgP/L	0
PolyP bound cations mg/L	0
Readily bio. COD (complex) mgCOD/L	0
Acetate mgCOD/L	0
Propionate mgCOD/L	0
Methanol mgCOD/L	0
Dissolved H2 mgCOD/L	0
Dissolved methane mg/L	0
Ammonia N mgN/L	0
Sol. bio. org. N mgN/L	0
Nitrite N mgN/L	0
Nitrate N mgN/L	0
Dissolved nitrogen gas mgN/L	0
PO4-P (Sol. & Me Complexed) mgP/L	0
Sol. inert COD mgCOD/L	0
Sol. inert TKN mgN/L	0
Inorganic S.S. mgISS/L	0
Struvite mgISS/L	0
Hydroxy-dicalcium-phosphate mgISS/L	0
Hydroxy-apatite mgISS/L	0
Magnesium mg/L	0
Calcium mg/L	0
Metal mg/L	7230.23
Other Cations (strong bases) meq/L	5.00
Other Anions (strong acids) meq/L	407.79
Total CO2 mmol/L	7.00
User defined 1 mg/L	0
User defined 2 mg/L	0
User defined 3 mgVSS/L	0
User defined 4 mgISS/L	0
Dissolved oxygen mg/L	0
Flow	4

Configuration information for all Splitter units

Operating data Average (flow/time weighted as required)

Element name	Split method	Average Split specification
WAS splitter	Flowrate [Side]	76.9999999743333
Splitter21	Flowrate [Side]	14400

BioWin Album

Album page - Influent

Influent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	135.35	487.25	
Total suspended solids	152.37	548.54	
Particulate COD	216.52	779.47	
Filtered COD	83.48	300.53	
Total COD	300.00	1080.00	
Soluble PO4-P	3.40	12.23	
Total P	4.70	16.92	
Filtered TKN	31.49	113.38	
Particulate TKN	6.51	23.42	
Total Kjeldahl Nitrogen	38.00	136.80	
Filtered Carbonaceous BOD	43.07	155.06	
Total Carbonaceous BOD	136.93	492.94	
Nitrite + Nitrate	0.20	0.72	
Total N	38.20	137.52	
Total inorganic N	25.81	92.92	
Alkalinity	8.06	29.02	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	5.20	18.71	
Total precipitated solids	0	0	
Total inorganic suspended solids	17.03	61.29	
Ammonia N	25.61	92.20	
Nitrate N	0.20	0.72	

Parameters	Value	Units

lbum page - Anoxic

Anoxic			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	2022.81	43650.38	
Total suspended solids	3146.32	67894.53	
Particulate COD	2996.42	64659.97	
Filtered COD	33.52	723.33	
Total COD	3029.94	65383.30	
Soluble PO4-P	0.02	0.37	
Total P	121.74	2626.97	
Filtered TKN	7.22	155.85	
Particulate TKN	172.03	3712.20	
Total Kjeldahl Nitrogen	179.25	3868.05	
Filtered Carbonaceous BOD	6.95	150.00	
Total Carbonaceous BOD	732.08	15797.64	
Nitrite + Nitrate	0.15	3.25	
Total N	179.40	3871.29	
Total inorganic N	5.38	116.15	
Alkalinity	10.89	234.99	mmol/L and kmol/d
pH	7.17		
Volatile fatty acids	0.99	21.30	
Total precipitated solids	566.34	12221.09	
Total inorganic suspended solids	1123.50	24244.15	
Ammonia N	5.23	112.90	
Nitrate N	0.11	2.48	

Parameters	Value	Units
Hydraulic residence time	0.8	hours
Flow	21579.05	m3/d
MLSS	3146.32	mg/L
Total solids mass	2202.42	kg
Total readily biodegradable COD	9.53	mg/L
Total oxygen uptake rate	0.00	mgO/L/hr

Carbonaceous OUR	0.00	mgO/L/hr
Nitrogenous OUR	0.00	mgO/L/hr
Net. ammonia removal rate	-0.68	mgN/L/hr
Nitrate production rate	0.00	mgN/L/hr
Nitrite production rate	4.89	mgN/L/hr
Nitrate removal rate	4.89	mgN/L/hr
Nitrite removal rate	4.98	mgN/L/hr
Net. nitrate production rate	-4.89	mgN/L/hr
Net. nitrite production rate	-0.09	mgN/L/hr
Dissolved N2 gas production rate	4.98	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	2.46	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	5.99	mgN/gVASS/hr
OTE	100.00	%
OTR	0	kg/hr
SOTE	100.00	%
SOTR	0	kg/hr
Air supply rate	0	m3/hr (20C, 101.325 kPa or 1 atm)
Air flow rate / diffuser	0	m3/hr (20C, 101.325 kPa or 1 atm)
# of diffusers	0	
Off gas flow rate (dry)	1.95	m3/hr
Oxygen content	0	%
Carbon dioxide content	70.83	%
Ammonia content	0.01	%
Actual DO sat. conc.	9.65	mg/L
Velocity gradient	69.31	1/s

Album page - Aerobic

Aerobic			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	2011.02	43396.00	
Total suspended solids	3134.99	67650.19	
Particulate COD	2976.30	64225.74	
Filtered COD	24.14	520.89	
Total COD	3000.44	64746.63	
Soluble PO4-P	0.01	0.27	
Total P	121.74	2626.97	
Filtered TKN	2.55	54.93	
Particulate TKN	171.89	3709.33	
Total Kjeldahl Nitrogen	174.44	3764.26	
Filtered Carbonaceous BOD	1.09	23.54	
Total Carbonaceous BOD	713.79	15402.99	
Nitrite + Nitrate	4.79	103.45	
Total N	179.23	3867.71	
Total inorganic N	5.31	114.55	
Alkalinity	10.22	220.55	mmol/L and kmol/d
pH	7.07		
Volatile fatty acids	0.01	0.26	
Total precipitated solids	566.20	12217.98	
Total inorganic suspended solids	1123.97	24254.19	
Ammonia N	0.51	11.10	
Nitrate N	4.67	100.79	

Parameters	Value	Units
Hydraulic residence time	2.6	hours
Flow	21579.05	m3/d
MLSS	3134.99	mg/L
Total solids mass	7241.84	kg
Total readily biodegradable COD	1.54	mg/L
Total oxygen uptake rate	19.41	mgO/L/hr
Carbonaceous OUR	11.30	mgO/L/hr
Nitrogenous OUR	8.11	mgO/L/hr
Net. ammonia removal rate	1.84	mgN/L/hr
Nitrate production rate	1.86	mgN/L/hr
Nitrite production rate	1.96	mgN/L/hr
Nitrate removal rate	0.09	mgN/L/hr
Nitrite removal rate	1.93	mgN/L/hr

Net. nitrate production rate	1.77	mgN/L/hr
Net. nitrite production rate	0.03	mgN/L/hr
Dissolved N2 gas production rate	0.06	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.03	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.08	mgN/gVASS/hr
OTE	13.45	%
OTR	46.64	kg/hr
SOTE	41.39	%
SOTR	140.33	kg/hr
Air supply rate	1244.52	m3/hr (20C, 101.325 kPa or 1 atm)
Air flow rate / diffuser	0.66	m3/hr (20C, 101.325 kPa or 1 atm)
# of diffusers	1878.00	
Off gas flow rate (dry)	1221.71	m3/hr
Oxygen content	18.16	%
Carbon dioxide content	2.42	%
Ammonia content	0.00	%
Actual DO sat. conc.	9.65	mg/L
Velocity gradient	108.71	1/s

Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	4.69	16.80	
Total suspended solids	7.33	26.25	
Particulate COD	6.94	24.86	
Filtered COD	24.13	86.44	
Total COD	31.06	111.30	
Soluble PO4-P	0.01	0.03	
Total P	0.29	1.05	
Filtered TKN	2.54	9.12	
Particulate TKN	0.40	1.44	
Total Kjeldahl Nitrogen	2.95	10.55	
Filtered Carbonaceous BOD	1.09	3.91	
Total Carbonaceous BOD	2.75	9.86	
Nitrite + Nitrate	4.79	17.17	
Total N	7.74	27.72	
Total inorganic N	5.31	19.01	
Alkalinity	5.63	20.16	mmol/L and kmol/d
pH	6.98		
Volatile fatty acids	0.01	0.04	
Total precipitated solids	1.34	4.79	
Total inorganic suspended solids	2.64	9.45	
Ammonia N	0.51	1.84	
Nitrate N	4.67	16.73	
Parameters	Value	Units	

Album page - Digester effluent

Digester Effluent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	9911.51	210.15	
Total suspended solids	16742.58	354.99	
Particulate COD	14784.23	313.47	
Filtered COD	23.45	0.50	
Total COD	14807.68	313.97	
Soluble PO4-P	47.44	1.01	
Total P	748.46	15.87	
Filtered TKN	1.82	0.04	
Particulate TKN	817.04	17.32	
Total Kjeldahl Nitrogen	818.86	17.36	
Filtered Carbonaceous BOD	0.54	0.01	

Total Carbonaceous BOD	1908.93	40.47	
Nitrite + Nitrate	1.15	0.02	
Total N	820.01	17.39	
Total inorganic N	1.30	0.03	
Alkalinity	14.75	0.31	mmol/L and kmol/d
pH	6.85		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	3599.51	76.32	
Total inorganic suspended solids	6831.08	144.84	
Ammonia N	0.15	0.00	
Nitrate N	1.07	0.02	

Parameters	Value	Units

Album page - Clarifier

Model clarifier19			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	4.69	16.80	
Total suspended solids	7.33	26.25	
Particulate COD	6.94	24.86	
Filtered COD	24.13	86.44	
Total COD	31.06	111.30	
Soluble PO4-P	0.01	0.03	
Total P	0.29	1.05	
Filtered TKN	2.54	9.12	
Particulate TKN	0.40	1.44	
Total Kjeldahl Nitrogen	2.95	10.55	
Filtered Carbonaceous BOD	1.09	3.91	
Total Carbonaceous BOD	2.75	9.86	
Nitrite + Nitrate	4.79	17.17	
Total N	7.74	27.72	
Total inorganic N	5.31	19.01	
Alkalinity	5.63	20.16	mmol/L and kmol/d
pH	6.98		
Volatile fatty acids	0.01	0.04	
Total precipitated solids	1.34	4.79	
Total inorganic suspended solids	2.64	9.45	
Ammonia N	0.51	1.84	
Nitrate N	4.67	16.73	

Parameters	Value	Units
Hydraulic residence time	2.49	hours
Effluent flow	3583.05	m3/d
Return activated sludge flow	3600.00	m3/d
Height of specified concentration	0.43	m
Return activated sludge TSS	6259.84	mg/L
Effluent solids	7.33	mg/L
Solids loading rate	115.11	kg/(m2 d)
Surface overflow rate	18.28	m3/(m2 d)
Total solids mass	709.28	kg

Album page - Thickener

WAS Thickener			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	829.18	46.27	
Total suspended solids	1295.78	72.30	
Particulate COD	1227.17	68.47	
Filtered COD	24.13	1.35	
Total COD	1251.30	69.82	
Soluble PO4-P	0.01	0.00	

Total P	50.20	2.80	
Filtered TKN	2.54	0.14	
Particulate TKN	70.87	3.95	
Total Kjeldahl Nitrogen	73.42	4.10	
Filtered Carbonaceous BOD	1.09	0.06	
Total Carbonaceous BOD	294.95	16.46	
Nitrite + Nitrate	4.79	0.27	
Total N	78.21	4.36	
Total inorganic N	5.31	0.30	
Alkalinity	7.42	0.41	mmol/L and kmol/d
pH	6.98		
Volatile fatty acids	0.01	0.00	
Total precipitated solids	236.63	13.20	
Total inorganic suspended solids	466.61	26.04	
Ammonia N	0.51	0.03	
Nitrate N	4.67	0.26	

Parameters	Value	Units
Hydraulic residence time	34.91	hours
Effluent flow	55.80	m3/d
Return activated sludge flow	21.20	m3/d
Height of specified concentration	0.80	m
Return activated sludge TSS	19323.13	mg/L
Effluent solids	1295.78	mg/L
Solids loading rate	17.21	kg/(m2 d)
Surface overflow rate	1.99	m3/(m2 d)
Total solids mass	548.94	kg
Percent removal	85.00	%

Album page - Aerobic Digester

Aerobic Digester			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	9911.51	210.15	
Total suspended solids	16742.60	354.99	
Particulate COD	14784.23	313.47	
Filtered COD	23.45	0.50	
Total COD	14807.68	313.97	
Soluble PO4-P	47.44	1.01	
Total P	748.46	15.87	
Filtered TKN	1.82	0.04	
Particulate TKN	817.04	17.32	
Total Kjeldahl Nitrogen	818.86	17.36	
Filtered Carbonaceous BOD	0.54	0.01	
Total Carbonaceous BOD	1908.93	40.47	
Nitrite + Nitrate	1.15	0.02	
Total N	820.01	17.39	
Total inorganic N	1.30	0.03	
Alkalinity	14.48	0.31	mmol/L and kmol/d
pH	6.86		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	3599.53	76.32	
Total inorganic suspended solids	6831.09	144.84	
Ammonia N	0.15	0.00	
Nitrate N	1.07	0.02	

Parameters	Value	Units
Hydraulic residence time	314.7	hours
Flow	21.20	m3/d
MLSS	16742.60	mg/L
Total solids mass	4654.44	kg
Total readily biodegradable COD	0.77	mg/L
Total oxygen uptake rate	12.53	mgO/L/hr
Carbonaceous OUR	8.69	mgO/L/hr
Nitrogenous OUR	3.84	mgO/L/hr
Net. ammonia removal rate	0.00	mgN/L/hr

Nitrate production rate	1.11	mgN/L/hr
Nitrite production rate	1.92	mgN/L/hr
Nitrate removal rate	1.12	mgN/L/hr
Nitrite removal rate	1.92	mgN/L/hr
Net. nitrate production rate	-0.01	mgN/L/hr
Net. nitrite production rate	0.00	mgN/L/hr
Dissolved N2 gas production rate	0.78	mgN/L/hr
Spec. dissolved N2 gas production rate per VSS	0.08	mgN/gVSS/hr
Spec. dissolved N2 gas production per VASS	0.34	mgN/gVASS/hr
OTE	16.83	%
OTR	3.48	kg/hr
SOTE	41.59	%
SOTR	8.41	kg/hr
Air supply rate	74.22	m3/hr (20C, 101.325 kPa or 1 atm)
Air flow rate / diffuser	0.48	m3/hr (20C, 101.325 kPa or 1 atm)
# of diffusers	154.00	
Off gas flow rate (dry)	72.44	m3/hr
Oxygen content	17.43	%
Carbon dioxide content	3.23	%
Ammonia content	0.00	%
Actual DO sat. conc.	10.07	mg/L
Velocity gradient	86.02	1/s
VSS destruction	19.84	%

Album page – Digester Effluent

Digester Effluent			
Parameters	Conc. (mg/L)	Mass rate (kg/d)	Notes
Volatile suspended solids	9911.51	210.15	
Total suspended solids	16742.58	354.99	
Particulate COD	14784.23	313.47	
Filtered COD	23.45	0.50	
Total COD	14807.68	313.97	
Soluble PO4-P	47.44	1.01	
Total P	748.46	15.87	
Filtered TKN	1.82	0.04	
Particulate TKN	817.04	17.32	
Total Kjeldahl Nitrogen	818.86	17.36	
Filtered Carbonaceous BOD	0.54	0.01	
Total Carbonaceous BOD	1908.93	40.47	
Nitrite + Nitrate	1.15	0.02	
Total N	820.01	17.39	
Total inorganic N	1.30	0.03	
Alkalinity	14.75	0.31	mmol/L and kmol/d
pH	6.85		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	3599.51	76.32	
Total inorganic suspended solids	6831.08	144.84	
Ammonia N	0.15	0.00	
Nitrate N	1.07	0.02	
Parameters	Value	Units	