Evaluation of Nitrification Inhibition Using Bench-Scale Rate Measurements, Profile Sampling, and Process Simulation Modeling

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Abstract

The Hampton Roads Sanitation District (HRSD) operates thirteen treatment plants in the eastern Virginia area with a combined capacity of 231 million gallons per day (mgd). The Nansemond Treatment Plant (NTP) is one of the larger facilities, and is designed to treat 30 mgd using a 3-stage Virginia Initiative Process (VIP) biological nutrient removal (BNR) process. The majority of the influent is domestic, but there is also a large industrial contribution, particularly from a hog processing facility, landfill leachate, and significant loads from septage and grease deliveries (Bilyk et al, 2008). NTP is currently being upgraded to a 5-stage Bardenpho process to achieve improved total nitrogen (TN) removal. For several years starting in about 2001, NTP has experienced continuous and sporadic nitrification upsets that cannot be explained by plant operations events. Sporadic nitrification upsets are characterized by sharp increases in effluent ammonia and nitrite with decreases in nitrate concentrations due to reduced growth rates in bacteria. The result is reduced overall total nitrogen (TN) removal. Continuous inhibition is evidenced by a previous engineering report by Hazen and Sawyer, P.C. (2007), whereby it was suggested that the ammonia oxidizing bacteria (AOB) maximum specific growth rate (μ_{max}) be reduced from 0.9 to 0.57 days^{-1}. This has significant implications in terms of the required aeration volume for consistent nitrification at cold temperatures.

The objective of this project was to determine whether the NTP influent wastewater does in fact exhibit inhibition to ammonia (AOB) and nitrite oxidizing bacteria (NOB), evaluated independently, and to determine the impact on polyphosphate accumulating organism activity

(PAO). Because the historical operational experiences and data analysis suggested inhibited AOB and NOB activity, an investigation was initiated targeting the source of that inhibition. After conducting seventeen weeks of batch experiments the source of inhibition was not determined. Batch experiments however, did reveal other possible sources of inhibition including large amounts of chemical toilet waste received at NTP possibly containing quaternary ammonium compounds (QACs).

Due to available blower capacity during construction it was planned that nitrification would not be maintained during the fall of 2009. In an effort to stop nitrification, the solids retention time (SRT) was purposely reduced over a period of about one month (as wastewater temperature cooled) until additional blower capacity was available. This provided an opportunity to study baseline nitrification kinetics and determine the potential for continuous inhibition through profile sampling. Simulation modeling of the profile sampling and plant data was performed with *Biowin 3.1* (EnviroSim, Ltd.) as a means for comparison and to generate μ_{max} values for AOB to compare with the original design μ_{max} of 0.57^{-1}.

Profile sampling was conducted from the primary effluent to the secondary effluent with samples collected along the length of the BNR process. This was being done to address the following issues:

- Conduct baseline sampling prior to a more detailed nitrification inhibition study estimated to begin in May 2010, which will include influent sampling and the operation of bench-scale sequencing batch reactors. This will be used to establish “normal” COD, nutrient and DO profiles though the VIP process without (and possibly with) the impact of inhibitory conditions, specifically with respect to N conversions and P release and uptake along the process.

- Evaluate the potential for nitrite accumulation in the process and its potential effect on aerobic phosphate uptake by phosphorus accumulating organisms (PAOs).
- Evaluate the impact of sporadic ferric chloride addition to the biological process as a means of preventing effluent TP exceedances.
- Evaluate the design μ_{max} to the actual observed μ_{max} for AOB through simulation modeling.
- Compare modeling and observed profile data for signs of any continuous nitrification inhibition.

Experimental results from batch-rate testing confirmed the sporadically inhibitory nature of NTP primary effluent when combined with other stable nitrifying biomasses. Investigation into quaternary ammonium compounds (QACs) which were contained in the chemical toilet waste suggested that QACs at higher concentrations caused some inhibition of NOB activity, but no significant impact on AOB activity. Profile sampling demonstrated no signs of sporadic or continuous nitrification inhibition or impact of nitrite accumulation and ferric chloride addition on biological treatment processes. Modeling of the profile data generated similar profiles; however, there were slight variations as the model predicted nitrification to stop earlier than what was actually observed. From the modeling it was also determined that the maximum specific growth rate (μ_{max}) of ammonia oxidizing bacteria (AOB) was in the range of 0.50 – 60 days^{-1}. This supported batch and profile work that showed NTP PE exhibited some degree of continuous inhibition. Diurnal loadings however, were not accounted for in the modeling which could slightly underestimate the actual AOB μ_{max} value. Several suspected inhibitors were eliminated as potential causes of inhibition, including waste from a hog processing facility, landfill leachate, the addition of ferric chloride, plant internal recycle streams, branches of the collection system, and chemical toilet disinfectants containing QACs.

References

Bilyk, K., Cubbage, L., Stone, A., Pitt, P., Dano, J., and Balzer, B. 2008. Unlocking the Mystery of Biological Phosphorus Removal Upsets and Inhibited Nitrification at a 30 mgd BNR Facility. *Proceedings of the Water Environment Federation Technical Conference and Exposition*, 2008.

Hazen and Sawyer. 2007. *Nansemond Treatment Plant Nutrient Reduction Improvement Technical Memorandum.*

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Introduction

1.1 Project Background

The Nansemond Treatment Plant (NTP) is one of the larger facilities of the thirteen plants operated by the Hampton Roads Sanitation District (HRSD) with a maximum monthly design capacity of 30 million gallons per day (MGD). This facility was originally designed as a 3-stage Virginia Initiative Process (VIP) biological nutrient removal (BNR) system as shown in Figure 1.1 (Bilyk et al., 2008) and is currently being upgraded to a 5-stage Bardenpho process with external carbon addition. The majority of the influent is domestic, but there is also a large industrial contribution, particularly from a hog processing facility, landfill leachate, and significant loads from septage and grease deliveries (Bilyk et al., 2008).

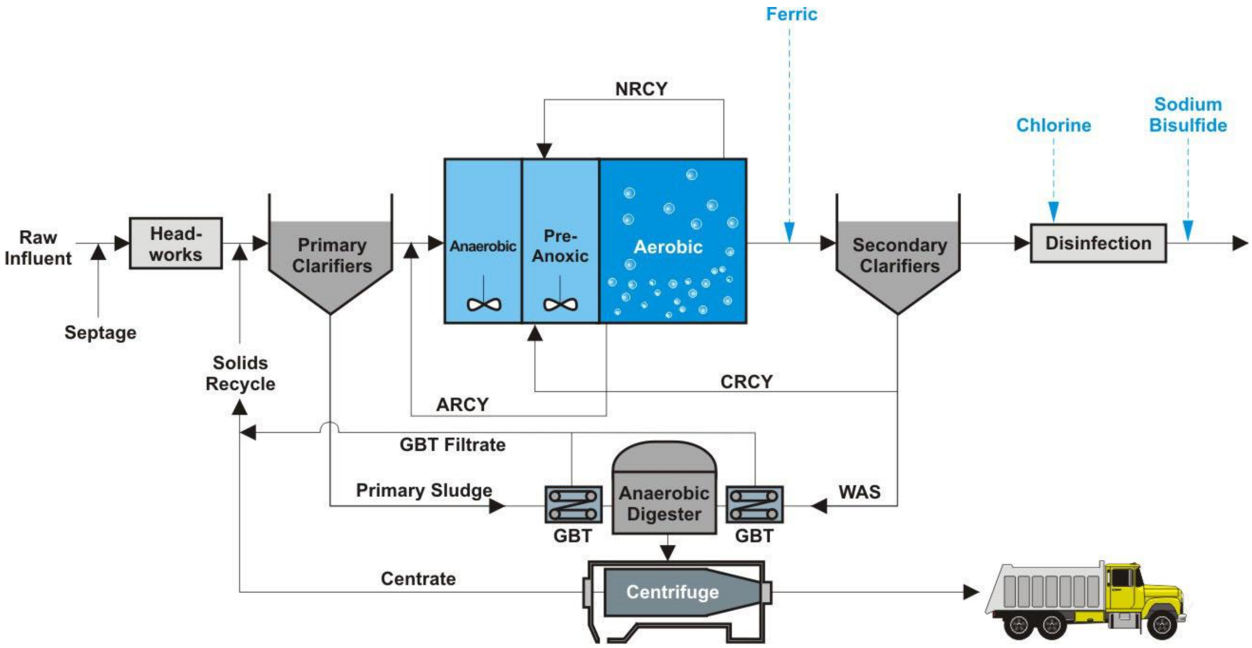

Figure 1.1 3-Stage VIP (2008) NTP Process Flow Diagram (Bilyk et al., 2008)

NTP began operations as a 10 mgd secondary treatment plant in 1983. Expansions and upgrades were completed in May 1998, which converted the facility into a 30 mgd BNR facility. Since the upgrade the facility has experienced mixed success in the BNR mode (Balzer et al., 2005). This determination was based upon the plant's efficiency in removing nitrogen. The VIP plant in Norfolk, VA which also employs the VIP process began BNR operations approximately seven (7) years prior to similar Nansemond operations (Balzer et al., 2005). Nitrogen removal was similar at both facilities (Table 1.1) during the first two years of side-by-side operation (1999 & 2000) (Balzer et al., 2005). Nansemond experienced an unexpected decline in nitrogen removal efficiency starting in 2001, which has continued to the present (Balzer et al., 2005). This deficiency in performance has been variable and has not been consistent from 2001 to the present time.

Table 1.1 Percent TN Removal for HRSD's Nansemond and VIP Treatment Plants (1999-2009)

PLANT	NP	VIP
YEAR	[% Removal]	[% Removal]
1999	69.9	71.5
2000	64.2	67.0
2001	53.1	66.3
2002	64.4	67.1
2003	45.0	62.5
2004	55.6	71.9
2005	50.6	67.83
2006	70.8	69.67
2007	68	65.83
2008	70.3	72.58
2009	50	60
MEAN	**60.2**	**67.5**

NTP achieves continuous complete nitrification during certain periods consistently meeting desired effluent limits. In spite of this, NTP has also experienced unexplained sporadic nitrification upsets for a number of years and even in summer months when compared to the VIP plant (Figure 1.2 and 1.3) and some indication of continuous nitrification inhibition, as demonstrated by calibration of a process simulation model to historical plant performance data (Hazen & Sawyer, 2007). The previous target total nitrogen (TN) treatment objective was 12 mg/L on a seasonal basis. This has changed more recently to a permitted limit of 8 mg/L TN on an annual average basis (Bilyk et al., 2008).

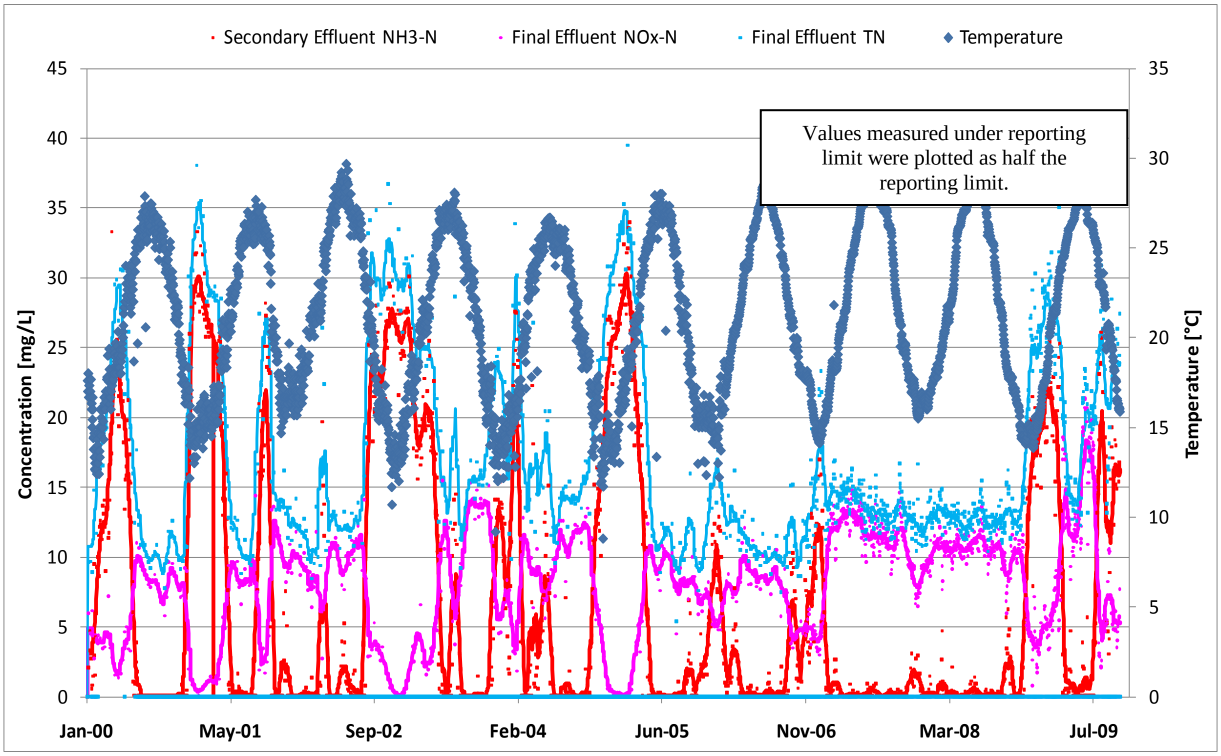

Figure 1.2 NTP Historical Effluent Ammonia, NOx-N, and Total Nitrogen Profile 2000-2009 (Lines represent 30-day rolling averages).

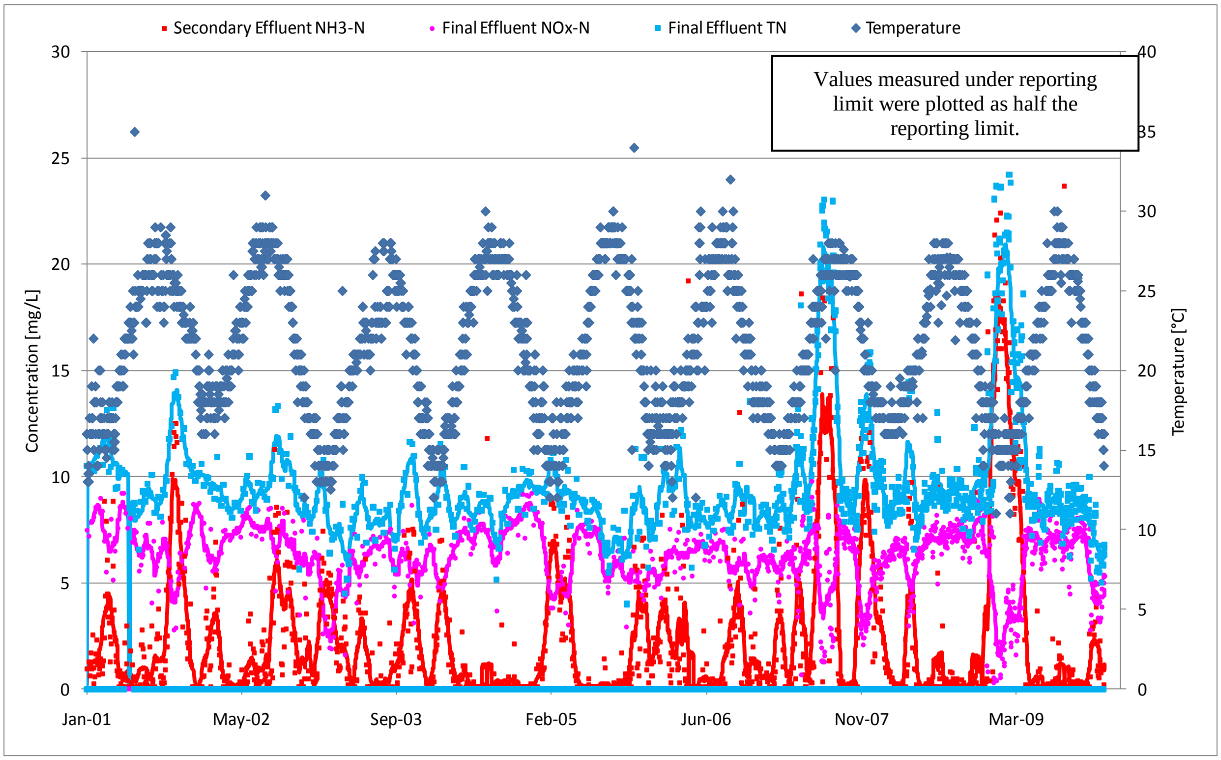

Figure 1.3 VIP Historical Effluent Ammonia, NOx-N, and Total Nitrogen Profile 2001-2009 (Lines represent 30-day rolling averages).

In addition the plant also experienced regular biological phosphorus removal upsets (Figure 1.4) which forced NTP to add large quantities of ferric chloride to avoid permit violations for effluent TP (Bilyk et al., 2008). It was the goal of NTP to meet a treatment objective of 1 mg/L of total phosphorus (TP) on an annual average basis (Bilyk et al., 2008).

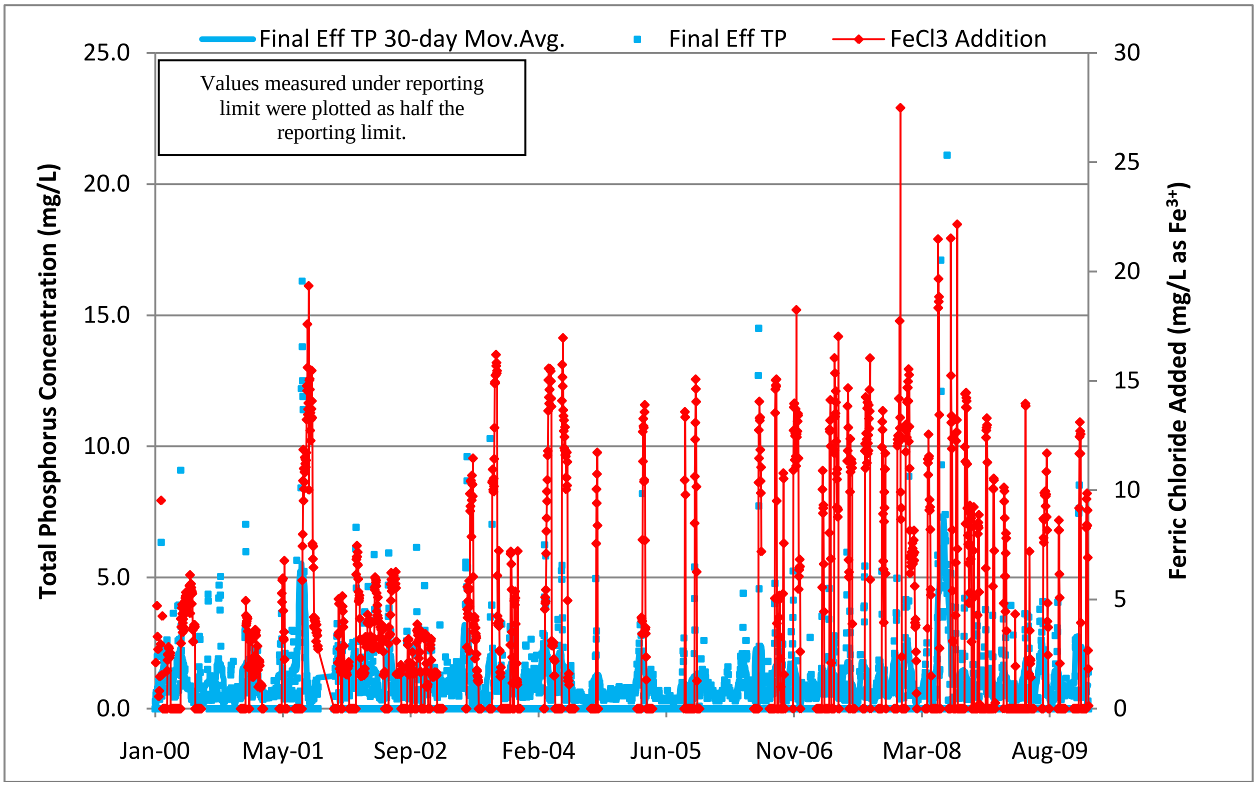

Figure 1.4 NTP Historical Effluent TP and Ferric Chloride Addition 2000-2009

1.1.1 Investigation of Inhibition

HRSD has expended considerable time and resources investigating possible sources of inhibition. It was originally presumed that contributions from industrial loads, either from a hog processing facility or landfill leachate, were the culprits for sporadic failure in nitrification and bio-P upsets. These sources were tested specifically as part of this work.

1.1.2 Facility Upgrades

In order to meet future permit limits NTP is currently being upgraded to a 5-stage Bardenpho process (Figure 1.5). This upgrade also will provide increased aeration volume/capacity to enhance both nitrification and Bio-P removal. The new upgrades will also incorporate a full-scale proprietary technology developed by Ostara that uses a fluidized bed reactor to recover phosphorus and ammonia through struvite precipitation from the centrate being generated at NTP. The harvested struvite can then be utilized as a slow release fertilizer (Ostara, 2007).

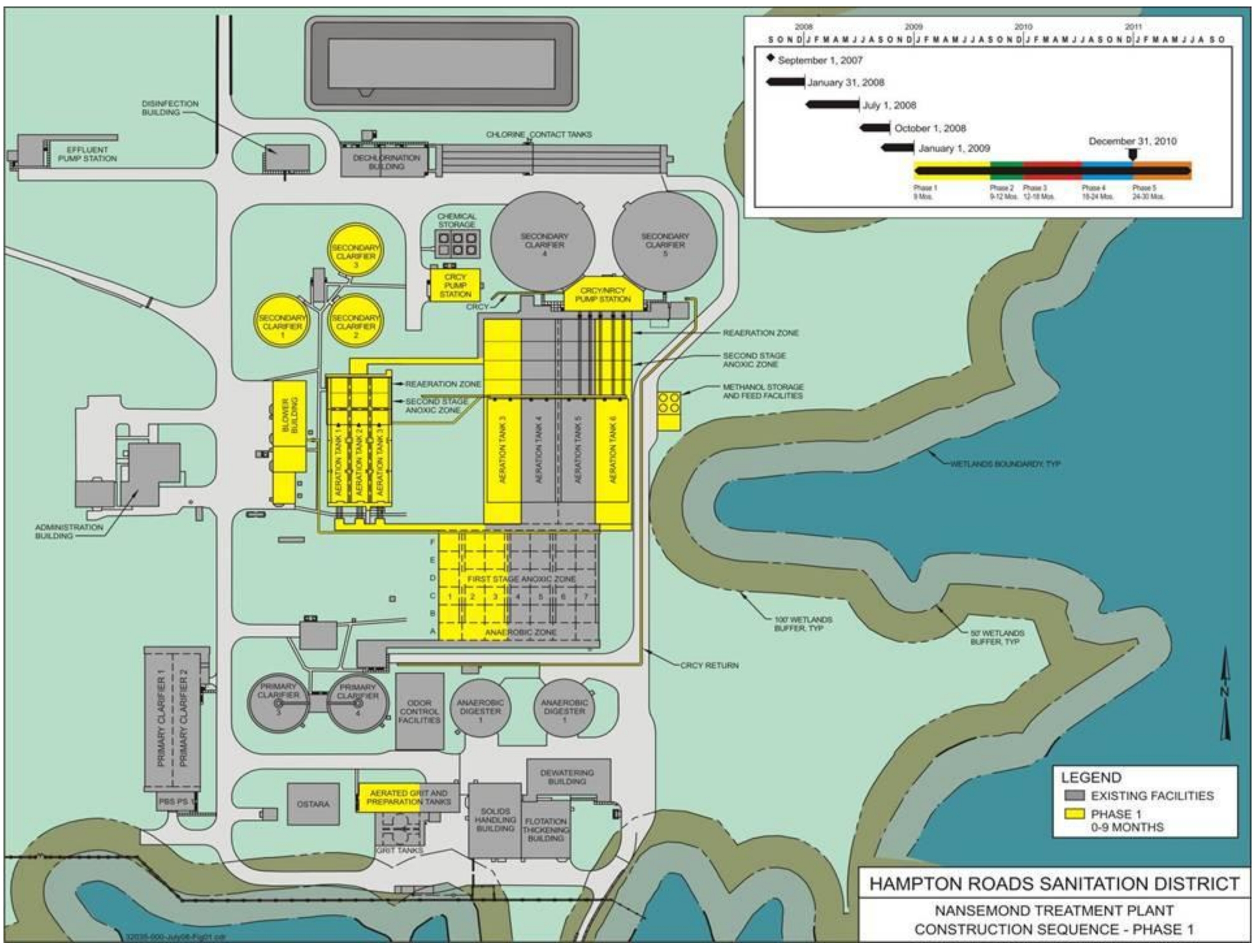

Figure 1.5 NTP with Upgrades to 5-stage Bardenpho Process.

A preliminary engineering report by Hazen and Sawyer, P.C. for the current nutrient removal upgrade, suggested that the ammonia oxidizing bacteria (AOB) maximum specific growth rate ($\mu_{max, AOB}$) be reduced from the default value of 0.90 days^{-1} to 0.57 days^{-1} to account for high effluent ammonia data during the calibration period (Hazen & Sawyer, 2007). This has significant implications in terms of the required aeration volume for consistent nitrification at cold temperatures. NTP along with the other HRSD James River basin facilities are required to meet a combined annual discharge limit of 6 million pounds TN to the James River – bubble permit limit (Balzer et al., 2005). It was originally assumed that NTP would nitrify year-round with this background inhibition. This would only be made possible however, by reconfiguring the BNR process to allow the 2^{nd} anoxic zone to operate aerobically (swing zone). Removing an anoxic zone would reduce overall TN removal because the process would essentially change from the 5-stage Bardenpho process to an A2O Process. If the inhibition can be eliminated then there would no longer be a need to configure the 2^{nd} anoxic zone to run aerobically, providing improved annual average TN removal. This would ensure that NTP and the other James River HRSD facilities meet the TN bubble permit limit with more certainty.

1.2 Research Objectives

The objectives of this study were the following:

- Establish the inhibitory characteristics of the NTP influent wastewater through bench-scale experimentation
- Study baseline nitrification kinetics and to evaluate the presence of a source of continuous inhibition
- Model the baseline nitrification kinetics and compare these values to previously calculated kinetic values.

1.2.1 Bench-scale Experimentation

The initial objectives of this research were to investigate the inhibition of nitrification at NTP through independent evaluation of ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) rates, as well as, determine the impact of inhibition on polyphosphate accumulating organism activity (PAO). This was accomplished through the use of a wide variety of NTP, targeted industry, and control wastewater and biomass samples to attempt to identify possible sources of inhibition through batch rate measurements using bench-scale reactors.

1.2.2 Baseline Profile Sampling

In an effort to better understand the BNR process at the facility, profile sampling was also performed in conjunction with the bench-scale reactor experiments during the summer and fall of 2009. During the initial upgrades to the facility, nitrification was maintained; however, due to available blower capacity during construction it was planned that nitrification would not be maintained during the fall of 2009. In an effort to stop nitrification, the solids retention time (SRT) was purposely reduced over a period of about one month (as wastewater temperature cooled) until additional blower capacity was available. This coincided with the profile sampling creating an opportunity to study nitrification kinetics as the plant stopped nitrifying. Profile sampling was conducted until the plant completely ceased nitrifying in the fall of 2009. This work consisted of collecting grab samples through the BNR process and analyzing the samples for ammonia (NH_3-N), nitrite (NO_2-N), nitrate (NO_3-N), ortho-phosphate (PO_4-P), and soluble COD (sCOD), pH, and DO.

1.2.3 Biowin Simulation Modeling

The profile sampling data were combined with plant operating data and modeled using *Biowin 3.1* (EnviroSim, Ltd.). The profile sampling period (7-23-09 to 11-5-09) was divided into 5 separate periods to generate a calibrated model. The modeling for four of the periods was first performed in steady-state conditions. The period in which NTP stopped nitrifying had to be calibrated with a dynamic model. A calibrated simulation was then generated over the entire period of profile samples. These simulations were compared to data collected during the profile sampling to better understand the level of continuous nitrification inhibition.

1.3 Thesis Organization

- Chapter two is dedicated to providing literature reviews of nitrification inhibition with known and suspected sources of inhibition, batch-rate measurements, and profile sampling.
- Chapter three provides methodologies for grab sampling, batch reactor construction, batch reactor operation, profile sampling, analysis of nutrients, and modeling.
- Two manuscripts were included which encompass the different aspects of this research: Bench-Scale Batch Testing, profile sampling, and simulation modeling of the process.

This research provides insight into measuring nitrification inhibition kinetics, evaluation of possible inhibitors, data exhibiting a fully-nitrifying plant falling out of nitrification, and modeling work which provides a comparison of measured plant performance data versus simulation modeling & profile sampling data.

1.4 References

Balzer, B., Cox, M., Deluna, J., Ghosn, S., Hogg, P., Kennedy, G., Pletl, J. 2005. The Status of Biological Nutrient Removal at HRSD's Nansemond Treatment Plant. NITRO Team Report.

Bilyk, K., Cubbage, L., Stone, A., Pitt, P., Dano, J., and Balzer, B. 2008. Unlocking the Mystery of Biological Phosphorus Removal Upsets and Inhibited Nitrification at a 30 mgd BNR Facility. *Proceedings of the Water Environment Federation Technical Conference and Exposition*, WEFTEC 08.

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2. Literature Review

2.1 Nitrification Inhibition

Biological nutrient removal processes involving nitrification are widely incorporated in wastewater treatment plants. The need for nitrification in wastewater treatment arises from water quality concerns over (1) the effect of ammonia on receiving water with respect to DO concentrations (2) the toxicity of ammonia in receiving waters to aquatic and marine life, (3) the need to provide nitrogen removal to control eutrophication, and (4) the need to provide nitrogen control for water-reuse applications including groundwater infiltration (Metcalf & Eddy, 2003). Nitrification is well recognized as the most sensitive process in biological nutrient removal (BNR) systems and is susceptible to problems arising from pH, temperature, dissolved oxygen (DO) concentrations, substrate concentrations, and chemical inhibitors (Juliastuti et al., 2003a). Conventional aerobic nitrification involves the oxidation of ammonia to nitrate by two different types of bacteria, ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) (Metcalf & Eddy, 2003).

$$NH_4^+ + 1.5\ O_2 \rightarrow 2\ H^+ + H_2O + NO_2^- \qquad (1)$$

$$NO_2^- + 0.5\ O_2 \rightarrow NO_3^- \qquad (2)$$

The biochemical reactions above take place in nitrification processes in which ammonium is oxidized to nitrite by AOB and then nitrite is oxidized to nitrate through NOB. Based on the chemical reactions it can be noted that nitrification is an aerobic autotrophic process. Nitrification has been used for years to remove ammonia from wastewater prior to discharge.

Nitrifying bacteria have maximum specific growth rates that are much slower than heterotrophic bacteria in activated sludge processes. Generally, the minimum allowable solids retention time (SRT) for operation of a nitrifying activated sludge process is controlled by nitrification kinetics per the commonly used design equations presented below:

$$\frac{1}{SRT_{\min}} = \mu_a \tag{3}$$

$$\mu_a = \left(\frac{\mu_{\max,a} N}{K_N + N}\right)\left(\frac{DO}{K_o + DO}\right) + b_a \tag{4}$$

where μ_a is the nitrifier specific growth rate, $\mu_{max,a}$ is the nitrifier maximum specific growth rate, N is the target effluent ammonia-N concentration, K_N is the nitrifier Monod half-saturation coefficient for ammonia, DO is the aeration basin dissolved oxygen concentration, K_o is the nitrifier Monod half-saturation coefficient for oxygen, and b_a is the autotrophic decay rate (Metcalf & Eddy, 2003).

The actual SRT used for process design is typically determined by multiplying the minimum SRT for nitrification by a safety factor ranging from 1.5 to a value as high as 5.0 (extended aeration). It is commonly found that chemical inhibitors tend to reduce the nitrifier maximum specific growth rate, $\mu_{max,a}$, but can also potentially increase the nitrifier half-saturation coefficient for ammonia, K_N. With the input of chemical inhibitor, the SRT_{min} would increase, possibly approaching the design SRT. If a system is operating at a given design SRT, this suggests that the presence of a chemical inhibitor may not affect process performance (effluent ammonia-N concentration) but could make the system much more susceptible to nitrification problems as a result of wastewater temperature fluctuations or peak ammonia loading events. As a result, it is critical to evaluate the effect of chemical inhibitors on nitrification kinetic parameters or on direct surrogates of those parameters (e.g. nitrate generation rate) (Kelly et al, 2004; Daigger and Sadick, 1998; Hockenbury and Grady, 1977).

Nitrification is not only used for ammonia removal, but is also commonly used in conjunction with denitrification processes for total nitrogen removal. The denitrification process is less sensitive to changes in pH, temperature, and other factors than the nitrification process; therefore it is practical to investigate the more sensitive nitrification process (Pagga et al, 2006). The specific inhibition of nitrification could have dramatic effects on a plants ability to treat wastewater properly and discharge within permitted limits. For many of the compounds, the concentrations that inhibit the nitrifying bacteria may be an order of magnitude lower than the concentrations which inhibit the heterotrophic bacteria that remove biodegradable organic matter (Daigger and Sadick, 1998). For this reason, it is important to know the inhibition potential of substances on nitrification to prevent disturbances (Pagga et al, 2006). It is generally advised to test chemicals and wastewaters which might be considered toxic or inhibitory by suitable laboratory tests in advance (Pagga et al, 2006). Many facilities have reported experiencing biotreatment process upset conditions based on a WERF Report survey conducted in 2000 (Love and Bott, 2000). Ineffective nitrification was reported as the second most inhibited process to COD/BOD removal out of survey conducted on 110 different treatment facilities (Love and Bott, 2000). This suggests that nitrification inhibition is a widespread and common problem found at wastewater treatment facilities.

There are several types of experiments and methods used to examine nitrification inhibition. Experiments can be carried out using continuously stirred tank reactors, batch reactors, or nitrifying bioreactors in bench, pilot, and full scale studies (Hu et al, 2004). Nitrification inhibition can be measured through measuring oxygen uptake rates, also known as respirometry, and nitrate generation or ammonia uptake rate (NGR or AUR). In most cases, the experiments listed above utilize nitrifying biomass or activated sludge from a wastewater treatment plant that is being studied and add different possible or known inhibitors to the reactors to examine oxygen, ammonia, nitrate, and nitrite uptake and generation rates. Although there is extensive literature on nitrification inhibition each situation must be independently evaluated to assess the cause of inhibition and solution to the problem. There are many potential sources of nitrification inhibition in wastewater which are discussed further in subsequent sections

2.1.1 Chemical Inhibition

Many transient upset events are known to be caused by shock loads of toxic chemicals. Furthermore, studies have shown that chemical toxins can detrimentally affect all the essential processes within an activated sludge treatment system (Henriques et al, 2007). Organic compounds at certain concentrations can promote inhibition of nitrification. According to literature it has been observed that chlorobenzene and trichloroethylene are capable of causing inhibition at much lower concentrations than phenol or ethylbenzene (Juliastuti et al, 2003a). Previous research by others has found nitrification to be highly susceptible to upset in wastewater treatment (Blum and Speece, 1991; Wood et al, 1981). Full-scale and laboratory-scale studies have shown that industrial contaminants are frequently the source of such upset events, and these sources can adversely affect the nitrification process for weeks (Hu et al, 2002; Nowak and Svardal, 1993). Literature has also shown that inhibitory chemicals can often be formed in the solids processing trains of wastewater treatment facilities (Daigger and Sadick, 1998). Numerous studies using pure cultures of nitrifying bacteria have reported that industrial toxins can be inhibitory (Anthonisen et al, 1976; Blum and Speece, 1991; Grunditz and Dalhammar, 2001). Furthermore, recovery of nitrification after an inhibitory event can take time (Stasinakis et al, 2003), leaving the treatment system vulnerable to permit violations and the downstream environment vulnerable to ecological damage (Kelly et al, 2004).

2.1.2 Impact of Heavy Metals on Biological Treatment

Metals have been found in significant concentrations in various wastewater streams. Contributions from industrial sources have been assumed as a cause of nitrification inhibition in more recent times (Hu et al, 2002). This is supported by the increasing trend of discharging industrial effluent to publicly owned treatment works (POTW) for treatment, which increases the possibility of contamination in the influent by metal ions (Stasinakis et al, 2003). Although a constant low-level exposure to metals does not typically affect microbial activity due to biomass acclimation, shock loads of metals can lead to complete failure of biological processes (Hu et al, 2004). The presence of heavy metals can also adversely affect the operation of biological treatment processes by accumulating to inhibitory concentrations. Many studies have investigated the effects of heavy metals in biological systems alone or in combination with others.

A high variation is seen in the reported inhibitory range for metals, since different experimental conditions exist in all studies (i.e. exposure time, type of buffer, pH, type and concentration of ligands) (Semerci et al, 2007). In addition to this, interpretation of results is based on different metal species such as total, labile, free or biosorbed metal. Under these circumstances, it is very difficult to compare the inhibitory concentration ranges (Semerci et al, 2007). Previous short-term studies have demonstrated that nitrification inhibition generally correlates well with the aqueous free metal cation concentration (Hu et al, 2004). There are many different types of metals which can be found in wastewaters of both municipal and industrial origin; however, nickel, cadmium, copper, and zinc are some of the more commonly found metals because of their widespread industrial use (Hu et al, 2004). Inhibition of nitrification is clear for heavy metals such as cadmium, zinc, and copper when the biomass is exposed to higher shock load (24-hour period) concentrations of the metal (0.2 – 0.65 mg/L Cd^{2+}, 0.5 – 3 mg/L Zn^{2+}, 10 – 12.5 mg/L Cu^{2+}) as supported by literature (Hu et al, 2002, Kelly and Love, 2004, Semerci et al, 2007, Madoni et al, 1999). Metals also have a dual effect on microbial growth and act either as trace elements or as inhibitors (Juliastuti et al, 2003).

2.1.3 Quaternary Ammonium Compounds (QAC)

Quaternary ammonium compounds (QACs) or quaternary ammonium salts (quaternary ammines) are salts of quaternary ammonium cations with a coordinating anion (e.g. chloride). They are organic compounds that contain four functional groups attached covalently to a positively charged central nitrogen atom (R_4N+). These functional groups (R) include at least one long chain alkyl group, and the rest are either methyl or benzyl groups. QACs are extensively used in domestic and industrial applications as surfactants, emulsifiers, fabric softeners, disinfectants and corrosion inhibitors (Tezel et al, 2007).

QACs are of importance here because it has been determined that acute inhibition of both heterotrophic COD removal and nitrification, especially the nitrite oxidation process, can be inhibited at high concentrations (Kreuzinger et al, 2007). Boethling (Boethling, 1984) suggests that at higher concentrations, for which no acclimation has occurred, the presence of QACs causes significant inhibition. There has been some investigation into the impact of QACs on biological wastewater treatment, which have found that acclimation may occur, one reason for which appears to be complexation of QACs with anionic surfactants and/or adsorption to particulate matter (Yang et al, 2008). The focus of this review is the effect of common QACs used as disinfectants and deodorants for chemical toilet liquids and their impact on aerobic biological wastewater treatment.

The Hampton Roads Sanitation District (HRSD) Nansemond Treatment Plant (NTP) receives large quantities of chemical toilet waste that are discharged to the plant in slug doses via tank truck to the septage receiving station (see Tables 2.1 and 2.2). It was hypothesized that the QACs contained in this chemical toilet waste could be a possible source for the sporadic nitrification inhibition that is experienced at the NTP.

Table 2.1 Septage Waste Received for Several HRSD WWTPs

Wastewater Treatment Plant	Residential Septage [gallons/year]	Chemical Toilet Waste [gallons/year]	Total Delivered Waste [gallons/year]	Average Daily Flow [MGD]	Chemical Toilet Waste [gallons/day]	Total Septage [gallons/day]
Atlantic	501,937	560,258	1,885,655	40	1,535	5,166
Boat Harbor	90,762	852,656	1,618,515	14.9	2,336	4,434
Chesapeake-Elizabeth	454,906	369,426	1,284,278	13.2	1,012	3,519
Nansemond	**1,800,999**	**1,291,602**	**4,427,292**	**18.5**	**3,539**	**12,130**
Williamsburg	1,549,416	272,326	4,000,171	15.7	746	10,959
York River	2,592,031	76,418	2,730,400	12.9	209	7,481

Table 2.2 Septage Waste Received as a Fraction of Average Daily Plant Flow

WWTP Loading Highest to Lowest	Chemical Toilet Waste [gallons/day]	Chemical Toilet Waste [% Avg Day Flow]
Nansemond	**3,539**	**0.019**
Boat Harbor	2,336	0.016
Chesapeake-Elizabeth	1,012	0.008
Williamsburg	746	0.005
Atlantic	1,535	0.004
York River	209	0.002

2.1.3.1 Impact of QACs on Biological Treatment

Relevant QACs associated with disinfectants or chemical toilet additives are BAC, DDAC, dichlorobenzyl dimethyl dodecyl ammonium chloride, cetyltrlmethylammonium bromide, and laurylpyridlnlum methosulfate (Gerike et al, 1990). Previous research has been focused on BAC and DDAC, although one study was conducted which examined all the above QACs and the biodegradability and inhibitory threshold concentrations of these compounds (Geirke et al, 1990). It was found from this study that inhibitory effects were noted either in an oxygen consumption inhibition test (respirometry) or by comparing the degradation performance in a biological test culture with disinfectant added to a control (Gerike et al, 1990).

Study from the work of Boethling suggests that even with equivalent amounts of anionic surfactants and acclimation, slug loading which would result in temporarily high concentration in treatment plants could upset plant function and completely inhibit nitrification (Boethling, 1984). This implies that increases in QAC concentration would have a disruptive effect on sewage treatment even when anionic surfactants are also present (Boethling, 1984). This is especially true for the nitrification process, which appears to be somewhat more sensitive to inhibition by QACs than heterotrophic COD removal (Boethling, 1984).

In an another study, it was determined that the second step of nitrification for which nitrite oxidizing bacteria (NOB) convert nitrite (NO_2^-) to nitrate (NO_3^{--}) exhibited the greatest inhibition in response to QAC loading (Kreuzinger et al, 2007). The study used both short and long term tests to look at both acute and chronic inhibition of nitrification due to exposure to QAC compounds. For acute tests, oxygen consumption for carbon removal and nitrification were measured after addition of various concentrations (0.02, 0.2, 0.5, 1, 5, 10, 25, 50, 100 mg/L) of the single QACs, BAC-C12–16 and DDACC10–18, and these data were used to estimate acute maximum autotrophic growth rates (Kreuzinger et al, 2007). Chronic inhibition was evaluated in bench-scale biological treatment systems with continuous dosage of the test substances in synthetic wastewater (peptone, meat extract, urea, NaCl, $CaCl_2$, $MgSO_4$, K_2HPO_4) for a duration of 6 months, applying final concentrations of 0.1, 1 and 2 mg/L QAC mixture described above for at least 1 month. Chronic effects were assessed by comparing COD removal and nitrification efficiency with a control that did not receive QAC (Kreuzinger et al, 2007). It was found that the following QACs and concentrations were inhibitory to nitrification; Benzyldimethyldodecylammonium chloride (BDMDAC):8-22 mg/L, dichlorobenzyldimethyldodecylammonium chloride (DCBDMDAC):16 mg/L, and cetyltrlmethylammonlum bromide (CTAB):15 mg/L (Kreuzinger et al, 2007). These values were measured using the oxygen consumption inhibition test method.

Results from recent research on alkyl benzel dimethyl ammonium chloride (AB), using mixed aerobic and nitrifying cultures, demonstrated that the mixed aerobic cultures are able to efficiently degrade up to 50 mg/L AB when fed with dextrin and peptone (Yang et al, 2008). Nitrification was complete at a concentration 20 mg/L AB only after an acclimation period, but was almost fully inhibited at 50 mg/L (Yang et al, 2008). This supports previous work which suggests that aerobic cultures can efficiently degrade QACs if properly acclimated at lower concentrations, but at higher concentrations or slug loads can experience complete inhibition. A mixed aerobic culture was also fed only AB as the external nitrogen and carbon source and was able to achieve high AB degradation at both 20 and 50 mg/L AB (Yang et al, 2008).

Nitrifying cultures were also examined with the addition of AB from 2-20 mg/L (Yang et al, 2008). Results from this assessment showed that at lower concentrations (2 and 5 mg/L AB) there was no significant inhibition compared to the control, although the rate of the first step of nitrification (NH_3-N to NO_2-N) was slower than the control (Yang et al, 2008). Inhibition starting at 10-20 mg/L AB was apparent in the nitrifying cultures as ammonia was not fully utilized at 10 mg/L and complete inhibition occurred above 15 mg/L (Yang et al, 2008). An interesting finding from this study was that no nitrite accumulation was observed which suggests that in this particular work AOB were more sensitive to AB than NOB (Yang et al., 2008).

2.1.4 Impact of Nitrification Inhibition on Biological Nutrient Removal (BNR)

The inhibition of nitrification, whatever the cause may be, has a tremendous impact on BNR process performance. Ineffective nitrification can lead to nitrite accumulation which could also have an effect on biological phosphorus removal (Bio-P) (Meinhold et al, 1999). Nitrite accumulation at higher concentrations has been found to interfere with PAO metabolism causing PHA utilization and anoxic phosphate uptake to cease (Meinhold et al, 1999). Nitrate is preferred for use during PAO metabolism as it can be utilized in both nitrogen and phosphorus removal creating a "double use" which will result in reduced sludge production. Also nitrate is preferred over oxygen as it can reduce aeration demand (Meinhold et al, 1999).

Nitrification inhibition can also create issues for denitrification. Nitrate is provided from the return activated sludge (RAS), which is recycled from the secondary clarifiers. If NOB activity is inhibited than less nitrate would be produced, thus impacting denitrifiers which utilize nitrate as a primary electron acceptor.

A typical uninhibited AOB maximum specific growth rate is 0.80-1.0 d^{-1}; however, conditions that lead to continuous nitrifier inhibition could have growth rates significantly less than this range. For process design, AOB maximum specific growth rate generally controls the minimum SRT; therefore inhibited rates can create issues with the activated sludge process in a BNR system. Increase in the minimum SRT due to slower nitrification kinetics would require larger aeration tank volumes and associated aeration in addition to potentially larger secondary clarifiers.

2.2 Bench-Rate Measurements

2.2.1 AOB & NOB Rate Measurement

AOB and NOB activity is important when reviewing a plant's nitrification performance. The kinetic parameters associated with these rates, such as the maximum specific growth rate, are important when examining plant performance and are also a good indication of whether the plant is nitrifying properly. Traditional single-step modeling of nitrification is adequate under sole rate limitation by NH_4^+–N to NO_2^-–N oxidation (Chandran et al, 2000b). However, such modeling yields meaningless kinetic parameter estimates when NO_2^-–N to NO_3^-–N oxidation or both oxidation steps limit overall nitrification during periods of the test assay (Chandran et al, 2000b). Respirometry - based two step nitrification models can permit biokinetic estimation of both NH_4^+–N to NO_2^-–N oxidation and NO_2^-–N to NO_3^-–N oxidation from a single NH_4^+–N to NO_3^-–N oxidation respirogram (Chandran et al, 2000). However, for any nitrification design or control efforts based on batch respirometry derived biokinetic estimates, it is beneficial to identify the rate-limiting step in overall nitrification by estimating and comparing the kinetics of each step (Chandran et al, 2005).

Both full-scale and laboratory scale studies using the activated sludge process have suggested that a wide variety of industrial chemicals can inhibit the nitrification process for extended periods (Stasinakis et al, 2003; Kelly et al, 2004; Nowak et al, 1993), and that recovery from this inhibition can take a significant amount of time (Kelly et al, 2004; Stasinakis et al, 2003). Respirometry, which measures oxygen uptake rate and nitrate generation rate (NGR), which determines the nitrate production rate, are most commonly used to measure nitrification inhibition (Kelly and Love, 2004). Another common method for determining nitrification rates and inhibition is through the use of titrimetric techniques which examine nitrification rates based on the rate of base addition for pH stabilization (Kelly and Love, 2004).

The two main methods used to evaluate nitrification kinetics related to this work and, specifically the effect of chemical toxins on nitrification:

1. Respirometry: involves the measurement of oxygen uptake rate (OUR) for microbes associated with biological treatment. A sample of mixed liquor is removed from a full-, pilot-, or bench-scale system, placed in a sealed reactor, possibly amended with substrate

or nitrification inhibitor, and the rate of oxygen consumption is monitored over time. To evaluate nitrification kinetics, a sample of mixed liquor is added to a temperature-controlled respirometer reactor with and without (control) a chemical stressor. The mixed liquor can be supplemented with primary effluent (PE), ammonia-spiked PE, secondary effluent (SE), ammonia, or nitrite. When conducting experiments to measure nitrification kinetics it is desired to start the experiment with relatively high levels of ammonia to allow for a longer experimental run and to ensure that the maximum nitrification rate is maintained. If this is the case, careful control of pH must be maintained to ensure the pH does not drop below about 6.8-7.0 (alkalinity is typically added in the form of sodium carbonate). If organic substrate is added (e.g. PE), these experiments can be run with and without nitrification inhibitor to distinguish between heterotrophic and autotrophic oxygen uptake. Since endogenous heterotrophic oxygen uptake can occur without organic substrate addition, experiments are often run with and without nitrification inhibitor even when ammonia is the only substrate added to the mixed liquor. It is possible to calculate nitrification kinetic parameters based on specific oxygen uptake rate (SOUR) profiles (note that the term "specific" indicates that the OUR has been normalized to the biomass concentration).

2. Nitrate/Nitrite Generation Rate: In order to evaluate the nitrification process fully independent of heterotrophic activity, kinetic rates directly related to the consumption or production of reactants and products of the nitrification process itself can be measured, specifically nitrate/nitrite generation rate (NGR) or ammonia uptake rate (AUR). The specific nitrification rate (SNR) can be obtained by normalizing to biomass concentration, and this data can be used to determine the autotrophic kinetic parameters

described above. For these experiments, a sample of mixed liquor is added to small temperature controlled reactors (approximately 3.0 L). The reactor is mixed and aerated, and the inhibitor of interest added to the stressed reactor. Once all residual organic substrate associated with the mixed liquor sample itself is consumed, ammonia or nitrite is spiked into the reactor, and caution must be taken to ensure that pH and alkalinity remain within acceptable limits – preferable pH 7 to 8 at all times. The nitrate, nitrite, and ammonia concentrations are monitored over time using typical analytical methods (APHA, 1998). It is critical to rapidly separate the mixed liquor from the soluble supernatant as quickly as possible after removing a sample from the reaction reactor. Typically, samples are removed from the reaction reactors at predetermined time intervals and rapidly centrifuged. The supernatant is poured off and immediately filtered through a 0.45 µm membrane filter. The filtrate can then be preserved for subsequent analysis.

Respirometry is a good method of measuring nitrification inhibition, but also has proven useful for indicating activated sludge process stability both in lab and full-scale experimentation (Kelly and Love, 2004). Respirometry has an advantage over NGR in that it is rapid and doesn’t require extensive sample analyses. Unfortunately respirometry measures the total oxygen uptake rate of a biomass. This requires several iterations of tests to determine the respiration rate of only the nitrifying bacteria in a mixed community like mixed liquor because the nitrifying bacteria must be specifically inhibited from other species. To do this, a total respirometry must be performed as well as a respirometry where the biomass has been inhibited for nitrification using compounds such as heavy metals, organic compounds, QACs or industrial wastes (Kelly and Love, 2004). NGR provides a direct measure of the rate of nitrification, as it measures the generation of nitrate and nitrite, the product of two-stage nitrification (Kelly and Love, 2004). This can be used to measure AOB rates based on NOx-N generation or NOB based on NO_3-N generation. Although it provides a direct measure, it also requires more time to complete than respirometry.

Kelly et al (2004b) compared the use of respirometry to NGR measurement for two different chemical compounds and suggested that NGR is the preferred method for determining nitrification inhibition because the NGR test yields a direct measure of the nitrification rate through measurement of the final product while respirometry only provided indirect measurement of nitrifier activity (Kelly and Love, 2004). It was also noted that during one of the experiments in comparing respirometry and NGR measurement due to cadmium inhibition, respirometry seemed to over predict inhibition at lower concentrations and under predict inhibition at higher concentrations (Kelly and Love, 2004). NGR test results also exhibited better reproducibility within duplicate reactors (Kelly and Love, 2004).

2.2.2 Biological Phosphorus Rate Measurement

The use of enhanced biological phosphorus removal (EBPR) has been shown to be an economical and environmentally acceptable method for reducing phosphorus from wastewaters (Erdal, et al, 2006). The most common and widely used test method for measuring EBPR is the uptake and release test (URT). URTs provide a qualitative assessment of phosphorus accumulating organisms (PAO) activity in activated sludge that can be used to develop kinetic parameters for process simulation model calibration, such as the ratio of phosphate released to acetate consumed, and providing information on phosphate uptake kinetics that can be used to estimate the time required to remove quantities of phosphate in the aerobic zone (Neethling et al., 2005). By adding excess volatile fatty acids (VFA) such as sodium acetate to mixed liquor, PAO activity and the amount of stored phosphorus limit the measured phosphate release

(Neethling et al, 2005). The ratio of uptake HRT to release HRT can be used as a performance indicator as it correlates well to the observed performance in full-scale facilities according to Neethling et al (2005). Ratio between uptake and release rate can also be used as a performance indicator if data is consistent and accurate in determining aerobic contact time in full-scale treatment (Neethling et al, 2005).

There are several parameters known to influence phosphorus removal efficiency. Availability of readily biodegradable substrate in the influent of the system plays an important role in performance (Mota et al, 2001). VFAs used by PAOs are generated by fermentation under anaerobic conditions and some may be present in more septic wastewaters (Mota et al, 2001). The presence of nitrate in the anoxic stages of EBPR processes is widely recognized to have a repressive effect on phosphorus release and on net phosphorus removal (Mota et al, 2001). This is because the presence of nitrate creates a competition between denitrifying bacteria and PAOs for the VFAs which are the typical carbon source for the formation of polyhydroxyalkanoates (PHAs) (Mota et al, 2001). Studies have shown that better system performance was related to reduced competition for substrate in the non-oxic zones, which results in larger populations of PAOs, and thus, greater EBPR efficiency (Erdal et al, 2006). Solids retention time and temperature have also shown to play an important role in EBPR efficiency which has been supported by several different studies (Whang et al, 2001; Erdal et al, 2006). Other factors which can contribute to reliable EBPR performance include the role of fermenters or other processes used to enhance EBPR, the management of return flows from anaerobic solids processing steps, and chemical addition for phosphorus polishing and EBPR backup (Neethling et al, 2005).

2.3 Profile Sampling

Profile sampling of wastewater treatment plants provides an effective method for evaluating the performance of a BNR processes by sampling for species such as ammonia, nitrate, nitrite, orthophosphate, soluble COD, etc. through the treatment train. Profiles are most commonly incorporated with DO and nutrient profiles (NH_3-N, NO_3-N, etc.), but can be applied to different applications; examining different bacterial species or the solids content of a reactor. Although there is not much literature on this specific sampling method, it is very much often used in conjunction with modeling work and evaluating existing and future nutrient removal processes (Kochany et al, 2007; Scott et al, 2008; Kim et al, 2009). Profile sampling has also been used in determining the fate and transport of chemicals in wastewater treatment. There has been work conducted on the fate and transport of mercury, where samples were collected from various process locations and analyzed for mercury and methylmercury (Downing et al, 2008). When conducting profile sampling it is useful to determine what parameters need to be profiled to generate useful quantitative data. Another use for profile sampling is to determine various rates such as ammonia uptake rates, nitrate production rates, and phosphorus uptake and release rates. Grab sampling or composite sampling are both viable methods for profile sampling; however, composite sampling would require an automatic filtration system or manual composite sampling, since samples would require immediate filtration. The method for sampling is primarily based on the application, but generally involves the collection of various samples at different periods of time or various locations along the length of a treatment process.

One study used DO profiling during a feed cycle as an indication of upset conditions and monitoring SBR biomass recovery. It was found that based on DO profiling, upset conditions could be early detected and recovery measures quickly applied (Kochany et al, 2007). The same study using SBRs found that there was a correlation between the ammonia removal during a feed cycle and the oxygen concentration in the reactors providing the same air supply (Kochany et al, 2007). This suggests that monitoring the oxygen profile (DO) can be used instead of ammonia analyses. Since DO measurements are faster as compared to ammonia analyses, determining DO profile during a feed cycle can provide useful information about efficiency of the biological system, without using expensive ammonia on-line analyzers (Kochany et al, 2007).

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3. Methodology

3.1 Bench-Scale Batch Reactor Experimentation

3.1.1 Sample Collection

Batch reactor experimentation was conducted by collecting biomass samples from the aeration basin effluent of several full-scale wastewater treatment plants. Grab samples were collected unless otherwise arranged with HRSD to collect composites. All samples were collected and stored in polypropylene carboys or similar containers. These samples were then transported to the lab and stored until use with continuous aeration for no longer than approximately 48 hours at room temperature. Biomass samples were collected from NTP; the HRSD VIP plant, which uses the same BNR process as NTP but does not experience inhibition; the Henrico County WWTP, which has a fully nitrifying 5-stage BNR process; and the HRSD York River plant from the sequencing batch reactor system.

Wastewater sources for experimentation were also collected via grab sample or composite sampling by HRSD based on the source being tested. Wastewater samples were collected including NTP and VIP primary effluent (PE); NTP and VIP secondary effluent (SE); raw wastewater from isolated branches of the NTP collection system; and industrial waste samples from a hog processing plant and a landfill leachate stream. Waste samples were also tested from other suspected sources such as chemical toilet disinfectants (quaternary ammonium compounds).

3.1.2 Batch Reactor Construction

Four parallel batch reactors were constructed of plexiglass and configured with vinyl and polypropylene fittings and appurtenances. The first reactor served as the control while operating conditions of the other three reactors were varied. Each reactor had a volume of 3 liters with individual ports for sampling and chemical addition (acetate, ammonia, nitrite, and phosphate) during experimentation as needed. A diffuser stone was incorporated into each reactor to provide air/oxygen or nitrogen based on the experiment. This allowed the reactors to be operated under aerobic, anoxic, or anaerobic conditions for nitrification, denitrification, and phosphorus release/uptake measurements. The reactors were configured to be air tight with a water seal on the headspace for anaerobic conditions. Mixing was provided through magnetic stir-bars and stir plates. Dissolved oxygen (DO) was kept constant using HACH LDO probes with HQ40d meters. Two probes were connected to a single HQ40d meter (total of four probes and two meters). National Instruments LabView 7.0 DO Controller was used to provide on and off control of four solenoid air supply valves with associated relays. pH was controlled and logged using Cole-Parmer pH meters/controllers connected to acid (1M H_2SO_4) and base (3M Na_2CO_3) pumps. The reactors were placed in a water bath with a circulating chiller and immersion heaters to maintain a constant temperature during experimentation. Refer to Figure 3.1, 3.2, and 3.3 for a schematic and image of an individual reactor and for a complete schematic and image of the entire reactor configuration.

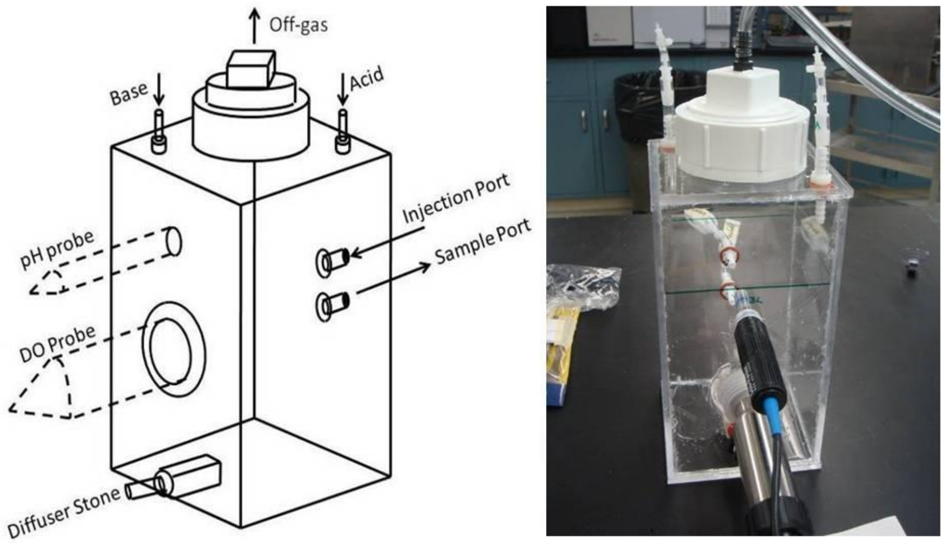

Figure 3.1 Reactor Schematic and Image

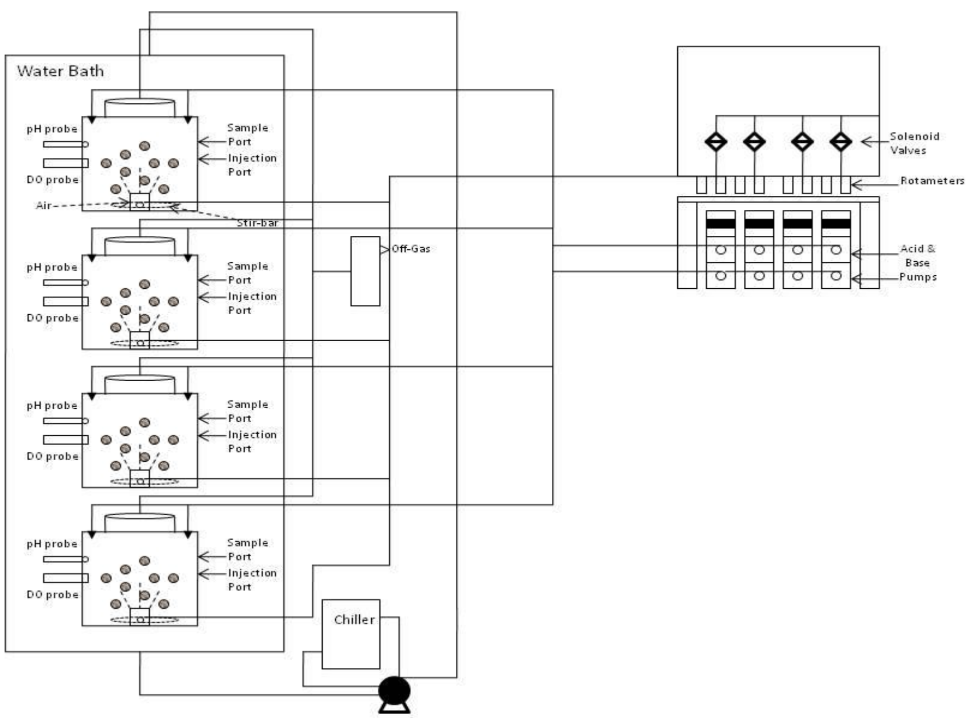

Figure 3.2 Complete Reactor System Schematic

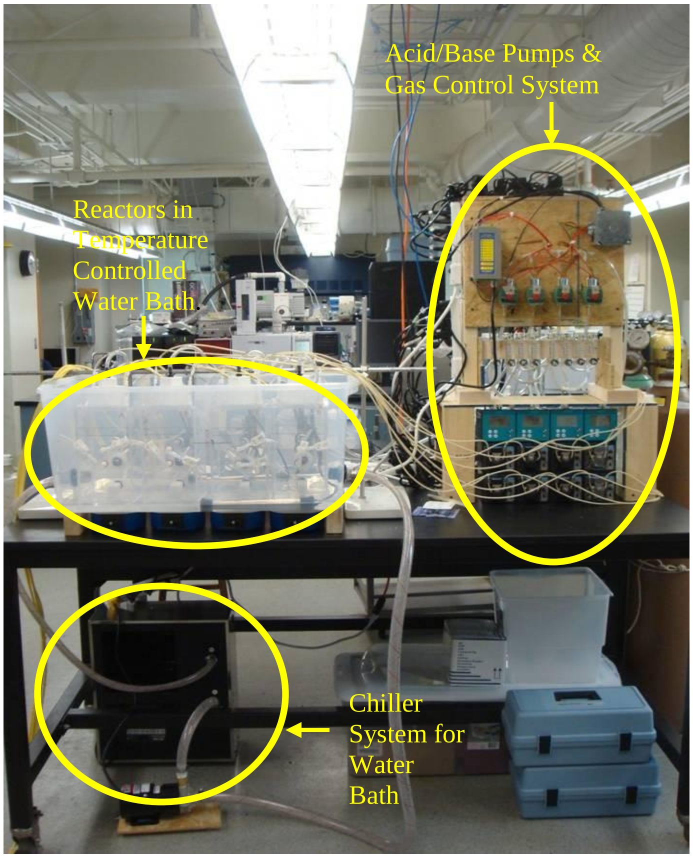

Figure 3.3 Complete Reactor Set-Up

3.1.3 Batch Reactor Operation

Experimentation consisted of the evaluation AOB, NOB, and Bio-P activity. The method for evaluating each type of experiment is discussed further in subsequent sections. Temperature for experimentation was based on the temperature of the biomass sample when it was collected onsite via grab sample. The matrix of experiments developed and completed is summarized in Table 3.1. The abbreviations in the table are as follows: Nansemond (NS), VIP (VIP), Henrico (HR), York River (YR), primary effluent (PE), secondary effluent (SE), raw water influent (RWI), primary clarifier influent (PCI), primary clarifier effluent (PCE), branches of collection system (Branch 1, 2, 3), iron addition (Fe).

Table 3.1 Batch Experiment Matrix

Week #	Biomass Source	Diluents		Experiments
1	Nansemond	a. NS/PE	b. VIP/PE	AOB, NOB, Bio-P
	VIP	c. VIP/PE	d. NS/PE	
2	Nansemond	a. NS/PE	b. VIP/PE	AOB, NOB, Bio-P
	VIP	c. VIP/PE	d. NS/PE	
3	Nansemond	a. VIP/SE + Leachate	b. VIP/SE	AOB, NOB, Bio-P
	VIP	c. VIP/SE + Leachate	d. VIP/SE	
4	Nansemond	a. NS/PE	b. HR/PE	AOB, NOB
	Henrico	c. HR/PE	d. NS/PE	
5	Nansemond	a. VIP/SE + Hog Plant	b. VIP/SE	AOB, NOB, Bio-P
	VIP	c. VIP/SE + Hog Plant	d. VIP/SE	
6	Nansemond	a. VIP/SE + Leachate	b. VIP/SE	AOB, NOB
	VIP	c. VIP/SE + Leachate	d. VIP/SE	
7	Nansemond	a. VIP/SE	b. VIP/SE + Branch 1	AOB, NOB
	VIP	c. VIP/SE + Branch 2	d. VIP/SE + Branch 3	
8	Nansemond	a. VIP/SE	b. VIP/SE + Branch 2a	AOB, NOB
	VIP	c. VIP/SE + Branch 2b	d. VIP/SE + Branch 3	
9	Nansemond	a. VIP/SE	b. VIP/SE + Cedar Ln PS	AOB, NOB
	VIP	c. VIP/SE + Gum Rd. PRS	d. VIP/SE + Pughsville PRS	
10	Nansemond	a. VIP/PE	b. NTP RWI	AOB, NOB
	VIP	c. NTP PCI	d. NTP PCE	
11	Nansemond	a. VIP/SE	b. VIP/SE + 20 mg/L Fe	AOB, NOB
	VIP	c. VIP/SE + 35 mg/L Fe	d. VIP/SE + 50 mg/L Fe	
12	Nansemond	a. VIP/SE	b. VIP/SE + 20 mg/L Fe	AOB, NOB
	VIP	c. VIP/SE + 35 mg/L Fe	d. VIP/SE + 50 mg/L Fe	
13	York River (YR)	a. YR/SE	b. YR/SE + 20 mg/L Fe	AOB, NOB
	York River (YR)	c. YR/SE + 35 mg/L Fe	d. YR/SE + 50 mg/L Fe	
14	York River (YR)	a. YR/PE	b. NTP RWI	AOB
	York River (YR)	c. NTP PCI	d. NTP PCE	
15	York River (YR)	a. YR/SE	b. YR/SE + 0.574 mL **Chem Toilet Additive***	AOB, NOB
	York River (YR)	c. YR/SE + 13.96 mL **Chem. Toilet Additive***	d. YR/SE + 62.84 mL **Chem Toilet Additive***	
16	York River (YR)	a. YR Mixed Liquor (ML)	b. YR ML + 15 mL Product B	AOB, NOB
	York River (YR)	c. YR ML + 30 mL Product B	d. YR ML + 60 mL Product B	
17	York River (YR)	a. YR Mixed Liquor (ML)	b. YR ML + 60 mL Product B	AOB, NOB
	York River (YR)	c. YR ML + 120 mL Product B	d. YR ML + 180 mL Product B	

***NOTE: Week 15 Experimentation – Two different Chemical Toilet Additives used for the two different days of experimentation (NatureFresh – Day 1 & Blue Works – Day 2)**

3.1.3.1 AOB Experimentation

AOB activity was evaluated by spiking the reactors with ammonia and monitoring NO_x-N and NO_3-N generation rate over three hours (Kelly et al, 2004). During an AOB experiment the collected biomass was concentrated to approximately 8000 mg/L MLSS prior to experimentation. Then the reactor was filled 1/3 by volume with biomass and 2/3 by volume with a diluent (primary effluent, waste sample, etc.). Additional ammonia was added to achieve a total ammonia concentration of approximately 40 mg/L NH_4-N to provide sufficient ammonia during experimentation to prevent depletion. Dissolved oxygen (DO) and pH were constantly monitored and maintained within desired limits using online control systems. DO was maintained between 5-7 mg/L during experiments with a pH between 7.0-7.2. Each AOB experiment was conducted for 3 hours with 5 samples collected evenly throughout this period of time. Samples were immediately filtered through 0.45μm membrane filters after collection. AOB activity was based on NO_x-N generation rate.

3.1.3.2 NOB Experimentation

NOB activity was assessed by adding in nitrite (ensuring ammonia concentrations were low) and monitoring the rate of NO_2-N depletion and NO_3-N generation. NOB experimentation was conducted very similar except after the reactors were filled by volume as mentioned above they were aerated for approximately one hour to allow uptake of any residual ammonia. Samples were taken prior to starting the NOB Experimentation and analyzed for NH_4-N to ensure that the ammonia concentration in each reactor was <1 mg/L NH_4-N (detection limit of HACH TNT 831 NH_4-N analysis method). After it was determined that the ammonia concentration in each reactor was depleted, approximately 25 mg/L NO_2-N was added, and then 5 samples were collected evenly over a 3 hour test period. Samples were immediately filtered through 0.45μm membrane filters after collection. DO and pH were maintained within the same parameters as was used for the AOB experiment. NOB activity was based on NO_3-N generation rate and NO_2-N uptake rate.

3.1.3.3 Bio-P Experimentation

Bio-P activity was determined by monitoring P uptake and release rates. Experimentation was conducted using the same concentrated biomass as in the AOB & NOB experimentation (~8000 mg/L MLSS). Experimentation was conducted in three phases: uptake, release, and a second uptake. During the first uptake (aerobic) phase, each reactor was filled with 1/3 by volume of biomass and 2/3 by volume of PE or another tested wastewater source. Then each reactor was spiked with 5 mg/L of PO_4-P to reach a target of 20 mg/L P in each reactor since it was presumed approximately 15 mg/L of PO_4-P would be present from the biomass and PE/wastewater sample. The first uptake phase was conducted for 1-2 hours and 3 samples were collected during this time with immediate filtration using 0.45µm membrane filters. During both uptake phases, pH was always controlled between 7.0-7.2 while the DO was maintained between 5-7 mg/L. After this initial uptake phase, the reactors were deaerated by sparging nitrogen (N_2) gas and reducing the DO to 0 mg/L which was maintained throughout the release phase. After the DO was reduced to 0 mg/L, each reactor was spiked with 200 mg/L acetate as COD. It was desired to have all NO_3-N and NO_2-N depleted, but this was not always the case. pH was controlled the same as in the uptake phase experiment and 5 samples were collected over a 1 hour period with immediate filtration using 0.45µm membrane filters. After the 1 hour release phase nitrogen was shut-off and then air/oxygen was sparged into the reactors to once again raise the DO and maintain the DO between 5-7 mg/L. As soon as the air/oxygen sparge began, 5 samples were collected over a 1-2 hour period with immediate filtration using 0.45µm membrane filters. All the samples from both uptake phases and the release phase were analyzed using the same methods used for the AOB and NOB experiments noted in the subsequent 3.3 Analytical Methods section. Rates based on PO_4-P release and uptake was normalized to MLVSS concentrations for each experiment.

All experimentation was conducted in this manner except for that conducted during weeks 16 & 17, during which the entire reactor volume was filled with biomass due to the biomass from the York River plant at that time being very dilute.

3.2 Profile Sampling

Profile sampling was conducted from the primary effluent to the secondary effluent with samples collected along the length of the BNR process. A total of 15 samples were collected. Analysis of soluble COD (sCOD), Ammonia (NH_4-N), Nitrate (NO_3-N), Nitrite (NO_2-N), ortho-phosphate (PO_4-P) at all sampling locations.

- Primary Clarifier Effluent (PE) - **1** Sample
- Anaerobic/Anoxic Tanks (AA1, AA2, AA3, AA4, AA5, AA6) - **6** Samples, 1 sample per cell for a single train
- Aeration Tank (AE1, AE1.25, AE1.5, AE3, AE5) - **5** samples, 1 at the beginning, 3 intermediate, 1 at the end for a single tank. The aeration tank was originally divided into 5 equal sample points along the length of the tank. AE1, AE2, AE3, AE4, AE5. Based on the data results two of the intermediate points were changed. Instead of taking 5 equally spaced points two were taken between the distance of AE1 and AE2, which became AE1.25 and AE1.5 to better capture ammonia uptake, nitrite consumption, and nitrate production. AE4 was eliminated as values were similar to AE5 (Figure 3.4).
- Clarifier Recycle (RAS) - **1** sample

- Secondary Clarifier Influent Distribution Channel (IDC) - **1** sample
- Secondary Clarifier Effluent (SE) - **1** sample

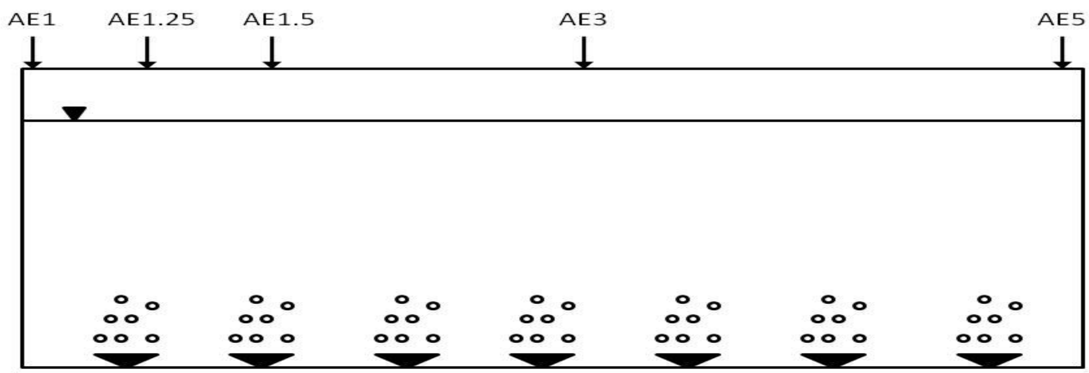

Figure 3.4 Aeration Tank Profile Sample Points

Each sample was collected via grab sample from the surface of the tank using a bucket or sample dipper. The sample was allowed to settle for approximately 30 seconds to allow a supernatant layer to form. The supernatant was then aspirated and immediately filtered through 0.45µm membrane filters using a portable vacuum filtration system. DO and pH were measured and recorded when each grab sample was collected. Each sample was also collected in accordance with corresponding HRTs associated with each process. Samples were collected in two different containers; (1) 15 mL centrifuge tube for on-site analysis using HACH colorimetric test kits and (2) 40 mL VOA vial for soluble COD analysis by the HRSD Central Environmental Laboratory (CEL) . All samples collected were kept chilled in a cooler on ice until they could be refrigerated to <6°C. Samples which were collected and placed into the 40 mL VOA vials were preserved with H_2SO_4 acid as soon as samples were collected and stored at a temperature of <6°C in a refrigerator until they were transported for analysis by CEL the following morning.

This process for profile sampling was performed twice a week during normal plant operation hours (0600 to 1500) for a period of approximately 2 and half months until the plant stopped nitrifying.

3.3 Analytical Methods

3.3.1 AOB, NOB, and Bio-P Analysis

Samples were analyzed for NH_4-N, NO_2-N, NO_3-N, and PO_4-P using HACH colorimetric test kits, ion chromatography (IC), and flow injection analysis (FIA) (see subsections 3.3.3, 3.3.6, 3.3.7, 3.3.8). MLSS and MLVSS were performed at the end of the experimentation per *Standard Methods* (APHA et al, 1995). Nitrate production rates, phosphorus uptake and release rates were calculated by normalizing the slope of each chemical constituent by the MLVSS concentration and adjusting units to mg/g MLVSS/hr.

3.3.2 Profile Sampling Analysis

Sample analysis for profile sampling was conducted both on-site and off-site. Analytes measured at NTP for each profile include: PO_4-P, NH_4-N, NO_3-N, NO_2-N which were conducted using various HACH colorimetric test kits (see subsections 3.3.3 – 3.3.6) and a HACH DR2800 spectrophotometer. Analysis of NO_2-N was performed the same day as sample collection, while analysis of PO_4-P, NH_4-N, and NO_3-N were conducted the following day. Samples were preserved by refrigeration overnight after NO_2-N analysis was complete. Off-site analysis by CEL consisted of soluble COD and quality assurance and quality control samples (QA/QC) of the same analytes measured on-site using *Standard Methods*.

3.3.3 Ammonia (NH_4-N) HACH Test Kit

Ammonia was analyzed using HACH Test N' Tube (TNT) 831 kit and HACH DR2800 spectrophotometer. This method uses the salicylate method, whereby ammonium ions react with hypochlorite and salicylate ions in the presence of sodium nitroprusside to as a catalyst form indophenol. The amount of color formed is directly proportional to the NH_4-N present.

3.3.4 Nitrate (NO_3-N) HACH Test Kit

Nitrate was analyzed using HACH TNT 835 kit. This kit incorporates the dimethylphenol method where nitrate ions in solution with sulfuric and phosphoric acids react with 2,6-dimethyphenol to form 4-nitro-2,6-dimethyphenol.

3.3.5 Nitrite (NO_2-N) HACH Test Kit

Nitrite was analyzed using NitriVer3 Nitrite Reagent Powder Pillows and 10 mL sample vials. This kit uses the diazotization method where nitrite in the sample reacts with sulfanilic acid to form a intermediate diazonium salt. This salt combined with chromotropic acid forms a pink color which is directly proportional to the amount of nitrite present.

3.3.6 Ortho-Phosphate (PO_4-P) HACH Test Kit

Ortho-Phosphate was analyzed using the HACH Reactive Phosphate TNT Reagent Kit. This test kit uses the USEPA-approved PhosVer3 method where orthophosphate reacts with molybdate in an acid to produce a mixed complex. Ascorbic acid then reduces this complex, producing an intense blue color.

3.3.7 Ion Chromatography

IC analysis was conducted for measuring nitrate only for the batch experimentation work. The IC was used in conjunction with conductivity detection (Dionex ICS-1000), an AS14A analytical column and AG14A guard column, an ASRS conductivity suppressor, and an eluent flow of 1.0 mL/min of 1.0 mM NaHCO3 and 8.0 mM Na2CO3.

3.3.8 Flow Injection Analysis

FIA was conducted for measuring nitrite, nitrate, and phosphate for batch experimentation work using a SEAL Analytics auto-analyzer system. FIA analysis incorporated a volume of 2 mL of sample in sample vials and placed into a sample tray. The tray was then placed into the FIA instrument along with various reagents required for the different analyte test methods. A schedule was then configured using the associated computer software with the instrument and analyzed. QA/QC samples were measured every 10 samples and test methods were always standardized prior to analysis of actual samples. Data output was provided in concentrations in mg/L as NO_2-N, NO_3-N, and PO_4-P.

3.4 Biowin Modeling

Modeling was performed using Biowin version 3.1, a biological wastewater treatment simulation package developed by EnviroSim Ltd (Flamborough, Ontario, Canada) and based on the IWA activated sludge models. Biowin was incorporated into this work to compare the data generated from the profile sampling with previous work performed by Hazen and Sawyer, P.C. (H&S). The Biowin model was calibrated using recent plant performance data and previous simulation modeling work from H&S. There are various wastewater fractions (Table 3.2) which must be adjusted by the user based on the wastewater source (Primary Effluent). Wastewater fraction inputs for this work were derived from the NTP model created by H&S. The H&S NTP model was simulated with the raw influent characteristics that were generated from historical plant data and a two week special sampling study specified by H&S. The effluent data from the primary clarifier of this simulation was used to calculate wastewater fractions for the input of the simulation for the profile sampling work. Primary clarification was not simulated as part of this effort. Kinetic parameters such as maximum specific growth rate ($\mu_{max, AOB}$) and nitrite half saturation concentration were changed based on the work done by H&S in addition to changes made to fit the simulation model to the profile sampling data. A Garret wasting configuration was incorporated to simplify modeling of secondary clarification (Figure 3.5), and the waste rate was then adjusted accordingly to match the solids wasted (lbs/day) from the plant performance data within a reasonable range. Diurnal load variations were not considered as part of this modeling.

Table 3.2 Biowin Influent Wastewater Fractions

Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	**0.310**
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.180**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.610**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.155**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.169**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.740**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.300**
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.030**
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.820**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	**0.009**
FZbh - Non-poly-P heterotrophs [gCOD/g of total COD]	0.000	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.000	0.0001
FZaob - Ammonia oxidizers [gCOD/g of total COD]	0.000	0.0001
FZnob - Nitrite oxidizers [gCOD/g of total COD]	0.000	0.0001
FZamob - Anaerobic ammonia oxidizers [gCOD/g of total COD]	0.000	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.000	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.000	0.0001
FZbam - Acetoclastic methanogens [gCOD/g of total COD]	0.000	0.0001
FZbhm - H2-utilizing methanogens [gCOD/g of total COD]	0.000	0.0001

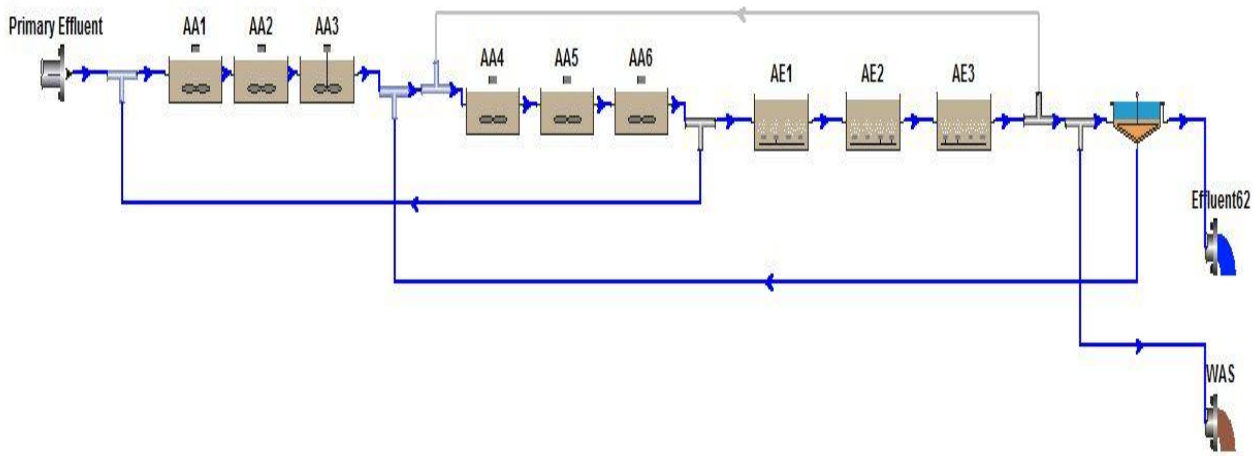

Figure 3.5 Biowin Simulation Model (Garrett Wasting Configuration)

The Biowin simulation was also reconfigured for dynamic simulation. During the profile sample period one anaerobic/anoxic (AA) train was taken offline and so the model had to be adjusted to be able to model this during the entire profile period. For this reason a separate set of AA tanks were added and the flow split between the two trains in the model. One train received 4/5 of the flow and train B received 1/5 of the flow. When all tanks were online the flow was split to each of the trains to simulate the actual 5 trains that were online in the full-scale. When the one train was shut down in the full-scale the flow split to train B (1/5 of the flow) was stopped to mimic what actually occurred (Figure 3.6).

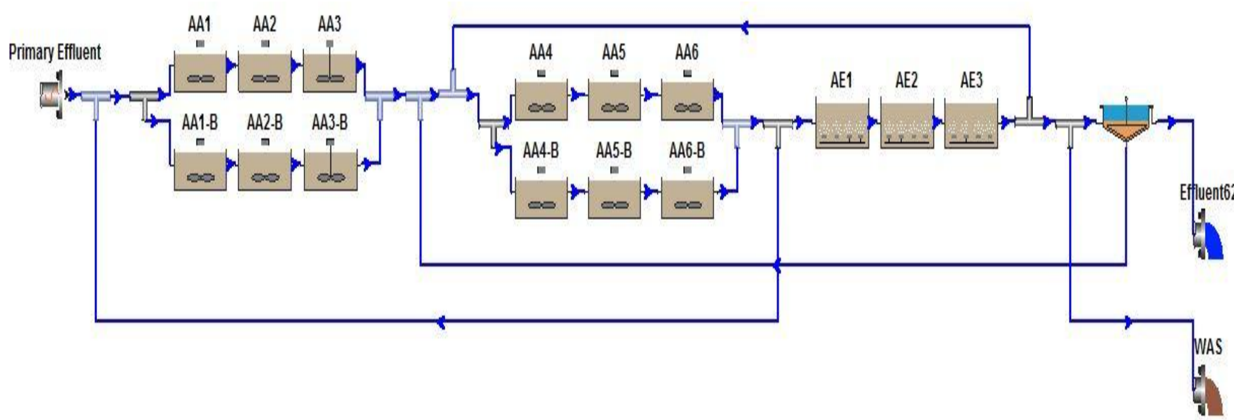

Figure 3.6 Biowin Model for Dynamic Simulation

3.4.1 Steady-State Simulations

Simulations were created for individual periods of the profile sampling as well as a simulation for the entire profile sampling period. Individual periods were created based on changes in mixed liquor suspended solids, changes in process; 5 anaerobic/anoxic trains to 4 anaerobic/anoxic trains; the Nitrate recycle (NRCY) being active and inactive, and the cease of nitrification. Steady-state simulations incorporated the use of constant input values for recycle streams, WAS, and other inputs. The entire profile sampling event was divided into 5 different periods and each period was modeled using steady-state conditions to calibrate the simulation except for the 4th period.

3.4.2 Dynamic Simulations

During the 4th period the plant was falling out of nitrification and therefore this period had to be modeled dynamically to calibrate it properly. The model for the entire profile sampling event from start to finish was modeled dynamically as well. Itineraries for influent (Primary Effluent) characteristics, temperature, recycle rates, waste rates, and clarifier removal rates were all set based on plant performance data and the steady-state & dynamic calibration models.

3.5 References

American Public Health Association, American Water Works Association, Water Environment Federation. (1998). *Standard Methods for the Examination of Water and Wastewater*; 20$_{th}$ ed.: Washington D.C.

Kelly, R.T., II, Love, N.G., 2004. A Critical Comparison of Methods Used to Determine Nitrification Inhibition. *Water Environmental Federation*, (15) 166-180.

4. Manuscript 1 – Evaluation of Nitrification Inhibition Using Bench-Scale Rate Measurements

Abstract

The Nansemond Treatment Plant (NTP) operated by the Hampton Roads Sanitation District (HRSD) was originally designed as a 3-stage VIP biological nutrient removal (BNR) process (Bilyk et al., 2008). NTP is currently being upgraded to a 5-stage Bardenpho process to achieve improved total nitrogen (TN) removal. NTP has experienced unexplained sporadic nitrification upsets for a number of years and some indication of continuous nitrification inhibition, as demonstrated by calibration of a process simulation model to historical data. A preliminary engineering report by Hazen and Sawyer, P.C., suggested that the ammonia oxidizing bacteria (AOB) maximum specific growth rate (μ_{max}) be reduced from 0.90 to 0.57 days^{-1} to account for high effluent ammonia data during the calibration period (Hazen & Sawyer, 2007). This has significant implications in terms of the required aeration volume for consistent nitrification at cold temperatures. A study was undertaken using a wide variety of NTP, targeted industry (hog processing facility and landfill leachate), and control wastewater and biomass samples to attempt to identify possible sources of inhibition through batch rate measurements using bench-scale reactors. Biomass samples were collected from various well nitrifying facilities to compare nitrification kinetics. Experiments were carried out using four batch reactors in parallel. This batch rate testing independently evaluated AOB and NOB activity based on NO_x-N generation and NO_3-N generation/NO_2-N depletion, respectively. Experimental results to date have confirmed the sporadically inhibitory nature of NTP primary effluent when combined with other nitrifying biomasses; however, no specific source has been determined. NTP receives large quantities of chemical toilet waste that are discharged to the plant in slug doses via tank truck to

the septage receiving station. Investigation into quaternary ammonium compounds (QACs) which were contained in the chemical toilet waste suggested that QACs at higher concentrations caused some inhibition to NOB activity, but no significant impact on AOB activity.

4.1 Introduction

The Hampton Roads Sanitation District (HRSD) operates thirteen treatment plants in the Hampton Roads, Virginia, area with a combined capacity of 231 million gallons per day (mgd) (Bilyk et al., 2008).The Nansemond Treatment Plant (NTP) is one of the larger facilities operated by HRSD and was designed to treat 30 mgd (max monthly) using a 3-stage Virginia Imitative Process (VIP) biological nutrient removal (BNR) process (Figure 4.1 and 4.2) (Bilyk et al., 2008). The majority of the influent is domestic, but there is also a large industrial contribution, particularly from a pig processing facility, landfill leachate, and significant loads from septage and grease deliveries (Bilyk et al, 2008). NTP has had a long history of issues with nitrification after its initial upgrade to a BNR facility in 1998.

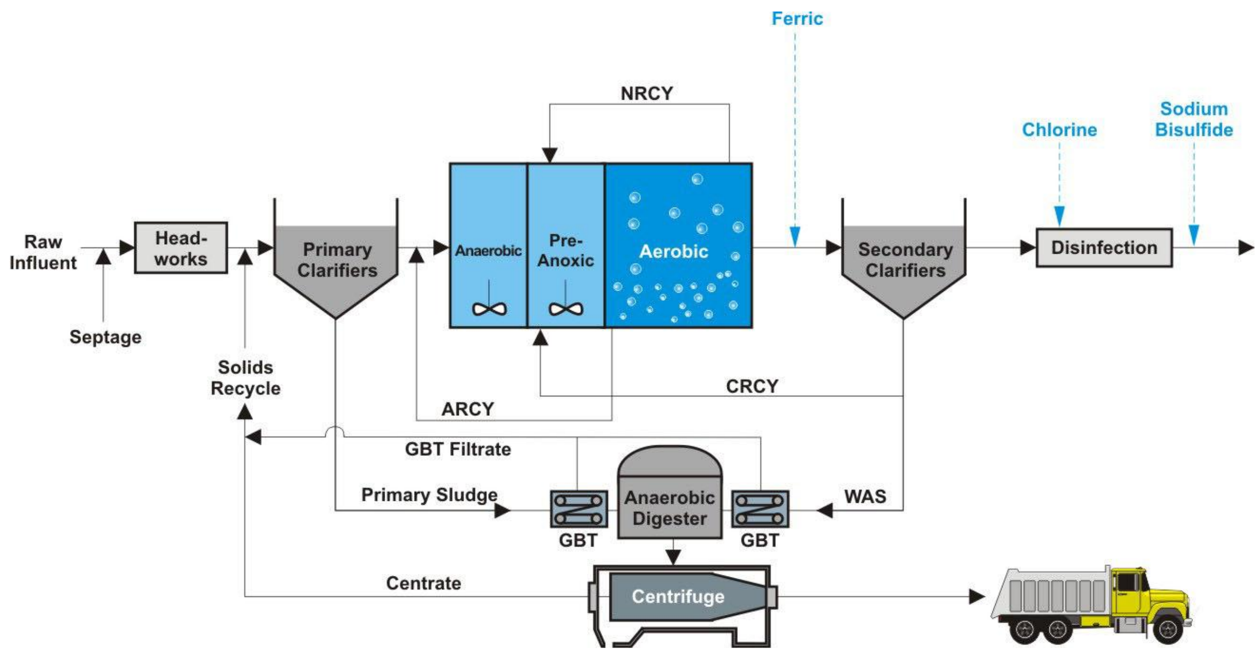

Figure 4.1 3-Stage VIP Process at NTP in 2008 (Bilyk et al., 2008).

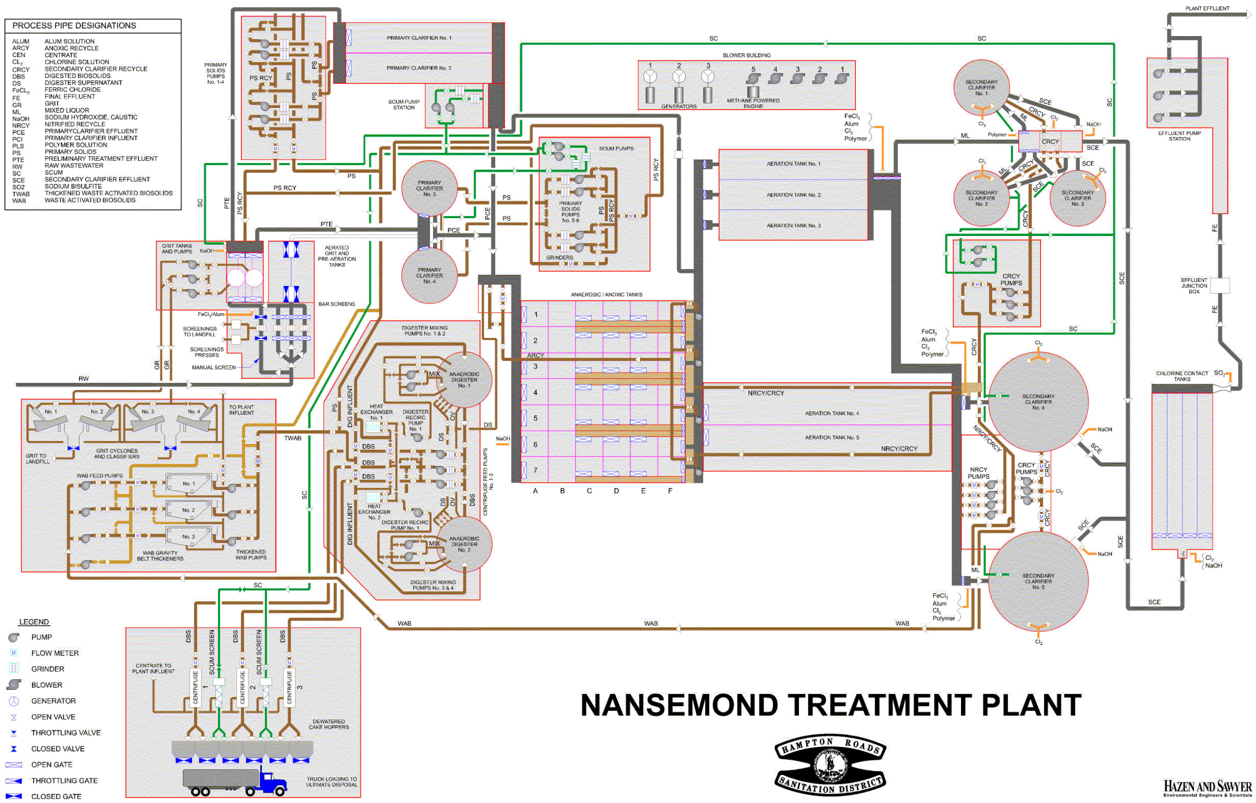

Figure 4.2 NTP 3-Stage VIP Process Plant Layout

Starting in 2001 until the present the plant has experienced continuous and sporadic nitrification upsets without much explanation. This determination was based upon the plant's efficiency in removing nitrogen. The VIP plant in Norfolk, VA which also employs the VIP process began BNR operations approximately seven (7) years prior to similar Nansemond operations (Balzer et al., 2005). Nitrogen removal was similar at both facilities (Table 4.1) during the first two years of side-by-side operation (1999 & 2000) (Balzer et al., 2005). Nansemond experienced an unexpected decline in nitrogen removal efficiency starting in 2001 which has continued to the present (Balzer et al., 2005). This deficiency in performance has been variable and has not been consistent from 2001 to the present time.

Table 4.1 Percent TN Removal for HRSD's Nansemond and VIP Treatment Plants (1999-2009)

PLANT	**NP**	**VIP**
YEAR	[% Removal]	[% Removal]
1999	69.9	71.5
2000	64.2	67.0
2001	53.1	66.3
2002	64.4	67.1
2003	45.0	62.5
2004	55.6	71.9
2005	50.6	67.83
2006	70.8	69.66667
2007	68	65.83333
2008	70.3	72.58333
2009	50	60
MEAN	**60.2**	**67.5**

NTP achieves continuous complete nitrification during certain periods consistently meeting desired effluent limits. In spite of this, NTP has also experienced unexplained sporadic nitrification upsets for a number of years when compared to the VIP plant (Figure 4.3 and 4.4) and some indication of continuous nitrification inhibition, as demonstrated by calibration of a process simulation model to historical plant performance data. The previous target total nitrogen (TN) treatment objective was 12 mg/L on a seasonal basis. This has changed more recently to a permitted limit of 8 mg/L TN on an annual average basis (Bilyk et al., 2008).

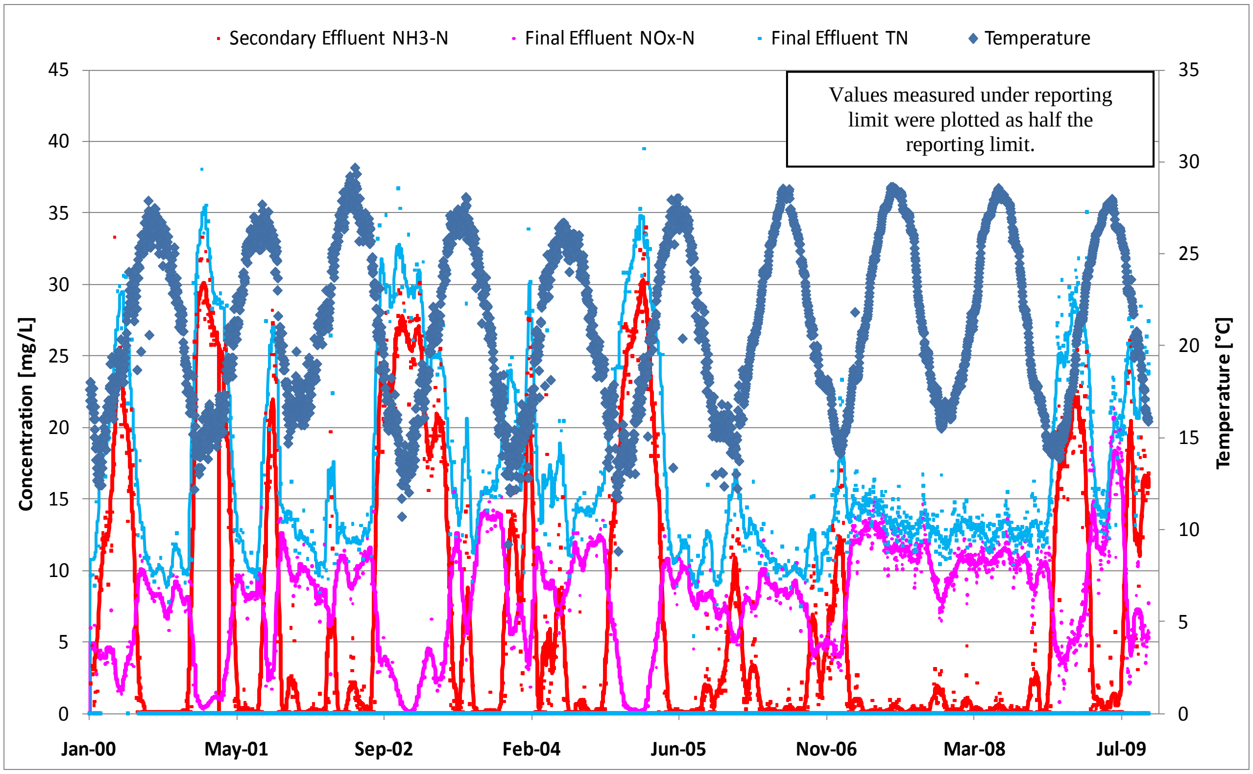

Figure 4.3 NTP Historical Effluent Ammonia, NOx-N, and Total Nitrogen Profile 2000-2009 (Lines represent 30-day rolling averages).

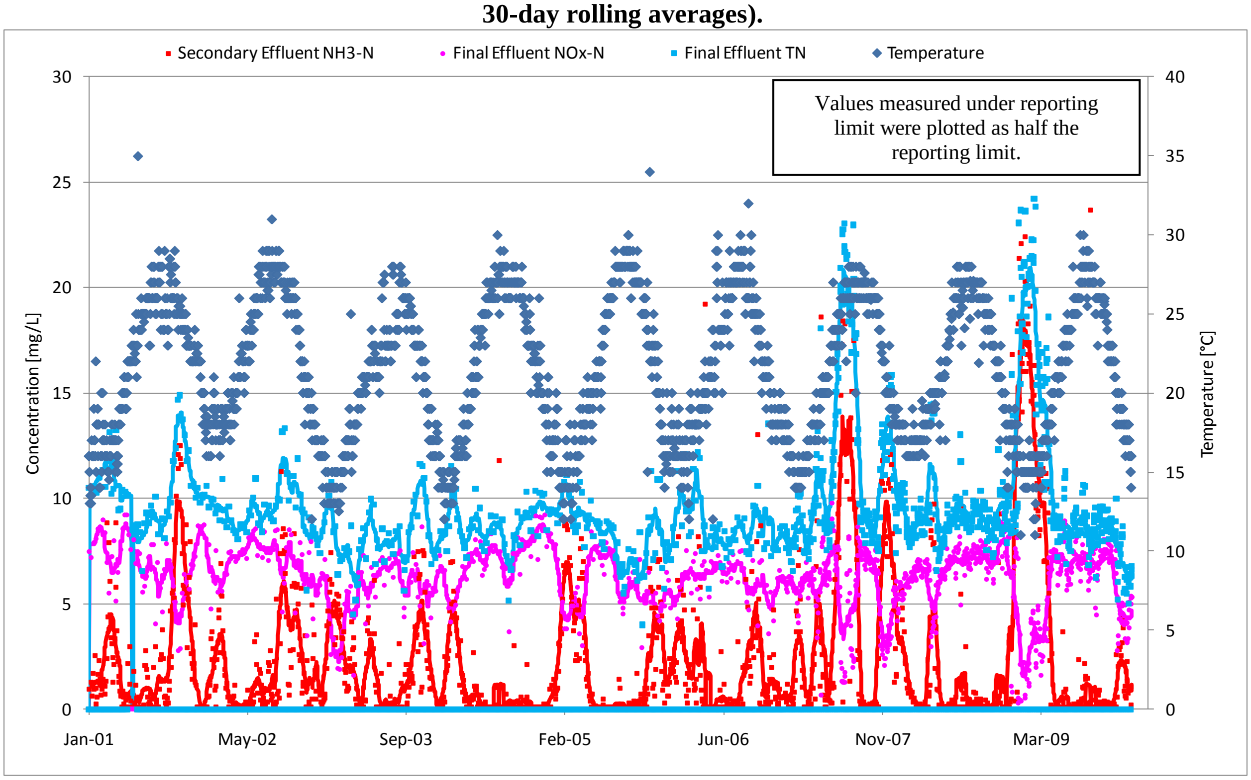

Figure 4.4 VIP Historical Effluent Ammonia, NOx-N, and Total Nitrogen Profile 2001-2009 (Lines represent 30-day rolling averages).

In addition the plant also experienced regular biological phosphorus removal upsets (Figure 4.5) which forced NTP to add large quantities of ferric chloride to avoid permit violations for effluent TP (Bilyk et al., 2008). It was the goal of NTP to meet a treatment objective of 1 mg/L of total phosphorus (TP) on an annual average basis (Bilyk et al., 2008).

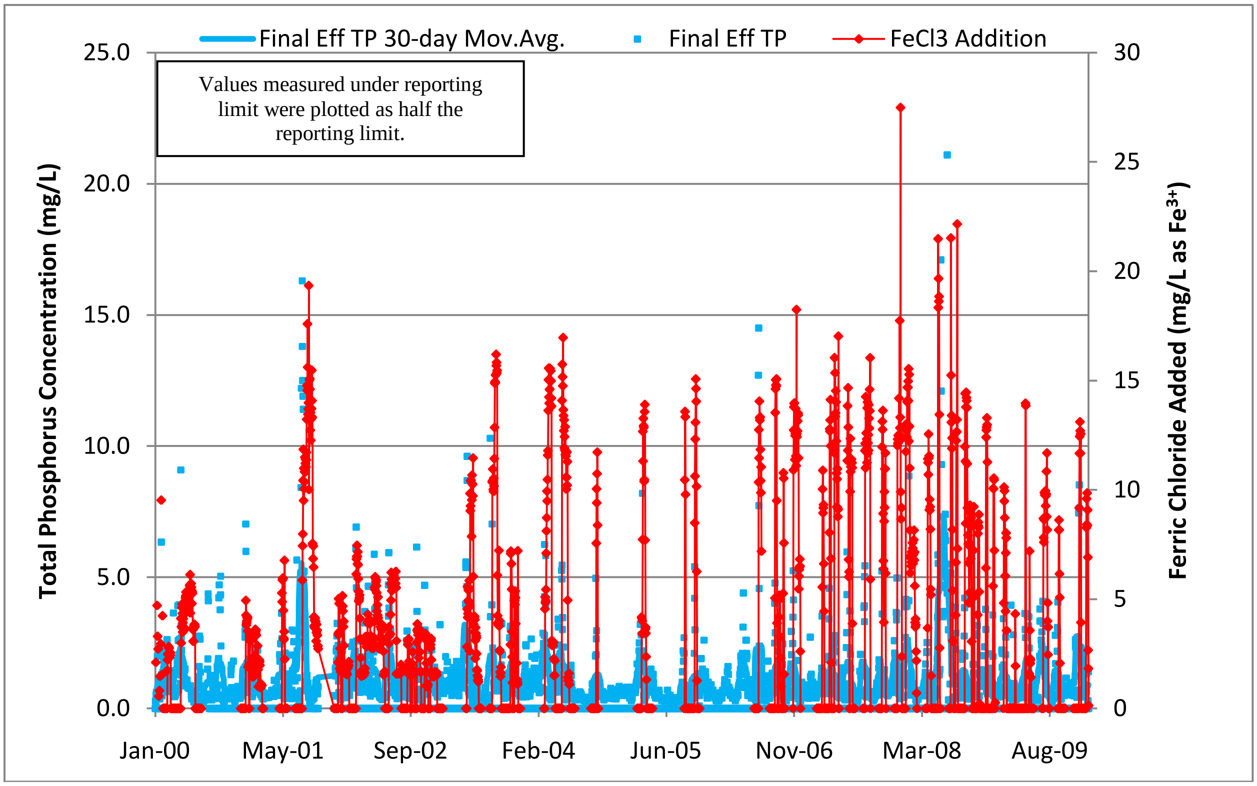

Figure 4.5 NTP Historical Effluent TP and Ferric Chloride Addition 2000-2009

This presented an issue as NTP along with other treatment facilities which discharge to the James River are required starting in 2011 to meet a combined annual discharge limit of 6 million pounds of total nitrogen (TN) (Balzer et al., 2005). Investigation as to possible contributors of nitrification inhibition has attributed the sources including industrial discharges (hog processing plant or landfill leachate) and truck-delivered waste received at the facility septage, grease, and chemical toilet waste. NTP receives large quantities of chemical toilet waste that are discharged to the plant in slug doses via tank truck to the septage receiving station (see

Tables 4.4 and 4.5). It was hypothesized that the quaternary ammonium compounds (QACs) contained in this chemical toilet waste could be a possible source for the sporadic nitrification inhibition that is experienced at the NTP.

Quaternary ammonium compounds (QACs) or quaternary ammonium salts (quaternary ammines) are salts of quaternary ammonium cations with a coordinating anion (e.g. chloride). They are organic compounds that contain four functional groups attached covalently to a positively charged central nitrogen atom (R_4N+). These functional groups (R) include at least one long chain alkyl group, and the rest are either methyl or benzyl groups. QACs are extensively used in domestic and industrial applications as surfactants, emulsifiers, fabric softeners, disinfectants and corrosion inhibitors (Tezel et al, 2007). QACs are of importance because it has been determined that acute inhibition of both heterotrophic COD removal and nitrification, especially the nitrite oxidation process, can be inhibited at high concentrations (Kreuzinger et al, 2007).

In order to meet future permit limits NTP is currently being upgraded to a 5-stage Bardenpho process (Figure 4.6). This will increase aeration volume/capacity and enhance both nitrification and Bio-P removal. The new upgrades will also incorporate a full-scale proprietary technology developed by Ostara that uses a fluidized bed reactor to recover phosphorus and ammonia through struvite precipitation from the centrate being generated at NTP. The harvested struvite can then be utilized as a slow release fertilizer (Ostara, 2007).

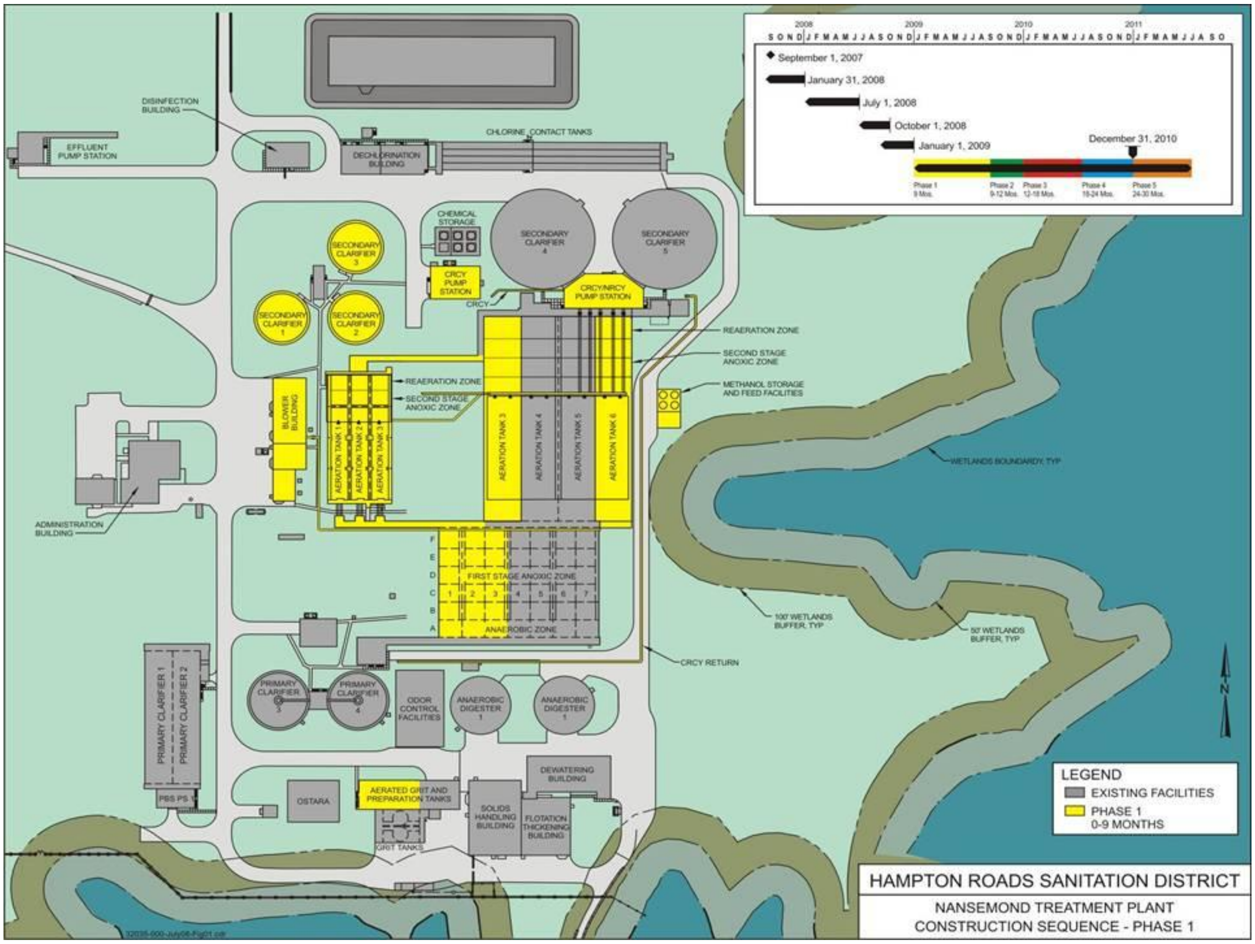

Figure 4.6 NTP with Upgrades to 5-stage Bardenpho Process.

A preliminary engineering report by Hazen and Sawyer, P.C. for the current nutrient removal upgrade, suggested that the ammonia oxidizing bacteria (AOB) maximum specific growth rate ($\mu_{max, AOB}$) be reduced from the default value of 0.90 $days^{-1}$ to 0.57 $days^{-1}$ to account for high effluent ammonia data during the calibration period (Hazen & Sawyer, 2007). This has significant implications in terms of the required aeration volume for consistent nitrification at cold temperatures. It was originally assumed that NTP would nitrify year-round with this background inhibition. This would only be made possible however, by reconfiguring the BNR process to allow the 2^{nd} anoxic zone to operate aerobically (swing zone). Removing an anoxic zone would reduce overall TN removal because the process would essentially change from the 5-stage Bardenpho process to an A2O Process. If the inhibition can be eliminated then there would no longer be a need to configure the 2^{nd} anoxic zone to run aerobic in cold temperature conditions, providing improved annual average TN removal. This would ensure that NTP and the other James River HRSD facilities meet the TN bubble permit limit with more certainty. The objectives of this study were the following:

- Establish the inhibitory characteristics of the NTP influent wastewater by bench-scale experiments independently evaluating ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) rates.
- Study and evaluate possible sources of inhibition from the industrial loads and chemical toilet waste received suspected of containing QACs and their affect on nitrification kinetics.

4.2 Methodology

4.2.1 Sample Collection

Batch reactor experiments were conducted by collecting biomass samples from the aeration basin effluent of several full-scale wastewater treatment plants. Grab samples were collected unless otherwise arranged with HRSD to collect composites. All samples were collected and stored in polypropylene carboys or similar containers. These samples were then transported to the lab and stored until use with continuous aeration for no longer than approximately 48 hours at room temperature. Biomass samples were collected from NTP; the HRSD VIP plant, which uses the same BNR process as NTP but does not experience inhibition; the Henrico County WWTP, which has a fully nitrifying 5-stage BNR process; and the HRSD York River plant from the sequencing batch reactor system.

Wastewater sources for experiments were also collected via grab sample or composite sampling by HRSD based on the source being tested. Wastewater samples were collected including NTP and VIP primary effluent (PE); NTP and VIP secondary effluent (SE); raw wastewater from isolated branches of the NTP collection system; and industrial waste samples from a hog processing plant and a landfill leachate stream. Waste samples were also tested from other suspected sources such as chemical toilet disinfectants (quaternary ammonium compounds).

4.2.2 Batch Reactor Construction

Four parallel batch reactors were constructed of plexiglass and configured with vinyl and polypropylene fittings and appurtenances. The first reactor served as the control while operating conditions of the other three reactors were varied. Each reactor had a volume of 3 liters with individual ports for sampling and chemical addition (acetate, ammonia, nitrite, and phosphate) during experiments as needed. A diffuser stone was incorporated into each reactor to provide air/oxygen or nitrogen based on the experiment. This allowed the reactors to be operated under aerobic, anoxic, or anaerobic conditions for nitrification, denitrification, and phosphorus release/uptake measurements. The reactors were configured to be air tight with a water seal on the headspace for anaerobic conditions. Mixing was provided through magnetic stir-bars and stir plates. Dissolved oxygen (DO) was kept constant using HACH LDO probes with HQ40d meters. Two probes were connected to a single HQ40d meter (total of four probes and two meters). National Instruments LabView 7.0 DO Controller was used to provide on and off control of four solenoid air supply valves with associated relays. pH was controlled and logged using Cole-Parmer pH meters/controllers connected to acid (1M H_2SO_4) and base (3M Na_2CO_3) pumps. The reactors were placed in a water bath with a circulating chiller and immersion heaters to maintain a constant temperature during experiments. Refer to Figure 4.7, 4.8, and 4.9 for a schematic and image of an individual reactor and for a complete schematic and image of the entire reactor configuration.

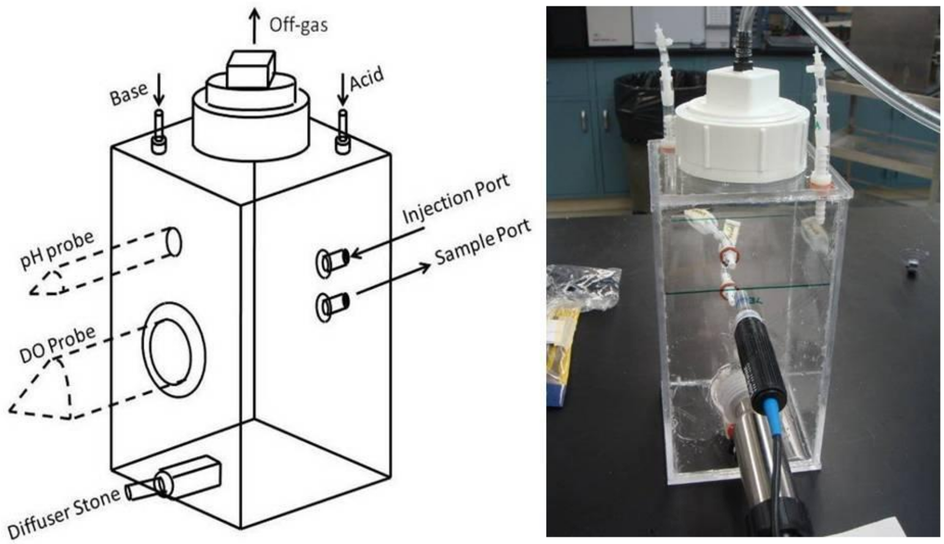

Figure 4.7 Reactor Schematic and Image

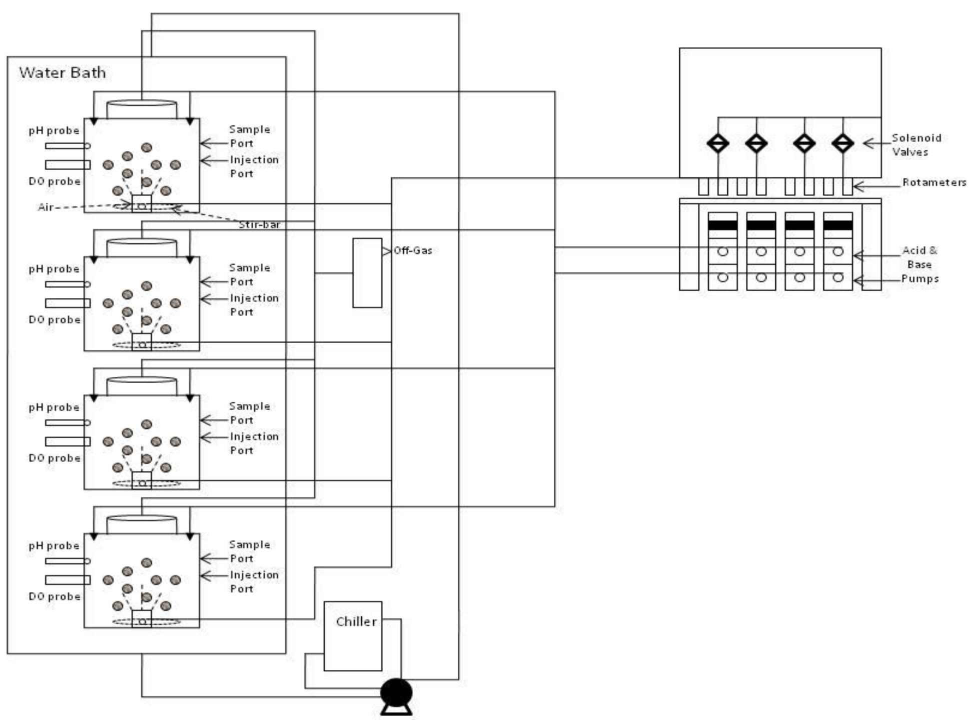

Figure 4.8 Complete Reactor System Schematic

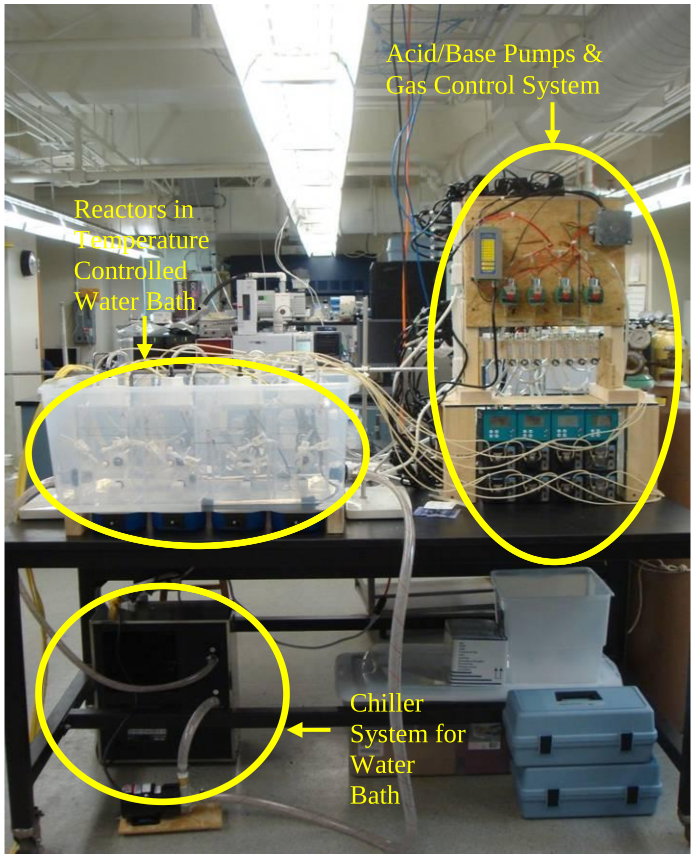

Figure 4.9 Complete Reactor Set-Up

4.2.3 Batch Reactor Operation

Experiments consisted of the evaluation AOB, NOB, and Bio-P activity. The method for evaluating each type of experiment is discussed further in subsequent sections. Temperature for experiments was based on the temperature of the biomass sample when it was collected onsite via grab sample. The matrix of experiments developed and completed is summarized in Table 4.2.

Table 4.2 Batch Experiment Matrix

Week #	Biomass Source	Diluents		Experiments
1	Nansemond	a. NTP/PE	b. VIP/PE	AOB, NOB, Bio-P
	VIP	c. VIP/PE	d. NTP/PE	
2	Nansemond	a. NTP/PE	b. VIP/PE	AOB, NOB, Bio-P
	VIP	c. VIP/PE	d. NTP/PE	
3	Nansemond	a. VIP/SE + Leachate	b. VIP/SE	AOB, NOB, Bio-P
	VIP	c. VIP/SE + Leachate	d. VIP/SE	
4	Nansemond	a. NTP/PE	b. HR/PE	AOB, NOB
	Henrico	c. HR/PE	d. NTP/PE	
5	Nansemond	a. VIP/SE + Hog Plant	b. VIP/SE	AOB, NOB, Bio-P
	VIP	c. VIP/SE + Hog Plant	d. VIP/SE	
6	Nansemond	a. VIP/SE + Leachate	b. VIP/SE	AOB, NOB
	VIP	c. VIP/SE + Leachate	d. VIP/SE	
7	Nansemond	a. VIP/SE	b. VIP/SE + Branch 1	AOB, NOB
	VIP	c. VIP/SE + Branch 2	d. VIP/SE + Branch 3	
8	Nansemond	a. VIP/SE	b. VIP/SE + Branch 2a	AOB, NOB
	VIP	c. VIP/SE + Branch 2b	d. VIP/SE + Branch 3	
9	Nansemond	a. VIP/SE	b. VIP/SE + Cedar Ln PS	AOB, NOB
	VIP	c. VIP/SE + Gum Rd. PRS	d. VIP/SE + Pughsville PRS	
10	Nansemond	a. VIP/PE	b. NTP RWI	AOB, NOB
	VIP	c. NTP PCI	d. NTP PCE	
11	Nansemond	a. VIP/SE	b. VIP/SE + 20 mg/L Fe	AOB, NOB
	VIP	c. VIP/SE + 35 mg/L Fe	d. VIP/SE + 50 mg/L Fe	
12	Nansemond	a. VIP/SE	b. VIP/SE + 20 mg/L Fe	AOB, NOB
	VIP	c. VIP/SE + 35 mg/L Fe	d. VIP/SE + 50 mg/L Fe	
13	York River (YR)	a. YR/SE	b. YR/SE + 20 mg/L Fe	AOB, NOB
	York River (YR)	c. YR/SE + 35 mg/L Fe	d. YR/SE + 50 mg/L Fe	
14	York River (YR)	a. YR/PE	b. NTP RWI	AOB
	York River (YR)	c. NTP PCI	d. NTP PCE	
15	York River (YR)	a. YR/SE	b. YR/SE + 0.574 mL **Chem Toilet Additive***	AOB, NOB
	York River (YR)	c. YR/SE + 13.96 mL **Chem. Toilet Additive***	d. YR/SE + 62.84 mL **Chem Toilet Additive***	
16	York River (YR)	e. YR Mixed Liquor (ML)	f. YR ML + 15 mL Product B	AOB, NOB
	York River (YR)	g. YR ML + 30 mL Product B	h. YR ML + 60 mL Product B	
17	York River (YR)	e. YR Mixed Liquor (ML)	f. YR ML + 60 mL Product B	AOB, NOB
	York River (YR)	g. YR ML + 120 mL Product B	h. YR ML + 180 mL Product B	

***NOTE: Week 15 Experiments – Two different Chemical Toilet Disinfectants (Product A & B) used for the two different days of experiments.**

Table Abbreviations:

NTP – Nansemond Treatment Plant
HR – Henrico County Treatment Plant
PE – Primary Effluent
ML – Mixed Liquor
VIP – Virginia Initiative Process Treatment Plant
YR – York River Treatment Plant
SE – Secondary Effluent
RWI – Raw wastewater influent

PCI – Primary clarifier influent **PCE – Primary clarifier effluent**
PS – Pump Station **PRS – Pressure reducing station**

4.2.3.1 AOB Experiments

AOB activity was evaluated by spiking the reactors with ammonia and monitoring NO_x-N and NO_3-N generation rate over three hours (Kelly et al, 2004). During an AOB experiment the collected biomass was concentrated to approximately 8000 mg/L MLSS prior to experiments. Then the reactor was filled 1/3 by volume with biomass and 2/3 by volume with a diluent (primary effluent, waste sample, etc.). Additional ammonia was added to achieve a total ammonia concentration of approximately 40 mg/L NH_4-N to provide sufficient ammonia during experiments to prevent depletion. Dissolved oxygen (DO) and pH were constantly monitored and maintained within desired limits using online control systems. DO was maintained between 5-7 mg/L during experiments with a pH between 7.0-7.2. Each AOB experiment was conducted for 3 hours with 5 samples collected evenly throughout this period of time. Samples were immediately filtered through 0.45μm membrane filters after collection. AOB activity was based on NO_x-N generation rate.

4.2.3.2 NOB Experiments

NOB activity was assessed by adding in nitrite (ensuring ammonia concentrations were low) and monitoring the rate of NO_2-N depletion and NO_3-N generation. NOB experiments was conducted very similar except after the reactors were filled by volume as mentioned above they were aerated for approximately one hour to allow uptake of any residual ammonia. Samples were taken prior to starting the NOB Experiments and analyzed for NH_4-N to ensure that the ammonia concentration in each reactor was <1 mg/L NH_4-N (detection limit of HACH TNT 831 NH_4-N analysis method). After it was determined that the ammonia concentration in each reactor was depleted, approximately 25 mg/L NO_2-N was added, and then 5 samples were collected evenly over a 3 hour test period. Samples were immediately filtered through 0.45µm membrane filters after collection. DO and pH were maintained within the same parameters as was used for the AOB experiment. NOB activity was based on NO_3-N generation rate and NO_2-N uptake rate.

4.2.3.3 Bio-P Experiments

Bio-P activity was determined by monitoring P uptake and release rates. Experiments was conducted using the same concentrated biomass as in the AOB & NOB experiments (~8000 mg/L MLSS). Experiments were conducted in three phases: uptake, release, and a second uptake. During the first uptake (aerobic) phase, each reactor was filled with 1/3 by volume of biomass and 2/3 by volume of PE or another tested wastewater source. Then each reactor was spiked with 5 mg/L of PO_4-P to reach a target of 20 mg/L P in each reactor since it was presumed approximately 15 mg/L of PO_4-P would be present from the biomass and PE/wastewater sample. The first uptake phase was conducted for 1-2 hours and 3 samples were collected during this time with immediate filtration using 0.45µm membrane filters. During both uptake phases, pH was always controlled between 7.0-7.2 while the DO was maintained between 5-7 mg/L. After this initial uptake phase, the reactors were deaerated by sparging nitrogen (N_2) gas and reducing the DO to 0 mg/L which was maintained throughout the release phase. After the DO was reduced to 0 mg/L, each reactor was spiked with 200 mg/L acetate as COD. It was desired to have all NO_3-N and NO_2-N depleted, but this was not always the case. pH was controlled the same as in the uptake phase experiment and 5 samples were collected over a 1 hour period with immediate filtration using 0.45µm membrane filters. After the 1 hour release phase nitrogen was shut-off and then air/oxygen was sparged into the reactors to once again raise the DO and maintain the DO between 5-7 mg/L. As soon as the air/oxygen sparge began, 5 samples were collected over a 1-2 hour period with immediate filtration using 0.45µm membrane filters. All the samples from both uptake phases and the release phase were analyzed using the same methods used for the AOB and NOB experiments noted in the subsequent 3.3 Analytical Methods section. Rates based on PO_4-P release and uptake was normalized to MLVSS concentrations for each experiment.

All experiments was conducted in this manner except for that conducted during weeks 16 & 17, during which the entire reactor volume was filled with biomass due to the biomass from the York River plant at that time being very dilute.

4.2.4 Analytical Methods

Samples were analyzed for NH_4-N, NO_2-N, NO_3-N, and PO_4-P using HACH colorimetric test kits, ion chromatography (IC), and flow injection analysis (FIA) (see subsections 3.3.3, 3.3.6, 3.3.7, 3.3.8). MLSS and MLVSS were performed at the end of the experiments per *Standard Methods* (APHA et al., 1998). Nitrate production rates, phosphorus uptake and release rates were calculated by normalizing the slope of each chemical constituent by the MLVSS. Normalizing the slope refers to the calculated slope being divided by the mixed liquor volatile suspended solids and converted into the appropriate units of mg/g MLVSS/hr.

4.2.4.1 Ammonia (NH_3-N) HACH Test Kit

Ammonia was analyzed using HACH Test N' Tube (TNT) 831 kit and HACH DR2800 spectrophotometer. This method uses the salicylate method, whereby ammonium ions react with hypochlorite and salicylate ions in the presence of sodium nitroprusside to as a catalyst form indophenol. The amount of color formed is directly proportional to the ammonia nitrogen present.

4.2.4.2 Nitrate (NO_3-N) HACH Test Kit

Nitrate was analyzed using HACH TNT 835 kit. This kit incorporates the dimethylphenol method where nitrate ions in solution with sulfuric and phosphoric acids react with 2,6-dimethyphenol to form 4-nitro-2,6-dimethyphenol.

4.2.4.3 Nitrite (NO_2-N) HACH Test Kit

Nitrite was analyzed using NitriVer3 Nitrite Reagent Powder Pillows and 10 mL sample vials. This kit uses the diazotization method where nitrite in the sample reacts with sulfanilic acid to form a intermediate diazonium salt. This salt combined with chromotropic acid forms a pink color which is directly proportional to the amount of nitrite present.

4.2.4.4 Ortho-Phosphate (PO_4-P) HACH Test Kit

Ortho-Phosphate was analyzed using the HACH Reactive Phosphate TNT Reagent Kit. The kit analyzed 5 mL of sample in a vial. This test kit uses the USEPA PhosVer3 method where orthophosphate reacts with molybdate in an acid to produce a mixed complex. Ascorbic acid then reduces this complex, producing an intense blue color.

4.2.4.5 Ion Chromatography

IC analysis was conducted for measuring nitrate only for the batch experiments work. The IC was used in conjunction with conductivity detection (Dionex ICS-1000), an AS14A analytical column and AG14A guard column, an ASRS conductivity suppressor, and an eluent flow of 1.0 mL/min of 1.0 mM $NaHCO_3$ and 8.0 mM Na_2CO_3.

4.2.4.6 Flow Injection Analysis

FIA was conducted for measuring nitrite, nitrate, and phosphate for batch experiments work using a SEAL Analytics auto-analyzer system. FIA analysis incorporated a volume of 2 mL of sample in sample vials and placed into a sample tray. The tray was then placed into the FIA instrument along with various reagents required for the different analyte test methods. A schedule was then configured using the associated computer software with the instrument and analyzed. QA/QC samples were measured every 10 samples and test methods were always standardized prior to analysis of actual samples. Data output was provided in concentrations in mg/L as NO_2-N, NO_3-N, and PO_4-P.

4.3 Results and Discussion

4.3.1 AOB and NOB Batch Rate Results

AOB and NOB kinetics were independently evaluated based on NOx-N production (AOB), NO_3-N production (NOB), and NO_2-N consumption rates (NOB). These rates were calculated based on a linear regression of the change in nitrogen species concentration over the experimental period (Figure 4.10). These slopes were divided by the mixed liquor volatile suspended solids (MLVSS) to normalize the rate to the biomass concentration, referred to here as the "specific" rate. The representative experiment shown below in Figure 4.10 plots the measured nitrogen species, NH_4-N, NO_2-N, NO_3-N, NO_x-N (NO_2-N + NO_3-N), versus time. Batch experiments were conducted for a total of 17 weeks. Results from the initial batch-rate testing (Weeks 1-4) confirmed the inhibitory characteristics of NTP wastewater. Whenever NTP wastewater was combined with a stable nitrifying biomass there was an observed decrease in NO_x-N production, nitrate production, and nitrite consumption rates (Figure 4.11).

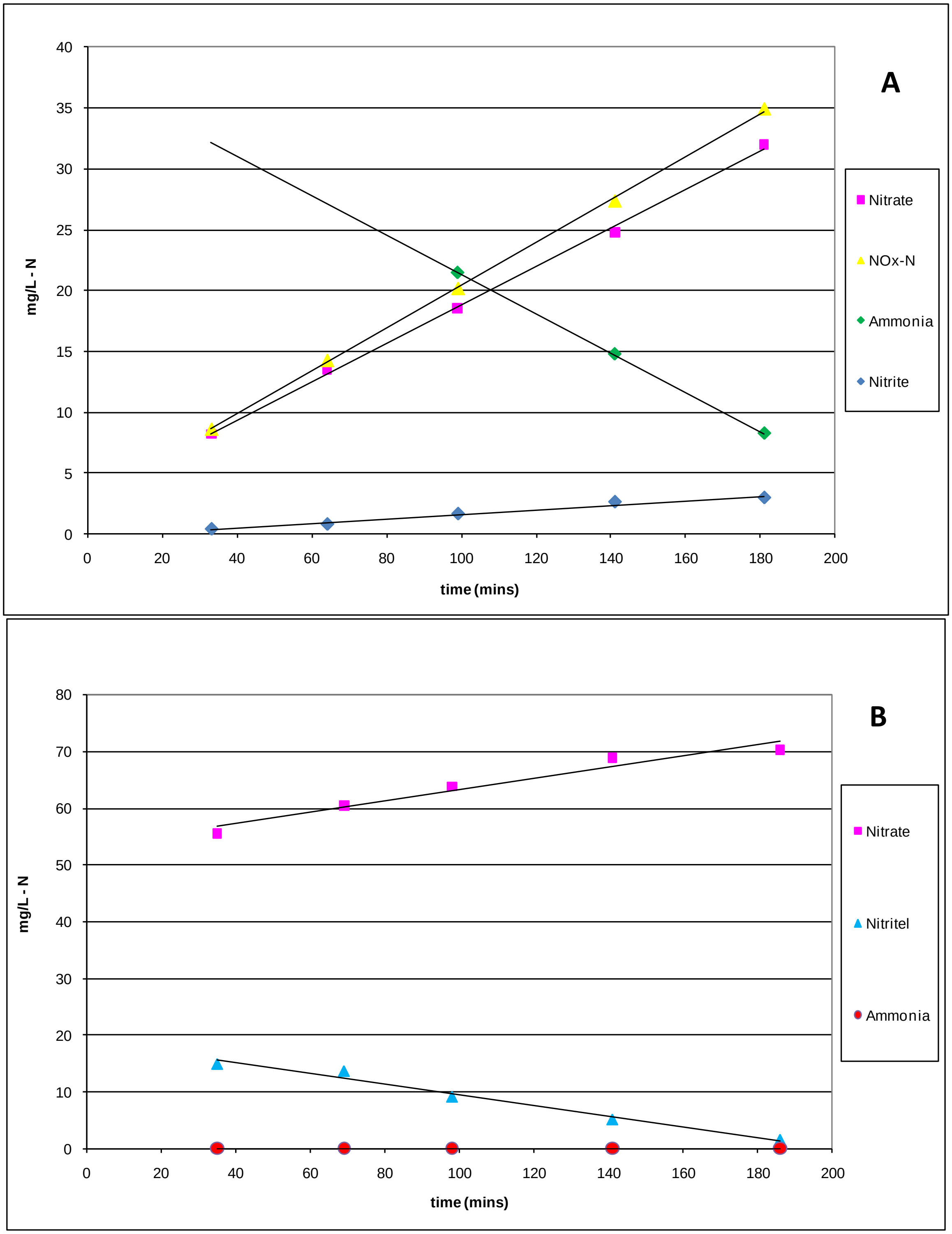

Figure 4.10 Representative Experiment – a. AOB experiment, b. NOB experiment

The data presented from the Week 4 experiment showed some inhibition when the Henrico County (HR) WWTP biomass (control) was combined with NTP PE compared to HR

PE. Although this was true, evaluation of the 95% confidence intervals between the regression slopes revealed that it was not statistically significant as only five data points were collected. This did not provide enough data points to evaluate the regression slopes, but data such as that presented in Figure 4.11 was repeatedly seen through multiple experiments. This being the case, it was determined that NTP PE exhibited some inhibitory characteristics. When NTP biomass was combined with HR PE there was little observed improvement in AOB and NOB activity, likely because the NTP biomass had already been exposed to some degree of inhibition.

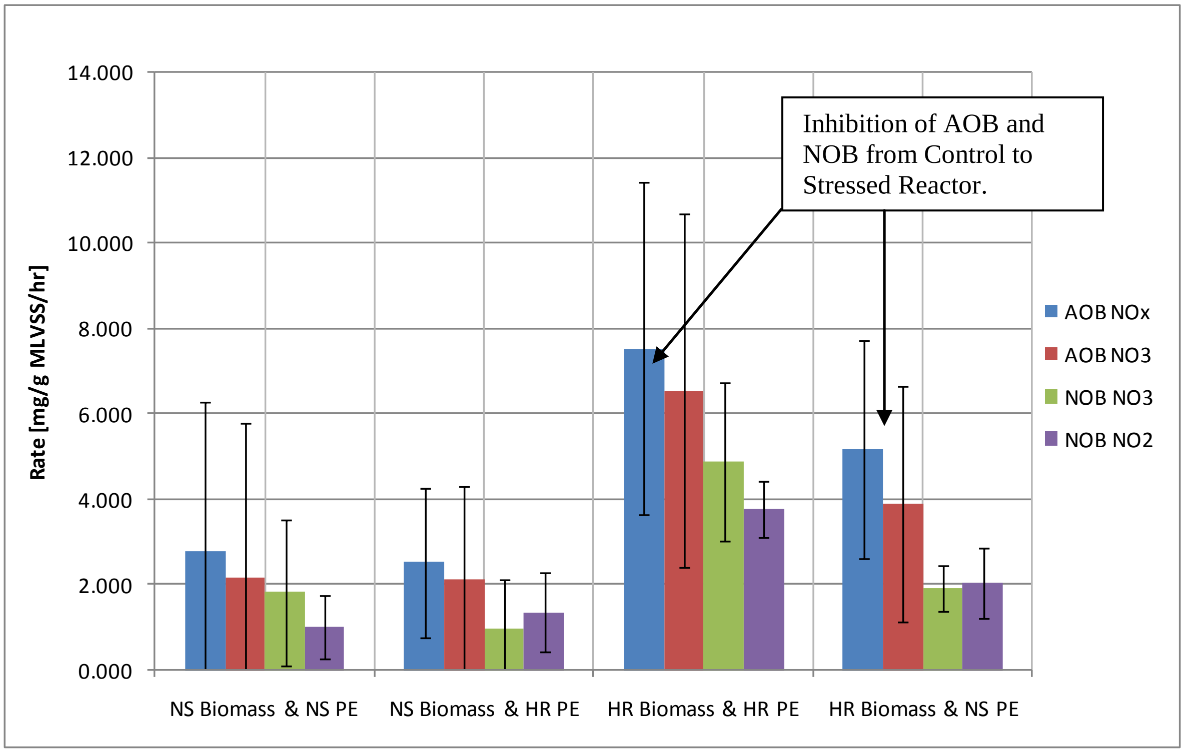

Figure 4.11 Comparisons of AOB & NOB Rates with Control (Week 4 – NTP and Henrico County). (Error bars represent the 95% confidence interval of the regression slope.)

There were several suspected wastewater sources were tested (Table 4.4). Initial testing of inhibitors was for the waste received from a hog processing facility and leachate from a landfill. Results from the testing of both wastewater sources provided no significant differences in AOB and NOB activity compared to the control (Figure 4.12 and 4.13). This was determined based on the difference between the 95% confidence intervals of the regression slopes. Since only five data points were collected during the experiments, the error in the slopes were much greater; however, through multiple experiments of other wastewater sources similar results were observed. This supported that there was no significant difference in AOB and NOB activity from these suspected sources of inhibition. It should be noted that experiments on both of these waste streams were repeated producing similar results. In testing the two waste streams, biomass from the VIP plant was used as the control to compare to the performance of NTP biomass.

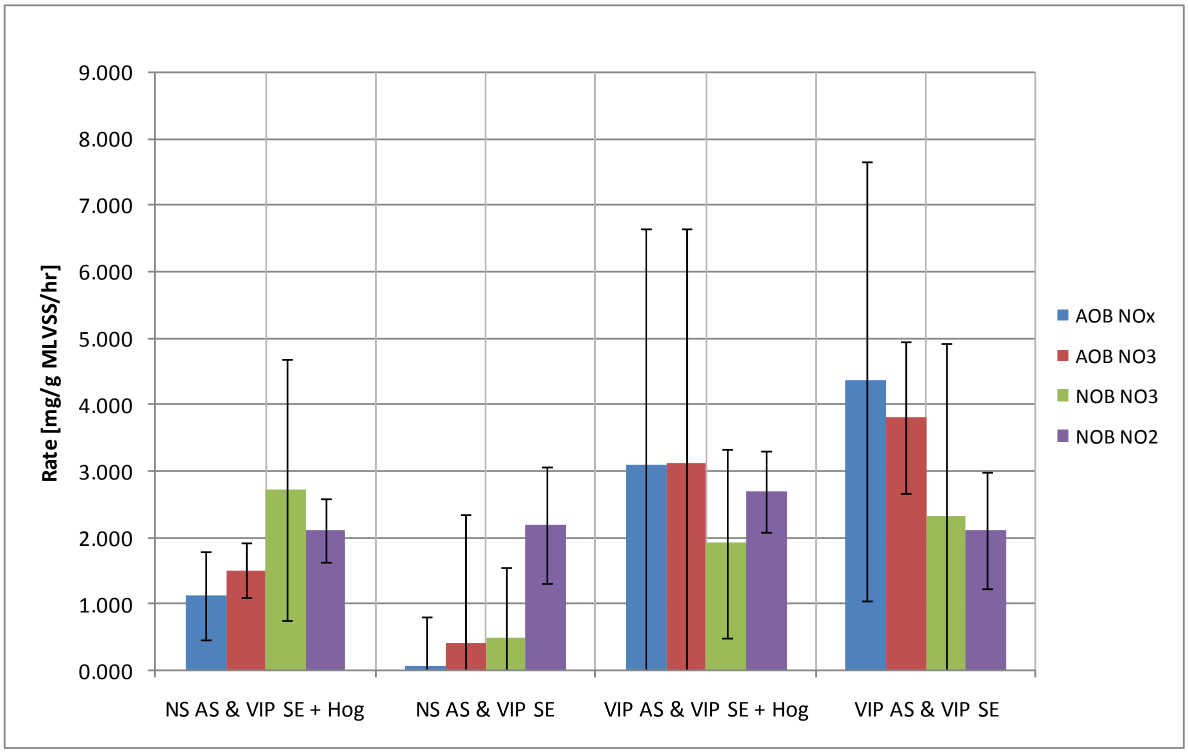

Figure 4.12 Hog Processing Plant Rate Comparison.
(Error bars represent the 95% confidence interval of the regression slope.)

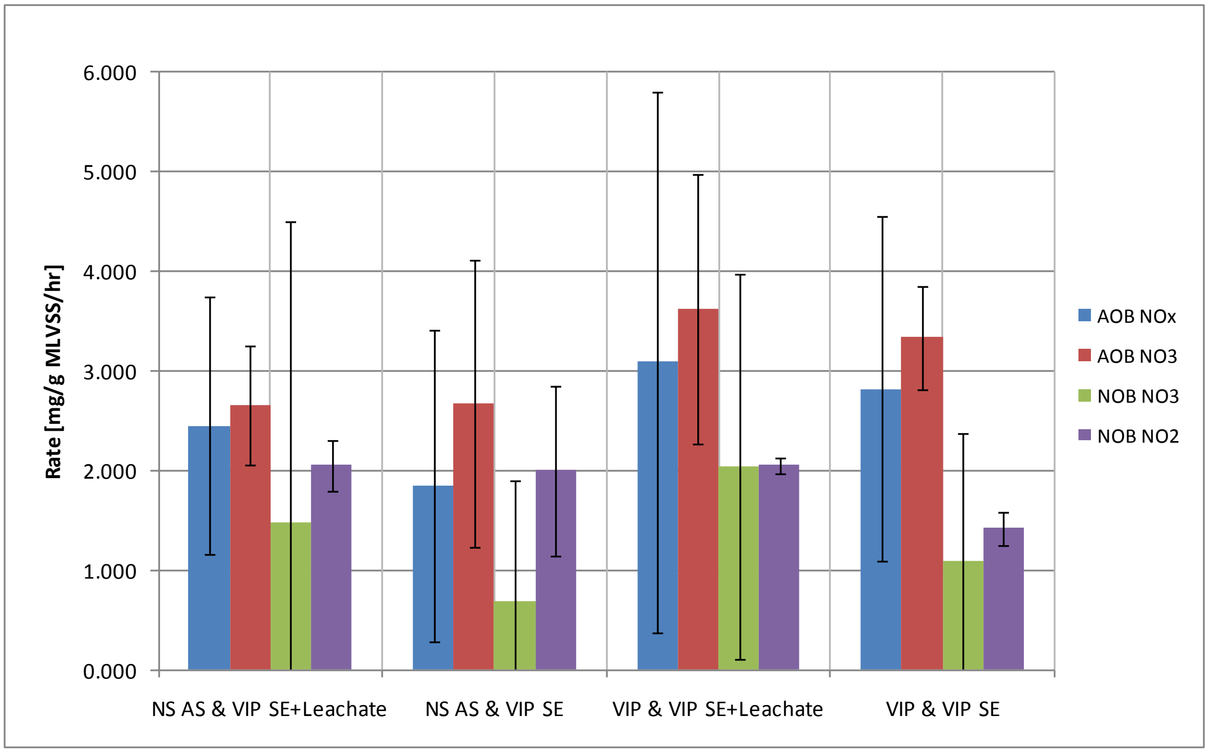

Figure 4.13 Landfill Leachate Rate Comparisons.
(Error bars represent the 95% confidence interval of the regression slope.)

Experiments with other wastewater sources generated similar results as the landfill leachate and hog processing plant. There were no significant signs of inhibition from any of the tested waste streams listed in Table 4.2 based on similar results from multiple experiments, in spite of the lack of difference in the 95% confidence interval of the slopes.

Week 14 experiments were conducted to evaluate the impact of internal recycle streams within NTP. The tested sources included the raw wastewater influent (RWI), primary clarifier influent (PCI), and primary clarifier effluent (PCE). The tested samples were composite samples collected over a four day period (Monday – Thursday) by HRSD. Two duplicate AOB experiments were conducted for each day of composite sample to examine NO_x-N (NO_2-N + NO_3-N) and NO_3-N generation for a total of eight experiments (Figure 4.14). Some mild signs of inhibition were observed between the control and other reactors. The changes in AOB rates between the different tested sources (RWI, PCI, PCE) however, were not significantly different.

This suggested that the inhibitory source was in the plant raw influent and not an internal recycle stream issue. Graphical representation suggested that the York River Biomass was affected negatively by the addition of the Nansemond RWI when compared to the Nansemond PCI and PCE. For this reason a linear regression was performed on the NOx-N rate for one of the days to examine the 95% confidence in the slopes from the different reactors (Table 4.3). The highlighted values represent the 95% confidence interval on the regression slopes between Reactor A (York River Biomass & York River PE) and Reactor B (York River Biomass & Nansemond RWI). The results suggested that the differences in slopes were not statistically different at the 95% confidence level, but were very close to this limit. This inferred that it may not have been a recycle stream issue, but it could have been an insignificant amount of truck delivered septage or grease received during the sampling week.

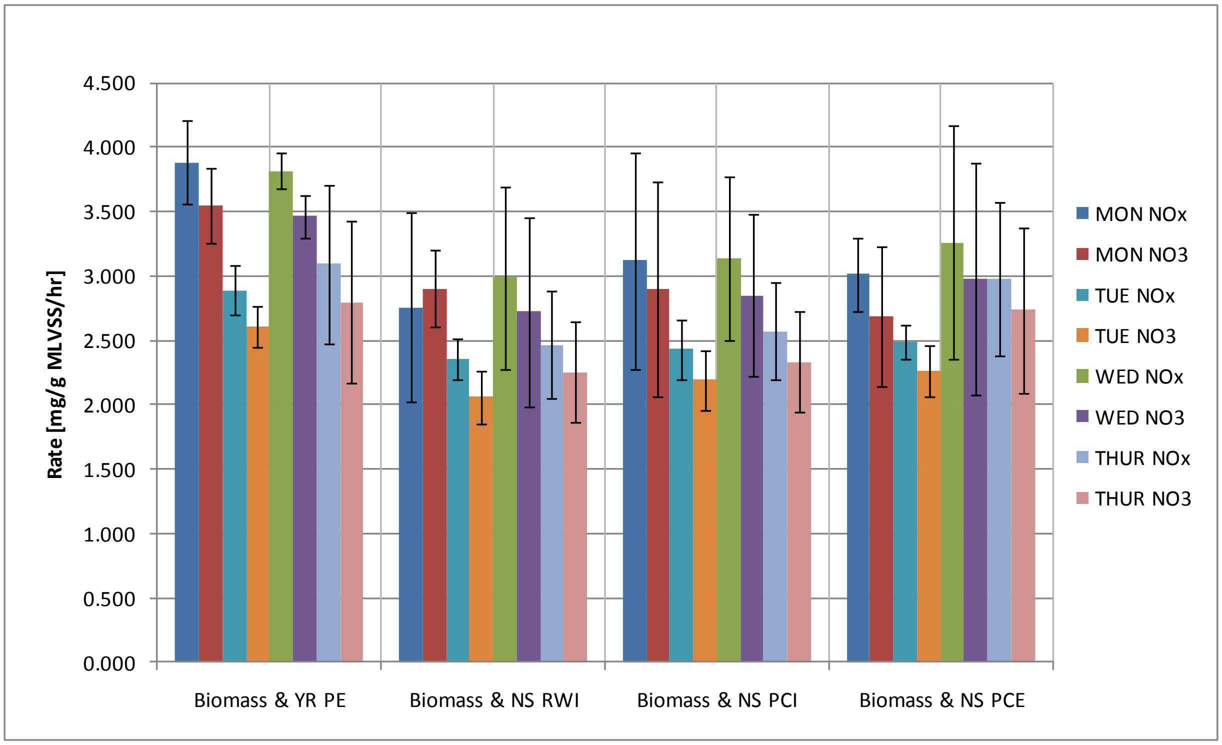

Figure 4.14 AOB Comparisons for Composite Samples of NTP Internal Recycle Streams (Week 14). (Error bars represent the 95% confidence interval of the regression slope.)

Table 4.3 Linear Regression for Calculation of 95% Confidence

MONDAY COMPOSITE SAMPLE			
Reactor	**Lower 95%**	**Slope (Regression)**	**Upper 95%**
A	0.0544	0.0593	0.0643
B	0.0334	0.0457	0.0579
C	0.0371	0.0507	0.0643
D	0.0449	0.0495	0.0541
TUESDAY COMPOSITE SAMPLE			
Reactor	**Lower 95%**	**Slope (Regression)**	**Upper 95%**
A	0.0412	0.0441	0.0470
B	0.0364	0.0390	0.0416
C	0.0358	0.0396	0.0433
D	0.0388	0.0409	0.0431
WEDNESDAY COMPOSITE SAMPLE			
Reactor	**Lower 95%**	**Slope (Regression)**	**Upper 95%**
A	0.0435	0.0452	0.0468
B	0.0310	0.0407	0.0503
C	0.0326	0.0408	0.0490
D	0.0305	0.0424	0.0542
THURSDAY COMPOSITE SAMPLE			
Reactor	**Lower 95%**	**Slope (Regression)**	**Upper 95%**
A	0.0293	0.0366	0.0439
B	0.0279	0.0336	0.0392
C	0.0285	0.0335	0.0384
D	0.0309	0.0387	0.0465

4.3.2 Bio-P Batch Rate Results

Bio-P experiments were only conducted in conjunction with AOB and NOB experiments for four of the seventeen weeks. Bio-P experiments generated varied results. The varied results can be attributed to the fact that NTP was recovering from Bio-P upsets ($FeCl_3$ addition) when samples were collected. There was a noticeable effect on Bio-P performance of other biomass sources when combined with NTP PE. It was observed that when a stable biomass, in this case

VIP biomass, was combined with NTP PE there was a small decrease in phosphate uptake rate (Figure 4.15).

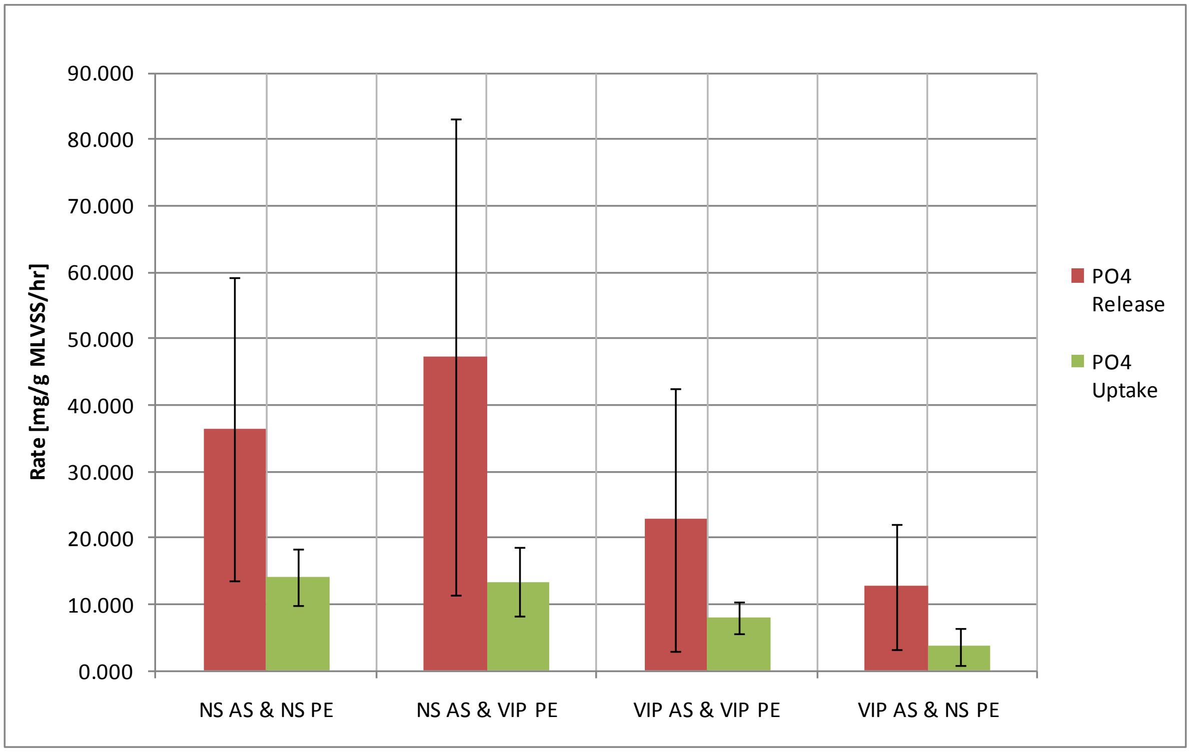

Figure 4.15 Bio-P Experiment with NTP and VIP Biomass and Primary Effluent. (Error bars represent the 95% confidence interval of the regression slope.)

In some cases when biomass samples were collected ferric chloride was being added to assist in phosphorus removal at NTP. For this reason experiments were also conducted examining varying ferric chloride concentrations on nitrification (Figure 4.16 and 4.17). Experiments with ferric chloride addition were conducted for a total of three weeks (Week 11, 12, and 13). Week 11 and 12 were carried out using VIP biomass and week 13 using York River biomass. With appropriate control of pH after Fe^{3+} addition, there were no significant changes between the different concentrations of ferric chloride added (as Fe^{3+}). This suggested that there was no impact of ferric chloride addition on nitrification rates for both AOB and NOB, even at very high concentrations.

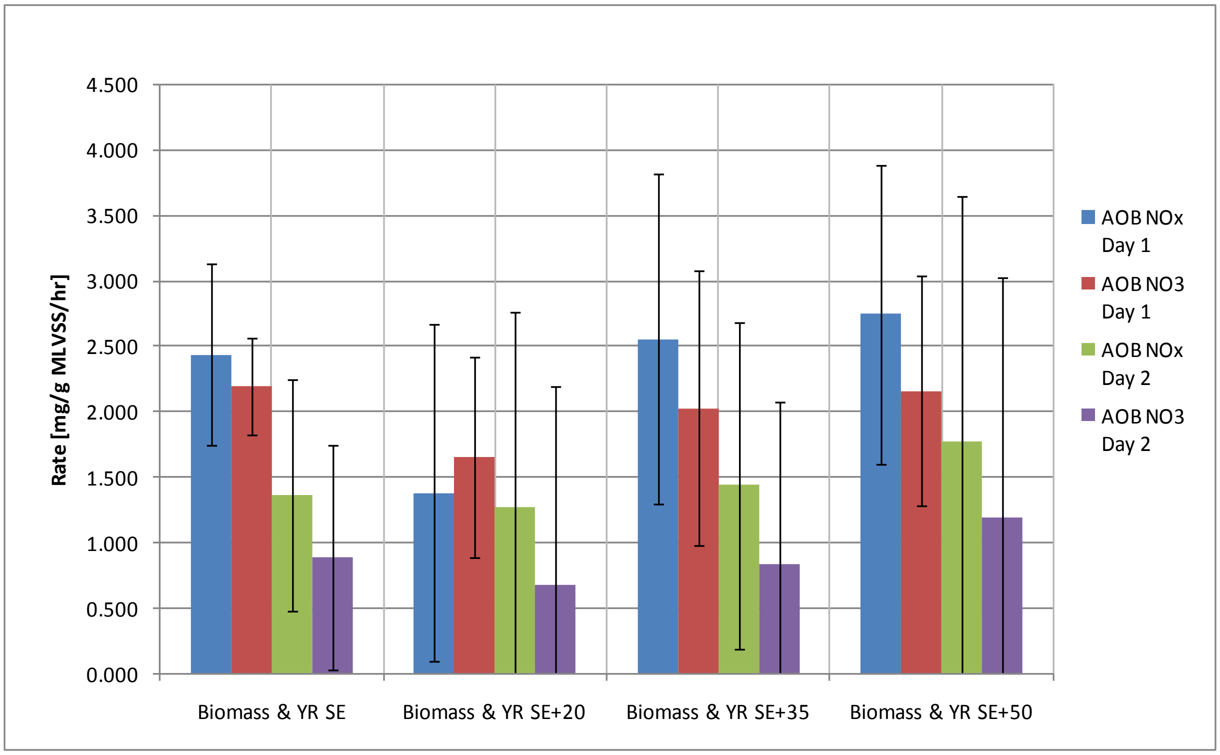

Figure 4.16 AOB Comparison with Ferric Chloride Addition (Week 13). (Error bars represent the 95% confidence interval of the regression slope. 20, 35, and 50 = mg/L as Fe^{3+} added to each reactor.)

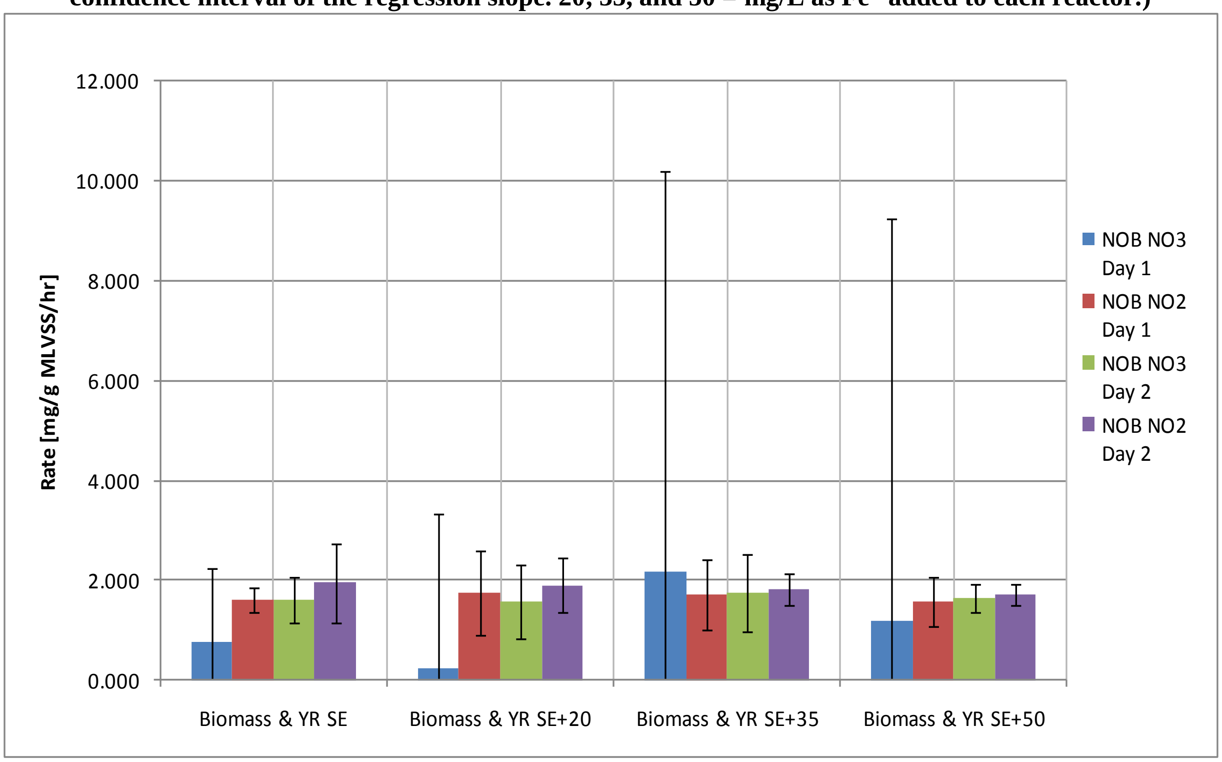

Figure 4.17 NOB Comparisons with Ferric Chloride Addition (Week 13). (Error bars represent the 95% confidence interval of the regression slope. 20, 35, and 50 = mg/L as Fe^{3+} added to each reactor.)

4.3.3 QAC Batch Rate Testing

Three experiments were performed examining chemical toilet disinfectants suspected of containing QACs. Two different chemical toilet disinfectants were used for testing, Product A and Product B; however, Product A was found to contain no QACs. Various assumptions were made when determining concentrations of chemical toilet disinfectant to add to each stressed reactor. Based on the large quantity of chemical toilet waste delivered to NTP (Table 4.4 and 4.5) it was decided to use three different assumptions for calculating experiment doses.

1. NTP received trucked waste deliveries all during one month of the year, Monday – Friday only, during the normal 8 hour workday.
2. NTP received waste during two months of the summer and received the waste over 40 days, Monday – Friday, in 5 hour periods throughout the 8 hour workday.
3. NTP received waste during summer months (June, July, August) when use of portable toilets was at a peak, receiving the waste over 60 days in 6 hour periods throughout the 8 hour workday.

Table 4.4 Septage Waste Received for Several HRSD WWTPs

Wastewater Treatment Plant	Residential Septage [gallons/year]	Chemical Toilet Waste [gallons/year]	Total Delivered Waste [gallons/year]	Average Daily Flow [MGD]	Chemical Toilet Waste [gallons/day]	Total Septage [gallons/day]
Atlantic	501,937	560,258	1,885,655	40	1,535	5,166
Boat Harbor	90,762	852,656	1,618,515	14.9	2,336	4,434
Chesapeake-Elizabeth	454,906	369,426	1,284,278	13.2	1,012	3,519
Nansemond	**1,800,999**	**1,291,602**	**4,427,292**	**18.5**	**3,539**	**12,130**
Williamsburg	1,549,416	272,326	4,000,171	15.7	746	10,959
York River	2,592,031	76,418	2,730,400	12.9	209	7,481

Table 4.5 Septage Waste Received as a Fraction of Average Daily Plant Flow

WWTP Loading Highest to Lowest	Chemical Toilet Waste [gallons/day]	Chemical Toilet Waste [% Avg Day Flow]
Nansemond	**3,539**	**0.019**
Boat Harbor	2,336	0.016
Chesapeake-Elizabeth	1,012	0.008
Williamsburg	746	0.005
Atlantic	1,535	0.004
York River	209	0.002

Results from the experiments showed no significant signs of inhibition or variability in concentration of Product A (Figure 4.18).

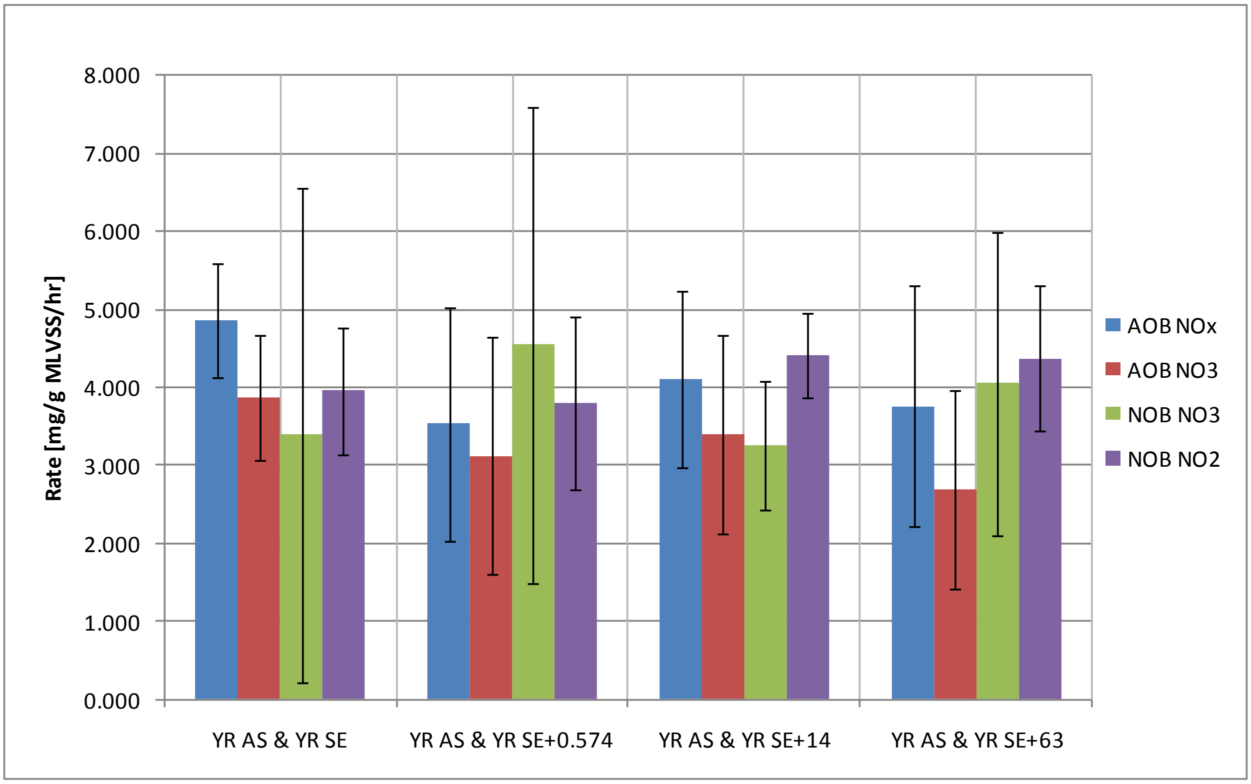

Figure 4.18 QAC Experiment with Product A (Week 15). (Error bars represent the 95% confidence interval of the regression slope. 0.574, 14, 63 = mL of Product A added to reactor.)

It was observed in Product B experiments containing QACs, that there was a mild reduction in NOB activity at higher concentrations (Figure 4.19). This was true for the first day of experiments, but was not replicated in the second day of experiments. The decrease in NOB activity however, was consistent with literature which suggested that NOB exhibit greatest inhibition in response to QAC loading (Kreuzinger et al, 2007). Therefore it was proposed that Product B at higher concentrations may cause some inhibition of nitrification.

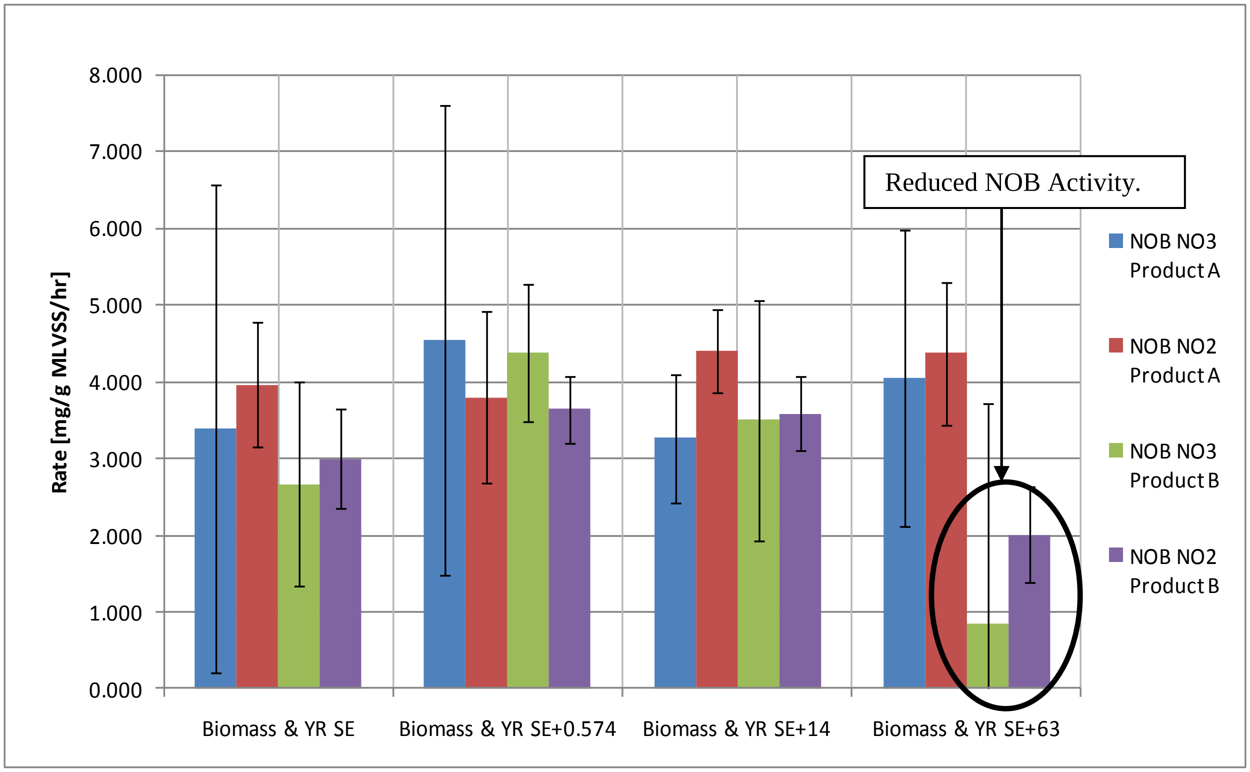

Figure 4.19 Chemical Toilet Disinfectants containing QACs (Week 15). (Error bars represent the 95% confidence interval of the regression slope. 0.574, 14, 63 = mL of Product added to reactor.)

Further experiments in the later two weeks (week 16 and 17) using Product B generated different results from week 15 experiments. It was desired in these experiments to use Product B at higher concentrations to show more significant inhibition of NOB or some reduction in AOB rates. Results however, from week 16 and 17 showed very slight inhibition in rates at higher concentrations, but with AOB and not NOB rates (Figure 4.20). In some cases performance was better or similar with the addition of QACs.

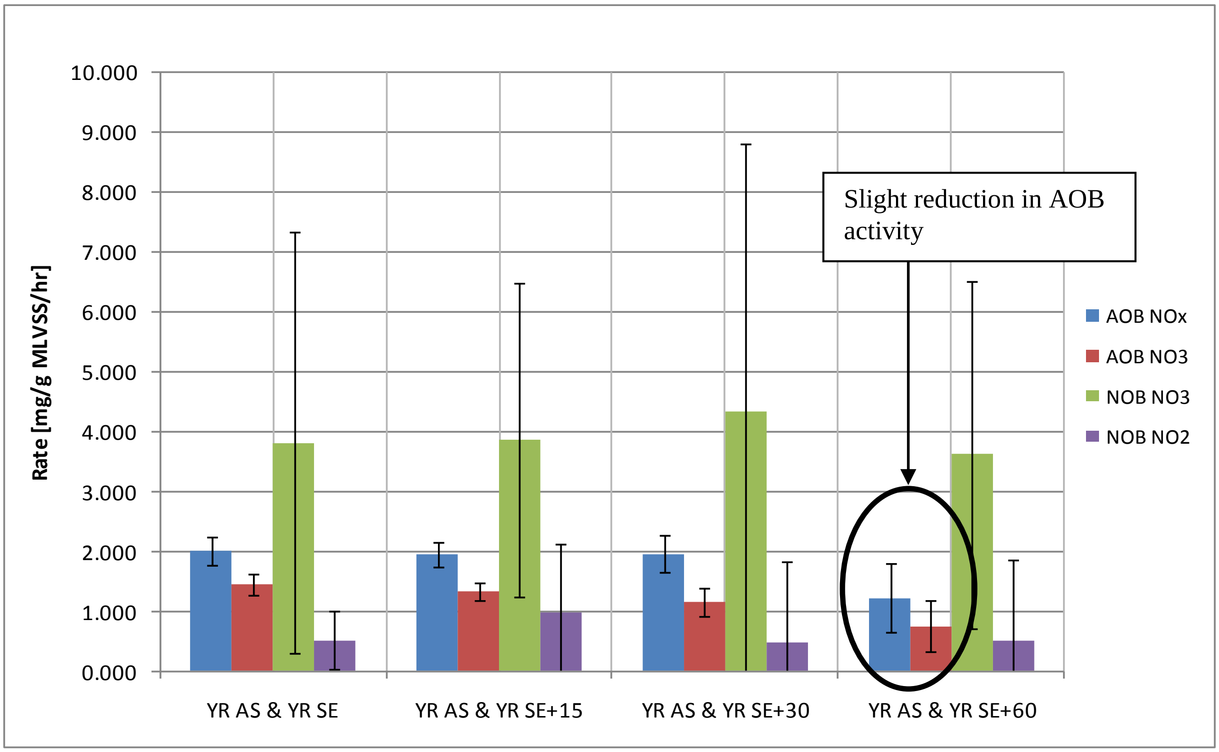

Figure 4.20 Experiments with Chemical Toilet Additive containing QACs (Week 16). (Error bars represent the 95% confidence interval of the regression slope. 15, 30, and 60 = mL of Product B added to reactor.)

4.4 Conclusion

Based on the batch experiments, no significant inhibitor was identified as the cause of sporadic nitrification problems at NTP; the batch-rate testing did show that NTP PE was consistently inhibitory on a seemingly continuous basis. The H&S model calibration based on historical plant data suggested a reduction in AOB μ_{max} from 0.9 days^{-1} to 0.57 days^{-1}, which supported the finding that there was some degree of continuous inhibition. It was also determined that wastewater derived from the hog processing plant and the previously suspected landfill leachate did not cause inhibition of nitrification or bio-P at least at the time the samples were collected. This does not exclude the possibility of an upset or unusual shock load event at one of these industries impacting nitrification at NTP. Evaluation of the various wastewater sources provided an opportunity to study each source independently and its inhibitory characteristics on both AOB and NOB activity. Although there were large margins of error for some of the tests based on the 95% confidence interval of the regression slopes, data generated from the repeated experiments suggested similar findings. It was also determined that batch experiments were not sufficient to determine the source of sporadic inhibition. For this reason it was planned to reconfigure the bench-scale experiments to continuous sequencing batch reactors (SBRs) which would be run in parallel to the full-scale plant.

4.5 References

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5. Manuscript 2 – Evaluation of the Nansemond Treatment Plant Biological Nutrient Removal Process through Baseline Profile Sampling and Modeling.

Abstract

During the initial upgrades to the Nansemond Treatment Plant (NTP), nitrification was maintained; however, due to available blower capacity during construction it was planned that nitrification would not be maintained during the fall of 2009. In an effort to stop nitrification, the solids retention time (SRT) was purposely reduced over a period of about one month (as wastewater temperature cooled) until additional blower capacity was available. This provided an excellent opportunity to study baseline nitrification kinetics and to evaluate the presence of a source of continuous inhibition. This involved profile sampling via grab samples along the biological nutrient removal (BNR) process starting from the primary effluent to secondary effluent. Samples were immediately filtered upon collection and analyzed on-site for ammonia, nitrite, nitrate, and orthophosphate. Profile sampling was conducted until the plant completely ceased nitrifying in the fall of 2009. The profile sampling data were modeled using *Biowin 3.1* (EnviroSim, Ltd.). Using plant performance data, a calibrated dynamic model was generated over the period of profile samples. These simulations were then compared to data collected during the profile sampling to better estimate the level of continuous nitrification inhibition**.** Results from the profile sampling showed no apparent indication of sporadic nitrification inhibition. Evaluation of the BNR process also demonstrated that there was little impact on nitrification from nitrite accumulation or sporadic addition of ferric chloride. Modeling of the profile data generated similar profiles; however, there were slight variations as the model predicted nitrification to stop earlier than what was observed. From the modeling, it was also

estimated that the maximum specific growth rate (μ_{max}) of ammonia oxidizing bacteria (AOB) was approximately in the range of 0.50 – 0.60 days^{-1}, similar to the design value of 0.57d^{-1}.

5.1 Introduction

An initial investigation of nitrification inhibition was conducted at the Nansemond Treatment Plant (NTP) using bench-scale batch reactor experiments to confirm inhibition of nitrification and then identify possible sources of inhibition in the summer 2008 to summer 2009 (Yi et al, 2010). Through several weeks of batch experiments testing of various industrial sources (hog processing plant and landfill leachate), plant recycle streams, ferric chloride addition, and quaternary ammonium compounds (QACs) was conducted. Batch reactors were used to evaluate nitrification kinetics, both AOB and NOB independently; however, identification of an inhibitor for the nitrification was still inconclusive. NTP was undergoing upgrades from a 3-stage VIP process to a 5-stage Bardenpho process to achieve more stringent nutrient limits. During the initial upgrades to the facility, nitrification was maintained; however, due to available blower capacity during construction it was planned that nitrification would not be maintained during the fall of 2009. In an effort to stop nitrification, the solids retention time (SRT) was purposely reduced over a period of about one month (as wastewater temperature cooled) until additional blower capacity was available. This coincided with the profile sampling creating an opportunity to study nitrification kinetics as the plant stopped nitrifying.

NTP began operations as a 10 mgd secondary treatment plant in 1983. Expansions and upgrades were completed in May 1998, which converted the facility into a 30 mgd BNR facility. Since the upgrade the facility has experienced mixed success in the BNR mode (Balzer et al., 2005). This determination was based upon the plant's efficiency in removing nitrogen. The VIP plant in Norfolk, VA which also employs the VIP process began BNR operations approximately seven (7) years prior to similar Nansemond operations (Balzer et al., 2005). Nitrogen removal was similar at both facilities during the first two years of side-by-side operation (1999 & 2000) (Balzer et al., 2005). Nansemond experienced an unexpected decline in nitrogen removal efficiency starting in 2001 which has continued to the present (Balzer et al., 2005). This deficiency in performance has been variable and has not been consistent from 2001 to the present time.

Profile sampling of wastewater treatment plants provides an effective method for evaluating the performance of a BNR processes by sampling for species such as ammonia, nitrate, nitrite, orthophosphate, soluble COD, etc. through the treatment train. Profiles are most commonly incorporated with DO and nutrient profiles (NH_3-N, NO_3-N, etc.), but can be applied to different applications; examining different bacterial activities in a treatment process. Profile sampling is often used in conjunction with modeling work and evaluating existing and future nutrient removal processes (Kochany et al, 2007; Scott et al, 2008; Kim et al, 2009).

The profile sampling data were combined with plant operating data and modeled using *Biowin 3.1* (EnviroSim, Ltd.). The profile sampling period (7-23-09 to 11-5-09) was divided into 5 separate periods to generate a calibrated model. The modeling for four of the periods was first performed in steady-state conditions. The period in which NTP stopped nitrifying had to be calibrated with a dynamic model. A calibrated simulation was then generated over the entire period of profile samples. These simulations were compared to data collected during the profile sampling to better understand the level of continuous nitrification inhibition.

The purpose of the baseline profile sampling and modeling was to address the following issues:

- Conduct baseline sampling prior to the more detailed nitrification inhibition study estimated to begin in March 2010, which will include influent sampling and the operation of bench-scale sequencing batch reactors. This will be used to establish "normal" COD, nutrient and DO profiles though the VIP process without (and possibly with) the impact of inhibitory conditions, specifically with respect to N conversions and P release and uptake along the process.

- Evaluate the potential for nitrite accumulation in the process and its potential effect on aerobic phosphate uptake.
- Evaluate the impact of sporadic ferric chloride addition to the biological process as a means of preventing effluent TP exceedances.
- Evaluate the design μ_{max} to the actual observed μ_{max} for AOB through simulation modeling.
- Compare modeling and observed profile data for signs of continuous nitrification inhibition.

5.2 Methodology

Under normal circumstances, samples were collected during morning hours for 2 days of a normal business week from 7/23/09 to 11/5/09 via grab samples from the surface of each tank or reactor with a bucket. After the sample was collected it was allowed to settle for approximately 30 seconds until a supernatant layer was evident. Supernatant was then aspirated from the surface of the sample bucket using a 60 ml syringe. The sample would then be immediately filtered through the vacuum filtration system incorporating 0.45 μm membrane filters and transferred to the appropriate sample vial (see 5.2.1 Sample Preservation and Containers). DO and pH were measured and recorded when each grab sample was collected. This process was repeated for a total of two profiles per week. During each day of sampling the first sample collection point would be from the primary clarifier effluent. All successive collection points were taken along the length of the BNR treatment process (refer to Figure 5.2) according to the actual hydraulic retention time presented in Table 5.1 (including the impact of recycle streams). The clarifier influent distribution channel sample was collected immediately following the last aeration basin sample and the RAS sample immediately after the secondary effluent sample was taken. A total of 15 samples were collected. Analysis of soluble COD (sCOD), Ammonia (NH_4-N), Nitrate (NO_3-N), Nitrite (NO_2-N), ortho-phosphate (PO_4-P) at all sampling locations.

- Primary Clarifier Effluent (PE) - **1** Sample
- Anaerobic/Anoxic Tanks (AA1, AA2, AA3, AA4, AA5, AA6) - **6** Samples, 1 sample per cell for a single train
- Aeration Tank (AE1, AE1.25, AE1.5, AE3, AE5) - **5** samples, 1 at the beginning, 3 intermediate, 1 at the end for a single tank. The aeration tank was originally divided into 5 equal sample points along the length of the tank. AE1, AE2, AE3, AE4, AE5. Based on the results, two of the intermediate points were changed. Instead of taking 5 equally spaced points, two were taken between the distance of AE1 and AE2, which became AE1.25 and AE1.5 to better capture ammonia uptake, nitrite consumption, and nitrate production. AE4 was eliminated as values were similar to AE5 (Figure 5.1).
- Clarifier Recycle (RAS) - **1** sample
- Secondary Clarifier Influent Distribution Channel (IDC) - **1** sample
- Secondary Clarifier Effluent (SE) - **1** sample

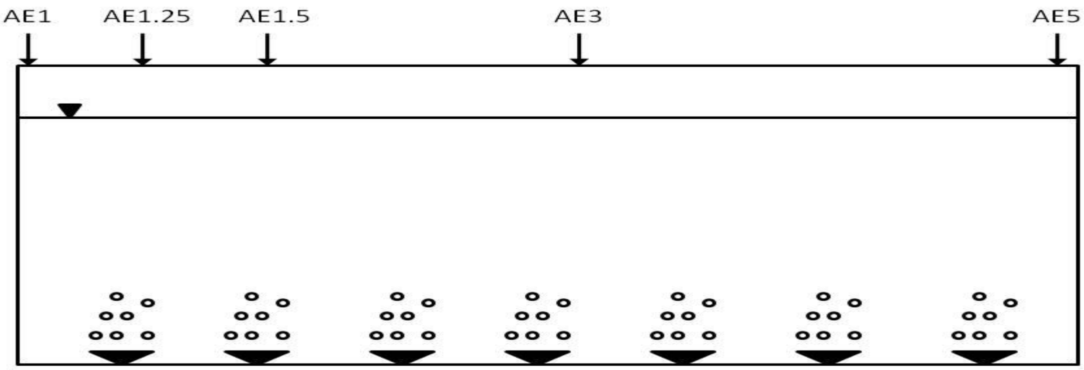


Figure 5.1 Aeration Tank Profile Sample Points

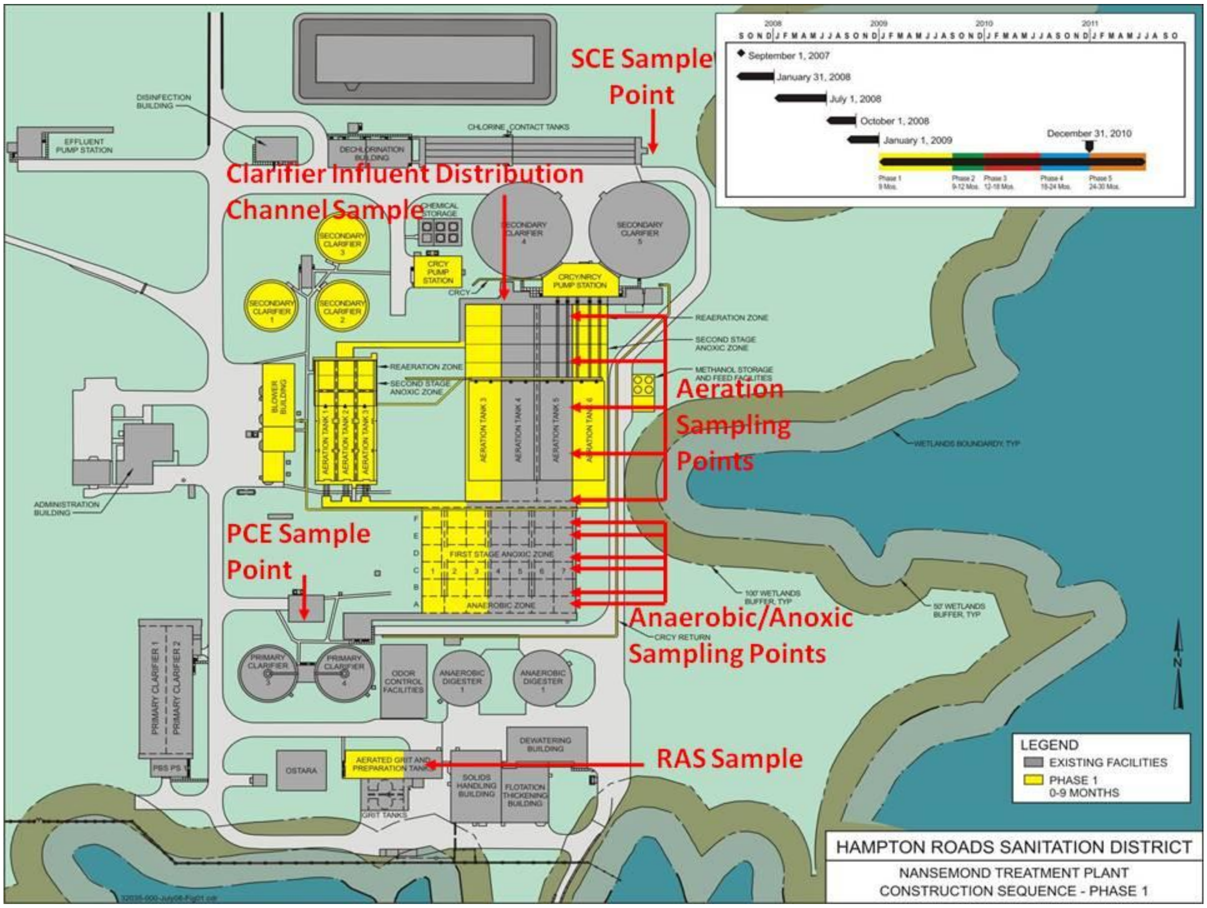


Figure 5.2 Profile Sampling Collection Points

As part of the process to stop nitrification, the nitrate recycle pump was also turned off converting all the anaerobic/anoxic cells to an anaerobic environment. Also due to upgrade efforts, the number of anaerobic/anoxic trains was reduced from 5 to 4 during the sampling period. This slightly changed the HRT in regards to sample collection; however, sample collection was still obtained based on the initial calculation of HRT from the start of the profile sampling. Profile sampling was conducted for a period of approximately 2 and half months until the plant stopped nitrifying.

5.2.1 Sample Preservation and Containers

After samples were collected and immediately filtered through 0.45μm membrane filters by vacuum pumps and associated filtration equipment they were placed into various containers for preservation before analysis. Table 5.2 provides a summary of the various containers, quantity of samples, and analysis methods which were used for the baseline profile sampling.

Table 5.1 Sample Preservation and Container Summary

Analysis Location:	NP	CEL	QA/QC by CEL
Sample Container	15 ml centrifuge tube	40 ml VOA vial + H_2SO_4	(1) 40 ml VOA vial (2) 40 ml VOA vial + H_2SO_4
Analytes	PO_4-P NH_4-N NO_3-N NO_2-N	sCOD	(1) PO_4-P NO_3-N NO_2-N (2) NH_4-N
Probe/Equipment	DO, pH		
No. Samples/week	15 x 2 = 30	15 x 2 = 30	2 x 2 = 4
No. Samples/month	120	120	16
Total No. Samples (duration of profiling)	480	480	64

Note: The CEL sample vial used for sCOD analysis could also be used for the QA/QC sample for NH_4-N analysis.

5.2.2 Analytical Methods

Sample analysis for profile sampling was conducted both on-site and off-site. Analytes measured at NTP for each profile include: PO_4-P, NH_4-N, NO_3-N, NO_2-N which were conducted using various HACH colorimetric test kits (see subsections 5.2.2.1 – 5.2.2.4) and a

HACH DR2800 spectrophotometer. Analysis of NO_2-N was performed the same day as sample collection, while analysis of PO_4-P, NH_4-N, and NO_3-N were conducted the following day. Samples were preserved by refrigeration overnight after NO_2-N analysis was complete. Off-site analysis by CEL consisted of soluble COD and quality assurance and quality control samples (QA/QC) of the same analytes measured on-site using *Standard Methods*.

5.2.2.1 Ammonia (NH_3-N) HACH Test Kit

Ammonia was analyzed using HACH Test N' Tube (TNT) 831 kit and HACH DR2800 spectrophotometer. This method uses the salicylate method, whereby ammonium ions react with hypochlorite and salicylate ions in the presence of sodium nitroprusside to as a catalyst form indophenol. The amount of color formed is directly proportional to the NH_4-N present.

5.2.2.2 Nitrate (NO_3-N) HACH Test Kit

Nitrate was analyzed using HACH TNT 835 kit. This kit incorporates the dimethylphenol method where nitrate ions in solution with sulfuric and phosphoric acids react with 2,6-dimethyphenol to form 4-nitro-2,6-dimethyphenol.

5.2.2.3 Nitrite (NO_2-N) HACH Test Kit

Nitrite was analyzed using NitriVer3 Nitrite Reagent Powder Pillows and 10 mL sample vials. This kit uses the diazotization method where nitrite in the sample reacts with sulfanilic acid to form a intermediate diazonium salt. This salt combined with chromotropic acid forms a pink color which is directly proportional to the amount of nitrite present.

5.2.2.4 Ortho-Phosphate (PO_4-P) HACH Test Kit

Ortho-Phosphate was analyzed using the HACH Reactive Phosphate TNT Reagent Kit. This test kit uses the USEPA-approved PhosVer3 method where orthophosphate reacts with molybdate in an acid to produce a mixed complex. Ascorbic acid then reduces this complex, producing an intense blue color.

5.2.3 Biowin Modeling Methodology

Modeling was performed using Biowin version 3.1, a biological wastewater treatment simulation package developed by EnviroSim Ltd (Flamborough, Ontario, Canada) and based on the IWA activated sludge models. Biowin was incorporated into this work to compare the data generated from the profile sampling with previous work performed by Hazen and Sawyer, P.C. (H&S). The Biowin model was calibrated using plant performance data from 7/23/09 to 11/5/09 period and previous simulation modeling work from H&S. Primary effluent wastewater fraction inputs for this work were derived from the NTP model created by H&S. The H&S NTP model was simulated with the raw influent characteristics that were generated from historical plant data and a two week special sampling study specified by H&S. The effluent data from the primary clarifier of this simulation was used to calculate wastewater fractions for the input of the simulation for the profile sampling work. Primary clarification was not simulated as part of this effort. Kinetic parameters such as maximum specific growth rate ($\mu_{max, AOB}$) and nitrite half saturation concentration were changed based on the work done by H&S in addition to changes made to fit the simulation model to the profile sampling data. A Garrett wasting configuration was incorporated to simplify modeling of secondary clarification (Figure 5.3), and the waste rate was then adjusted accordingly to match the solids wasted (lbs/day) from the plant performance data within a reasonable range. A Garrett wasting configuration directly wastes activated sludge from the aeration effluent, rather than wasting sludge from the secondary clarifier underflow (typical configuration). Diurnal load variations were not considered as part of this modeling.

Table 5.2 Biowin Influent Wastewater Fractions

Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	**0.310**
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.180**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.610**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.155**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.169**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.740**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.300**
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.030**
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.820**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	**0.009**
FZbh - Non-poly-P heterotrophs [gCOD/g of total COD]	0.000	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.000	0.0001
FZaob - Ammonia oxidizers [gCOD/g of total COD]	0.000	0.0001
FZnob - Nitrite oxidizers [gCOD/g of total COD]	0.000	0.0001
FZamob - Anaerobic ammonia oxidizers [gCOD/g of total COD]	0.000	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.000	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.000	0.0001
FZbam - Acetoclastic methanogens [gCOD/g of total COD]	0.000	0.0001
FZbhm - H2-utilizing methanogens [gCOD/g of total COD]	0.000	0.0001

5.2.3.1 Steady-State Simulation

Simulations were created for individual periods of the profile sampling as well as a simulation for the entire profile sampling period. Individual periods were created based on changes in mixed liquor suspended solids, changes in process; 5 anaerobic/anoxic trains to 4 anaerobic/anoxic trains; the Nitrate recycle (NRCY) being active and inactive, and the cease of nitrification. Steady-state simulations incorporated the use of constant input values. The entire profile sampling event was divided into 5 different periods and each period was modeled using steady-state conditions to calibrate the model except for the 4th period. Steady-state simulations were performed using the configuration shown in Figure 5.3.

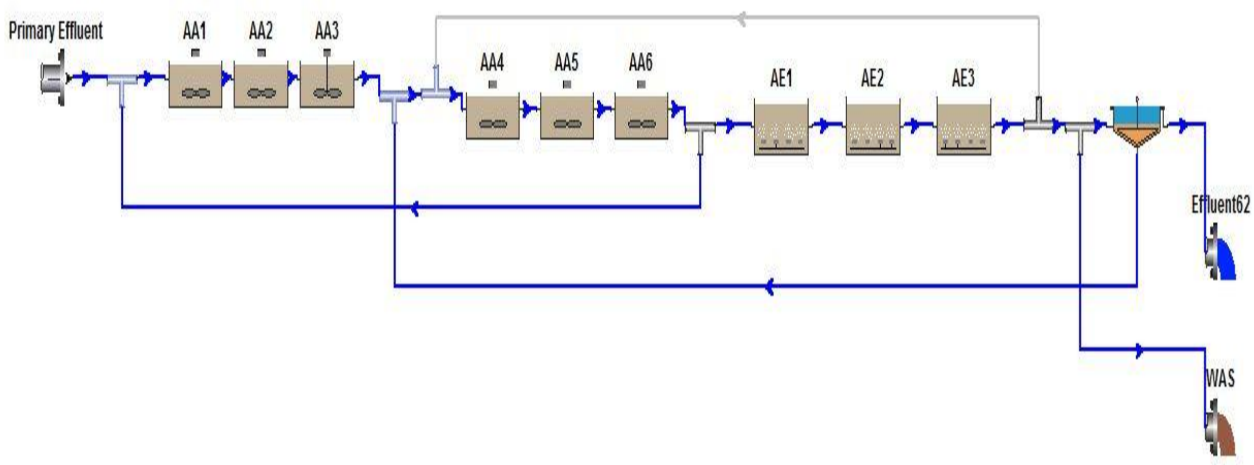


Figure 5.3 Biowin Simulation Model (Garrett Wasting Configuration)

5.2.3.2 Dynamic Simulation

Dynamic simulations were used to calibrate the model for the entire profile sampling event from start to finish. This required a reconfiguration of the model to account for dynamic simulation of one train being removed from service. This was done by creating a second anaerobic/anoxic train (train B) which only received 1/5 of the flow while the main train received 4/5 of the flow. During the period when all 5 trains were in operation the flow would be split to the 1/5 and 4/5 trains for a total of 5/5 (5 trains). Once the simulation reached the time period when one train was taken off-line, the simulation stopped the split of flow to train B (1/5) (Figure 5.4). This diverted all of the flow to the main anaerobic/anoxic train (4/5), simulating the system going from 5 to 4 anaerobic/anoxic trains. Dynamic simulations were first brought to steady-state using constant values from period 1 steady-state simulation and then simulated dynamically for the entire period. Itineraries for the various inputs were all based on plant performance data (WAS, NRCY, ARCY, RAS, Temperature, etc.).

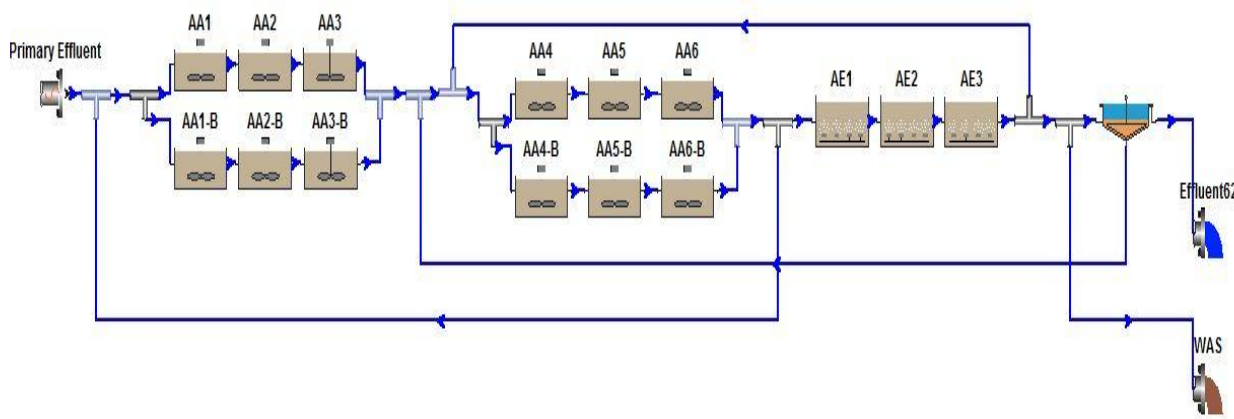


Figure 5.4 Biowin Model for Dynamic Simulation

5.3 Results and Discussion

5.3.1 Profile Sampling

During the start of the profile sampling, Anaerobic/Anoxic (AA) trains 3-7, Aeration Tanks (AE) 4 and 5, and Secondary Clarifiers 4 and 5 were being operated at NP. Based on daily plant data as of July 23, 2009, the average daily flow rate over the entire profile sampling period was 18.11 MGD (final effluent). There was one nitrate recycle (NRCY) pump active at a flow of approximately 19.5 MGD, the anoxic recycle (ARCY) flow was 19.0 MGD, and the clarifier recycle (RAS) flow for secondary clarifiers 4 and 5 was 5.7 MGD each. Traditionally NRCY rates tend to be two or three times the influent flow. However, since the plant only had one recycle pump running at a rate of about the average daily flow this suggests that denitrification performance in the anoxic tanks is limited by nitrate availability. The plant added ferric chloride on an as needed basis to the aeration basin when the effluent TP approached the treatment objective. The hydraulic retention times (HRT) at the flow during the initial profile sampling for the different treatment processes are presented in Table 5.4.

Table 5.3 Hydraulic Retention Times at Current Average Day Flow Rate

	No. Units	Vol. Each Unit	Total Vol.	HRT w/out Recycle	HRT w/Recycle	Cumm. HRT w/RCY
	In Service	[MG]	[MG]	[hr]	[hr]	[hr]
Anaerobic Cell 1	5	0.174	0.87	1.21	0.58	0.58
Anaerobic Cell 2	5	0.174	0.87	1.21	0.58	1.15
Anaerobic Cell 3	5	0.174	0.87	1.21	0.58	1.73
Anoxic Cell 1	5	0.174	0.87	1.21	0.31	2.04
Anoxic Cell 2	5	0.174	0.87	1.21	0.31	2.35
Anoxic Cell 3	5	0.174	0.87	1.21	0.31	2.66
Aeration Tank	2	2.7	5.4	7.50	2.69	5.35
Secondary Clarifier	2	2.25	4.5	6.25	3.77	9.11

Profiling sampling started July 7, 2009 and ended on November 5, 2009. The data collected during this time period provided an overview of a BNR process coming out of nitrification as the SRT was intentionally lowered to stop nitrification. Figures 5.5 and 5.6 provide an overview of the influent (primary effluent) and secondary effluent characteristics during the entire profile sampling period. NH_4-N and NO_x-N data demonstrate that the plant began to stop nitrifying in early October, as the NH_4-N increased and the NO_x-N decreased. There was an observed steady increase in the influent phosphate which was attributed to centrate from the centrifuges and filtrate from the gravity belt thickeners.

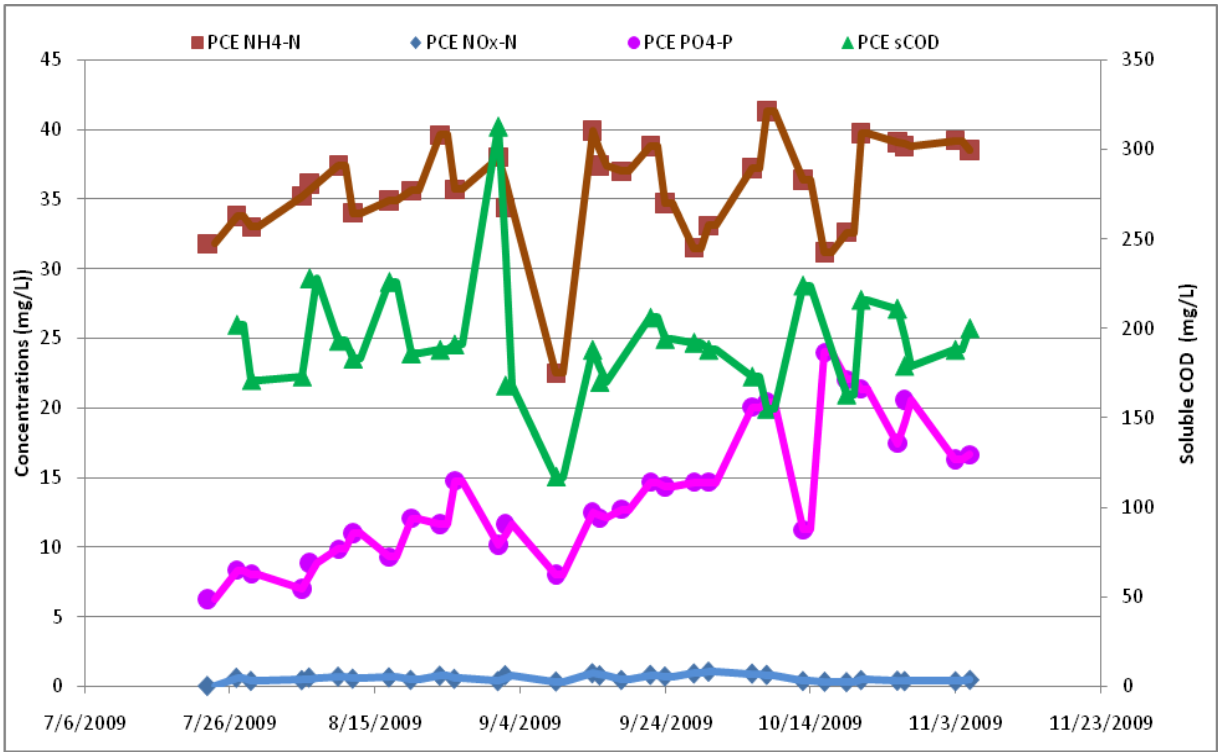


Figure 5.5 Influent Characteristics (Primary Clarifier Effluent – PCE)

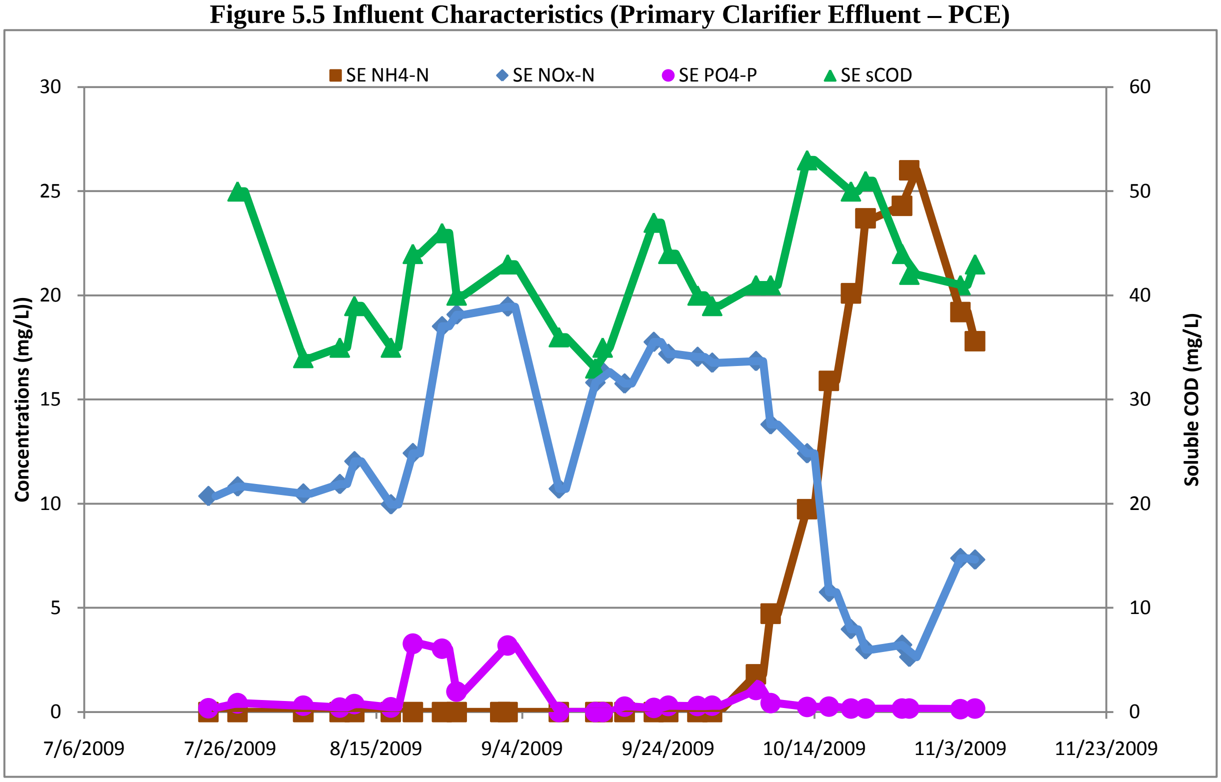


Figure 5.6 Secondary Effluent (SE) Characteristics

Profile sampling data were compared to the monthly plant performance data (composite samples) collected by HRSD. Results from the comparison proved to be very similar (Figure 5.7). This similarity supports the accuracy of the profile sampling data and the use of this data as a means for modeling nitrification performance to determine a maximum specific growth rate (μ_{max}) for AOB to compare to design μ_{max} used for the upgrade of the facility.

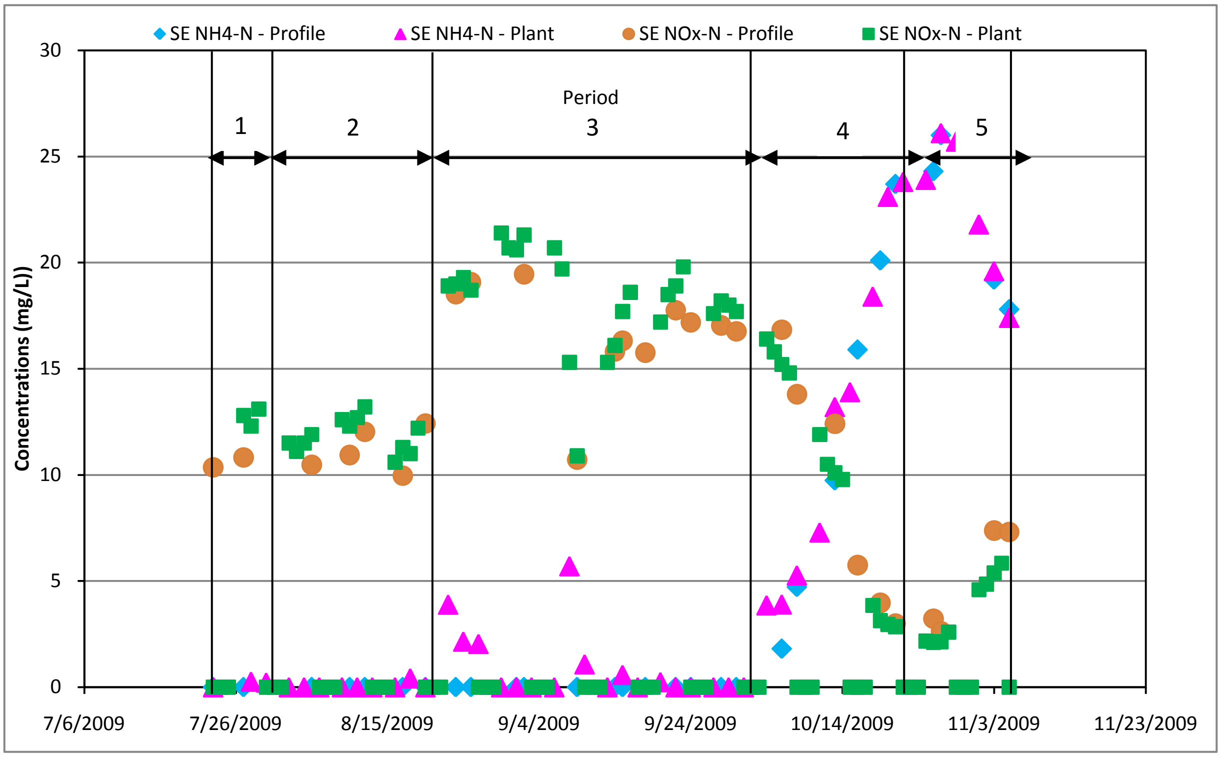


Figure 5.7 Comparison of Profile to Plant Performance Data

Temperature was very consistent from day to day sampling (Figure 5.8). It was observed that temperature slowly decreased as the weather changed. The coldest temperature that was observed was 22.5°C in November. Figure 5.9 demonstrates the relationship between the WAS rate and the SRT. It was observed that as the SRT was reduced throughout the profile sampling, the WAS rate correspondingly increased, until nitrification began to fail. At this point, the SRT was increased once again and the WAS decreased. The mixed liquor suspended solids (MLSS) data are consistent with the WAS and SRT data (Figure 5.8). Figure 5.10 was generated to show the correlation between AOB washout SRT as a function of temperature assuming DO and pH were not limiting. The μ_{max} values used for calculating the AOB washout SRT were 0.90, 0.70, 0.60, and 0.50 day^{-1} (see equation (1) below). Figures 5.8 showed that nitrification began to fail around a temperature of 22°C and based on Figure 5.9 the SRT during this failure was approximately 3 to 4 days. Based on the AOB washout SRT curve, at a temperature of 22°C, the μ_{max} which predicted an SRT in the range of 3 to 4 days was approximately 0.45 to 0.41 day^{-1} based on equation (2) below. In calculating the above approximately μ_{max} for AOB an SRT of 3.5 days was used at a temperature 22°C. The calculated value suggested that the approximate range of μ_{max} for AOB to be between 0.40 – 0.60 days^{-1}.

$$SRT = \frac{1}{\left(\mu_{max} \bullet \theta_{max}^{T-20}\right) - \left(b_i \bullet \theta_i^{T-20}\right)} \tag{1}$$

$$\mu_{max} = \frac{\frac{1}{SRT} + \left(b_i \bullet \theta_i^{T-20}\right)}{\theta_{max}^{T-20}} \tag{2}$$

Where:

SRT = solids retention time

μ_{max} = maximum specific growth rate

θ_{max} = Arrhenius temperature coefficient for growth

b_i = decay rate

θ_i = Arrhenius temperature coefficient for decay

T = temperature

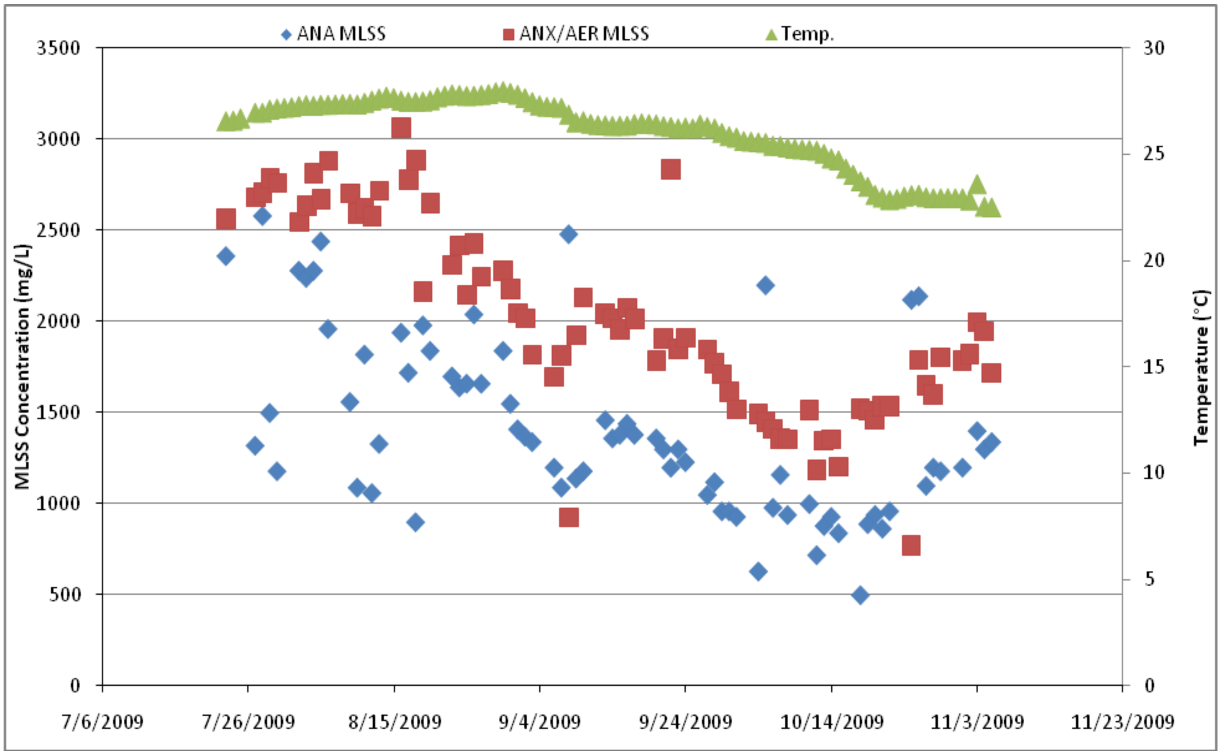


Figure 5.8 Mixed Liquor Suspended Solids (MLSS) and Temperature During Profile Sampling

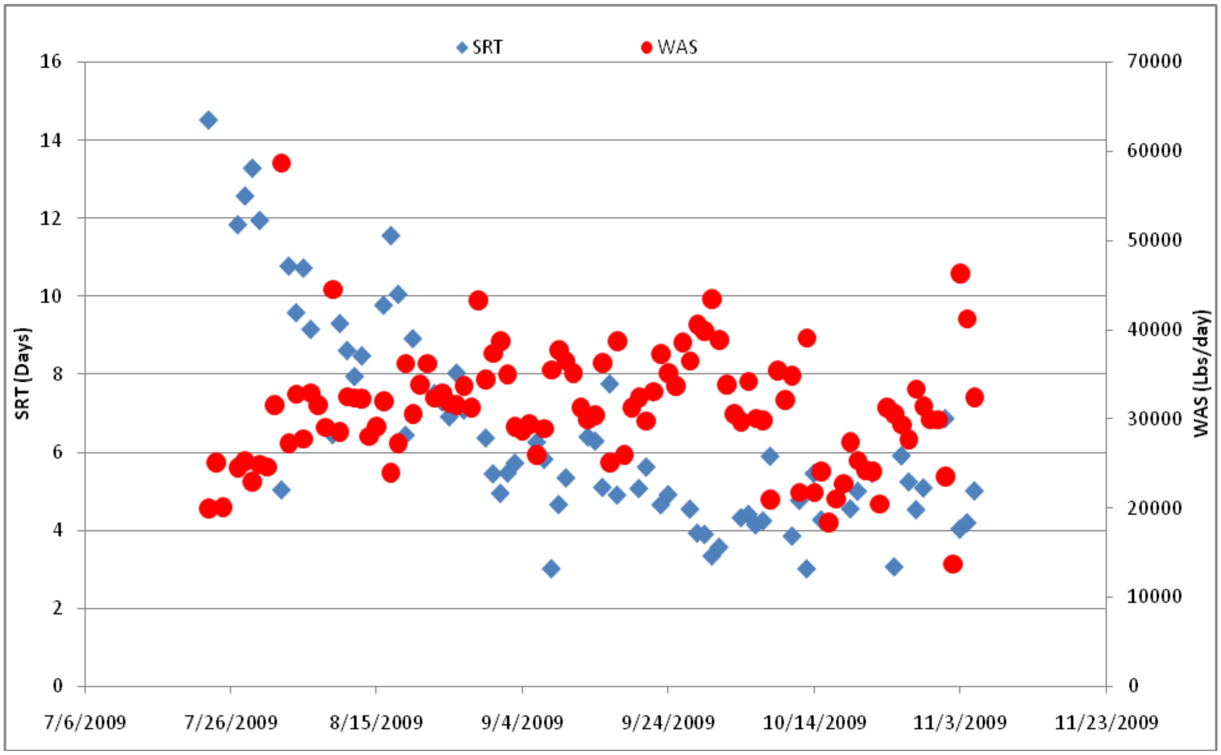


Figure 5.9 WAS and SRT During Profile Sampling

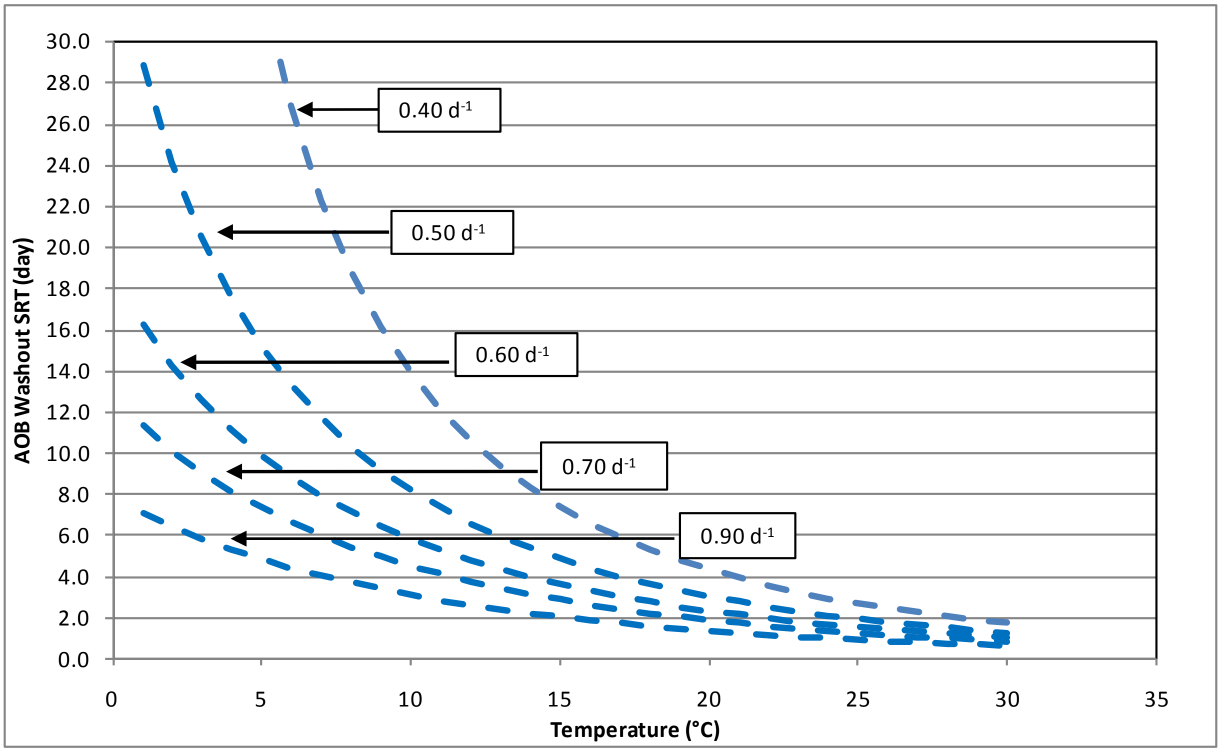


Figure 5.10 AOB Washout SRT as a Function of Temperature - μ_{max} = 0.40 to 0.90 days^{-1}.

Profile sampling data were also used to calculate ammonia uptake rates (AUR), specific ammonia uptake rates (SAUR), nitrate production rates (NPR), and specific nitrate production rates (SNPR). Slope regressions were performed of ammonia and nitrate concentrations over the hydraulic residence time (HRT) in the aeration tanks to determine uptake and production rates. In order to calculate the specific rates, the AUR and NPR were normalized to the mixed liquor volatile suspended solids (MLVSS). Nitrification performance was stable and rates were increasing until the SRT was purposely reduced to stop nitrification. This loss of nitrification was observed in the specific rates as time progressed from the start of the profile sampling to the end (Figure 5.11).

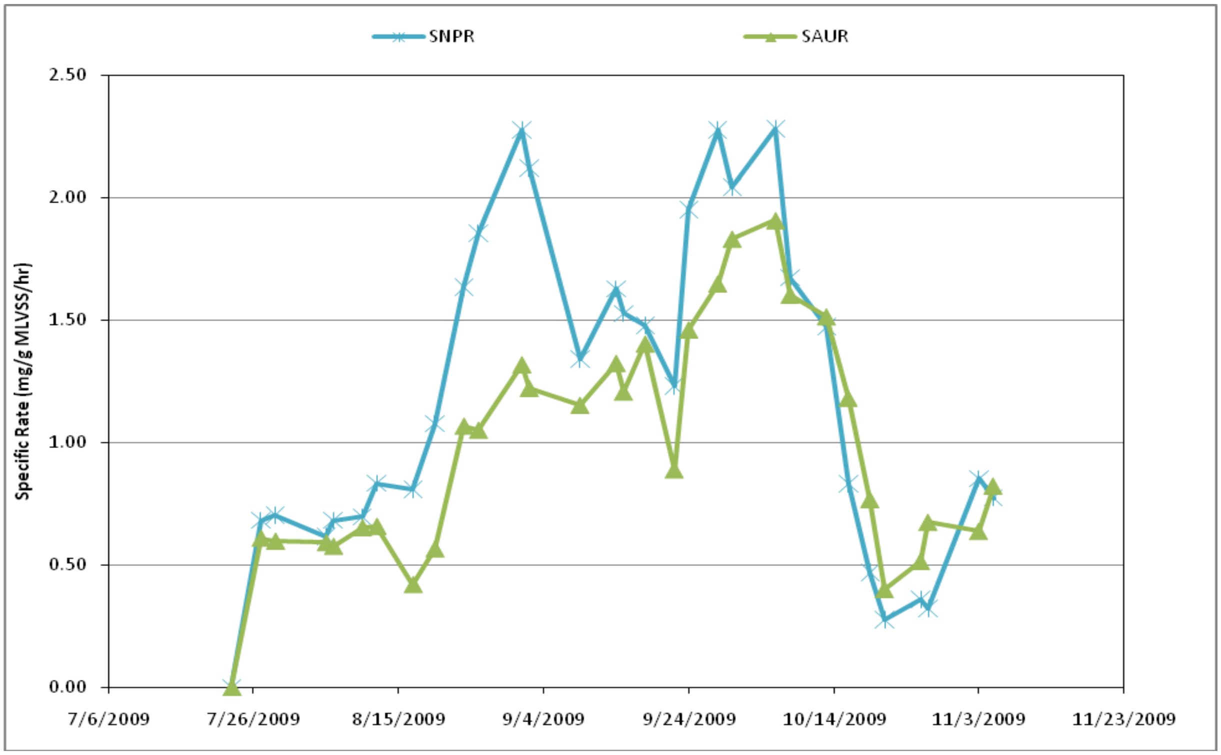


Figure 5.11 Specific Ammonia Uptake Rate (SAUR) and Specific Nitrate Production Rate (SNPR)

It was of interest to evaluate the potential for nitrite accumulation in the process and its potential effect on aerobic phosphate uptake by PAOs. Figure 5.12 shows aerobic nitrite concentration over the profile sampling period. The data shown represent individual profile experiments that were representative of the sampling period as a whole. It was evident that nitrite was present and accumulated to some degree as nitrification stopped. Although this was true, Figure 5.13 shows continued uptake of phosphate in the aerobic zone even after nitrification had stopped.

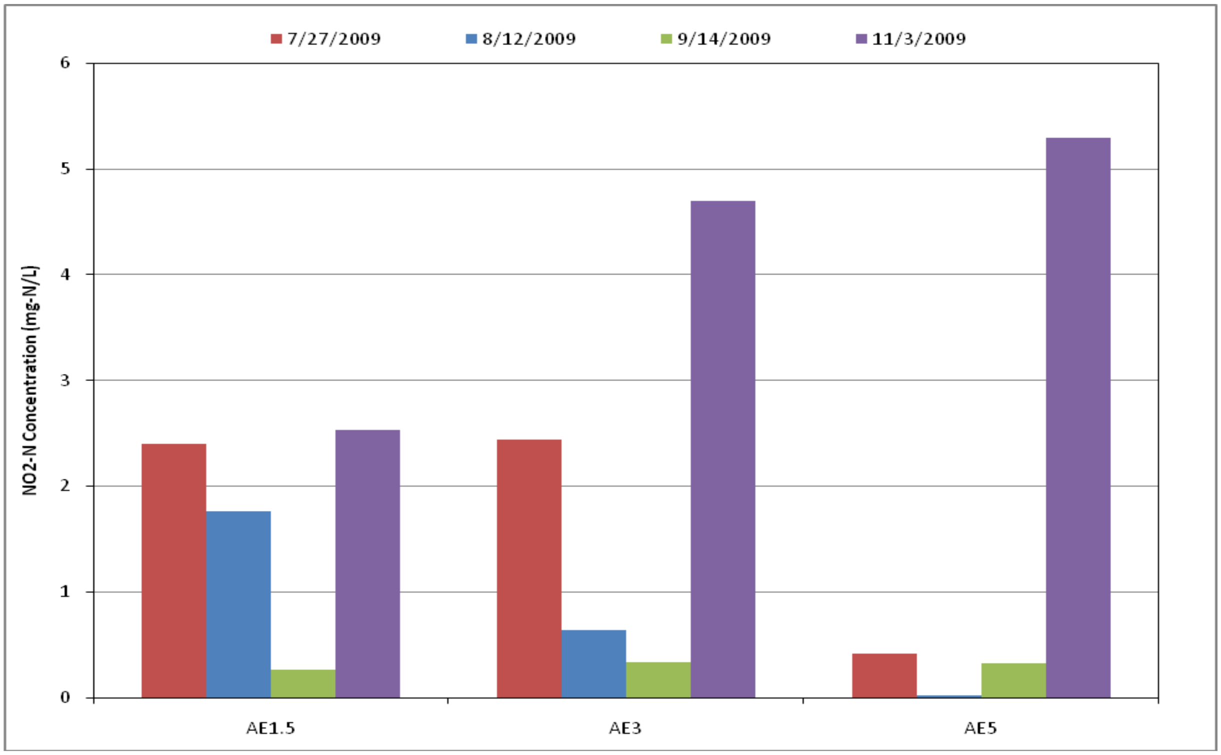


Figure 5.12 Aerobic NO_2-N Concentrations

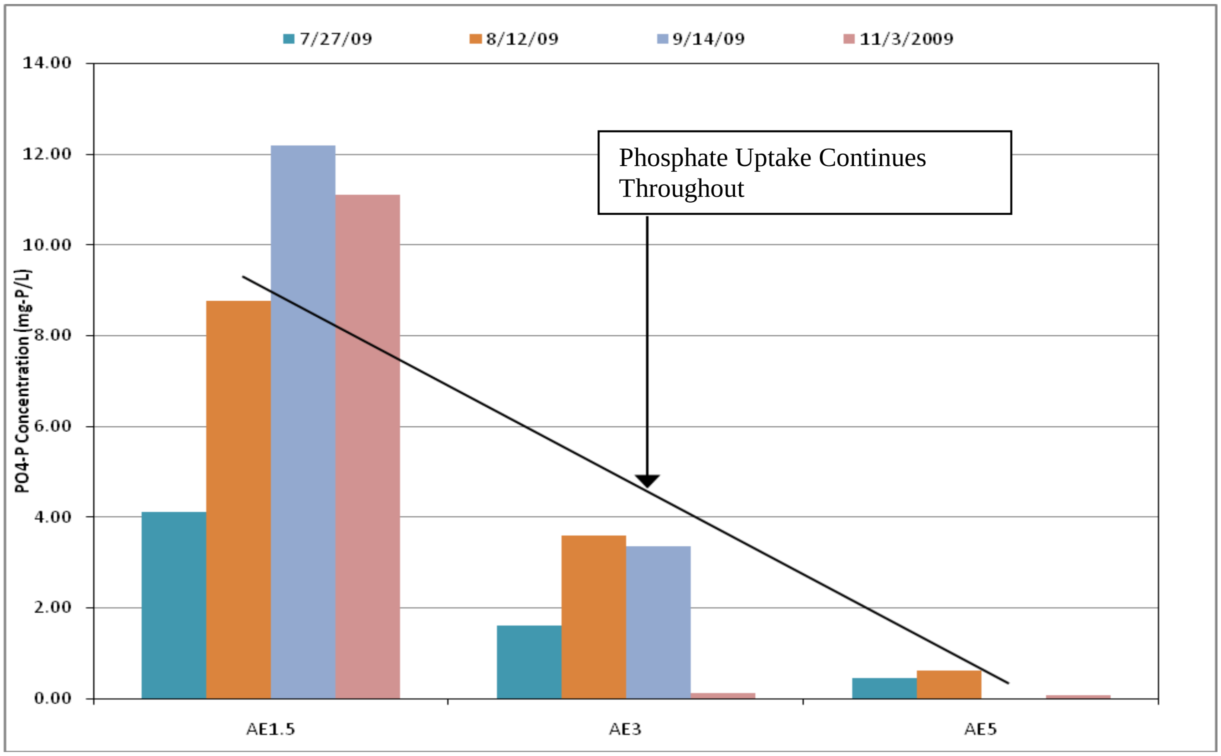


Figure 5.13 Aerobic PO_4-P Uptake

Data for late September and most of October were not shown on these figures due to the variability of this time period. Between September 30 and October 21 nitrification rates began to decrease and eventually ceased in late October/early November. This period of time was evaluated independently; however, aerobic phosphate uptake continued throughout the period of time when nitrification stopped (Figure 5.14). This suggested that there was no significant effect of nitrite accumulation on the aerobic phosphate uptake.

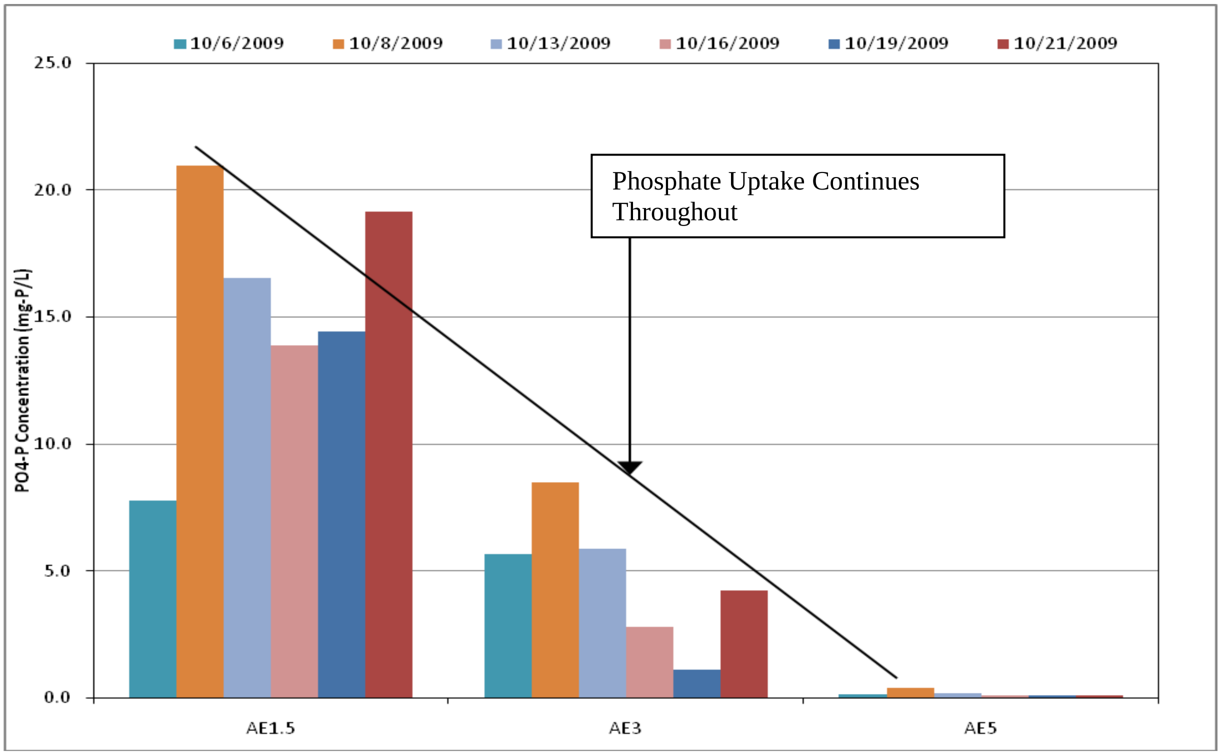


Figure 5.14 Aerobic PO4-P Uptake (10/6/09 - 10/21/09)

Ferric chloride was sporadically added during certain periods of the profile sampling to prevent effluent TP exceedances. Table 5.4 shows the dates during the profile sampling period in which ferric chloride was added to assist in TP removal. During these dates there was no observed change in nutrient profiles between days with and without the addition of ferric chloride. This suggested that there was no significant impact of ferric chloride on nitrogen removal.

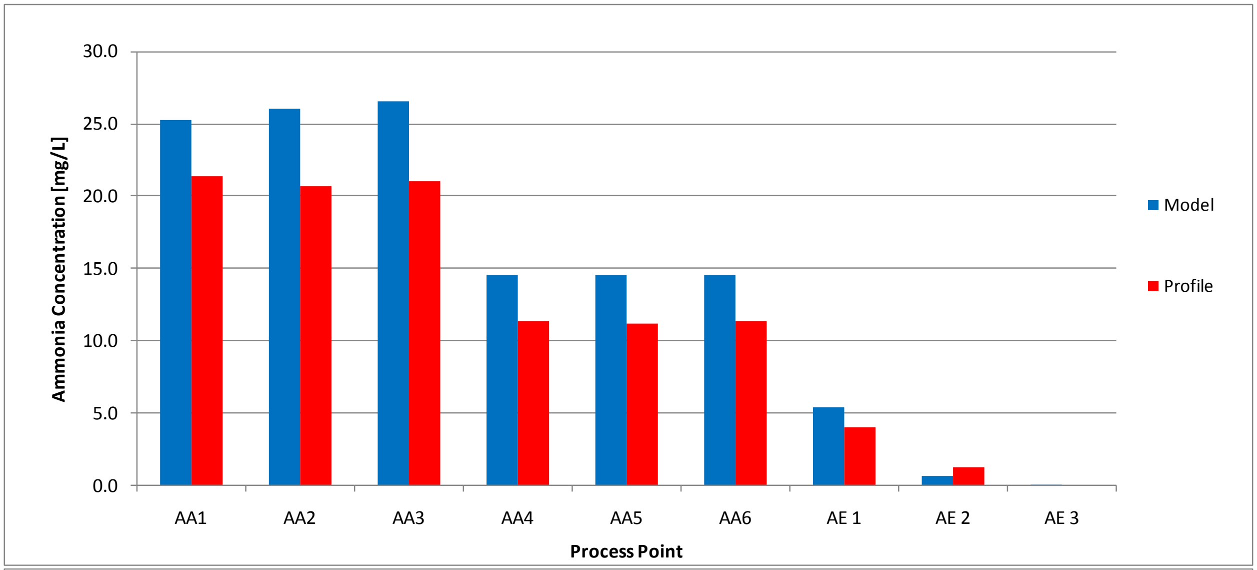
Table 5.4 Wastewater Characteristics during Ferric Chloride Addition

		MLSS		SE Chem. Addition		SC EFF	FIN EFF	FIN EFF	FIN EFF	FIN EFF
	WAS	ANA	ANX/AER	Chem	Dose	NH3	NOx	T-N	T-P	OPO4
Date	[lbs/day]	[mg/L]	[mg/L]	Type	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
7/23/09	19957	2360	3940	Fe3	4.00	< 0.20				
7/24/09	25136			Fe3	4.84					
7/25/09	20080			Fe3	2.46					
7/26/09										
7/27/09	24512	1320	4060				12.8	15.4	0.55	0.258
7/28/09	25240	2580	4100			0.26	12.3	15.3	0.54	0.395
7/29/09	22932	1500	4220				13.1	15.6	0.49	0.334
7/30/09	24902	1180	4180			0.22				
7/31/09	24585									
8/22/09	36228									
8/23/09	32336	1700	3120			3.89	18.9	21.1	2.79	2.51
8/24/09	32935	1640	3180				19	21.1	1.71	1.54
8/25/09	31741	1660	2860	Fe3	0.02	2.15	19.3	21.4	0.96	0.74
8/26/09	31562	2040	3280	Fe3	0.02		18.7	21.9	0.85	0.578
8/27/09	33687	1660	3160	Fe3	0.02	2.04				
8/28/09	31233									
8/29/09	43327									
8/30/09	34395	1840	3160			< 0.20	21.4	23.5	2.18	1.9
8/31/09	37346	1550	2980				20.7	22.8	3.08	2.59
9/1/09	38706	1410	2800			< 0.20	20.6	22.4	2.93	2.73
9/2/09	34972	1370	2800				21.3	23.3	4.06	3.52
9/3/09	29091	1340	2420			< 0.20				
9/4/09	28724									
9/5/09	29398			Fe3	8.17					
9/6/09	25968	1200	2320	Fe3	8.62	< 0.20	20.7	22.1	0.69	0.514
9/7/09	28892	1090	2480	Fe3	8.17		19.7	22.3	0.67	0.399
9/8/09	35490	2480	1100	Fe3	6.16	5.7	15.3	21.0	0.63	0.277
9/9/09	37745	1140	2600	Fe3	5.08		10.9	13.2	0.44	0.092
9/10/09	36473	1180	2880	Fe3	2.07	1.08				
9/11/09	35126									
9/12/09	31251									
9/13/09	29903	1460	2760			< 0.20	15.3	16.9	0.48	0.21

5.3.2 Biowin Modeling

5.3.2.1 Steady-State Simulations

Model calibration was first conducted for periods 1, 2, 3, and 5 using steady-state conditions. Periods 1, 2, 3, and 5 are individual time periods during the profile sampling where MLSS, SRT, primary effluent TKN, and other wastewater characteristics were similar in value (refer to Figure 5.7). The results presented from the steady-state calibration were comparable to actual profile and plant performance data in regards to nutrient and specific rate profiles (Figures 5.15 – 5.19). The results suggested that modeling kinetics were similar in value to the actual observed.



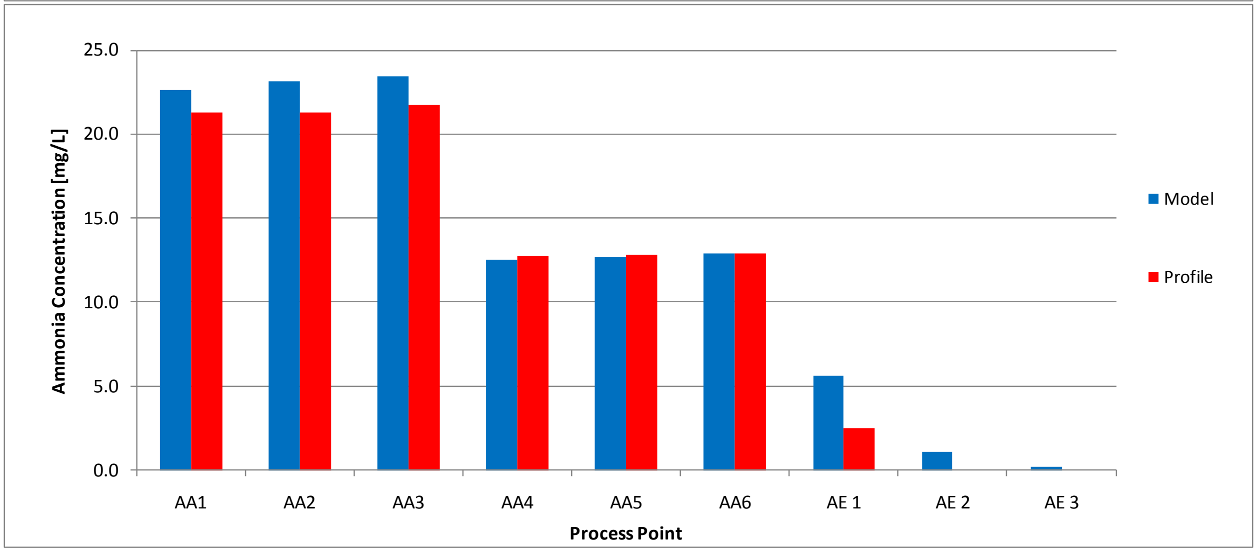


Figure 5.15 Ammonia Comparisons for Period 1-Top (7/23/09 – 7/31/09) & 2-Bottom (8/1/09 – 8/21/09)

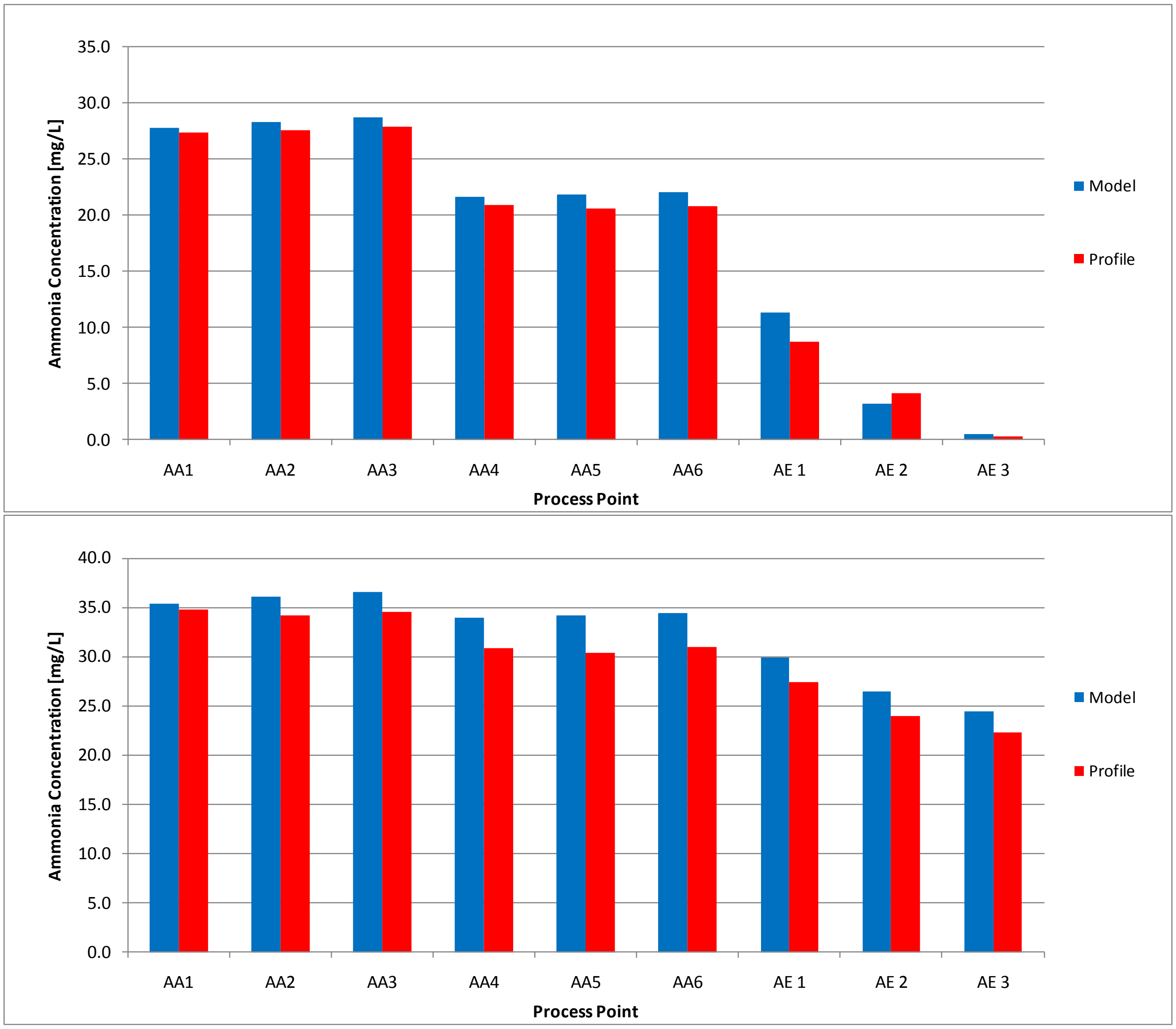


Figure 5.16 Ammonia Comparisons for Period 3-Top (8/22/09 – 10/2/09) & 5-Bottom (10/23/09 – 11/5/09)

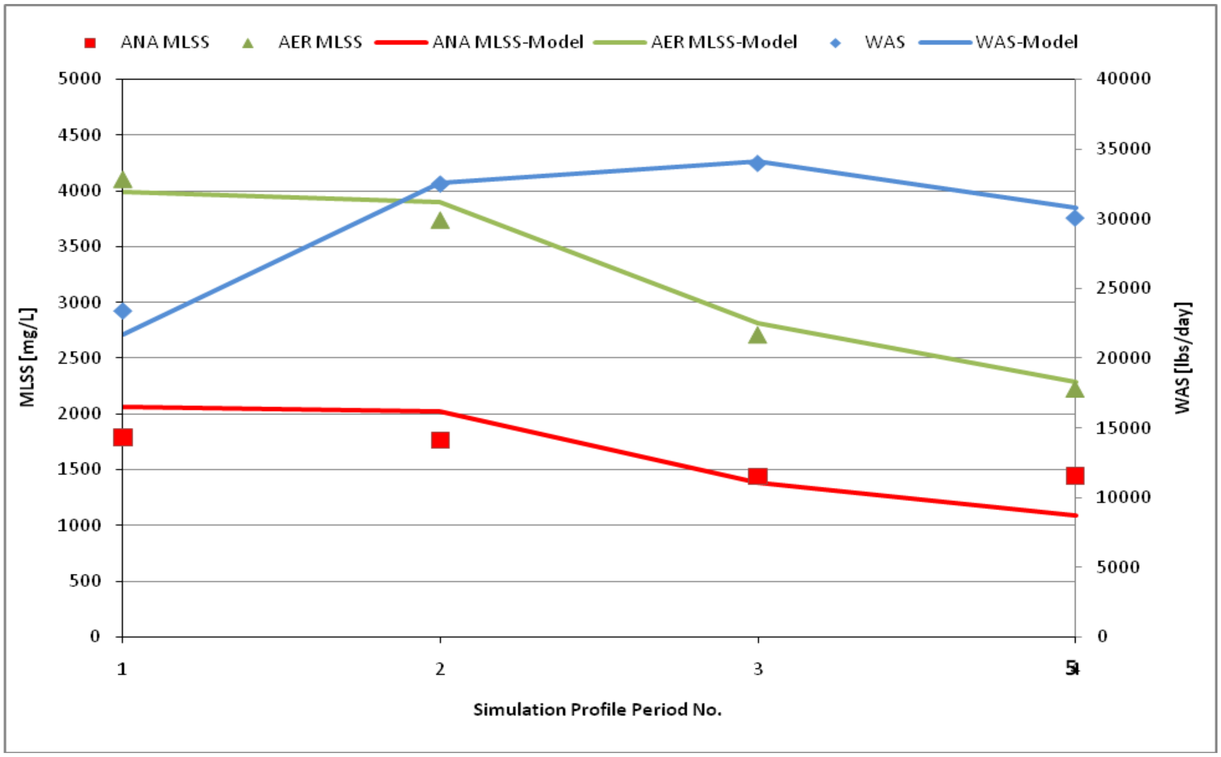


Figure 5.17 Mixed Liquor and WAS Comparison for Periods 1, 2, 3, and 5

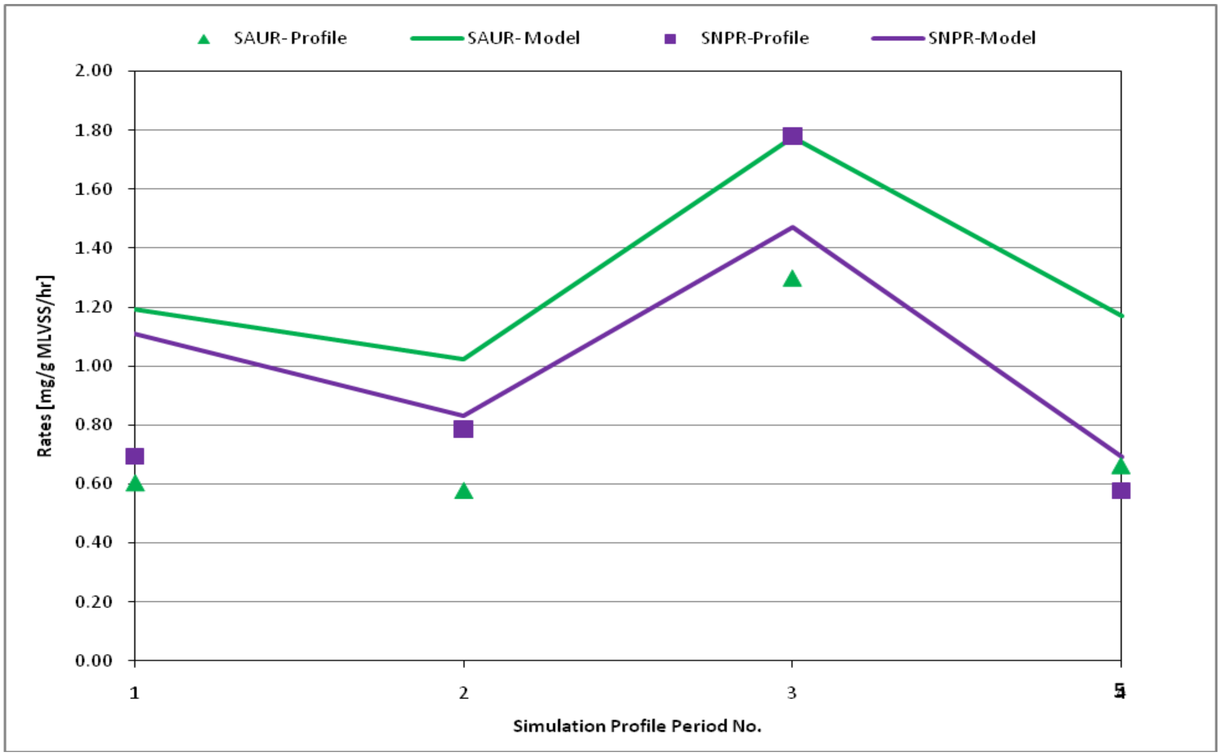


Figure 5.18 Nitrification Rate Comparisons for Periods 1, 2, 3, and 5

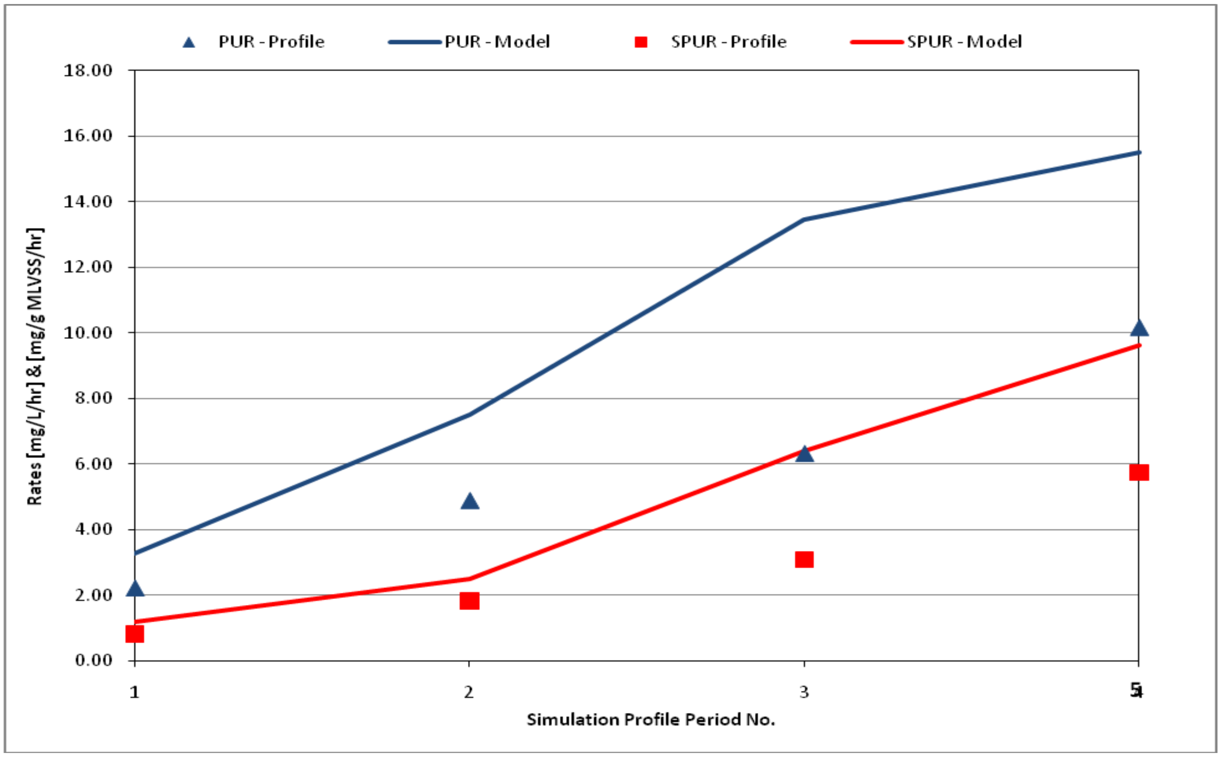


Figure 5.19 Phosphate Uptake Comparisons for Periods 1, 2, 3, and 5

Although similar, the specific rates calculated from the model were generally greater than what was actually observed. This suggested either that the model predicted better performance than the observed rates or the calibration was off, thus creating the differential.

5.3.2.2 Dynamic Simulations

Dynamic simulation generated similar results to profile and plant performance data; however, some of the data were not matched perfectly to the actual observed data. Period 4 (10/3/09 to 10/22/09) was modeled dynamically, as well, since it was the period where nitrification rates declined ; however, the model could not be calibrated properly for this period alone. It was speculated that periods of high PE COD and TKN caused by removing primary clarifiers from service, which were not captured by the WAS and SRT, were the main cause of the offset between the model and the observed data. Due to the high COD and TKN during this period, the MLSS concentrations in the reactors increased; however, the plant data suggested a decline in the WAS rather than an increase. The model continued to match the SRT, but the WAS and MLSS were not well correlated due the high PE COD and TKN (Figure 5.20). The figure demonstrated the offset between the model and observed plant data. The model, in the case of all the nutrients, failed to match the observed data and constantly over predicted the effluent concentrations. There were also unknown spikes observed starting at 10/14/09 believed to be caused by the high PE COD and TKN.

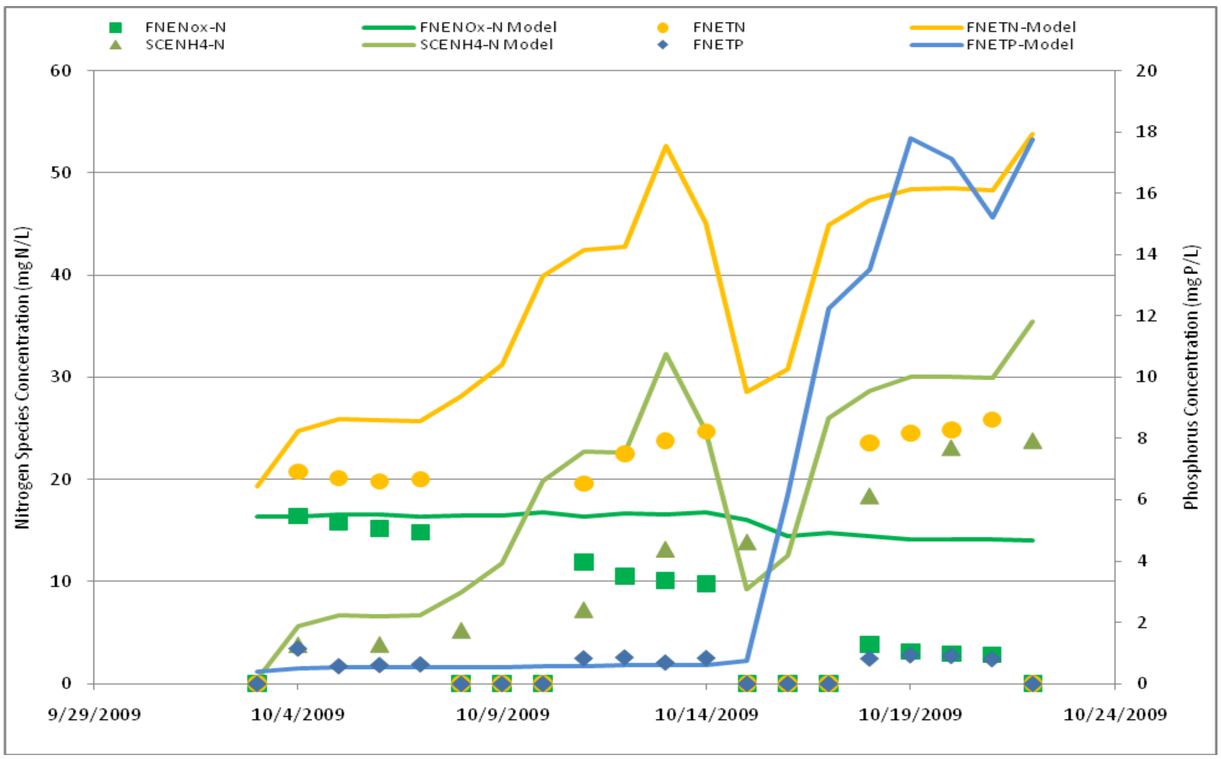


Figure 5.20 Nutrient Profile of Period 4 Dynamic Simulation

Therefore, instead of modeling period 4 separately, dynamic simulations of the entire profile sampling period were developed. There were noticeable differences between the model and observed data during the period from 10/3/09 to 10/22/09 for NH_4-N, NO_3-N, MLSS, SRT, and WAS (Figure 5.21, 5.22, 5.23, 5.24). From 7/23/09 to 10/2/09 MLSS slowly decreased as the plant reduced the SRT, thus increasing the WAS. The model followed this pattern until approximately 10/3/09. After this point, it was noted that the model SRT continued to match the plant SRT; however, large differences were observed between the MLSS and WAS in comparison to plant data. Nutrient profiles behaved similarly as they initially matched plant data and then a large variation was seen. These unknown spikes predicted by the model in solids wasting, mixed liquor, and nutrient concentrations were not observed in the actual profile and plant data. The model also continued to predict failure of nitrification sooner than the actual data, which was followed by a steady recovery. It was suspected that the origin of the issue was input data taken from the plant, as there was a large increase in the inorganic suspended solids and total kheldajl nitrogen (TKN) casued by removing primary clarifiers from service.

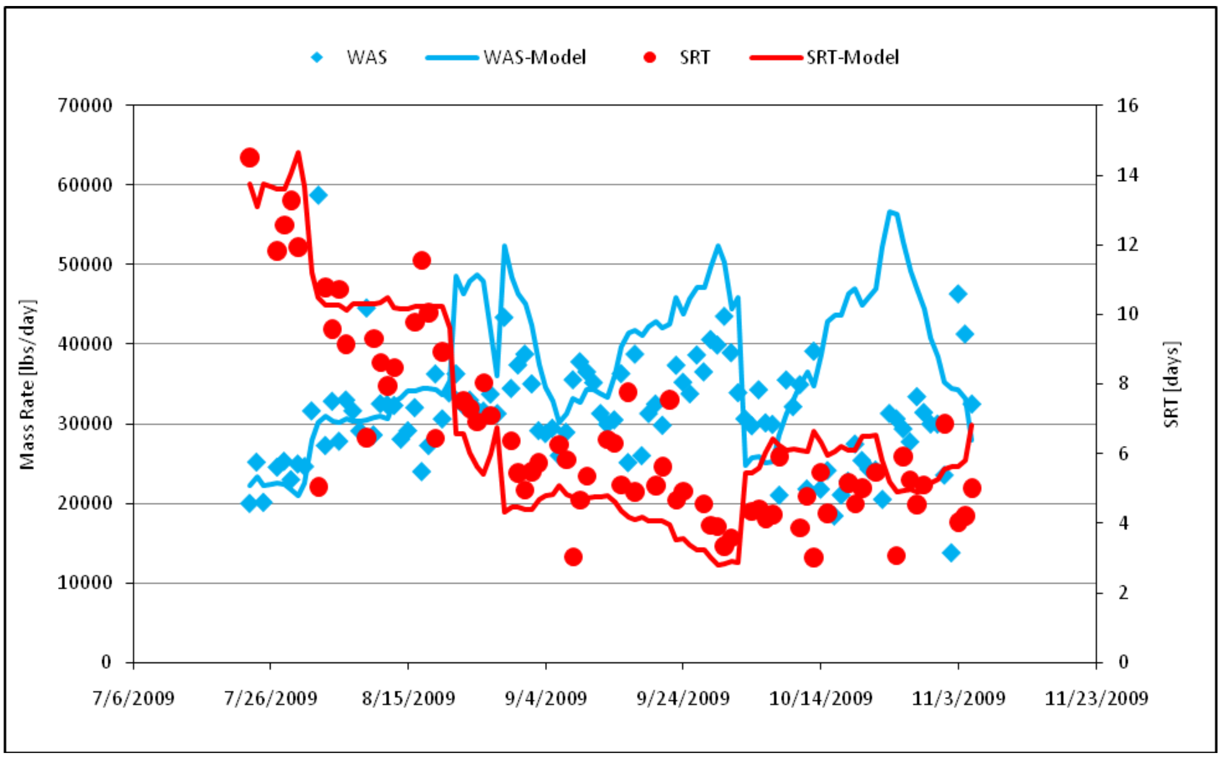


Figure 5.21 Comparison of WAS and SRT Plant Data to Model Data – μ_{max} = 0.62days^{-1}

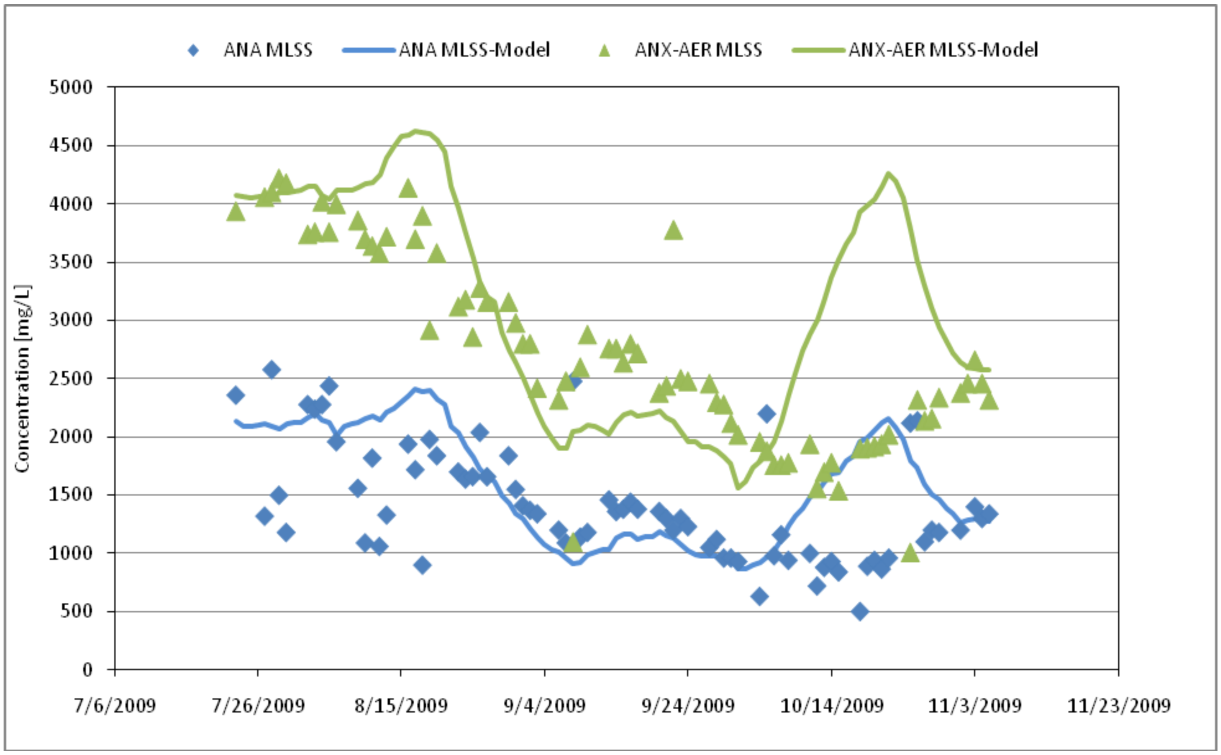


Figure 5.22 Mixed Liquor Suspended Solids Comparison – μ_{max} = 0.62days^{-1}

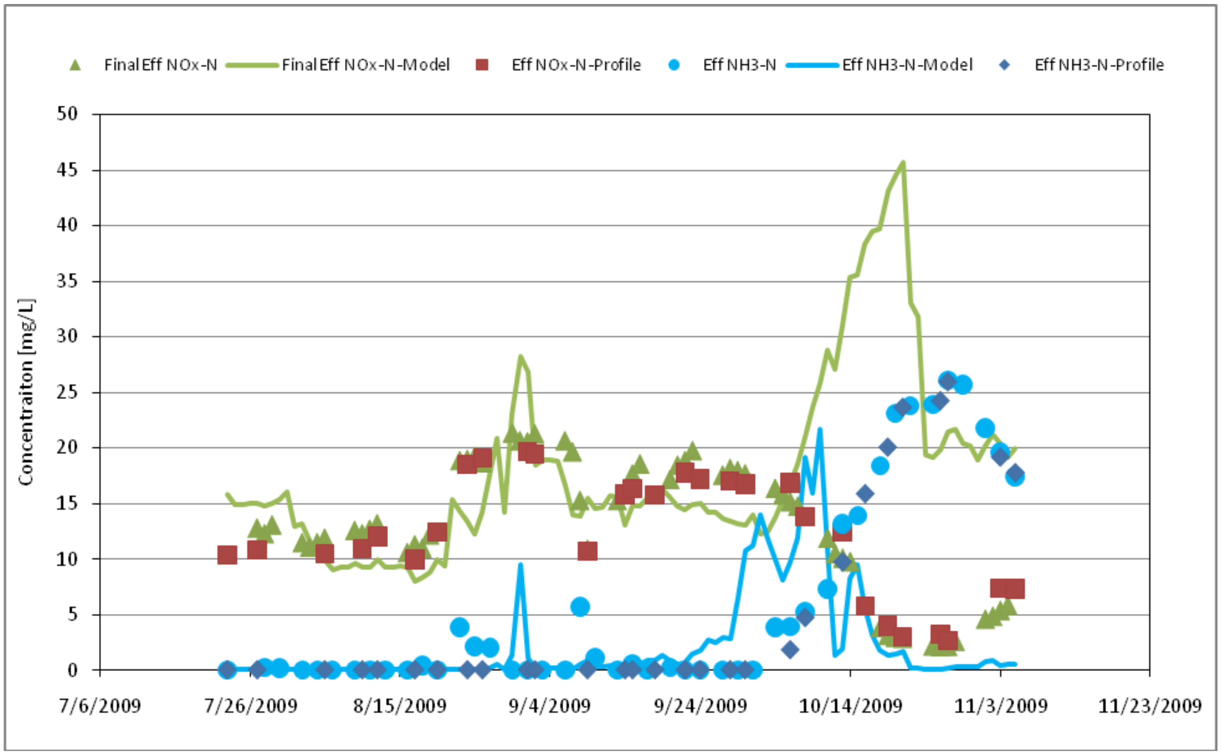


Figure 5.23 Final Effluent Nitrogen Species Comparison – μ_{max} = 0.62days^{-1}

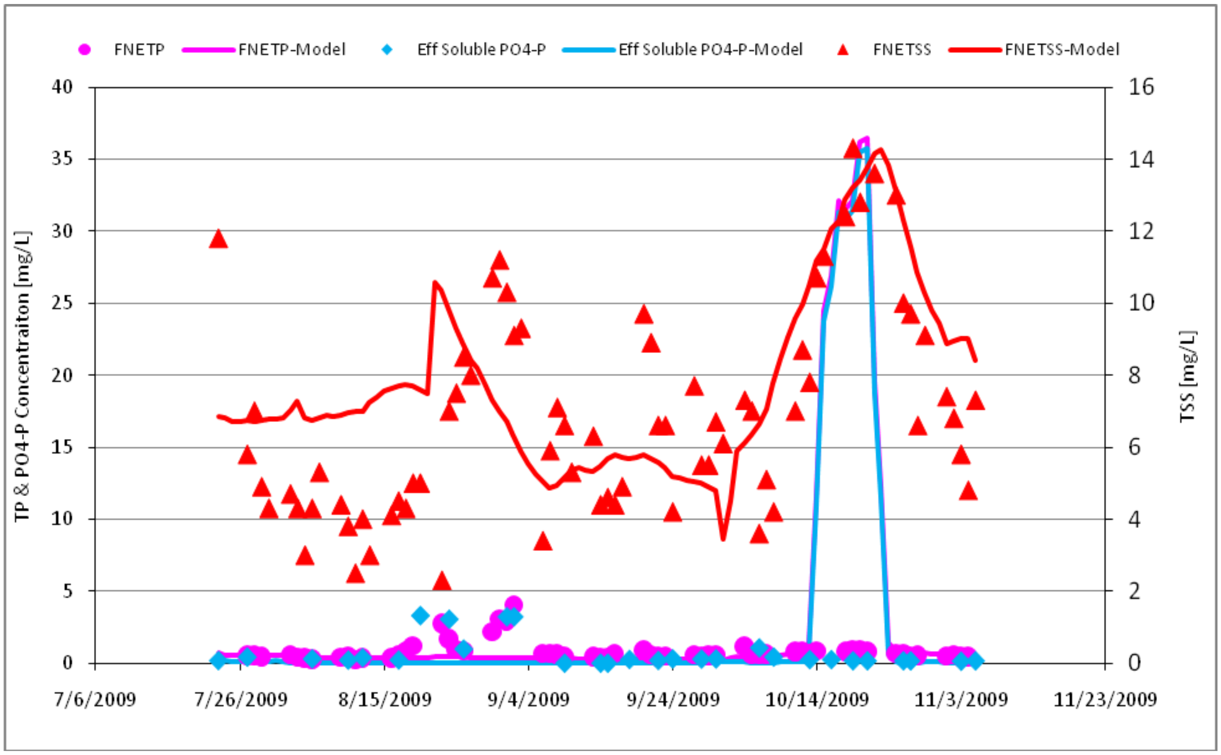


Figure 5.24 Final Effluent TP / TSS and Secondary Effluent ortho-Phosphate Comparison – μ_{max} = 0.62days^{-1}

Profiles of the secondary effluent ammonia concentration across the BNR process for certain dates demonstrated similar trends (Figure 5.25). The model and profile data were comparable until about 10/3/09 when a reduction in nitrification performance was observed. At this point the model predicted nitrification failure sooner than the observed data and then recovery.

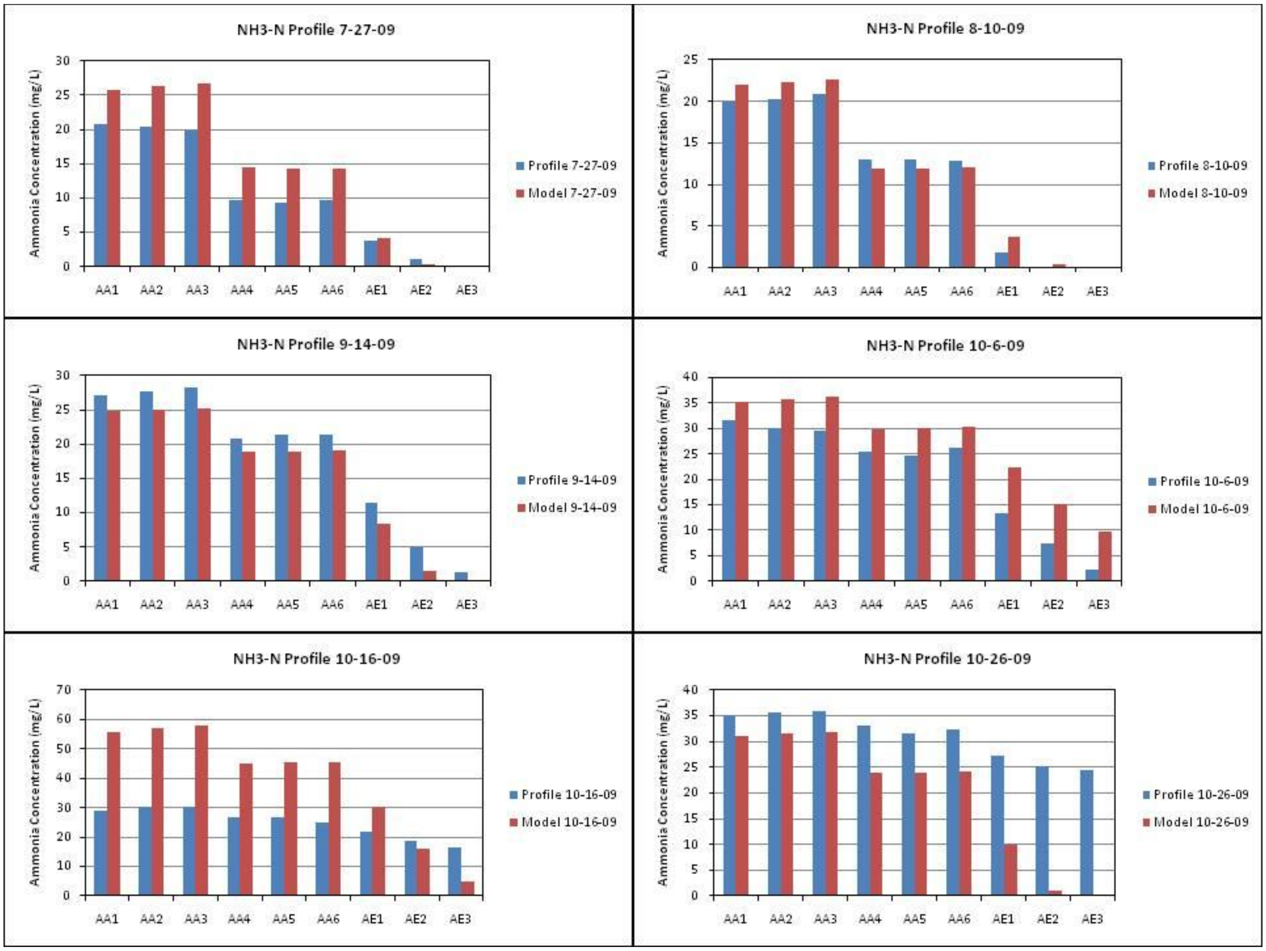


Figure 5.25 Ammonia Comparisons across BNR Process

Biowin modeling suggested that nitrification would stop sooner than what the actual profile data showed. The plant had intentionally stopped the NRCY and reduced the SRT to stop nitrification; however, the plant continued to nitrify for several more weeks.

Modeling provided a means of comparing the actual observed μ_{max} for AOB to the original design μ_{max}. The AOB μ_{max} value used for design was 0.57 days^{-1}. Modeling was carried out using various μ_{max} values to determine which value best fit the profile and plant data. Despite the variation between the model and the observed, the modeling suggested an approximate μ_{max} value close to a value in the range of 0.50 to 0.60 days^{-1} (Figure 5.26 and 5.27). The suggested range of μ_{max} values was determined based on the effluent NH_4-N and NOx-N comparisons between generated data from Biowin and profile data. Although Biowin continued to show failure of nitrification to occur sooner than the profile data, simulations generally followed the pattern that was seen in the profile data. Diurnal load variations were not considered as part of the modeling. This suggested that the actual in situ μ_{max} for AOB might be slightly greater than the projected μ_{max}. Regardless, it appeared that the suggested μ_{max} value and the original design value were similar.

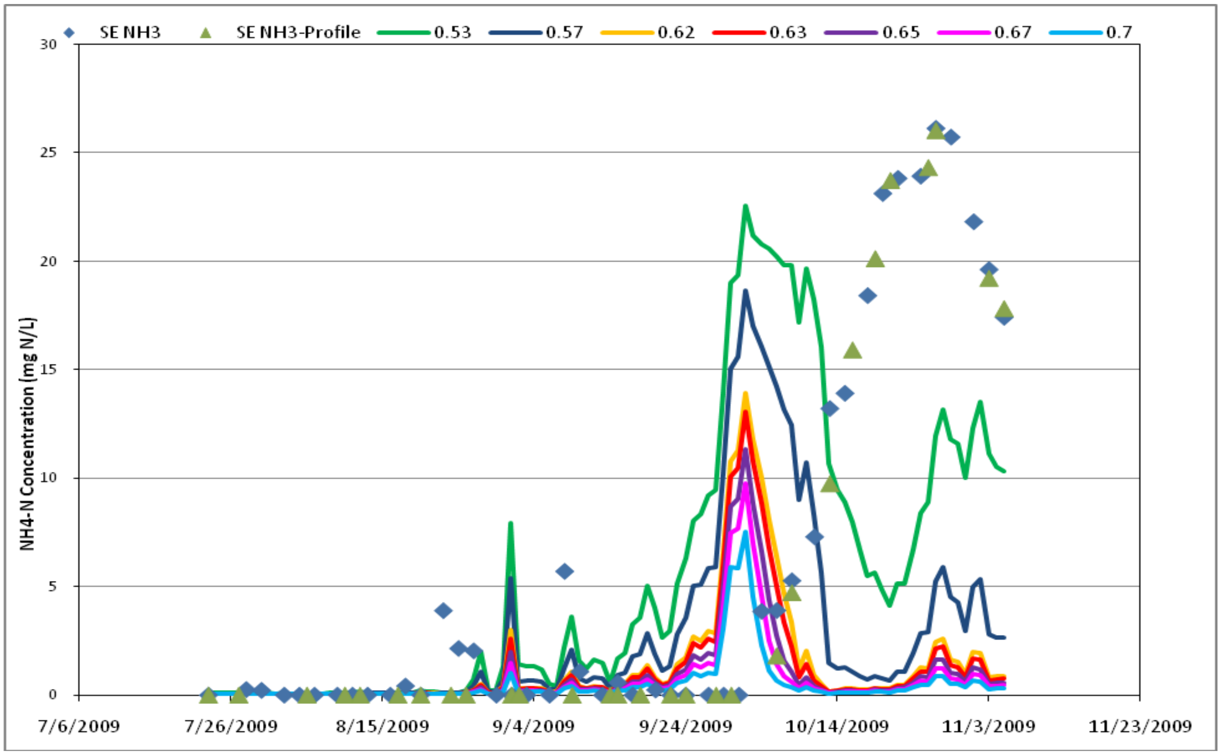


Figure 5.26 Comparison of μ_{max} for AOB to NH_4-N

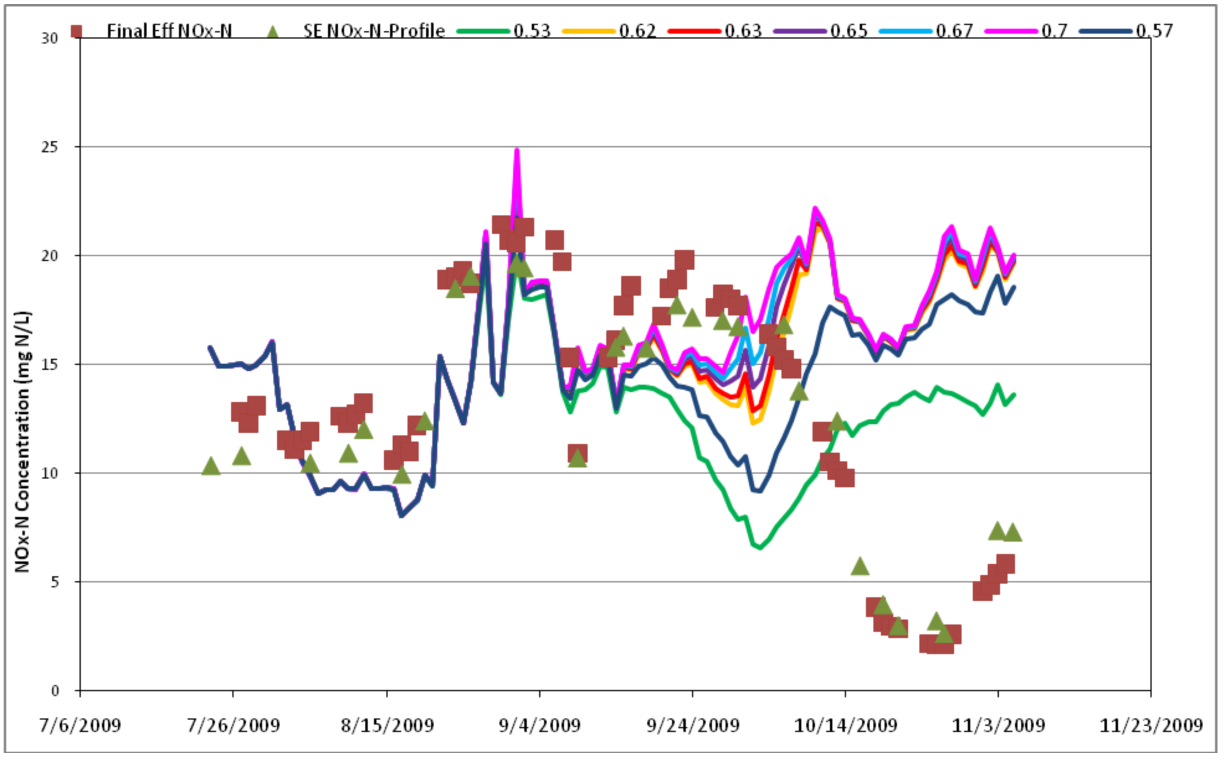


Figure 5.27 Comparison of μ_{max} for AOB to NOx-N

5.4 Conclusion

Based on results from the profile sampling and Biowin modeling, it was suggested that there was no significant sporadic inhibition event during the sampling period. Profile and plant data was collected which demonstrated a fully nitrifying plant ceasing to nitrify as the SRT was reduced to values below which one would not expect nitrification to be normally maintained (Figure 5.7). This allowed for the use of simulation modeling to estimate a μ_{max} for AOB which correlates with the observed data. This estimated value could then be compared to the original design value. Modeling suggested a μ_{max} for AOB to be approximately in the range of 0.50 – 0.60 days^{-1}, based primarily on the effluent ammonia concentrations, which was similar to the original design value of 0.57 days^{-1}. This supported previous batch-rate testing which suggested that there was some form of continuous inhibition present in the wastewater at NTP. Though model and profile/plant data were somewhat similar, the model did not match the profile data within a reasonable difference towards the end of the sampling. Reasoning behind the difference was high PE COD and TKN concentrations recorded in the plant performance data. These high concentrations were caused by bad samples collected during this period where primary clarifiers were being taken in and out of service.

5.5 References

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6. Engineering Significance

The purpose of this project was to identify a specific source of inhibition which would cause failure of nitrification and determine the inhibitory characteristics of NTP influent wastewater. The first objective was to attempt to find the cause of sporadic nitrification upset events at NTP, and at the outset of this work, it was hypothesized that possible sources included the hog processing facility, landfill leachate, and truck delivered septage/FOG/chemical toilet waste could be the cause. AOB and NOB batch rate testing using a range of biomass and wastewater sources suggested that there was some level of continuous inhibition, however no significant source of sporadic inhibition was observed.

The profile sampling and modeling, combined with the calibrated model developed from historical plant data by H&S seemed to indicate this as well. Based on this work, there was definitely some degree of continuous nitrification inhibition characterized by an apparent AOB μ_{max} reduction from a typical value of 0.9 days^{-1} to a value approximately in the range of 0.50 – 0.60 days^{-1}. An evaluation of the nitrification process at the treatment plant was performed as the SRT was reduced to stop nitrification (13 days to 3-4 days). Evaluation of the profile sampling data showed that the plant ceased nitrification at an approximate SRT of 3 to 4 days and a temperature around 22°C. It was suggested that for these parameters, the AOB μ_{max} at which washout occurred would be close to a value of 0.45 to 0.41 day^{-1}. This was based on an AOB washout curve developed as a function of the temperature (not including rate reduction due to pH and DO).

Although the suspected inhibitors such as the hog processing facility and landfill leachate were eliminated as causes of inhibition based on this work, these sources should be reconsidered in the future. Sporadic nitrification inhibition was not observed using samples collected on one of several days. For this reason, it was proposed in future work to configure continuous batch reactors to examine if the nitrification failure is caused over a period of time or capture the sporadic failure.

The next step was to determine the extent of the continuous nitrification inhibition. This was carried out through profile sampling of the BNR process. This provided a means for looking at nutrient concentrations through the treatment process to determine if any part of the treatment process was operating inefficiently or where issues may arise. The plant sporadically added ferric chloride to assist in meeting effluent TP limits; however, there were no observed affects on nitrification. No trends were observed in the influent received at the plant or plant process operations based on the profile sampling which would indicate an inhibition issue. The loss of nitrification was captured as the plant purposely reduced the SRT to stop nitrification.

Biowin modeling was used to calculate the μ_{max} value based on the correlation of effluent nutrient concentrations between the model and profile data. The model failed to perfectly match the observed data towards the end of the profile sampling, where there were noticeable differences. It was believed that the cause was due to primary clarifiers being taken out of service. This caused the collected samples to contain higher concentrations of COD and TKN which created a false representative sample. In spite of this, the model was still used to calculate a range of μ_{max} values which best correlated with the profile data. After several iterations with different μ_{max} values, it was determined that the range of values which best fit the observed effluent ammonia and NO_x-N concentrations were between 0.50 – 0.60 day^{-1}.

Appendices

7.1 Appendix A

PERIOD 1 (7/23/09 - 7/31/09)

SIMULATION INPUTS

Primary Effluent Fractions		
Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	0.270
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.220**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.615**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.157**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.171**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.744**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.148**
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.033**
FupN - N: COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.849**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	0.011

Primary Effluent Itinerary				**CONSTANT**						
Flow	Total COD mgCOD/L	TKN mgN/L	TP mgP/L	NO3-N mgN/L	pH	Alk. mmol/L	ISS mgISS/L	Ca mg/L	Mg mg/L	DO mg/L
18.36 Increased by = Original =	**422.10** ↑ 0% 422.1	46.2	9.56	0.1	7	5.4 Increased by = Original =	**21.84** ↑ 0% 21.84	12	6	0

*NOTE: Values are averages of effluent data taken from Nansemond MPOR

Process	**Total Vol. [MG]**	**HRT w/out recycle [hr]**	**DO-Set Point [mg/L]**	**Tanks in Service [No.]**	**% Removal [%]**	**Sludge Blanket**	**Underflow - Constant [MGD]**
Anaerobic Tanks (3 cells per Train)	2.606193	1.17	un-aerated	5	-	-	-
Anoxic Tanks (3 cells per Train)	2.606193	1.17	un-aerated	5	-	-	-
Aeration Tank 1	1.800	1.453	2	2	-	-	-
Aeration Tank 2	1.800	1.453	2	2	-	-	-
Aeration Tank 3	1.800	1.453	2	2	-	-	-
Secondary Clarifier	4.510	3.640	-	2	**99.9**	0.2	0.00

SPLITTERS	Rate in Side (S) [MGD]	Desired Avg. Solids Waste [lbs/d]	Flow Data	Avg. Over Period	Avg. Calc. SRT [days]
WAS	**0.65**	23418	ARCY =	18.90	12.82
NRCY	19.5		NRCY ON =	19.5	
ARCY	18.90		CRCY =	11.37	
			Daily =	18.35	
			Temperature =	26.89	

PARAMETERS (KINETIC)

AOB

Name	Default	Value	Arrhenius
Max. spec. growth rate [1/d]	0.9	**0.53**	1.072
Substrate (NH4) half sat. [mgN/L]	0.7	0.7	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiHNO2 [mmol/L]	0.005	0.005	1

NOB

Name	Default	Value	Arrhenius
Max. spec. growth rate [1/d]	0.7	0.7	1.06
Substrate (NO2) half sat. [mgN/L]	0.1	0.1	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiNH3 [mmol/L]	0.075	0.075	1

SWITCHES

Name	Default	Value
Heterotrophic DO half sat. [mgO2/L]	0.05	0.05
Aerobic denit. DO half sat. [mgO2/L]	0.05	0.05
Ammonia oxidizer DO half sat. [mgO2/L]	0.25	0.25
Nitrite oxidizer DO half sat. [mgO2/L]	0.5	0.5
Anaerobic ammonia oxidizer DO half sat. [mgO2/L]	0.01	0.01
Anoxic NO3 half sat. [mgN/L]	0.1	0.1
Anoxic NO2 half sat. (mgN/L)	0.01	**0.1**
NH3 nutrient half sat. [mgN/L]	1.00E-04	**0.001**
PolyP half sat. [mgP/L]	0.01	0.01
VFA sequestration half sat. [mgCOD/L]	5	5
P uptake half sat. [mgP/L]	0.15	0.15
P nutrient half sat. [mgP/L]	0.001	0.001
Autotroph CO2 half sat. [mmol/L]	0.1	0.1
Heterotrophic Hydrogen half sat. [mgCOD/L]	1	1
Propionic acetogens Hydrogen half sat. [mgCOD/L]	5	5

Synthesis anion/cation half sat. [meq/L]	0.01	0.01

SUMMARY OF INPUTS

Total SRT [days]	WAS [lbs/day]	ANA MLSS [mg/L]	ANX MLSS [mg/L]	AER MLSS [mg/L]	FIN EFF TKN [mg/L]	FIN EFF NOx [mg/L]	FIN EFF T-N [mg/L]	FIN EFF T-P [mg/L]	FIN EFF TSS [mg/L]	SC EFF NH4-N [mg/L]
12.82	23418	1788	4100	4100	2.72	12.73	15.45	0.53	6.76	0.24

Profile Data

SC EFF OPO4-P [mg/L]	SC EFF NOx-N [mg/L]	SC EFF NH4-N [mg/L]	AUR [mg/L/hr]	SAUR [mg/g MLVSS/hr]	NPR [mg/L/hr]	SNPR [mg/g MLVSS/hr]	PUR [mg/L/hr]	SPUR [mg/g MLVSS/hr]
0.30	10.59	<1.0	1.65	0.60	1.90	0.69	2.241	0.820

PERIOD 2 (8/1/09 - 8/21/09)

SIMULATION INPUTS

Primary Effluent Fractions

Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	0.270
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.220**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.615**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.157**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.171**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.744**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.148**
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.033**
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.849**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	0.011

Primary Effluent Itinerary **CONSTANT**

Flow	Total COD mgCOD/L	TKN mgN/L	TP mgP/L	NO3-N mgN/L	pH	Alk. mmol/L	ISS mgISS/L	Ca mg/L	Mg mg/L	DO mg/L
19.2 Increased by =	**630.53** ↑ 23%	40.65	8.83	0.1	7	5.4 Increased by =	**25.4** ↑ 23%	12	6	0

Original =	512.6					Original =	20.62			

*NOTE: Values are averages of effluent data taken from Nansemond MPOR

Process	Total Vol. [MG]	HRT w/out recycle [hr]	DO-Set Point [mg/L]	Tanks in Service [No.]	% Removal [%]	Sludge Blanket	Underflow - Constant [MGD]
Anaerobic Tanks (3 cells per Train)	2.606193	1.17	un-aerated	5	-	-	-
Anoxic Tanks (3 cells per Train)	2.606193	1.17	un-aerated	5	-	-	-
Aeration Tank 1	1.800	1.453	2	2	-	-	-
Aeration Tank 2	1.800	1.453	2	2	-	-	-
Aeration Tank 3	1.800	1.453	2	2	-	-	-
Secondary Clarifier	4.510	3.640	-	2	**99.9**	0.2	0.00

SPLITTERS	Rate in Side (S) [MGD]	Desired Avg. Solids Waste [lbs/d]	Flow Data	Avg. Over Period	Avg. Calc. SRT [days]
			ARCY =	19.01	
WAS	**1**	23418	NRCY ON =	19.5	8.85
NRCY	19.5		CRCY =	11.80	
ARCY	19.01		Daily =	19.18	
			Temperature =	27.44	

PARAMETERS (KINETIC)

AOB

Name	Default	Value	Arrhenius
Max. spec. growth rate [1/d]	0.9	**0.53**	1.072
Substrate (NH4) half sat. [mgN/L]	0.7	0.7	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiHNO2 [mmol/L]	0.005	0.005	1

NOB

Name	Default	Value	Arrhenius
Max. spec. growth rate [1/d]	0.7	0.7	1.06
Substrate (NO2) half sat. [mgN/L]	0.1	0.1	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiNH3 [mmol/L]	0.075	0.075	1

SWITCHES

Name	Default	Value
Heterotrophic DO half sat. [mgO2/L]	0.05	0.05
Aerobic denit. DO half sat. [mgO2/L]	0.05	0.05

Ammonia oxidizer DO half sat. [mgO2/L]	0.25	0.25
Nitrite oxidizer DO half sat. [mgO2/L]	0.5	0.5
Anaerobic ammonia oxidizer DO half sat. [mgO2/L]	0.01	0.01
Anoxic NO3 half sat. [mgN/L]	0.1	0.1
Anoxic NO2 half sat. (mgN/L)	0.01	**0.1**
NH3 nutrient half sat. [mgN/L]	1.00E-04	**0.001**
PolyP half sat. [mgP/L]	0.01	0.01
VFA sequestration half sat. [mgCOD/L]	5	5
P uptake half sat. [mgP/L]	0.15	0.15
P nutrient half sat. [mgP/L]	0.001	0.001
Autotroph CO2 half sat. [mmol/L]	0.1	0.1
Heterotrophic Hydrogen half sat. [mgCOD/L]	1	1
Propionic acetogens Hydrogen half sat. [mgCOD/L]	5	5
Synthesis anion/cation half sat. [meq/L]	0.01	0.01

SUMMARY OF INPUTS

Total SRT [days]	WAS [lbs/day]	ANA MLSS [mg/L]	ANX MLSS [mg/L]	AER MLSS [mg/L]	FIN EFF TKN [mg/L]	FIN EFF NOx [mg/L]	FIN EFF T-N [mg/L]	FIN EFF T-P [mg/L]	FIN EFF TSS [mg/L]	SC EFF NH4-N [mg/L]
8.85	32509	1763	3735	3735	1.81	11.83	13.63	.51	4.1	.42

Profile Data

SC EFF OPO4-P [mg/L]	SC EFF NOx-N [mg/L]	SC EFF NH4-N [mg/L]	AUR [mg/L/hr]	SAUR [mg/g MLVSS/hr]	NPR [mg/L/hr]	SNPR [mg/g MLVSS/hr]	PUR [mg/L/hr]	SPUR [mg/g MLVSS/hr]
0.88	11.17	<1.0	1.55	0.58	2.12	0.79	4.91	1.82

PERIOD 3 (8/22/09 - 10/2/09)

SIMULATION INPUTS

Primary Effluent Fractions		
Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	0.270
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.220**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.615**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.157**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.171**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.744**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.148**

Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.033**
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.849**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	0.011

Primary Effluent Itinerary					**CONSTANT**					
Flow	Total COD mgCOD/L	TKN mgN/L	TP mgP/L	NO3-N mgN/L	pH	Alk. mmol/L	ISS mgISS/L	Ca mg/L	Mg mg/L	DO mg/L
19.96 Increased by = Original =	**565.1** ↑ 20% 470.9	41.7	11.3	0.1	7	5.4 Increased by = Original =	**23.71** ↑ 20% 19.76	12	6	0

*NOTE: Values are averages of effluent data taken from Nansemond MPOR

Process	**Total Vol. [MG]**	**HRT w/out recycle [hr]**	**DO-Set Point [mg/L]**	**Tanks in Service [No.]**	**% Removal [%]**	**Sludge Blanket**	**Underflow - Constant [MGD]**
Anaerobic Tanks (3 cells per Train)	**2.085**	**0.91**	un-aerated	**4**	-	-	-
Anoxic Tanks (3 cells per Train)	**2.085**	**0.91**	un-aerated	**4**	-	-	-
Aeration Tank 1	1.800	1.453	2	2	-	-	-
Aeration Tank 2	1.800	1.453	2	2	-	-	-
Aeration Tank 3	1.800	1.453	2	2	-	-	-
Secondary Clarifier	4.510	3.640	-	2	**99.85**	0.2	0.00

SPLITTERS	**Rate in Side (S) [MGD]**	**Desired Avg. Solids Waste [lbs/d]**	**Flow Data**	**Avg. Over Period**	**Avg. Calc. SRT [days]**
WAS	**1.45**	33986	ARCY =	17.86	5.59
NRCY	0		NRCY ON =	0	
ARCY	17.86		CRCY =	11.92	
			Daily =	19.99	
			Temperature =	26.84	

PARAMETERS (KINETIC)

AOB

Name	**Default**	**Value**	**Arrhenius**
Max. spec. growth rate [1/d]	0.9	**0.53**	1.072
Substrate (NH4) half sat. [mgN/L]	0.7	0.7	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiHNO2 [mmol/L]	0.005	0.005	1

NOB			
Name	**Default**	**Value**	**Arrhenius**
Max. spec. growth rate [1/d]	0.7	0.7	1.06
Substrate (NO2) half sat. [mgN/L]	0.1	0.1	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiNH3 [mmol/L]	0.075	0.075	1

SWITCHES		
Name	**Default**	**Value**
Heterotrophic DO half sat. [mgO2/L]	0.05	0.05
Aerobic denit. DO half sat. [mgO2/L]	0.05	0.05
Ammonia oxidizer DO half sat. [mgO2/L]	0.25	0.25
Nitrite oxidizer DO half sat. [mgO2/L]	0.5	0.5
Anaerobic ammonia oxidizer DO half sat. [mgO2/L]	0.01	0.01
Anoxic NO3 half sat. [mgN/L]	0.1	0.1
Anoxic NO2 half sat. (mgN/L)	0.01	**0.1**
NH3 nutrient half sat. [mgN/L]	1.00E-04	**0.001**
PolyP half sat. [mgP/L]	0.01	0.01
VFA sequestration half sat. [mgCOD/L]	5	5
P uptake half sat. [mgP/L]	0.15	0.15
P nutrient half sat. [mgP/L]	0.001	0.001
Autotroph CO2 half sat. [mmol/L]	0.1	0.1
Heterotrophic Hydrogen half sat. [mgCOD/L]	1	1
Propionic acetogens Hydrogen half sat. [mgCOD/L]	5	5
Synthesis anion/cation half sat. [meq/L]	0.01	0.01

SUMMARY OF INPUTS

Total SRT [days]	WAS [lbs/day]	ANA MLSS [mg/L]	ANX MLSS [mg/L]	AER MLSS [mg/L]	FIN EFF TKN [mg/L]	FIN EFF NOx [mg/L]	FIN EFF T-N [mg/L]	FIN EFF T-P [mg/L]	FIN EFF TSS [mg/L]	SC EFF NH4-N [mg/L]
5.59	33986	1440	2710	2710	2.16	18.38	20.54	1.20	6.89	2.24

Profile Data

SC EFF OPO4-P [mg/L]	SC EFF NOx-N [mg/L]	SC EFF NH4-N [mg/L]	AUR [mg/L/hr]	SAUR [mg/g MLVSS/hr]	NPR [mg/L/hr]	SNPR [mg/g MLVSS/hr]	PUR [mg/L/hr]	SPUR [mg/g MLVSS/hr]
1.31	17	<1.0	2.64	1.3	3.65	1.78	6.35	3.09

PERIOD 5 (10/23/09 - 11/5/09)

SIMULATION INPUTS

Primary Effluent Fractions		
Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	0.270
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.220**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.615**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.157**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.171**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.744**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.148**
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.033**
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.849**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	0.011

Primary Effluent Itinerary				**CONSTANT**						
Flow	Total COD mgCOD/L	TKN mgN/L	TP mgP/L	NO3-N mgN/L	pH	Alk. mmol/L	ISS mgISS/L	Ca mg/L	Mg mg/L	DO mg/L
19.27	**481.3**	46.1	13.6	0.1	7	5.4	**22**	12	6	0
	↑						↑			
Increased by =	0%					Increased by =	0%			
Original =	481.3					Original =	21.97			

*NOTE: Values are averages of effluent data taken from Nansemond MPOR

Process	**Total Vol. [MG]**	**HRT w/out recycle [hr]**	**DO-Set Point [mg/L]**	**Tanks in Service [No.]**	**% Removal [%]**	**Sludge Blanket**	**Underflow - Constant [MGD]**
Anaerobic Tanks (3 cells per Train)	**2.085**	**0.91**	un-aerated	**4**	-	-	-
Anoxic Tanks (3 cells per Train)	**2.085**	**0.91**	un-aerated	**4**	-	-	-
Aeration Tank 1	1.800	1.453	2	2	-	-	-
Aeration Tank 2	1.800	1.453	2	2	-	-	-
Aeration Tank 3	1.800	1.453	2	2	-	-	-
Secondary Clarifier	4.510	3.640	-	2	**99.8**	0.2	0.00

	Rate in Side (S)	**Desired Avg. Solids Waste**	**Flow Data**	**Avg. Over Period**	**Avg. Calc. SRT**

SPLITTERS	[MGD]	[lbs/d]	ARCY =	16.99	[days]
WAS	**1.6**	30075	NRCY ON =	0	4.90
NRCY	0		CRCY =	11.40	
ARCY	16.99		Daily =	19.13	
			Temperature =	22.49	

PARAMETERS (KINETIC)

AOB

Name	Default	Value	Arrhenius
Max. spec. growth rate [1/d]	0.9	**0.53**	1.072
Substrate (NH4) half sat. [mgN/L]	0.7	0.7	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiHNO2 [mmol/L]	0.005	0.005	1

NOB

Name	Default	Value	Arrhenius
Max. spec. growth rate [1/d]	0.7	0.7	1.06
Substrate (NO2) half sat. [mgN/L]	0.1	0.1	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiNH3 [mmol/L]	0.075	0.075	1

SWITCHES

Name	Default	Value
Heterotrophic DO half sat. [mgO2/L]	0.05	0.05
Aerobic denit. DO half sat. [mgO2/L]	0.05	0.05
Ammonia oxidizer DO half sat. [mgO2/L]	0.25	0.25
Nitrite oxidizer DO half sat. [mgO2/L]	0.5	0.5
Anaerobic ammonia oxidizer DO half sat. [mgO2/L]	0.01	0.01
Anoxic NO3 half sat. [mgN/L]	0.1	0.1
Anoxic NO2 half sat. (mgN/L)	0.01	**0.1**
NH3 nutrient half sat. [mgN/L]	1.00E-04	**0.001**
PolyP half sat. [mgP/L]	0.01	0.01
VFA sequestration half sat. [mgCOD/L]	5	5
P uptake half sat. [mgP/L]	0.15	0.15
P nutrient half sat. [mgP/L]	0.001	0.001
Autotroph CO2 half sat. [mmol/L]	0.1	0.1
Heterotrophic Hydrogen half sat. [mgCOD/L]	1	1
Propionic acetogens Hydrogen half sat. [mgCOD/L]	5	5
Synthesis anion/cation half sat. [meq/L]	0.01	0.01

SUMMARY OF INPUTS

Total SRT [days]	WAS [lbs/day]	ANA MLSS [mg/L]	ANX MLSS [mg/L]	AER MLSS [mg/L]	FIN EFF TKN [mg/L]	FIN EFF NOx [mg/L]	FIN EFF T-N [mg/L]	FIN EFF T-P [mg/L]	FIN EFF TSS [mg/L]	SC EFF NH4-N [mg/L]
4.89	30075	1442	2225	2225	24.35	3.71	28.06	0.56	8.05	22.4

Profile Data

SC EFF OPO4-P [mg/L]	SC EFF NOx-N [mg/L]	SC EFF NH4-N [mg/L]	AUR [mg/L/hr]	SAUR [mg/g MLVSS/hr]	NPR [mg/L/hr]	SNPR [mg/g MLVSS/hr]	PUR [mg/L/hr]	SPUR [mg/g MLVSS/hr]
0.16	9.30	21.8	1.18	0.66	1.05	0.58	10.2	5.74

7.2 Appendix B

Complete Simulation Dynamic (7/23/09 - 11/5/09)

SIMULATION INPUTS

Primary Effluent Fractions		Input
Name	Default	Value
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.270	**0.310**
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.150	**0.180**
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.500	**0.610**
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.080	**0.155**
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.080	**0.169**
Fna - Ammonia [gNH3-N/gTKN]	0.750	**0.740**
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.250	**0.300**
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.020	**0.030**
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.035	**0.030**
Fpo4 - Phosphate [gPO4-P/gTP]	0.750	**0.820**
FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD]	0.011	**0.009**

Process	Total Vol. [MG]	HRT w/out recycle [hr]	DO-Set Point [mg/L]	Tanks in Service [No.]	% Removal [%]	Sludge Blanket	Underflow - Constant [MGD]
Anaerobic Tanks (3 cells per Train) Phase 1	2.606193	1.17	un-aerated	5	-	-	-
Anaerobic Tanks (3 cells per Train) Phase 2	2.084954	0.91	un-aerated	4			
Anoxic Tanks (3 cells per Train) Phase 1	2.606193	1.17	un-aerated	5	-	-	-

Anoxic Tanks (3 cells per Train) Phase 2	2.084954	0.91	un-aerated	4			
Aeration Tank 1	1.800	1.45	2	2	-	-	-
Aeration Tank 2	1.800	1.45	2	2	-	-	-
Aeration Tank 3	1.800	1.45	**1**	2	-	-	-
Secondary Clarifier	4.510	3.640	-	2	**Variable**	0.2	0.00

PARAMETERS (KINETIC)

AOB

Name	**Default**	**Value**	**Arrhenius**
Max. spec. growth rate [1/d]	0.9	**0.62**	1.072
Substrate (NH4) half sat. [mgN/L]	0.7	0.7	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiHNO2 [mmol/L]	0.005	0.005	1

NOB

Name	**Default**	**Value**	**Arrhenius**
Max. spec. growth rate [1/d]	0.7	0.7	1.06
Substrate (NO2) half sat. [mgN/L]	0.1	0.1	1
Aerobic decay rate [1/d]	0.17	0.17	1.029
Anoxic/anaerobic decay rate [1/d]	0.08	0.08	1.029
KiNH3 [mmol/L]	0.075	0.075	1

SPLITTER ITINERARY

ARCY		**NRCY**		**CRCY**		**WAS**		**Temperature**		**Clarifier**	**ANA/ANX**	
Time	Split	Time	Split	Time	Split	Time	Split	Time	Temp	% Removal	Time	Split
0	18.8	0	19.5	0	11.8	0	0.65	0	26.55	99.9	0	0.2
1	18.8	1	19.5	1	11.5	1	0.68	1	26.58	99.9	1	0.2
2	18.7	2	19.5	2	11.1	2	0.65	2	26.68	99.9	2	0.2
3		3		3		3	0.65	3		99.9	3	0.2
4	19.0	4	19.5	4	11.1	4	0.65	4	26.95	99.9	4	0.2
5	18.9	5	19.5	5	11.1	5	0.65	5	26.95	99.9	5	0.2
6	19.1	6	19.5	6	11.8	6	0.63	6	27.1	99.9	6	0.2
7	19.0	7	19.5	7	11.3	7	0.61	7	27.15	99.9	7	0.2
8	19.0	8	19.5	8	11.2	8	0.65	8	27.18	99.9	8	0.2
9	18.8	9	19.5	9	11.1	9	1.00	9	27.21	99.9	9	0.2
10	19.4	10	19.5	10	11.9	10	1.07	10	27.27	99.9	10	0.2
11	19.5	11	19.5	11	12.4	11	1.10	11	27.31	99.9	11	0.2
12	19.3	12	19.5	12	11.1	12	1.10	12	27.28	99.9	12	0.2
13	19.4	13	19.5	13	11.1	13	1.10	13	27.32	99.9	13	0.2

14	19.6	14	19.5	14	13.1	14	1.09	14	27.32	99.9	14	0.2
15	19.1	15	19.5	15	12.0	15	1.08	15	27.34	99.9	15	0.2
16	19.1	16	19.5	16	11.6	16	1.09	16	27.36	99.9	16	0.2
17	19.0	17	19.5	17	11.7	17	1.09	17	27.37	99.9	17	0.2
18	19.0	18	19.5	18	11.7	18	1.09	18	27.34	99.9	18	0.2
19	19.0	19	19.5	19	11.5	19	1.09	19	27.42	99.9	19	0.2
20	19.0	20	19.5	20	11.9	20	1.07	20	27.52	99.9	20	0.2
21	18.9	21	19.5	21	12.4	21	1.10	21	27.62	99.9	21	0.2
22	18.8	22	19.5	22	12.3	22	1.10	22	27.71	99.9	22	0.2
23	18.9	23	19.5	23	12.5	23	1.10	23	27.64	99.9	23	0.2
24	18.9	24	19.5	24	11.9	24	1.10	24	27.52	99.9	24	0.2
25	18.8	25	19.5	25	11.6	25	1.10	25	27.46	99.9	25	0.2
26	18.5	26	19.5	26	11.6	26	1.10	26	27.46	99.9	26	0.2
27	18.9	27	19.5	27	11.5	27	1.10	27	27.48	99.9	27	0.2
28	18.4	28	19.5	28	11.5	28	1.09	28	27.54	99.9	28	0.2
29	18.7	29	19.5	29	11.5	29	1.17	29	27.68	99.9	29	0.2
30	18.5	30	0	30	11.6	30	1.45	30	27.75	99.85	30	0.2
31	18.3	31	0	31	11.6	31	1.45	31	27.81	99.85	31	0.2
32	18.1	32	0	32	11.6	32	1.58	32	27.79	99.85	32	0.2
33	18.2	33	0	33	11.5	33	1.70	33	27.74	99.85	33	0.2
34	17.9	34	0	34	11.2	34	1.77	34	27.75	99.85	34	0.2
35	18.3	35	0	35	11.5	35	1.60	35	27.79	99.85	35	0.2
36	18.0	36	0	36	11.8	36	1.41	36	27.83	99.85	36	0.2
37	18.3	37	0	37	11.7	37	2.21	37	27.92	99.85	37	0
38	18.2	38	0	38	11.5	38	2.17	38	27.97	99.85	38	0
39	18.0	39	0	39	11.8	39	2.16	39	27.89	99.85	39	0
40	18.0	40	0	40	11.5	40	2.21	40	27.8	99.85	40	0
41	17.8	41	0	41	11.4	41	2.21	41	27.64	99.85	41	0
42	17.8	42	0	42	11.3	42	2.08	42	27.45	99.85	42	0
43	17.9	43	0	43	11.2	43	2.04	43	27.3	99.85	43	0
44	17.9	44	0	44	11.1	44	2.04	44	27.23	99.85	44	0
45	18.2	45	0	45	10.8	45	1.95	45	27.21	99.85	45	0
46	17.9	46	0	46	11.7	46	2.04	46	27.18	99.85	46	0
47	17.7	47	0	47	14.1	47	2.03	47	26.86	99.85	47	0
48	17.7	48	0	48	14.0	48	1.99	48	26.5	99.85	48	0
49	17.6	49	0	49	13.9	49	2.04	49	26.55	99.85	49	0
50	17.4	50	0	50	13.1	50	2.04	50	26.43	99.85	50	0
51	17.5	51	0	51	12.4	51	2.04	51	26.37	99.85	51	0
52	18.1	52	0	52	12.2	52	2.04	52	26.36	99.85	52	0
53	18.0	53	0	53	12.1	53	2.12	53	26.33	99.85	53	0
54	17.7	54	0	54	12.0	54	2.25	54	26.34	99.85	54	0
55	17.8	55	0	55	11.9	55	2.32	55	26.34	99.85	55	0

56	17.6	56	0	56	12.0	56	2.37	56	26.42	99.85	56	0
57	17.6	57	0	57	11.9	57	2.32	57	26.46	99.85	57	0
58	17.8	58	0	58	12.0	58	2.38	58	26.42	99.85	58	0
59	18.2	59	0	59	11.8	59	2.39	59	26.4	99.85	59	0
60	17.7	60	0	60	11.1	60	2.39	60	26.32	99.85	60	0
61	17.8	61	0	61	11.2	61	2.45	61	26.28	99.85	61	0
62	17.9	62	0	62	11.5	62	2.75	62	26.21	99.85	62	0
63	17.6	63	0	63	11.4	63	2.74	63	26.26	99.85	63	0
64	17.5	64	0	64	12.6	64	2.88	64	26.21	99.85	64	0
65	17.5	65	0	65	12.3	65	3.03	65	26.39	99.85	65	0
66	17.4	66	0	66	12.5	66	3.03	66	26.28	99.85	66	0
67	17.3	67	0	67	12.2	67	3.25	67	26.21	99.85	67	0
68	17.4	68	0	68	12.2	68	3.52	68	26	99.85	68	0
69	17.4	69	0	69	11.7	69	3.47	69	25.85	99.85	69	0
70	17.6	70	0	70	5.9	70	3.43	70	25.78	99.85	70	0
71	17.6	71	0	71	11.5	71	3.42	71	25.62	99.85	71	0
72	17.7	72	0	72	11.7	72	1.80	72	25.59	99.8	72	0
73	17.6	73	0	73	11.5	73	1.80	73	25.56	99.8	73	0
74	17.5	74	0	74	11.2	74	1.75	74	25.53	99.8	74	0
75	17.7	75	0	75	11.2	75	1.62	75	25.4	99.8	75	0
76	17.5	76	0	76	11.2	76	1.51	76	25.39	99.8	76	0
77	17.2	77	0	77	11.2	77	1.55	77	25.31	99.8	77	0
78	17.2	78	0	78	11.2	78	1.57	78	25.26	99.8	78	0
79	17.0	79	0	79	11.4	79	1.54	79	25.22	99.8	79	0
80	17.5	80	0	80	11.2	80	1.55	80	25.2	99.8	80	0
81	17.2	81	0	81	11.2	81	1.55	81	25.16	99.8	81	0
82	17.2	82	0	82	10.9	82	1.40	82	25.02	99.8	82	0
83	16.7	83	0	83	11.3	83	1.48	83	24.8	99.8	83	0
84	17.1	84	0	84	12.0	84	1.56	84	24.71	99.8	84	0
85	17.2	85	0	85	11.9	85	1.53	85	24.32	99.8	85	0
86	17.2	86	0	86	11.7	86	1.49	86	24.03	99.8	86	0
87	17.3	87	0	87	11.8	87	1.52	87	23.72	99.8	87	0
88	17.2	88	0	88	11.6	88	1.52	88	23.46	99.8	88	0
89	17.2	89	0	89	11.2	89	1.43	89	23.08	99.8	89	0
90	17.1	90	0	90	11.2	90	1.42	90	22.95	99.8	90	0
91	17.1	91	0	91	11.3	91	1.41	91	22.84	99.8	91	0
92	16.9	92	0	92	11.4	92	1.60	92	22.89	99.8	92	0
93	16.9	93	0	93	11.5	93	1.79	93	23	99.8	93	0
94	16.8	94	0	94	11.8	94	1.89	94	23.07	99.8	94	0
95	17.0	95	0	95	11.1	95	1.90	95	23.09	99.8	95	0
96	16.6	96	0	96	11.4	96	1.89	96	22.97	99.8	96	0
97	16.6	97	0	97	11.3	97	1.92	97	22.92	99.8	97	0

98	17.2	98	0	98	11.4	98	1.92	98	22.92	99.8	98	0
99	17.1	99	0	99	11.5	99	1.84	99	22.93	99.8	99	0
100	17.1	100	0	100	11.5	100	1.80	100	22.92	99.8	100	0
101	17.1	101	0	101	11.5	101	1.70	101	22.92	99.8	101	0
102	17.1	102	0	102	11.4	102	1.69	102	22.82	99.8	102	0
103	17.1	103	0	103	11.8	103	1.69	103	23.59	99.8	103	0
104	17.1	104	0	104	11.9	104	1.64	104	22.53	99.8	104	0
105	17.1	105	0	105	10.3	105	1.39	105	22.49	99.8	105	0

7.3 Appendix C – Profile Sampling Data and Calculated Rates

Week	Profile	Date	Actual SRT [days]	Aerobic MLSS [mg/L]	Average AER DO [mg/L]	Min AER pH	AUR (NH4-N Slope) [mg/L/hr]	SAUR [mg/g MLVSS/hr]	NPR (NOx-N Slope) [mg/L/hr]	SNPR [mg/g MLVSS/hr]	Highest AER NO_2-N Concentration [mg/L]	PUR (PO_4-P Uptake Slope) [mg/L/hr]	SPUR [mg/g MLVSS/hr]	Clarifier IDC NH_4-N [mg/L]	Clarifier IDC NOx-N [mg/L]	Clarifier IDC PO_4-P Concentration [mg/L]
1	1	7/23/2009	12.6	3940	2.09	6.84	-	-	-	-	2.95	-	-	0.00	10.7	0.2
2	1	7/27/2009	14.3	4060	1.9	6.9	1.6	0.6	1.8	0.7	2.44	2.13	0.80	0.00	10.5	0.3
	2	7/29/2009	12.6	4220	2.1	6.9	1.7	0.6	2.0	0.7	2.1	2.4	0.8	0.0	12.2	0.3
3	1	8/5/2009	9.8	3760	1.6	6.9	1.6	0.6	1.6	0.6	1.4	7.1	2.6	0.0	10.3	0.3
	2	8/6/2009	9.9	4000	1.4	6.9	1.7	0.6	2.0	0.7	1.7	3.8	1.3	0.0	11.7	0.2
4	1	8/10/2009	8.1	3700	1.8	6.8	1.7	0.7	1.8	0.7	1.4	4.1	1.6	0.0	11.0	0.3
	2	8/12/2009	8.3	3640	2.3	6.9	1.7	0.7	2.2	0.8	1.8	3.8	1.5	0.0	11.8	0.4
5	1	8/17/2009	10.5	3700	1.3	6.8	1.2	0.4	2.2	0.8	0.9	6.1	2.2	0.0	10.2	0.4
	2	8/20/2009	7.7	3580	1.9	6.8	1.5	0.6	2.9	1.1	0.7	4.7	1.8	0.0	12.1	3.9
6	1	8/24/2009	7.2	3180	1.3	6.7	2.6	1.1	4.0	1.6	0.4	6.9	2.8	0.0	18.5	4.1
	2	8/26/2009	7.3	3280	1.3	6.7	2.6	1.1	4.5	1.9	0.5	6.9	2.9	1.0	18.9	3.0
7	1	9/1/2009	5.2	2800	1.3	6.7	2.7	1.3	4.7	2.3	1.3	5.4	2.7	0.0	19.7	4.1
	2	9/2/2009	5.4	2800	1.3	6.7	2.5	1.2	4.3	2.1	0.3	4.8	2.4	0.0	19.3	4.5
8	1	9/9/2009	4.3	2600	1.7	6.5	2.2	1.2	2.6	1.3	0.3	4.9	2.6	0.0	11.0	0.0
9	1	9/14/2009	5.9	2760	1.8	6.7	2.7	1.3	3.3	1.6	0.3	6.3	3.1	0.0	15.6	0.0
	2	9/15/2009	6.4	2640	2.0	6.6	2.4	1.2	3.1	1.5	0.4	7.1	3.5	0.0	16.5	0.0
	3	9/18/2009	4.4	2720	1.5	6.7	2.8	1.4	3.0	1.5	0.5	6.5	3.2	0.0	16.1	0.3
10	1	9/22/2009	5.9	3780	1.7	6.7	2.5	0.9	3.5	1.2	0.6	7.3	2.6	0.0	18.1	0.2
	2	9/24/2009	4.8	2480	2.0	6.7	2.8	1.5	3.7	2.0	1.0	7.0	3.7	0.0	17.4	0.2
11	1	9/28/2009	4.1	2300	2.0	6.7	2.9	1.6	4.0	2.3	1.3	7.0	4.0	0.0	17.2	0.3
	2	9/30/2009	3.6	2120	1.8	6.6	3.0	1.8	3.3	2.0	1.8	6.0	3.7	0.0	16.8	1.1

12	1	10/6/2009	5.0	1760	2.3	6.6	2.7	1.9	3.2	2.3	2.6	7.2	5.1	2.3	16.9	0.1
	2	10/8/2009	4.0	1780	1.7	-	2.2	1.6	2.3	1.7	4.0	7.3	5.4	5.8	13.3	0.4
13	1	10/13/2009	4.4	1700	1.8	6.8	2.0	1.5	2.0	1.5	6.3	8.4	6.2	10.9	11.6	0.1
	2	10/16/2009	4.9	1540	1.4	6.8	1.4	1.2	1.0	0.8	3.2	9.0	7.5	16.1	5.6	0.2
14	1	10/19/2009	4.9	1910	1.6	6.9	1.2	0.8	0.7	0.5	2.0	9.7	6.4	21.0	3.7	0.1
	2	10/21/2009	5.3	1940	1.2	6.9	0.6	0.4	0.4	0.3	1.5	11.0	7.2	24.9	2.9	0.2
15	1	10/26/2009	5.9	2320	1.4	6.9	0.9	0.5	0.6	0.4	1.9	10.3	5.8	24.2	3.3	0.1
	2	10/27/2009	5.2	2140	1.1	7.0	1.1	0.7	0.5	0.3	1.5	9.0	5.5	26.8	2.7	0.2
16	1	11/3/2009	4.0	2660	1.3	6.8	1.3	0.6	1.7	0.9	5.3	9.4	4.7	19.1	7.3	0.1
	2	11/5/2009	4.6	2320	1.0	6.8	1.4	0.8	1.3	0.8	5.3	12.0	7.0	18.8	7.0	0.2

Week	Profile	Date	Max ANA PO_4-P Release [mg/L]	Avg. ANA NO_3-N Concentration [mg/L]	AA4 NOx-N [mg/L]	AA6 NOx-N [mg/L]	AA1 PO_4-P Release Slope [mg/L/hr]	AA1 Specific PO_4-P Release Rate [mg/g MLVSS/hr]	AA2 PO_4-P Release Slope [mg/L/hr]	AA2 Specific PO_4-P Release Rate [mg/g MLVSS/hr]	AA3 PO_4-P Release Slope [mg/L/hr]	AA3 Specific PO_4-P Release Rate [mg/g MLVSS/hr]	AA4 PO_4-P Release Slope [mg/L/hr]	AA4 Specific PO_4-P Release Rate [mg/g MLVSS/hr]	AA5 PO_4-P Release Slope [mg/L/hr]	AA5 Specific PO_4-P Release Rate [mg/g MLVSS/hr]	AA6 PO_4-P Release Slope [mg/L/hr]	AA6 Specific PO_4-P Release Rate [mg/g MLVSS/hr]	(AA1) COD Uptake Slope [mg/L/hr]	(AA1) Specific COD Uptake Rate [mg/g MLVSS/hr]	(AA1) PO_4-P/COD [mg/mg]
1	1	7/23/2009	17.8	0.0	1.2	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	7/27/2009	28.4	0.7	2.9	0.5	13.5	14.4	10.5	11.2	2.16	2.31	-1.07	-0.40	-0.05	-0.02	1.03	0.39	50.4	53.8	13.5
	2	7/29/2009	20.2	0.5	2.3	0.3	16.1	14.9	4.3	4.0	4.08	3.77	-0.14	-0.05	-0.01	0.00	0.58	0.21	40.4	37.5	16.1
3	1	8/5/2009	23.9	0.3	1.5	0.3	12.9	7.0	6.8	3.7	4.74	2.56	-0.30	-0.11	-0.30	-0.11	4.38	1.64	44.8	24.2	12.9
	2	8/6/2009	28.6	0.3	1.5	0.3	18.5	12.8	9.3	6.4	6.36	4.38	-0.19	-0.06	0.05	0.02	1.07	0.37	67.2	46.3	18.5
4	1	8/10/2009	24.6	0.4	1.9	0.3	13.4	16.4	7.6	9.3	5.46	6.67	0.15	0.06	0.01	0.01	1.24	0.48	59.8	73.2	13.4
	2	8/12/2009	23.4	0.4	1.7	0.0	13.4	9.1	8.7	5.9	5.25	3.56	0.14	0.05	0.00	0.00	1.03	0.39	46.6	31.6	13.4
5	1	8/17/2009	27.7	0.3	0.7	0.3	15.0	11.0	8.1	5.9	5.74	4.23	0.33	0.12	0.04	0.02	1.15	0.42	64.4	47.4	15.0
	2	8/20/2009	27.3	0.6	2.5	0.3	14.5	10.1	8.8	6.1	5.98	4.16	-0.18	-0.07	0.26	0.10	1.17	0.44	45.6	31.8	14.5

6	1	8/24/2009	35.0	0.2	0.3	0.3	10.9	8.4	11.1	8.5	6.81	5.26	0.98	0.40	0.39	0.16	2.11	0.87	43.1	33.3	10.9
	2	8/26/2009	28.5	0.3	1.0	0.3	14.9	9.4	8.7	5.5	6.46	4.06	0.09	0.04	0.12	0.05	1.80	0.74	42.7	26.8	14.9
7	1	9/1/2009	27.7	0.1	1.0	0.0	11.8	10.6	11.0	9.8	7.16	6.43	0.08	0.04	0.26	0.13	2.23	1.09	113.5	101.9	11.8
	2	9/2/2009	30.1	0.6	2.7	0.3	15.9	14.4	13.4	12.1	5.84	5.26	-0.36	-0.18	0.11	0.06	2.02	1.00	43.1	38.9	15.9
8	1	9/9/2009	12.7	0.3	0.4	0.3	8.6	9.8	6.8	7.7	4.27	4.87	-0.25	-0.13	0.12	0.06	1.62	0.84	32.5	37.0	8.6
9	1	9/14/2009	20.3	0.4	0.5	0.3	7.7	7.0	9.9	9.0	6.33	5.74	0.38	0.19	0.43	0.21	2.24	1.11	35.3	32.0	7.7
	2	9/15/2009	21.1	0.4	1.1	0.3	13.5	12.4	9.0	8.3	6.37	5.84	-0.16	-0.08	-0.07	-0.04	2.45	1.25	50.6	46.4	13.5
	3	9/18/2009	25.8	0.3	0.5	0.0	11.6	11.4	11.9	11.6	7.24	7.09	0.18	0.09	0.16	0.08	2.90	1.44	-	-	11.6
10	1	9/22/2009	25.3	0.4	0.4	0.4	7.1	7.9	10.7	11.9	7.08	7.86	1.42	0.50	0.45	0.16	3.25	1.15	41.8	46.4	7.1
	2	9/24/2009	27.1	0.3	0.8	0.3	16.2	17.1	10.9	11.5	7.82	8.25	-0.26	-0.14	0.30	0.16	3.02	1.58	52.6	55.5	16.2
11	1	9/28/2009	22.7	0.3	0.5	0.3	7.8	9.1	10.1	11.7	7.11	8.25	1.87	1.06	0.40	0.23	2.77	1.56	28.3	32.8	7.8
	2	9/30/2009	24.6	0.3	0.7	0.4	15.2	20.8	8.7	12.0	6.83	9.36	1.71	1.06	1.66	1.03	1.37	0.85	35.4	48.5	15.2
12	1	10/6/2009	20.2	0.3	0.4	0.3	4.0	4.6	9.0	10.4	6.92	8.02	2.95	2.09	0.22	0.16	2.58	1.83	16.3	18.9	4.0
	2	10/8/2009	20.6	0.3	0.7	0.3	11.0	13.5	10.5	12.8	7.50	9.17	-0.03	-0.02	-0.22	-0.16	3.36	2.49	23.8	29.1	11.0
13	1	10/13/2009	31.0	0.4	0.4	0.4	11.2	14.9	10.6	14.1	7.12	9.52	1.96	1.46	0.47	0.35	3.54	2.63	35.3	47.2	11.2
	2	10/16/2009	17.6	0.3	0.3	0.3	-0.3	-0.4	12.6	16.9	4.48	5.99	3.21	2.67	0.69	0.57	2.64	2.20	-	-	-0.3
14	1	10/19/2009	21.0	0.3	0.3	0.3	0.1	0.1	9.2	11.6	6.45	8.14	2.98	1.97	1.15	0.76	2.87	1.90	0.8	1.0	0.1
	2	10/21/2009	21.7	0.4	0.4	0.4	5.0	6.5	11.3	14.5	7.28	9.35	2.21	1.44	0.73	0.47	5.19	3.39	44.6	57.2	5.0
15	1	10/26/2009	32.5	0.3	0.3	0.3	9.5	5.2	13.9	7.6	7.41	4.07	2.48	1.39	1.43	0.80	2.43	1.36	42.4	23.3	9.5
	2	10/27/2009	22.8	0.0	0.0	0.0	10.3	11.0	12.0	12.8	7.58	8.11	0.96	0.58	0.15	0.09	3.00	1.82	43.1	46.1	10.3
16	1	11/3/2009	31.7	0.1	0.0	0.0	14.6	12.4	13.2	11.2	8.79	7.48	0.11	0.06	0.48	0.24	2.97	1.49	43.5	37.0	14.6
	2	11/5/2009	34.3	0.3	0.3	0.3	9.0	8.1	14.4	13.0	7.25	6.52	2.52	1.47	0.33	0.19	4.11	2.40	25.6	23.0	9.0

7.4 Appendix D - Plant Characteristics during Profile Sampling

Week	Profile	Date	# Chem Used [lbs]	FeCl3 Hrs Used [hr]	FeCl3 Addition [mg/L]	Primary Clarifier Effluent Flow [MGD]	ARCY Flow [MGD]	CRCY Flow [MGD]	NRCY Flow [MGD]	ANA MLTSS [mg/L]	ANA % VOL [%]	ANA MLVSS [mg/L]	ANX MLTSS [mg/L]	ANX % VOL [%]	ANX MLVSS [mg/L]	AER MLTSS [mg/L]	AER % VOL [%]	AER MLVSS [mg/L]
1	1	7/23/2009	1000.0	24.0	4.0	18	19	12	20	2360	69	1628	3940	65	2561	3940	65	2561
2	1	7/27/2009	0.0	0.0	0.0	18	19	11	20	1320	71	937	4060	66	2680	4060	66	2680
	2	7/29/2009	0.0	0.0	0.0	19	19	12	20	1500	72	1080	4220	66	2785	4220	66	2785
3	1	8/5/2009	0.0	0.0	0.0	18	19	11	20	2440	76	1854	3760	71	2670	3760	71	2670
	2	8/6/2009	0.0	0.0	0.0	22	20	13	20	1960	74	1450	4000	72	2880	4000	72	2880
4	1	8/10/2009	0.0	0.0	0.0	19	19	12	20	1090	75	818	3700	70	2590	3700	70	2590
	2	8/12/2009	0.0	0.0	0.0	20	19	12	20	1820	81	1474	3640	72	2621	3640	72	2621
5	1	8/17/2009	0.0	0.0	0.0	19	19	12	20	1720	79	1359	3700	75	2775	3700	75	2775
	2	8/20/2009	0.0	0.0	0.0	19	18	12	20	1840	78	1435	3580	74	2649	3580	74	2649
6	1	8/24/2009	0.0	0.0	0.0	19	18	12	0	1640	79	1296	3180	76	2417	3180	76	2417
	2	8/26/2009	0.0	0.0	0.0	19	18	11	0	2040	78	1591	3280	74	2427	3280	74	2427
7	1	9/1/2009	0.0	0.0	0.0	19	18	11	0	1410	79	1114	2800	73	2044	2800	73	2044
	2	9/2/2009	0.0	0.0	0.0	19	18	11	0	1370	81	1110	2800	72	2016	2800	72	2016
8	1	9/9/2009	1500.1	22.0	5.1	25	18	14	0	1140	77	878	2600	74	1924	2600	74	1924
9	1	9/14/2009	0.0	0.0	0.0	20	18	12	0	1360	81	1102	2760	73	2015	2760	73	2015
	2	9/15/2009	0.0	0.0	0.0	20	18	12	0	1380	79	1090	2640	74	1954	2720	74	2013
	3	9/18/2009	0.0	0.0	0.0	20	18	12	0	1380	74	1021	2720	74	2013	2720	74	2013
10	1	9/22/2009	0.0	0.0	0.0	19	18	11	0	1200	75	900	3780	75	2835	3780	75	2835
	2	9/24/2009	0.0	0.0	0.0	20	18	11	0	1230	77	947	2480	77	1910	2480	77	1910
11	1	9/28/2009	0.0	0.0	0.0	21	17	12	0	1120	77	862	2300	77	1771	2300	77	1771
	2	9/30/2009	0.0	0.0	0.0	20	17	12	0	960	76	730	2120	76	1611	2120	76	1611
12	1	10/6/2009	0.0	0.0	0.0	19	18	11	0	980	88	862	1760	80	1408	1760	80	1408
	2	10/8/2009	0.0	0.0	0.0	19	17	11	0	940	87	818	1780	76	1353	1780	76	1353

13	1	10/13/2009	0.0	0.0	0.0	19	17	11	0	880	85	748	1700	79	1343	1700	79	1343
	2	10/16/2009	0.0	0.0	0.0	20	17	12	0	840	89	748	1540	78	1201	1540	78	1201
14	1	10/19/2009	0.0	0.0	0.0	20	17	12	0	890	89	792	1910	79	1509	1910	79	1509
	2	10/21/2009	0.0	0.0	0.0	19	17	11	0	865	90	779	1940	79	1533	1940	79	1533
15	1	10/26/2009	0.0	0.0	0.0	19	17	11	0	2140	85	1819	2320	77	1786	2320	77	1786
	2	10/27/2009	0.0	0.0	0.0	19	17	11	0	1100	85	935	2140	77	1648	2140	77	1648
16	1	11/3/2009	0.0	0.0	0.0	19	17	12	0	1400	84	1176	2660	75	1995	2660	75	1995
	2	11/5/2009	0.0	0.0	0.0	19	17	10	0	1340	83	1112	2320	74	1717	2320	74	1717

7.5 Appendix E - QAC Addition Calculation

Nansemond Plant

AVG Flow	Chem. Toilet Waste
[gal/day]	[gal/day]
18500000	3,539

Chemical Liquid Addition

2	oz	per	5	gal
59.14	mL	per	18.925	L
Chemical Stock	3.12	mL/L		

Dose 1

Peak Duration	20	days
Duration/day	4	hr
Reactor Size	3	L
Chem Dose	11796.7	gal
Flow Volume	370000000	gal
Percentage	0.00319	
Reactor Dose	9.56	mL

Assumptions:
Receive peak waste during one month of the year. Receive the waste out of the 20 days in 4 hour periods throughout the 8 hour workday.

Dose 2

Peak Duration	40	days
Duration/day	5	hr
Reactor Size	3	L
Chem Dose	29491.7	gal
Flow Volume	740000000	gal
Percentage	0.00797	
Reactor Dose	23.91	mL

Assumptions:
Receive peak waste during two months of the summer. Receive the waste out of the 40 days in 5 hour periods throughout the 8 hour workday

Dose 2

Peak Duration	60	days
Duration/day	6	hr
Reactor Size	3	L
Chem Dose	53085.0	gal
Flow Volume	1110000000	gal
Percentage	0.01435	
Reactor Dose	43.04	mL

Assumptions:
Receive peak waste during summer months (June, July, August) when use of portable toilets is at a peak. Receive the waste out of the 60 days in 6 hour periods throughout the 8 hour workday.

7.5 Appendix F – Iron Addition Calculation and Plan

NS Treatment plant Iron Addition

Iron addition rate =	3000	lbs/day Fe
Flow Rate =	19	MGD
Fe Dose =	18.93	mg/L Fe

FeCl3 Stock Solution in Lab

FeCl3 Stock =	341	g/L FeCl3
As Fe =	117	g/L Fe

Day 1

Reactor	NS Mixed Liquor (L)	Fe Dose (mg/L Fe)	Fe Stock (uLs)	VIP SE (L)
A	1	0	0	2
B	1	20	511	2
C	1	35	895	2
D	1	50	1278	2

- Add 1.0 L NS mixed liquor to each reactor
- Add 2 L of VIP SE, and start pH and DO control
- Wait 10 Min
- Record pH
- Add FeCl3 stock solution to Reactors B, C, D
- Add Corresponding Alkalinity
- Record pH reduction immediately after Fe Addition
- Wait 2 hours

-Start experiment as normal

Day 2

Reactor	VIP Mixed Liquor (L)	Fe Dose (mg/L Fe)	Fe Stock (uLs)	VIP SE (L)
A	1	0	0.0	2
B	1	20	170.4	2
C	1	35	298.2	2
D	1	50	426.0	2

- Add 1.0 L VIP mixed liquor to each reactor
- Start aeration and wait ~10 min
- measure pH by dipping calibrated probe into top of reactor
- Add FeCl3 stock solution to Reactors B, C, D
- Wait 2 hours
- measure pH by dipping calibrated probe into top of reactor

- Add 2 L of VIP SE, and start pH and DO control
- Wait for all pH and DO to stabilize at setpoint
- Wait at least 15-20 min

-Start experiment as normal

7.6 Appendix G – Weekly Profile Sampling Data

Week 1 – 7/23/09

Date	Sample Time	Time from Start to Finish	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	min			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
23-Jul-09	7:15	0	PE	-	31.80	0.00	0.07	0.07	6.30	1.66	6.99
23-Jul-09	7:24	9	AA1	Anaerobic	19.10	0.00	0.05	0.05	21.46	0.06	7.00
23-Jul-09	7:58	43	AA2	Anaerobic	20.10	0.00	0.03	0.03	23.98	0.12	7.05
23-Jul-09	8:32	77	AA3	Anaerobic	20.00	0.00	0.03	0.03	24.15	0.05	7.01
23-Jul-09	9:06	111	AA4	Anoxic	9.25	0.00	1.21	1.21	8.48	0.06	6.98
23-Jul-09	9:24	129	AA5	Anoxic	9.10	0.00	0.95	0.95	7.90	0.07	6.97
23-Jul-09	9:42	147	AA6	Anoxic	10.30	0.00	0.08	0.08	7.73	0.03	6.94
23-Jul-09	10:00	165	AER1	Aerobic	12.35	0.00	0.06	0.06	10.70	0.04	7.01
23-Jul-09	10:32	197	AER2	Aerobic	2.87	0.00	2.48	2.48	1.53	3.10	6.87
23-Jul-09	11:04	229	AER3	Aerobic	2.84	5.77	2.95	8.72	0.82	2.83	6.85
23-Jul-09	11:36	261	AER4	Aerobic	0.00	7.89	2.65	10.54	0.25	2.78	6.84
23-Jul-09	12:08	293	AER5	Aerobic	0.00	8.86	2.08	10.94	0.25	1.71	6.89
23-Jul-09	12:11	296	IDC	-	0.00	8.86	1.81	10.67	0.24	3.20	6.90
23-Jul-09	15:11	476	SE	-	0.00	8.71	1.65	10.36	0.18	3.18	7.02
23-Jul-09	15:27	492	RAS	-	1.16	0.00	0.81	0.81	5.16	0.10	6.98

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
12.60	3940	2.09	6.84				

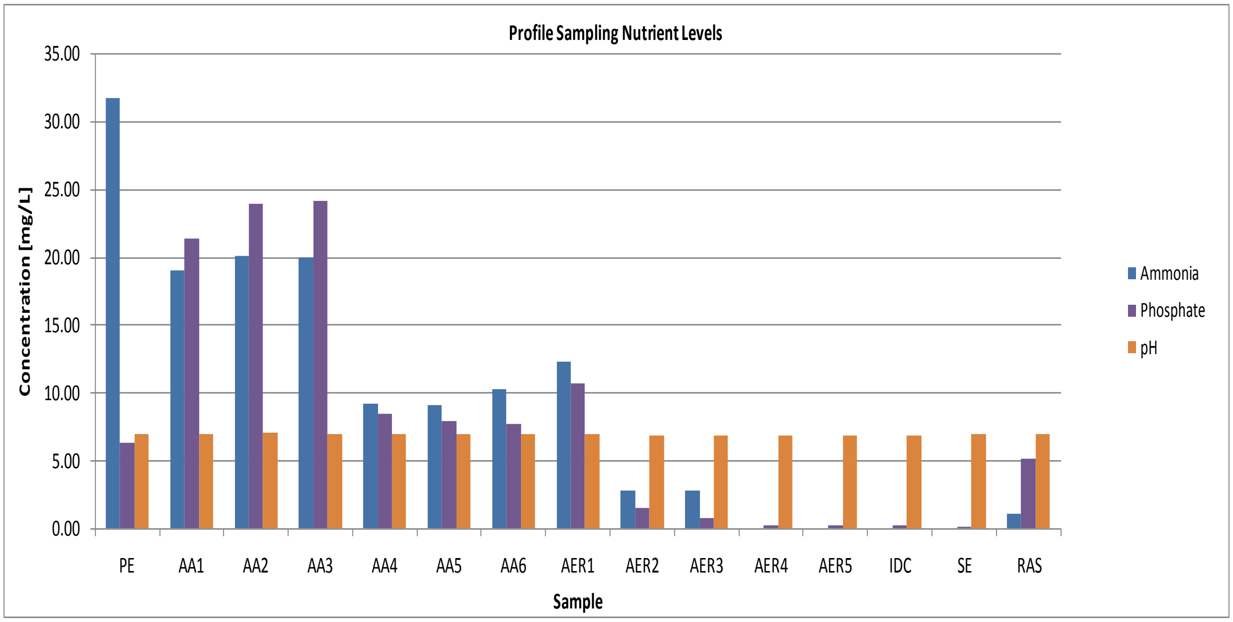
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration	AA4 NOx-N	AA6 NOx-N
[mg/L]	[mg/L/hr]	mg/g MLVSS/hr	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2.95			0.0000	10.6700	0.2	17.85	0.000	1.21	0.08

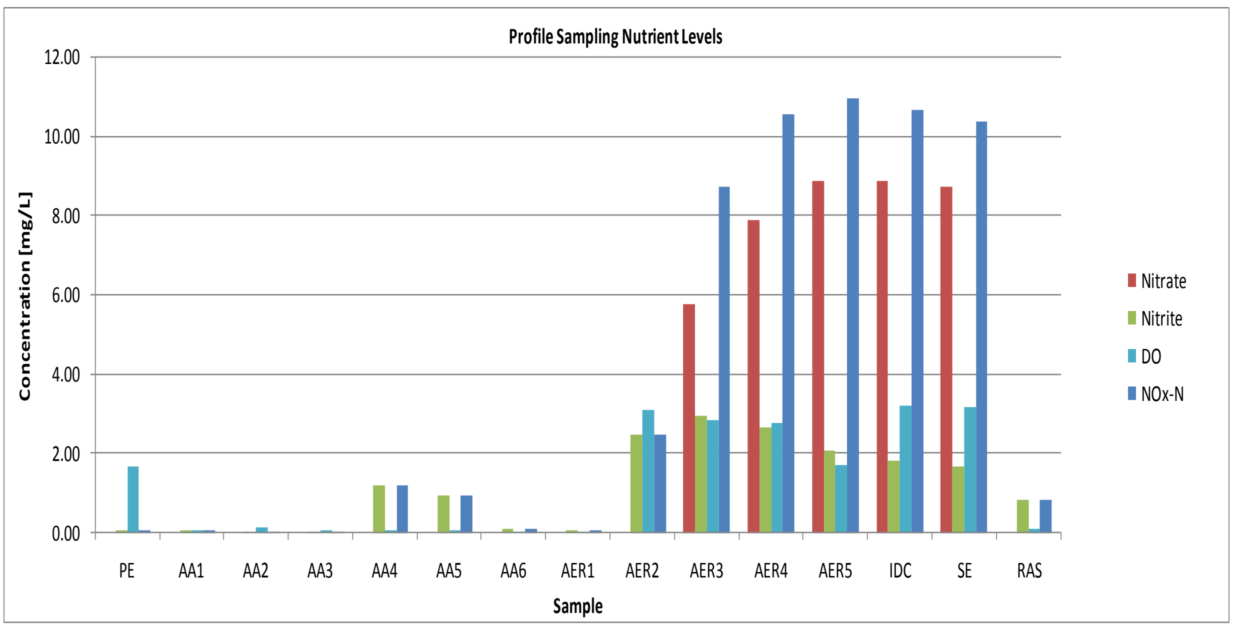
AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
1000	24.000	4.000	18.14	18.84	11.832	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
2360	69	1628	3940	65	2561	3940	65	2561





Week 2 – 7/27/09 & 7/29/09

PROFILE 1:	Train 7, Aeration Tank 4, Clarifier 4										
Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
27-Jul-09	7:46	0	PE	-	33.80	0.61	0.02	0.64	8.35	0.79	7.01
27-Jul-09	8:13	1.15	AA1	Anaerobic	20.80	0.39	0.02	0.41	24.72	0.07	7.08
27-Jul-09	8:43	2.31	AA2	Anaerobic	20.30	0.33	0.01	0.34	36.79	0.06	7.05
27-Jul-09	9:13	3.46	AA3	Anaerobic	19.90	0.45	0.03	0.48	25.94	0.08	7.03
27-Jul-09	9:43	4.61	AA4	Anoxic	9.60	1.92	0.98	2.90	9.79	0.05	7.01
27-Jul-09	10:00	5.76	AA5	Anoxic	9.35	0.51	1.05	1.56	9.50	0.09	7.02
27-Jul-09	10:19	6.92	AA6	Anoxic	9.65	0.41	0.05	0.46	9.85	0.05	7.04
27-Jul-09	10:35	0.00	AER1	Aerobic	12.75	0.35	0.11	0.46	13.87	0.05	7.05
27-Jul-09	11:05	1.79	AER2	Aerobic	3.69	5.56	2.40	7.96	4.11	2.28	6.86
27-Jul-09	11:35	3.57	AER3	Aerobic	1.12	7.79	2.44	10.23	1.61	2.14	6.87
27-Jul-09	12:05	5.36	AER4	Aerobic	0.00	9.62	0.98	10.60	2.00	2.83	6.96
27-Jul-09	12:35	7.15	AER5	Aerobic	0.00	10.30	0.42	10.72	0.46	1.95	6.96
27-Jul-09	12:40		IDC	-	0.00	10.20	0.32	10.52	0.32	2.33	6.98
27-Jul-09	15:46		SE	-	0.00	10.40	0.42	10.82	0.42	3.41	7.11
27-Jul-09	16:13		RAS	-	1.16	0.95	2.72	3.67	2.22	0.07	7.07

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
202					
65					
63					
65					
48					
54					
48					
57					
48					
49					
46					
44					
50					
50	-	<0.20	12.3	11.9	0.43
51					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
14.31	4060	1.85	6.86	1.63	0.61	1.83	0.68

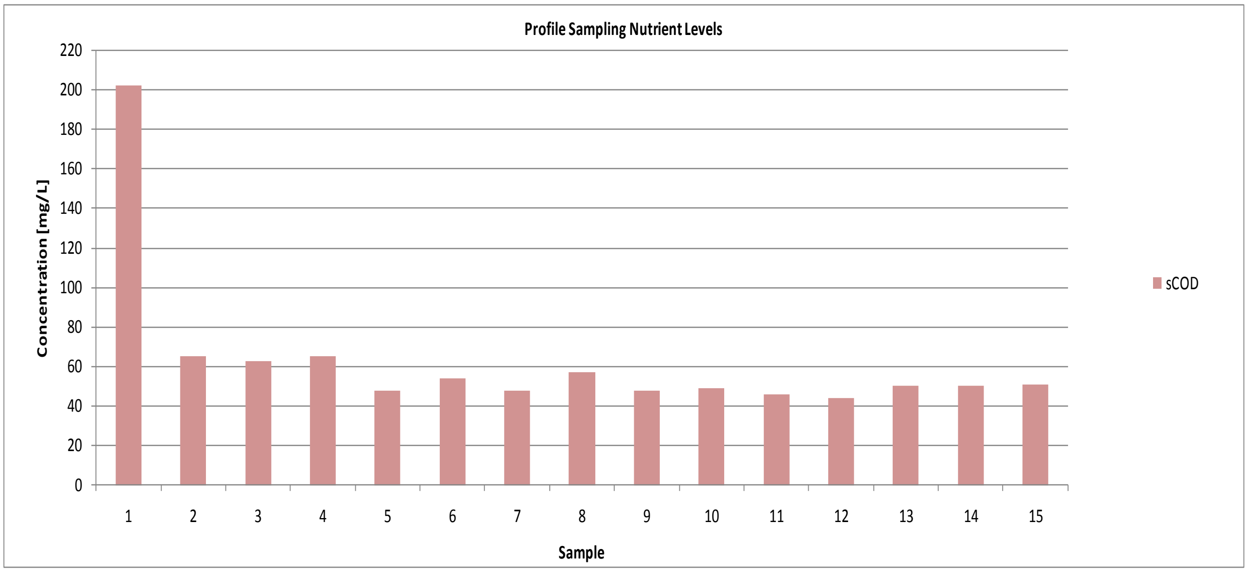
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2.44	2.13	0.80	0.0000	10.5200	0.3	28.44	0.669

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
2.90	0.46	13.53	14.43	10.50	11.21	2.16	2.31

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-1.07	-0.40	-0.05	-0.02	1.03	0.39	50.40	53.78	0.27

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.11	19.02	11.117	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1320	71	937	4060	66	2680	4060	66	2680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Concentration [mg/L]
Sample
sCOD
0
20
40
60
80
100
120
140
160
180
200
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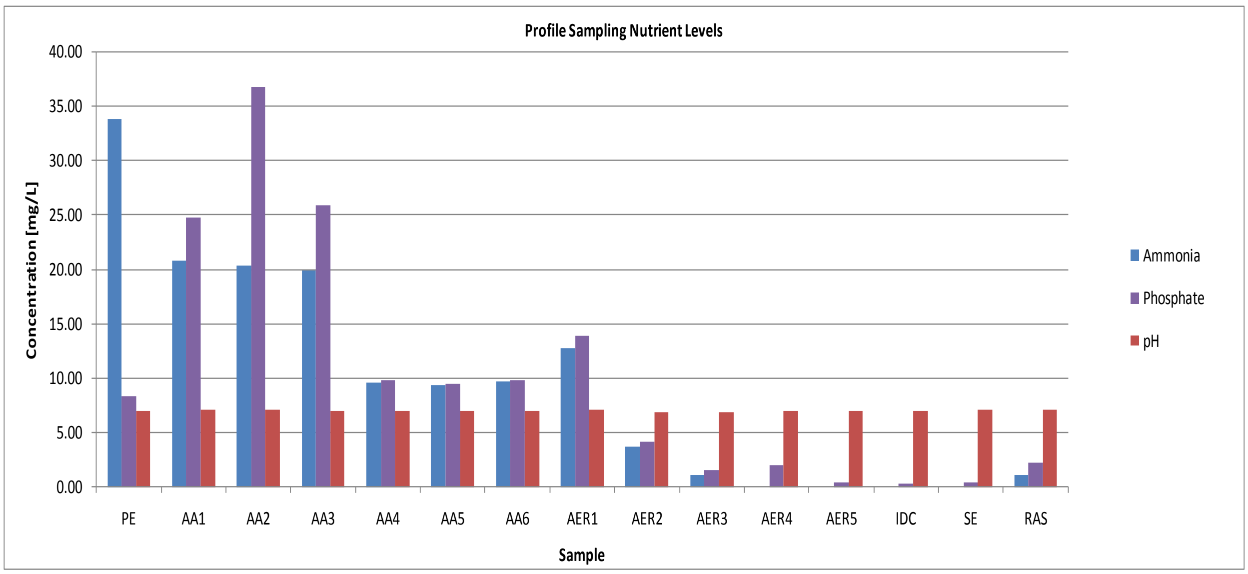
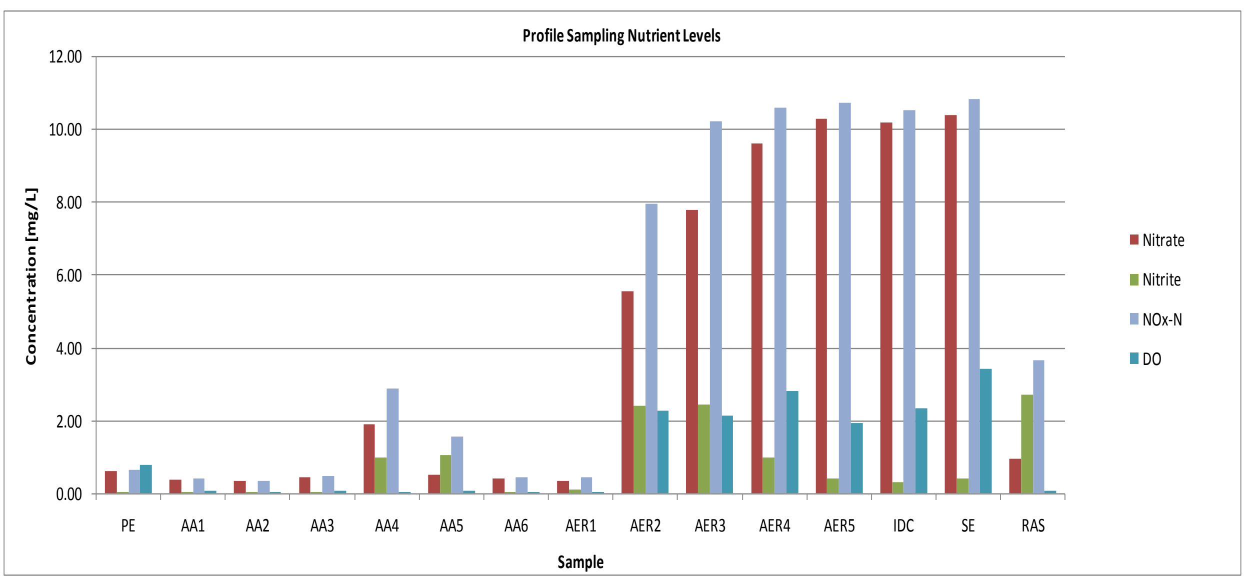
11
12
13
14
15


Profile Sampling Nutrient Levels
Concentration [mg/L]
Sample
Ammonia
Phosphate
pH
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS


Profile Sampling Nutrient Levels
Concentration [mg/L]
Sample
Nitrate
Nitrite
NOx-N
DO
0.00
2.00
4.00
6.00
8.00
10.00
12.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS

PROFILE 2: Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
29-Jul-07	7:15	0	PE	-	33.00	0.39	0.03	0.42	8.08	0.92	7.19
29-Jul-07	7:24	1.08	AA1	Anaerobic	21.90	0.27	0.02	0.28	28.23	0.13	7.15
29-Jul-07	7:58	2.16	AA2	Anaerobic	21.00	0.35	0.01	0.36	23.98	0.07	7.11
29-Jul-07	8:32	3.25	AA3	Anaerobic	22.10	0.26	0.01	0.26	25.78	0.06	7.11
29-Jul-07	9:06	4.33	AA4	Anoxic	13.20	1.52	0.79	2.31	13.71	0.09	7.09
29-Jul-07	9:24	5.41	AA5	Anoxic	13.00	0.44	0.73	1.17	13.64	0.07	7.10
29-Jul-07	9:42	6.49	AA6	Anoxic	13.10	0.28	0.05	0.33	13.48	0.06	7.07
29-Jul-07	10:00	0.00	AER1	Aerobic	12.70	0.30	0.08	0.38	13.71	0.10	7.10
29-Jul-07	10:32	1.79	AER2	Aerobic	4.34	5.55	1.88	7.43	5.06	2.64	6.91
29-Jul-07	11:04	3.57	AER3	Aerobic	1.37	8.17	2.10	10.27	2.03	2.20	6.89
29-Jul-07	11:36	5.36	AER4	Aerobic	0.00	10.50	0.62	11.12	0.72	3.34	6.98
29-Jul-07	12:08	7.15	AER5	Aerobic	0.00	11.60	0.16	11.76	0.41	2.31	6.96
29-Jul-07	12:11		IDC	-	0.00	12.10	0.12	12.22	0.32	2.74	6.97
SAMPLE NOT COLLECTED			SE	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAMPLE NOT COLLECTED			RAS	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample: NONE

EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
171	-	-	-	-	-
67					
66					
65					
53					
56					
50					
47					
49					
45					
40					
40					
42					
0					
0					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
12.59	4220	2.12	6.89	1.66	0.60	1.96	0.70

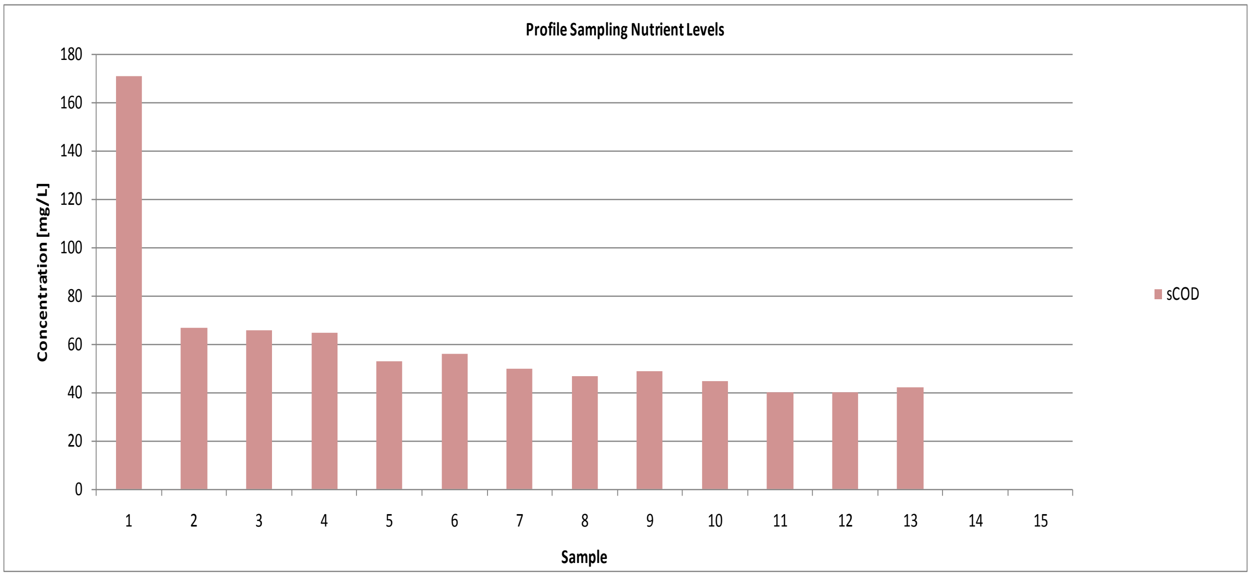
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2.10	2.35	0.84	0.0000	12.2200	0.3	20.15	0.519

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
2.31	0.33	16.13	14.94	4.30	3.98	4.08	3.77

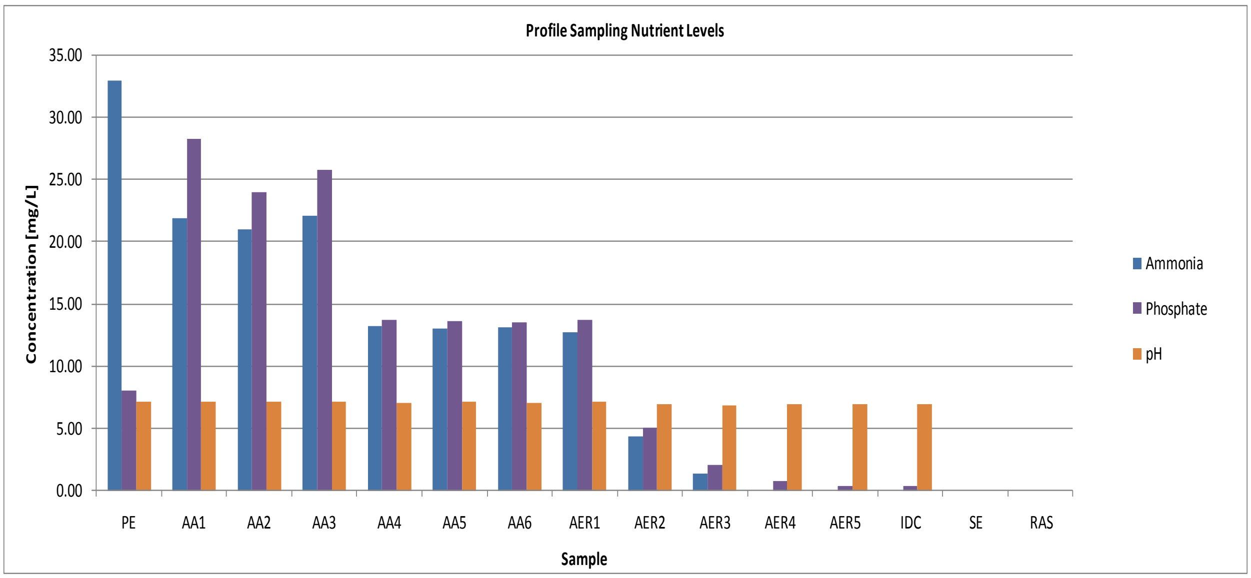
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.14	-0.05	-0.01	0.00	0.58	0.21	40.45	37.45	0.40

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.29	19.11	11.811	19.5

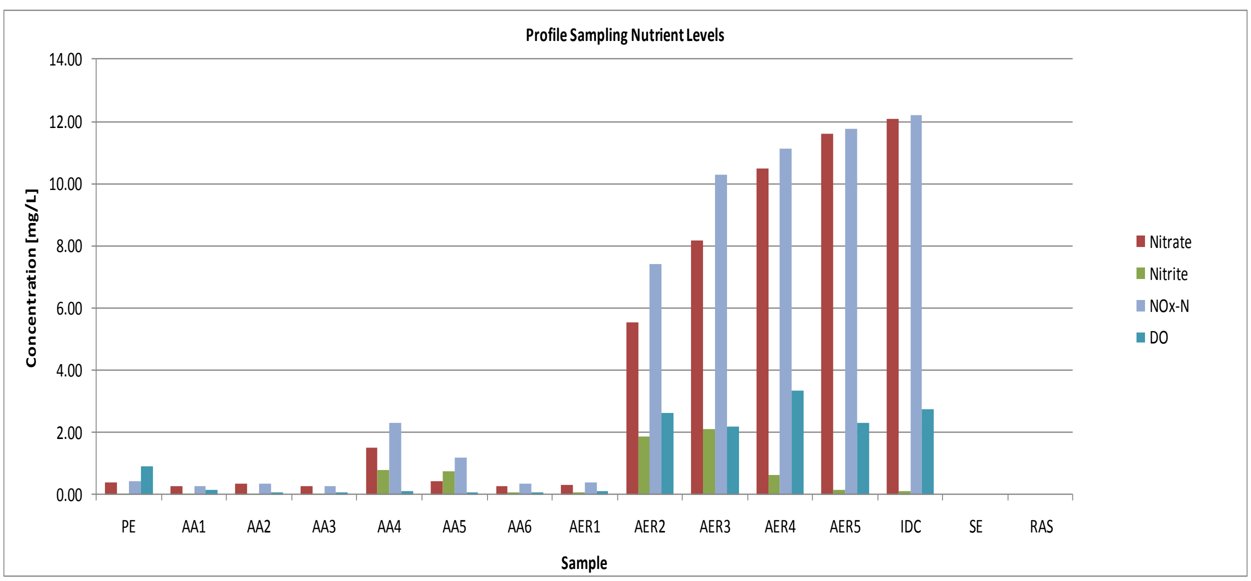
ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1500	72	1080	4220	66	2785	4220	66	2785



Profile Sampling Nutrient Levels
Concentration [mg/L]
180
160
140
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Sample
sCOD



Profile Sampling Nutrient Levels
Concentration [mg/L]
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH



Profile Sampling Nutrient Levels
Concentration [mg/L]
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

Week 3 – 8/5/09 & 8/6/09

PROFILE 1:	Train 5, Aeration Tank 5, Clarifier 5										
Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
5-Aug-09	7:46	0	PE	-	35.20	0.44	0.04	0.47	7.02	0.30	6.97
5-Aug-09	8:13	1.15	AA1	Anaerobic	20.90	0.24	0.01	0.25	26.43	0.06	7.06
5-Aug-09	8:43	2.30	AA2	Anaerobic	20.50	0.35	0.02	0.37	29.04	0.07	7.05
5-Aug-09	9:13	3.45	AA3	Anaerobic	21.30	0.27	0.02	0.29	30.92	0.06	7.05
5-Aug-09	9:43	4.60	AA4	Anoxic	12.15	0.73	0.80	1.53	16.64	0.07	7.03
5-Aug-09	10:00	5.75	AA5	Anoxic	12.05	0.24	0.03	0.27	14.95	0.07	7.03
5-Aug-09	10:19	6.90	AA6	Anoxic	12.20	0.25	0.02	0.27	15.89	0.06	7.01
5-Aug-09	10:35	0.00	AER1	Aerobic	12.75	0.30	0.04	0.34	40.63	0.07	7.04
5-Aug-09	11:05	1.78	AER2	Aerobic	2.66	6.00	1.44	7.44	6.79	2.28	6.89
5-Aug-09	11:35	3.56	AER3	Aerobic	0.00	8.45	0.82	9.27	1.66	2.32	6.88
5-Aug-09	12:05	5.34	AER4	Aerobic	0.00	9.36	0.16	9.52	0.44	2.97	6.92
5-Aug-09	12:35	7.13	AER5	Aerobic	0.00	9.98	0.04	10.02	0.26	0.30	6.94
5-Aug-09	12:40		IDC	-	0.00	10.30	0.03	10.33	0.26	2.80	6.96
5-Aug-09	15:46		SE	-	0.00	10.40	0.08	10.48	0.30	3.24	7.23
5-Aug-09	16:13		RAS	-	1.23	1.48	1.74	3.22	5.61	0.08	7.03

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
173					
58					
60					
62					
51					
50					
50					
50					
45					
<25					
41					
39					
37					
34	0.234	<0.20	11.2	11.2	<0.01
56					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
9.81	3760	1.59	6.88	1.58	0.59	1.65	0.62

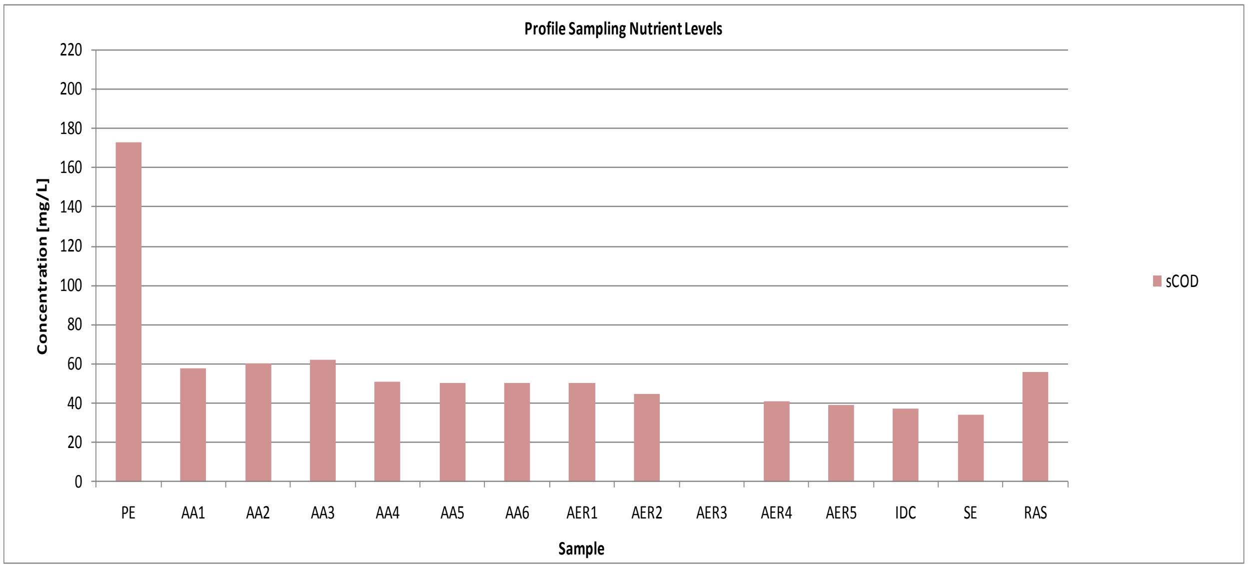
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.44	7.06	2.64	0.0000	10.3300	0.3	23.90	0.346

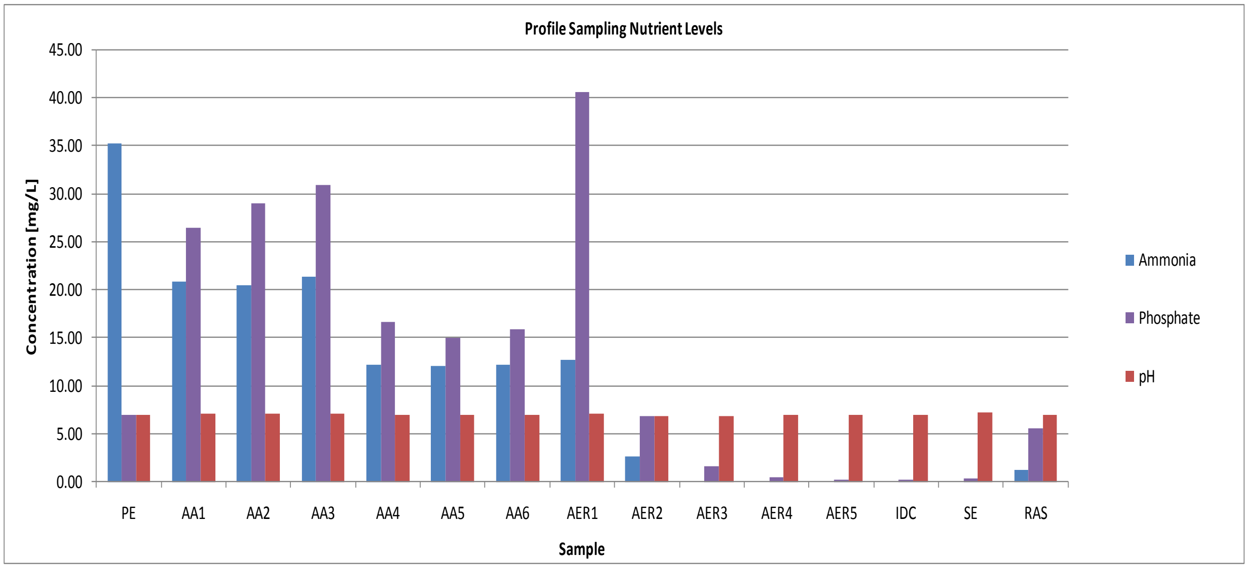
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.53	0.27	12.90	6.96	6.84	3.69	4.74	2.56

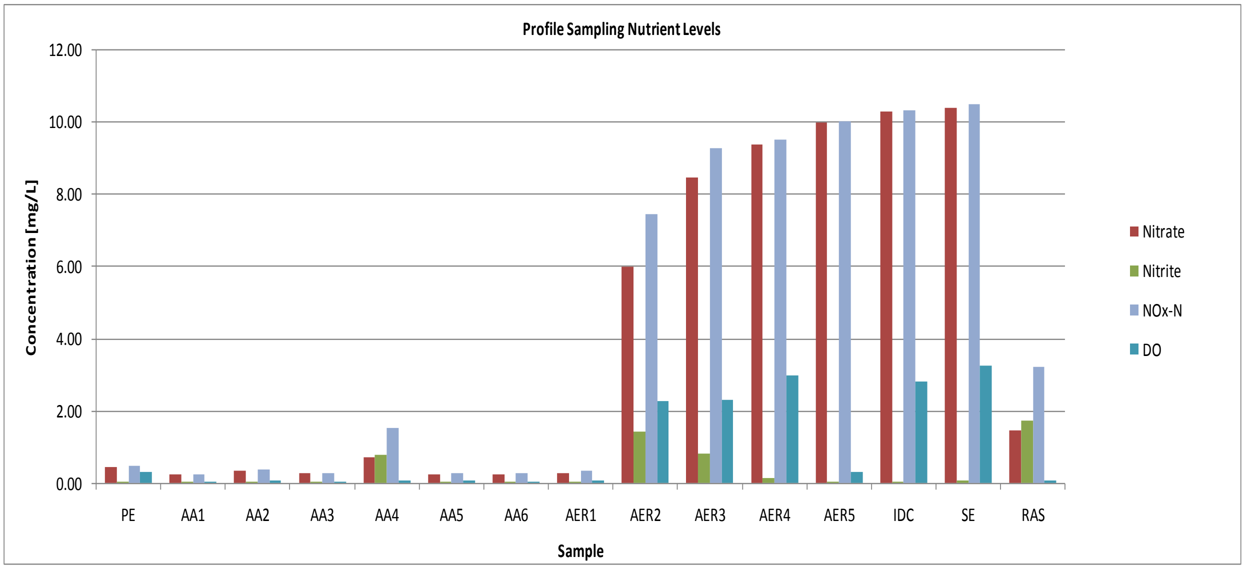
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.30	-0.11	-0.30	-0.11	4.38	1.64	44.79	24.15	0.29

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.16	19.38	11.087	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
2440	76	1854	3760	71	2670	3760	71	2670


Profile Sampling Nutrient Levels
Concentration [mg/L]
Sample
sCOD
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS


Profile Sampling Nutrient Levels
Concentration [mg/L]
Sample
Ammonia
Phosphate
pH
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS


Profile Sampling Nutrient Levels
Concentration [mg/L]
Sample
Nitrate
Nitrite
NOx-N
DO
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS

PROFILE 2:	Train 4, Aeration Tank 4, Clarifier 4										
Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
6-Aug-09	7:15	0	PE	-	36.10	0.62	0.03	0.65	8.89	1.04	7.05
6-Aug-09	7:24	0.97	AA1	Anaerobic	23.80	0.29	0.02	0.31	32.63	0.09	7.13
6-Aug-09	7:58	1.93	AA2	Anaerobic	23.30	0.32	0.01	0.33	35.57	0.07	7.11
6-Aug-09	8:32	2.90	AA3	Anaerobic	24.00	0.26	0.01	0.28	37.53	0.05	7.09
6-Aug-09	9:06	3.86	AA4	Anoxic	13.60	0.68	0.87	1.55	20.31	0.06	7.06
6-Aug-09	9:24	4.83	AA5	Anoxic	13.70	0.25	0.03	0.28	20.56	0.05	7.06
6-Aug-09	9:42	5.79	AA6	Anoxic	14.25	0.27	0.03	0.30	21.21	0.09	7.06
6-Aug-09	10:00	0.00	AER1	Aerobic	13.55	0.32	0.06	0.38	21.13	0.09	7.05
6-Aug-09	10:32	1.78	AER2	Aerobic	2.49	8.31	1.66	9.97	6.10	1.64	6.86
6-Aug-09	11:04	3.56	AER3	Aerobic	0.00	10.60	0.62	11.22	1.50	2.75	6.86
6-Aug-09	11:36	5.34	AER4	Aerobic	0.00	11.60	0.05	11.65	0.29	2.14	6.88
6-Aug-09	12:08	7.13	AER5	Aerobic	0.00	11.70	0.06	11.76	0.22	0.13	6.93
6-Aug-09	12:11		IDC	-	0.00	11.70	0.02	11.72	0.16	2.46	6.93
SAMPLE NOT COLLECTED			SE	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAMPLE NOT COLLECTED			RAS	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	NONE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
228	-	-	-	-	-
77					
70					
77					
56					
38					
47					
60					
40					
38					
34					
52					
35					
0					
0					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
9.93	4000	1.35	6.86	1.66	0.58	1.97	0.68

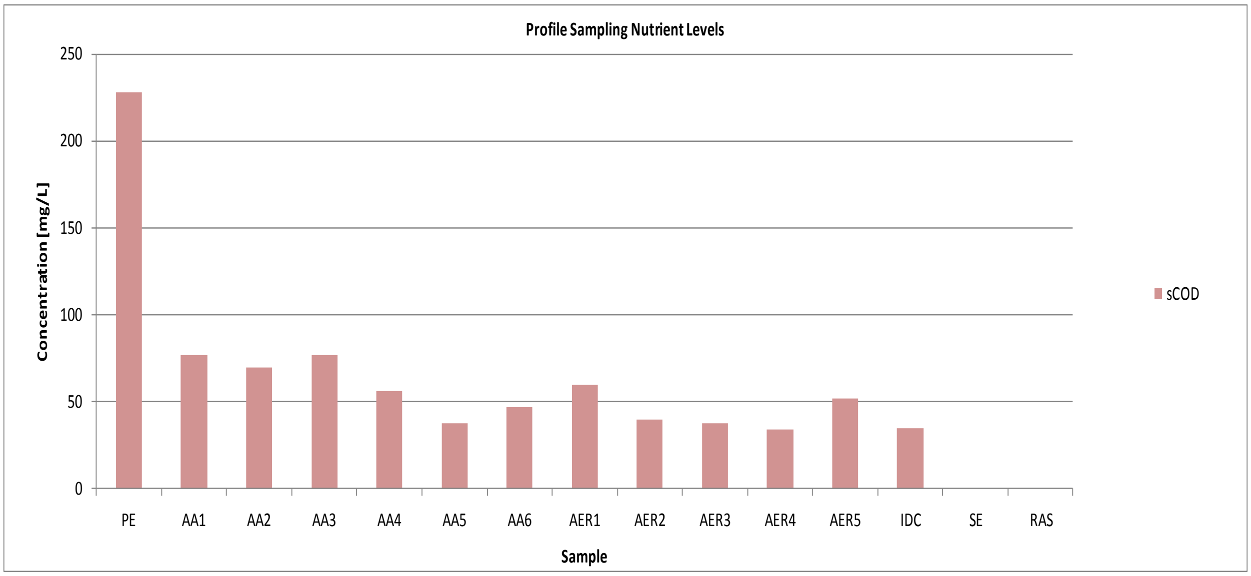
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.66	3.77	1.31	0.0000	11.7200	0.2	28.63	0.345

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.55	0.30	18.52	12.77	9.32	6.42	6.36	4.38

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.19	-0.06	0.05	0.02	1.07	0.37	67.19	46.33	0.28

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	21.63	19.64	13.08	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1960	74	1450	4000	72	2880	4000	72	2880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AA1
AA2
AA3
AA4
AA5
AA6
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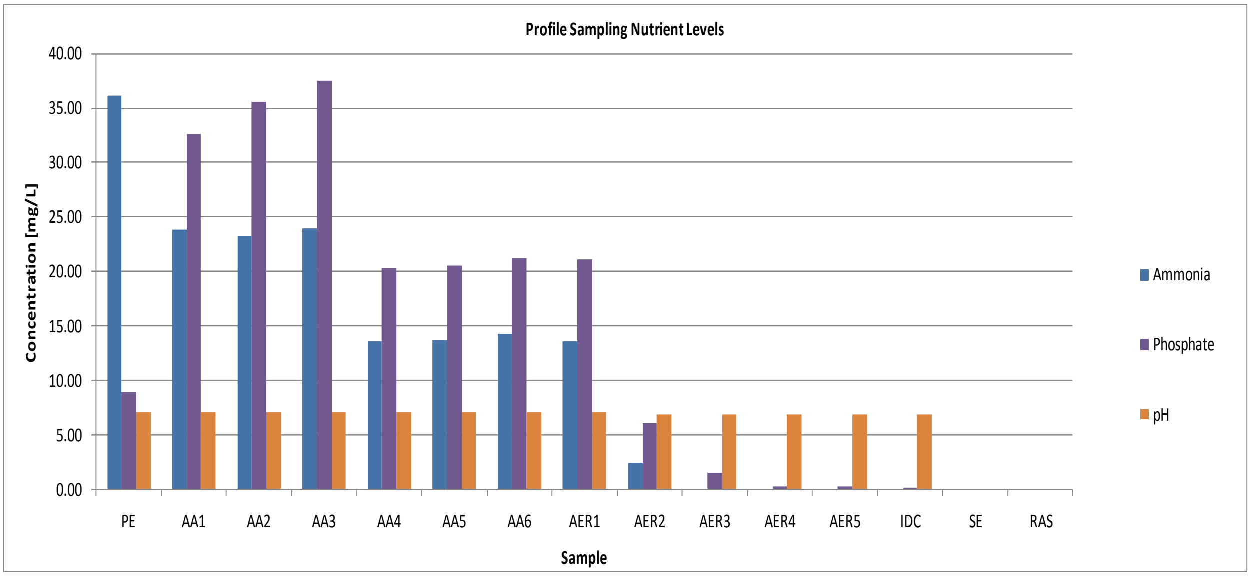
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
sCOD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10.00
5.00
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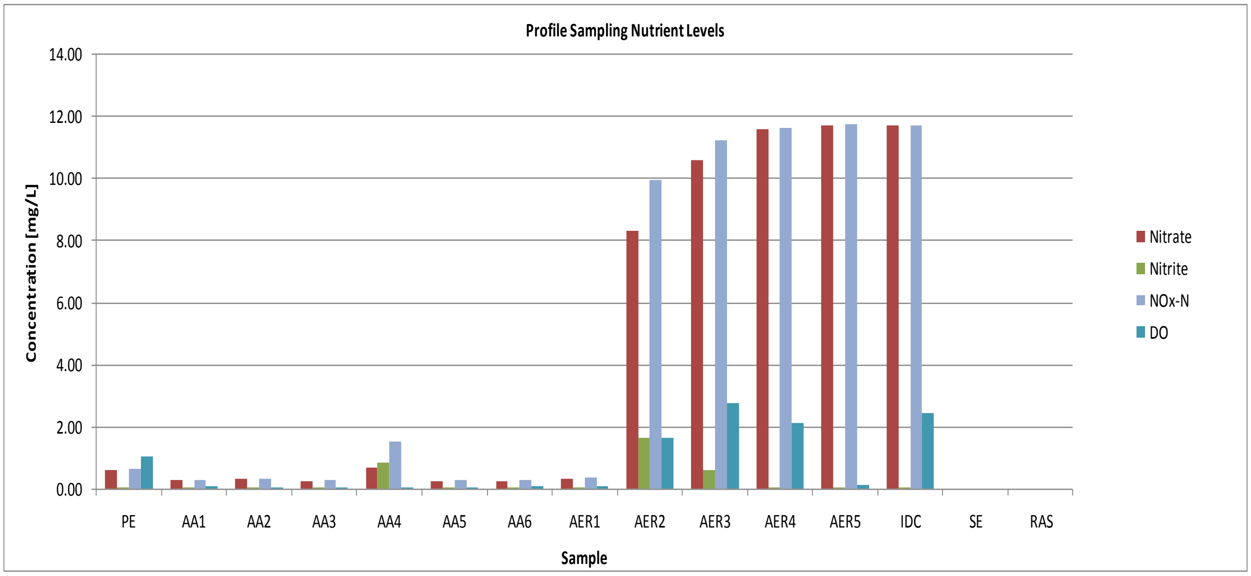
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH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AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

Week 4 – 8/10/09 & 8/12/09

PROFILE 1: Train 5, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
10-Aug-09	6:54	0	PE	-	37.40	0.68	0.04	0.72	9.87	2.10	7.02
10-Aug-09	7:10	1.10	AA1	Anaerobic	19.90	0.24	0.01	0.25	29.94	0.05	7.04
10-Aug-09	7:40	2.19	AA2	Anaerobic	20.30	0.26	0.01	0.27	32.14	0.08	7.03
10-Aug-09	8:10	3.29	AA3	Anaerobic	20.90	0.26	0.01	0.27	34.51	0.05	7.02
10-Aug-09	8:40	4.38	AA4	Anoxic	13.05	1.25	0.60	1.85	20.07	0.06	7.01
10-Aug-09	8:55	5.48	AA5	Anoxic	13.00	0.26	0.02	0.28	20.15	0.08	6.99
10-Aug-09	9:10	6.57	AA6	Anoxic	12.85	0.26	0.02	0.29	20.56	0.07	6.98
10-Aug-09	9:25	0.00	AER1	Aerobic	13.45	0.33	0.05	0.38	22.68	0.06	6.97
10-Aug-09	9:55	1.70	AER2	Aerobic	1.82	7.90	1.36	9.26	6.27	2.83	6.78
10-Aug-09	10:25	3.39	AER3	Aerobic	0.00	9.24	0.76	10.00	3.18	3.06	6..79
10-Aug-09	10:55	5.09	AER4	Aerobic	0.00	10.30	0.05	10.35	0.77	2.76	6.78
10-Aug-09	11:25	6.79	AER5	Aerobic	0.00	10.90	0.03	10.93	0.33	0.04	6.83
10-Aug-09	11:34		IDC	-	0.00	11.00	0.03	11.03	0.30	2.64	6.87
10-Aug-09	14:34		SE	-	0.00	10.90	0.04	10.94	0.22	3.04	7.17
10-Aug-09	14:50		RAS	-	0.00	3.05	1.81	4.86	2.15	0.16	7.02

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample: SE

EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
193					
54					
59					
54					
44					
47					
46					
49					
36					
37					
40					
36					
42					
35	0.218	<0.20	11.4	11.4	0.02
66					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
8.12	3700	1.75	6.78	1.69	0.65	1.81	0.70

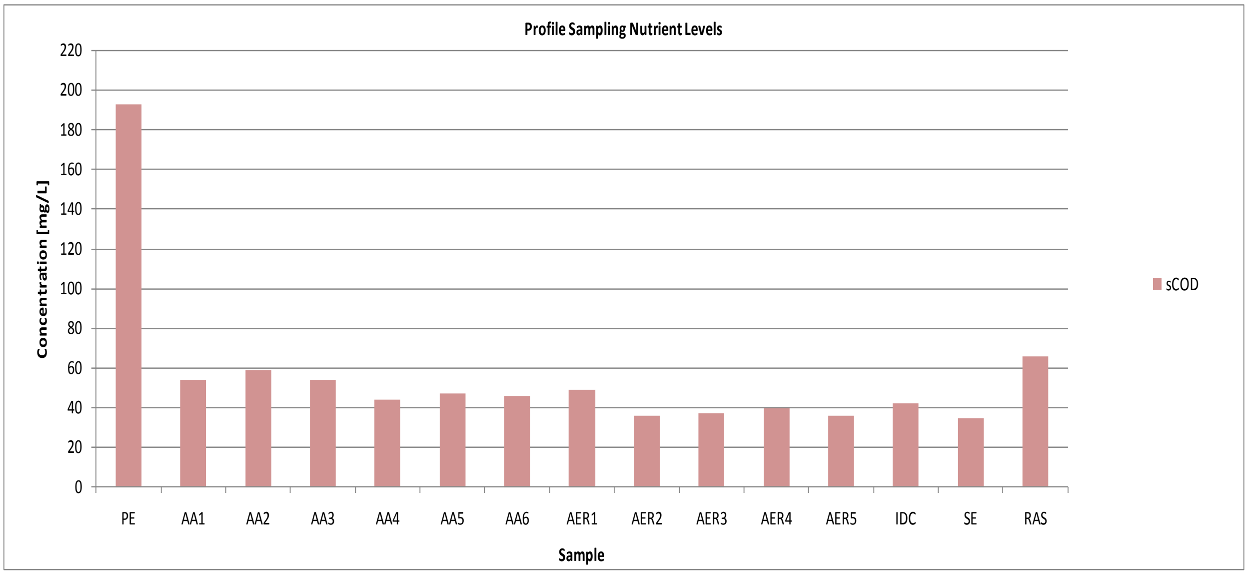
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.36	4.05	1.57	0.0000	11.0250	0.3	24.64	0.422

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.85	0.29	13.44	16.45	7.61	9.30	5.46	6.67

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.15	0.06	0.01	0.01	1.24	0.48	59.83	73.18	0.22

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.06	19.04	11.731	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1090	75	818	3700	70	2590	3700	70	2590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140
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100
80
60
40
20
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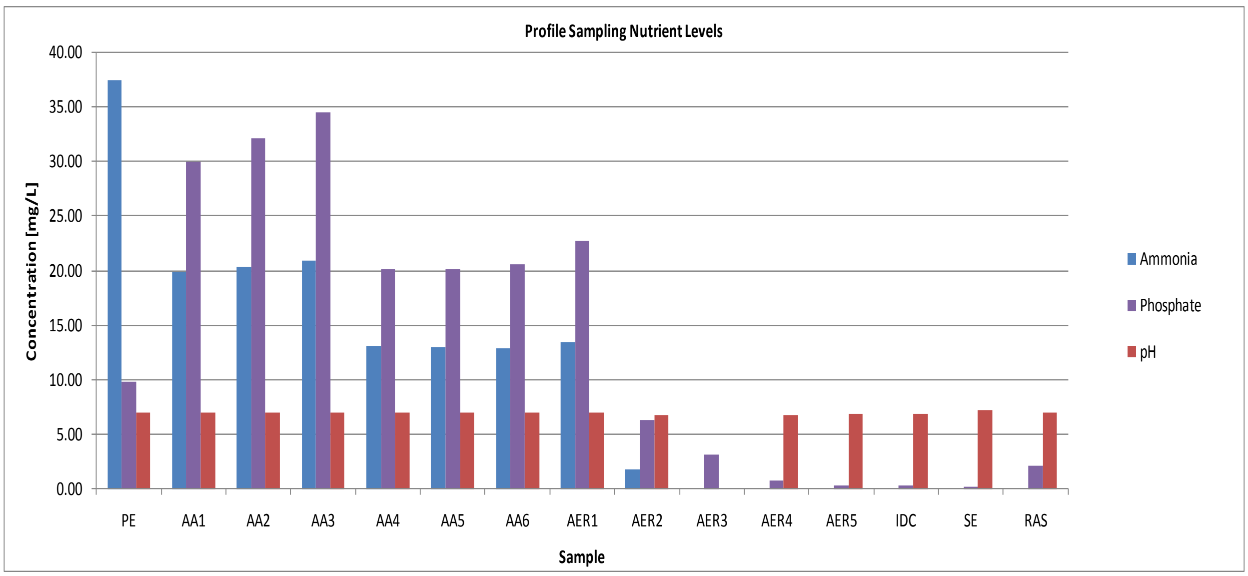
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
sCOD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Concentration [mg/L]
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5.00
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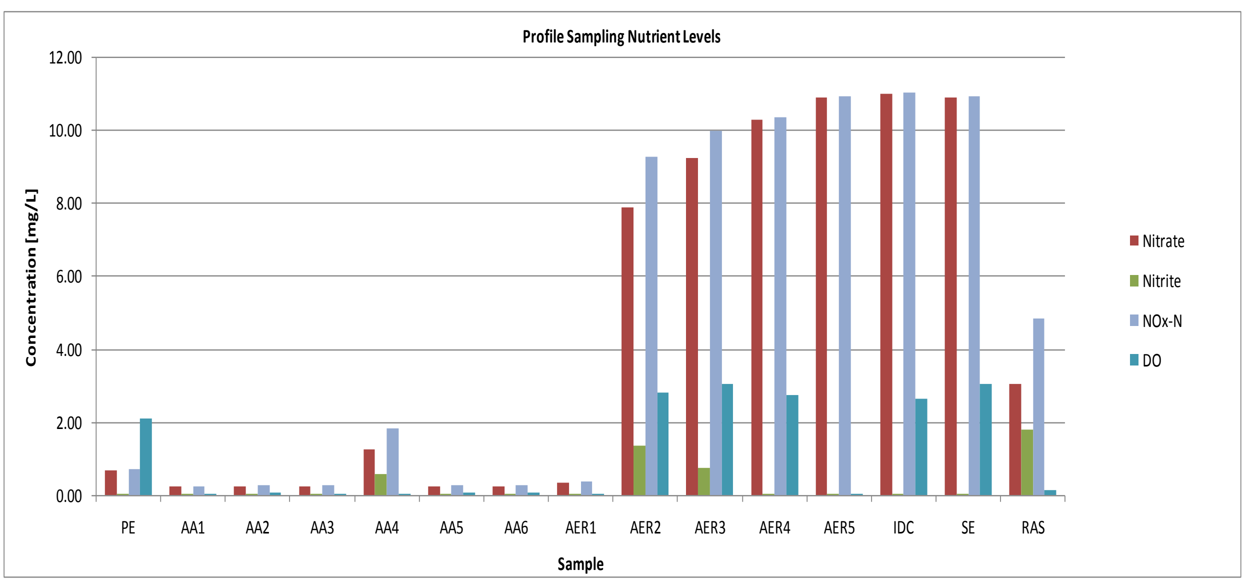
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH


Profile Sampling Nutrient Levels
Concentration [mg/L]
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8.00
6.00
4.00
2.00
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PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

PROFILE 2:	Train 4, Aeration Tank 4, Clarifier 4										
Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
12-Aug-09	7:52	0	PE	-	34.00	0.53	0.04	0.58	11.01	0.40	7.11
12-Aug-09	8:07	1.05	AA1	Anaerobic	22.20	0.36	0.02	0.38	29.86	0.07	7.17
12-Aug-09	8:37	2.10	AA2	Anaerobic	22.50	0.33	0.02	0.34	34.02	0.08	7.12
12-Aug-09	9:07	3.15	AA3	Anaerobic	22.40	0.28	0.03	0.30	34.43	0.06	7.11
12-Aug-09	9:37	4.21	AA4	Anoxic	13.55	1.18	0.56	1.74	20.15	0.06	7.05
12-Aug-09	9:52	5.26	AA5	Anoxic	13.35	0.42	0.31	0.73	20.15	0.06	7.04
12-Aug-09	10:07	6.31	AA6	Anoxic	13.20	0.00	0.02	0.02	20.64	0.08	7.06
12-Aug-09	10:22	0.00	AER1	Aerobic	13.30	0.25	0.02	0.27	21.05	0.10	7.05
12-Aug-09	10:58	1.70	AER2	Aerobic	2.70	7.79	1.76	9.55	8.78	2.91	6.86
12-Aug-09	11:22	3.39	AER3	Aerobic	0.00	10.70	0.64	11.34	3.59	4.03	6.88
12-Aug-09	11:52	5.09	AER4	Aerobic	0.00	12.00	0.04	12.04	1.25	3.05	6.91
12-Aug-09	12:22	6.79	AER5	Aerobic	0.00	12.20	0.03	12.23	0.63	1.48	6.91
12-Aug-09	12:27		IDC	-	0.00	11.80	0.02	11.82	0.38	3.26	6.92
12-Aug-09	15:37		SE	-	0.00	12.00	0.03	12.03	0.38	2.68	7.10
12-Aug-09	15:56		RAS	-	0.00	4.47	1.73	6.20	2.19	0.06	6.98

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	IDC					
	EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	$O\text{-}PO_4$	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N	
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L	
183						
67						
69						
63						
50						
49						
46						
47						
42						
42						
43						
36						
38	0.484	<0.20	13.1	13.1	0.03	
39						
59						

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
8.34	3640	2.31	6.86	1.73	0.66	2.19	0.83

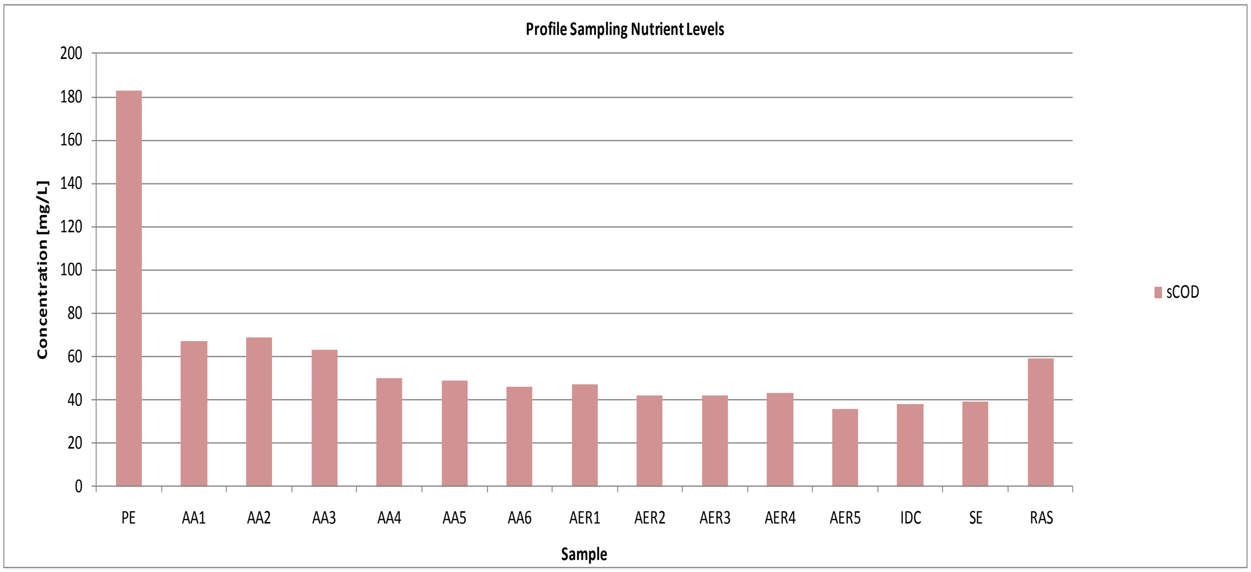
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.76	3.81	1.45	0.0000	11.8200	0.4	23.41	0.427

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.74	0.02	13.45	9.12	8.69	5.90	5.25	3.56

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.14	0.05	0.00	0.00	1.03	0.39	46.59	31.60	0.29

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.86	19.02	11.943	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1820	81	1474	3640	72	2621	3640	72	2621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AA2
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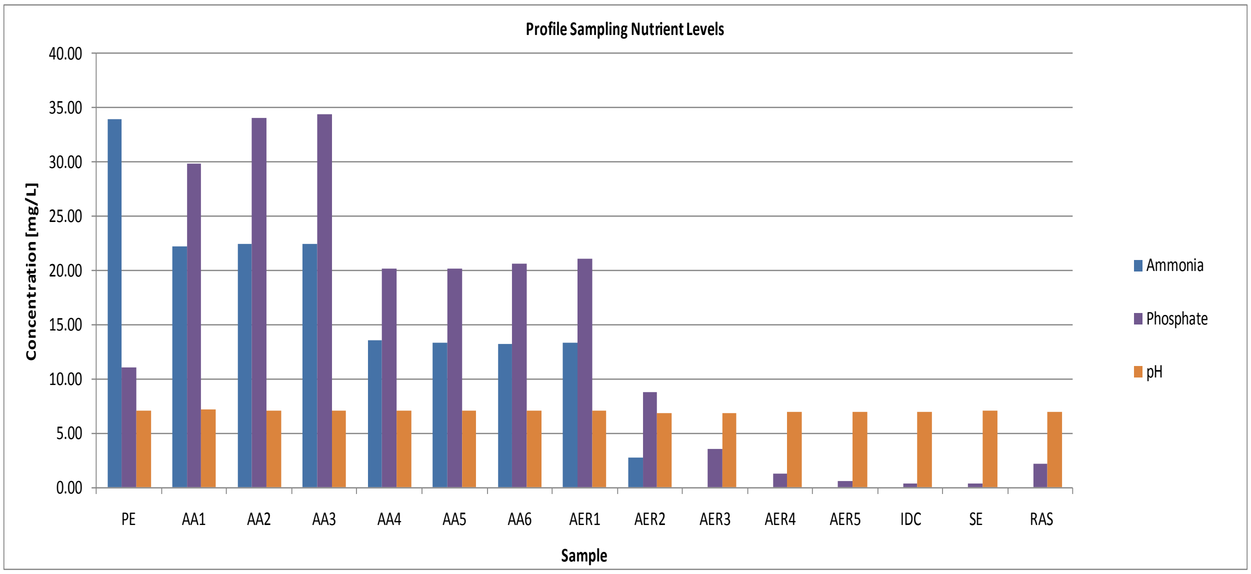
SE
RAS
Sample
sCOD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Concentration [mg/L]
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5.00
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PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
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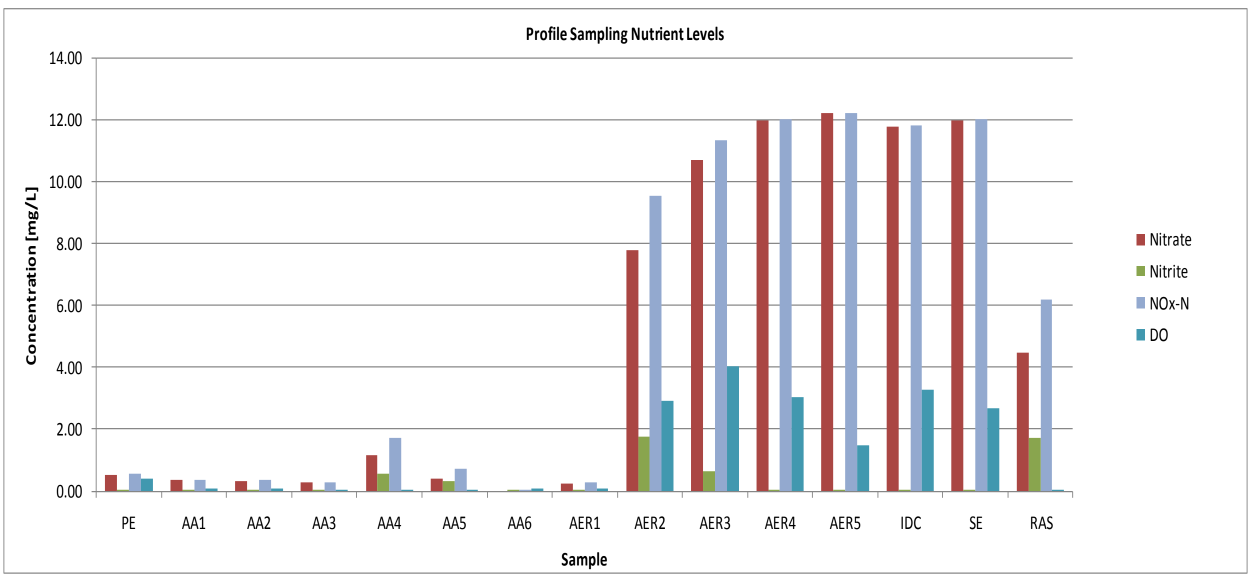
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH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Concentration [mg/L]
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6.00
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2.00
0.00
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AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

Week 5 – 8/17/09 & 8/20/09

PROFILE 1 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
17-Aug-09	6:55	0	PE	-	34.90	0.63	0.03	0.66	9.30	0.98	6.72
17-Aug-09	7:14	1.10	AA1	Anaerobic	19.40	0.29	0.01	0.30	33.04	0.06	7.05
17-Aug-09	7:44	2.20	AA2	Anaerobic	18.90	0.31	0.02	0.32	34.92	0.07	7.03
17-Aug-09	8:14	3.31	AA3	Anaerobic	19.40	0.25	0.01	0.26	37.04	0.11	7.00
17-Aug-09	8:44	4.41	AA4	Anoxic	11.70	0.47	0.21	0.68	22.92	0.08	6.99
17-Aug-09	9:00	5.51	AA5	Anoxic	12.00	0.24	0.01	0.25	23.17	0.06	6.98
17-Aug-09	9:15	6.61	AA6	Anoxic	12.10	0.25	0.02	0.27	23.82	0.05	7.00
17-Aug-09	9:30	0.00	AER1	Aerobic	12.25	0.29	0.02	0.31	24.31	0.10	6.97
17-Aug-09	10:00	0.85	AER2	Aerobic	1.55	7.34	0.90	8.24	7.57	2.04	6.80
17-Aug-09	10:30	1.71	AER3	Aerobic	0.00	8.92	0.22	9.14	3.25	2.57	6.80
17-Aug-09	11:00	3.41	AER4	Aerobic	0.00	9.41	0.03	9.44	0.82	1.87	6.82
17-Aug-09	11:30	6.83	AER5	Aerobic	0.00	10.10	0.04	10.14	0.46	0.09	6.83
17-Aug-09	11:37		IDC	-	0.00	10.20	0.03	10.23	0.39	2.20	6.92
17-Aug-09	15:00		SE	-	0.00	9.94	0.02	9.96	0.22	2.80	7.16
17-Aug-09	15:20		RAS	-	0.00	2.55	1.78	4.33	6.13	0.30	6.93

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
226					
72					
77					
76					
56					
59					
59					
54					
48					
51					
42					
42					
39					
35	0.172	<0.20	10.6	10.6	0.02
64					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
10.45	3700	1.33	6.80	1.17	0.42	2.25	0.81

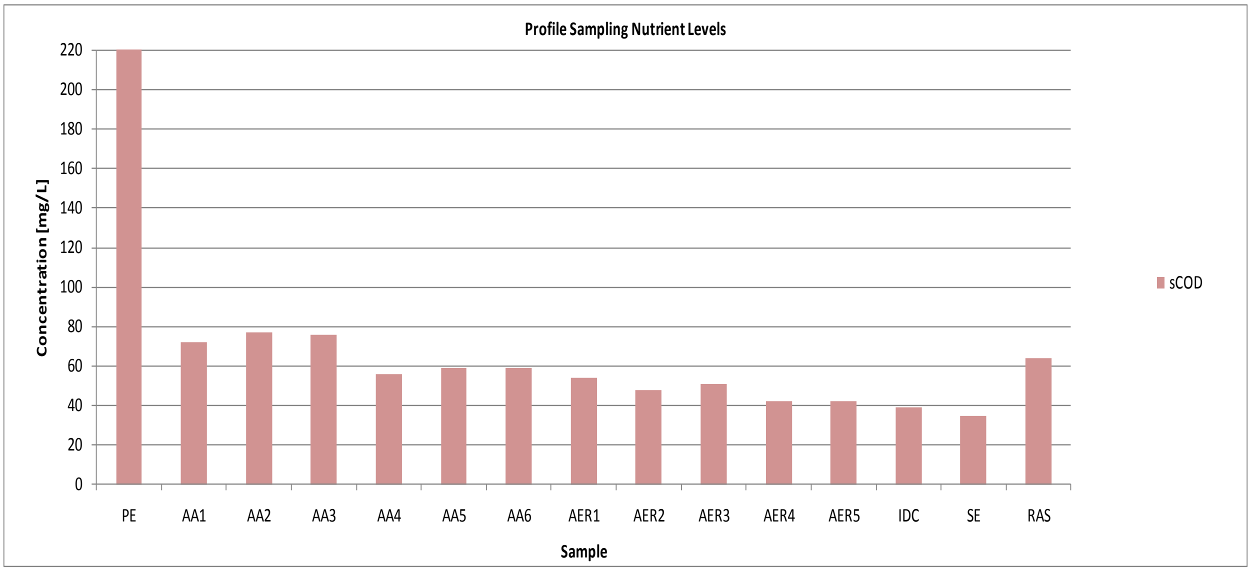
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.90	6.10	2.20	0.0000	10.2250	0.4	27.74	0.300

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.68	0.27	14.99	11.03	8.08	5.95	5.74	4.23

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.33	0.12	0.04	0.02	1.15	0.42	64.39	47.38	0.23

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.95	18.75	11.602	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1720	79	1359	3700	75	2775	3700	75	2775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60
80
100
120
140
160
180
200
220
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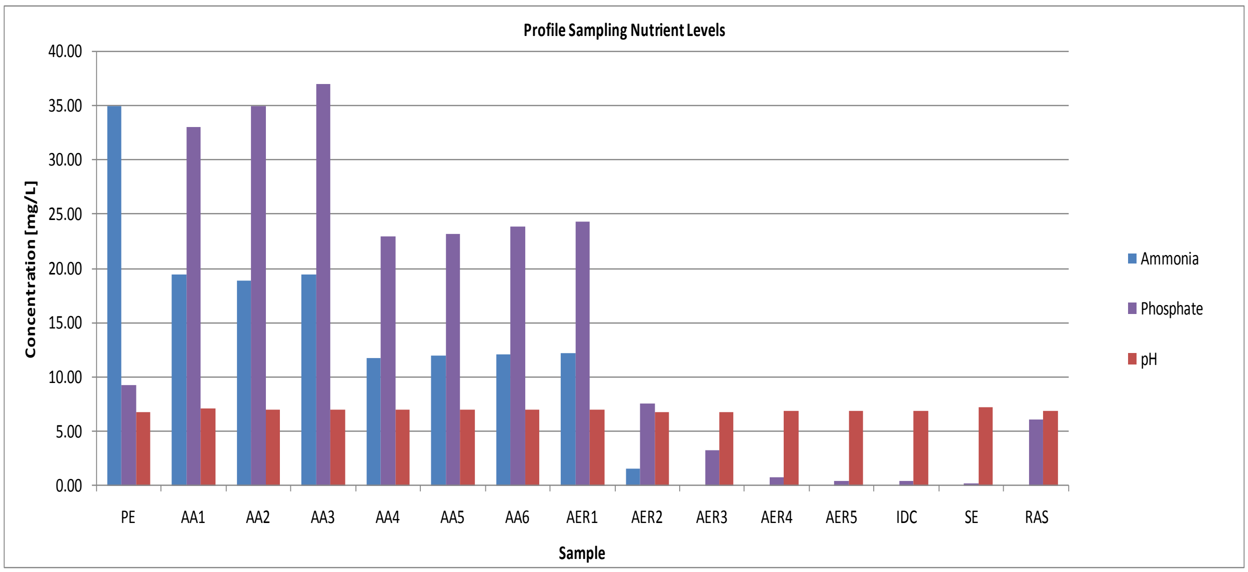
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
sCOD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20.00
25.00
30.00
35.00
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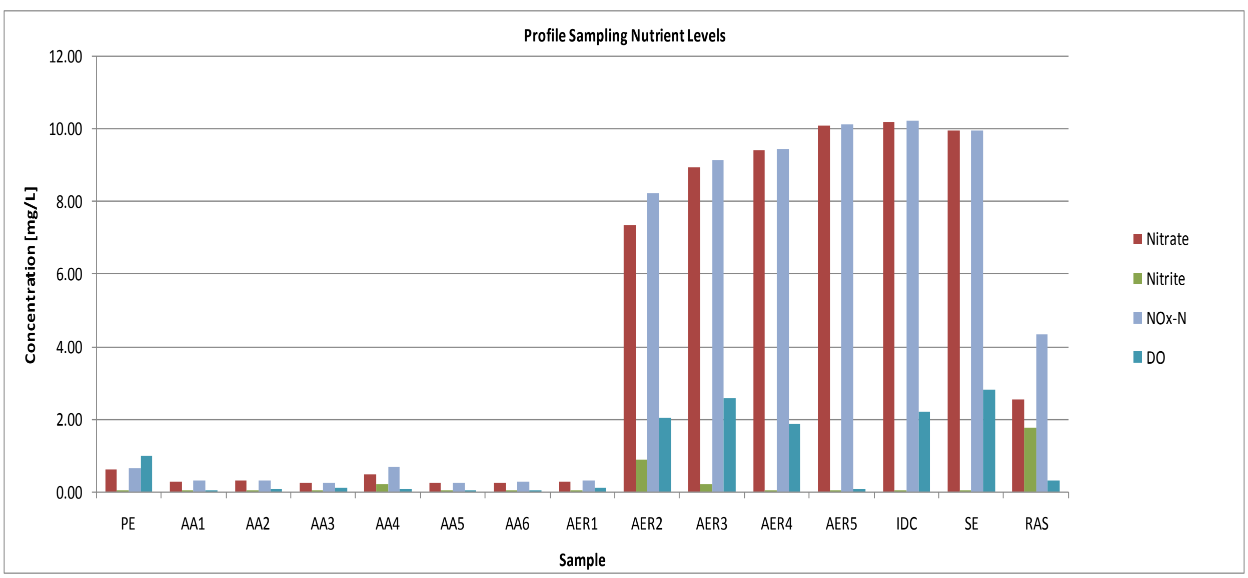
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH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Concentration [mg/L]
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4.00
6.00
8.00
10.00
12.00
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AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER2
AER3
AER4
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

PROFILE 2 Train 5, Aeration Tank 4, Clarifier 4											
Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
20-Aug-09	7:08	0	PE	-	35.60	0.45	0.04	0.49	12.07	1.62	7.22
20-Aug-09	7:25	1.11	AA1	Anaerobic	21.70	0.25	0.02	0.27	34.83	0.06	7.13
20-Aug-09	7:55	2.22	AA2	Anaerobic	22.20	0.32	0.01	0.33	37.61	0.07	7.10
20-Aug-09	8:25	3.33	AA3	Anaerobic	22.30	0.30	0.01	0.32	39.40	0.06	7.09
20-Aug-09	8:55	4.44	AA4	Anoxic	12.60	1.97	0.49	2.46	23.33	0.08	7.03
20-Aug-09	9:10	5.56	AA5	Anoxic	12.80	0.47	0.37	0.84	24.80	0.08	7.06
20-Aug-09	9:25	6.67	AA6	Anoxic	12.95	0.26	0.01	0.28	25.53	0.05	7.07
20-Aug-09	9:40	0.00	AER1	Aerobic	13.45	0.30	0.03	0.33	25.70	0.08	7.07
20-Aug-09	9:55	0.85	AER1.5	Aerobic	3.65	7.86	0.64	8.50	12.07	3.15	6.89
20-Aug-09	10:10	1.71	AER2	Aerobic	3.60	7.80	0.68	8.48	12.04	2.53	6.88
20-Aug-09	10:40	3.41	AER3	Aerobic	0.00	11.30	0.32	11.62	7.15	1.40	6.81
20-Aug-09	11:40	6.83	AER5	Aerobic	0.00	12.30	0.02	12.32	4.19	2.36	6.85
20-Aug-09	11:45		IDC	-	0.00	12.10	0.02	12.12	3.95	2.48	6.87
20-Aug-09	14:46		SE	-	0.00	12.40	0.02	12.42	3.28	2.65	7.01
20-Aug-09	15:07		RAS	-	0.00	4.21	1.37	5.58	8.58	0.16	6.96

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
186					
68					
62					
64					
51					
47					
50					
48					
40					
40					
44					
40					
41					
44		<0.20	13.6	13.6	0.02
58					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
7.67	3580	1.90	6.81	1.50	0.57	2.85	1.08

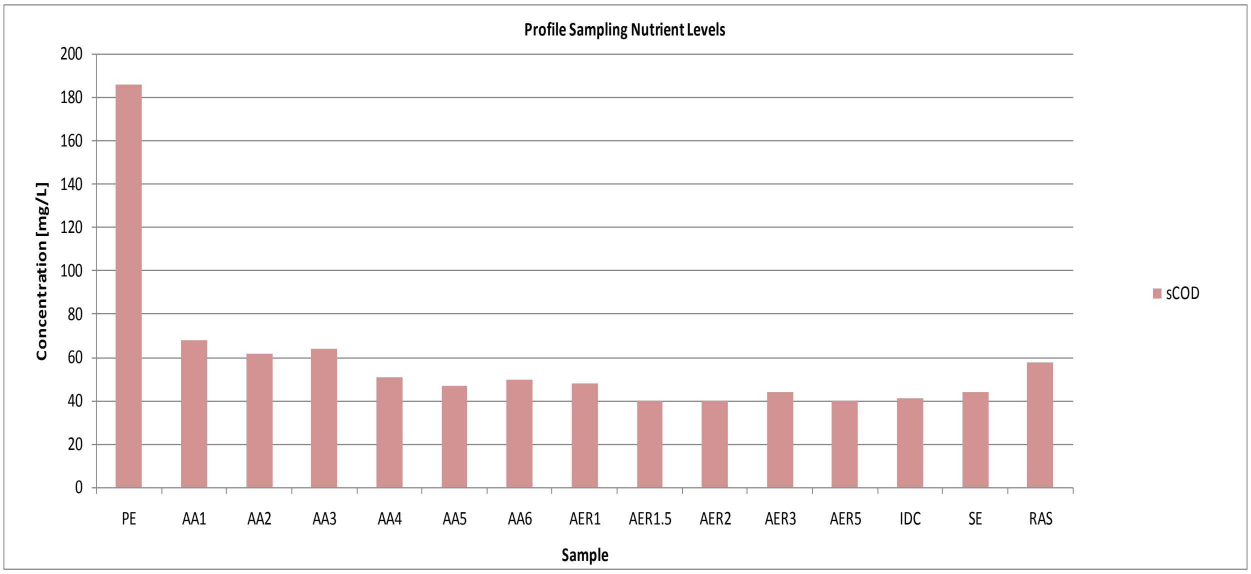
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.68	4.68	1.77	0.0000	12.1200	3.9	27.33	0.594

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
2.46	0.28	14.48	10.09	8.79	6.12	5.98	4.16

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.18	-0.07	0.26	0.10	1.17	0.44	45.59	31.76	0.32

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.79	18.43	11.501	19.5

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1840	78	1435	3580	74	2649	3580	74	2649


Profile Sampling Nutrient Levels
Concentration [mg/L]
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140
120
100
80
60
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20
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PE
AA1
AA2
AA3
AA4
AA5
AA6
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AER1.5
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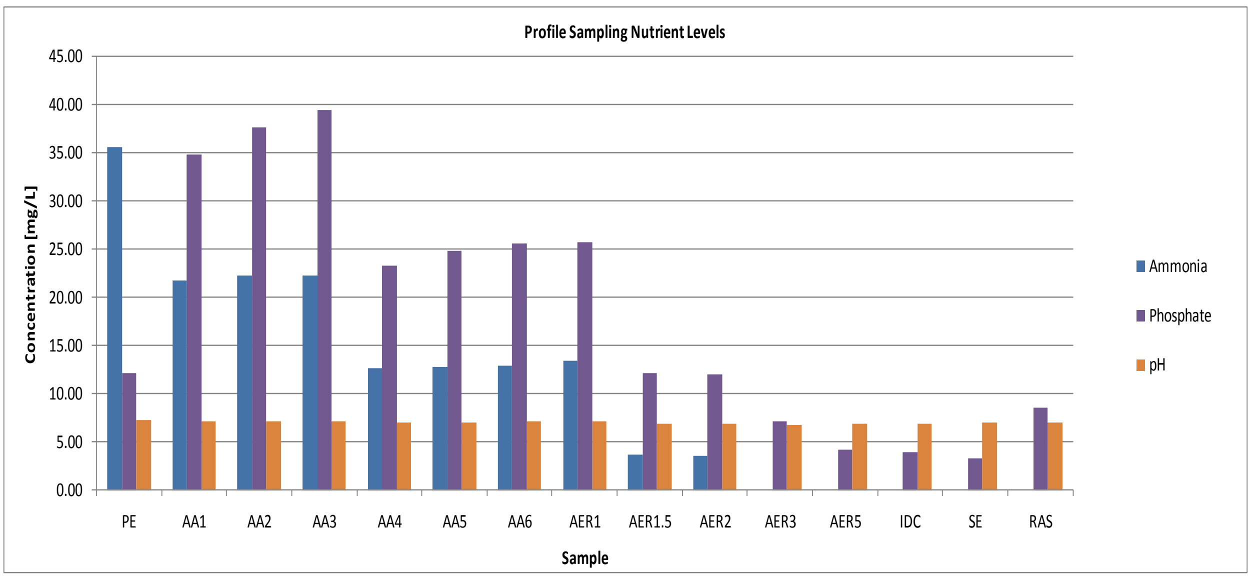
AER5
IDC
SE
RAS
Sample
sCOD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Concentration [mg/L]
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30.00
25.00
20.00
15.00
10.00
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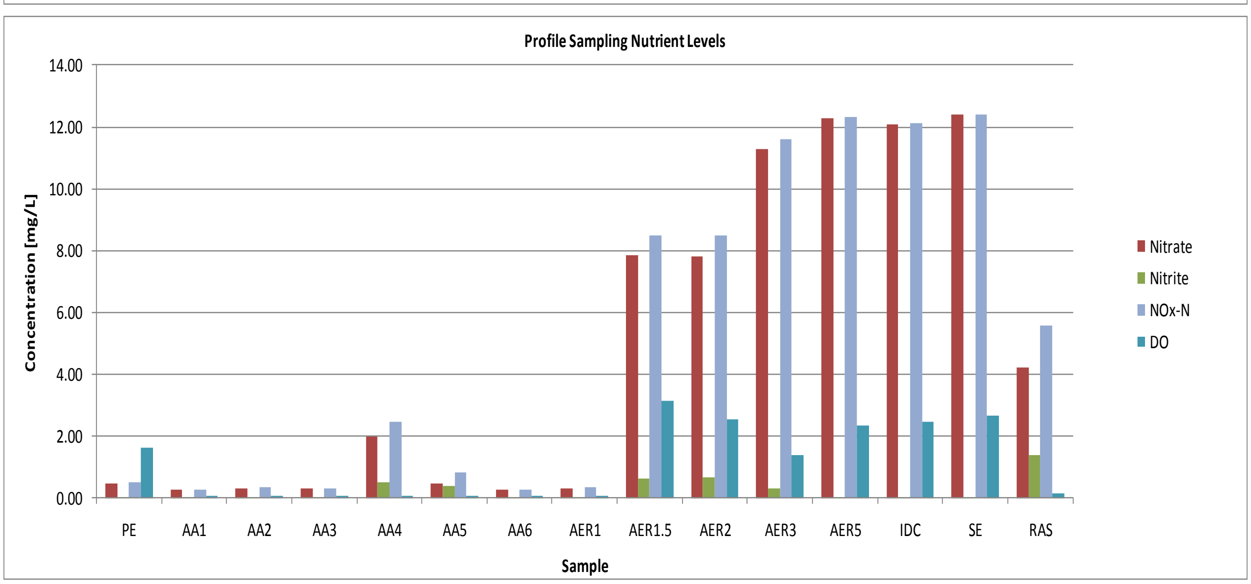
0.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER1.5
AER2
AER3
AER5
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH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Concentration [mg/L]
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10.00
8.00
6.00
4.00
2.00
0.00
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AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER1.5
AER2
AER3
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

Week 6 – 8/24/09 & 8/26/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
24-Aug-09	7:18	0	PE	-	39.60	0.73	0.05	0.79	11.67	1.72	7.09
24-Aug-09	7:33	1.10	AA1	Anaerobic	29.00	0.31	0.01	0.32	40.79	0.09	7.06
24-Aug-09	8:03	2.20	AA2	Anaerobic	27.70	0.28	0.01	0.29	45.68	0.06	7.08
24-Aug-09	8:33	3.30	AA3	Anaerobic	27.50	0.39	0.02	0.41	46.34	0.07	7.03
24-Aug-09	9:03	4.40	AA4	Anaerobic	23.60	0.23	0.02	0.25	41.93	0.08	7.04
24-Aug-09	9:18	5.50	AA5	Anaerobic	22.50	0.00	0.01	0.01	44.05	0.06	7.01
24-Aug-09	9:33	6.60	AA6	Anaerobic	23.00	0.26	0.01	0.28	46.66	0.06	6.99
24-Aug-09	9:48	0.00	AER1	Aerobic	22.00	0.23	0.01	0.24	40.63	0.10	6.99
24-Aug-09	9:56	0.34	AER1.25	Aerobic	14.40	5.61	0.24	5.85	27.08	1.94	6.99
24-Aug-09	10:04	0.68	AER1.5	Aerobic	8.25	11.30	0.44	11.74	18.03	2.79	6.86
24-Aug-09	10:49	3.41	AER3	Aerobic	3.23	16.36	0.40	16.76	10.15	1.53	6.73
24-Aug-09	11:49	6.82	AER5	Aerobic	0.00	18.70	0.13	18.83	4.47	0.11	6.72
24-Aug-09	11:54		IDC	-	0.00	18.40	0.11	18.51	4.11	1.67	6.73
24-Aug-09	14:54		SE	-	0.00	18.34	0.17	18.51	3.03	2.18	6.87
24-Aug-09	15:07		RAS	-	1.48	8.91	2.54	11.45	9.82	0.08	6.68

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
188					
81					
80					
70					
70					
65					
66					
66					
53					
49					
47					
44					
45					
46	2.81	0.48	19.4	19.2	0.18
55					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
7.24	3180	1.29	6.72	2.58	1.07	3.95	1.63

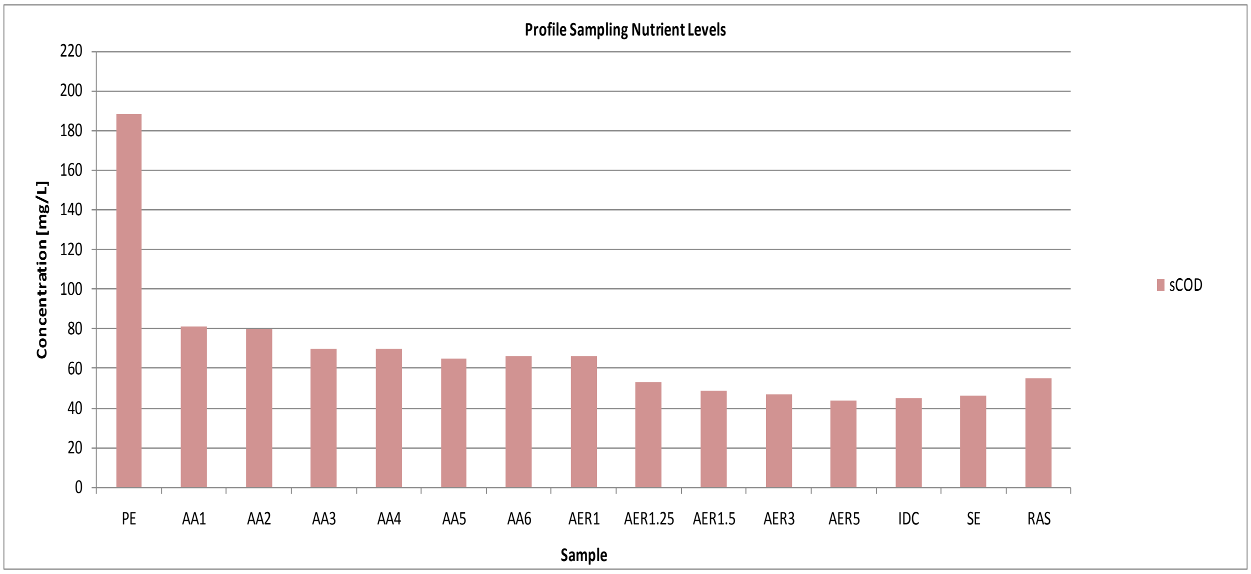
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.44	6.87	2.84	0.0000	18.5100	4.1	35.00	0.246

AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.25	0.28	10.94	8.44	11.05	8.53	6.81	5.26

AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.98	0.40	0.39	0.16	2.11	0.87	43.11	33.28	0.25

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.98	18.11	11.603	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1640	79	1296	3180	76	2417	3180	76	2417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AA2
AA3
AA4
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AER5
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RAS
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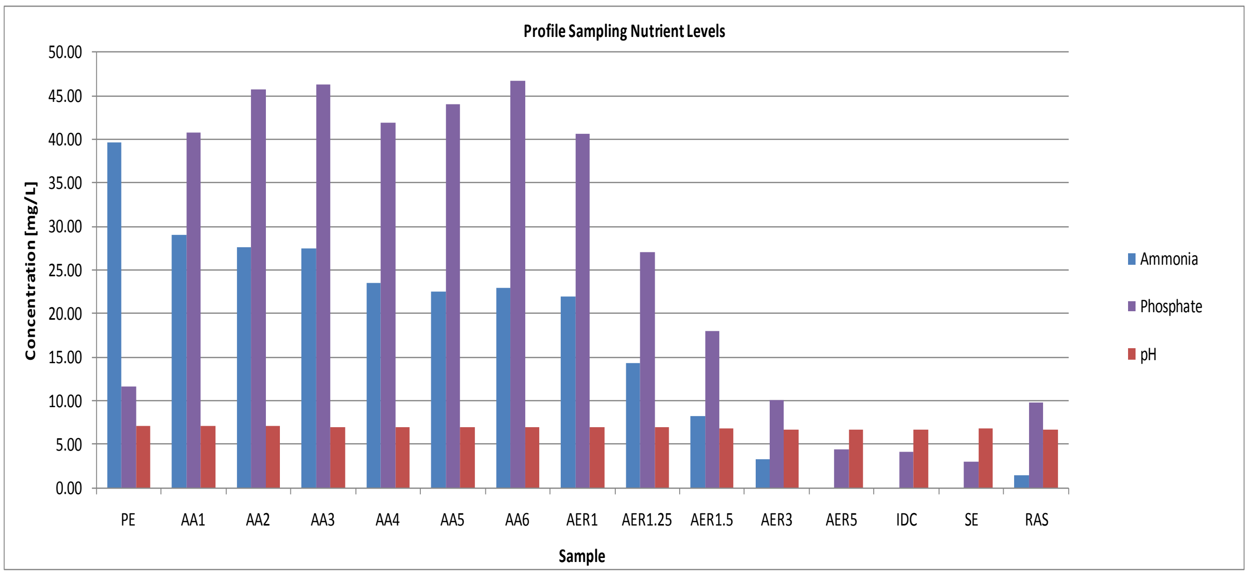
sCOD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30.00
25.00
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15.00
10.00
5.00
0.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
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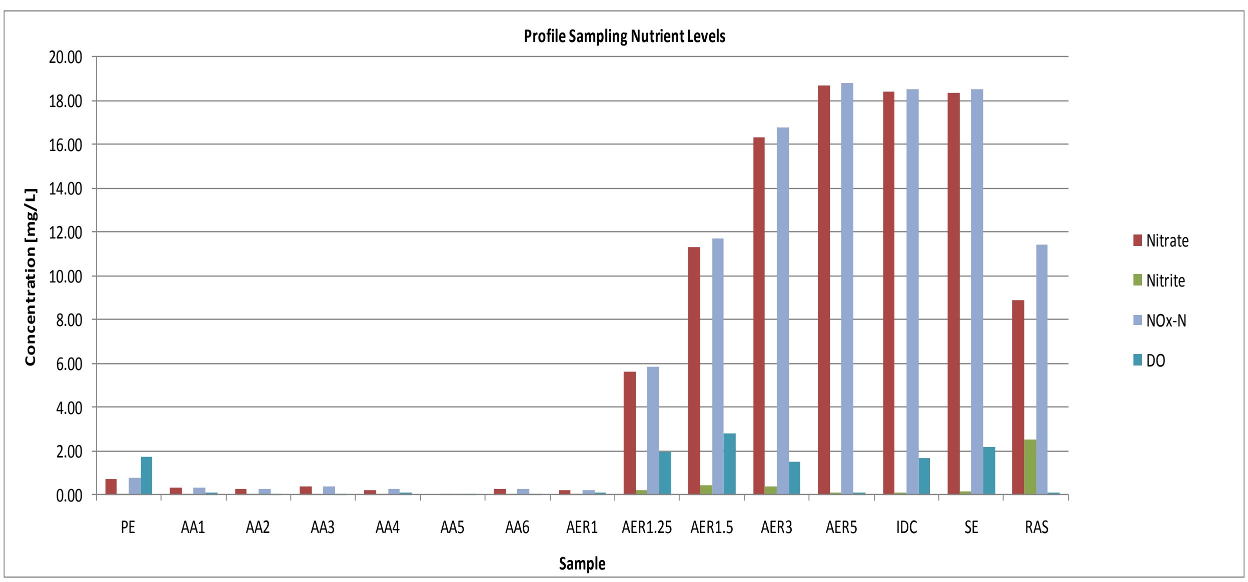
AER1.5
AER3
AER5
IDC
SE
RAS
Sample
Ammonia
Phosphate
pH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Concentration [mg/L]
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
PE
AA1
AA2
AA3
AA4
AA5
AA6
AER1
AER1.25
AER1.5
AER3
AER5
IDC
SE
RAS
Sample
Nitrate
Nitrite
NOx-N
DO

PROFILE 2 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
26-Aug-09	7:10	0	PE	-	35.70	0.51	0.06	0.57	14.77	2.23	7.20
26-Aug-09	7:16	1.13	AA1	Anaerobic	28.40	0.32	0.02	0.34	41.44	0.06	7.04
26-Aug-09	7:46	2.25	AA2	Anaerobic	28.00	0.30	0.01	0.32	41.12	0.06	7.04
26-Aug-09	8:16	3.38	AA3	Anaerobic	28.80	0.34	0.02	0.36	43.24	0.09	7.05
26-Aug-09	8:46	4.50	AA4	Anaerobic	23.00	0.44	0.60	1.04	34.10	0.10	6.97
26-Aug-09	9:01	5.63	AA5	Anaerobic	22.60	0.28	0.02	0.30	34.75	0.05	6.96
26-Aug-09	9:16	6.76	AA6	Anaerobic	22.10	0.27	0.02	0.29	34.92	0.05	6.95
26-Aug-09	9:31	0.00	AER1	Aerobic	21.90	0.27	0.02	0.29	33.77	0.10	6.94
26-Aug-09	9:39	0.34	AER1.25	Aerobic	16.90	3.59	0.20	3.79	23.98	1.84	6.95
26-Aug-09	9:47	0.68	AER1.5	Aerobic	7.89	10.90	0.18	11.08	12.16	2.86	6.88
26-Aug-09	10:32	3.41	AER3	Aerobic	2.36	17.20	0.52	17.72	4.57	1.87	6.68
26-Aug-09	11:36	6.82	AER5	Aerobic	1.31	18.26	0.11	18.37	2.06	0.06	6.67
26-Aug-09	11:42		IDC	-	1.04	18.70	0.18	18.88	2.97	0.62	6.65
26-Aug-09	14:30		SE	-	0.00	18.86	0.22	19.08	0.98	2.10	6.90
26-Aug-09	14:48		RAS	-	1.19	11.90	0.82	12.72	2.84	0.26	6.68

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
191					
80					
82					
81					
70					
68					
63					
61					
58					
52					
45					
47					
46					
40		<0.20	20.4	20.2	0.24
55					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
7.34	3280	1.35	6.67	2.55	1.05	4.50	1.85

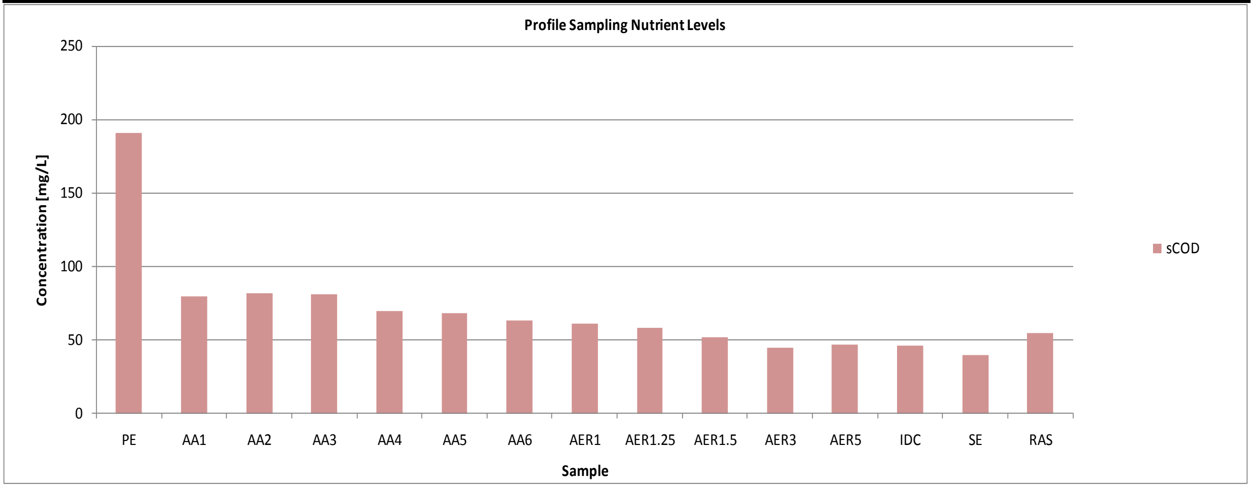
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.52	6.92	2.85	1.0400	18.8800	3.0	28.47	0.326

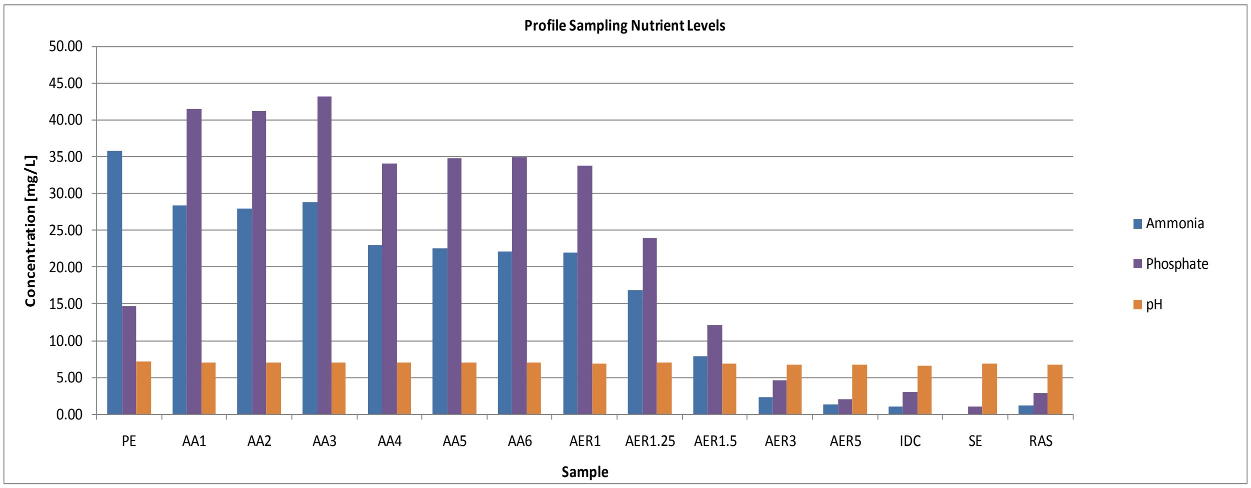
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.04	0.29	14.89	9.36	8.68	5.45	6.46	4.06

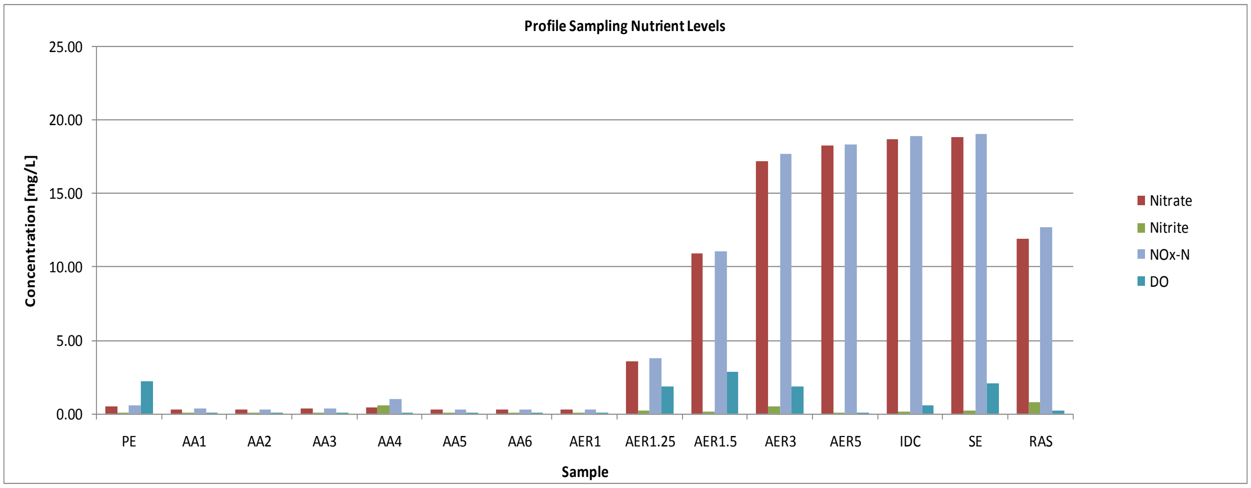
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.09	0.04	0.12	0.05	1.80	0.74	42.70	26.83	0.35

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.54	17.92	11.241	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
2040	78	1591	3280	74	2427	3280	74	2427







Week 7 – 9/1/09 & 9/2/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
1-Sep-09	8:02	0	PE	-	38.00	0.39	0.02	0.41	10.20	1.72	7.09
1-Sep-09	8:19	0.88	AA1	Anaerobic	28.90	0.23	0.02	0.25	31.33	0.09	7.06
1-Sep-09	8:49	1.77	AA2	Anaerobic	30.40	0.00	0.01	0.01	35.89	0.06	7.08
1-Sep-09	9:19	2.65	AA3	Anaerobic	31.20	0.00	0.01	0.01	37.85	0.07	7.03
1-Sep-09	9:49	3.53	AA4	Anaerobic	22.55	0.45	0.58	1.03	30.51	0.08	7.04
1-Sep-09	10:04	4.41	AA5	Anaerobic	22.35	0.00	0.02	0.02	31.65	0.06	7.01
1-Sep-09	10:19	5.30	AA6	Anaerobic	23.05	0.00	0.02	0.02	32.14	0.06	6.99
1-Sep-09	10:34	0.00	AER1	Aerobic	21.80	0.24	0.02	0.26	31.49	0.10	6.99
1-Sep-09	10:42	0.34	AER1.25	Aerobic	15.40	5.65	0.22	5.87	21.94	1.94	6.99
1-Sep-09	10:50	0.68	AER1.5	Aerobic	9.19	10.40	0.40	10.80	15.26	2.79	6.86
1-Sep-09	11:35	3.42	AER3	Aerobic	2.21	17.56	1.32	18.88	7.99	1.53	6.73
1-Sep-09	12:35	6.84	AER5	Aerobic	0.00	19.82	0.02	19.84	4.31	0.11	6.72
1-Sep-09	12:40		IDC	-	0.00	19.64	0.02	19.66	4.08	1.67	6.73
1-Sep-09	15:41		SE	-	0.00	19.64	0.02	19.66	3.20	2.18	6.87
1-Sep-09	15:57		RAS	-	0.00	15.60	1.78	17.38	5.74	0.08	6.68

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
313					
88					
76					
77					
60					
62					
57					
57					
48					
51					
47					
40					
48					
46		<0.20	20.8	20.8	0.02
51					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.21	2800	1.29	6.72	2.70	1.32	4.65	2.28

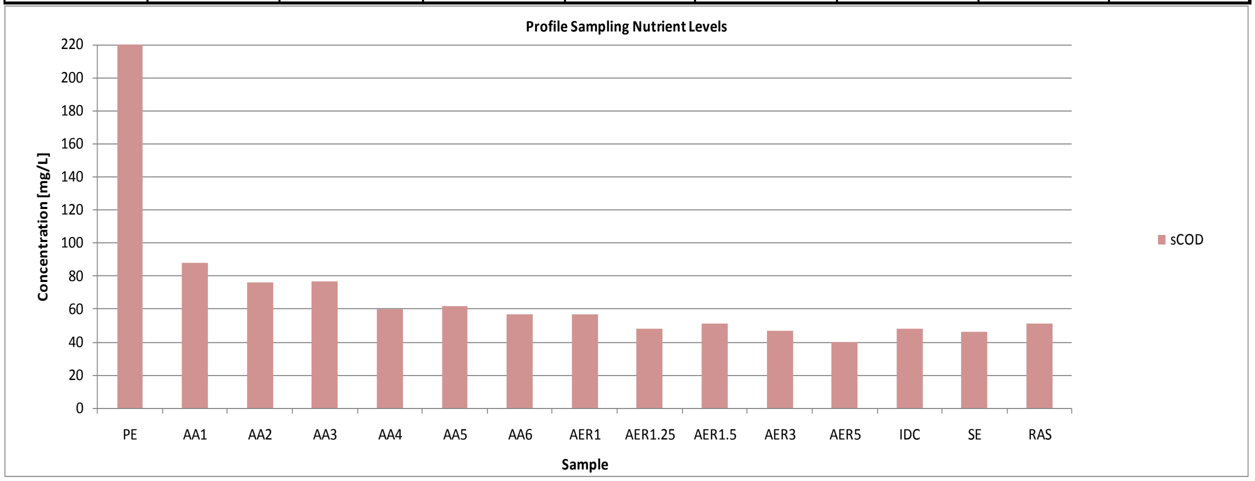
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.32	5.44	2.66	0.0000	19.6550	4.1	27.66	0.113

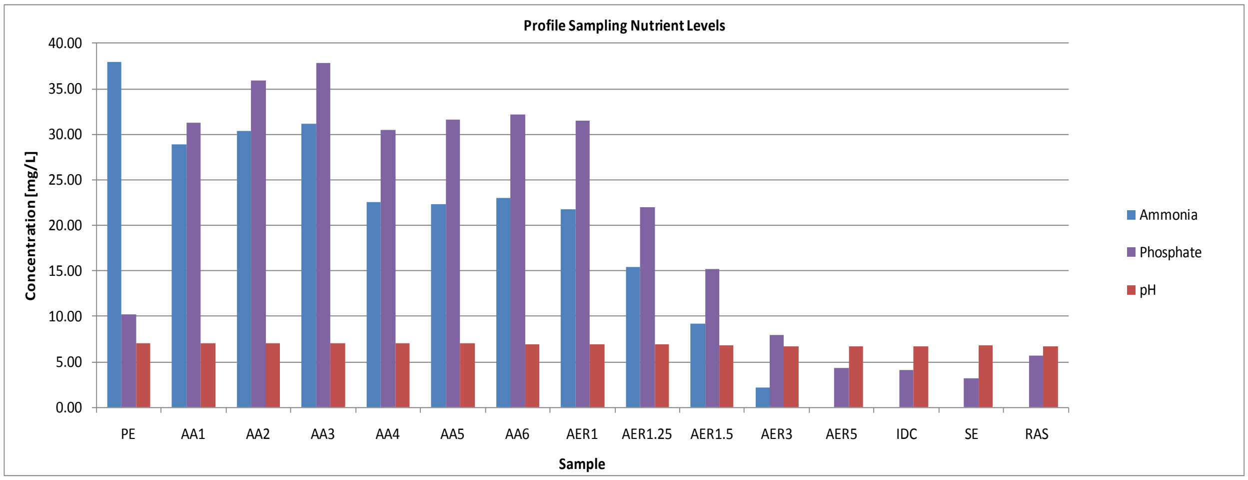
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.03	0.02	11.81	10.61	10.96	9.84	7.16	6.43

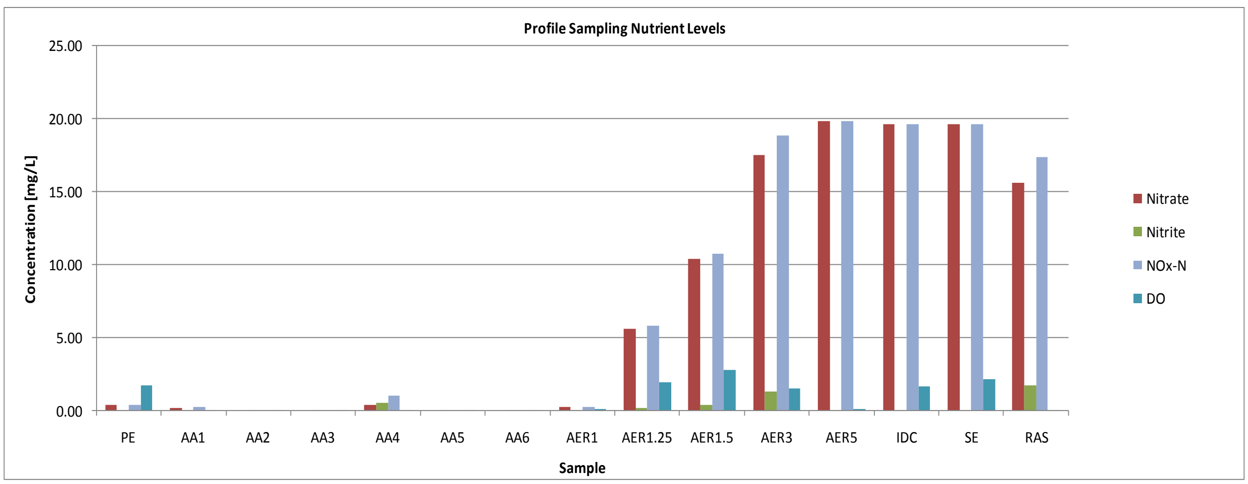
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.08	0.04	0.26	0.13	2.23	1.09	113.48	101.88	0.10

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.92	18	11.482	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1410	79	1114	2800	73	2044	2800	73	2044







PROFILE 2 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
2-Sep-09	7:10	0	PE	-	34.40	0.74	0.07	0.82	11.67	2.23	7.20
2-Sep-09	7:25	0.89	AA1	Anaerobic	27.30	0.26	0.02	0.28	34.43	0.06	7.04
2-Sep-09	7:55	1.77	AA2	Anaerobic	29.90	0.24	0.01	0.25	41.77	0.06	7.04
2-Sep-09	8:25	2.65	AA3	Anaerobic	29.10	0.54	0.01	0.56	37.36	0.09	7.05
2-Sep-09	8:55	3.53	AA4	Anaerobic	20.05	1.68	1.05	2.73	28.72	0.10	6.97
2-Sep-09	9:10	4.41	AA5	Anaerobic	19.80	0.54	0.49	1.03	29.21	0.05	6.96
2-Sep-09	9:25	5.30	AA6	Anaerobic	20.30	0.28	0.01	0.29	29.21	0.05	6.95
2-Sep-09	9:40	0.00	AER1	Aerobic	19.85	0.26	0.02	0.28	29.04	0.10	6.94
2-Sep-09	9:48	0.34	AER1.25	Aerobic	13.75	5.45	0.20	5.65	20.97	1.84	6.95
2-Sep-09	9:56	0.68	AER1.5	Aerobic	8.77	9.51	0.24	9.75	15.01	2.86	6.88
2-Sep-09	10:41	3.42	AER3	Aerobic	1.84	17.08	0.34	17.42	8.42	1.87	6.68
2-Sep-09	11:41	6.84	AER5	Aerobic	0.00	19.02	0.03	19.05	4.50	0.06	6.67
2-Sep-09	11:47		IDC	-	0.00	19.24	0.01	19.25	4.50	0.62	6.65
2-Sep-09	14:47		SE	-	0.00	19.44	0.01	19.45	3.20	2.10	6.90
2-Sep-09	14:59		RAS	-	0.00	15.02	0.16	15.18	6.20	0.26	6.68

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
168					
74					
72					
69					
58					
71					
54					
50					
45					
45					
39					
38					
42					
43	2.78	<0.20	20.5	20.5	0.02
52					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.38	2800	1.35	6.67	2.46	1.22	4.28	2.12

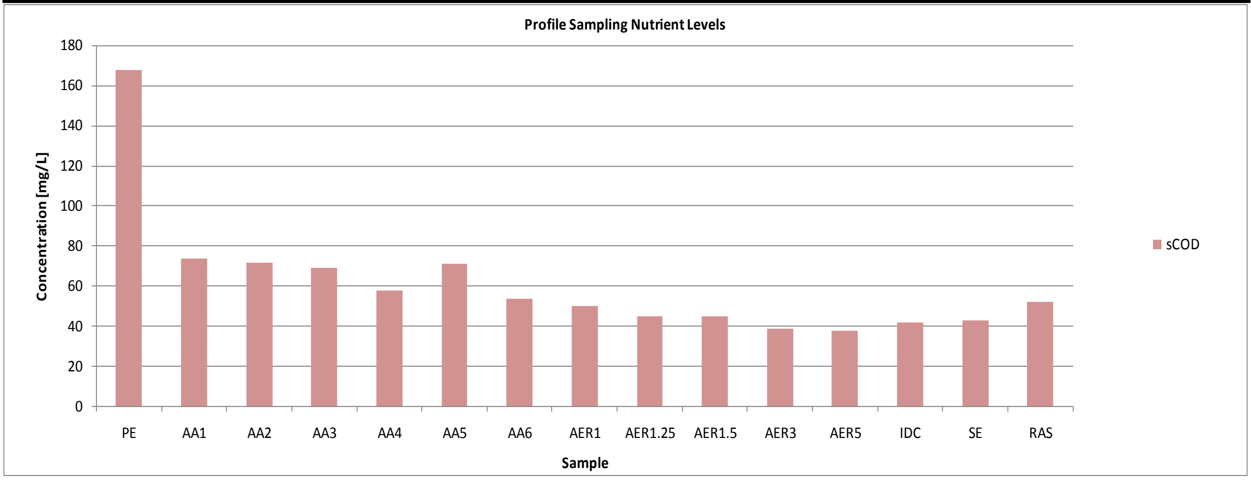
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.34	4.82	2.39	0.0000	19.2500	4.5	30.10	0.590

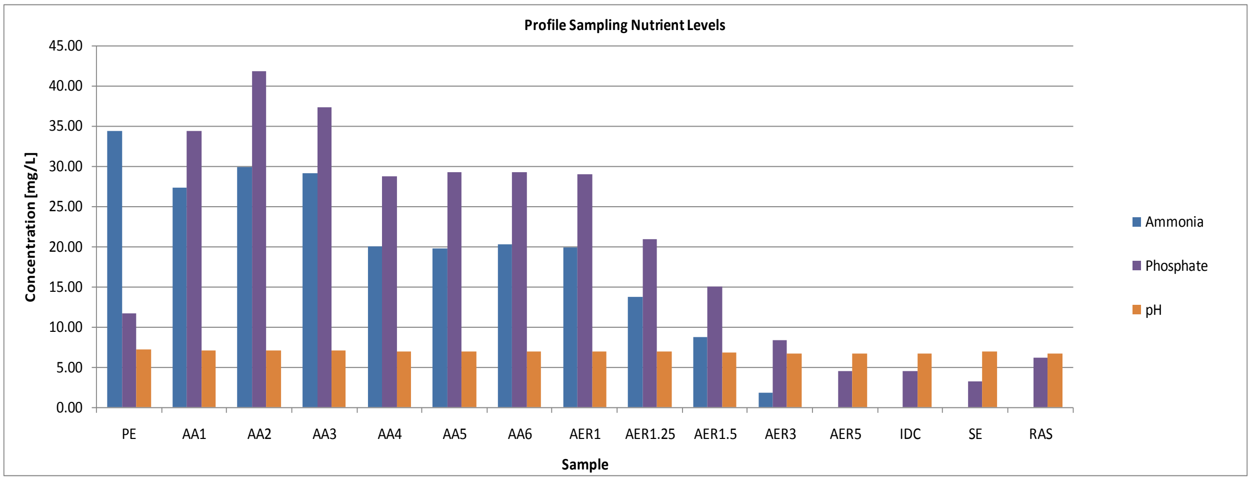
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
2.73	0.29	15.94	14.37	13.39	12.06	5.84	5.26

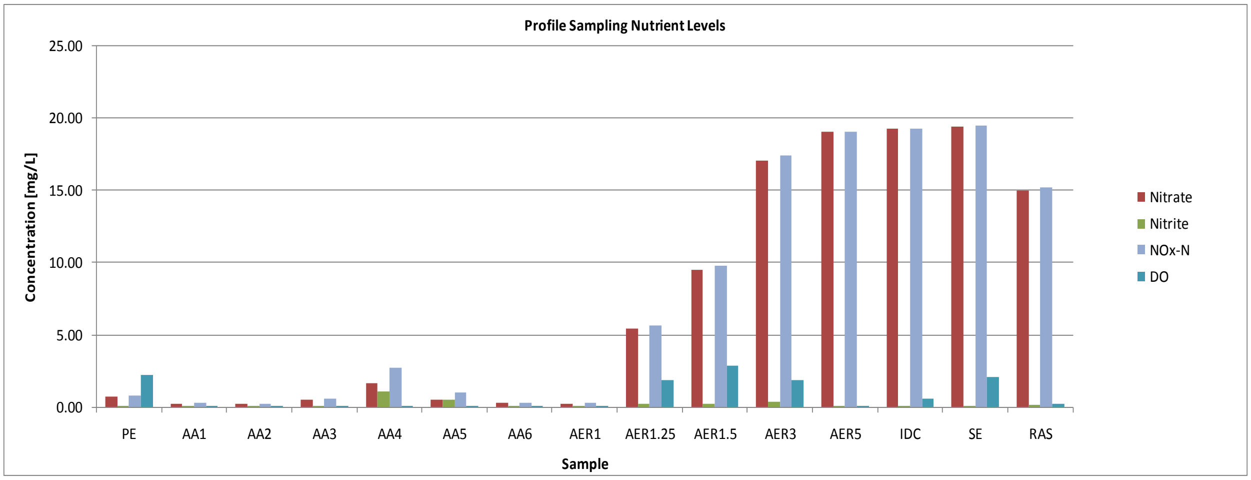
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.36	-0.18	0.11	0.06	2.02	1.00	43.12	38.86	0.37

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.74	17.82	11.361	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1370	81	1110	2800	72	2016	2800	72	2016







Week 8 – 9/9/09

PROFILE 1 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH PP	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
9-Sep-09	8:10	0	PE	-	22.50	0.36	0.02	0.38	8.02	0.60	7.04
9-Sep-09	8:24	0.68	AA1	Anaerobic	18.20	0.33	0.02	0.35	17.70	0.08	7.03
9-Sep-09	8:44	1.36	AA2	Anaerobic	18.10	0.24	0.02	0.26	19.90	0.07	7.03
9-Sep-09	9:19	2.04	AA3	Anaerobic	18.60	0.24	0.02	0.26	20.70	0.07	7.04
9-Sep-09	9:45	2.72	AA4	Anaerobic	14.40	0.41	0.02	0.43	15.30	0.08	6.91
9-Sep-09	9:58	3.40	AA5	Anaerobic	14.35	0.32	0.01	0.34	15.70	0.11	6.89
9-Sep-09	10:15	4.08	AA6	Anaerobic	13.85	0.30	0.02	0.32	17.20	0.11	6.88
9-Sep-09	10:28	0.00	AER1	Aerobic	14.20	0.29	0.02	0.31	16.90	0.11	6.90
9-Sep-09	10:36	0.26	AER1.25	Aerobic	11.55	1.87	0.16	2.03	10.40	1.95	6.90
9-Sep-09	10:45	0.53	AER1.5	Aerobic	8.53	3.40	0.23	3.63	6.21	3.01	6.86
9-Sep-09	11:30	2.63	AER3	Aerobic	4.02	7.52	0.29	7.81	0.73	3.10	6.61
9-Sep-09	12:30	5.27	AER5	Aerobic	1.21	10.30	0.21	10.51	0.00	0.39	6.47
9-Sep-09	12:38		IDC	-	0.00	10.78	0.21	10.99	0.00	2.69	6.52
9-Sep-09	15:26		SE	-	0.00	10.60	0.11	10.71	0.00	1.93	6.56
9-Sep-09	15:45		RAS	-	0.00	2.49	2.79	5.28	1.74	0.13	6.52

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

*NOTE: These values are <0.5 mg/L PO_4-P

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
117					
69					
60					
58					
53					
54					
55					
58					
60					
43					
44					
34					
34					
36	0.097	<.20	11.7	11.6	0.12
44					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.35	2600	1.71	6.47	2.22	1.15	2.58	1.34

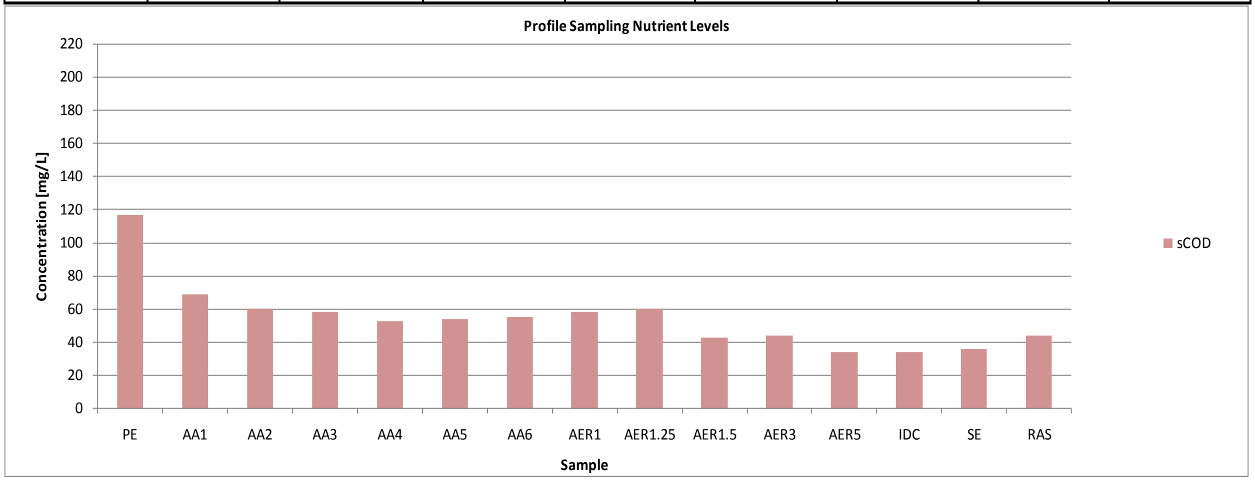
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.29	4.91	2.55	0.0000	10.9860	0.0	12.68	0.309

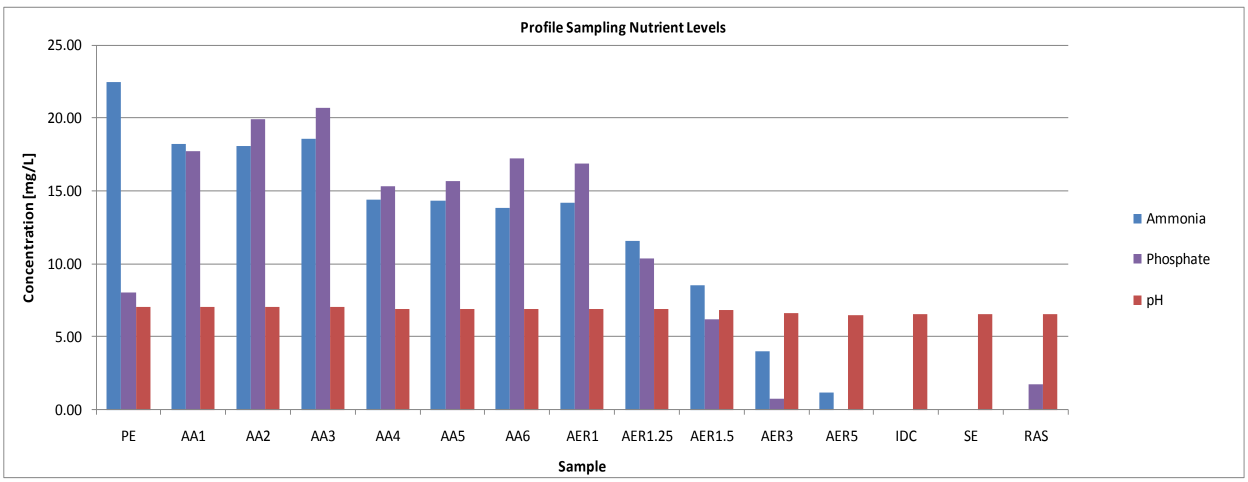
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.43	0.32	8.59	9.79	6.76	7.70	4.27	4.87

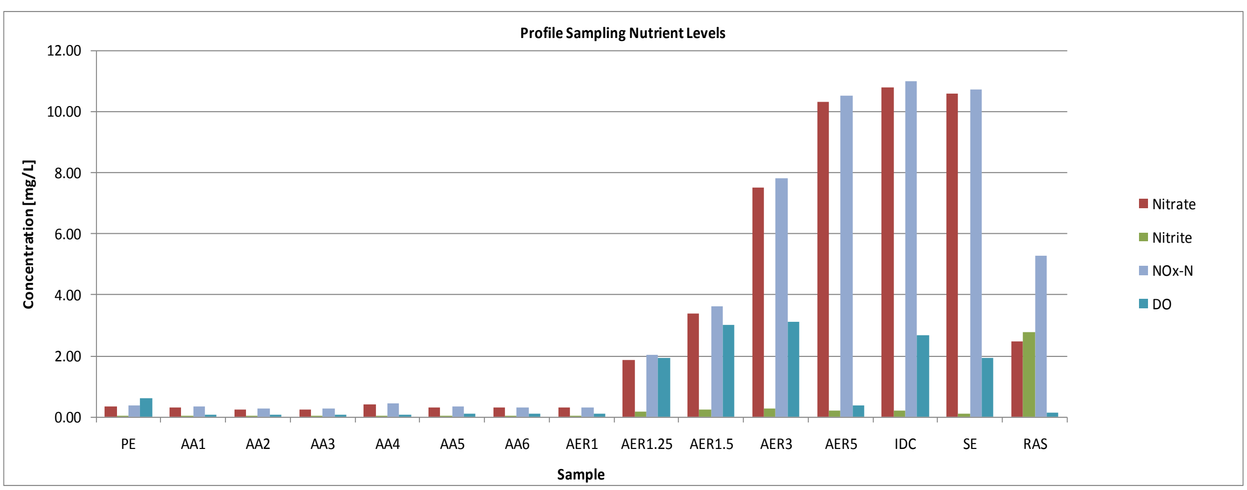
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.25	-0.13	0.12	0.06	1.62	0.84	32.46	36.98	0.26

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
1500	22.000	5.100	24.58	17.68	14.032	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1140	77	878	2600	74	1924	2600	74	1924







Week 9 – 9/14/09, 9/15/09, & 9/18/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
14-Sep-09	7:00	0	PE	-	39.90	0.91	0.04	0.95	12.50	1.48	7.01
14-Sep-09	7:15	0.84	AA1	Anaerobic	27.20	0.42	0.01	0.43	26.90	0.09	7.06
14-Sep-09	7:45	1.68	AA2	Anaerobic	27.70	0.36	0.01	0.38	31.20	0.08	7.07
14-Sep-09	8:15	2.53	AA3	Anaerobic	28.20	0.32	0.01	0.33	32.80	0.08	7.09
14-Sep-09	8:45	3.37	AA4	Anaerobic	20.90	0.42	0.04	0.46	26.50	0.06	7.03
14-Sep-09	9:00	4.21	AA5	Anaerobic	21.45	0.32	0.01	0.33	28.30	0.07	7.04
14-Sep-09	9:15	5.05	AA6	Anaerobic	21.45	0.32	0.01	0.33	29.10	0.08	7.01
14-Sep-09	9:30	0.00	AER1	Aerobic	21.00	0.37	0.01	0.38	29.10	0.05	7.01
14-Sep-09	9:38	0.33	AER1.25	Aerobic	16.65	3.48	0.16	3.64	18.40	2.83	7.01
14-Sep-09	9:46	0.65	AER1.5	Aerobic	11.50	6.51	0.26	6.77	12.20	2.90	6.99
14-Sep-09	10:39	3.26	AER3	Aerobic	4.92	12.26	0.33	12.59	3.35	3.05	6.77
14-Sep-09	11:39	6.52	AER5	Aerobic	1.34	15.30	0.32	15.62	0.00	0.37	6.67
14-Sep-09	11:41		IDC	-	0.00	15.30	0.28	15.58	0.00	2.08	6.67
14-Sep-09	14:39		SE	-	0.00	15.54	0.27	15.81	0.00	2.16	6.81
14-Sep-09	14:57		RAS	-	0.00	8.70	2.48	11.18	1.38	0.13	6.73

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

*NOTE: These values are <0.5 mg/L PO_4-P

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
188					
95					
78					
73					
57					
57					
55					
52					
43					
40					
38					
33					
34					
33		0.35	16.1	15.8	0.31
51					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.93	2760	1.84	6.67	2.67	1.32	3.28	1.63

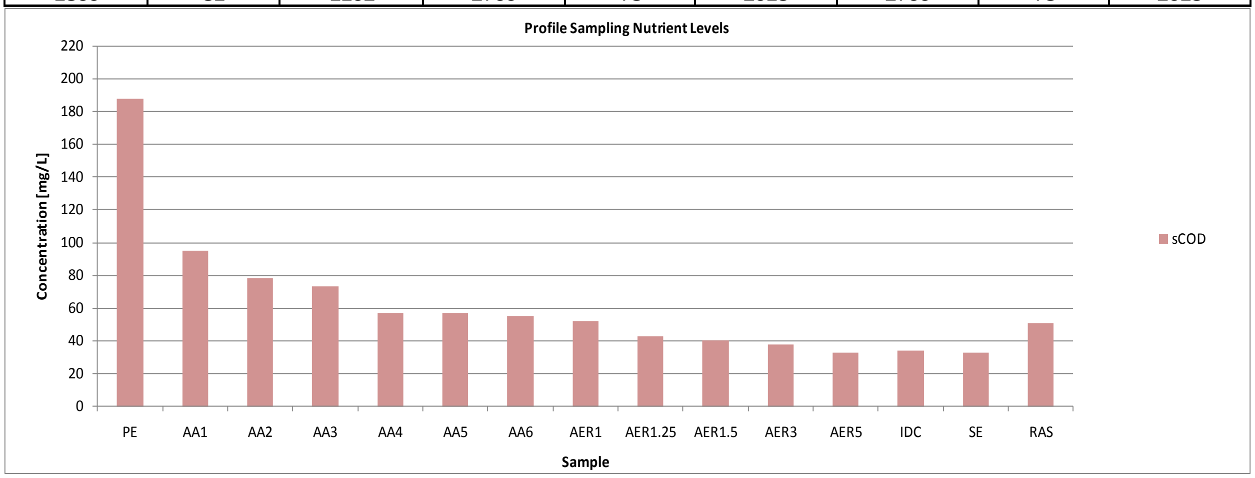
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.33	6.28	3.12	0.0000	15.5820	0.0	20.30	0.360

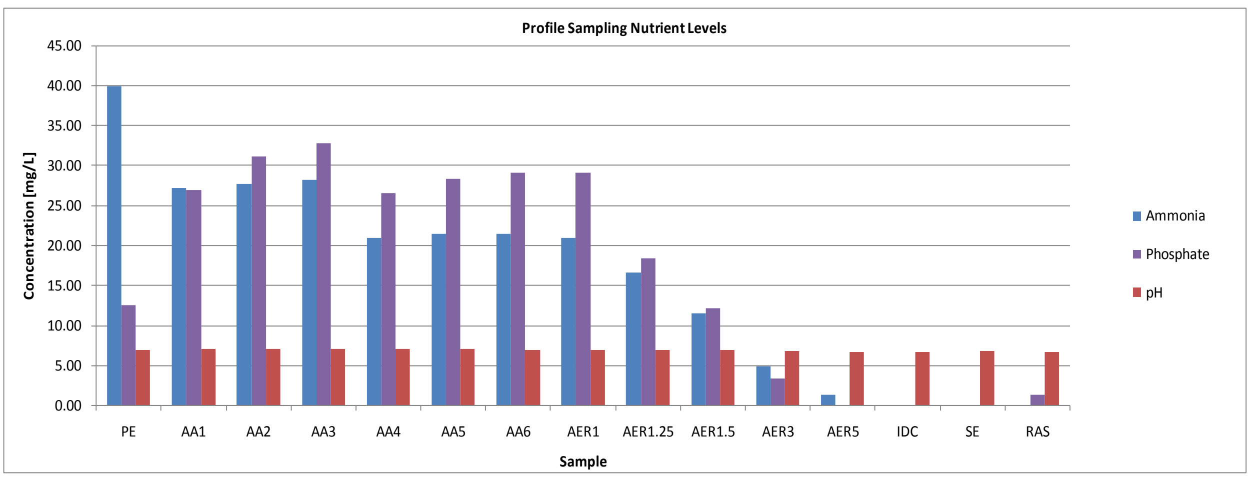
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.46	0.33	7.72	7.00	9.88	8.97	6.33	5.74

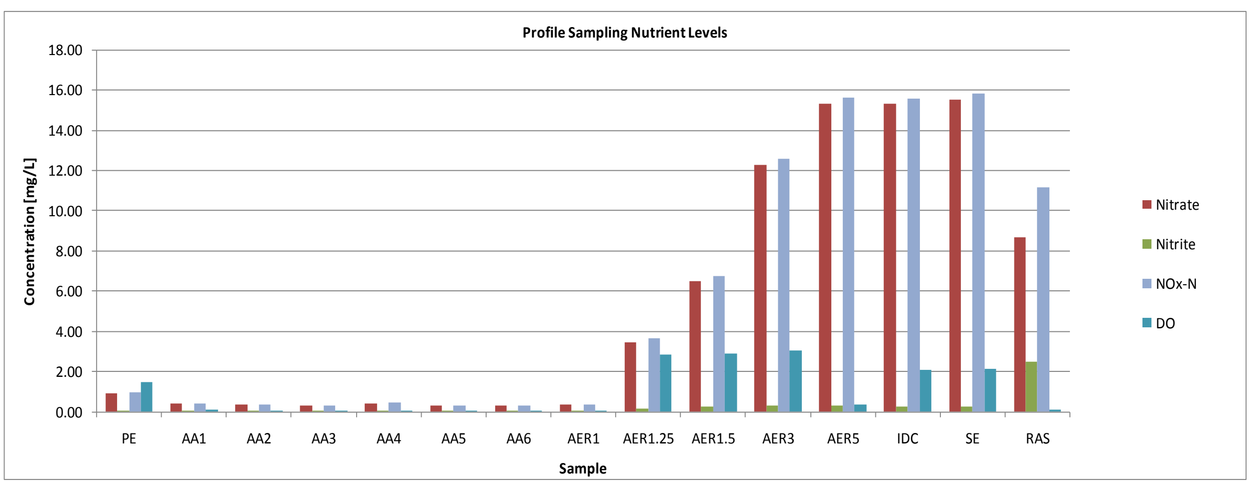
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.38	0.19	0.43	0.21	2.24	1.11	35.25	32.00	0.22

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.84	18.03	12.075	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1360	81	1102	2760	73	2015	2760	73	2015







PROFILE 2 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
15-Sep-09	6:50	0	PE	-	37.40	0.75	0.06	0.81	12.10	1.26	7.15
15-Sep-09	7:08	0.84	AA1	Anaerobic	27.40	0.33	0.02	0.35	30.00	0.07	7.13
15-Sep-09	7:38	1.68	AA2	Anaerobic	28.50	0.30	0.01	0.31	31.50	0.07	7.11
15-Sep-09	8:08	2.53	AA3	Anaerobic	27.60	0.31	0.01	0.32	33.20	0.08	7.09
15-Sep-09	8:38	3.37	AA4	Anaerobic	19.25	0.63	0.43	1.05	24.60	0.08	7.03
15-Sep-09	8:53	4.21	AA5	Anaerobic	19.95	0.29	0.02	0.31	24.30	0.07	7.02
15-Sep-09	9:08	5.05	AA6	Anaerobic	20.45	0.28	0.01	0.30	25.90	0.07	7.00
15-Sep-09	9:23	0.00	AER1	Aerobic	21.70	0.30	0.02	0.31	27.40	0.09	7.04
15-Sep-09	9:31	0.33	AER1.25	Aerobic	16.65	3.22	0.15	3.37	18.20	3.02	7.04
15-Sep-09	9:39	0.65	AER1.5	Aerobic	2.44	6.16	0.27	6.43	12.30	3.55	7.02
15-Sep-09	10:28	3.26	AER3	Aerobic	5.92	11.42	0.37	11.79	0.00	2.89	6.82
15-Sep-09	11:28	6.52	AER5	Aerobic	0.00	15.30	0.32	15.62	0.00	0.26	6.64
15-Sep-09	11:32		IDC	-	0.00	16.28	0.17	16.45	0.00	2.36	6.70
15-Sep-09	14:32		SE	-	0.00	16.30	0.02	16.32	0.00	2.67	6.93
15-Sep-09	14:45		RAS	-	0.00	10.22	2.44	12.66	0.00	0.13	6.76

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

*NOTE: These values are <0.5 mg/L PO_4-P

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
170					
73					
71					
73					
59					
67					
55					
62					
51					
45					
44					
42					
40					
35	0.160	<0.20	17.7	17.7	0.02
50					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
6.38	2640	1.96	6.64	2.43	1.21	3.07	1.53

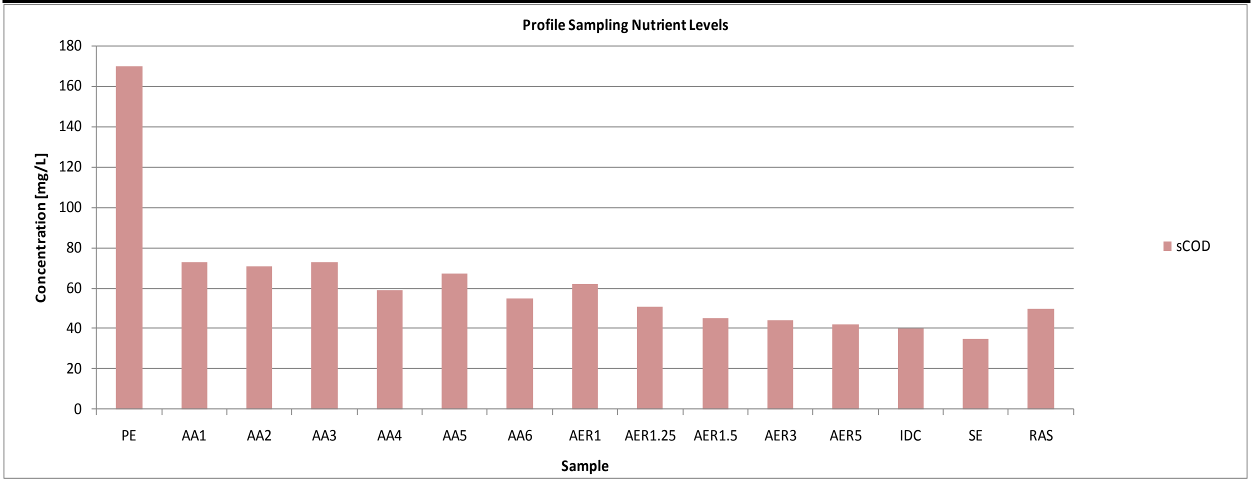
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.37	7.10	3.53	0.0000	16.4540	0.0	21.10	0.356

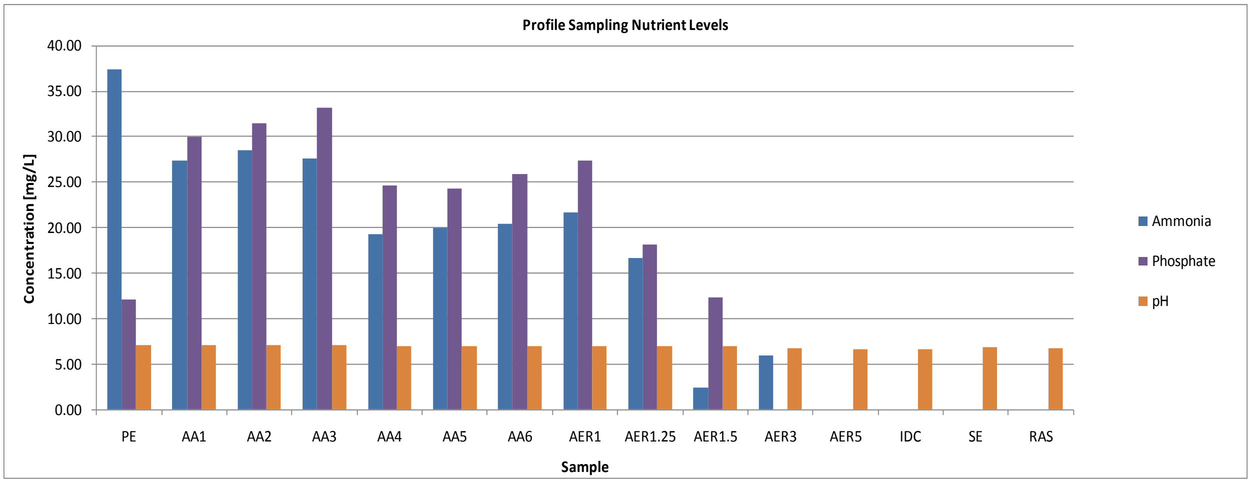
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
1.05	0.30	13.48	12.36	9.02	8.27	6.37	5.84

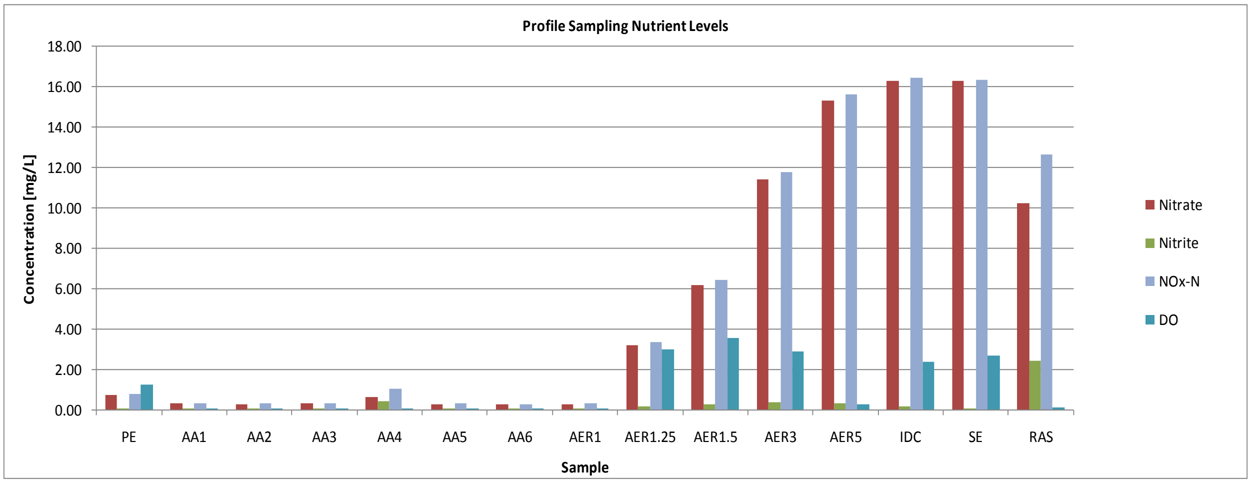
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.16	-0.08	-0.07	-0.04	2.45	1.25	50.59	46.40	0.27

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.77	17.66	11.995	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1380	79	1090	2640	74	1954	2720	74	2013







PROFILE 3 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
18-Sep-09	8:20	0	PE	-	37.00	0.46	0.03	0.49	12.73	1.67	7.02
18-Sep-09	8:34	0.83	AA1	Anaerobic	28.70	0.30	0.01	0.32	31.98	0.07	7.03
18-Sep-09	9:04	1.68	AA2	Anaerobic	28.20	0.31	0.01	0.32	37.36	0.08	7.03
18-Sep-09	9:34	2.53	AA3	Anaerobic	28.10	0.65	0.01	0.66	38.51	0.10	7.04
18-Sep-09	10:04	3.37	AA4	Anaerobic	20.10	0.40	0.09	0.49	30.51	0.15	7.01
18-Sep-09	10:19	4.21	AA5	Anaerobic	19.60	0.26	0.03	0.29	31.16	0.11	7.01
18-Sep-09	10:34	5.05	AA6	Anaerobic	19.85	0.00	0.01	0.01	33.12	0.12	6.98
18-Sep-09	10:49	0.00	AER1	Aerobic	20.40	0.00	0.01	0.01	33.94	0.07	6.99
18-Sep-09	10:58	0.33	AER1.25	Aerobic	17.10	2.70	0.19	2.89	26.43	1.89	6.99
18-Sep-09	11:06	0.65	AER1.5	Aerobic	11.95	6.75	0.42	7.17	16.15	3.07	6.97
18-Sep-09	11:51	3.26	AER3	Aerobic	6.06	10.82	0.51	11.33	8.48	2.35	6.79
18-Sep-09	12:51	6.52	AER5	Aerobic	0.00	15.48	0.21	15.69	0.71	0.31	6.65
18-Sep-09	12:59		IDC	-	0.00	16.02	0.04	16.06	0.35	2.47	6.71
18-Sep-09	15:59		SE	-	0.00	15.74	0.02	15.76	0.26	2.71	6.91
18-Sep-09	16:14		RAS	-	0.00	7.96	2.73	10.69	2.69	0.15	6.73

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

*NOTE: These values are <0.5 mg/L PO_4-P

QA/QC Sample:

EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.43	2720	1.54	6.65	2.83	1.40	2.98	1.48

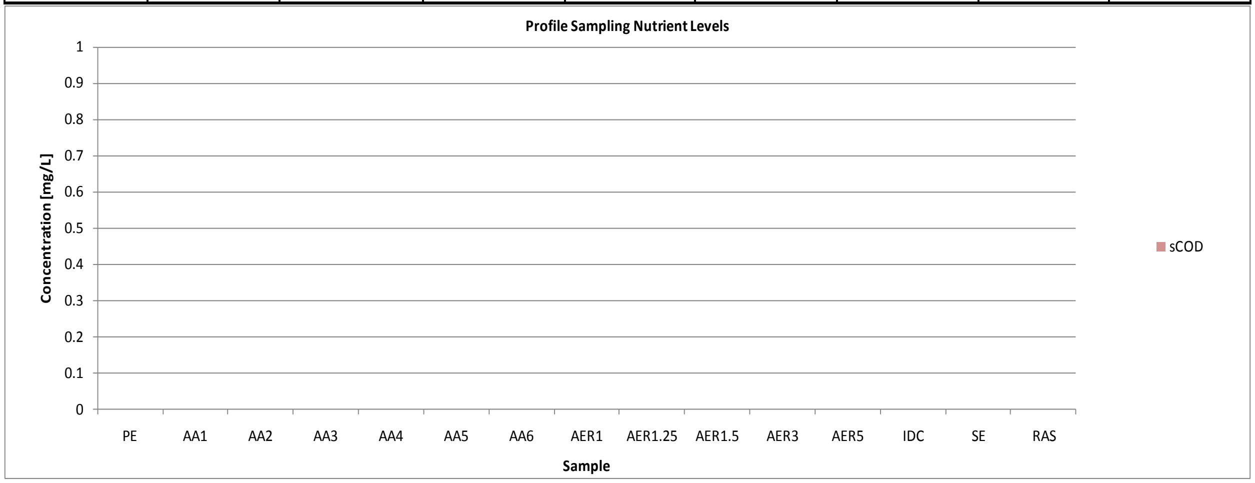
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.51	6.48	3.22	0.0000	16.0620	0.3	25.78	0.319

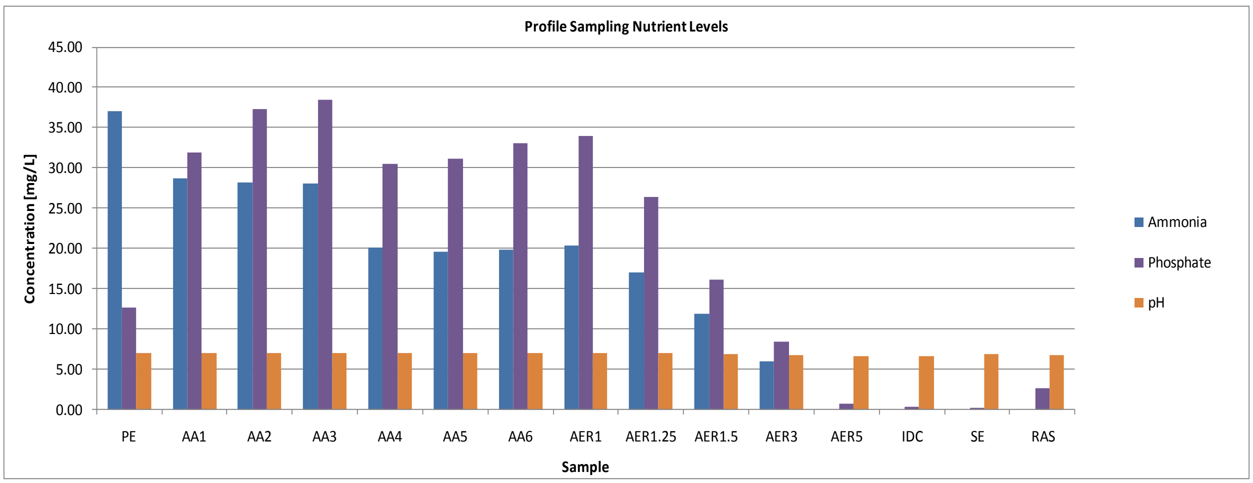
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.49	0.01	11.64	11.40	11.88	11.63	7.24	7.09

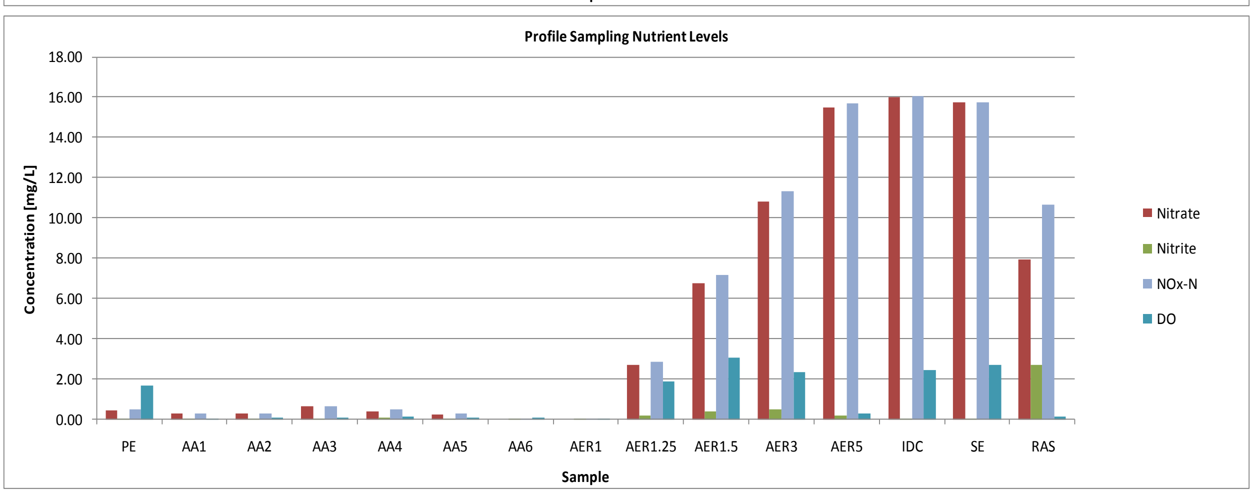
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ (AA1) COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.18	0.09	0.16	0.08	2.90	1.44	0.00	0.00	

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Primary Clarifier Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	20.19	18.03	12.075	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1380	74	1021	2720	74	2013	2720	74	2013







Week 10 – 9/22/09 & 9/24/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
22-Sep-09	7:03	0	PE	-	38.80	0.81	0.03	0.84	14.68	1.48	7.09
22-Sep-09	7:19	0.87	AA1	Anaerobic	28.30	0.36	0.02	0.37	32.96	0.08	7.08
22-Sep-09	7:49	1.73	AA2	Anaerobic	29.40	0.38	0.01	0.39	36.22	0.08	7.09
22-Sep-09	8:19	2.60	AA3	Anaerobic	31.80	0.36	0.01	0.38	37.69	0.07	7.09
22-Sep-09	8:49	3.46	AA4	Anaerobic	22.60	0.36	0.03	0.39	34.43	0.08	7.04
22-Sep-09	9:04	4.33	AA5	Anaerobic	22.65	0.34	0.02	0.35	36.38	0.08	7.04
22-Sep-09	9:19	5.19	AA6	Anaerobic	23.85	0.34	0.02	0.36	39.97	0.07	7.03
22-Sep-09	9:34	0.00	AER1	Aerobic	23.65	0.34	0.02	0.36	38.51	0.06	7.01
22-Sep-09	(;42	0.34	AER1.25	Aerobic	16.50	4.51	0.31	4.82	23.58	2.07	7.05
22-Sep-09	9:50	0.67	AER1.5	Aerobic	2.58	7.38	0.46	7.84	17.54	3.05	7.03
22-Sep-09	10:35	3.35	AER3	Aerobic	5.18	13.52	0.59	14.11	6.98	2.68	6.83
22-Sep-09	11:42	6.71	AER5	Aerobic	0.00	17.82	0.05	17.87	0.23	0.40	6.7
22-Sep-09	11:47		IDC	-	0.00	18.08	0.02	18.10	0.18	3.25	6.74
22-Sep-09	14:47		SE	-	0.00	17.74	0.02	17.76	0.19	2.87	6.89
22-Sep-09	15:05		RAS	-	0.00	10.74	2.76	13.50	2.45	0.12	6.73

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
206					
106					
102					
107					
78					
72					
73					
75					
62					
60					
52					
48					
45					
47	0.142	<0.20	18.4	18.4	0.02
56					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.95	3780	1.65	6.70	2.52	0.89	3.49	1.23

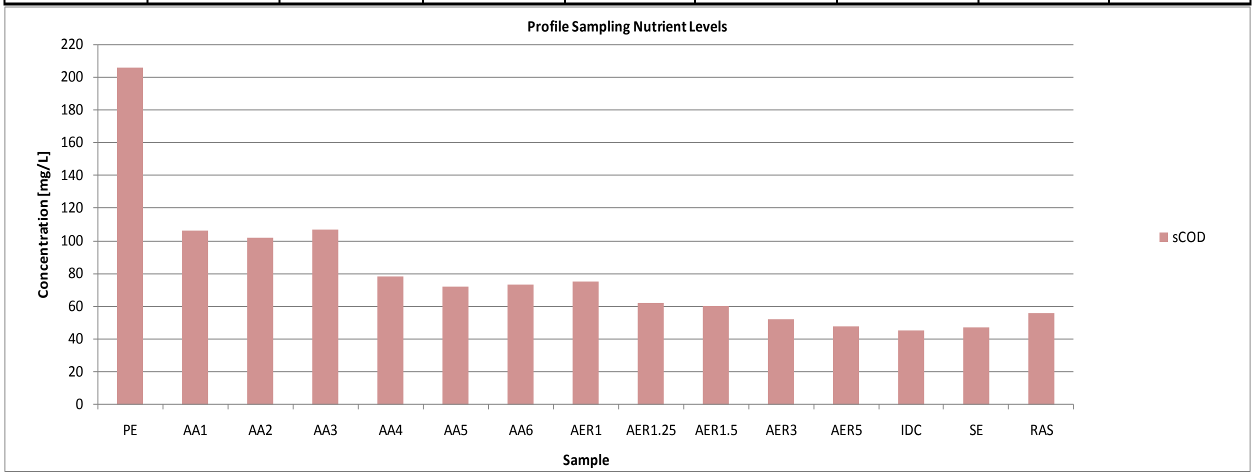
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
0.59	7.27	2.56	0.0000	18.1040	0.2	25.29	0.356

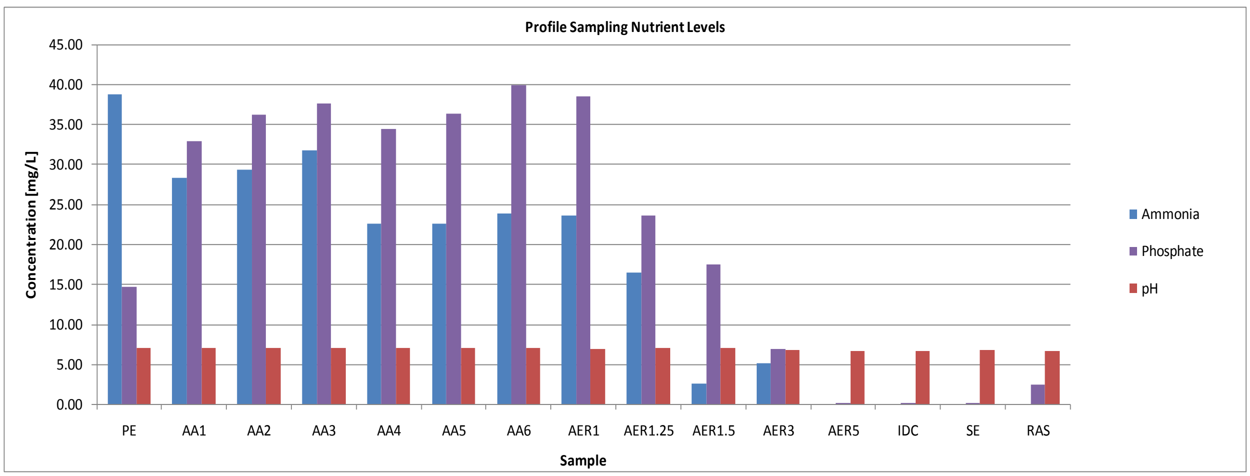
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.39	0.36	7.09	7.88	10.75	11.94	7.08	7.86

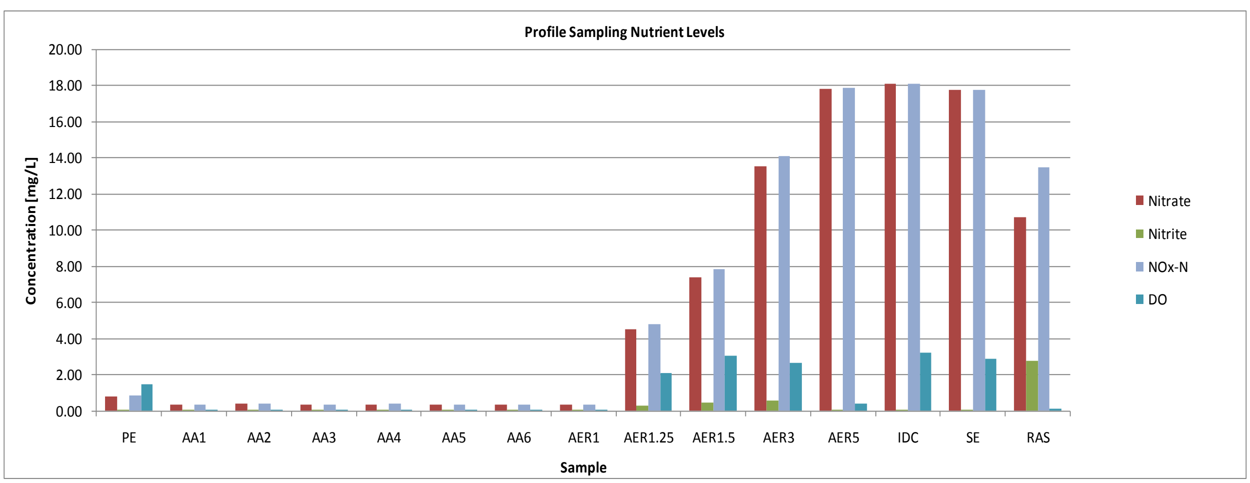
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
1.42	0.50	0.45	0.16	3.25	1.15	41.79	46.43	0.17

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.30	17.81	11.191	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1200	75	900	3780	75	2835	3780	75	2835







PROFILE 2 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
24-Sep-09	7:07	0	PE	-	34.70	0.69	0.03	0.73	14.36	1.68	7.06
24-Sep-09	7:24	0.85	AA1	Anaerobic	28.70	0.30	0.02	0.32	37.69	0.06	7.07
24-Sep-09	7:54	1.73	AA2	Anaerobic	27.50	0.31	0.02	0.33	39.16	0.07	7.08
24-Sep-09	8:24	2.60	AA3	Anaerobic	28.90	0.31	0.02	0.33	41.44	0.06	7.06
24-Sep-09	8:54	3.46	AA4	Anaerobic	20.60	0.48	0.27	0.75	31.00	0.08	7.02
24-Sep-09	9:09	4.33	AA5	Anaerobic	20.25	0.30	0.02	0.32	32.31	0.06	7.01
24-Sep-09	9:24	5.19	AA6	Anaerobic	20.10	0.32	0.02	0.33	34.75	0.06	7.00
24-Sep-09	9:39	0.00	AER1	Aerobic	20.95	0.31	0.02	0.33	35.41	0.06	7.02
24-Sep-09	9:48	0.34	AER1.25	Aerobic	16.55	3.30	0.36	3.66	25.70	2.28	7.02
24-Sep-09	9:56	0.67	AER1.5	Aerobic	10.85	7.58	0.84	8.42	16.89	2.90	6.97
24-Sep-09	10:41	3.35	AER3	Aerobic	3.56	13.52	1.03	14.55	6.95	2.35	6.75
24-Sep-09	11:41	6.71	AER5	Aerobic	0.00	17.14	0.03	17.17	0.38	2.40	6.72
24-Sep-09	11:52		IDC	-	0.00	17.38	0.02	17.40	0.21	4.26	6.88
24-Sep-09	14:52		SE	-	0.00	17.16	0.02	17.18	0.30	2.77	6.98
24-Sep-09	15:18		RAS	-	0.00	11.42	1.03	12.45	0.73	0.20	6.79

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
194					
90					
85					
84					
66					
67					
68					
66					
59					
56					
52					
46					
43					
44		<0.20	17.7	17.7	0.02
51					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.79	2480	2.00	6.72	2.79	1.46	3.73	1.95

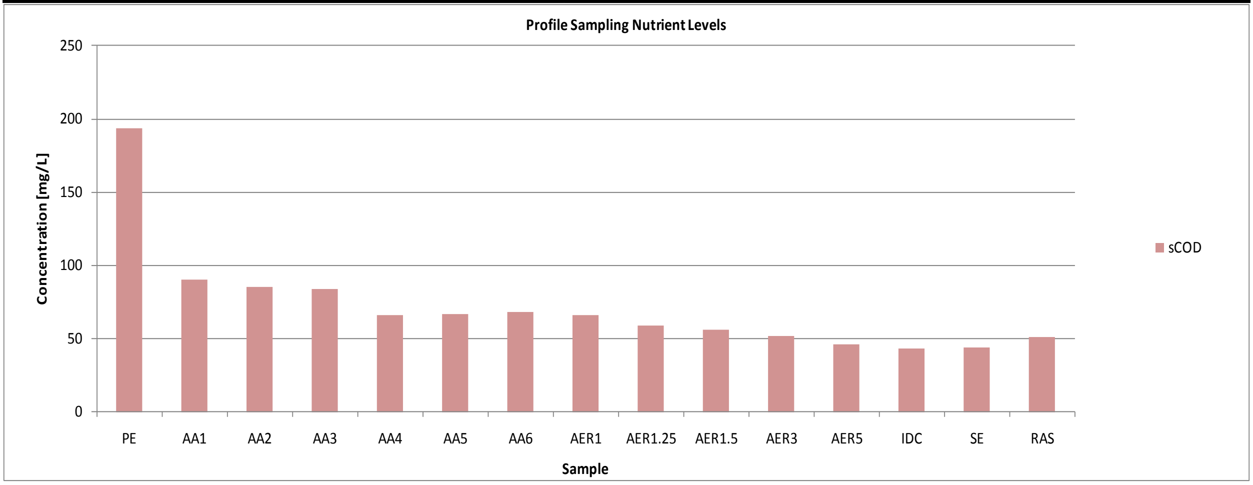
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.03	6.99	3.66	0.0000	17.3960	0.2	27.08	0.337

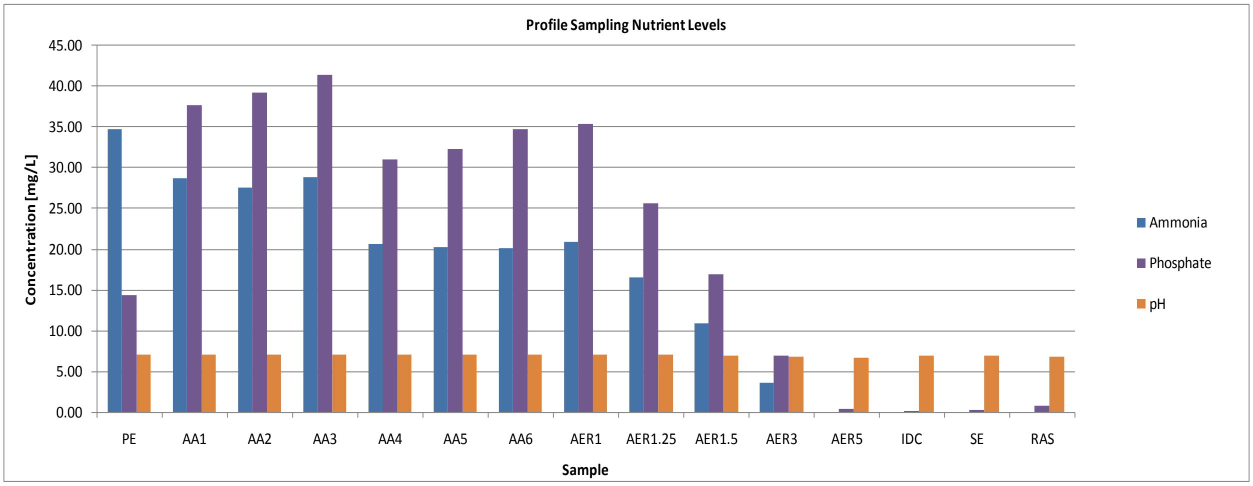
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.75	0.33	16.19	17.09	10.85	11.46	7.82	8.25

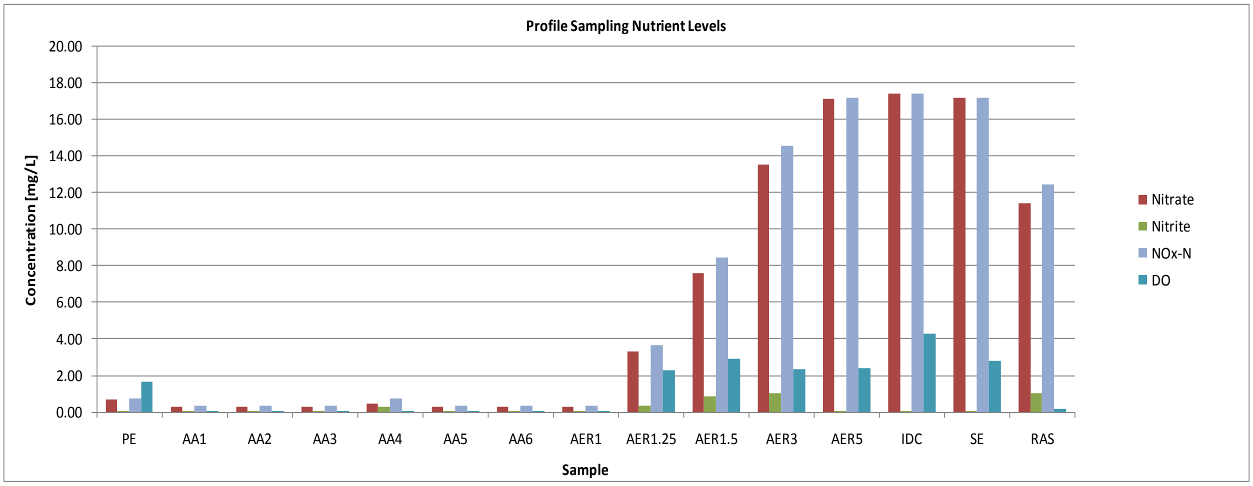
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.26	-0.14	0.30	0.16	3.02	1.58	52.59	55.53	0.31

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.73	17.64	11.432	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1230	77	947	2480	77	1910	2480	77	1910







Week 11 – 9/28/09 & 9/30/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
28-Sep-09	7:18	0	PE	-	31.50	0.90	0.04	0.94	14.68	1.06	6.98
28-Sep-09	7:34	0.81	AA1	Anaerobic	28.30	0.32	0.02	0.34	31.33	0.07	7.04
28-Sep-09	8:04	1.61	AA2	Anaerobic	28.00	0.35	0.02	0.37	33.77	0.07	7.06
28-Sep-09	8:34	2.42	AA3	Anaerobic	27.50	0.33	0.02	0.34	36.06	0.07	7.04
28-Sep-09	9:04	3.23	AA4	Anaerobic	22.00	0.39	0.13	0.53	33.77	0.07	7.01
28-Sep-09	9:19	4.03	AA5	Anaerobic	21.20	0.27	0.03	0.29	35.41	0.06	7.00
28-Sep-09	9:34	4.84	AA6	Anaerobic	21.50	0.27	0.02	0.30	37.36	0.07	7.01
28-Sep-09	9:49	0.00	AER1	Aerobic	21.15	0.27	0.03	0.29	35.89	0.06	7.01
28-Sep-09	9:58	0.31	AER1.25	Aerobic	15.95	3.05	0.52	3.57	26.19	2.48	7.00
28-Sep-09	10:06	0.63	AER1.5	Aerobic	10.25	6.41	1.08	7.49	17.21	3.08	6.95
28-Sep-09	10:51	3.13	AER3	Aerobic	4.05	13.10	1.33	14.43	8.71	2.77	6.70
28-Sep-09	11:51	6.25	AER5	Aerobic	0.00	17.22	0.06	17.28	0.58	1.45	6.67
28-Sep-09	12:00		IDC	-	0.00	17.18	0.02	17.20	0.33	3.67	6.71
28-Sep-09	15:00		SE	-	0.00	17.02	0.02	17.04	0.29	2.80	6.89
28-Sep-09	15:25		RAS	-	0.00	11.24	1.72	12.96	1.70	0.13	6.84

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
192					
109					
97					
92					
68					
64					
60					
60					
56					
47					
45					
38					
40					
40	0.332	<0.20	17.6	17.6	0.02
51					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.13	2300	1.97	6.67	2.92	1.65	4.03	2.28

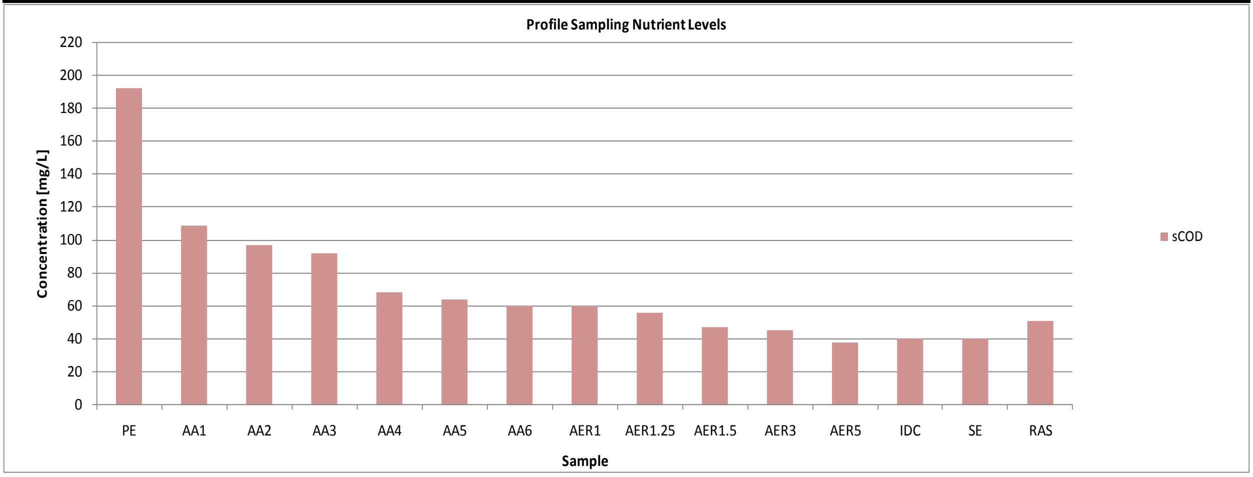
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.33	7.05	3.98	0.0000	17.2040	0.3	22.68	0.322

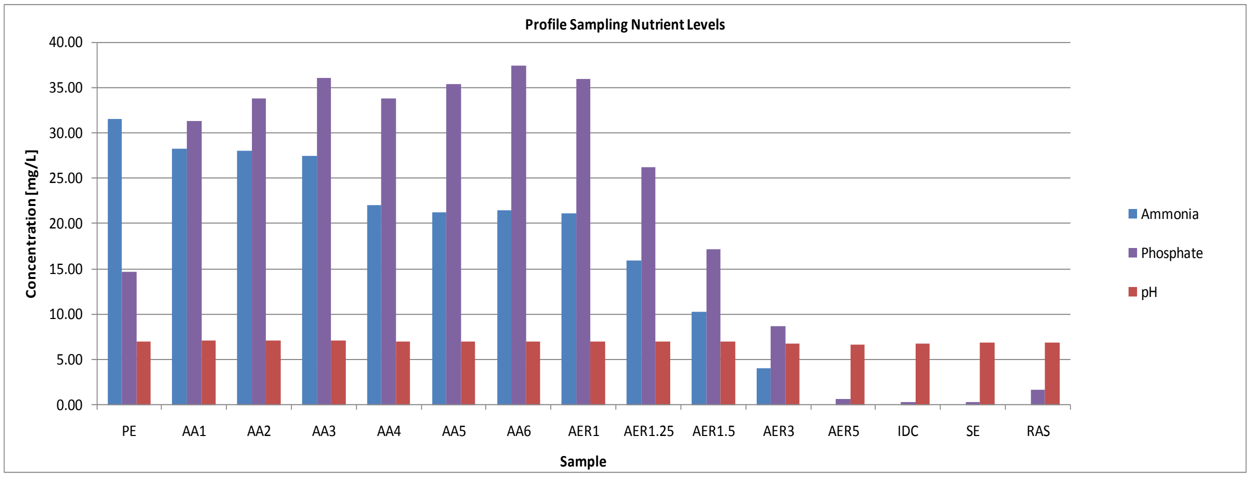
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.53	0.30	7.82	9.06	10.08	11.69	7.11	8.25

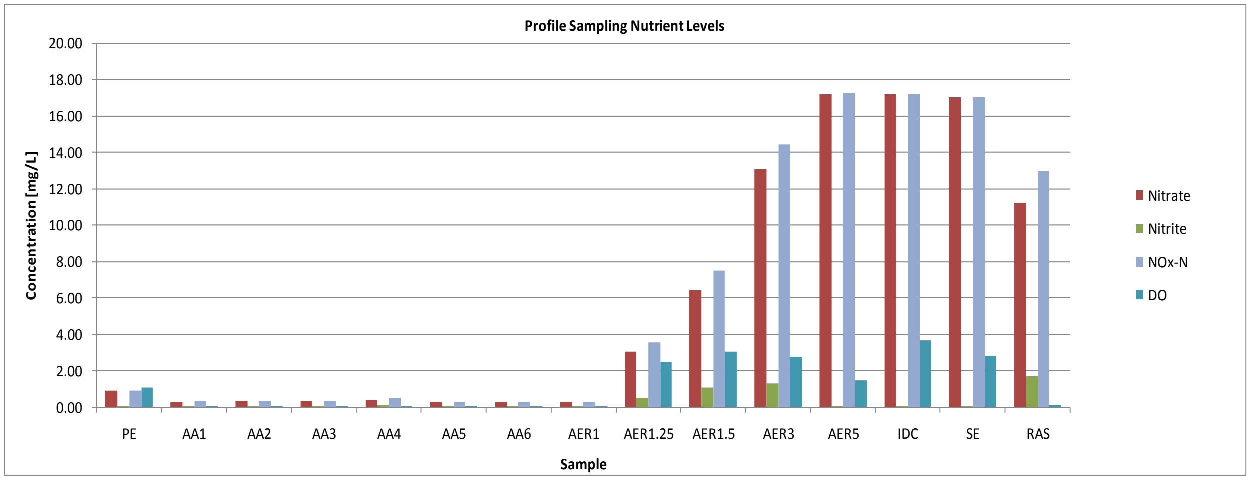
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
1.87	1.06	0.40	0.23	2.77	1.56	28.31	32.83	0.28

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	20.70	17.33	12.17	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1120	77	862	2300	77	1771	2300	77	1771







PROFILE 2 Train 5, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
30-Sep-09	7:15	0	PE	-	33.10	1.03	0.03	1.06	14.68	1.44	7.04
30-Sep-09	7:30	0.84	AA1	Anaerobic	28.70	0.31	0.01	0.32	36.38	0.11	7.13
30-Sep-09	8:00	1.61	AA2	Anaerobic	27.30	0.32	0.01	0.33	33.94	0.12	7.12
30-Sep-09	8:30	2.42	AA3	Anaerobic	27.50	0.32	0.02	0.34	35.08	0.12	7.10
30-Sep-09	9:00	3.23	AA4	Anaerobic	21.40	0.45	0.22	0.67	32.63	0.08	7.06
30-Sep-09	9:15	4.03	AA5	Anaerobic	20.35	0.32	0.03	0.35	39.32	0.08	7.04
30-Sep-09	9:30	4.84	AA6	Anaerobic	20.45	0.34	0.02	0.36	33.77	0.07	7.05
30-Sep-09	9:45	0.00	AER1	Aerobic	20.65	0.33	0.01	0.34	33.94	0.05	7.03
30-Sep-09	9:53	0.31	AER1.25	Aerobic	16.70	2.60	0.44	3.04	26.76	2.40	7.01
30-Sep-09	10:01	0.63	AER1.5	Aerobic	12.15	5.77	1.07	6.84	19.01	2.82	6.97
30-Sep-09	10:46	3.13	AER3	Aerobic	6.06	10.24	1.77	12.01	11.39	2.18	6.79
30-Sep-09	11:46	6.25	AER5	Aerobic	0.00	16.14	0.47	16.61	2.47	1.74	6.64
30-Sep-09	11:59		IDC	-	0.00	16.76	0.07	16.83	1.13	3.67	6.71
30-Sep-09	14:59		SE	-	0.00	16.74	0.02	16.76	0.30	3.33	6.93
30-Sep-09	15:15		RAS	-	0.00	12.24	1.44	13.68	1.66	0.20	6.75

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
188					
96					
90					
87					
58					
61					
55					
59					
54					
46					
40					
39					
42					
39		<0.20	17.6	17.6	0.02
45					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
3.63	2120	1.84	6.64	2.95	1.83	3.29	2.04

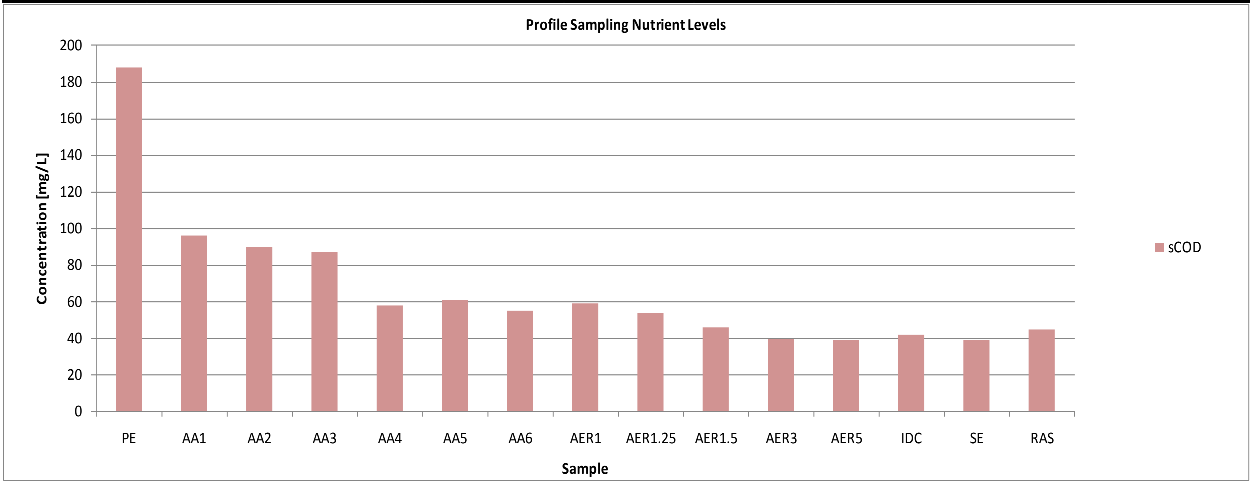
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.77	5.98	3.71	0.0000	16.8300	1.1	24.64	0.342

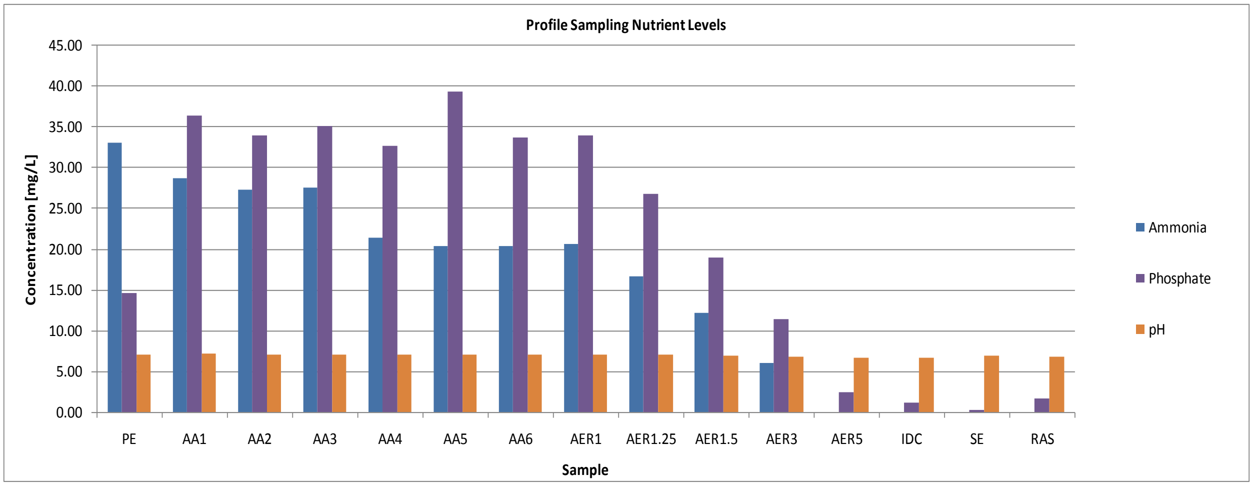
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.67	0.36	15.16	20.77	8.73	11.96	6.83	9.36

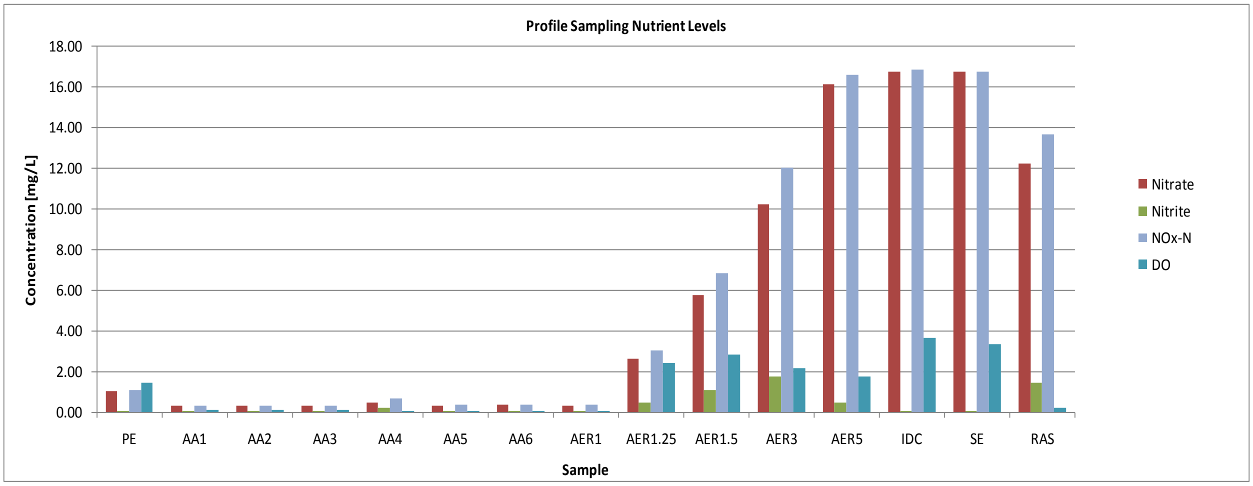
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/ COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
1.71	1.06	1.66	1.03	1.37	0.85	35.39	48.51	0.43

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.81	17.38	11.67	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
960	76	730	2120	76	1611	2120	76	1611







Week 12 – 10/6/09 & 10/8/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
6-Oct-09	7:03	0	PE	-	37.20	0.79	0.14	0.93	20.07	1.11	6.95
6-Oct-09	7:20	0.89	AA1	Anaerobic	31.50	0.36	0.02	0.37	33.45	0.11	7.04
6-Oct-09	7:50	1.79	AA2	Anaerobic	30.10	0.37	0.01	0.38	33.77	0.11	7.03
6-Oct-09	8:20	2.68	AA3	Anaerobic	29.50	0.31	0.01	0.33	36.38	0.08	7.03
6-Oct-09	8:50	3.57	AA4	Anaerobic	25.50	0.36	0.08	0.44	38.99	0.08	7.02
6-Oct-09	9:05	4.46	AA5	Anaerobic	24.60	0.30	0.02	0.32	39.97	0.09	7.02
6-Oct-09	9:20	5.36	AA6	Anaerobic	26.15	0.31	0.02	0.33	40.30	0.11	7.02
6-Oct-09	9:35	0.00	AER1	Aerobic	23.50	0.35	0.02	0.38	38.83	0.07	6.98
6-Oct-09	9:43	0.35	AER1.25	Aerobic	18.65	3.37	0.64	4.01	26.35	3.16	7.00
6-Oct-09	9:51	0.69	AER1.5	Aerobic	13.45	6.92	1.38	8.30	7.75	4.29	6.98
6-Oct-09	10:36	3.46	AER3	Aerobic	7.35	11.30	2.08	13.38	5.68	3.54	6.78
6-Oct-09	11:36	6.92	AER5	Aerobic	2.21	14.48	2.60	17.08	0.14	0.42	6.62
6-Oct-09	11:45		IDC	-	2.27	14.20	2.74	16.94	0.13	0.75	6.63
6-Oct-09	14:45		SE	-	1.81	14.10	2.74	16.84	1.06	2.32	6.82
6-Oct-09	15:03		RAS	-	2.53	7.58	4.42	12.00	2.82	0.23	6.71

*NOTE: These values are <1 mg/L NH_4-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
173					
106					
99					
96					
66					
64					
65					
60					
48					
47					
44					
39					
39					
41	0.304	1.68	17.4	14.6	2.8
44					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.01	1760	2.30	6.62	2.69	1.91	3.21	2.28

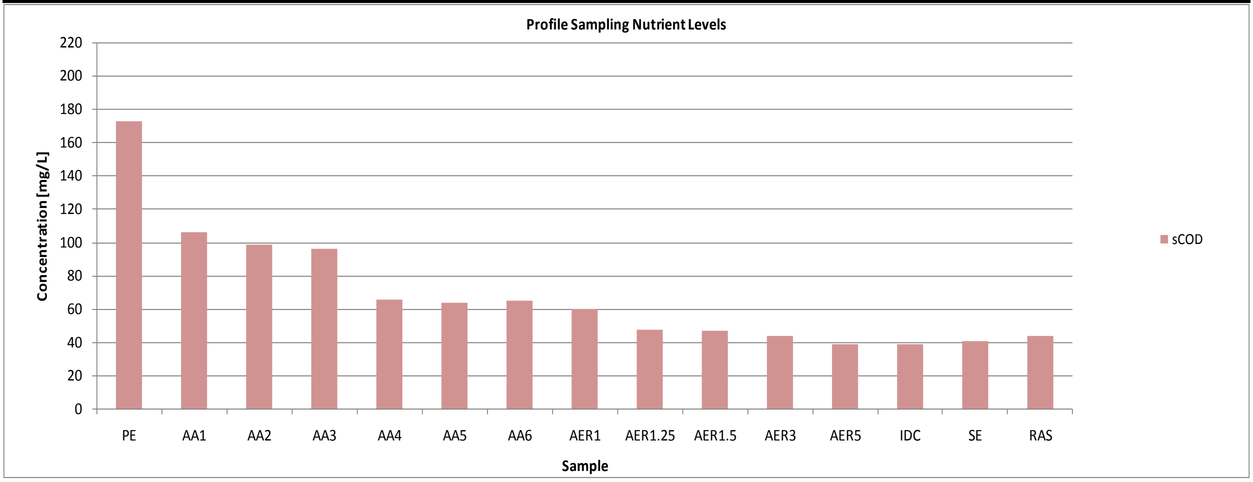
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2.60	7.23	5.13	2.2700	16.9400	0.1	20.23	0.334

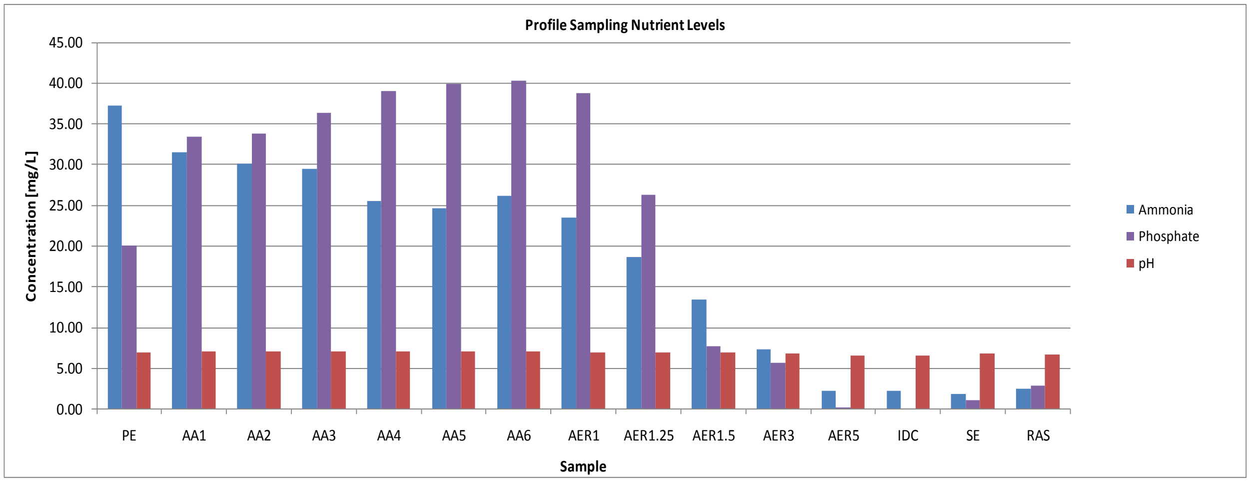
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.44	0.33	3.98	4.62	9.01	10.45	6.92	8.02

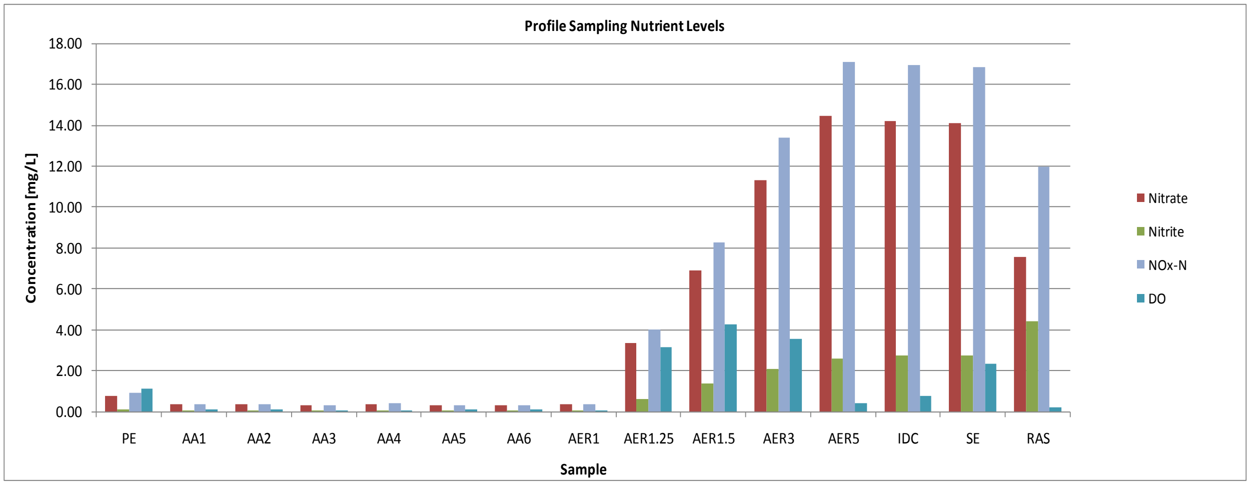
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
2.95	2.09	0.22	0.16	2.58	1.83	16.30	18.90	0.24

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.71	17.67	11.223	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
980	88	862	1760	80	1408	1760	80	1408







PROFILE 2 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
8-Oct-09	7:06	0	PE	-	41.30	0.69	0.15	0.84	20.39	0.53	6.95
8-Oct-09	7:22	0.89	AA1	Anaerobic	30.50	0.28	0.01	0.30	37.85	0.14	7.04
8-Oct-09	7:52	1.79	AA2	Anaerobic	30.70	0.29	0.01	0.30	38.99	0.23	7.10
8-Oct-09	8:22	2.68	AA3	Anaerobic	30.30	0.31	0.01	0.32	40.95	0.12	-
8-Oct-09	8:52	3.57	AA4	Anaerobic	23.80	0.44	0.25	0.69	35.41	0.15	-
8-Oct-09	9:07	4.46	AA5	Anaerobic	22.40	0.30	0.01	0.31	34.43	0.10	-
8-Oct-09	9:22	5.36	AA6	Anaerobic	22.20	0.30	0.02	0.32	36.55	0.11	-
8-Oct-09	9:37	0.00	AER1	Aerobic	22.65	0.28	0.02	0.30	39.16	0.06	-
8-Oct-09	9:45	0.35	AER1.25	Aerobic	20.20	1.98	0.80	2.78	27.41	2.46	-
8-Oct-09	9:53	0.69	AER1.5	Aerobic	17.30	3.44	1.48	4.92	20.97	2.80	-
8-Oct-09	10:38	3.46	AER3	Aerobic	11.90	6.48	2.78	9.26	8.48	1.97	-
8-Oct-09	11:38	6.92	AER5	Aerobic	6.44	9.40	4.02	13.42	0.39	0.97	-
8-Oct-09	11:51		IDC	-	5.84	8.92	4.40	13.32	0.44	0.18	-
8-Oct-09	14:58		SE	-	4.72	9.22	4.58	13.80	0.43	3.18	6.75
8-Oct-09	15:22		RAS	-	6.14	2.78	2.92	5.70	18.03	0.46	6.52

QA/QC Sample: SE

EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO4	NH4-N	NO2,3-N	NO3-N	NO2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
155					
90					
83					
75					
54					
57					
63					
64					
53					
44					
45					
45					
39					
41		5.06	13.7	9.05	4.65
48					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
3.96	1780	1.65	0.00	2.17	1.60	2.26	1.67

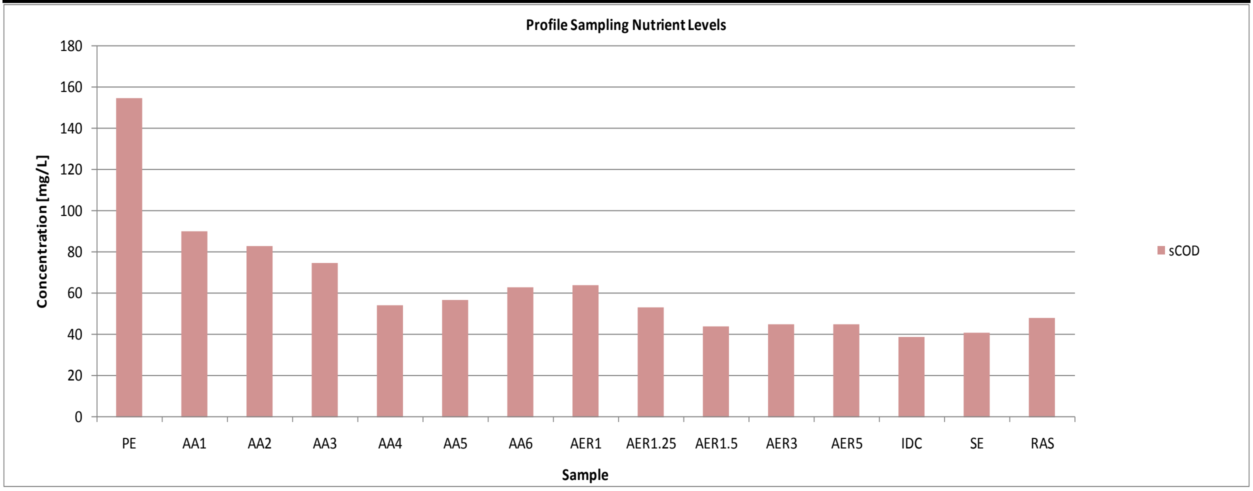
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
4.02	7.28	5.38	5.8400	13.3200	0.4	20.56	0.322

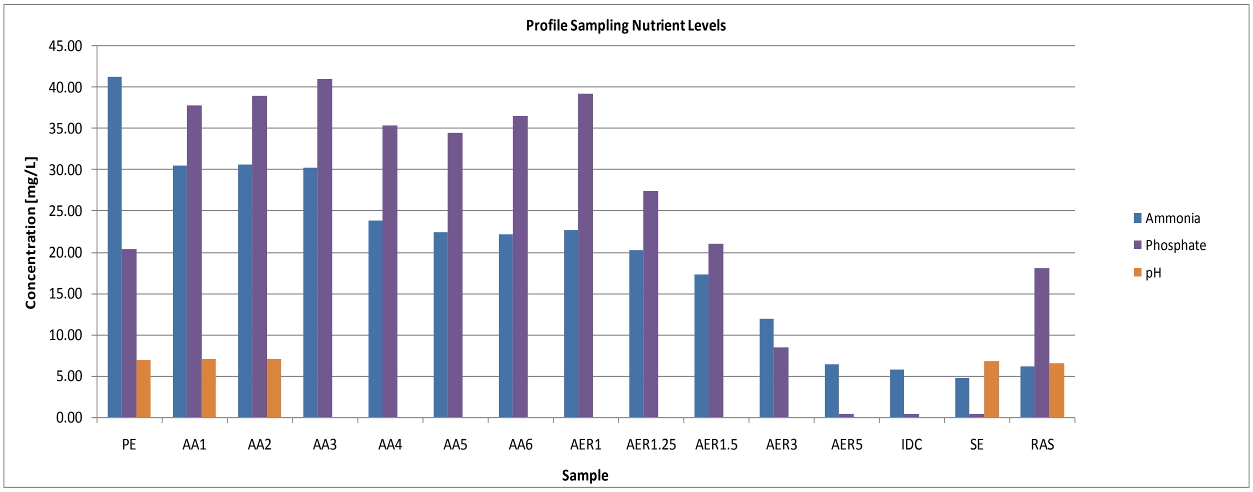
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.69	0.32	11.00	13.45	10.48	12.82	7.50	9.17

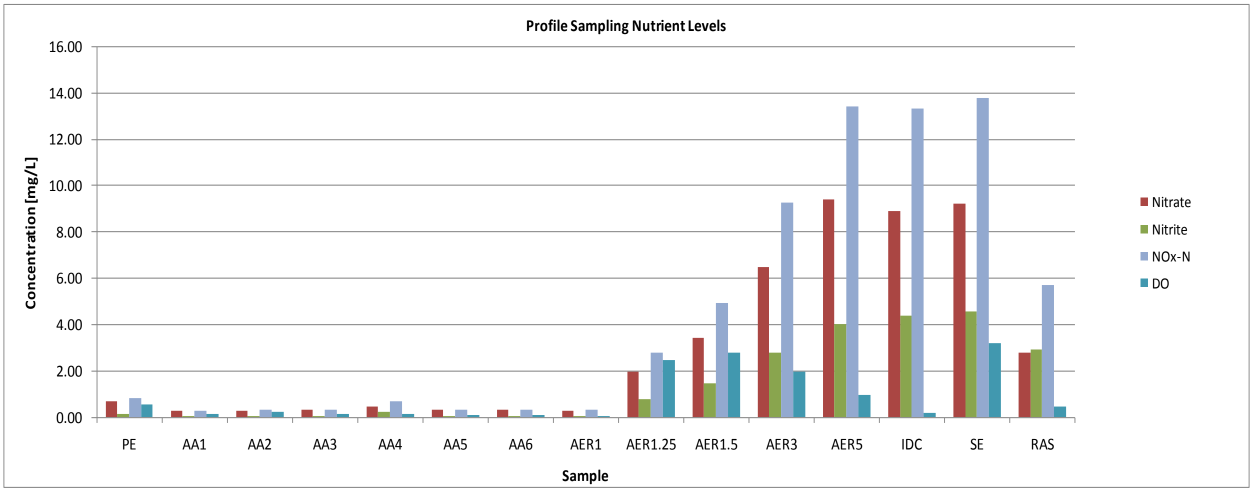
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
-0.03	-0.02	-0.22	-0.16	3.36	2.49	23.83	29.14	0.46

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.84	17.17	11.23	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
940	87	818	1780	76	1353	1780	76	1353







Week 13 – 10/13/09 & 10/16/09

PROFILE 1 Train 5, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
13-Oct-09	7:04	0	PE	-	36.40	0.38	0.03	0.41	11.26	1.43	6.41
13-Oct-09	7:26	0.90	AA1	Anaerobic	33.70	0.39	0.02	0.41	36.22	0.12	7.02
13-Oct-09	7:56	1.80	AA2	Anaerobic	32.70	0.42	0.02	0.43	38.34	0.14	7.03
13-Oct-09	8:26	2.70	AA3	Anaerobic	34.50	0.41	0.02	0.43	39.65	0.18	7.02
13-Oct-09	8:56	3.61	AA4	Anaerobic	27.70	0.35	0.02	0.37	37.85	0.09	7.01
13-Oct-09	9:11	4.51	AA5	Anaerobic	27.05	0.34	0.02	0.36	39.97	0.11	7.00
13-Oct-09	9:26	5.41	AA6	Anaerobic	27.15	0.37	0.02	0.39	42.26	0.09	6.98
13-Oct-09	9:41	0.00	AER1	Aerobic	26.85	0.69	0.02	0.71	43.56	0.08	7.00
13-Oct-09	9:49	0.35	AER1.25	Aerobic	22.90	1.69	1.72	3.41	27.08	1.93	7.01
13-Oct-09	9:58	0.70	AER1.5	Aerobic	19.35	2.98	3.10	6.08	16.56	3.34	7.03
13-Oct-09	10:43	3.49	AER3	Aerobic	15.00	4.43	4.60	9.03	5.87	2.63	6.87
13-Oct-09	11:43	6.99	AER5	Aerobic	10.40	5.70	6.30	12.00	0.16	0.97	6.77
13-Oct-09	11:50		IDC	-	10.90	5.30	6.30	11.60	0.14	0.78	6.74
13-Oct-09	14:50		SE	-	9.74	5.61	6.80	12.41	0.25	2.73	6.93
13-Oct-09	15:07		RAS	-	12.40	1.66	4.85	6.51	1.88	0.19	6.75

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
224					
122					
114					
118					
83					
76					
78					
78					
64					
56					
58					
64					
54					
53	0.293	9.86	12.1	5.16	6.94
62					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.43	1700	1.79	6.77	2.03	1.51	1.98	1.47

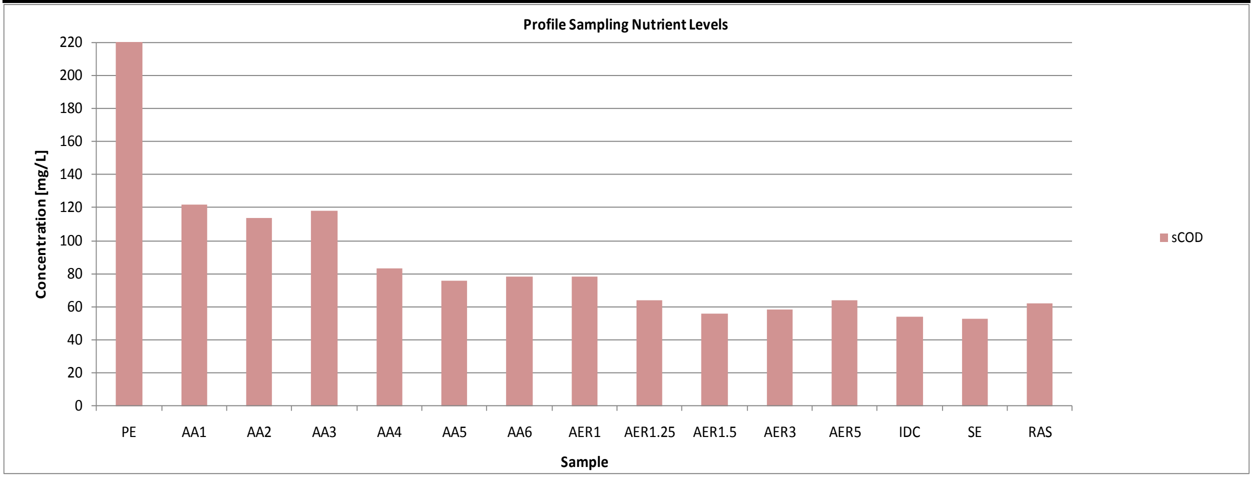
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
6.30	8.38	6.24	10.9000	11.6000	0.1	31.00	0.380

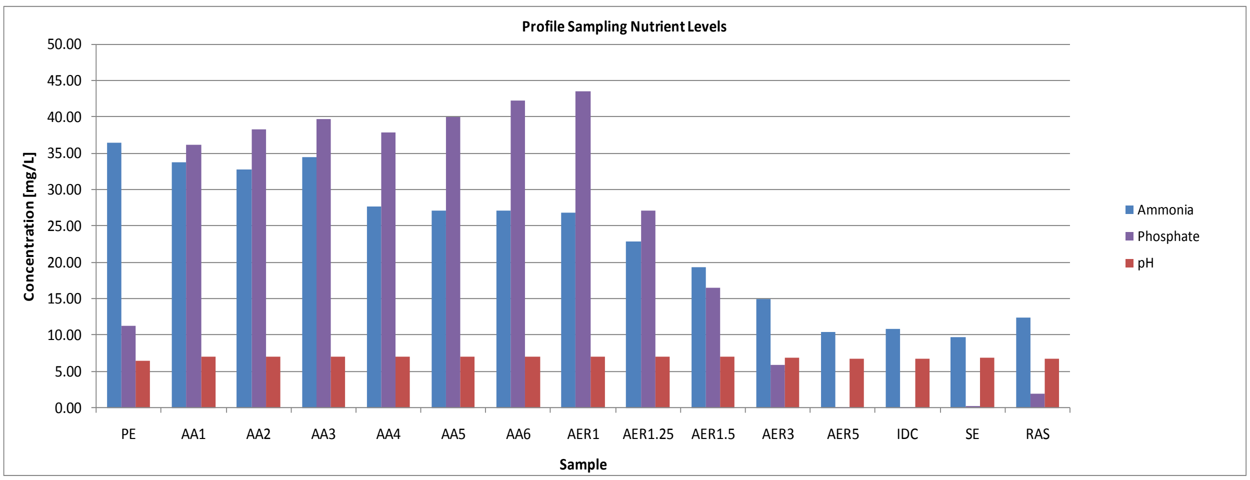
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.37	0.39	11.16	14.92	10.57	14.12	7.12	9.52

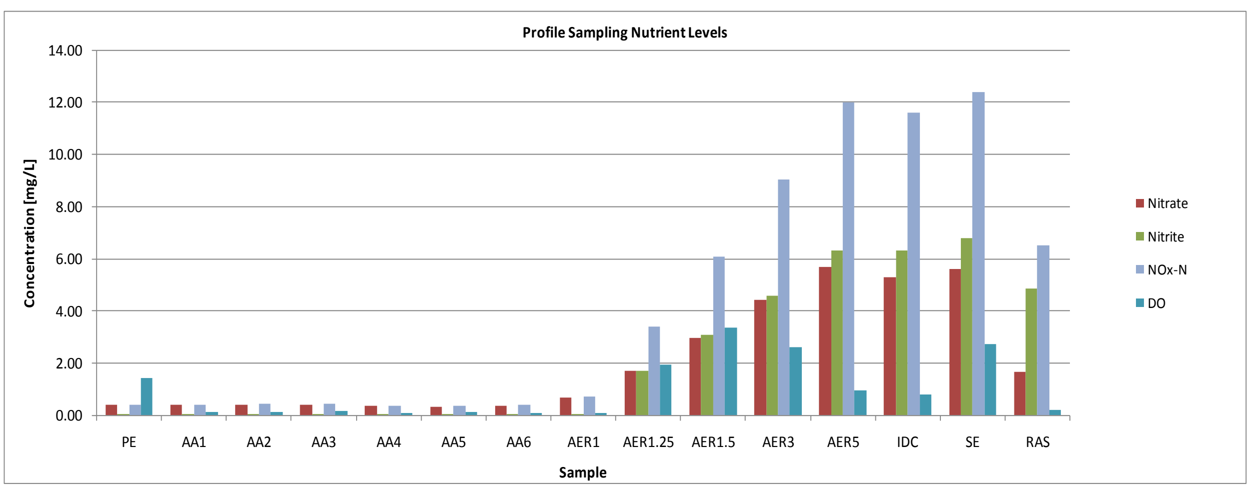
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
1.96	1.46	0.47	0.35	3.54	2.63	35.29	47.17	0.32

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.53	17.15	10.938	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
880	85	748	1700	79	1343	1700	79	1343







PROFILE 2 Train 6, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
16-Oct-09	9:43	0	PE	-	31.20	0.34	0.02	0.36	23.98	0.32	6.89
16-Oct-09	9:58	0.83	AA1	Anaerobic	29.00	0.35	0.01	0.37	31.33	0.20	7.01
16-Oct-09	10:13	1.80	AA2	Anaerobic	30.10	0.33	0.02	0.34	40.14	0.25	7.00
16-Oct-09	10:28	2.70	AA3	Anaerobic	30.10	0.35	0.01	0.36	34.26	0.18	7.00
16-Oct-09	10:43	3.61	AA4	Anaerobic	26.60	0.30	0.01	0.31	38.51	0.12	6.95
16-Oct-09	10:51	4.51	AA5	Anaerobic	26.80	0.34	0.01	0.35	41.61	0.11	6.96
16-Oct-09	10:59	5.41	AA6	Anaerobic	25.10	0.33	0.01	0.34	40.46	0.14	6.95
16-Oct-09	11:07	0.00	AER1	Aerobic	28.60	0.34	0.01	0.35	41.77	0.07	6.95
16-Oct-09	11:13	0.35	AER1.25	Aerobic	24.20	0.51	0.50	1.01	28.06	1.15	7.01
16-Oct-09	11:19	0.70	AER1.5	Aerobic	21.60	1.09	1.30	2.39	13.87	2.06	7.04
16-Oct-09	12:04	3.49	AER3	Aerobic	18.65	1.79	2.40	4.19	2.77	2.23	6.92
16-Oct-09	13:04	6.99	AER5	Aerobic	16.25	2.47	3.20	5.67	0.09	1.30	6.76
16-Oct-09	13:10		IDC	-	16.05	2.02	3.60	5.62	0.24	0.12	6.81
16-Oct-09	16:10		SE	-	15.90	1.75	4.00	5.75	0.25	2.72	6.96
16-Oct-09	16:30		RAS	-	15.65	0.60	1.10	1.70	3.92	0.40	6.93

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					
0					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.90	1540	1.36	6.76	1.42	1.18	1.00	0.83

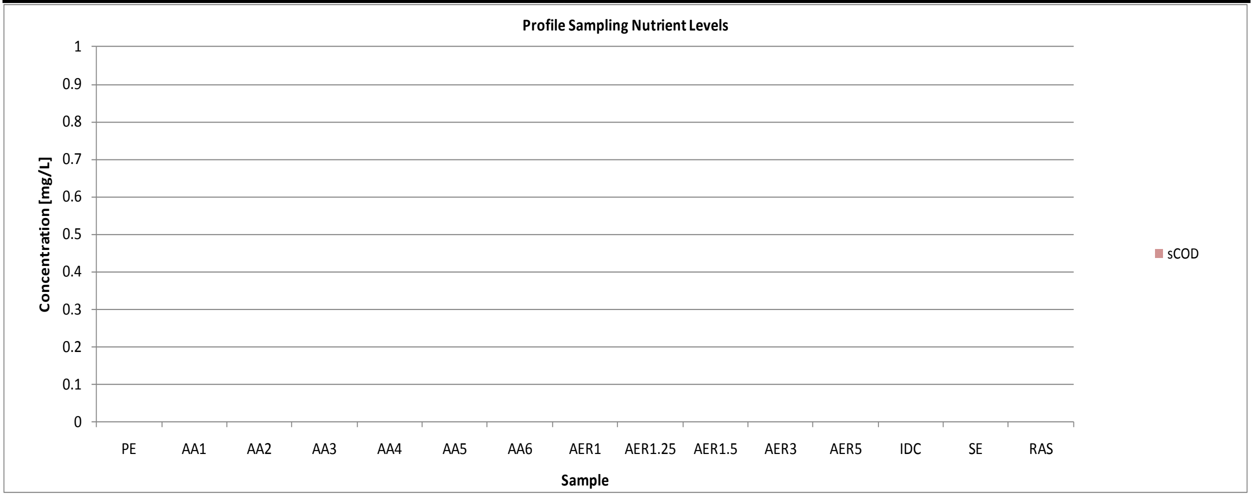
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
3.20	9.01	7.50	16.0500	5.6200	0.2	17.62	0.333

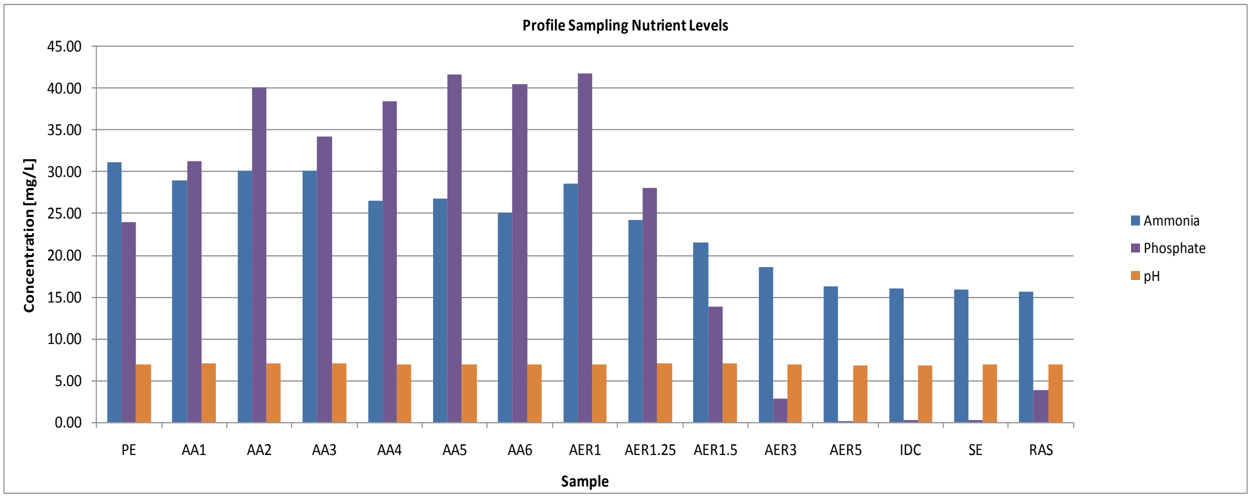
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.31	0.34	-0.29	-0.38	12.62	16.88	4.48	5.99

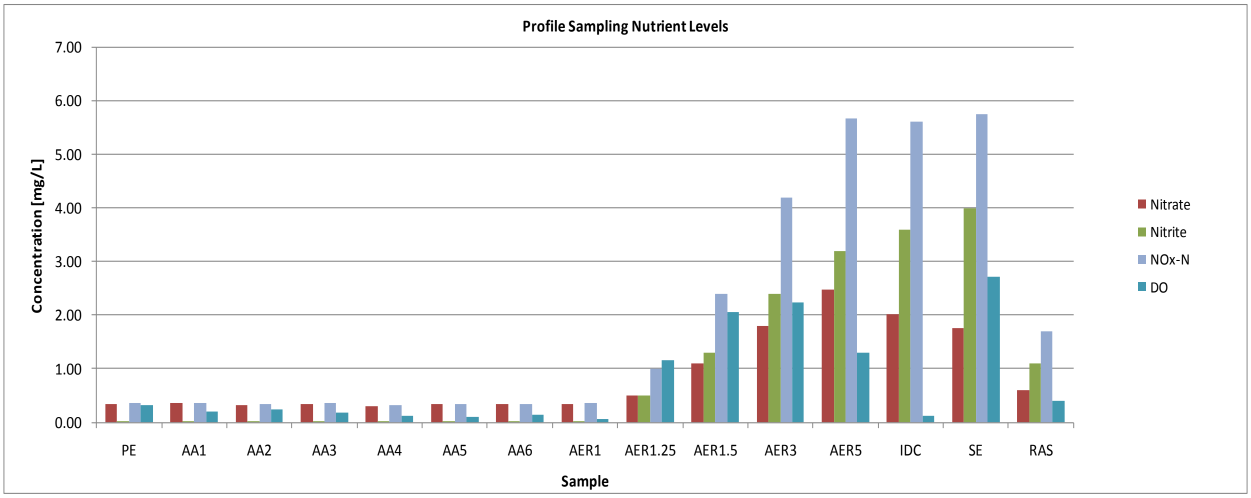
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
3.21	2.67	0.69	0.57	2.64	2.20	0.00	0.00	#DIV/0!

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	20.22	17.21	11.905	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
840	89	748	1540	78	1201	1540	78	1201







Week 14 – 10/19/09 & 10/21/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
19-Oct-09	8:50	0	PE	-	32.60	0.32	0.02	0.34	22.03	0.18	7..01
19-Oct-09	9:07	0.85	AA1	Anaerobic	32.10	0.32	0.01	0.34	31.98	0.12	7.02
19-Oct-09	9:37	1.71	AA2	Anaerobic	37.80	0.30	0.01	0.31	33.12	0.11	7.02
19-Oct-09	10:07	2.56	AA3	Anaerobic	32.30	0.31	0.02	0.32	34.59	0.12	7.01
19-Oct-09	10:37	3.41	AA4	Anaerobic	31.80	0.31	0.01	0.33	37.36	0.09	6.93
19-Oct-09	10:50	4.27	AA5	Anaerobic	30.60	0.30	0.01	0.31	42.26	0.12	6.96
19-Oct-09	11:03	5.12	AA6	Anaerobic	30.90	0.31	0.01	0.32	43.07	0.11	6.96
19-Oct-09	11:16	0.00	AER1	Aerobic	28.50	0.29	0.01	0.30	41.61	0.05	6.95
19-Oct-09	11:24	0.33	AER1.25	Aerobic	28.80	0.46	0.42	0.88	24.72	1.57	7.06
19-Oct-09	11:32	0.66	AER1.5	Aerobic	25.20	0.71	0.84	1.55	14.44	2.15	7.08
19-Oct-09	12:17	3.31	AER3	Aerobic	22.50	1.34	1.56	2.90	1.11	2.83	6.96
19-Oct-09	13:17	6.61	AER5	Aerobic	20.80	1.77	2.04	3.81	0.08	1.30	6.93
19-Oct-09	13:26		IDC	-	21.00	1.68	2.04	3.72	0.10	1.01	6.91
19-Oct-09	16:26		SE	-	20.10	1.63	2.34	3.97	0.16	4.41	7.08
19-Oct-09	16:54		RAS	-	21.80	0.26	0.04	0.30	3.75	0.32	6.88

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
163					
122					
124					
114					
84					
74					
77					
74					
61					
54					
61					
52					
47					
50	0.112	21.2	3.49	1.05	2.44
58					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.93	1910	1.58	6.93	1.16	0.77	0.71	0.47

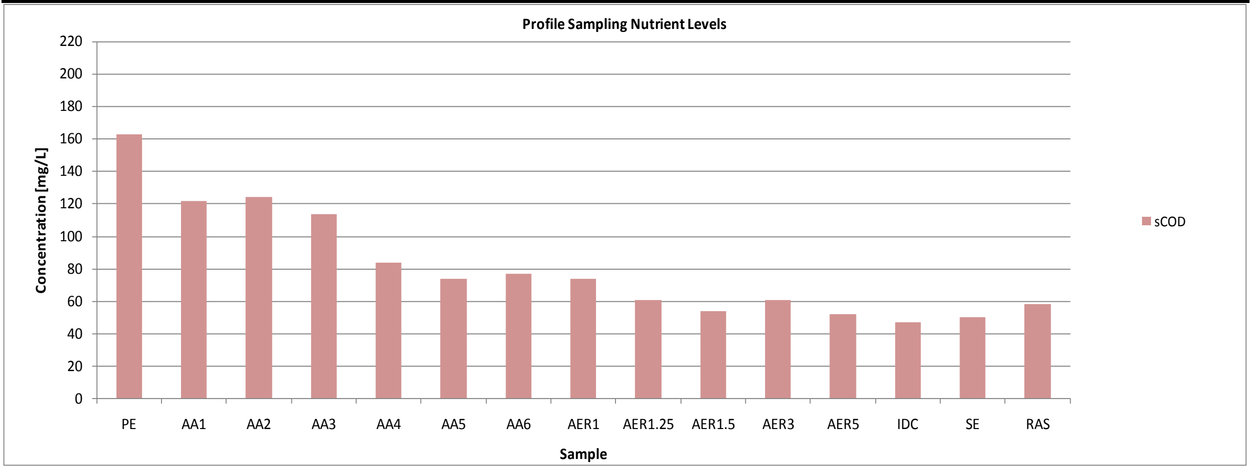
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2.04	9.71	6.43	21.0000	3.7200	0.1	21.05	0.309

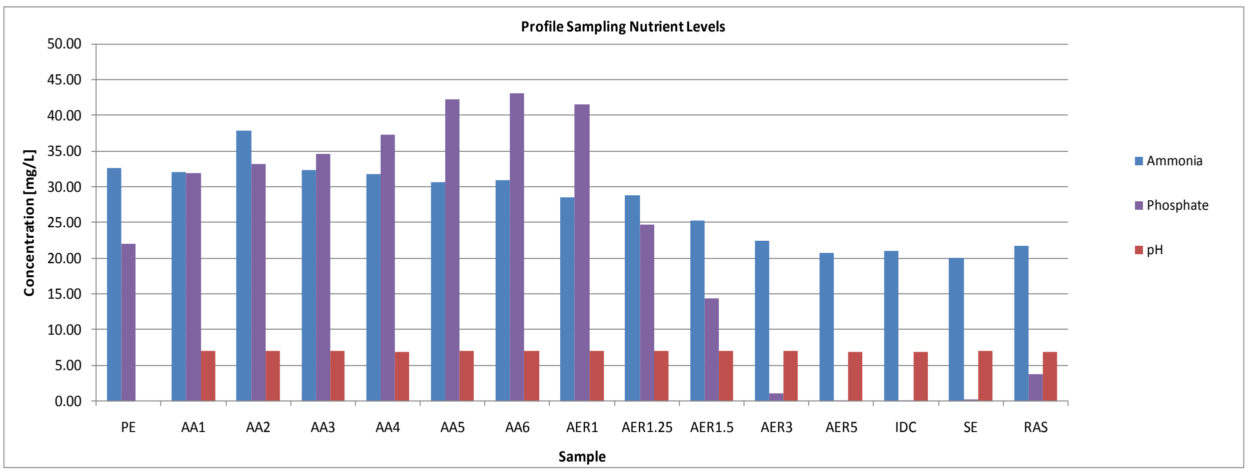
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.33	0.32	0.10	0.13	9.17	11.58	6.45	8.14

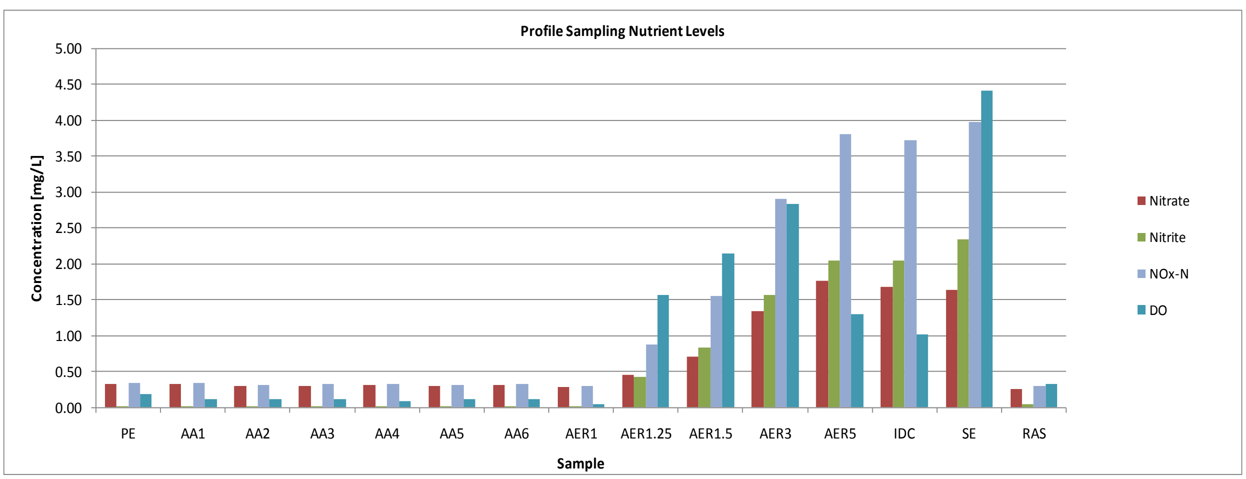
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
2.98	1.97	1.15	0.76	2.87	1.90	0.81	1.03	0.13

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	19.57	17.26	11.602	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
890	89	792	1910	79	1509	1910	79	1509







PROFILE 2 Train 5, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
21-Oct-09	6:53	0	PE	-	39.70	0.44	0.04	0.48	21.37	1.75	7.00
21-Oct-09	7:07	0.89	AA1	Anaerobic	33.10	0.36	0.01	0.37	36.22	0.15	6.99
21-Oct-09	7:37	1.71	AA2	Anaerobic	33.10	0.40	0.02	0.42	38.67	0.17	7.00
21-Oct-09	8:07	2.56	AA3	Anaerobic	33.50	0.44	0.02	0.46	39.32	0.19	6.98
21-Oct-09	8:37	3.41	AA4	Anaerobic	30.70	0.37	0.01	0.39	38.51	0.12	6.97
21-Oct-09	8:52	4.27	AA5	Anaerobic	30.40	0.38	0.01	0.40	41.61	0.13	6.91
21-Oct-09	9:07	5.12	AA6	Anaerobic	30.40	0.38	0.01	0.39	43.07	0.15	6.93
21-Oct-09	9:22	0.00	AER1	Aerobic	30.60	0.40	0.01	0.41	52.54	0.07	6.94
21-Oct-09	9:30	0.33	AER1.25	Aerobic	29.30	0.42	0.13	0.55	27.33	0.76	6.97
21-Oct-09	9:38	0.66	AER1.5	Aerobic	28.20	0.54	0.38	0.92	19.17	1.27	7.02
21-Oct-09	10:23	3.31	AER3	Aerobic	27.40	0.91	0.94	1.85	4.21	1.94	6.98
21-Oct-09	11:23	6.61	AER5	Aerobic	25.70	1.38	1.50	2.88	0.10	1.77	6.94
21-Oct-09	11:37		IDC	-	24.90	1.16	1.76	2.92	0.15	0.12	6.91
21-Oct-09	14:37		SE	-	23.70	1.06	1.94	3.00	0.17	2.62	7.01
21-Oct-09	14:59		RAS	-	23.70	0.30	0.03	0.32	4.11	0.24	6.92

QA/QC Sample: SE

EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO4	NH4-N	NO2,3-N	NO3-N	NO2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
216					
109					
103					
103					
83					
81					
75					
78					
64					
61					
64					
54					
52					
51		23.8	2.35	0.35	2
65					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.25	1940	1.16	6.94	0.61	0.40	0.42	0.28

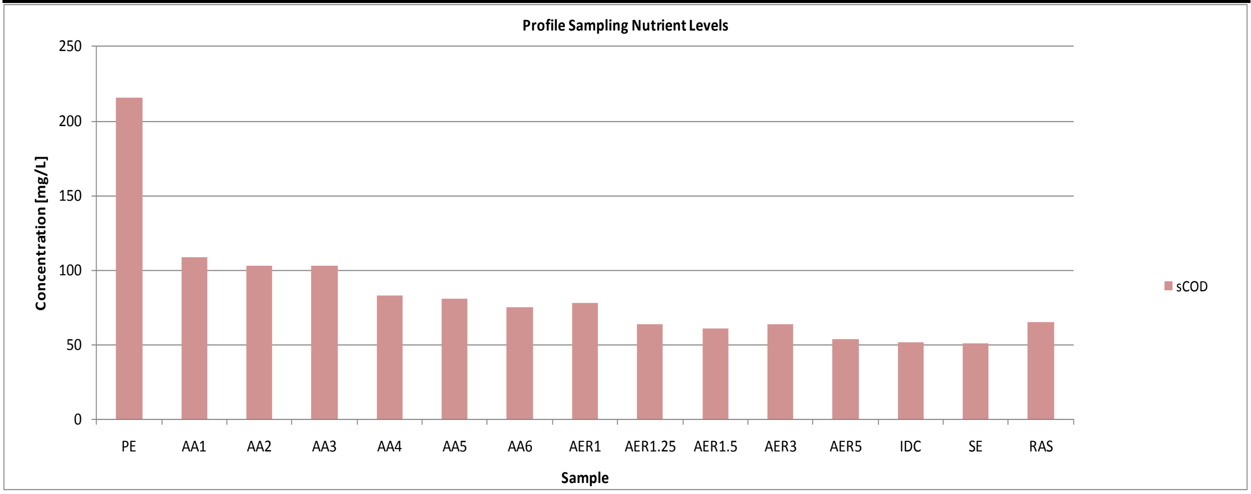
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.50	10.98	7.16	24.9000	2.9200	0.2	21.70	0.390

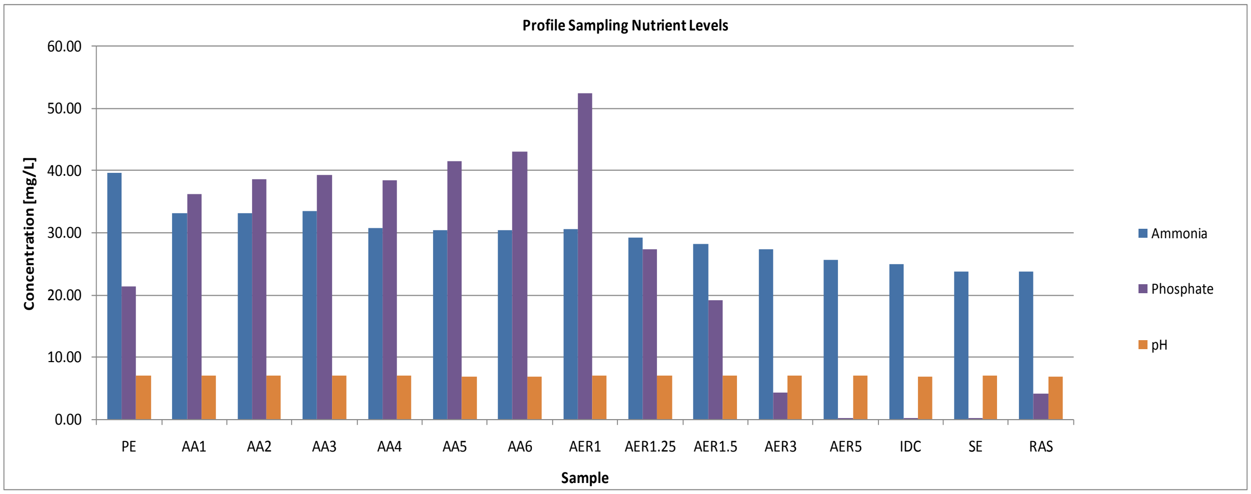
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.39	0.39	5.04	6.47	11.28	14.49	7.28	9.35

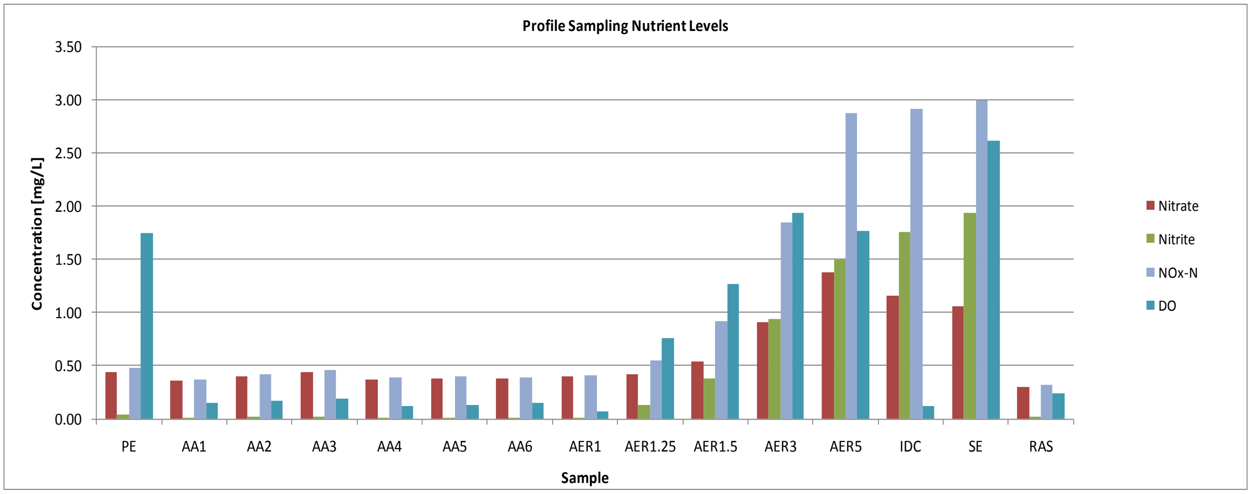
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
2.21	1.44	0.73	0.47	5.19	3.39	44.55	57.23	0.11

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.75	17.13	11.19	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
865	90	779	1940	79	1533	1940	79	1533







Week 15 – 10/26/09 & 10/27/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
26-Oct-09	7:11	0	PE	-	39.10	0.39	0.04	0.43	17.46	0.66	6.90
26-Oct-09	7:27	0.89	AA1	Anaerobic	35.20	0.29	0.01	0.30	39.65	0.17	6.99
26-Oct-09	7:57	1.78	AA2	Anaerobic	35.60	0.32	0.01	0.33	46.01	0.13	6.92
26-Oct-09	8:27	2.67	AA3	Anaerobic	36.00	0.29	0.01	0.30	44.38	0.11	6.98
26-Oct-09	8:57	3.55	AA4	Anaerobic	33.00	0.29	0.01	0.30	43.56	0.13	6.98
26-Oct-09	9:10	4.44	AA5	Anaerobic	31.60	0.29	0.01	0.31	49.93	0.10	6.97
26-Oct-09	9:23	5.33	AA6	Anaerobic	32.40	0.29	0.01	0.30	46.50	0.09	6.96
26-Oct-09	9:38	0.00	AER1	Aerobic	32.20	0.30	0.01	0.31	46.01	0.06	6.93
26-Oct-09	9:46	0.34	AER1.25	Aerobic	29.80	0.38	0.32	0.70	25.94	1.43	7.02
26-Oct-09	9:54	0.69	AER1.5	Aerobic	27.20	0.66	0.76	1.42	13.22	2.66	7.03
26-Oct-09	10:39	3.44	AER3	Aerobic	25.10	1.20	1.50	2.70	0.31	2.53	6.94
26-Oct-09	11:47	6.88	AER5	Aerobic	24.50	1.45	1.89	3.34	0.08	0.13	7.01
26-Oct-09	11:55		IDC	-	24.20	1.37	1.92	3.29	0.14	0.64	6.89
26-Oct-09	14:55		SE	-	24.30	1.26	1.96	3.22	0.17	3.04	7.12
26-Oct-09	15:19		RAS	-	25.20	0.29	0.03	0.32	3.79	0.22	6.98

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO$_4$	NH$_4$-N	NO$_{2,3}$-N	NO$_3$-N	NO$_2$-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
211					
103					
99					
98					
72					
65					
63					
64					
50					
49					
42					
42					
47					
44	0.101	24.7	2.64	0.63	2.01
53					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.90	2320	1.36	6.93	0.92	0.51	0.64	0.36

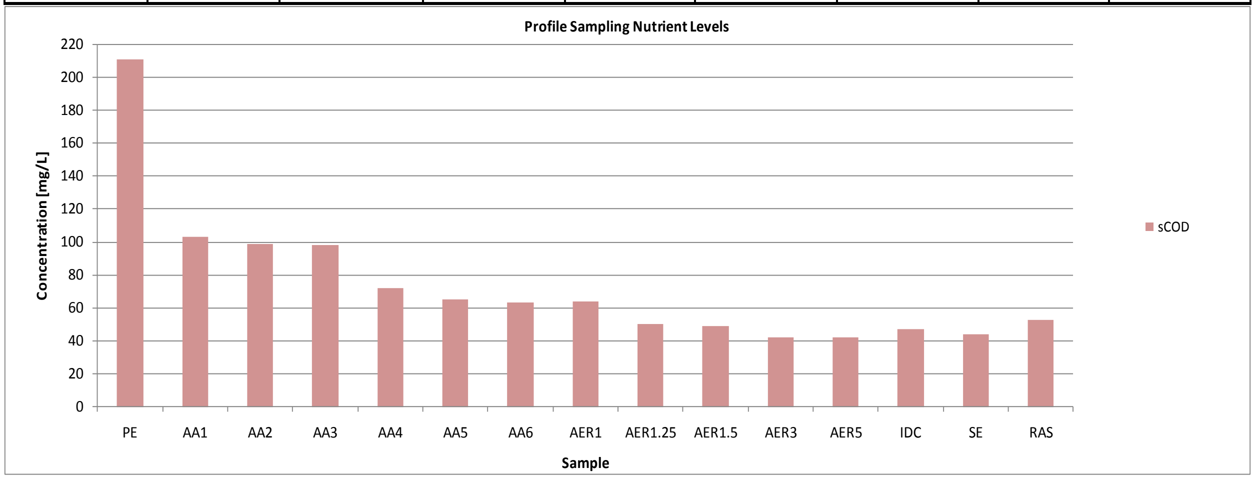
Highest AER NO$_2$-N Concentration	PUR (PO$_4$-P Uptake Slope)	SPUR	Clarifier IDC NH$_4$-N	Clarifier IDC NOx-N	Clarifier IDC PO$_4$-P Concentration	Max ANA PO$_4$-P Release	Avg. ANA NO$_3$-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.89	10.30	5.76	24.2000	3.2900	0.1	32.47	0.294

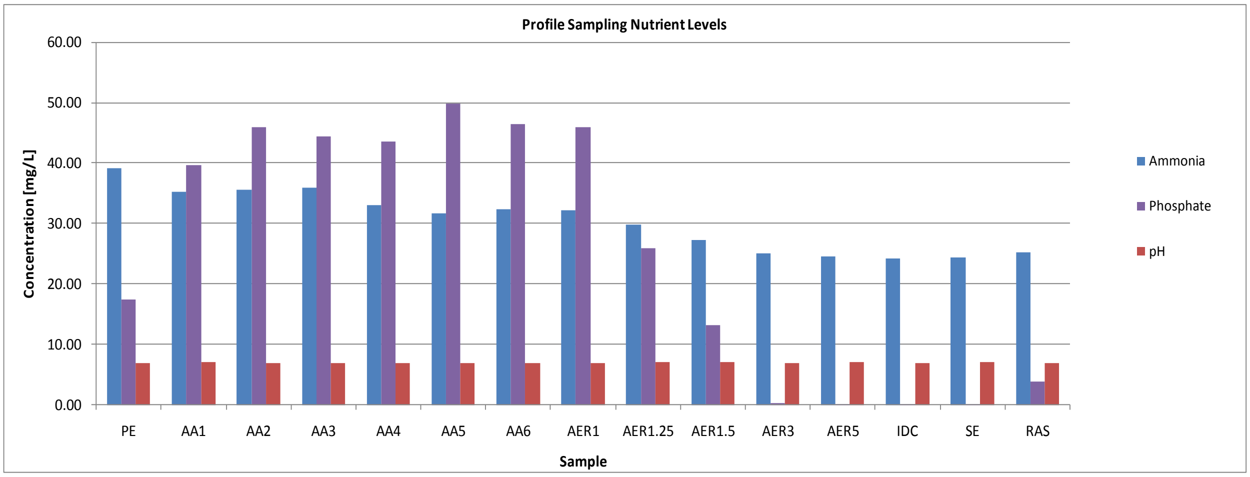
AA4 NOx-N	AA6 NOx-N	AA1 PO$_4$-P Release Slope	AA1 Specific PO$_4$-P Release Rate	AA2 PO$_4$-P Release Slope	AA2 Specific PO$_4$-P Release Rate	AA3 PO$_4$-P Release Slope	AA3 Specific PO$_4$-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.30	0.30	9.45	5.20	13.91	7.65	7.41	4.07

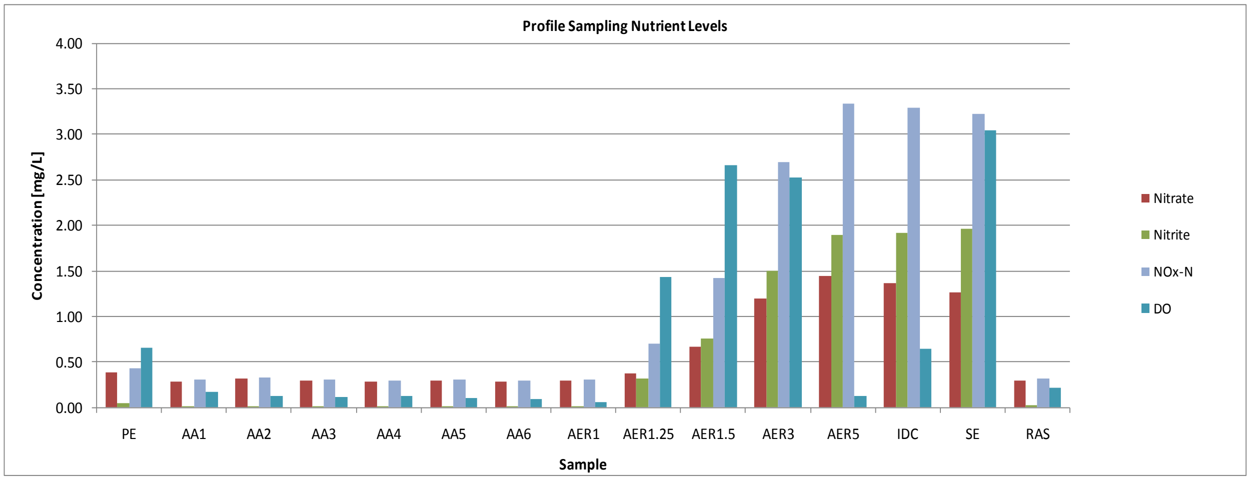
AA4 PO$_4$-P Release Slope	AA4 Specific PO$_4$-P Release Rate	AA5 PO$_4$-P Release Slope	AA5 Specific PO$_4$-P Release Rate	AA6 PO$_4$-P Release Slope	AA6 Specific PO$_4$-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO$_4$-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
2.48	1.39	1.43	0.80	2.43	1.36	42.44	23.33	0.22

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.80	17.01	11.129	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
2140	85	1819	2320	77	1786	2320	77	1786







PROFILE 2 Train 5, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
27-Oct-09	7:09	0	PE	-	38.80	0.36	0.05	0.40	20.56	0.51	7.01
27-Oct-09	7:26	0.88	AA1	Anaerobic	35.40	0.00	0.01	0.01	38.99	0.13	7.05
27-Oct-09	7:56	1.78	AA2	Anaerobic	35.70	0.00	0.01	0.01	42.58	0.16	7.05
27-Oct-09	8:26	2.67	AA3	Anaerobic	35.60	0.24	0.01	0.26	43.40	0.16	7.02
27-Oct-09	8:56	3.55	AA4	Anaerobic	32.50	0.00	0.01	0.01	38.83	0.12	7.01
27-Oct-09	9:03	4.44	AA5	Anaerobic	32.00	0.00	0.01	0.01	39.48	0.10	6.95
27-Oct-09	9:15	5.33	AA6	Anaerobic	33.30	0.00	0.01	0.01	40.63	0.10	6.96
27-Oct-09	9:37	0.00	AER1	Aerobic	31.80	0.24	0.01	0.25	41.12	0.10	6.97
27-Oct-09	9:46	0.34	AER1.25	Aerobic	35.50	0.26	0.19	0.45	25.29	0.83	7.01
27-Oct-09	9:55	0.69	AER1.5	Aerobic	33.60	0.43	0.43	0.86	15.66	1.55	7.07
27-Oct-09	10:40	3.44	AER3	Aerobic	28.10	0.94	1.18	2.12	2.27	1.75	7.02
27-Oct-09	11:45	6.88	AER5	Aerobic	26.70	1.18	1.50	2.68	0.08	1.35	6.95
27-Oct-09	11:53		IDC	-	26.80	0.92	1.79	2.71	0.15	0.13	6.92
27-Oct-09	14:53		SE	-	26.00	0.80	1.84	2.64	0.16	3.06	7.10
27-Oct-09	15:13		RAS	-	28.70	0.00	0.02	0.02	10.47	0.20	6.89

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
179					
86					
86					
79					
63					
63					
61					
61					
51					
48					
43					
42					
44					
42		26.6	2.1	0.23	1.87
64					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
5.20	2140	1.12	6.95	1.11	0.67	0.53	0.32

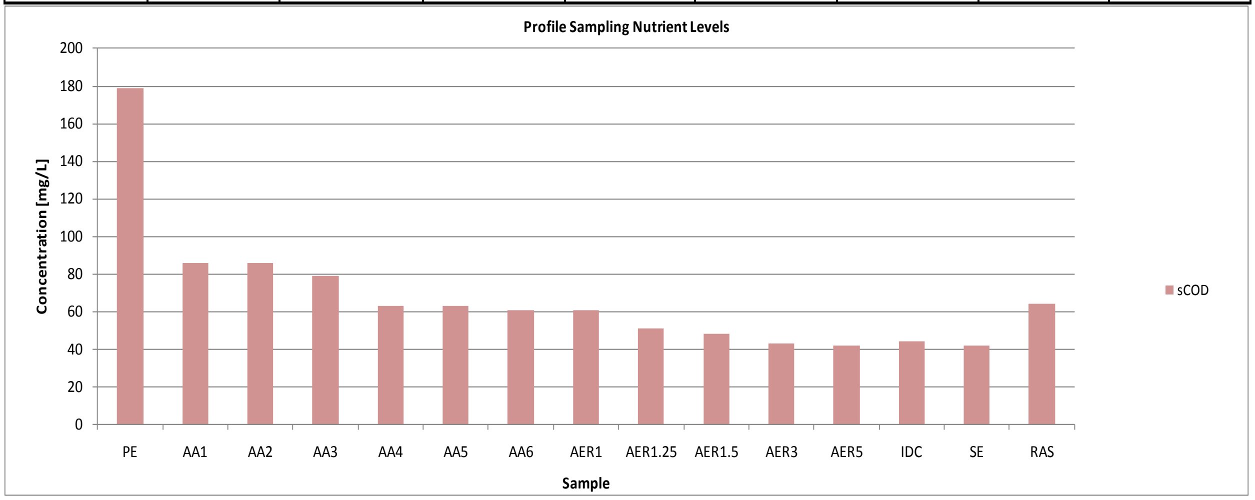
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
1.50	9.02	5.47	26.8000	2.7110	0.2	22.84	0.041

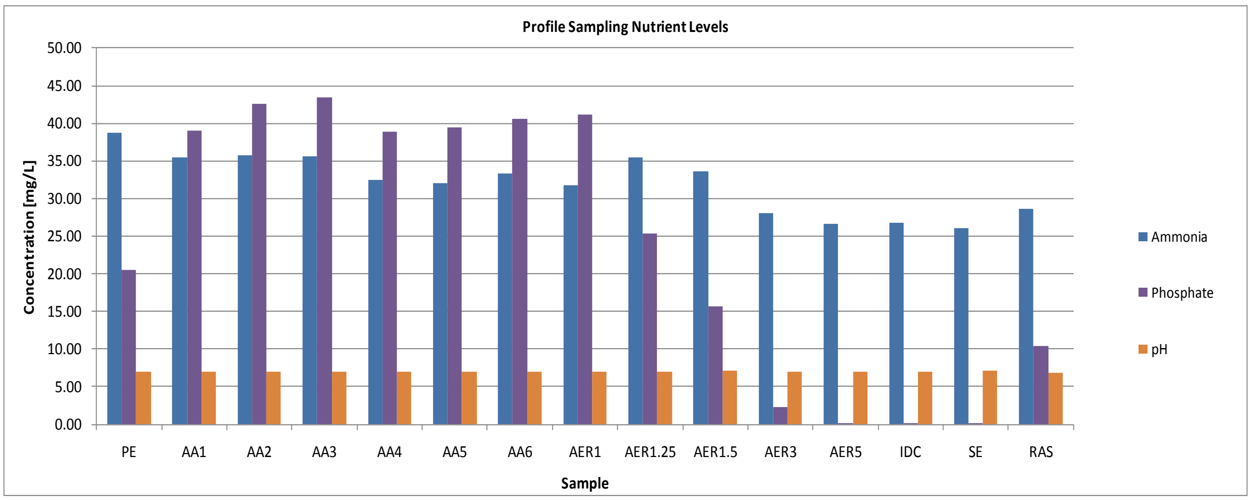
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.01	0.01	10.31	11.03	11.99	12.82	7.58	8.11

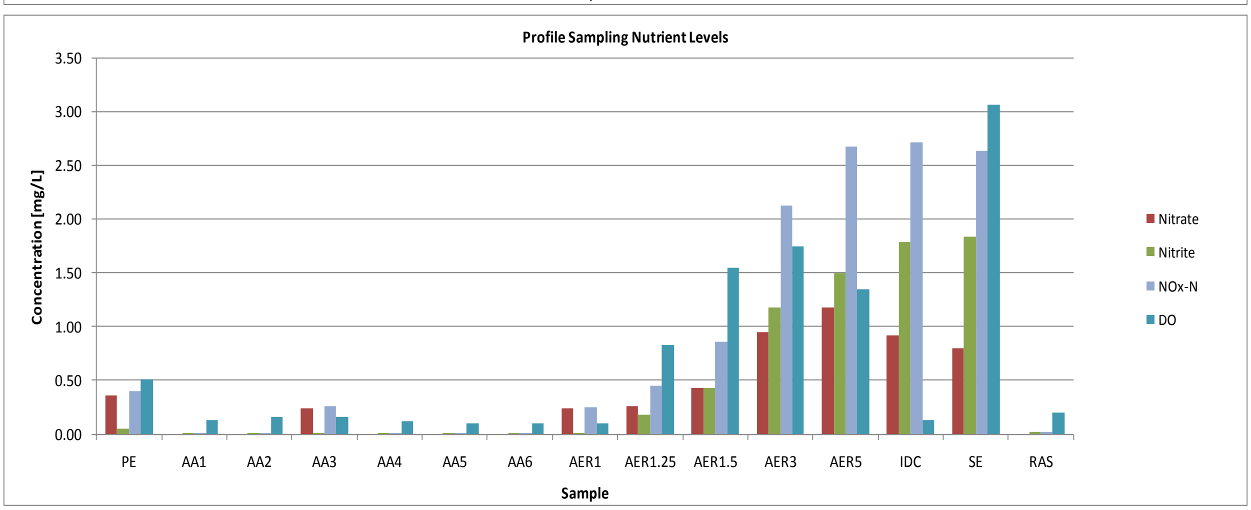
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.96	0.58	0.15	0.09	3.00	1.82	43.14	46.14	0.24

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.97	16.57	11.362	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1100	85	935	2140	77	1648	2140	77	1648







Week 16 – 11/3/09 & 11/5/09

PROFILE 1 Train 4, Aeration Tank 4, Clarifier 4

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
3-Nov-09	7:25	0	PE	-	39.20	0.36	0.04	0.39	16.32	1.40	7.11
3-Nov-09	7:38	0.89	AA1	Anaerobic	33.90	0.25	0.01	0.27	42.26	0.17	7.05
3-Nov-09	8:08	1.77	AA2	Anaerobic	32.70	0.24	0.01	0.25	46.01	0.13	7.04
3-Nov-09	8:38	2.66	AA3	Anaerobic	32.40	0.24	0.01	0.25	47.97	0.12	7.02
3-Nov-09	9:08	3.55	AA4	Anaerobic	29.10	0.00	0.01	0.01	40.79	0.11	6.98
3-Nov-09	9:23	4.43	AA5	Anaerobic	29.40	0.00	0.01	0.01	42.91	0.08	6.97
3-Nov-09	9:38	5.32	AA6	Anaerobic	29.20	0.00	0.01	0.01	43.56	0.09	6.97
3-Nov-09	9:53	0.00	AER1	Aerobic	29.40	0.00	0.01	0.01	43.07	0.06	6.96
3-Nov-09	10:01	0.34	AER1.25	Aerobic	25.90	0.70	1.36	2.05	22.03	1.57	7.02
3-Nov-09	10:09	0.69	AER1.5	Aerobic	24.20	1.23	2.53	3.76	11.09	2.68	7.05
3-Nov-09	10:54	3.43	AER3	Aerobic	20.30	2.12	4.70	6.82	0.12	2.03	6.86
3-Nov-09	11:54	6.87	AER5	Aerobic	19.10	2.33	5.30	7.63	0.08	0.30	6.84
3-Nov-09	12:06		IDC	-	19.10	2.10	5.22	7.32	0.09	0.45	6.83
3-Nov-09	15:08		SE	-	19.20	1.98	5.40	7.38	0.14	3.01	7.01
3-Nov-09	15:30		RAS	-	25.70	0.26	0.03	0.29	17.29	0.21	6.81

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample: SE

EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
188					
89					
78					
77					
60					
61					
61					
62					
51					
46					
46					
44					
41					
41	0.17	18.1	6.41	0.9	5.61
99					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.00	2660	1.33	6.84	1.27	0.64	1.70	0.85

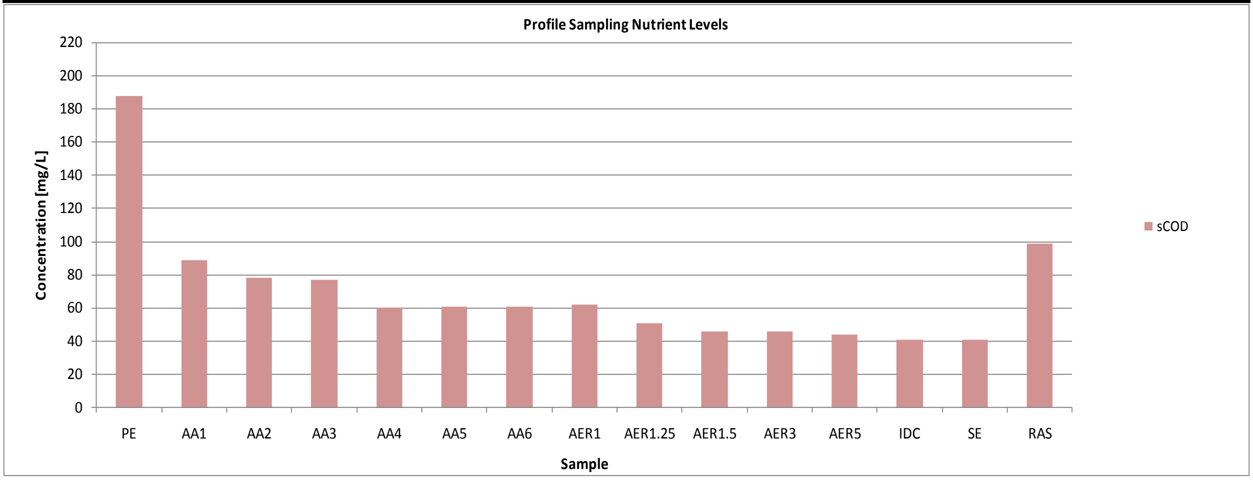
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
5.30	9.40	4.71	19.1000	7.3200	0.1	31.65	0.122

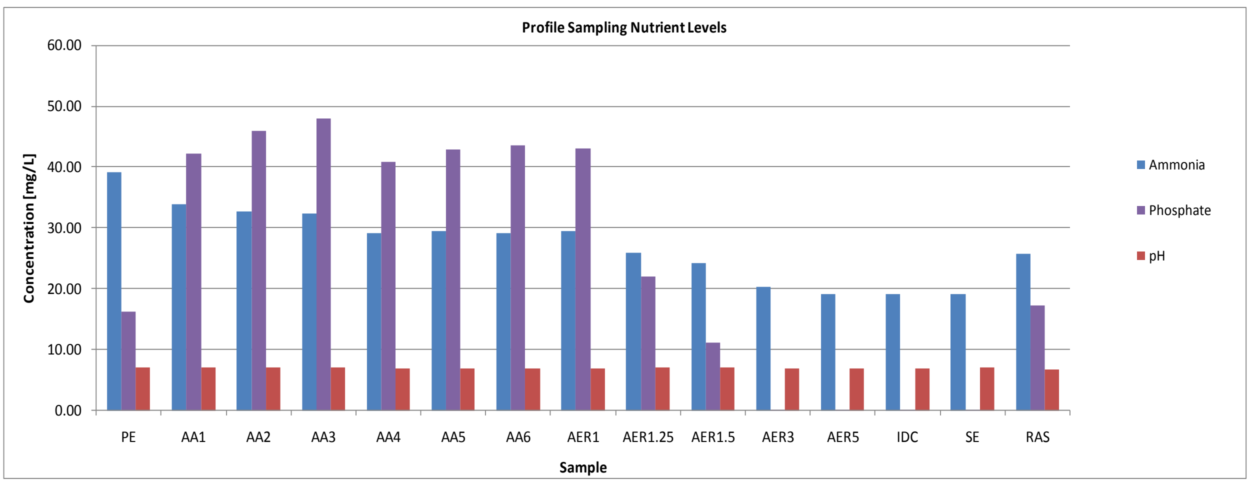
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.01	0.01	14.63	12.44	13.19	11.22	8.79	7.48

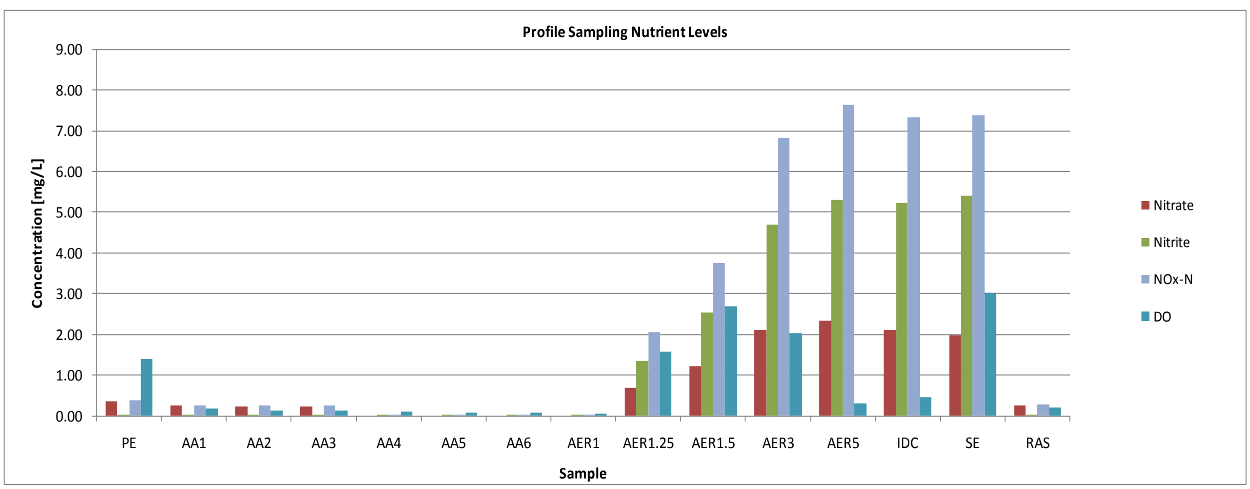
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
0.11	0.06	0.48	0.24	2.97	1.49	43.47	36.96	0.34

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.84	17.12	11.795	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1400	84	1176	2660	75	1995	2660	75	1995







PROFILE 2 Train 5, Aeration Tank 5, Clarifier 5

Date	Sample Time	HRT along BNR Process (w/out Recycles)	Sample Number	Reactor Type	Ammonia by HACH TNT	Nitrate by HACH TNT	Nitrite by HACH TNT	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT844	DO	pH
dd-mmm-yy	h:mm	hr			mg/L NH3-N	mg/L NO3-N	mg/L NO2-N	mg/L NOx-N	mg/L PO4-P	[mg/L]	[unitless]
5-Nov-09	7:40	0	PE	-	38.50	0.45	0.04	0.49	16.64	0.65	6.98
5-Nov-09	7:54	0.88	AA1	Anaerobic	34.60	0.25	0.02	0.27	40.79	0.18	7.01
5-Nov-09	8:24	1.77	AA2	Anaerobic	32.80	0.26	0.01	0.27	47.48	0.13	7.00
5-Nov-09	8:54	2.66	AA3	Anaerobic	33.90	0.28	0.01	0.30	44.71	0.14	6.99
5-Nov-09	9:24	3.55	AA4	Anaerobic	28.90	0.25	0.01	0.26	47.15	0.10	6.94
5-Nov-09	9:36	4.43	AA5	Anaerobic	28.40	0.25	0.01	0.26	48.62	0.14	6.94
5-Nov-09	9:48	5.32	AA6	Anaerobic	29.00	0.25	0.01	0.27	50.91	0.08	6.94
5-Nov-09	10:00	0.00	AER1	Aerobic	31.40	0.00	0.01	0.01	51.72	0.07	6.93
5-Nov-09	10:08	0.34	AER1.25	Aerobic	26.70	0.35	0.36	0.71	33.86	0.84	7.02
5-Nov-09	10:16	0.69	AER1.5	Aerobic	24.50	0.72	1.40	2.12	19.74	1.24	7.05
5-Nov-09	11:01	3.43	AER3	Aerobic	22.20	1.48	3.40	4.88	1.43	1.86	7.01
5-Nov-09	12:01	6.87	AER5	Aerobic	19.00	2.12	5.30	7.42	0.09	0.80	6.84
5-Nov-09	12:18		IDC	-	18.80	1.60	5.35	6.95	0.17	0.07	6.85
5-Nov-09	15:18		SE	-	17.80	1.61	5.70	7.31	0.16	3.18	6.98
5-Nov-09	15:32		RAS	-	24.00	0.00	0.04	0.04	15.50	0.14	6.85

*NOTE: These values are <1 mg/L NH_4-N

*NOTE: These values are <0.23 mg/L NO_3-N

QA/QC Sample:	SE				
EPA 365.1	EPA 350.1	EPA 353.2	EPA 353.2	EPA 353.2	EPA 353.2
sCOD by CEL	O-PO_4	NH_4-N	$NO_{2,3}$-N	NO_3-N	NO_2-N
[mg/L]	mg/L	mg/L	mg/L	mg/L	mg/L
200					
111					
96					
92					
62					
60					
60					
63					
54					
48					
43					
40					
44					
43		16.9	5.92	<0.20	5.81
78					

Actual SRT	Aerobic MLSS	Average AER DO	Min AER pH	AUR (NH4-N Slope)	SAUR	NPR (NOx-N Slope)	SNPR
[days]	[mg/L]	[mg/L]	[unitless]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/min]	[mg/g MLVSS/hr]
4.60	2320	0.96	6.84	1.41	0.82	1.33	0.77

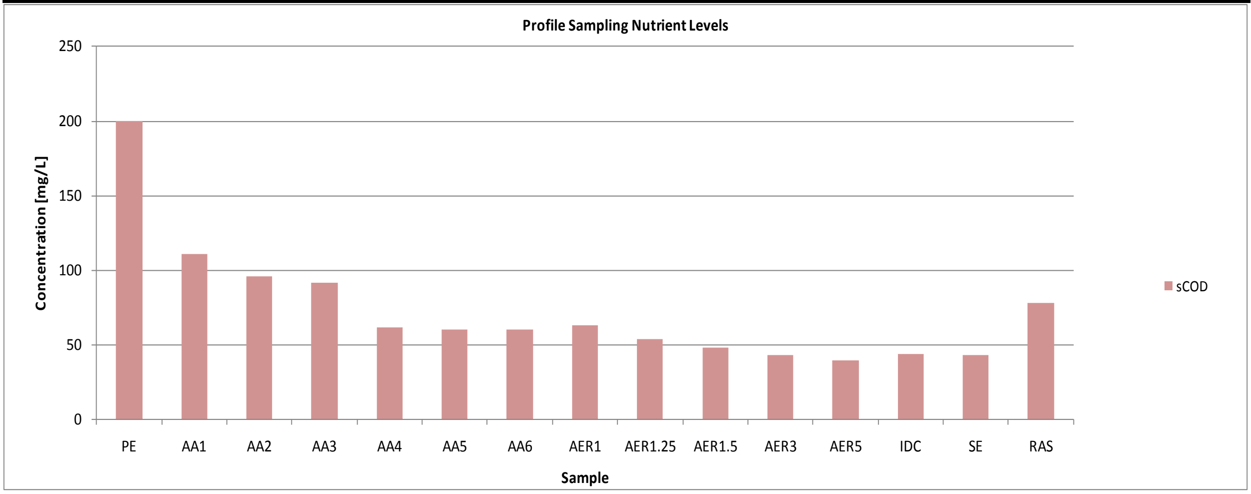
Highest AER NO_2-N Concentration	PUR (PO_4-P Uptake Slope)	SPUR	Clarifier IDC NH_4-N	Clarifier IDC NOx-N	Clarifier IDC PO_4-P Concentration	Max ANA PO_4-P Release	Avg. ANA NO_3-N Concentration
[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
5.30	12.03	7.01	18.8000	6.9500	0.2	34.26	0.257

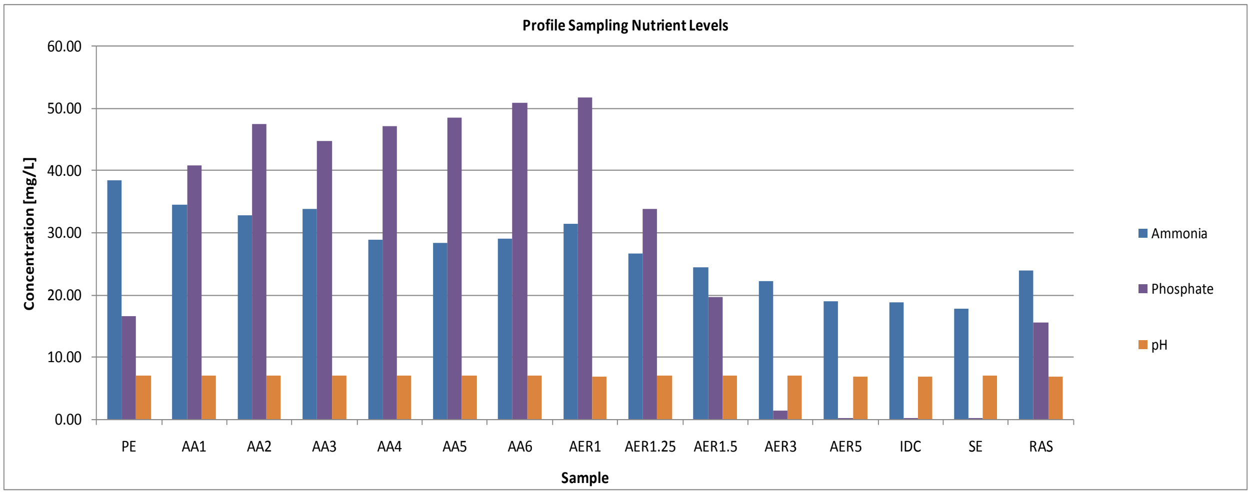
AA4 NOx-N	AA6 NOx-N	AA1 PO_4-P Release Slope	AA1 Specific PO_4-P Release Rate	AA2 PO_4-P Release Slope	AA2 Specific PO_4-P Release Rate	AA3 PO_4-P Release Slope	AA3 Specific PO_4-P Release Rate
[mg/L]	[mg/L]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]
0.26	0.27	8.96	8.06	14.42	12.96	7.25	6.52

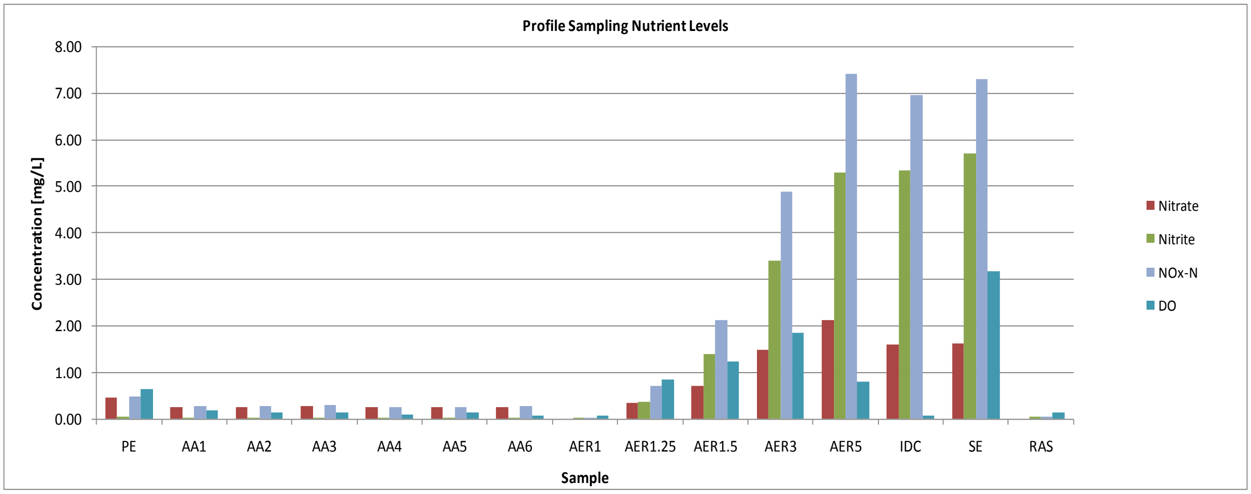
AA4 PO_4-P Release Slope	AA4 Specific PO_4-P Release Rate	AA5 PO_4-P Release Slope	AA5 Specific PO_4-P Release Rate	AA6 PO_4-P Release Slope	AA6 Specific PO_4-P Release Rate	(AA1) COD Uptake Slope	(AA1) Specific COD Uptake Rate	(AA1) PO_4-P/COD
[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/L/hr]	[mg/g MLVSS/hr]	[mg/mg]
2.52	1.47	0.33	0.19	4.11	2.40	25.64	23.05	0.35

# Chem Used	FeCl3 Hrs Used	FeCl3 Addition	Active Biosolid Influent Flow	ARCY Flow	CRCY Flow	NRCY Flow
[lbs]	[hr]	[mg/L]	[MGD]	[MGD]	[MGD]	[MGD]
0	0.000	0.000	18.97	17.12	10.298	0

ANA MLTSS	ANA % VOL	ANA MLVSS	ANX MLTSS	ANX % VOL	ANX MLVSS	AER MLTSS	AER % VOL	AER MLVSS
[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]	[mg/L]	[%]	[mg/L]
1340	83	1112	2320	74	1717	2320	74	1717







7.7 Appendix H – Batch Rate Experiment Data

Week 3 – Leachate

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

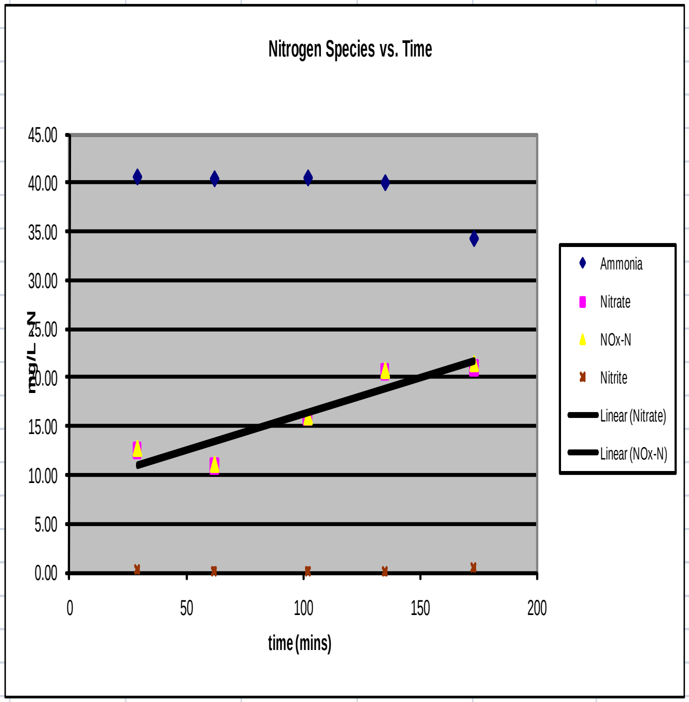
a. Spiked four 3L reactors with 50 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 8.5 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors A and C which incorporated leachate addition were spiked with 15 mL of the SPSA leachate (1:135 dilution) based on plant flow.

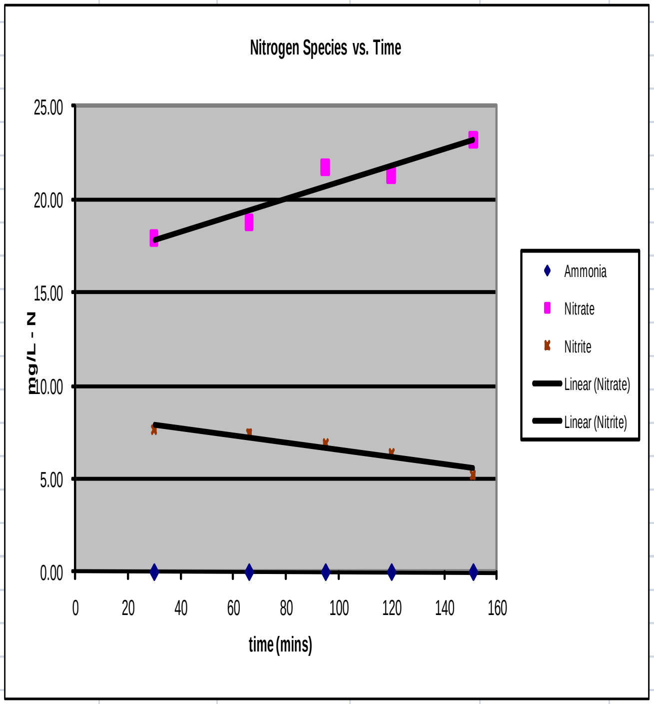
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <2 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
i. Reactors A and C which incorporated leachate addition were spiked with 15 mL of the SPSA leachate (1:135 dilution) based on plant flow.

Reactor A: Nansemond Activated Sludge/VIP SE + Leachate

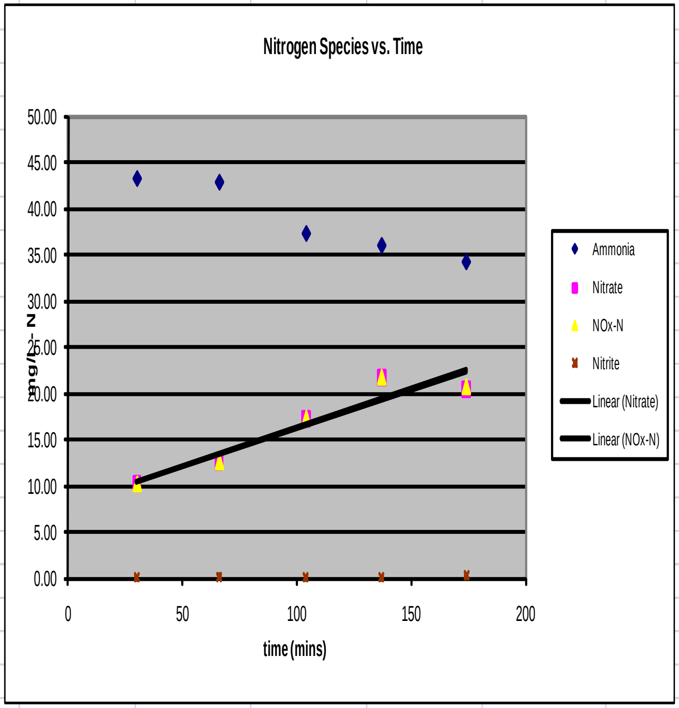
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	8:39	29	A1	24.8	30.42	40.60	12.50		0.22		6.92	12.73
Ammonia	8-Jul-08	9:12	62	A2	26.1	28.13	40.40	10.92		0.18		6.53	11.09
Ammonia	8-Jul-08	9:52	102	A3	27	27.47	40.50	15.81		0.12		6.63	15.93
Ammonia	8-Jul-08	10:25	135	A4	27.6	25.30	40.00	20.60		0.06		7.21	20.66
Ammonia	8-Jul-08	11:03	173	A5	27.9	24.55	34.20	20.94		0.41		8.62	21.35
Nitrite	9-Jul-08	10:11	30	A6	26.9	0.00	-	17.94		7.66		12.17	25.60
Nitrite	9-Jul-08	10:47	66	A7	27.6	0.00	-	18.76		7.46		12.00	26.22
Nitrite	9-Jul-08	11:16	95	A8	27.8	0.00	-	21.73		6.91		11.57	28.64
Nitrite	9-Jul-08	11:41	120	A9	28.1	0.00	-	21.30		6.37		12.43	27.66
Nitrite	9-Jul-08	12:12	151	A10	28.2	0.00	-	23.22		5.22		12.80	28.44

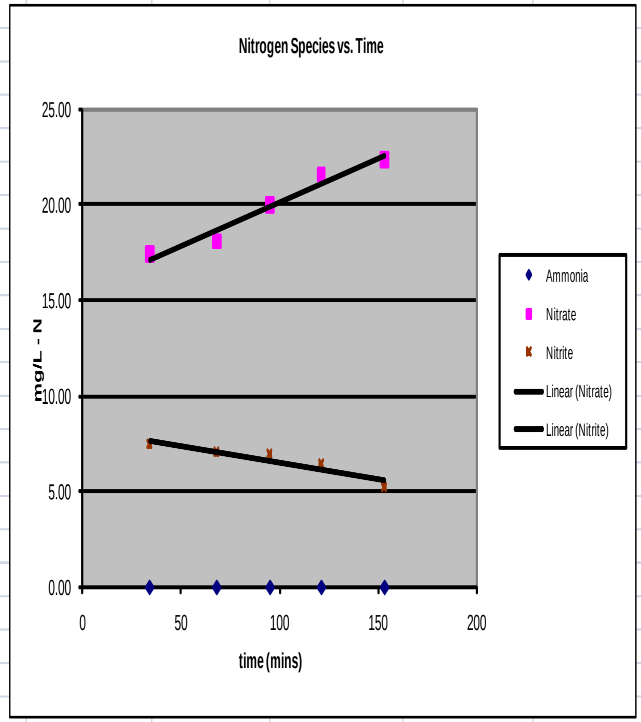




Reactor B: Nansemond Activated Sludge/VIP SE

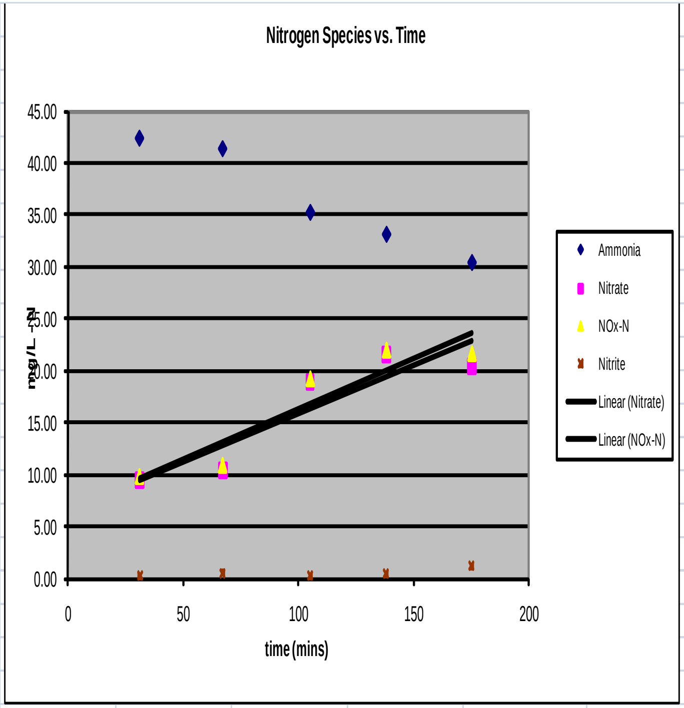
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	8:41	30	B1	25.1	31.10	43.30	10.20		0.07		5.44	10.27
Ammonia	8-Jul-08	9:17	66	B2	26.6	28.16	42.90	12.50		0.14		8.49	12.63
Ammonia	8-Jul-08	9:55	104	B3	27.4	25.74	37.30	17.24		0.10		5.96	17.33
Ammonia	8-Jul-08	10:28	137	B4	27.9	27.48	36.00	21.68		0.06		6.02	21.74
Ammonia	8-Jul-08	11:05	174	B5	28.2	102.8067ALT	34.20	20.46		0.26		6.45	20.72
Nitrite	9-Jul-08	10:16	34	B6	27.2	0.00	-	17.39		7.47		12.11	24.86
Nitrite	9-Jul-08	10:50	68	B7	27.8	0.00	-	18.10		7.03		14.22	25.13
Nitrite	9-Jul-08	11:17	95	B8	28	0.00	-	19.99		6.97		13.77	26.96
Nitrite	9-Jul-08	11:43	121	B9	28.3	0.00	-	21.57		6.45		15.07	28.02
Nitrite	9-Jul-08	12:15	153	B10	28.4	0.00	-	22.37		5.28		15.89	27.65

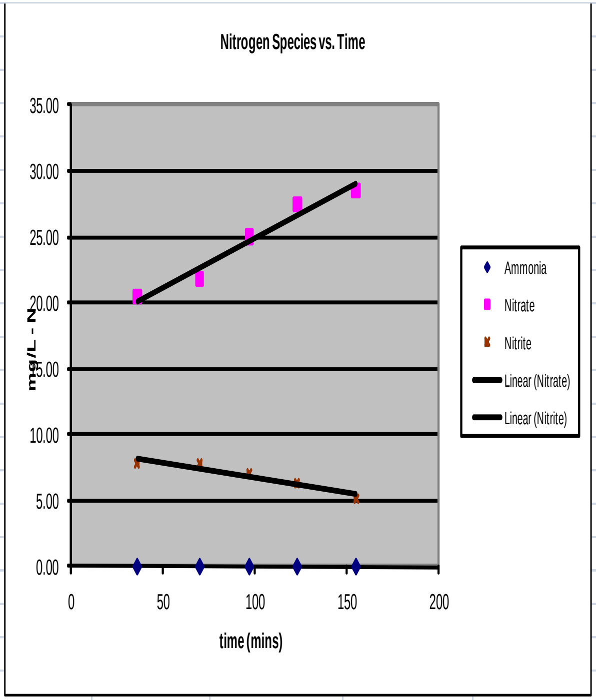




Reactor C: VIP Activated Sludge/VIP SE + Leachate

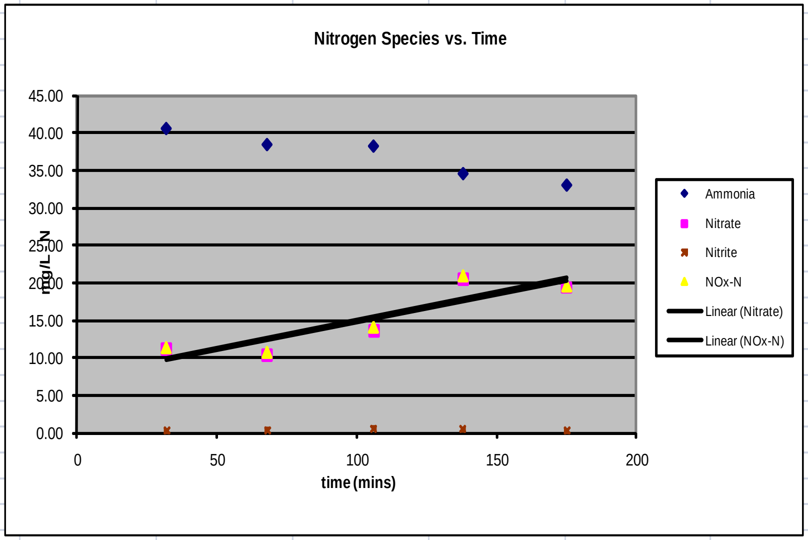
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	8:43	31	C1	25.1	32.75	42.30	9.51		0.28		4.14	9.78
Ammonia	8-Jul-08	9:19	67	C2	26.4	26.87	41.30	10.37		0.50		3.46	10.87
Ammonia	8-Jul-08	9:57	105	C3	27.2	23.28	35.20	18.97		0.25		3.17	19.22
Ammonia	8-Jul-08	10:30	138	C4	27.7	24.51	33.10	21.58		0.40		3.39	21.98
Ammonia	8-Jul-08	11:07	175	C5	28	19.85	30.40	20.46		1.19		3.49	21.65
Nitrite	9-Jul-08	10:18	36	C6	27.2	0.00	-	20.45		7.86		11.19	28.32
Nitrite	9-Jul-08	10:52	70	C7	27.9	0.00	-	21.79		7.80		11.92	29.60
Nitrite	9-Jul-08	11:19	97	C8	28	0.00	-	25.01		7.00		12.92	32.01
Nitrite	9-Jul-08	11:45	123	C9	28.3	0.00	-	27.49		6.33		12.55	33.82
Nitrite	9-Jul-08	12:17	155	C10	28.4	0.00	-	28.53		5.21		12.60	33.73

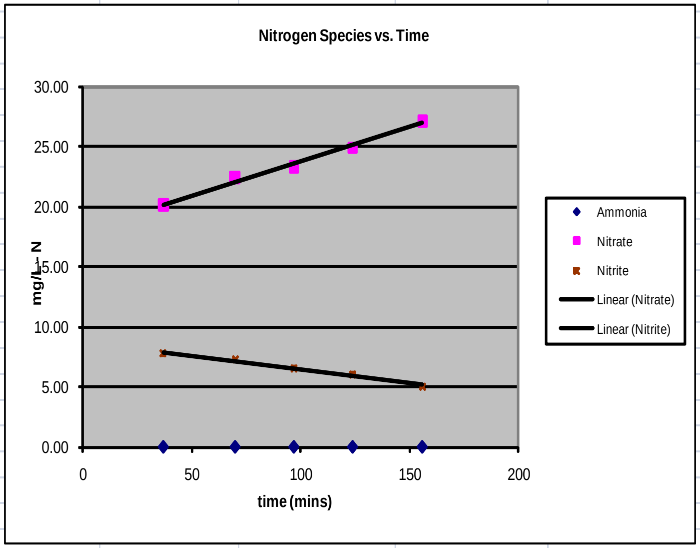




Reactor D: VIP Activated Sludge/VIP SE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	8:45	32	D1	25	29.51	40.50	11.15		0.21		1.08	11.36
Ammonia	8-Jul-08	9:21	68	D2	26.4	75.93	38.40	10.37		0.37		1.03	10.73
Ammonia	8-Jul-08	9:59	106	D3	27.2	28.67	38.20	13.55		0.55		1.94	14.10
Ammonia	8-Jul-08	10:31	138	D4	27.6	24.84	34.60	20.52		0.42		2.29	20.94
Ammonia	8-Jul-08	11:08	175	D5	27.95	24.85	33.10	19.37		0.22		2.85	19.59
Nitrite	9-Jul-08	10:20	37	D6	27.3	0.00	-	20.10		7.73		12.68	27.83
Nitrite	9-Jul-08	10:53	70	D7	27.9	0.00	-	22.44		7.26		15.05	29.69
Nitrite	9-Jul-08	11:20	97	D8	28	0.00	-	23.28		6.58		14.10	29.86
Nitrite	9-Jul-08	11:47	124	D9	28.35	0.00	-	24.88		6.02		15.74	30.90
Nitrite	9-Jul-08	12:19	156	D10	28.4	0.00	-	27.09		5.06		16.13	32.16





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
activated sludge	Ammonia	0.075	0.074		4.070	4.031		0.414	22.62	1763.64	1098.60
VIP Secondary	Nitrite		0.044	-0.020		2.487	-1.116	0.149	8.33	1760.00	1070.00
SPSA Leachate											
Reactor B: NS											
Activated Sludge	Ammonia	0.083	0.083		4.567	4.522		0.382	20.88	1775.83	1096.67
VIP Secondary	Nitrite		0.046	-0.017		2.090	-0.781	0.157	7.18	2247.50	1313.33
Effluent											
Reactor C: VIP											
Activated Sludge	Ammonia	0.097	0.093		4.602	4.376		0.532	25.16	1650.00	1268.18
VIP Secondary	Nitrite		0.074	-0.023		3.671	-1.142	0.186	9.18	1626.67	1216.67
SPSA Leachate											
Reactor D: VIP											
Activated Sludge	Ammonia	0.074	0.074		3.540	3.529		0.402	19.17	1683.33	1258.33
VIP Secondary	Nitrite		0.056	-0.022		2.723	-1.084	0.180	8.66	1621.67	1244.17
Effluent											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Sample Data Report for Nansemond Nitrification Inhibition Study

Bio-P Experimentation:

I. Bio - P

a. Spiked four 3L reactors with 5 mg/L PO_4- P to raise initial PO_4- concentration to roughly 15 mg/L PO_4- P. (Initial PO_4- concentration was determined through HACH TNT PO_4- Tubes at the end of the AOB/NOB experimentation).

b. The Bio-P experiment is run through an uptake/release/uptake method were the four reactors are aerobic/anaerobic/aerobic once more. During the release phase 200 mg/L of NaAc was added for COD manually to all 4 reactors.

c. Each reactor is running continously by use of stir bars .

d. 2 L of the diluent source is added to the reactors.

e. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 8.5 L.

f. Constant DO and pH were monitored and logged throughout the experiment.

g. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves during the uptake phases and then these valves were turned off and the oxygen/air was cut-off and then the system was deaerated and the DO was allowed to drop to 0 before beginning the release phase. During the release phase nitrogen was sparged into the reactors.

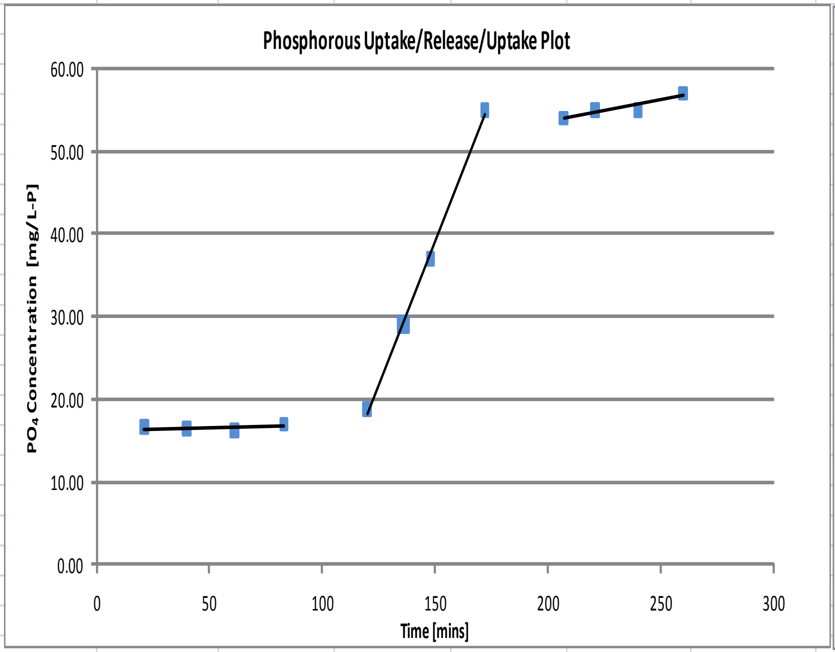
h. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

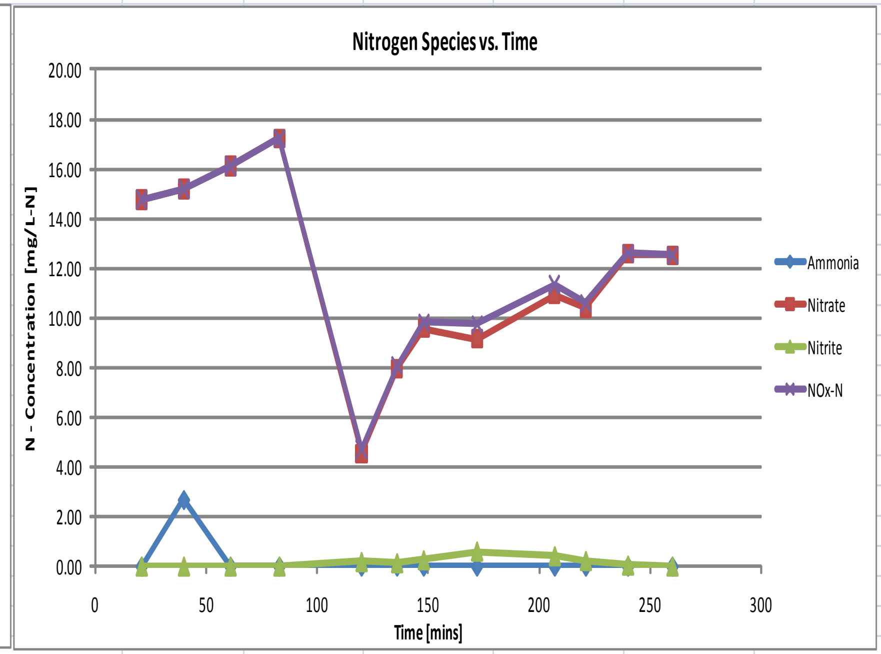
i. 4 samples were collected over a period of 1.5 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters during both uptake phases and 4 samples were collected over a period of 1 hour for the release phase.

j. Reactors A and C which incorporated leachate addition were spiked with 15 mL of the SPSA leachate (1:135 dilution) based on plant flow.

Reactor A: Nansemond Activated Sludge/ VIP SE + Leachate

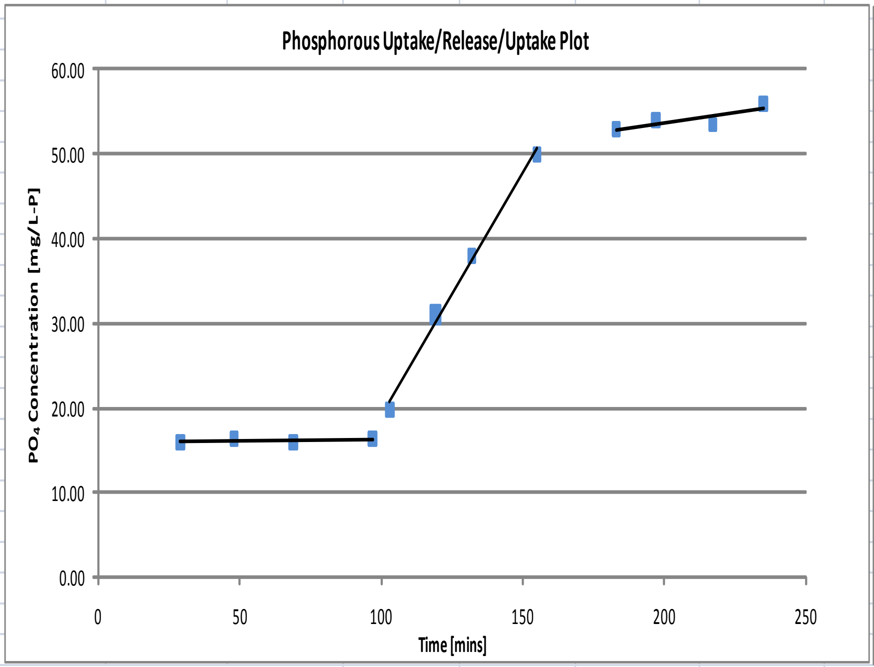
Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	9-Jul-08	14:46	21	A1	22	16.60	16.66	0.00	14.76		0.00		14.76
Uptake 1	9-Jul-08	15:05	40	A2	23.6	16.40	18.38	2.68	15.18		0.00		15.18
Uptake 1	9-Jul-08	15:26	61	A3	24.8	16.20	18.35	0.00	16.12		0.00		16.12
Uptake 1	9-Jul-08	15:53	83	A4	26	17.00	18.29	0.00	17.23		0.00		17.23
Release	9-Jul-08	16:30	120	A5	27.03	18.75	17.25	0.00	4.53		0.18		4.71
Release	9-Jul-08	16:46	136	A6	27.35	29.00	25.87	0.00	7.95		0.13		8.09
Release	9-Jul-08	16:58	148	A7	27.4	37.00	33.40	0.00	9.57		0.25		9.82
Release	9-Jul-08	17:22	172	A8	27.8	55.00	42.71	0.00	9.15		0.60		9.75
Uptake 2	9-Jul-08	17:57	207	A9	28.1	54.00	46.53	0.00	10.93		0.41		11.34
Uptake 2	9-Jul-08	18:11	221	A10	28.18	55.00	46.54	0.00	10.38		0.22		10.60
Uptake 2	9-Jul-08	18:30	240	A11	28.2	55.00	47.41	0.00	12.56		0.04		12.60
Uptake 2	9-Jul-08	18:50	260	A12	28.4	57.00	49.04	0.00	12.52		0.00		12.52

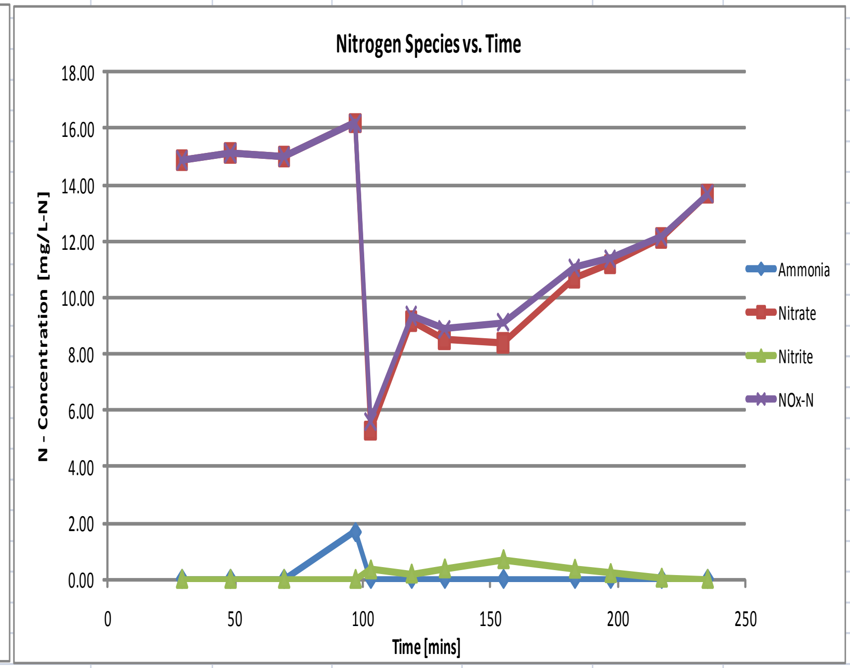




Reactor B: Nansemond Activated Sludge/VIP SE

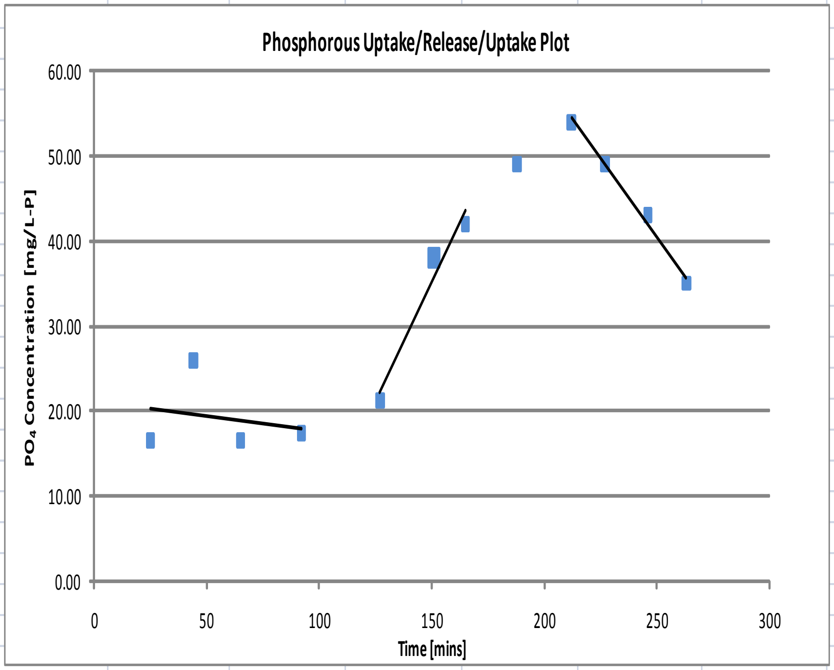
Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	9-Jul-08	14:50	29	B1	22.9	16.00	17.61	0.00	14.88		0.00		14.88
Uptake 1	9-Jul-08	15:08	48	B2	24.2	16.40	17.51	0.00	15.13		0.00		15.13
Uptake 1	9-Jul-08	15:29	69	B3	25.4	16.00	16.75	0.00	14.99		0.00		14.99
Uptake 1	9-Jul-08	15:57	97	B4	26.4	16.40	17.16	1.70	16.21		0.00		16.21
Release	9-Jul-08	16:32	103	B5	27.375	19.75	16.95	0.00	5.26		0.35		5.60
Release	9-Jul-08	16:48	119	B6	27.6	31.00	26.12	0.00	9.15		0.20		9.35
Release	9-Jul-08	17:01	132	B7	27.7	38.00	33.29	0.00	8.50		0.38		8.88
Release	9-Jul-08	17:24	155	B8	28.1	50.00	42.39	0.00	8.40		0.72		9.11
Uptake 2	9-Jul-08	17:59	183	B9	28.3	53.00	47.04	0.00	10.69		0.37		11.06
Uptake 2	9-Jul-08	18:13	197	B10	28.3	54.00	49.03	0.00	11.18		0.21		11.40
Uptake 2	9-Jul-08	18:33	217	B11	28.35	53.50	49.23	0.00	12.12		0.04		12.16
Uptake 2	9-Jul-08	18:51	235	B12	28.6	56.00	50.62	0.00	13.67		0.00		13.67

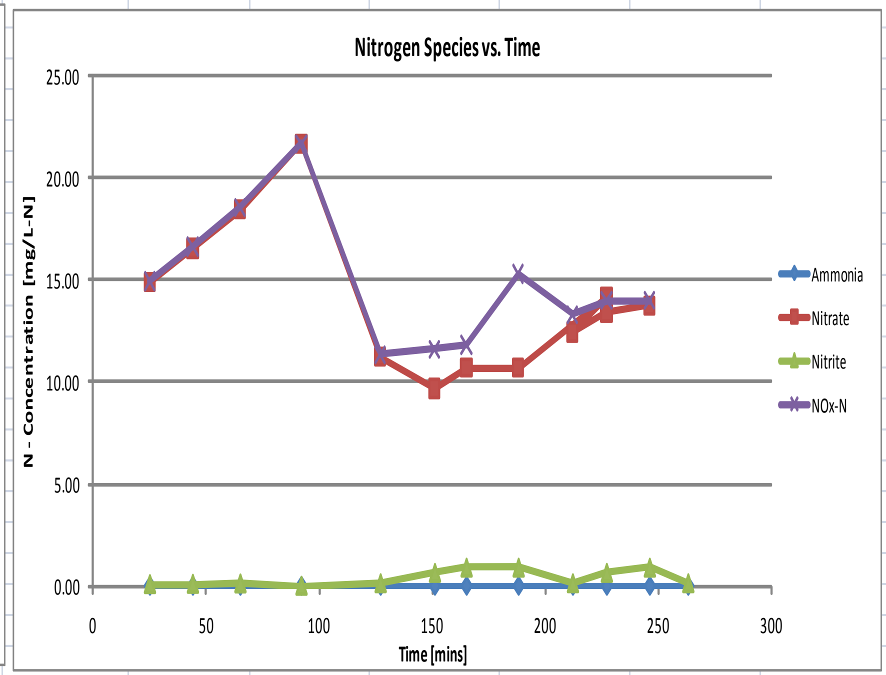




Reactor C: VIP Activated Sludge/VIP SE + Leachate

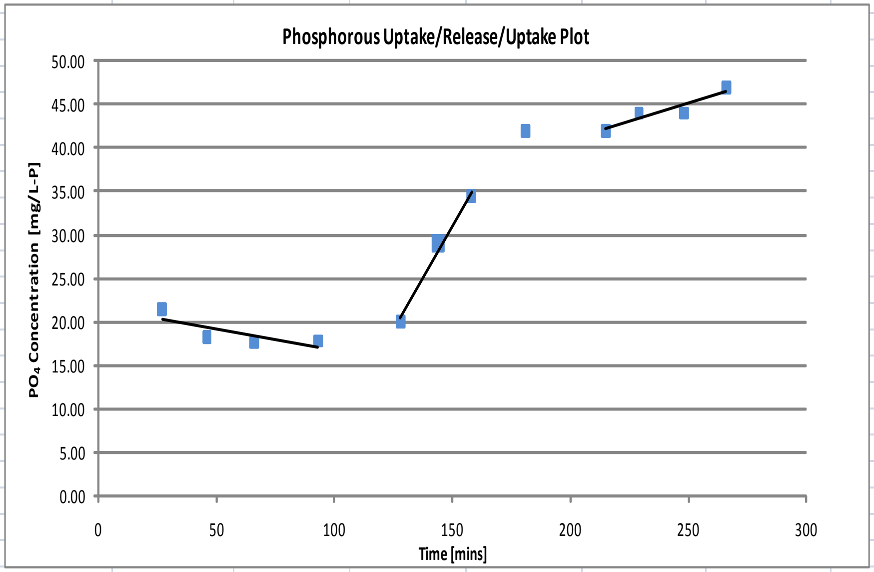
Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	9-Jul-08	14:52	25	C1	23	16.60	19.63	0.00	14.87		0.08		14.95
Uptake 1	9-Jul-08	15:11	44	C2	24.1	26.00	18.98	0.00	16.54		0.10		16.63
Uptake 1	9-Jul-08	15:32	65	C3	25.3	16.60	19.02	0.00	18.45		0.12		18.57
Uptake 1	9-Jul-08	15:59	92	C4	26.35	17.40	18.27	0.00	21.70		0.00		21.70
Release	9-Jul-08	16:34	127	C5	27.3	21.25	20.01	0.00	11.24		0.13		11.36
Release	9-Jul-08	16:50	151	C6	27.5	38.00	31.26	0.00	9.69		0.65		10.34
Release	9-Jul-08	17:04	165	C7	27.6	42.00	38.63	0.00	10.70		0.91		11.61
Release	9-Jul-08	17:27	188	C8	28	49.00	43.46	0.00	10.69		1.14		11.82
Uptake 2	9-Jul-08	18:01	212	C9	28.3	54.00	44.82	0.00	14.18		1.13		15.31
Uptake 2	9-Jul-08	18:16	227	C10	28.3	49.00	39.13	0.00	12.44		0.87		13.31
Uptake 2	9-Jul-08	18:35	246	C11	28.3	43.00	37.00	0.00	13.43		0.58		14.01
Uptake 2	9-Jul-08	18:52	263	C12	28.5	35.00	33.35	0.00	13.75		0.24		13.98

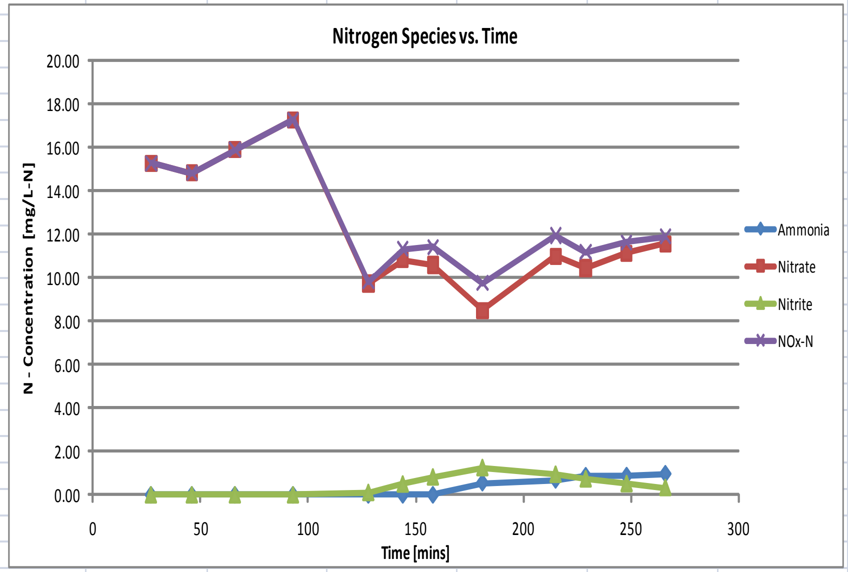




Reactor D: VIP Activated Sludge/VIP SE

Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	9-Jul-08	14:55	27	D1	22.9	21.40	19.11	0.00	15.27		0.00		15.27
Uptake 1	9-Jul-08	15:14	46	D2	24.15	18.20	18.03	0.00	14.83		0.00		14.83
Uptake 1	9-Jul-08	15:34	66	D3	25.3	17.60	19.07	0.00	15.89		0.00		15.89
Uptake 1	9-Jul-08	16:01	93	D4	26.3	17.80	18.23	0.00	17.26		0.00		17.26
Release	9-Jul-08	16:36	128	D5	27.2	20.00	18.18	0.00	9.72		0.11		9.83
Release	9-Jul-08	16:52	144	D6	27.5	29.00	24.25	0.00	10.83		0.50		11.32
Release	9-Jul-08	17:06	158	D7	27.6	34.50	29.07	0.00	10.60		0.82		11.42
Release	9-Jul-08	17:29	181	D8	28	42.00	36.34	0.56	8.50		1.25		9.75
Uptake 2	9-Jul-08	18:03	215	D9	28.2	42.00	37.62	0.69	11.00		0.95		11.95
Uptake 2	9-Jul-08	18:17	229	D10	28.2	44.00	40.92	0.87	10.43		0.74		11.17
Uptake 2	9-Jul-08	18:36	248	D11	28.4	44.00	42.31	0.88	11.12		0.52		11.64
Uptake 2	9-Jul-08	18:54	266	D12	28.5	47.00	43.67	0.96	11.56		0.34		11.90

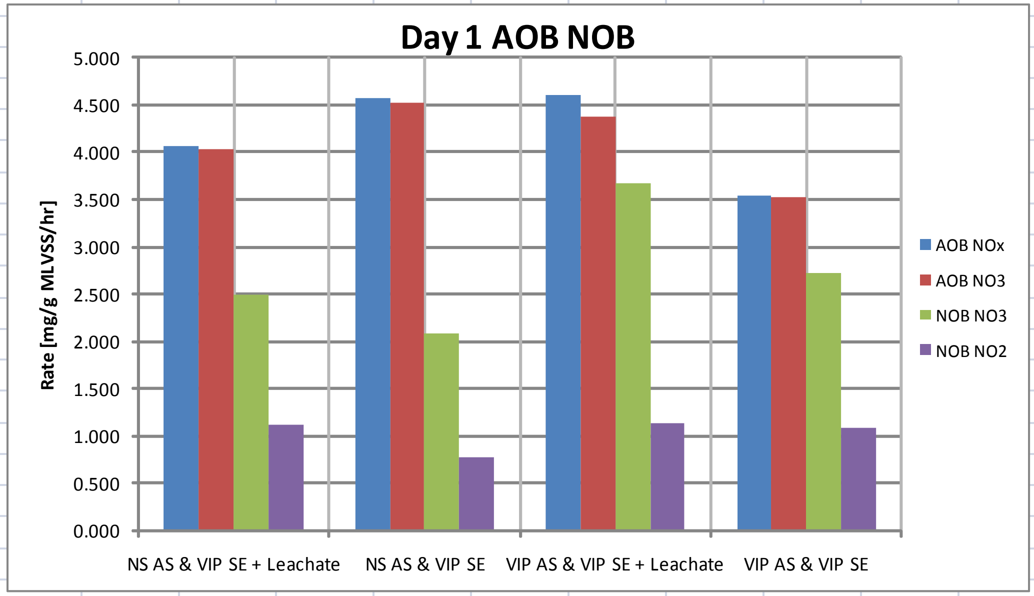




Summary	Experiment	PO_4 Slope (SEAL)	PO_4 Slope (TNT)	os Rate PO_4 (SEA	hos Rate PO_4 (TNT	OUR	SOUR	MLSS	MLVSS	Average NO_2^-
		mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L	mg/L
Reactor A: NS										
activated sludge	Uptake	0.023	0.005	1.035	0.235	0.061	2.81	1965.00	1315.00	0.00
VIP Secondary	Release	0.492	0.699	22.447	31.876	0.000	0.00	1965.00	1315.00	0.29
SPSA Leachate	Uptake	0.048	0.029	2.209	1.303	0.415	18.94	1965.00	1315.00	0.17
Reactor B: NS										
Activated Sludge	Uptake	-0.009	0.004	-0.439	0.187	0.077	3.91	1680.00	1180.00	0.00
VIP Secondary	Release	0.489	0.575	24.842	29.247	0.000	0.00	1680.00	1180.00	0.41
Effluent	Uptake	0.061	0.012	3.088	0.609	0.436	22.15	1680.00	1180.00	0.16
Reactor C: VIP										
Activated Sludge	Uptake	-0.018	-0.036	-0.914	-1.801	0.250	12.55	1450.00	1196.67	0.08
VIP Secondary	Release	0.392	0.563	19.670	28.203	0.000	0.00	1450.00	1196.67	0.73
SPSA Leachate	Uptake	-0.210	-0.323	-10.544	-16.205	0.511	25.65	1450.00	1196.67	0.70
Reactor D: VIP										
Activated Sludge	Uptake	-0.008	-0.049	-0.384	-2.485	0.167	8.43	1443.33	1190.00	0.00
VIP Secondary	Release	0.341	0.485	17.213	24.464	0.000	0.00	1443.33	1190.00	0.67
Effluent	Uptake	0.111	0.087	5.618	4.363	0.404	20.34	1443.33	1190.00	0.63

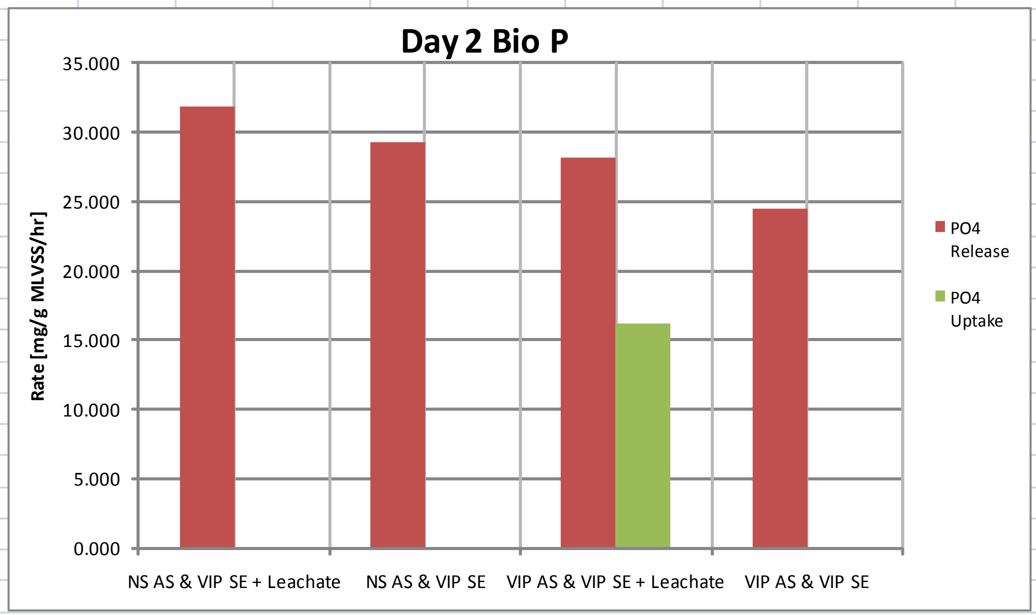
Day 1 AOB NOB

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP Secondary SPSA Leachate	4.070	4.031	2.487	1.116
Reactor B: NS Activated Sludge VIP Secondary Effluent	4.567	4.522	2.090	0.781
Reactor C: VIP Activated Sludge VIP Secondary SPSA Leachate	4.602	4.376	3.671	1.142
Reactor D: VIP Activated Sludge VIP Secondary Effluent	3.540	3.529	2.723	1.084



Day 2 Bio P

	Release	Uptake
Reactor A: NS Activated sludge VIP Secondary SPSA Leachate	31.876	0.000
Reactor B: NS Activated Sludge VIP Secondary Effluent	29.247	0.000
Reactor C: VIP Activated Sludge VIP Secondary SPSA Leachate	28.203	16.205
Reactor D: VIP Activated Sludge VIP Secondary Effluent	24.464	0.000



Week 4 – Henrico County Biomass Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

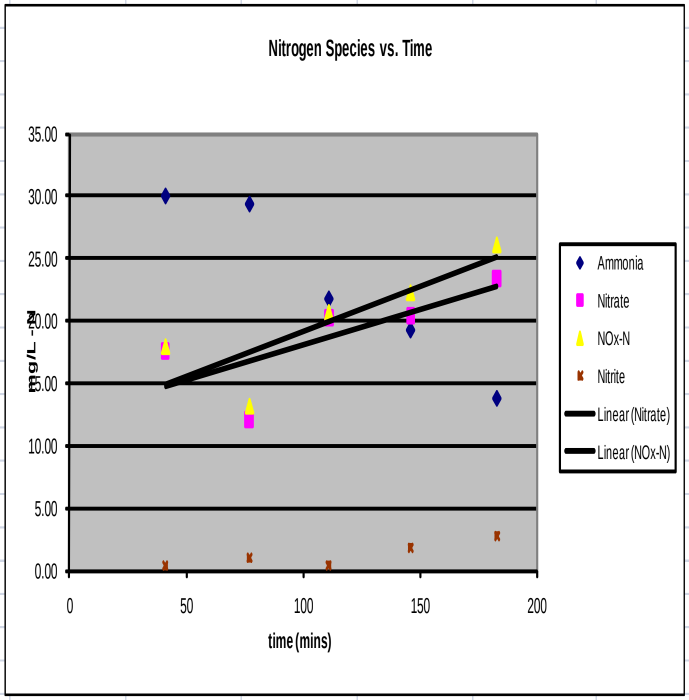
a. Spiked four 3L reactors with 25 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters

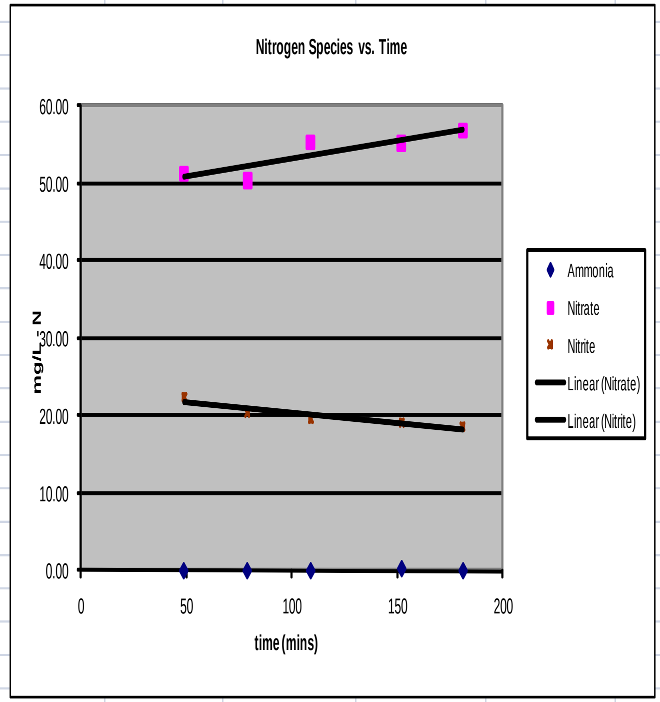
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.

Reactor A: Nansemond Activated Sludge/Nansemond PE

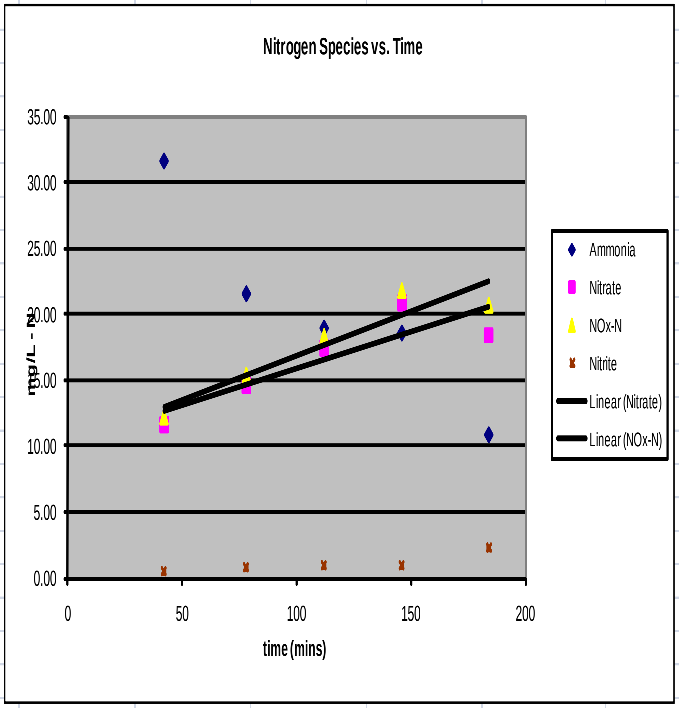
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	16:59	41	A1	27.8	35.36	30.00	17.55		0.35		1.39	17.90
Ammonia	8-Jul-08	17:35	77	A2	28	33.72	29.35	12.11		0.99		0.41	13.10
Ammonia	8-Jul-08	18:09	111	A3	28.2	29.11	21.75	20.20		0.46		0.00	20.66
Ammonia	8-Jul-08	18:44	146	A4	28.3	26.34	19.25	20.37		1.87		0.00	22.24
Ammonia	8-Jul-08	19:21	183	A5	28.4	19.46	13.78	23.34		2.75		0.00	26.09
Nitrite	9-Jul-08	7:32	49	A6	28.5	0.00	-	51.29		22.45		6.87	73.74
Nitrite	9-Jul-08	8:02	79	A7	28.7	0.00	-	50.39		20.47		6.74	70.86
Nitrite	9-Jul-08	8:32	109	A8	28.6	0.00	-	55.29		19.54		#VALUE!	74.83
Nitrite	9-Jul-08	9:15	152	A9	28.6	0.25	-	55.23		19.15		#VALUE!	74.38
Nitrite	9-Jul-08	9:44	181	A10	28.775	0.00	-	56.86		18.62		36.15	75.48

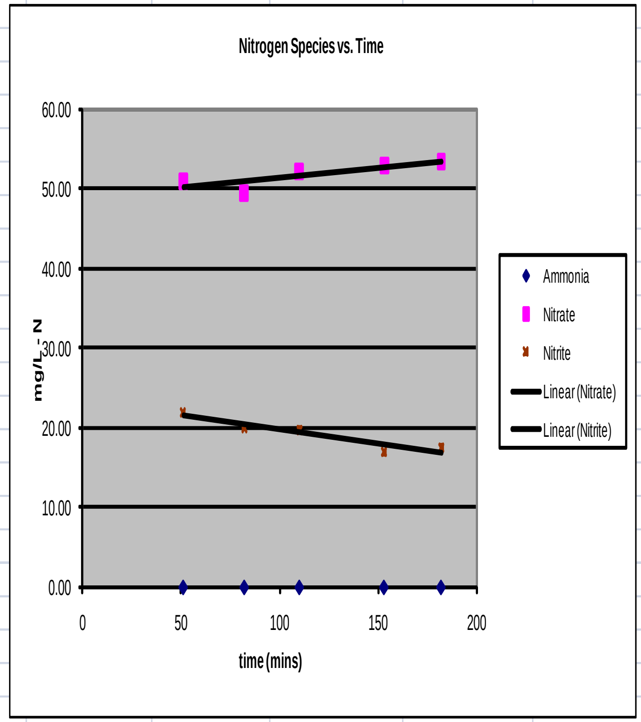




Reactor B: Nansemond Activated Sludge/Henrico PE

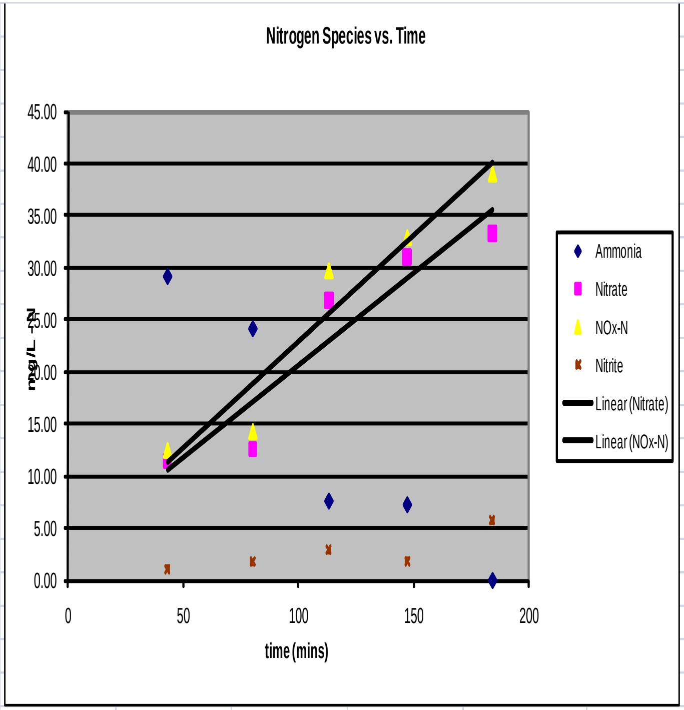
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	17:01	42	B1	27.3	31.65	31.60	11.66		0.51		0.00	12.16
Ammonia	8-Jul-08	17:37	78	B2	27.8	25.26	21.55	14.59		0.79		0.00	15.37
Ammonia	8-Jul-08	18:11	112	B3	28.1	25.88	18.95	17.39		0.93		0.00	18.31
Ammonia	8-Jul-08	18:45	146	B4	28.4	24.83	18.58	20.88		0.93		0.00	21.80
Ammonia	8-Jul-08	19:23	184	B5	28.3	22.59	10.88	18.39		2.30		0.00	20.70
Nitrite	9-Jul-08	7:35	51	B6	28.7	0.00	-	50.94		21.92		7.47	72.86
Nitrite	9-Jul-08	8:06	82	B7	28.72	0.00	-	49.44		19.98		8.71	69.42
Nitrite	9-Jul-08	8:34	110	B8	28.8	0.00	-	52.11		19.74		18.43	71.85
Nitrite	9-Jul-08	9:17	153	B9	28.7	0.00	-	52.91		16.90		53.17	69.81
Nitrite	9-Jul-08	9:46	182	B10	28.8	0.00	-	53.45		17.61		65.08	71.06

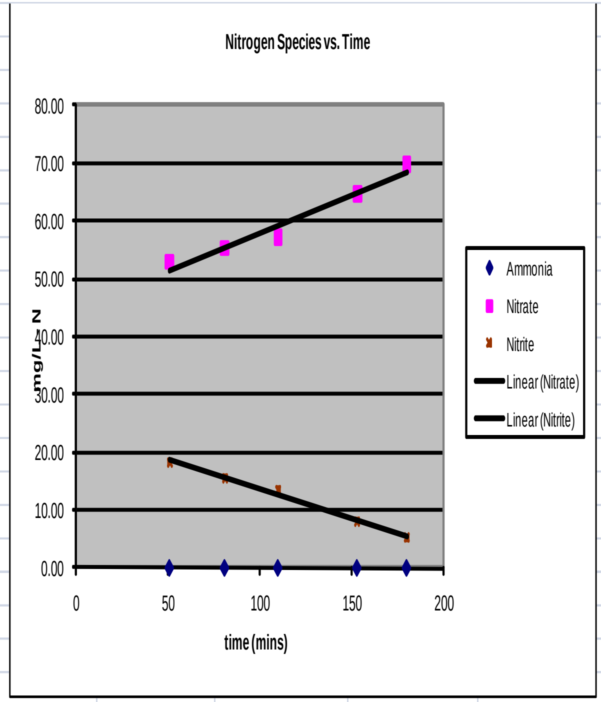




Reactor C: Henrico Activated Sludge/Henrico PE

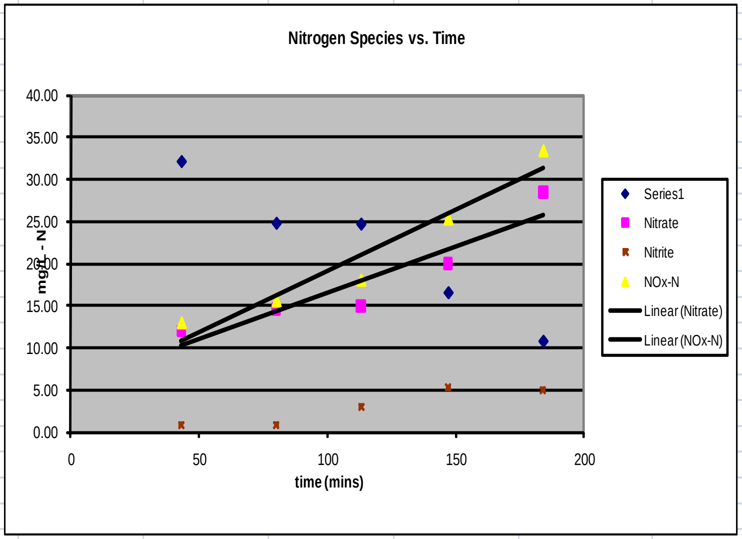
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	17:03	43	C1	27.1	30.09	29.10	11.42		1.05		0.00	12.47
Ammonia	8-Jul-08	17:40	80	C2	27.6	22.45	24.10	12.55		1.72		0.00	14.27
Ammonia	8-Jul-08	18:13	113	C3	28.1	14.76	7.60	26.79		2.91		0.00	29.70
Ammonia	8-Jul-08	18:47	147	C4	28.2	10.85	7.25	31.01		1.87		0.00	32.87
Ammonia	8-Jul-08	19:24	184	C5	28.4	-1.2769ELL	under range	33.29		5.69		0.49	38.98
Nitrite	9-Jul-08	7:37	51	C6	28.5	0.00	-	52.89		18.26		4.30	71.15
Nitrite	9-Jul-08	8:07	81	C7	28.7	0.00	-	55.31		15.59		3.87	70.90
Nitrite	9-Jul-08	8:36	110	C8	28.6	0.00	-	57.20		13.51		#VALUE!	70.71
Nitrite	9-Jul-08	9:19	153	C9	28.6	0.00	-	64.62		8.12		#VALUE!	72.74
Nitrite	9-Jul-08	9:46	180	C10	28.7	0.00	-	69.89		5.15		#VALUE!	75.04

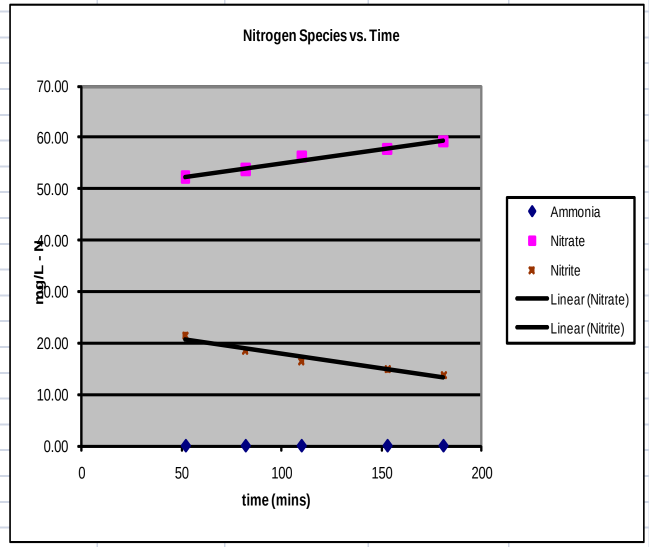




Reactor D: Henrcio Activated Sludge/Henrico PE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	17:04	43	D1	27.6	32.44	32.10	12.01		0.88		1.12	12.89
Ammonia	8-Jul-08	17:41	80	D2	27.9	26.44	24.75	14.61		0.89		0.87	15.50
Ammonia	8-Jul-08	18:14	113	D3	28.2	26.02	24.65	15.01		2.98		0.53	17.98
Ammonia	8-Jul-08	18:48	147	D4	28.3	20.66	16.48	19.98		5.26		0.53	25.24
Ammonia	8-Jul-08	19:25	184	D5	28.4	13.39	10.70	28.42		4.97		0.52	33.39
Nitrite	9-Jul-08	7:39	52	D6	28.575	0.00	-	52.27		21.45		7.66	73.72
Nitrite	9-Jul-08	8:09	82	D7	28.6	0.00	-	53.73		18.58		9.84	72.31
Nitrite	9-Jul-08	8:37	110	D8	28.6	0.00	-	56.29		16.44		20.14	72.73
Nitrite	9-Jul-08	9:20	153	D9	28.5	0.00	-	57.75		14.79		16.72	72.54
Nitrite	9-Jul-08	9:48	181	D10	28.7	0.00	-	59.19		13.71		19.30	72.90





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
activated sludge	Ammonia	0.072	0.056		2.800	2.173		0.665	25.83	2390.00	1545.00
NS Primary	Nitrite		0.047	-0.026		1.819	-1.015	0.219	8.50	2390.00	1545.00
Effluent											
Reactor B: NS											
Activated Sludge	Ammonia	0.066	0.056		2.518	2.111		0.576	21.88	2595.00	1580.00
HR Primary	Nitrite		0.025	-0.036		0.968	-1.352	0.174	6.59	2595.00	1580.00
Effluent											
Reactor C: HR											
Activated Sludge	Ammonia	0.204	0.177		7.541	6.537		1.047	38.66	2593.33	1625.83
HR Primary	Nitrite		0.132	-0.103		4.879	-3.786	0.331	12.22	2593.33	1625.83
Effluent											
Reactor D: HR											
Activated Sludge	Ammonia	0.146	0.110		5.162	3.897		0.933	33.08	2687.50	1691.67
NS Primary	Nitrite		0.054	-0.058		1.909	-2.056	0.258	9.16	2687.50	1691.67
Effluent											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 4 – Henrico County Biomass Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

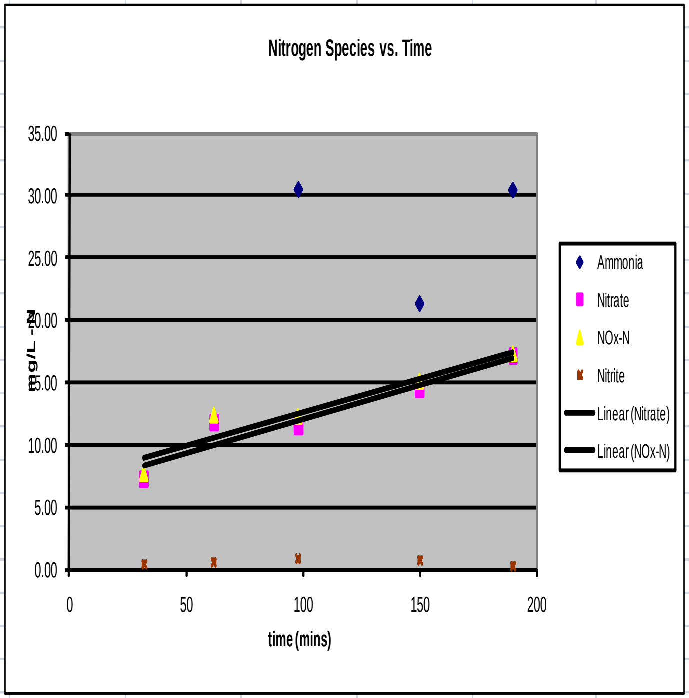
AOB & NOB Experimentation:

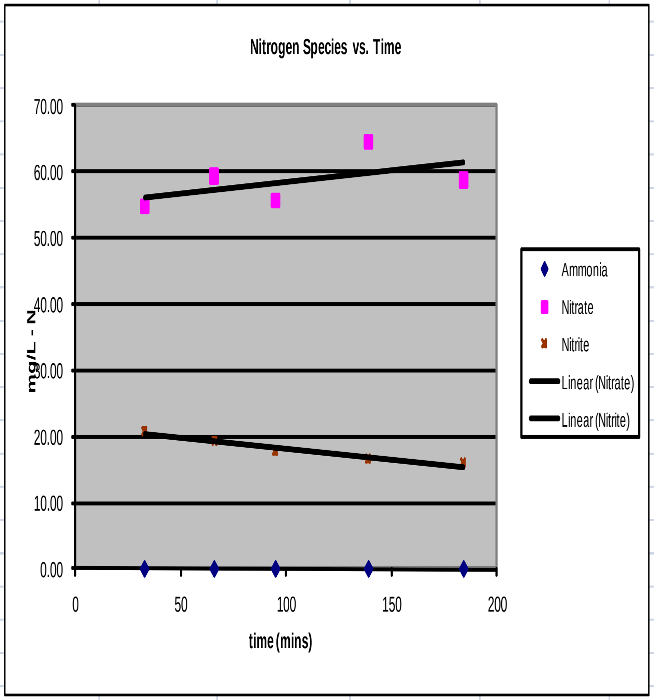
I. AOB
a. Spiked four 3L reactors with 25 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters

II. NOB
a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.

Reactor A: Nansemond Activated Sludge/Nansemond PE

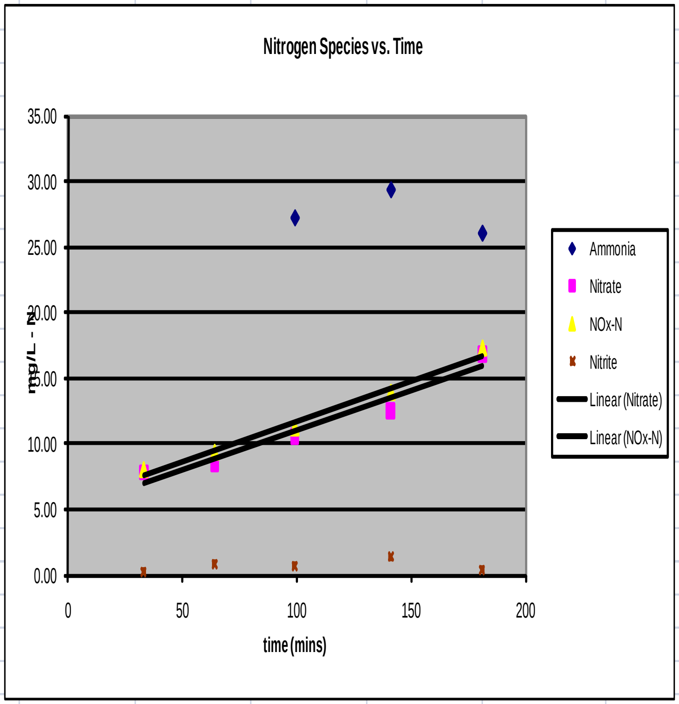
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	11:46	32	A1	25.3	29.63		7.27		0.40		13.06	7.67
Ammonia	8-Jul-08	12:16	62	A2	26.4	40.23		11.80		0.60		8.42	12.40
Ammonia	8-Jul-08	12:52	98	A3	27.2	20.20	30.55	11.47		0.82		4.08	12.29
Ammonia	8-Jul-08	13:34	150	A4	27.9	17.69	21.30	14.38		0.74		0.88	15.12
Ammonia	8-Jul-08	14:14	190	A5	28.0	15.30	30.50	17.07		0.28		0.00	17.34
Nitrite	9-Jul-08	7:12	33	A6	28.5	0.00	-	54.78		20.93		7.60	75.71
Nitrite	9-Jul-08	7:45	66	A7	28.7	0.00	-	59.38		19.46		8.66	78.83
Nitrite	9-Jul-08	8:14	95	A8	28.6	0.00	-	55.67		17.79		8.69	73.46
Nitrite	9-Jul-08	8:58	139	A9	28.6	0.00	-	64.57		16.55		9.22	81.13
Nitrite	9-Jul-08	9:43	184	A10	28.7	0.00	-	58.84		15.96		10.02	74.80

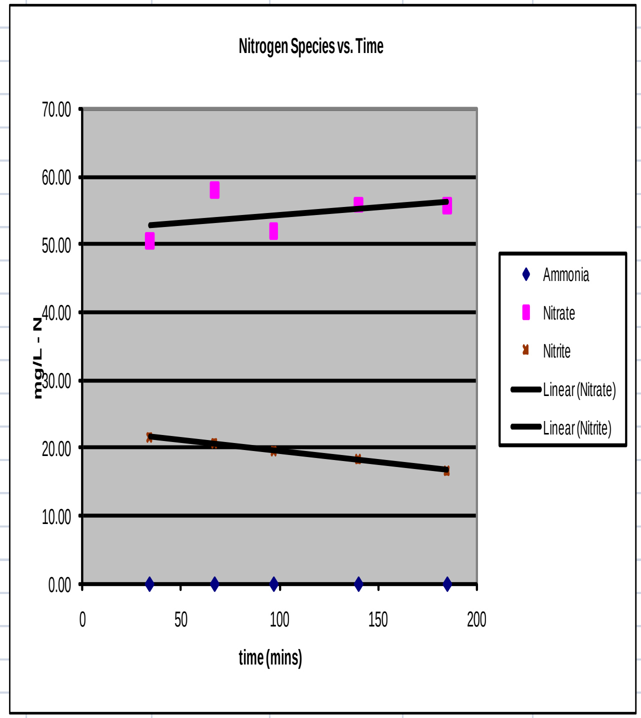




Reactor B: Nansemond Activated Sludge/Henrico PE

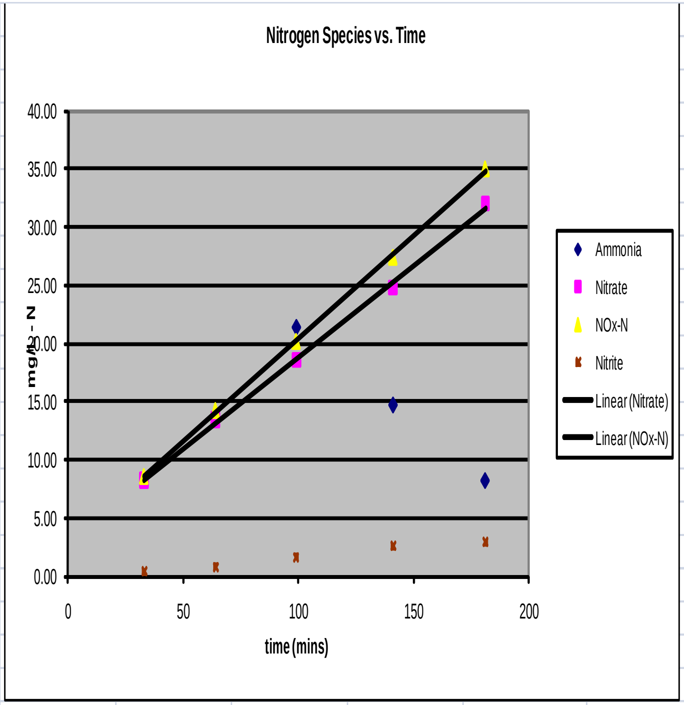
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	11:48	33	B1	25.5	23.42		7.81		0.27		4.27	8.08
Ammonia	8-Jul-08	12:19	64	B2	26.6	21.04		8.52		0.86		3.14	9.39
Ammonia	8-Jul-08	12:54	99	B3	27.3	15.03	27.25	10.53		0.69		1.75	11.22
Ammonia	8-Jul-08	13:36	141	B4	28.0	13.32	29.35	12.55		1.35		1.39	13.90
Ammonia	8-Jul-08	14:16	181	B5	28.1	11.80	26.10	16.84		0.39		1.33	17.23
Nitrite	9-Jul-08	7:14	34	B6	28.8	0.00	-	50.42		21.69		10.59	72.11
Nitrite	9-Jul-08	7:47	67	B7	28.9	0.00	-	57.99		20.82		10.68	78.80
Nitrite	9-Jul-08	8:17	97	B8	28.8	0.00	-	52.03		19.67		10.57	71.71
Nitrite	9-Jul-08	9:00	140	B9	28.82	0.00	-	55.83		18.39		10.62	74.22
Nitrite	9-Jul-08	9:45	185	B10	28.8	0.00	-	55.67		16.67		10.73	72.33

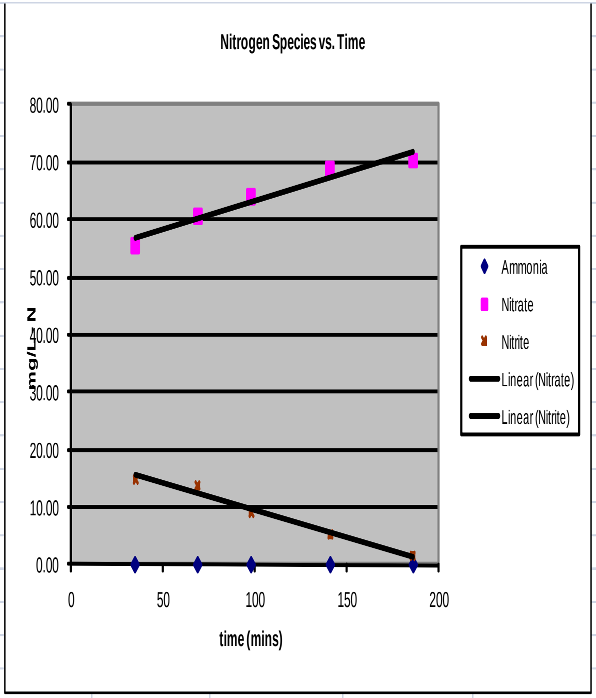




Reactor C: Henrico Activated Sludge/Henrico PE

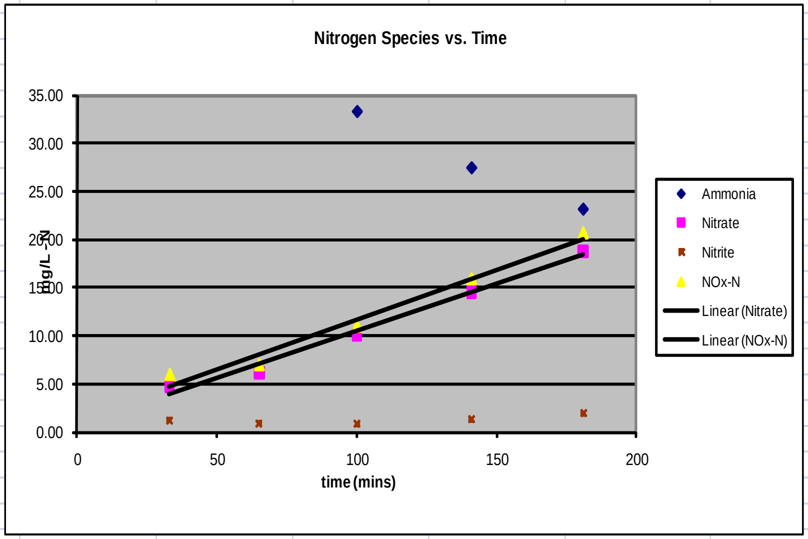
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	11:50	33	C1	25.4	36.10		8.20		0.39		1.22	8.59
Ammonia	8-Jul-08	12:21	64	C2	26.7	39.28		13.47		0.78		0.87	14.25
Ammonia	8-Jul-08	12:56	99	C3	27.4	7.99	21.45	18.55		1.63		0.58	20.17
Ammonia	8-Jul-08	13:38	141	C4	28	0.2303ELL	14.75	24.77		2.59		0.56	27.37
Ammonia	8-Jul-08	14:18	181	C5	28	4.28	8.23	32.01		2.94		0.76	34.95
Nitrite	9-Jul-08	7:16	35	C6	28.7	0.00	-	55.57		14.96		2.52	70.53
Nitrite	9-Jul-08	7:50	69	C7	28.8	0.00	-	60.55		13.71		2.50	74.25
Nitrite	9-Jul-08	8:19	98	C8	28.7	0.00	-	63.91		9.18		2.52	73.10
Nitrite	9-Jul-08	9:02	141	C9	28.8	0.00	-	68.83		5.20		2.63	74.03
Nitrite	9-Jul-08	9:47	186	C10	28.7	0.00	-	70.32		1.64		2.59	71.96

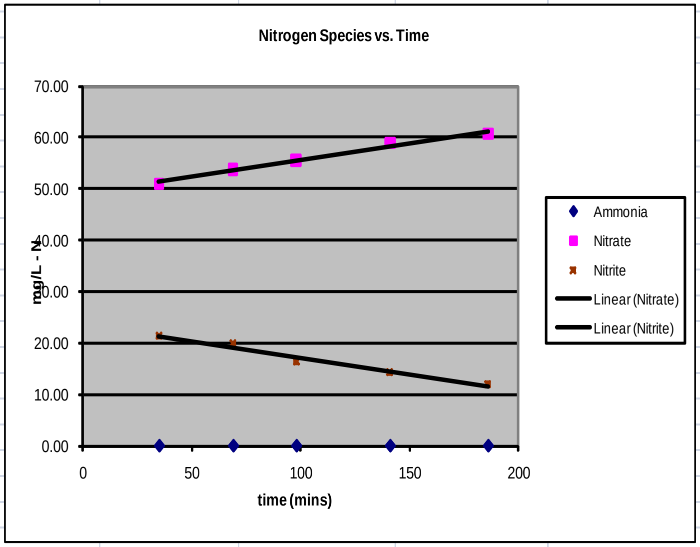




Reactor D: Henrcio Activated Sludge/Henrico PE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	8-Jul-08	11:51	33	D1	25.4	28.97		4.76		1.24		7.14	5.99
Ammonia	8-Jul-08	12:23	65	D2	26.65	25.53		6.10		0.90		7.98	7.00
Ammonia	8-Jul-08	12:58	100	D3	27.4	18.93	33.30	10.14		0.86		6.92	11.00
Ammonia	8-Jul-08	13:39	141	D4	27.9	14.07	27.45	14.56		1.34		6.00	15.89
Ammonia	8-Jul-08	14:19	181	D5	28	10.70	23.15	18.73		1.91		5.39	20.64
Nitrite	9-Jul-08	7:17	35	D6	28.7	0.00	-	50.94		21.36		4.13	72.30
Nitrite	9-Jul-08	7:51	69	D7	28.8	0.00	-	53.68		19.83		4.30	73.52
Nitrite	9-Jul-08	8:20	98	D8	28.7	0.00	-	55.62		16.28		4.04	71.90
Nitrite	9-Jul-08	9:03	141	D9	28.8	0.00	-	58.94		14.20		4.49	73.14
Nitrite	9-Jul-08	9:48	186	D10	28.8	0.00	-	60.68		11.99		4.71	72.67



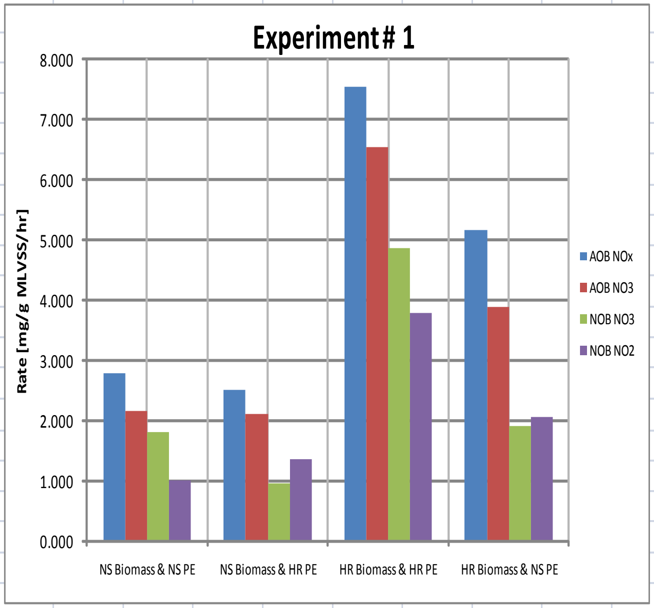


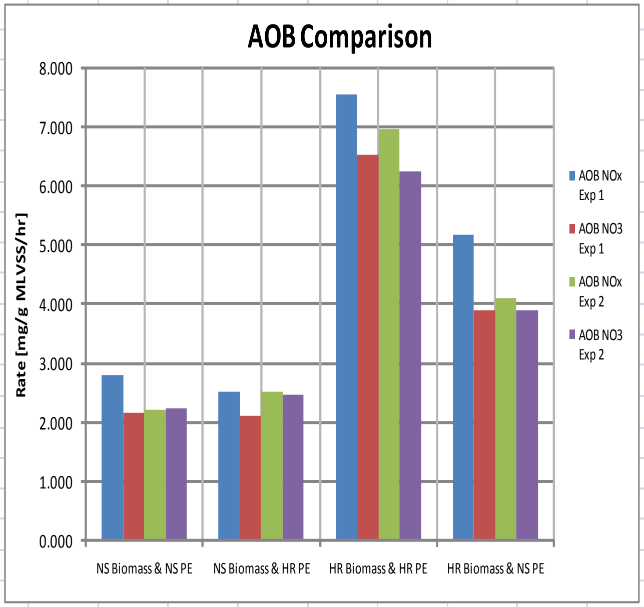
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS activated sludge	Ammonia	0.054	0.054		2.223	2.243		0.665	27.52	2340.00	1450.00
NS Primary Effluent	Nitrite		0.035	-0.033		1.447	-1.383	0.219	9.06	2340.00	1450.00
Reactor B: NS Activated Sludge	Ammonia	0.062	0.060		2.530	2.458		0.576	23.68	2325.00	1460.00
HR Primary Effluent	Nitrite		0.022	-0.033		0.919	-1.370	0.174	7.14	2325.00	1460.00
Reactor C: HR Activated Sludge	Ammonia	0.176	0.158		6.963	6.233		1.047	41.33	2393.33	1520.83
HR Primary Effluent	Nitrite		0.099	-0.094		3.922	-3.694	0.331	13.07	2393.33	1520.83
Reactor D: HR Activated Sludge	Ammonia	0.103	0.098		4.099	3.900		0.933	36.98	2350.00	1513.33
NS Primary Effluent	Nitrite		0.066	-0.064		2.602	-2.552	0.258	10.24	2350.00	1513.33

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

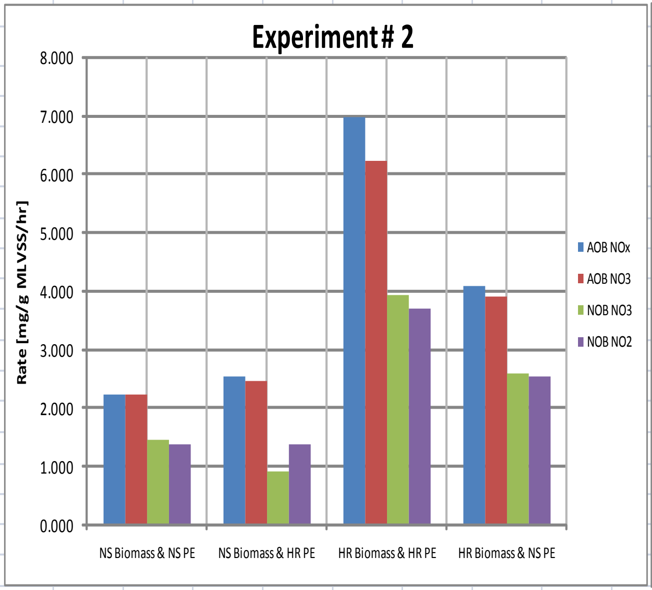
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge NS Primary Effluent	2.800	2.173	1.819	1.015
Reactor B: NS Activated Sludge HR Primary Effluent	2.518	2.111	0.968	1.352
Reactor C: HR Activated Sludge HR Primary Effluent	7.541	6.537	4.879	3.786
Reactor D: HR Activated Sludge NS Primary Effluent	5.162	3.897	1.909	2.056

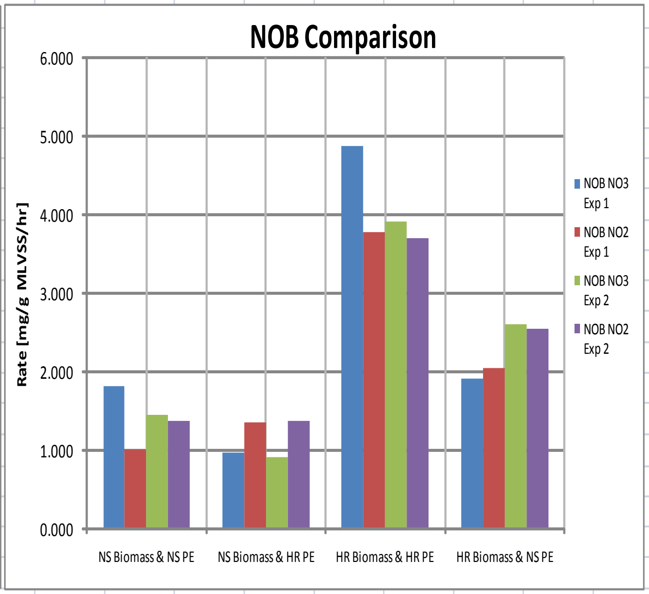




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge NS Primary Effluent	2.223	2.243	1.447	1.383
Reactor B: NS Activated Sludge HR Primary Effluent	2.530	2.458	0.919	1.370
Reactor C: HR Activated Sludge HR Primary Effluent	6.963	6.233	3.922	3.694
Reactor D: HR Activated Sludge NS Primary Effluent	4.099	3.900	2.602	2.552





Week 5 – Hog Processing Plant

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

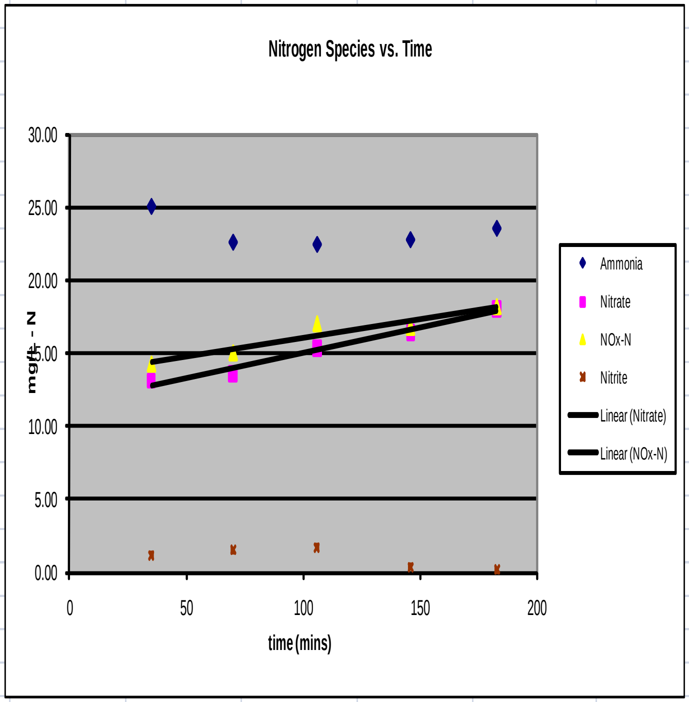
a. Spiked four 3L reactors with 30 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 8.5 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors A and C which incorporated industrial waste addition were spiked with 200 mL of Smithfield sample (1:10 dilution).

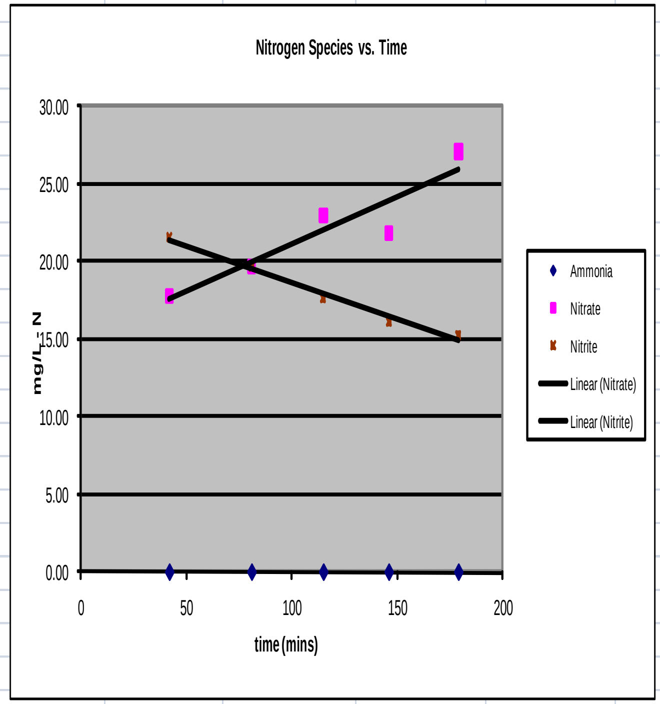
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <2 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
i. Reactors A and C which incorporated industrial waste addition were spiked with 200 mL of Smithfield sample (1:10 dilution).

Reactor A: Nansemond Activated Sludge/VIP SE + Smithfield

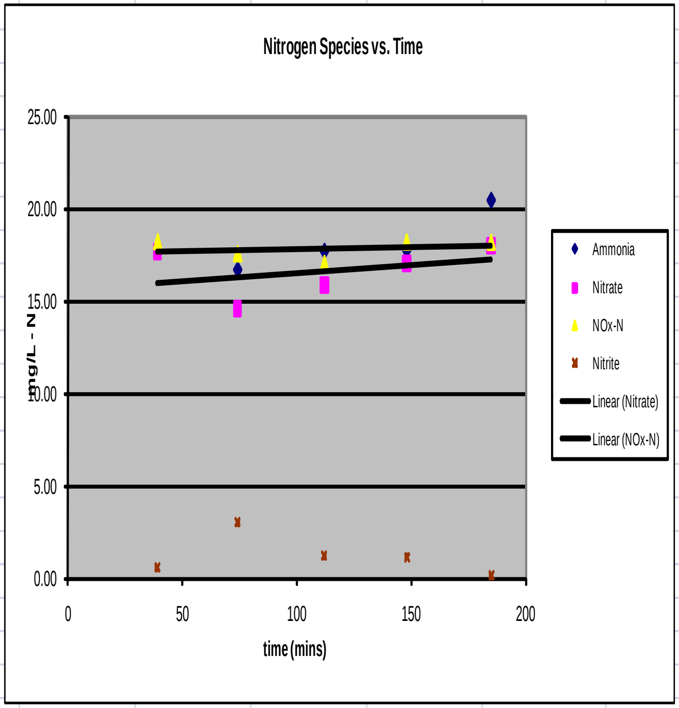
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	29-Jul-08	9:16	35	A1	25.6	18.27	25.10	13.14		1.15		~~6.92~~	14.29
Ammonia	29-Jul-08	9:51	70	A2	26.76666667	18.26	22.65	13.56		1.49		~~6.53~~	15.05
Ammonia	29-Jul-08	10:27	106	A3	27.4	16.91	22.50	15.31		1.70		~~6.63~~	17.02
Ammonia	29-Jul-08	11:07	146	A4	27.9	16.95	22.83	16.42		0.35		~~7.21~~	16.78
Ammonia	29-Jul-08	11:44	183	A5	28.2	15.47	23.60	18.01		0.16		~~8.62~~	18.17
Nitrite	29-Jul-08	17:29	42	A6	28.1	0.00	-	17.79		21.55		~~12.17~~	39.34
Nitrite	29-Jul-08	18:08	81	A7	28.2	0.00	-	19.69		19.65		~~12.00~~	39.34
Nitrite	29-Jul-08	18:42	115	A8	28.5	0.00	-	22.96		17.64		~~11.57~~	40.60
Nitrite	29-Jul-08	19:13	146	A9	28.5	0.00	-	21.82		16.11		~~12.43~~	37.93
Nitrite	29-Jul-08	19:46	179	A10	28.5	0.00	-	27.10		15.28		~~12.80~~	42.38

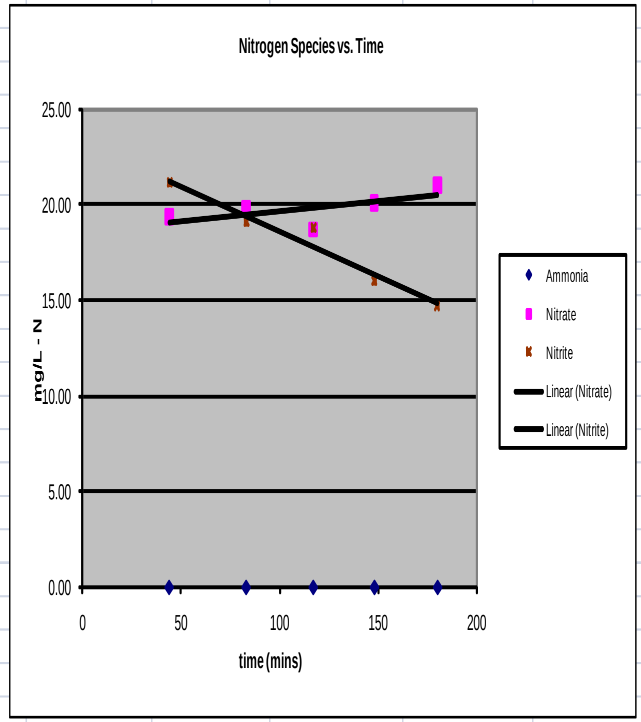




Reactor B: Nansemond Activated Sludge/VIP SE

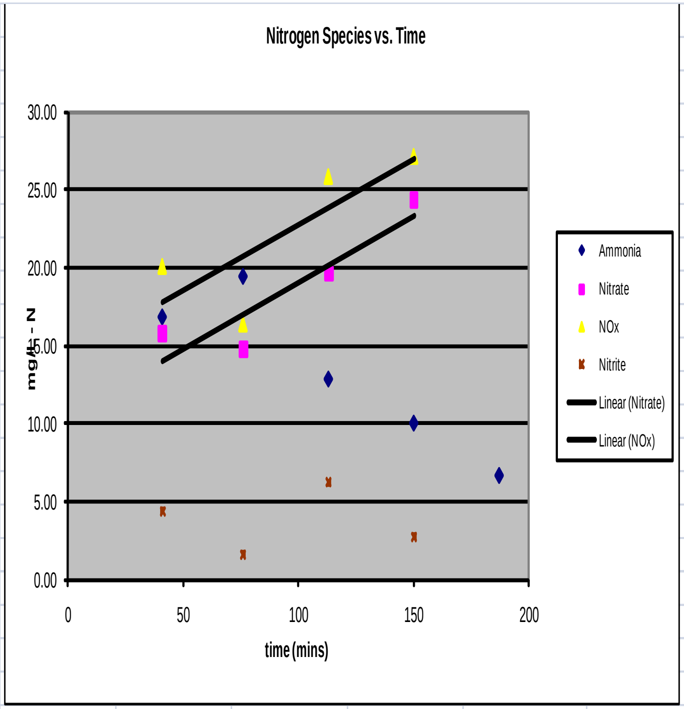
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	29-Jul-08	9:21	39	B1	26.1	14.58	17.70	17.63		0.55		~~5.44~~	18.18
Ammonia	29-Jul-08	9:56	74	B2	27.1	14.12	16.70	14.55		3.00		~~8.49~~	17.56
Ammonia	29-Jul-08	10:34	112	B3	27.7	12.02	17.70	15.88		1.18		~~5.96~~	17.05
Ammonia	29-Jul-08	11:10	148	B4	28.1	12.67	17.75	17.04		1.12		~~6.02~~	18.17
Ammonia	29-Jul-08	11:47	185	B5	28.4	13.14	20.45	17.99		0.16		~~6.45~~	18.15
Nitrite	29-Jul-08	17:32	44	B6	28.4	0.00	-	19.37		21.16		~~12.11~~	40.53
Nitrite	29-Jul-08	18:11	83	B7	28.4	0.00	-	19.82		19.07		~~14.22~~	38.89
Nitrite	29-Jul-08	18:45	117	B8	28.7	0.00	-	18.69		18.77		~~13.77~~	37.47
Nitrite	29-Jul-08	19:16	148	B9	28.7	0.00	-	20.10		16.02		~~15.07~~	36.12
Nitrite	29-Jul-08	19:48	180	B10	28.7	0.00	-	21.03		14.71		~~15.89~~	35.73

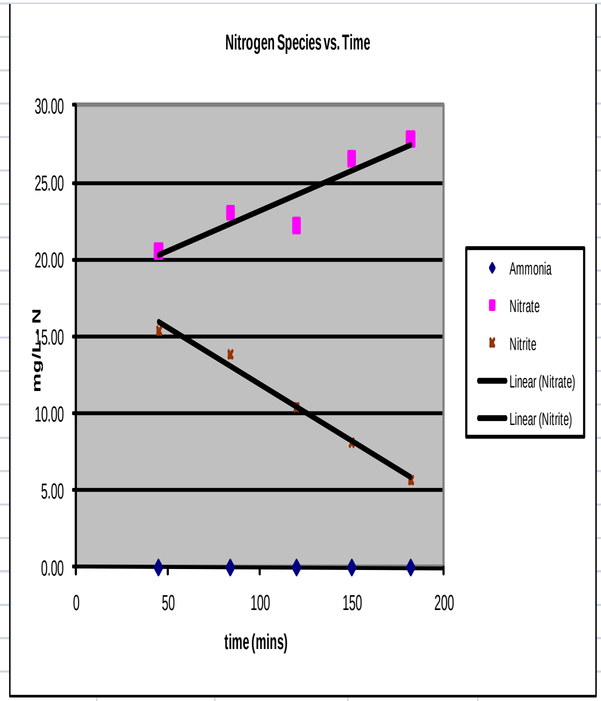




Reactor C: VIP Activated Sludge/VIP SE + Smithfield

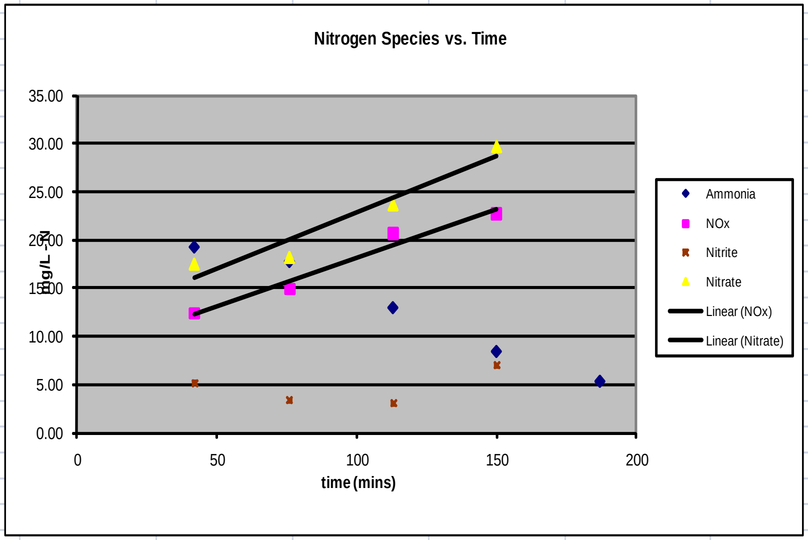
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	29-Jul-08	9:24	41	C1	25.8	17.91	16.80	15.72		4.36		~~4.14~~	20.08
Ammonia	29-Jul-08	9:59	76	C2	26.9	15.18	19.40	14.77		1.61		~~3.46~~	16.38
Ammonia	29-Jul-08	10:36	113	C3	27.5	8.20	12.83	19.61		6.24		~~3.17~~	25.84
Ammonia	29-Jul-08	11:13	150	C4	27.8	5.64	10.00	24.37		2.77		~~3.39~~	27.14
Ammonia	29-Jul-08	11:50	187	C5	28.2	2.65	6.65	25.37		0.00		~~3.49~~	25.37
Nitrite	29-Jul-08	17:34	45	C6	28.4	0.00	-	20.55		15.37		~~11.19~~	35.92
Nitrite	29-Jul-08	18:13	84	C7	28.3	0.00	-	23.06		13.83		~~11.92~~	36.89
Nitrite	29-Jul-08	18:49	120	C8	28.7	0.00	-	22.25		10.41		~~12.92~~	32.66
Nitrite	29-Jul-08	19:19	150	C9	28.6	0.00	-	26.57		8.15		~~12.55~~	34.73
Nitrite	29-Jul-08	19:51	182	C10	28.7	0.00	-	27.81		5.64		~~12.60~~	33.45

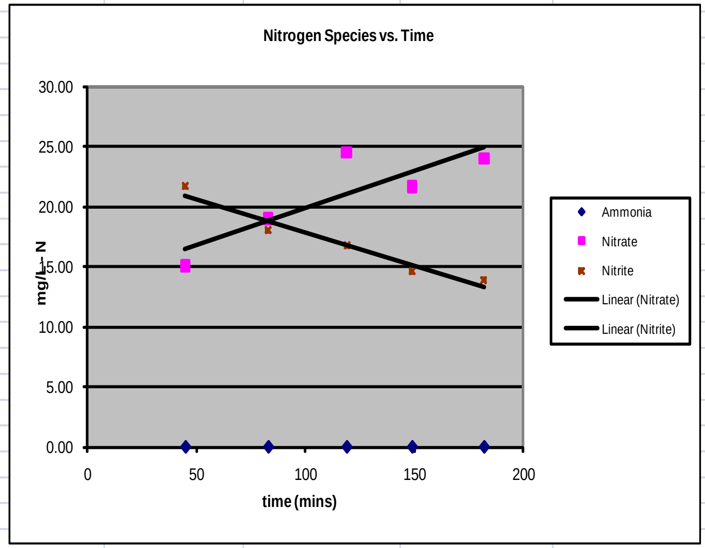




Reactor D: VIP Activated Sludge/VIP SE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	29-Jul-08	9:26	42	D1	25.94	14.00	19.30	12.37		5.19		~~1.08~~	17.55
Ammonia	29-Jul-08	10:00	76	D2	26.9	11.40	17.80	14.91		3.33		~~1.03~~	18.24
Ammonia	29-Jul-08	10:37	113	D3	27.475	6.99	13.00	20.64		3.01		~~1.94~~	23.64
Ammonia	29-Jul-08	11:14	150	D4	27.7	3.62	8.45	22.66		6.97		~~2.29~~	29.63
Ammonia	29-Jul-08	11:51	187	D5	28	0.00	5.35	25.17		0.00		~~2.85~~	25.17
Nitrite	29-Jul-08	17:36	45	D6	28.3	0.00	-	15.05		21.68		~~12.68~~	36.73
Nitrite	29-Jul-08	18:14	83	D7	28.2	0.00	-	18.98		17.98		~~15.05~~	36.96
Nitrite	29-Jul-08	18:50	119	D8	28.5	0.00	-	24.48		16.73		~~14.10~~	41.21
Nitrite	29-Jul-08	19:20	149	D9	28.5	0.00	-	21.64		14.62		~~15.74~~	36.26
Nitrite	29-Jul-08	19:53	182	D10	28.6	0.00	-	23.99		13.87		16.13	37.86





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS activated sludge VIP Secondary Smithfield	Ammonia	0.025	0.034		1.127	1.508		0.248	11.01	2090.00	1350.00
	Nitrite		0.061	-0.048		2.722	-2.115	0.187	8.32	2090.00	1350.00
Reactor B: NS Activated Sludge VIP Secondary Effluent	Ammonia	0.002	0.009		0.071	0.416		0.216	10.03	2030.00	1290.00
	Nitrite		0.010	-0.047		0.479	-2.191	0.157	7.32	2030.00	1290.00
Reactor C: VIP Activated Sludge VIP Secondary Smithfield	Ammonia	0.085	0.085		3.106	3.113		0.625	22.86	2120.00	1640.00
	Nitrite		0.052	-0.074		1.915	-2.692	0.269	9.83	2120.00	1640.00
Reactor D: VIP Activated Sludge VIP Secondary Effluent	Ammonia	0.116	0.101		4.359	3.812		0.525	19.72	2093.33	1596.67
	Nitrite		0.062	-0.056		2.328	-2.111	0.245	9.19	2093.33	1596.67

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Sample Data Report for Nansemond Nitrification Inhibition Study

Bio-P Experimentation:

I. Bio - P

a. Spiked four 3L reactors with 5 mg/L PO_4- P to raise initial PO_4- concentration to roughly 15 mg/L PO_4- P. (Initial PO_4- concentration was determined through HACH TNT PO_4- Tubes at the end of the AOB/NOB experimentation).

b. The Bio-P experiment was run through an uptake/release/uptake/release/uptake method were the four reactors are aerobic/anaerobic/aerobic once more. During the first release phase 100 mg/L of NaAc was added for COD manually to all 4 reactors and 200 mg/L of NaAc during the second release phase.

c. Each reactor is running continously by use of stir bars .

d. 2 L of the diluent source is added to the reactors.

e. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 8.5 L.

f. Constant DO and pH were monitored and logged throughout the experiment.

g. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves during the uptake phases and then these valves were turned off and the oxygen/air was cut-off and then the system was deaerated and the DO was allowed to drop to 0 before beginning the release phase. During the release phase nitrogen was sparged into the reactors.

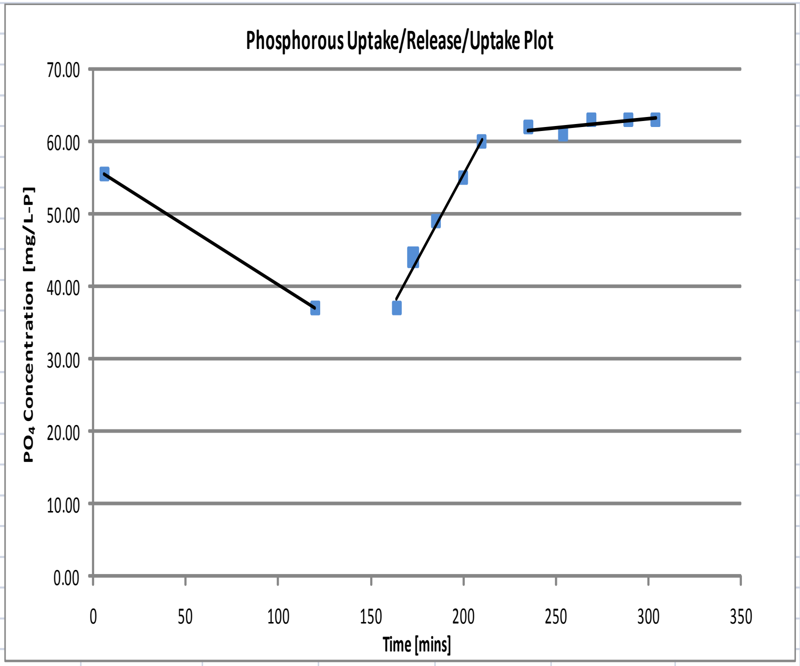
h. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

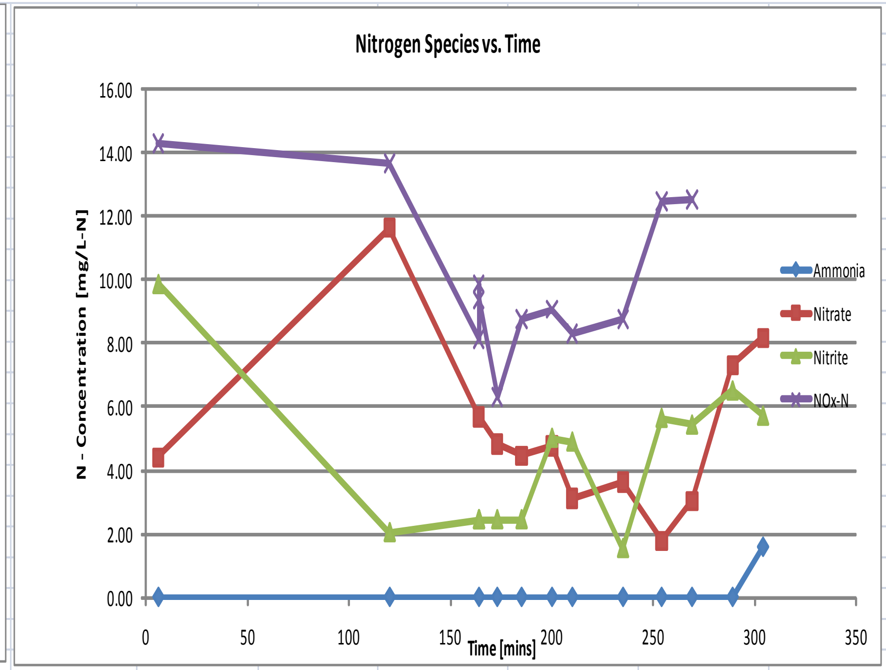
i. 2 samples were collected over a period of 2 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters during the second uptake phase and 5 samples were collected over a period of 1 and 1.5 housr during the second release phase and final uptake phase. The first uptake and release phases were used to eliminate any residual ammonia and nitrite.

j. Reactors A and C which incorporated industrial waste addition were spiked with 200 mL of Smithfield sample (1:10 dilution).

Reactor A: Nansemond Activated Sludge/VIP SE + Smithfield

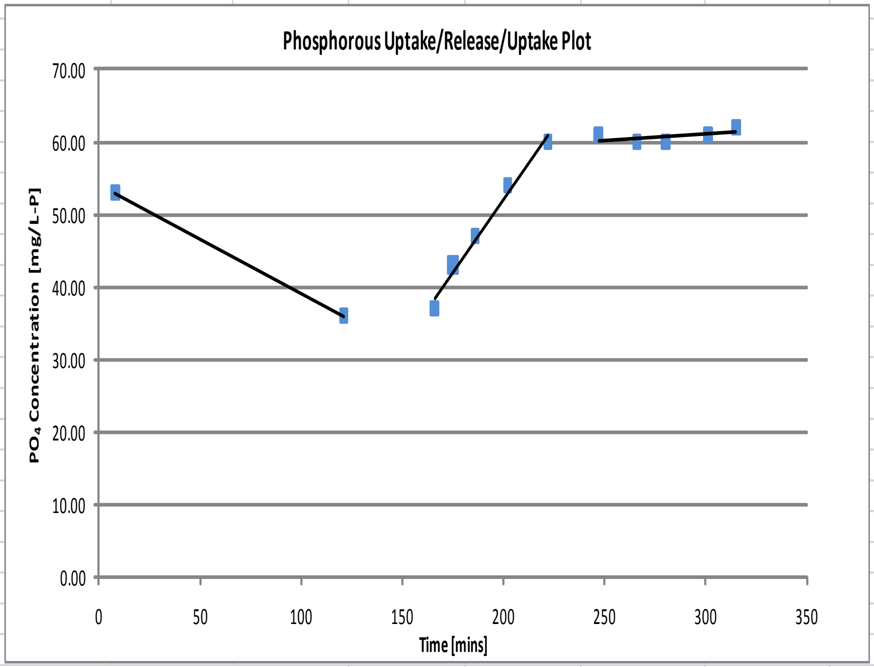
Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	30-Jul-08	13:35	6	A1	28.4	55.50	40.40	0.00	4.42		9.88		14.30
Uptake 1	30-Jul-08	15:29	120	A2	28.4	37.00	24.59	0.00	11.63		2.05		13.68
Release	30-Jul-08	16:13	164	A5	28.60	37.00	24.50	0.00	5.68		2.45		8.13
Release	30-Jul-08	16:22	173	A6	28.6	44.00	29.60	0.00	4.84		5.03		9.86
Release	30-Jul-08	16:34	185	A7	28.5	49.00	22.93	0.00	4.46		4.91		9.37
Release	30-Jul-08	16:49	200	A8	28.5	55.00	20.06	0.00	4.77		1.54		6.31
Release	30-Jul-08	17:09	210	A9	28.6	60.00	25.13	0.00	3.11		5.66		8.76
Uptake 2	30-Jul-08	17:34	235	A10	28.7	62.00	27.33	0.00	3.62		5.44		9.07
Uptake 2	30-Jul-08	17:53	254	A11	28.6	61.00	31.23	0.00	1.79		6.52		8.32
Uptake 2	30-Jul-08	18:08	269	A12	28.5	63.00	30.45	0.00	3.05		5.72		8.77
Uptake 2	30-Jul-08	18:28	289	A13	28.5	63.00	31.90	0.00	7.32		5.15		12.47
Uptake 3	30-Jul-08	18:43	304	A14	28.6	63.00	33.15	1.57	8.17		4.37		12.54

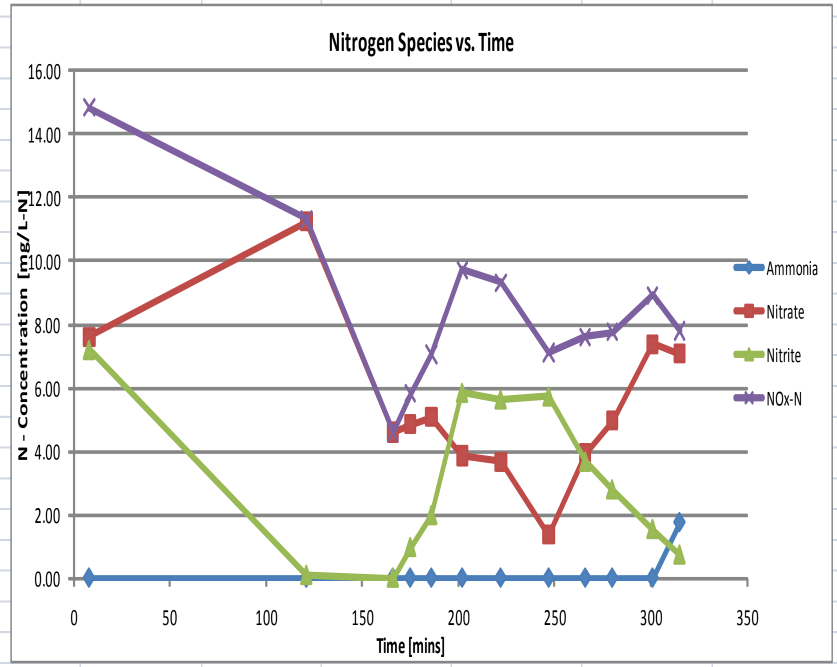




Reactor B: Nansemond Activated Sludge/VIP SE

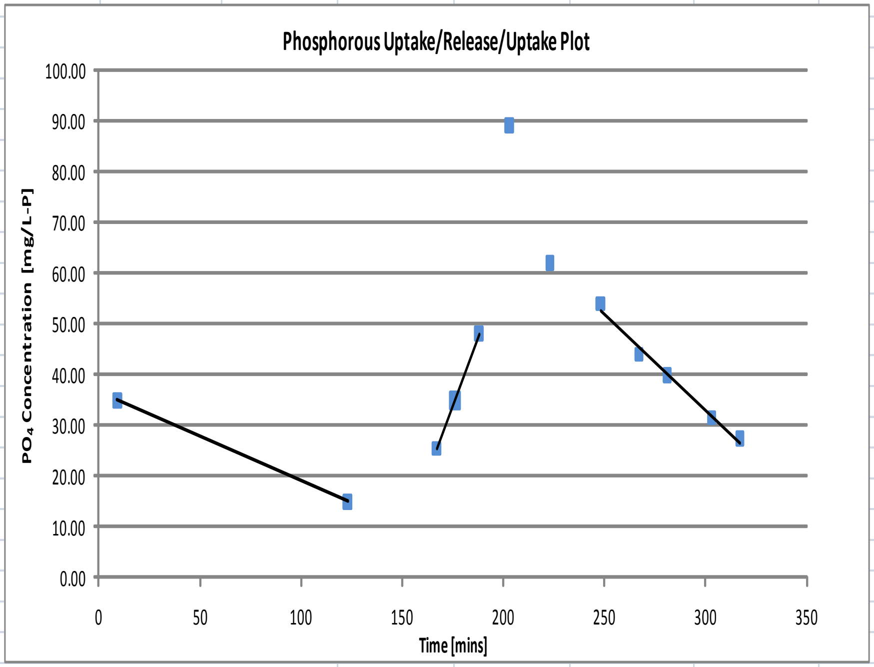
Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	30-Jul-08	13:38	8	B1	28.7	53.00	35.55	0.00	7.62		7.21		14.83
Uptake 1	30-Jul-08	15:31	121	B2	28.7	36.00	20.50	0.00	11.24		0.09		11.33
Release	30-Jul-08	16:16	166	B5	28.8	37.00	21.21	0.00	4.60		0.00		4.60
Release	30-Jul-08	16:25	175	B6	28.7	43.00	25.60	0.00	4.86		0.97		5.83
Release	30-Jul-08	16:36	186	B7	28.7	47.00	15.02	0.00	5.08		1.98		7.06
Release	30-Jul-08	16:52	202	B8	28.6	54.00	21.06	0.00	3.86		5.86		9.72
Release	30-Jul-08	17:12	222	B9	28.8	60.00	24.91	0.00	3.68		5.65		9.33
Uptake 2	30-Jul-08	17:37	247	B10	28.8	61.00	27.20	0.00	1.37		5.74		7.11
Uptake 2	30-Jul-08	17:56	266	B11	28.7	60.00	37.14	0.00	3.93		3.67		7.60
Uptake 2	30-Jul-08	18:10	280	B12	28.6	60.00	30.06	0.00	4.97		2.80		7.77
Uptake 2	30-Jul-08	18:31	301	B13	28.7	61.00	29.56	0.00	7.38		1.54		8.92
Uptake 2	30-Jul-08	18:45	315	B14	28.8	62.00	30.75	1.75	7.08		0.73		7.81

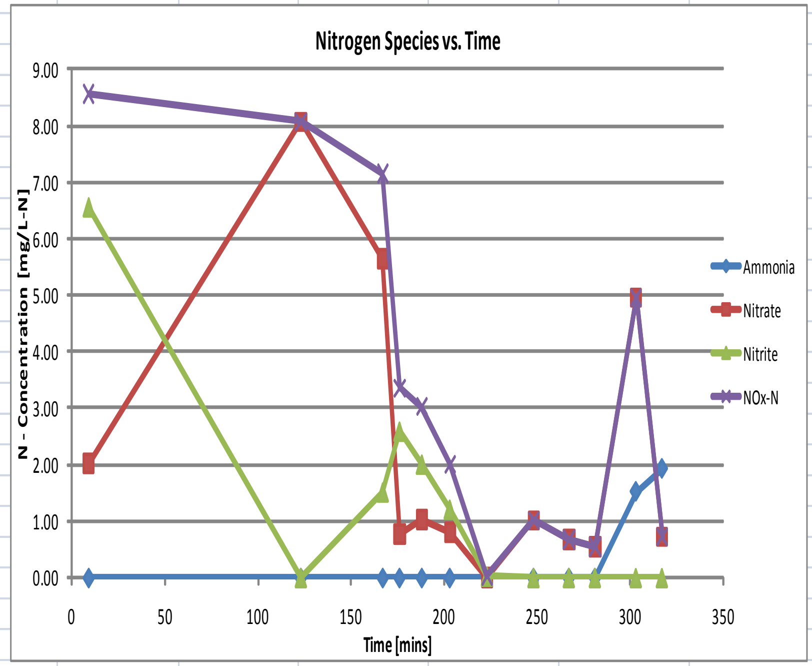




Reactor C: VIP Activated Sludge/VIP SE + Smithfield

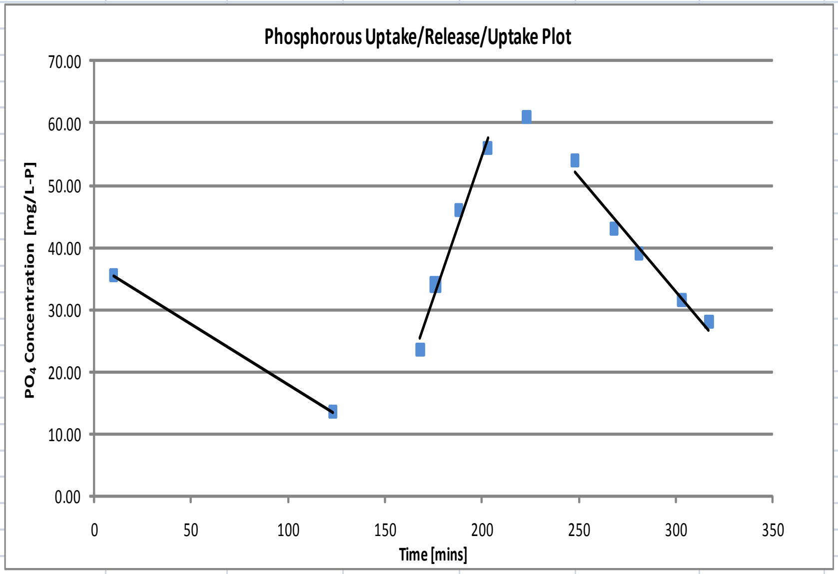
Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	30-Jul-08	13:40	9	C1	28.5	35.00	23.34	0.00	2.02		6.55		8.57
Uptake 1	30-Jul-08	15:34	123	C2	28.6	15.00	3.25	0.00	8.07		0.00		8.07
Release	30-Jul-08	16:18	167	C5	28.7	25.50	11.77	0.00	5.64		1.51		7.16
Release	30-Jul-08	16:27	176	C6	28.6	35.00	21.69	0.00	0.77		2.59		3.35
Release	30-Jul-08	16:39	188	C7	28.6	48.00	20.39	0.00	1.02		2.01		3.03
Release	30-Jul-08	16:54	203	C8	28.5	89.00	21.77	0.00	0.80		1.21		2.01
Release	30-Jul-08	17:14	223	C9	28.7	62.00	25.94	0.00	0.00		0.03		0.03
Uptake 2	30-Jul-08	17:39	248	C10	28.7	54.00	22.89	0.00	1.01		0.00		1.01
Uptake 2	30-Jul-08	17:58	267	C11	28.6	44.00	19.60	0.00	0.66		0.00		0.66
Uptake 2	30-Jul-08	18:12	281	C12	28.5	40.00	9.71	0.00	0.54		0.00		0.54
Uptake 2	30-Jul-08	18:34	303	C13	28.6	31.50	4.19	1.52	4.95		0.00		4.95
Uptake 2	30-Jul-08	18:48	317	C14	28.7	27.50	15.75	1.92	0.73		0.00		0.73

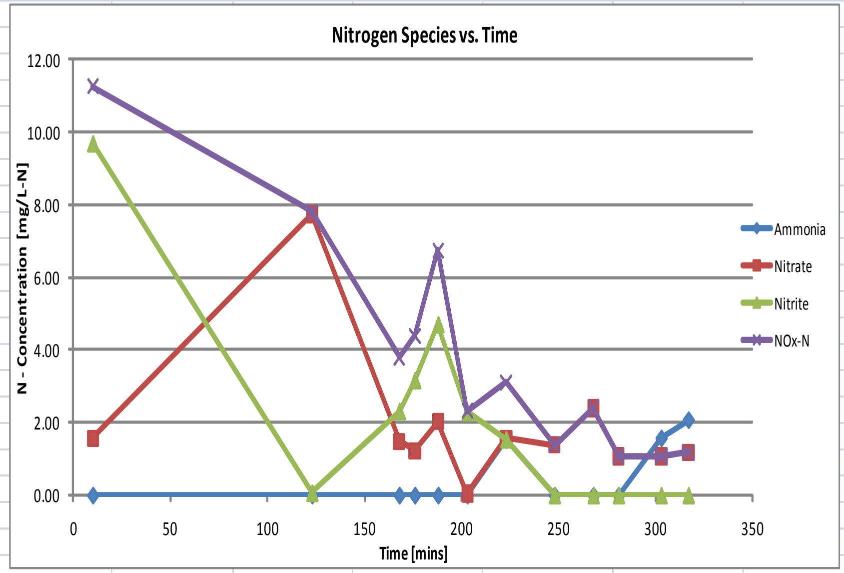




Reactor D: VIP Activated Sludge/VIP SE

Phosphorus Test	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Phosphate by TNT	Phosphate by AQ2 SEAL	Ammonia by AQ2 SEAL	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L P	mg/l P	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/L NOx-N
Uptake 1	30-Jul-08	13:42	10	D1	28.5	35.50	20.28	0.00	1.57		9.70		11.27
Uptake 1	30-Jul-08	15:35	123	D2	28.6	13.50	8.42	0.00	7.75		0.07		7.81
Release	30-Jul-08	16:20	168	D5	28.6	23.50	8.46	0.00	1.48		2.32		3.80
Release	30-Jul-08	16:28	176	D6	28.6	34.00	17.90	0.00	1.23		3.17		4.40
Release	30-Jul-08	16:40	188	D7	28.5	46.00	9.04	0.00	2.03		4.71		6.74
Release	30-Jul-08	16:55	203	D8	28.44	56.00	22.44	0.00	0.04		2.29		2.33
Release	30-Jul-08	17:15	223	D9	28.7	61.00	28.26	1.52	1.57		1.54		3.11
Uptake 2	30-Jul-08	17:40	248	D10	28.6	54.00	30.81	0.00	1.39		0.00		1.39
Uptake 2	30-Jul-08	18:00	268	D11	28.5	43.00	15.45	0.00	2.39		0.00		2.39
Uptake 2	30-Jul-08	18:13	281	D12	28.4	39.00	10.31	0.00	1.07		0.00		1.07
Uptake 2	30-Jul-08	18:35	303	D13	28.6	31.50	4.97	1.56	1.07		0.00		1.07
Uptake 2	30-Jul-08	18:49	317	D14	28.6	28.00	16.51	2.06	1.18		0.00		1.18

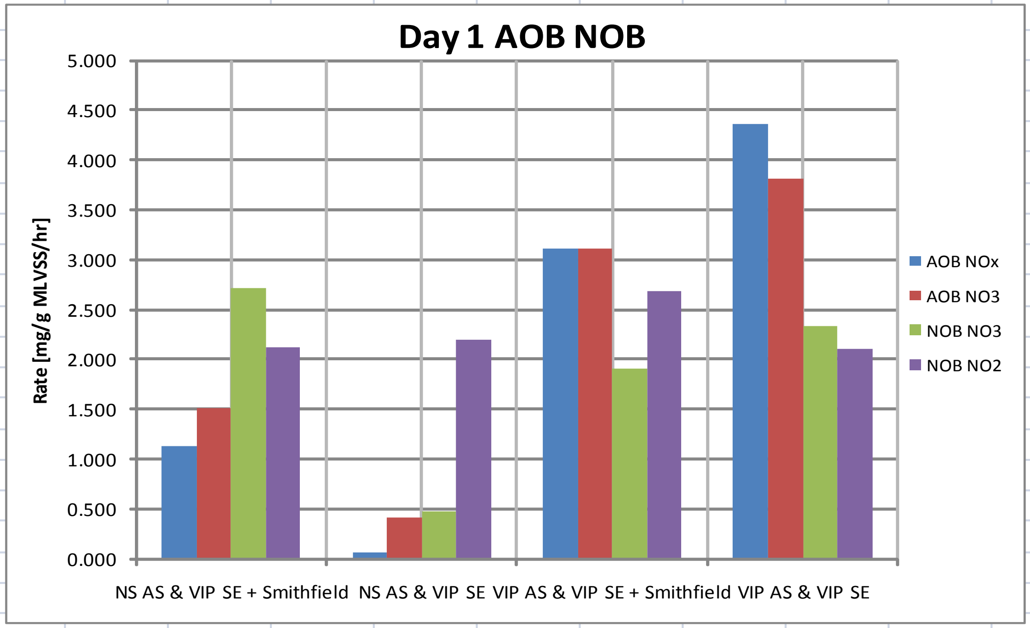




Summary	Experiment	PO_4 Slope (SEAL)	PO_4 Slope (TNT)	os Rate PO_4 (SEA	Phos Rate PO_4 (TNT	OUR	SOUR	MLSS	MLVSS	Average NO_2^-
		mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L	mg/L
Reactor A: NS										
activated sludge	Uptake	-0.139	-0.162	-6.303	-7.376	0.292	13.25	1890.00	1320.00	5.96
VIP Secondary	Release	-0.181	0.475	-8.223	21.592	0.000	0.00	1890.00	1320.00	3.48
Smithfield	Uptake	0.074	0.023	3.386	1.025	0.442	20.10	1890.00	1320.00	5.71
Reactor B: NS										
Activated Sludge	Uptake	-0.133	-0.150	-6.776	-7.650	0.251	12.76	1655.00	1180.00	3.65
VIP Secondary	Release	-0.081	0.402	-4.100	20.464	0.000	0.00	1655.00	1180.00	2.20
Effluent	Uptake	0.006	0.017	0.294	0.880	0.401	20.38	1655.00	1180.00	3.44
Reactor C: VIP										
Activated Sludge	Uptake	-0.176	-0.175	-6.244	-6.216	0.341	12.08	2173.33	1693.33	3.28
VIP Secondary	Release	0.219	1.072	7.744	37.987	0.000	0.00	2173.33	1693.33	1.58
Smithfield	Uptake	-0.363	-0.378	-12.854	-13.382	0.610	21.61	2173.33	1693.33	0.00
Reactor D: VIP										
Activated Sludge	Uptake	-0.105	-0.195	-3.713	-6.885	0.374	13.24	2433.33	1696.67	4.88
VIP Secondary	Release	0.285	0.918	10.073	32.477	0.000	0.00	2433.33	1696.67	3.12
Effluent	Uptake	-0.463	-0.369	-16.357	-13.035	0.519	18.34	2433.33	1696.67	0.00

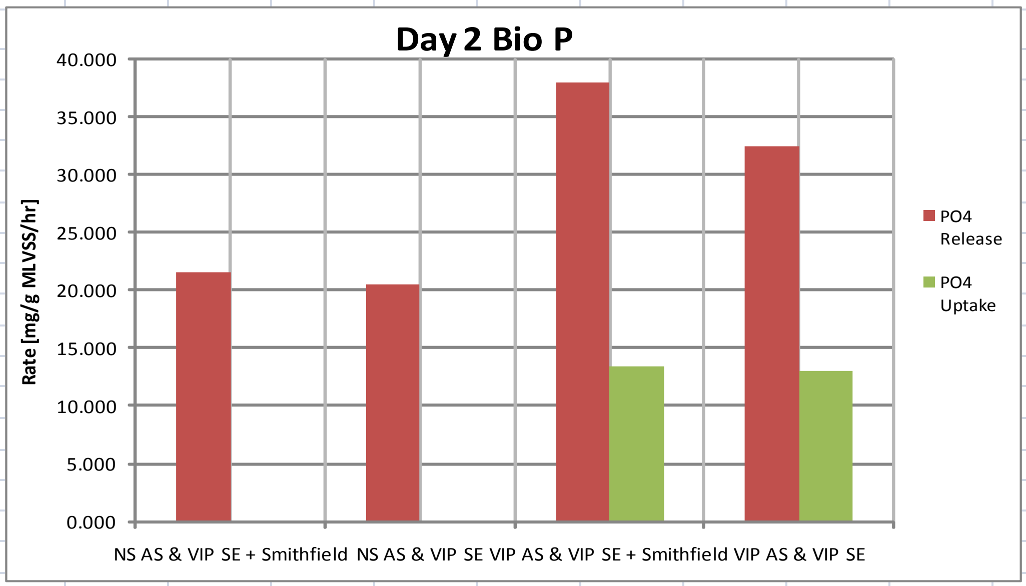
Day 1 AOB NOB

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP Secondary Smithfield	1.127	1.508	2.722	2.115
Reactor B: NS Activated Sludge VIP Secondary Effluent	0.071	0.416	0.479	2.191
Reactor C: VIP Activated Sludge VIP Secondary Smithfield	3.106	3.113	1.915	2.692
Reactor D: VIP Activated Sludge VIP Secondary Effluent	4.359	3.812	2.328	2.111



Day 2 Bio P

	Release	Uptake
Reactor A: NS Activated sludge VIP Secondary Smithfield	21.592	0.000
Reactor B: NS Activated Sludge VIP Secondary Effluent	20.464	0.000
Reactor C: VIP Activated Sludge VIP Secondary Smithfield	37.987	13.382
Reactor D: VIP Activated Sludge VIP Secondary Effluent	32.477	13.035



Week 6 – Landfill Leachate Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

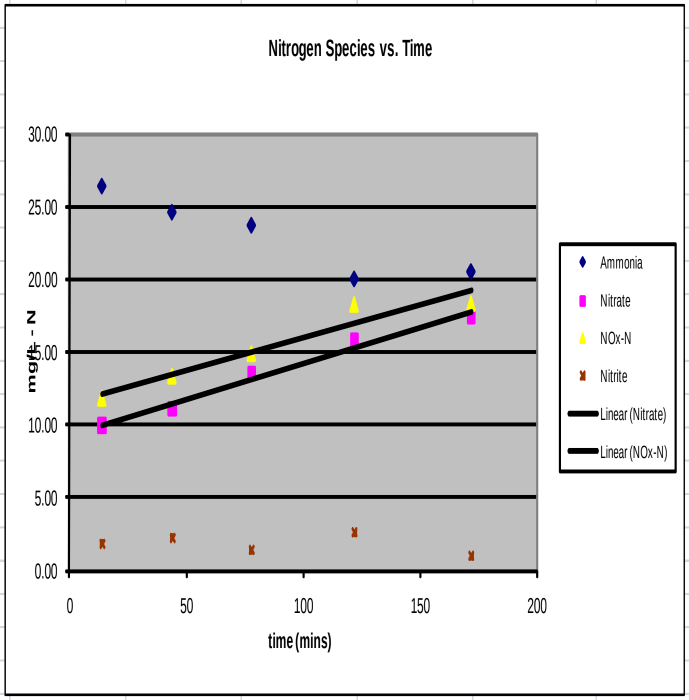
a. Spiked four 3L reactors with 30 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors A and C which incorporated leachate addition were spiked with 15 mL of the SPSA leachate (1:135 dilution) based on plant flow.

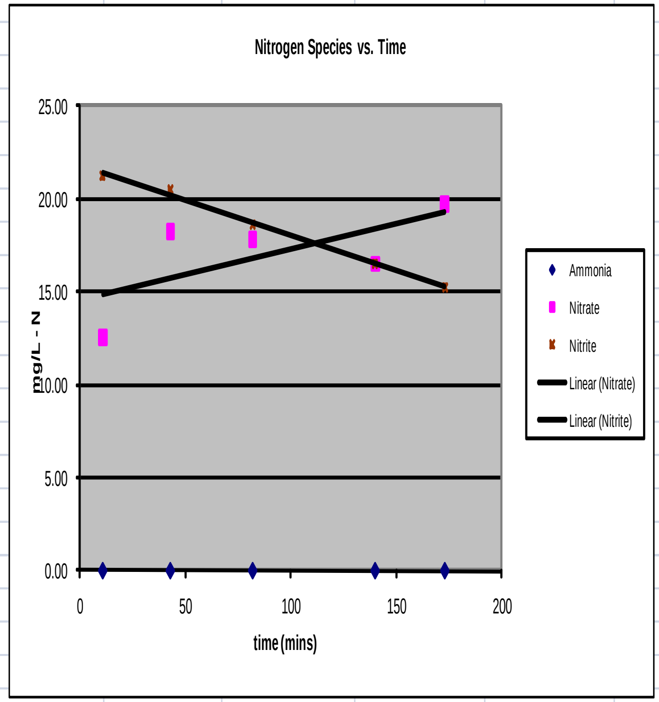
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors A and C which incorporated leachate addition were spiked with 15 mL of the SPSA leachate (1:135 dilution) based on plant flow.

Reactor A: Nansemond Activated Sludge/VIP SE + Leachate

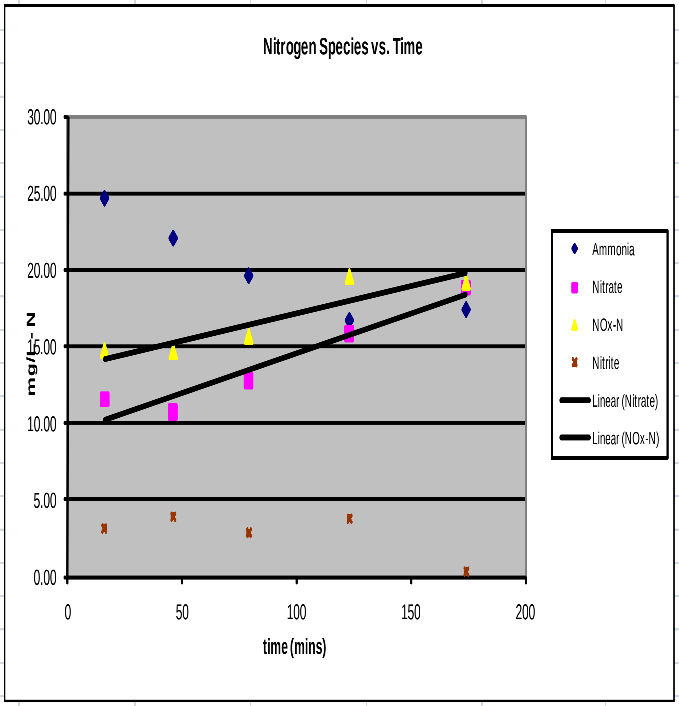
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	5-Aug-08	10:05	14	A1	28.1	26.03	26.40	9.96		1.83		2.24	11.79
Ammonia	5-Aug-08	10:35	44	A2	29	25.77	24.60	11.10		2.24		2.00	13.34
Ammonia	5-Aug-08	11:09	78	A3	29.7	23.09	23.70	13.50		1.40		2.14	14.90
Ammonia	5-Aug-08	11:53	122	A4	30.1	21.08	20.00	15.71		2.62		2.40	18.32
Ammonia	5-Aug-08	12:43	172	A5	30.4	18.91	20.50	17.41		0.97		2.71	18.38
Nitrite	5-Aug-08	17:08	11	A6	30.2	0.00	-	12.56		21.24		2.87	33.80
Nitrite	5-Aug-08	17:40	43	A7	30.2	0.00	-	18.28		20.49		3.68	38.77
Nitrite	5-Aug-08	18:19	82	A8	30.4	0.00	-	17.86		18.62		4.06	36.48
Nitrite	5-Aug-08	19:17	140	A9	30.5	0.00	-	16.52		16.51		4.90	33.04
Nitrite	5-Aug-08	19:50	173	A10	30.4	0.00	-	19.74		15.25		5.09	34.99

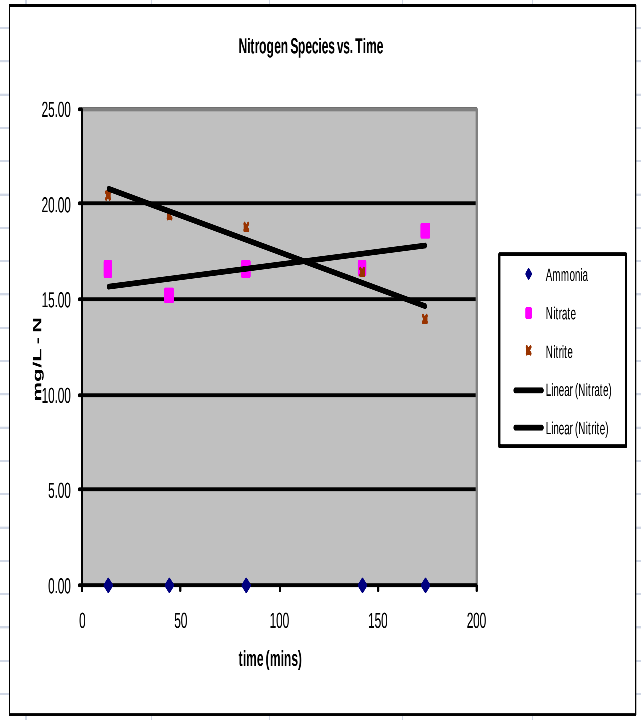




Reactor B: Nansemond Activated Sludge/VIP SE

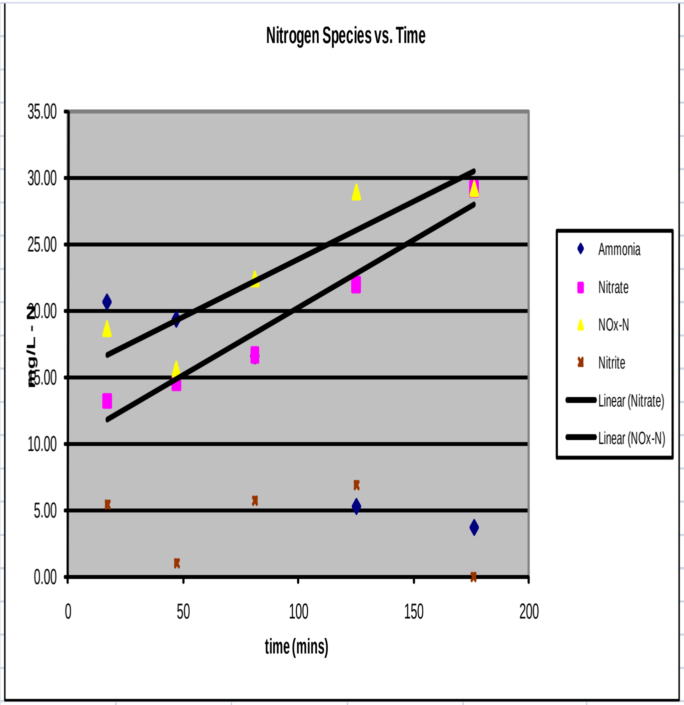
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	5-Aug-08	10:08	16	B1	28.2	26.08	24.70	11.56		3.15		2.86	14.71
Ammonia	5-Aug-08	10:38	46	B2	29.1	22.28	22.10	10.73		3.90		3.06	14.63
Ammonia	5-Aug-08	11:11	79	B3	29.8	22.60	19.65	12.80		2.83		3.17	15.63
Ammonia	5-Aug-08	11:55	123	B4	30.2	17.58	16.75	15.79		3.78		3.56	19.57
Ammonia	5-Aug-08	12:46	174	B5	30.5	17.16	17.45	18.84		0.34		3.99	19.18
Nitrite	5-Aug-08	17:11	13	B6	30.4	0.00	-	16.58		20.50		4.07	37.08
Nitrite	5-Aug-08	17:42	44	B7	30.3	0.00	-	15.20		19.38		4.49	34.58
Nitrite	5-Aug-08	18:21	83	B8	30.6	0.00	-	16.57		18.81		4.76	35.38
Nitrite	5-Aug-08	19:20	142	B9	30.6	0.00	-	16.65		16.41		5.42	33.06
Nitrite	5-Aug-08	19:52	174	B10	30.5	0.00	-	18.62		13.93		5.81	32.55

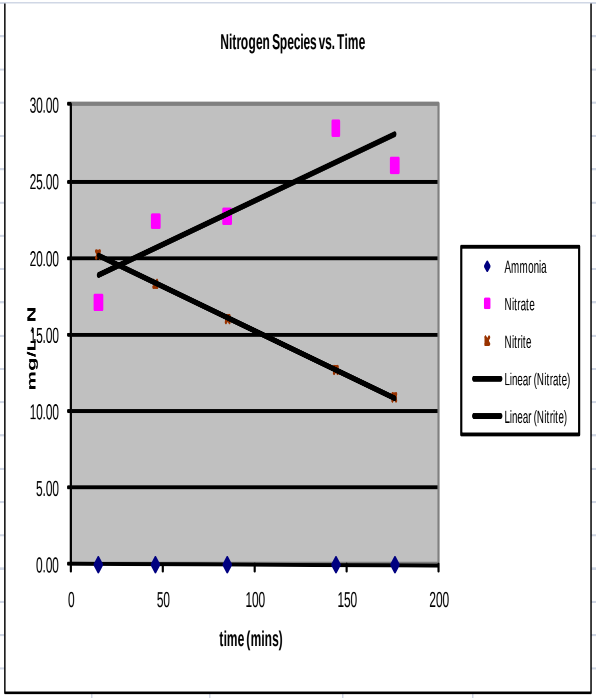




Reactor C: VIP Activated Sludge/VIP SE + Leachate

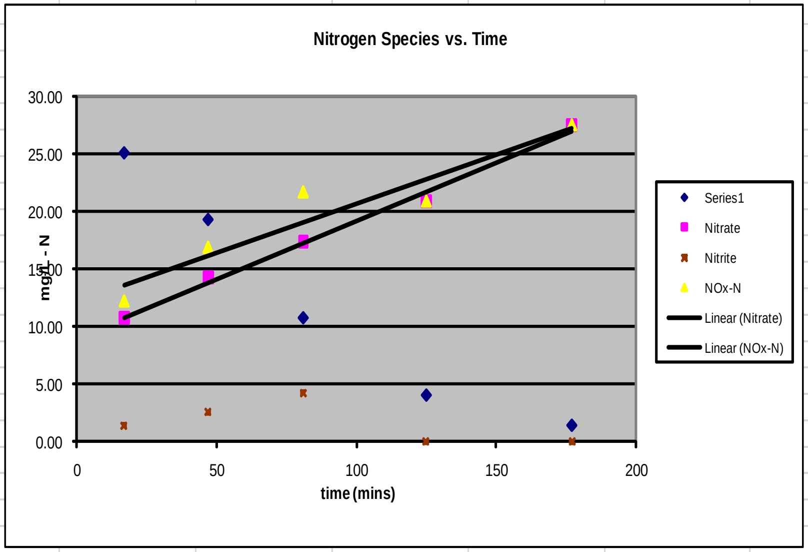
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	5-Aug-08	10:10	17	C1	28.3	23.91	20.60	13.17		5.43		0.13	18.59
Ammonia	5-Aug-08	10:40	47	C2	29.25	20.47	19.30	14.60		0.96		0.13	15.57
Ammonia	5-Aug-08	11:14	81	C3	29.8	16.52	16.55	16.62		5.70		0.33	22.32
Ammonia	5-Aug-08	11:58	125	C4	30.2	8.71	5.28	21.96		6.86		0.57	28.82
Ammonia	5-Aug-08	12:49	176	C5	30.3	0.00	3.70	29.08		0.00		2.02	29.08
Nitrite	5-Aug-08	17:13	15	C6	30.3	0.00	-	17.08		20.24		0.57	37.32
Nitrite	5-Aug-08	17:44	46	C7	30.2	0.00	-	22.40		18.27		1.42	40.67
Nitrite	5-Aug-08	18:23	85	C8	30.4	0.00	-	22.71		16.07		2.62	38.77
Nitrite	5-Aug-08	19:22	144	C9	30.5	0.00	-	28.44		12.73		4.01	41.17
Nitrite	5-Aug-08	19:54	176	C10	30.4	0.00	-	26.02		10.95		4.65	36.96

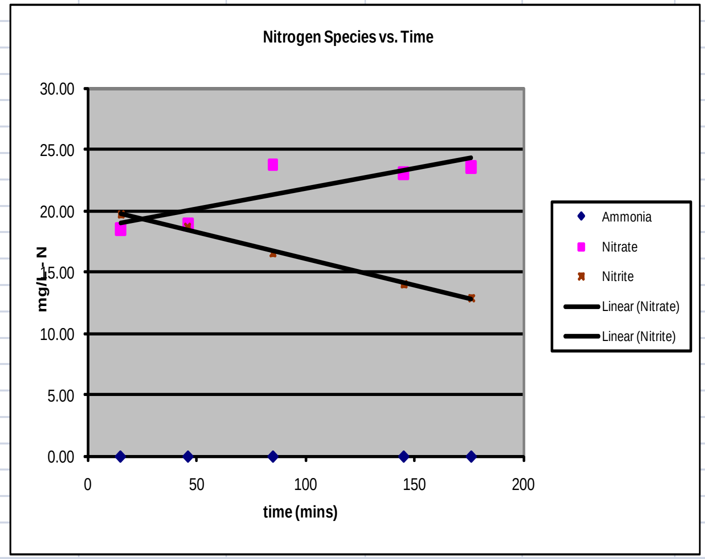




Reactor D: VIP Activated Sludge/VIP SE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	5-Aug-08	10:11	17	D1	28.3	25.16	25.20	10.77		1.44		0.75	12.22
Ammonia	5-Aug-08	10:41	47	D2	29.1	18.53	19.40	14.28		2.60		0.93	16.88
Ammonia	5-Aug-08	11:15	81	D3	29.7	11.71	10.85	17.39		4.31		1.24	21.70
Ammonia	5-Aug-08	11:59	125	D4	30.12	6.54	4.13	20.90		0.00		1.71	20.90
Ammonia	5-Aug-08	12:51	177	D5	30.3	0.00	1.50	27.53		0.00		2.40	27.53
Nitrite	5-Aug-08	17:14	15	D6	30	0.00	-	18.48		19.67		2.81	38.16
Nitrite	5-Aug-08	17:45	46	D7	29.9	0.00	-	18.94		18.67		3.25	37.61
Nitrite	5-Aug-08	18:24	85	D8	30.2	0.00	-	23.76		16.55		4.01	40.31
Nitrite	5-Aug-08	19:24	145	D9	30.3	0.00	-	23.11		14.02		4.92	37.13
Nitrite	5-Aug-08	19:55	176	D10	30.2	0.00	-	23.57		12.93		5.61	36.50





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.045	0.049		2.451	2.654		0.346	18.72	1830.00	1110.00
VIP Secondary	Nitrite		0.027	-0.038		1.472	-2.054	0.157	8.48	1830.00	1110.00
SPSA Leachate											
Reactor B: NS											
Activated Sludge	Ammonia	0.035	0.051		1.848	2.678		0.294	15.33	1890.00	1150.00
VIP Secondary	Nitrite		0.013	-0.038		0.694	-2.002	0.141	7.37	1890.00	1150.00
Effluent											
Reactor C: VIP											
Activated sludge	Ammonia	0.086	0.101		3.096	3.623		0.742	26.58	2147.50	1675.83
VIP Secondary	Nitrite		0.057	-0.057		2.046	-2.055	0.289	10.36	2147.50	1675.83
SPSA Leachate											
Reactor D: VIP											
Activated Sludge	Ammonia	0.086	0.101		2.820	3.336		0.604	19.92	2339.23	1820.00
VIP Secondary	Nitrite		0.033	-0.043		1.089	-1.423	0.291	9.58	2339.23	1820.00
Effluent											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 6 – Landfill Leachate Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

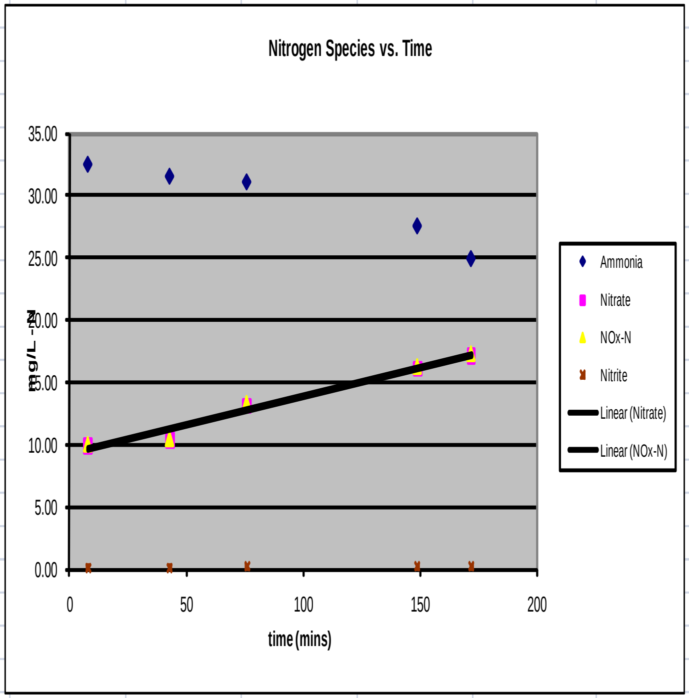
a. Spiked four 3L reactors with 30 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 1900 mL of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors A and C which incorporated leachate addition with 200 mL of the SPSA leachate (1:10 dilution) to simulate a slug load

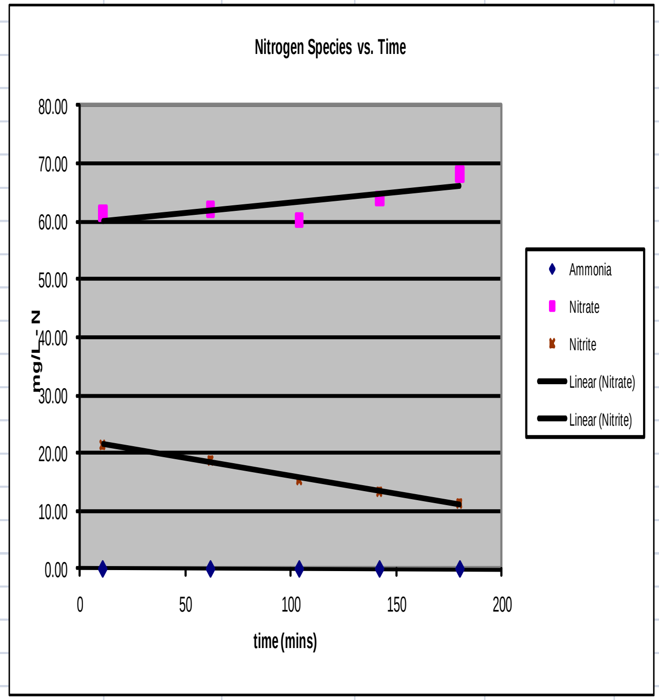
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors A and C which incorporated leachate addition with 200 mL of the SPSA leachate (1:10 dilution) to simulate a slug load

Reactor A: Nansemond Activated Sludge/VIP SE + Leachate

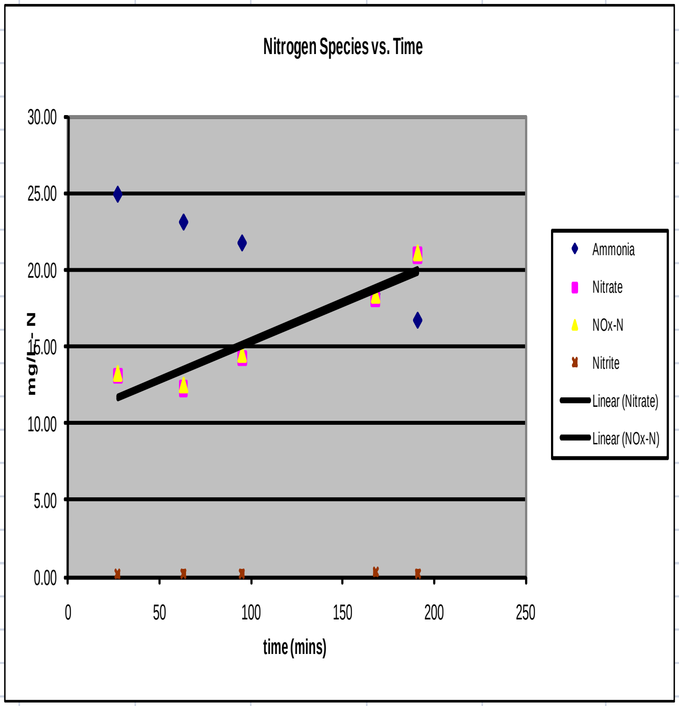
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	6-Aug-08	8:17	8	A1	24.95	33.07	32.50	9.89		0.13		8.09	10.02
Ammonia	6-Aug-08	8:52	43	A2	27.7	32.71	31.55	10.34		0.12		7.18	10.46
Ammonia	6-Aug-08	9:25	76	A3	28.9	31.42	31.10	13.12		0.19		4.57	13.32
Ammonia	6-Aug-08	10:38	149	A4	30.1	28.58	27.60	16.07		0.19		2.64	16.27
Ammonia	6-Aug-08	11:01	172	A5	30.3	26.54	25.00	17.13		0.17		2.32	17.30
Nitrite	7-Aug-08	6:48	11	A6	30.9	0.00	-	61.44		21.37		12.75	82.82
Nitrite	7-Aug-08	7:39	62	A7	30.9	0.00	-	62.02		18.74		12.48	80.75
Nitrite	7-Aug-08	8:21	104	A8	30.9	0.00	-	60.30		15.39		14.76	75.68
Nitrite	7-Aug-08	8:59	142	A9	30.9	0.00	-	63.93		13.44		14.80	77.37
Nitrite	7-Aug-08	9:37	180	A10	30.8	0.00	-	68.25		11.39		16.32	79.63

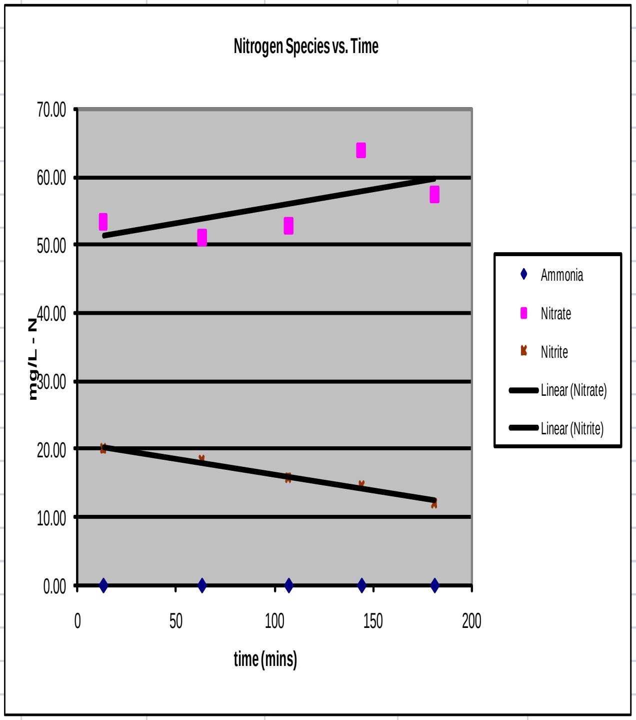




Reactor B: Nansemond Activated Sludge/VIP SE

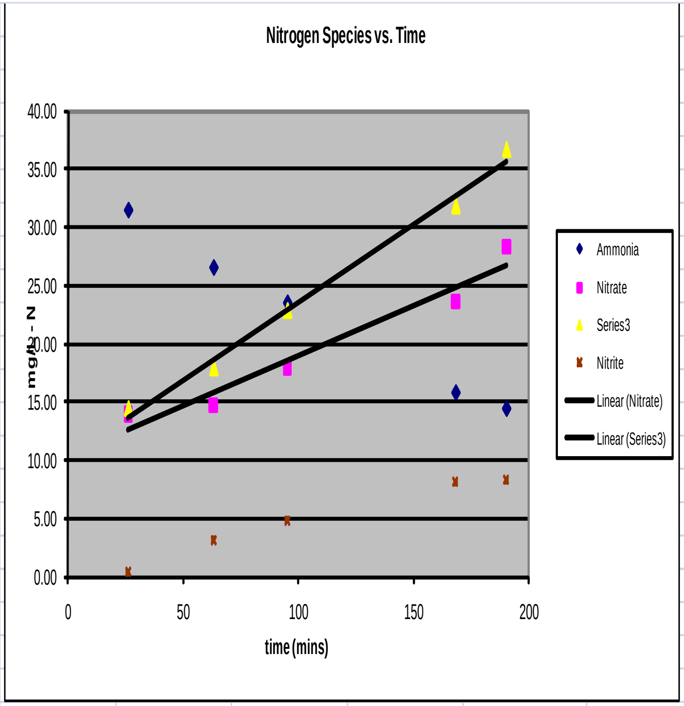
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	6-Aug-08	8:20	27	B1	30.1	30.45	24.90	13.07		0.15		7.09	13.21
Ammonia	6-Aug-08	8:56	63	B2	30.5	27.24	23.10	12.23		0.22		8.34	12.45
Ammonia	6-Aug-08	9:28	95	B3	30.6	23.90	21.75	14.22		0.23		7.92	14.46
Ammonia	6-Aug-08	10:41	168	B4	30.7	17.02	18.45	18.08		0.26		8.93	18.34
Ammonia	6-Aug-08	11:04	191	B5	30.8	17.00	16.75	20.91		0.21		8.55	21.12
Nitrite	7-Aug-08	6:51	13	B6	30.8	0.00	-	53.31		20.05		20.05	73.36
Nitrite	7-Aug-08	7:41	63	B7	30.9	0.00	-	51.04		18.38		21.12	69.41
Nitrite	7-Aug-08	8:25	107	B8	30.8	0.00	-	52.73		15.82		21.37	68.56
Nitrite	7-Aug-08	9:02	144	B9	30.8	0.00	-	63.91		14.54		21.98	78.45
Nitrite	7-Aug-08	9:39	181	B10	30.9	0.00	-	57.43		12.13		23.31	69.56

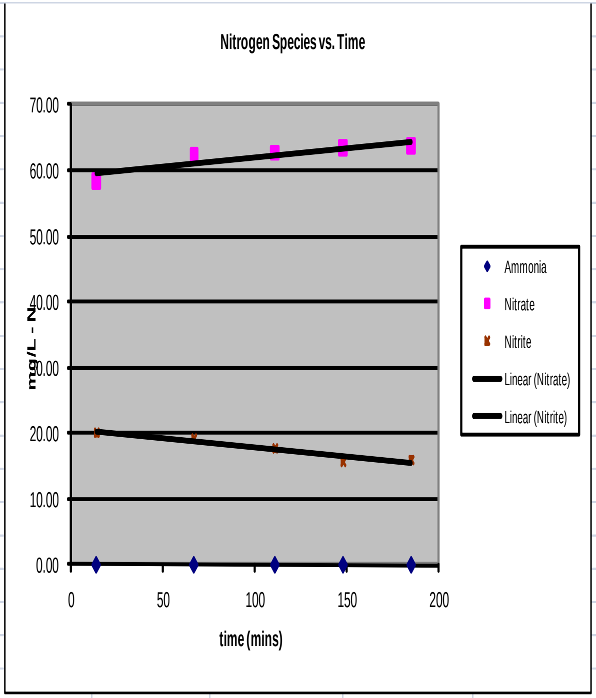




Reactor C: VIP Activated Sludge/VIP SE + Leachate

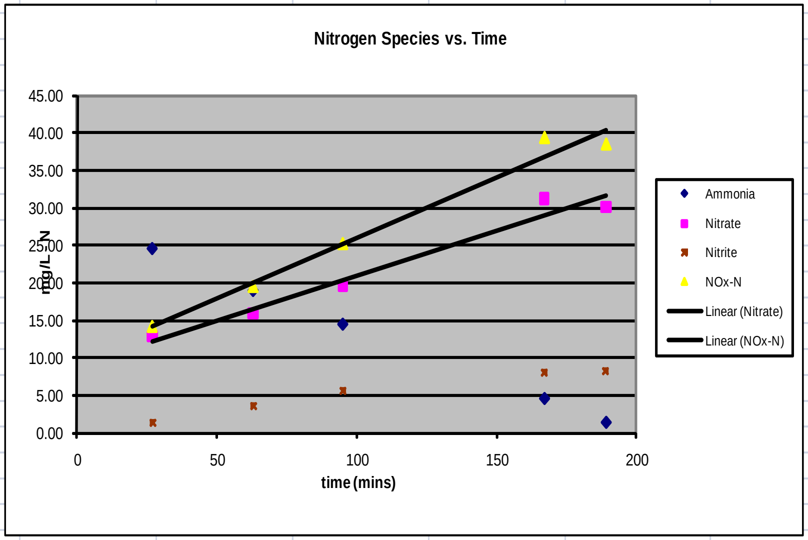
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	6-Aug-08	8:22	26	C1	29.975	33.12	31.50	13.94		0.42		1.76	14.36
Ammonia	6-Aug-08	8:59	63	C2	30.3	28.02	26.55	14.69		3.15		0.08	17.84
Ammonia	6-Aug-08	9:31	95	C3	30.3	23.51	23.50	17.91		4.86		0.14	22.77
Ammonia	6-Aug-08	10:44	168	C4	30.4	15.85	15.75	23.63		8.10		0.77	31.73
Ammonia	6-Aug-08	11:06	190	C5	30.4	14.33	14.38	28.30		8.29		1.93	36.59
Nitrite	7-Aug-08	6:53	14	C6	30.7	0.00	-	58.41		20.04		24.64	78.45
Nitrite	7-Aug-08	7:43	67	C7	30.7	0.00	-	62.17		19.19		24.24	81.36
Nitrite	7-Aug-08	8:27	111	C8	30.7	0.00	-	62.70		17.61		25.84	80.31
Nitrite	7-Aug-08	9:04	148	C9	30.8	0.00	-	63.44		15.70		24.72	79.14
Nitrite	7-Aug-08	9:41	185	C10	30.8	0.00	-	63.80		16.03		25.72	79.83

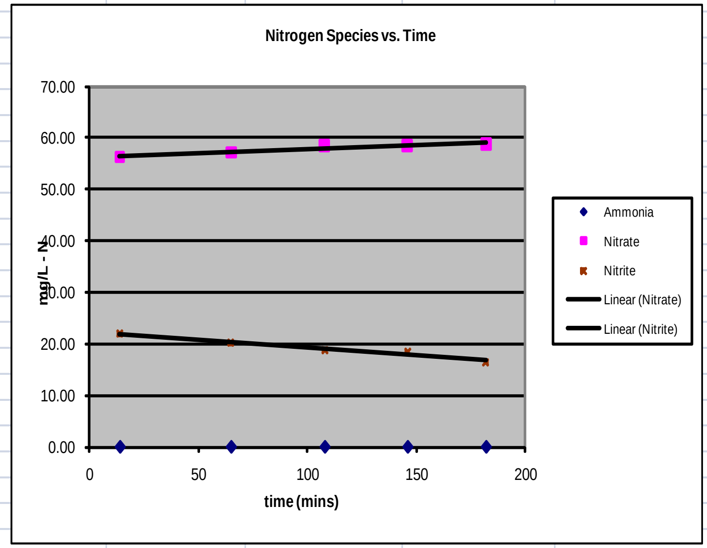




Reactor D: VIP Activated Sludge/VIP SE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	6-Aug-08	8:25	27	D1	30.4	26.85	24.50	12.90		1.36		3.06	14.25
Ammonia	6-Aug-08	9:01	63	D2	30.3	21.40	18.90	15.93		3.62		3.16	19.55
Ammonia	6-Aug-08	9:33	95	D3	30.35	15.66	14.40	19.57		5.66		3.36	25.23
Ammonia	6-Aug-08	10:45	167	D4	30.3	3.82	4.48	31.16		8.10		4.10	39.26
Ammonia	6-Aug-08	11:07	189	D5	30.4	0.00	1.29	30.11		8.29		4.59	38.40
Nitrite	7-Aug-08	6:54	14	D6	30.7	0.00	-	56.28		21.96		16.79	78.24
Nitrite	7-Aug-08	7:45	65	D7	30.6	0.00	-	57.14		20.15		17.56	77.29
Nitrite	7-Aug-08	8:28	108	D8	30.6	0.00	-	58.44		18.78		18.08	77.22
Nitrite	7-Aug-08	9:06	146	D9	30.6	0.00	-	58.53		18.44		18.32	76.97
Nitrite	7-Aug-08	9:42	182	D10	30.7	0.00	-	58.69		16.44		19.03	75.13



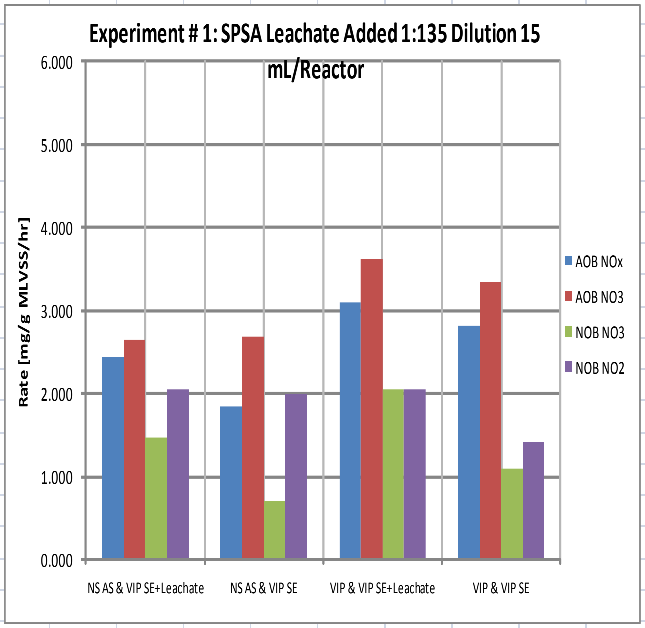


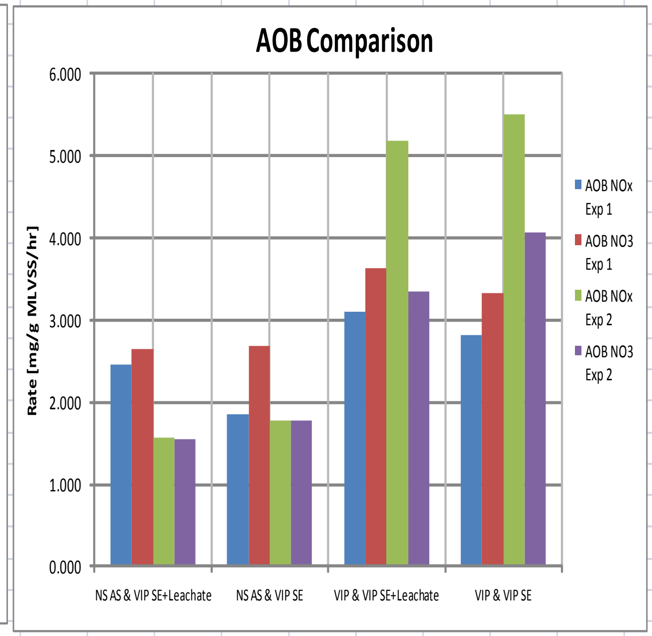
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.047	0.046		1.565	1.553		0.346	11.58	3015.00	1795.00
VIP Secondary	Nitrite		0.036	-0.060		1.190	-2.022	0.157	5.24	3015.00	1795.00
SPSA Leachate											
Reactor B: NS											
Activated Sludge	Ammonia	0.050	0.050		1.782	1.769		0.294	10.37	2880.00	1700.00
VIP Secondary	Nitrite		0.049	-0.047		1.740	-1.657	0.141	4.99	2880.00	1700.00
Effluent											
Reactor C: VIP											
Activated sludge	Ammonia	0.134	0.086		5.189	3.345		0.742	28.74	2005.00	1550.00
VIP Secondary	Nitrite		0.029	-0.027		1.139	-1.053	0.289	11.20	2005.00	1550.00
SPSA Leachate											
Reactor D: VIP											
Activated Sludge	Ammonia	0.162	0.119		5.508	4.061		0.604	20.60	2280.00	1760.00
VIP Secondary	Nitrite		0.015	-0.031		0.517	-1.043	0.291	9.90	2280.00	1760.00
Effluent											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

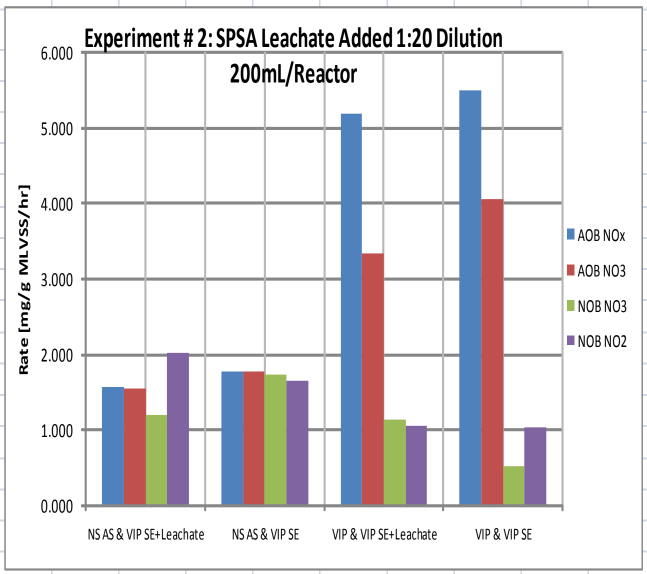
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE SPSA Leachate	2.451	2.654	1.472	2.054
Reactor B: NS Activated Sludge VIP SE	1.848	2.678	0.694	2.002
Reactor C: VIP Activated Sludge VIP SE SPSA Leachate	3.096	3.623	2.046	2.055
Reactor D: VIP Activated Sludge VIP SE	2.820	3.336	1.089	1.423

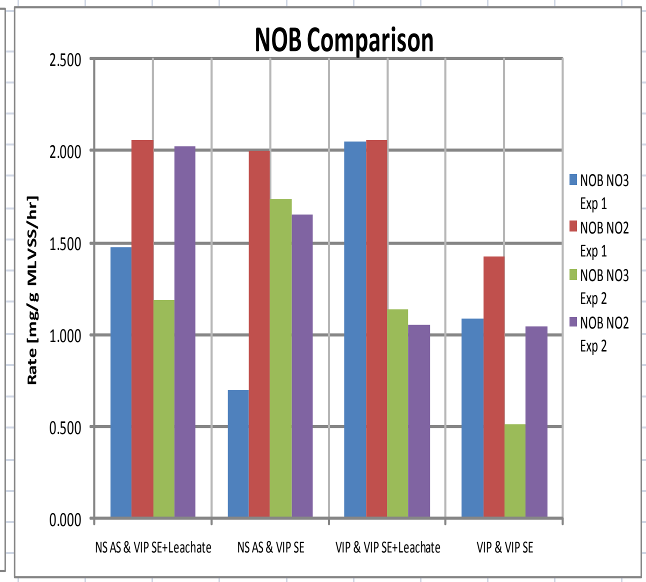




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE SPSA Leachate	1.565	1.553	1.190	2.022
Reactor B: NS Activated Sludge VIP SE	1.782	1.769	1.740	1.657
Reactor C: VIP Activated Sludge VIP SE SPSA Leachate	5.189	3.345	1.139	1.053
Reactor D: VIP Activated Sludge VIP SE	5.508	4.061	0.517	1.043





Week 7 – Branches of Collection System Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

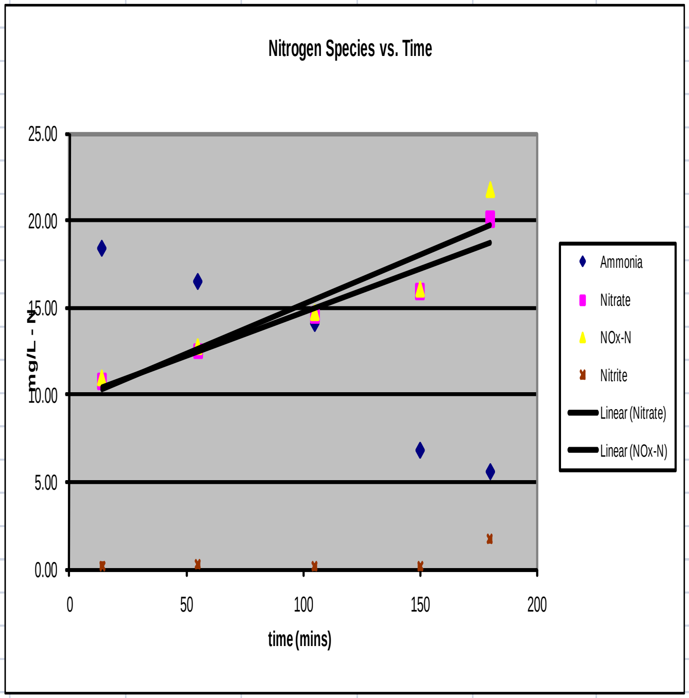
a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated Branch lines for each reactor.

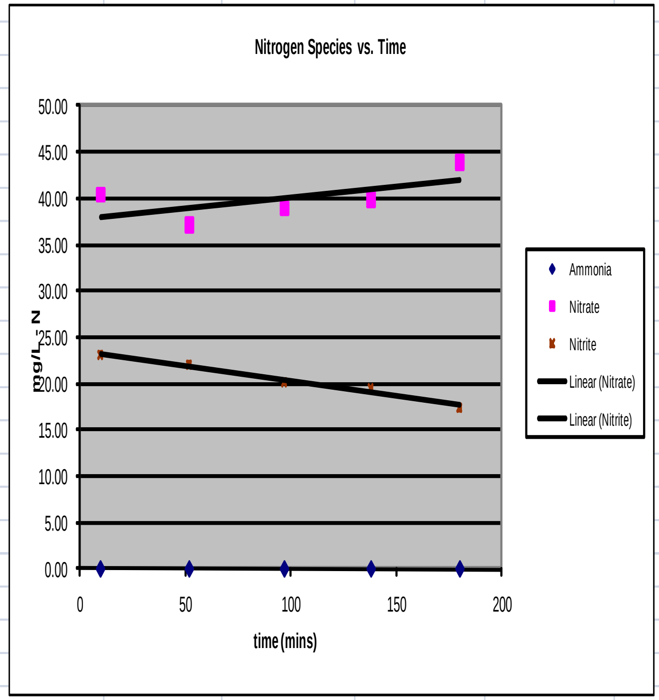
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated Branch lines for each reactor.

Reactor A: Nansemond Activated Sludge/VIP SE

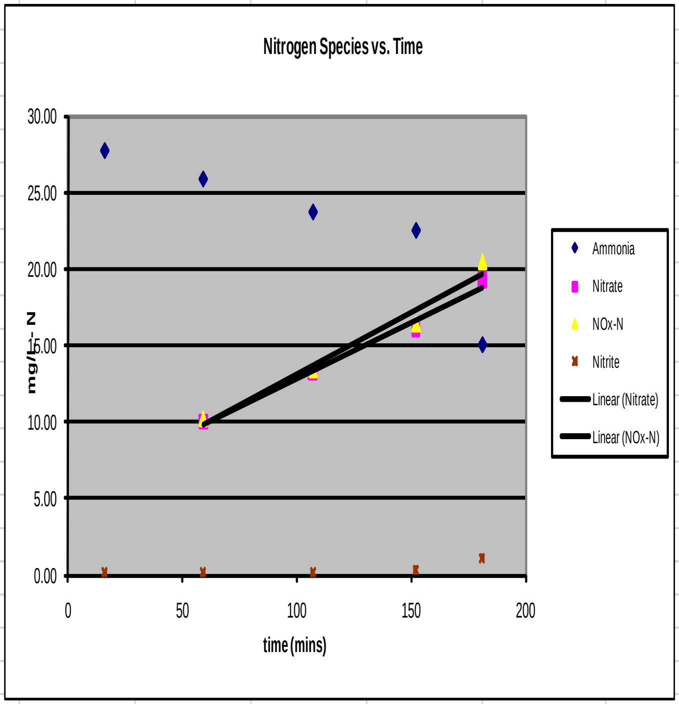
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	12-Aug-08	8:37	14	A1	29.9	25.00	18.40	10.76		0.17		2.01	10.93
Ammonia	12-Aug-08	9:18	55	A2	30.8	20.57	16.50	12.51		0.23		2.27	12.73
Ammonia	12-Aug-08	10:08	105	A3	30.4	19.48	14.10	14.56		0.13		2.41	14.69
Ammonia	12-Aug-08	10:53	150	A4	30.3	13.56	6.85	15.90		0.14		2.70	16.04
Ammonia	12-Aug-08	11:23	180	A5	30.2	15.14	5.63	20.07		1.70		3.07	21.77
Nitrite	13-Aug-08	6:52	10	A6	30.1	0.00	-	40.37		23.11		14.52	63.48
Nitrite	13-Aug-08	7:34	52	A7	30.25	0.00	-	37.07		22.12		12.02	59.19
Nitrite	13-Aug-08	8:19	97	A8	30.225	0.00	-	38.95		20.25		12.45	59.20
Nitrite	13-Aug-08	9:00	138	A9	30.3	0.00	-	39.91		19.43		16.59	59.34
Nitrite	13-Aug-08	9:42	180	A10	30.3	0.00	-	43.89		17.40		17.08	61.29

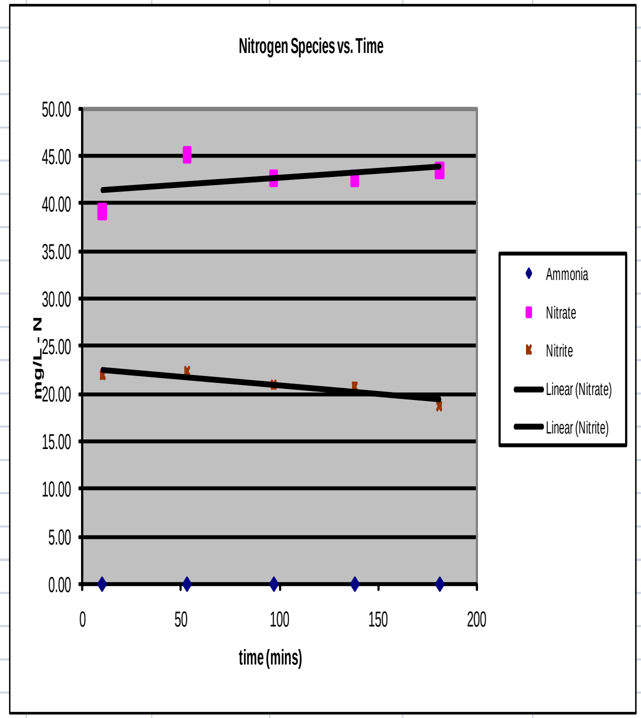




Reactor B: Nansemond Activated Sludge/VIP SE + Branch 1

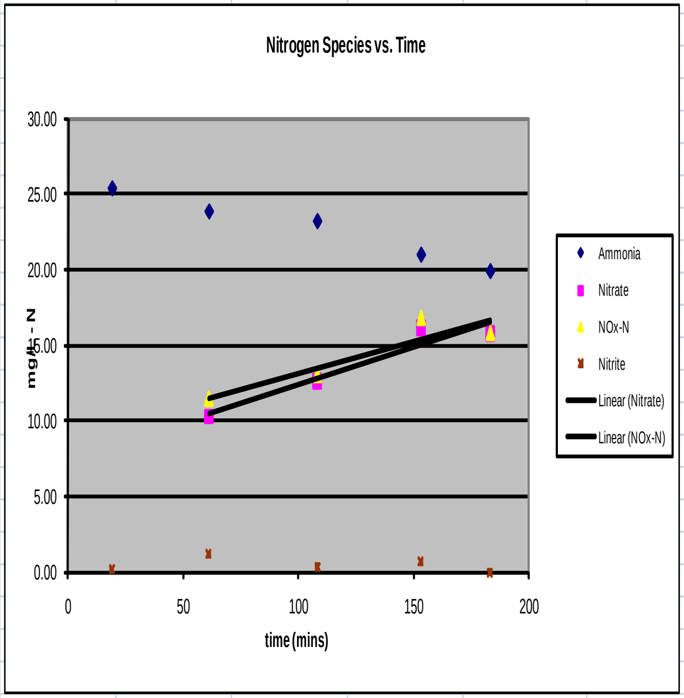
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	12-Aug-08	8:40	16	B1	30.0	29.21	27.70	17.65		0.17		7.87	17.82
Ammonia	12-Aug-08	9:23	59	B2	30.4	25.83	25.85	10.02		0.17		3.57	10.19
Ammonia	12-Aug-08	10:11	107	B3	30.4	21.44	23.70	13.23		0.15		1.96	13.38
Ammonia	12-Aug-08	10:56	152	B4	30.3	27.04	22.50	16.00		0.37		1.33	16.37
Ammonia	12-Aug-08	11:25	181	B5	30.2	15.08	15.05	19.31		1.11		1.13	20.41
Nitrite	13-Aug-08	6:53	10	B6	30.2	0.00	-	39.19		21.92		9.53	61.12
Nitrite	13-Aug-08	7:36	53	B7	30.3	0.00	-	45.08		22.38		9.96	67.46
Nitrite	13-Aug-08	8:20	97	B8	30.4	0.00	-	42.66		20.88		10.49	63.53
Nitrite	13-Aug-08	9:01	138	B9	30.3	0.00	-	42.63		20.79		11.80	63.42
Nitrite	13-Aug-08	9:44	181	B10	30.4	0.00	-	43.46		18.74		12.75	62.21

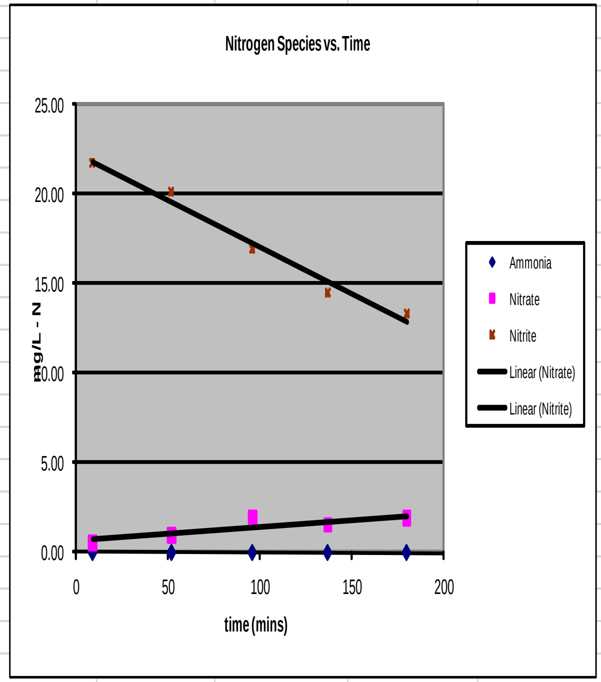




Reactor C: Nansemond Activated Sludge/VIP SE + Branch 2

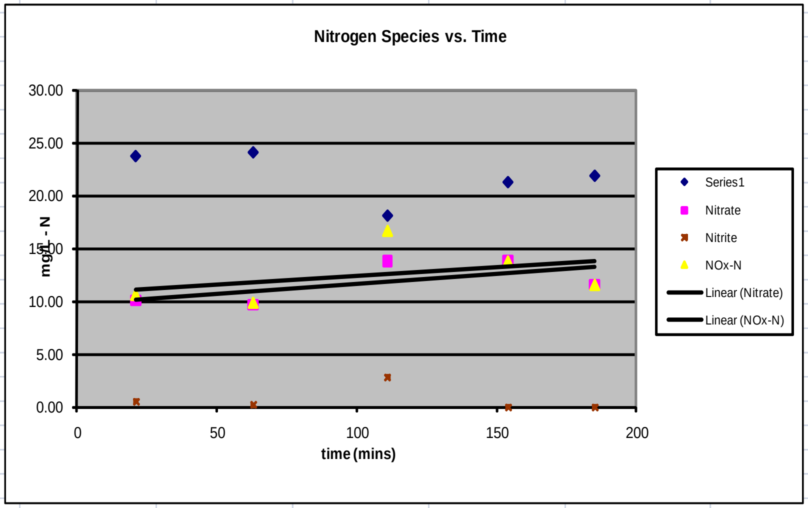
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	12-Aug-08	8:44	19	C1	29.8	30.53	25.40	14.28		0.17		7.53	14.45
Ammonia	12-Aug-08	9:26	61	C2	30.1	25.56	23.85	10.27		1.17		5.02	11.43
Ammonia	12-Aug-08	10:13	108	C3	30.08	24.72	23.20	12.63		0.36		3.69	12.99
Ammonia	12-Aug-08	10:58	153	C4	30.05	27.69	20.95	16.11		0.66		3.36	16.77
Ammonia	12-Aug-08	11:28	183	C5	30.08	0.00	19.85	15.78		0.00		2.86	15.78
Nitrite	13-Aug-08	6:54	9	C6	30.1	0.00	-	0.53		21.76		2.70	22.29
Nitrite	13-Aug-08	7:37	52	C7	30.2	0.00	-	0.98		20.12		2.59	21.11
Nitrite	13-Aug-08	8:21	96	C8	30.2	0.00	-	1.96		16.97		2.34	18.93
Nitrite	13-Aug-08	9:02	137	C9	30.2	0.00	-	1.55		14.50		2.95	16.06
Nitrite	13-Aug-08	9:45	180	C10	30.2	0.00	-	1.90		13.34		3.69	15.24

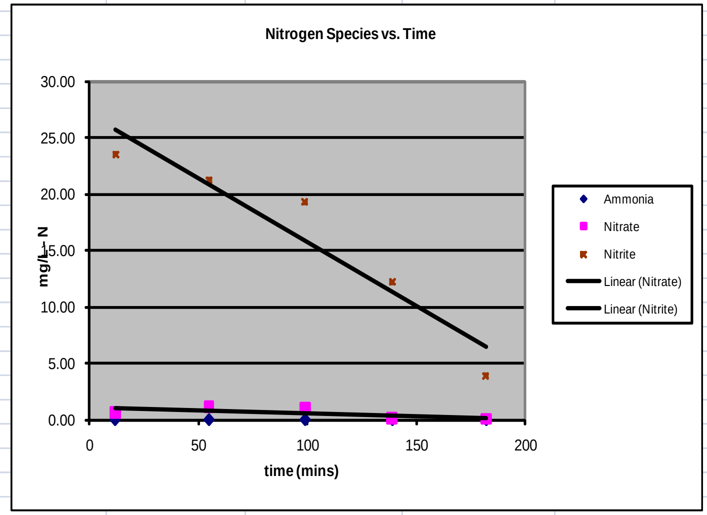




Reactor D: Nansemond Activated Sludge/VIP SE + Branch 3

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	12-Aug-08	8:47	21	D1	30.6	25.01	23.70	10.06		0.54		11.63	10.60
Ammonia	12-Aug-08	9:29	63	D2	29.8	19.56	24.05	9.65		0.20		17.26	9.86
Ammonia	12-Aug-08	10:17	111	D3	29.7	17.02	18.10	13.82		2.82		15.54	16.64
Ammonia	12-Aug-08	11:00	154	D4	29.6	16.64	21.25	13.75		0.00		22.52	13.75
Ammonia	12-Aug-08	11:31	185	D5	29.76	0.00	21.85	11.54		0.00		27.72	11.54
Nitrite	13-Aug-08	6:57	12	D6	29.9	0.00	-	0.62		23.51		0.00	24.14
Nitrite	13-Aug-08	7:40	55	D7	30	0.00	-	1.14		21.22		19.12	22.36
Nitrite	13-Aug-08	8:24	99	D8	30	0.00	-	1.06		19.27		21.34	20.32
Nitrite	13-Aug-08	9:04	139	D9	30.1	0.00	-	0.12		12.18		21.20	12.29
Nitrite	13-Aug-08	9:47	182	D10	30.1	0.00	-	0.06		3.91		76.97	3.97





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.057	0.051		2.354	2.090		0.292	12.09	2385.00	1450.00
VIP SE	Nitrite		0.023	-0.033		0.956	-1.371	0.108	4.48	2385.00	1450.00
Reactor B: NS											
Activated Sludge	Ammonia	0.080	0.074		3.600	3.293		0.441	19.75	2180.00	1340.00
VIP SE	Nitrite		0.014	-0.019		0.641	-0.834	0.103	4.59	2180.00	1340.00
Branch 1											
Reactor C: NS											
Activated Sludge	Ammonia	0.042	0.050		1.004	1.185		0.476	11.30	3455.00	2530.00
VIP SE	Nitrite		0.008	-0.053		0.185	-1.248	0.846	20.07	3455.00	2530.00
Branch 2											
Reactor D: NS											
Activated Sludge	Ammonia	0.016	0.018		0.201	0.232		0.475	6.02	5540.00	4740.00
VIP SE	Nitrite		-0.005	-0.113		-0.064	-1.436	0.282	3.57	5540.00	4740.00
Branch 3											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Note:
Reactor D was extremely difficult to filter, lot of foaming, very low DO (samples D9 and D10 DO was below 2), and very greasy

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

a. Spiked four 3L reactors with 20 mg/L NH_4 .

b. Each reactor is running continously by use of stir bars .

c. 1900 mL of the diluent source is added to the reactors.

d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.

e. Constant DO and pH were monitored and logged throughout the experiment.

f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.

g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters

i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated Branch lines for each reactor.

II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.

b. Each reactor is running continously by use of stir bars .

c. Constant DO and pH were monitored and logged throughout the experiment.

d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.

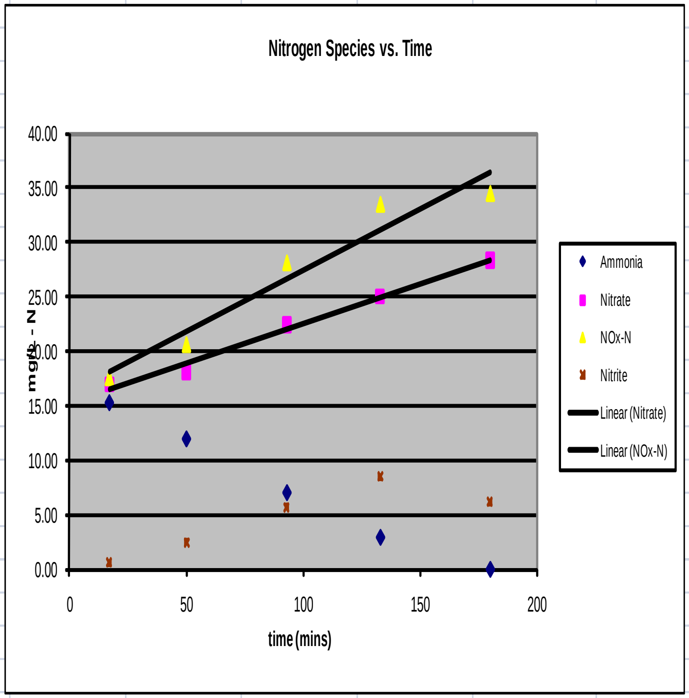
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

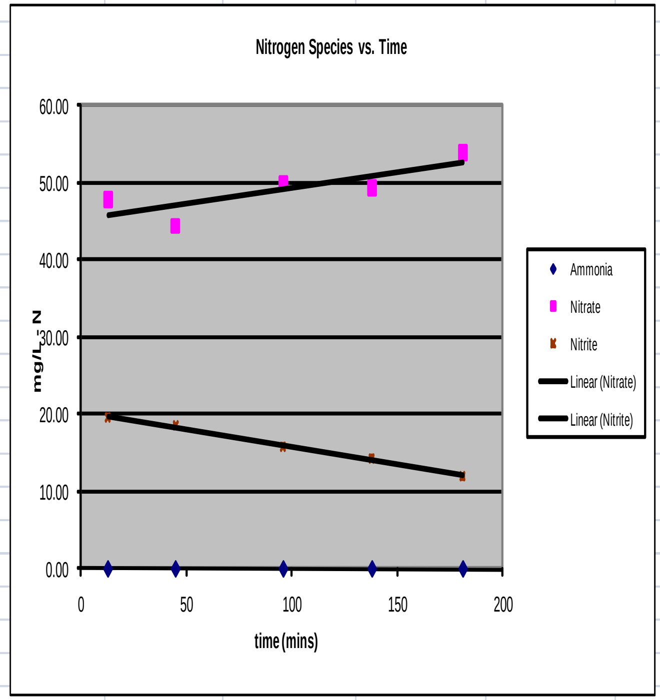
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.

g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated Branch lines for each reactor.

Reactor A: VIP Activated Sludge/VIP SE

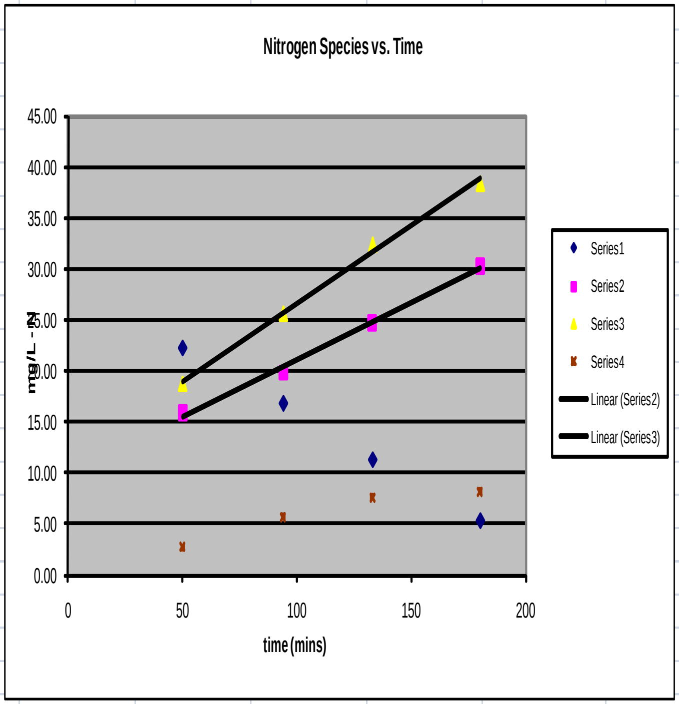
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Aug-08	12:45	17	A1	30.8	12.87	15.20	16.95		0.62		4.99	17.57
Ammonia	13-Aug-08	13:18	50	A2	30.7	15.69	11.90	18.14		2.47		5.04	20.61
Ammonia	13-Aug-08	14:01	93	A3	30.5	7.87	7.00	22.36		5.72		5.19	28.09
Ammonia	13-Aug-08	14:41	133	A4	30.4	1.4133ELL	2.93	25.00		8.44		5.89	33.44
Ammonia	13-Aug-08	15:28	180	A5	30.4	4.45	0.00	28.31		6.12		6.50	34.43
Nitrite	14-Aug-08	6:50	13	A6	29.9	0.00	-	47.93		19.74		15.78	67.67
Nitrite	14-Aug-08	7:22	45	A7	30.2	0.00	-	44.40		18.49		16.88	62.89
Nitrite	14-Aug-08	8:13	96	A8	30.5	0.00	-	49.99		15.92		17.71	65.91
Nitrite	14-Aug-08	8:55	138	A9	30.7	0.00	-	49.29		14.33		14.33	63.62
Nitrite	14-Aug-08	9:38	181	A10	30.7	0.00	-	53.84		12.01		18.53	65.85

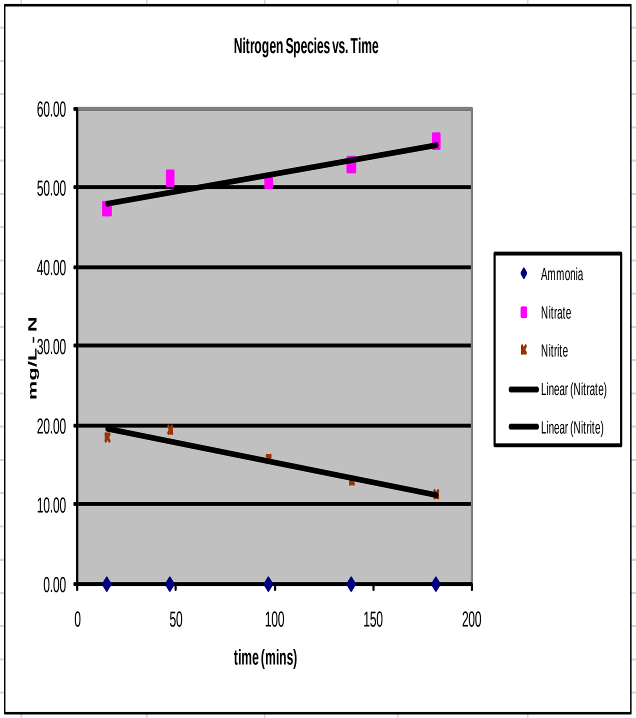




Reactor B: VIP Activated Sludge/VIP SE + Branch 1

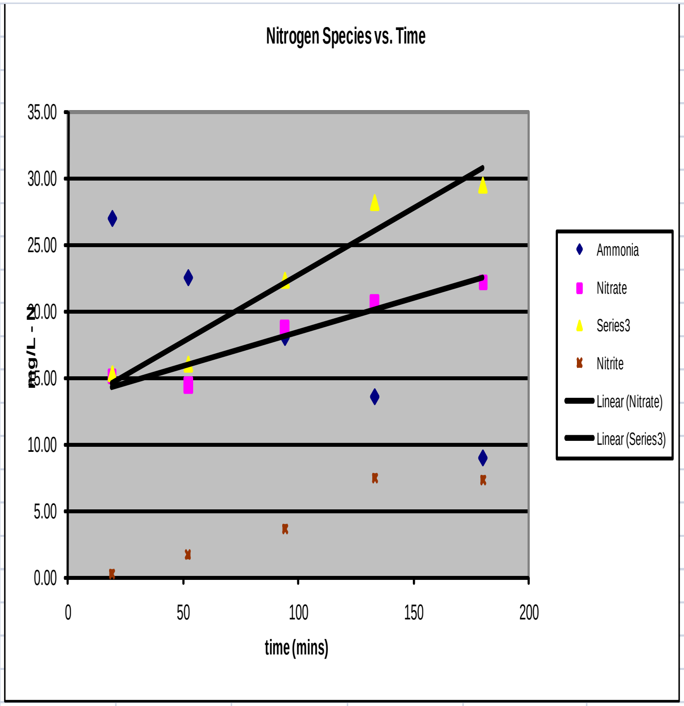
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Aug-08	12:48	19	B1	30.5	-	-	-		0.00		0.00	#VALUE!
Ammonia	13-Aug-08	13:19	50	B2	30.2	18.08	22.30	15.94		2.70		6.07	18.65
Ammonia	13-Aug-08	14:03	94	B3	30.3	10.98	16.85	19.84		5.73		4.39	25.57
Ammonia	13-Aug-08	14:42	133	B4	30.3	17.13	11.30	24.73		7.66		3.77	32.39
Ammonia	13-Aug-08	15:29	180	B5	30.3	3.28	5.30	30.27		8.14		3.75	38.41
Nitrite	14-Aug-08	6:52	15	B6	30.4	0.00	-	47.38		18.55		13.26	65.93
Nitrite	14-Aug-08	7:24	47	B7	30.6	0.00	-	51.15		19.45		14.23	70.60
Nitrite	14-Aug-08	8:14	97	B8	30.8	0.00	-	50.79		15.85		18.47	66.63
Nitrite	14-Aug-08	8:56	139	B9	30.8	0.00	-	52.96		12.99		15.20	65.94
Nitrite	14-Aug-08	9:39	182	B10	30.8	0.00	-	55.96		11.29		16.28	67.25

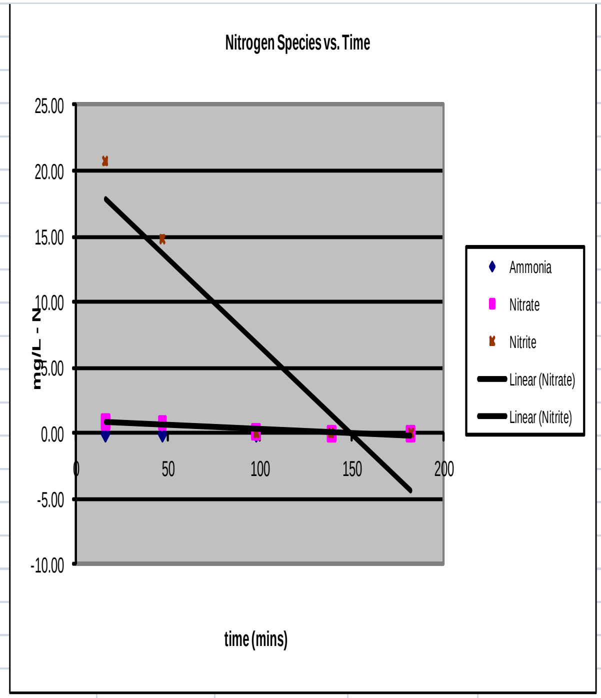




Reactor C: VIP Activated Sludge/VIP SE + Branch 2

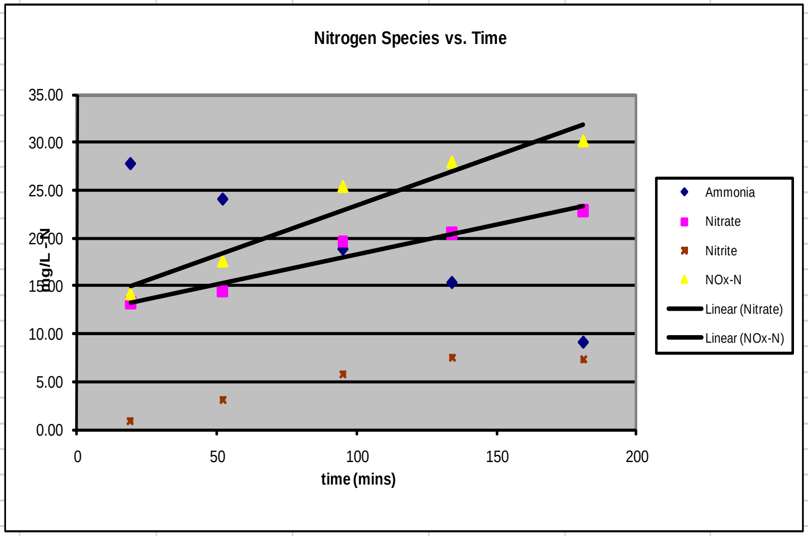
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Aug-08	12:49	19	C1	30.3	25.96	26.90	15.06		0.27		9.96	15.33
Ammonia	13-Aug-08	13:22	52	C2	30	23.99	22.45	14.40		1.65		5.95	16.05
Ammonia	13-Aug-08	14:04	94	C3	30.1	20.73	17.95	18.66		3.67		4.37	22.34
Ammonia	13-Aug-08	14:43	133	C4	30.1	13.82	13.50	20.67		7.49		3.90	28.17
Ammonia	13-Aug-08	15:30	180	C5	30	9.08	8.90	22.14		7.33		5.43	29.47
Nitrite	14-Aug-08	6:54	16	C6	30.0	0.00	-	0.88		20.75		0.81	21.63
Nitrite	14-Aug-08	7:25	47	C7	30.2	0.00	-	0.78		14.80		0.97	15.58
Nitrite	14-Aug-08	8:16	98	C8	30.2	0.00	-	0.09		0.01		0.24	0.10
Nitrite	14-Aug-08	8:57	139	C9	30.3	0.00	-	0.01		0.00		0.45	0.01
Nitrite	14-Aug-08	9:40	182	C10	30.35	0.00	-	0.00		0.00		0.42	0.00

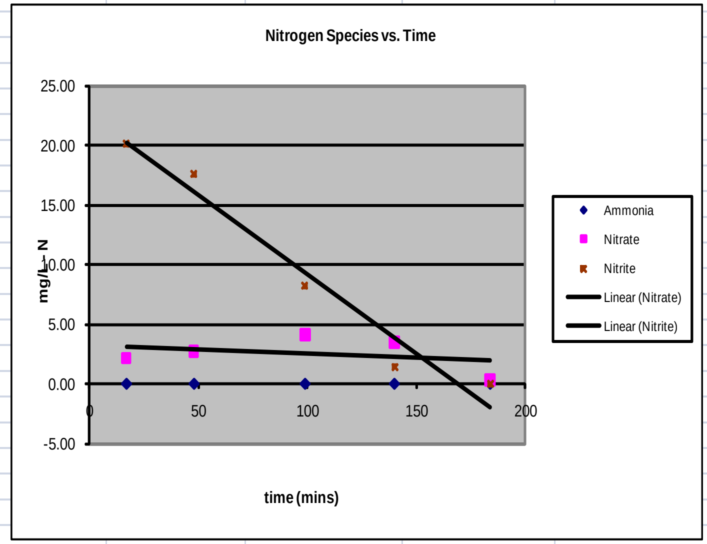




Reactor D: VIP Activated Sludge/VIP SE + Branch 3

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Aug-08	12:50	19	D1	30.4	24.70	27.80	13.22		0.92		15.93	14.13
Ammonia	13-Aug-08	13:23	52	D2	29.7	19.35	24.10	14.42		3.15		13.55	17.57
Ammonia	13-Aug-08	14:06	95	D3	29.65	22.67	18.90	19.62		5.77		10.59	25.40
Ammonia	13-Aug-08	14:45	134	D4	29.7	21.39	15.40	20.45		7.49		11.94	27.94
Ammonia	13-Aug-08	15:32	181	D5	29.6	0.00	9.18	22.85		7.33		11.98	30.17
Nitrite	14-Aug-08	6:56	17	D6	29.9	0.00	-	2.14		20.07		4.08	22.21
Nitrite	14-Aug-08	7:27	48	D7	30.1	0.00	-	2.71		17.54		3.41	20.26
Nitrite	14-Aug-08	8:18	99	D8	30.1	0.00	-	4.11		8.21		3.67	12.32
Nitrite	14-Aug-08	8:59	140	D9	30.1	0.00	-	3.49		1.43		1.19	4.92
Nitrite	14-Aug-08	9:43	184	D10	30.1	0.00	-	0.31		0.00		0.58	0.31



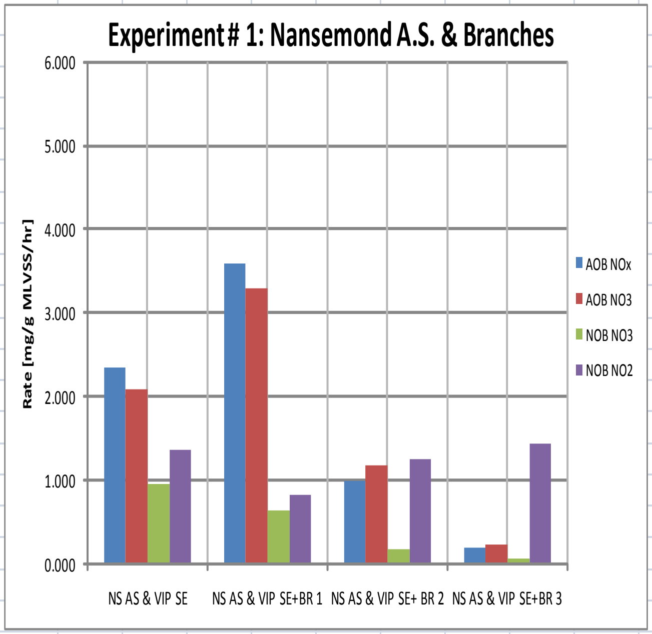


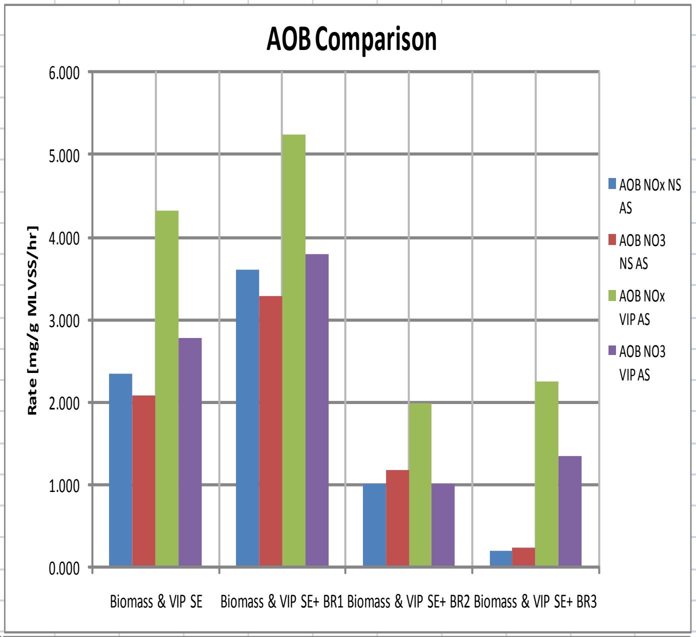
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: VIP											
Activated sludge	Ammonia	0.113	0.073		4.327	2.778		0.292	11.19	2023.33	1566.67
VIP SE	Nitrite		0.041	-0.046		1.551	-1.756	0.108	4.14	2023.33	1566.67
Reactor B: VIP											
Activated Sludge	Ammonia	0.154	0.112		5.245	3.804		0.441	15.04	2260.00	1760.00
VIP SE	Nitrite		0.044	-0.050		1.491	-1.706	0.103	3.50	2260.00	1760.00
Branch 1											
Reactor C: VIP											
Activated sludge	Ammonia	0.100	0.051		1.982	1.010		0.476	9.43	3650.00	3030.00
VIP SE	Nitrite		-0.006	-0.133		-0.119	-2.633	0.846	16.76	3650.00	3030.00
Branch 2											
Reactor D: VIP											
Activated Sludge	Ammonia	0.104	0.062		2.253	1.351		0.475	10.32	3255.00	2765.00
VIP SE	Nitrite		-0.007	-0.133		-0.151	-2.877	0.282	6.12	3255.00	2765.00
Branch 3											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

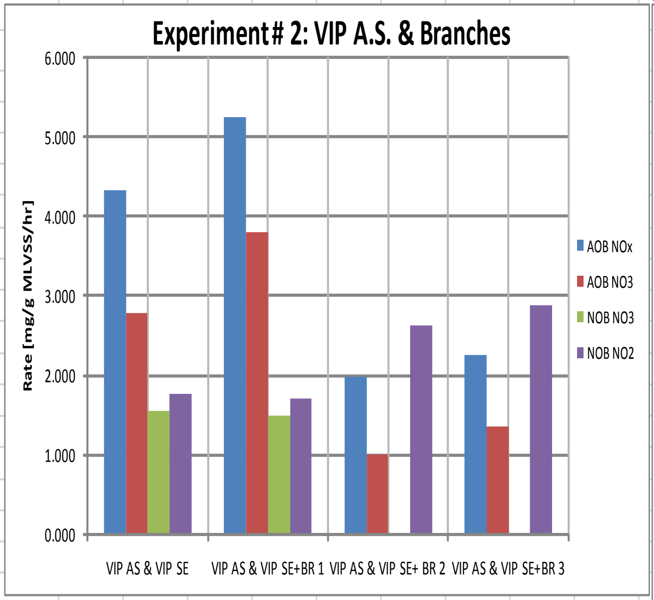
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE	2.354	2.090	0.956	1.371
Reactor B: NS Activated Sludge VIP SE Branch 1	3.600	3.293	0.641	0.834
Reactor C: NS Activated Sludge VIP SE Branch 2	1.004	1.185	0.185	1.248
Reactor D: NS Activated Sludge VIP SE Branch 3	0.201	0.232	0.064	1.436

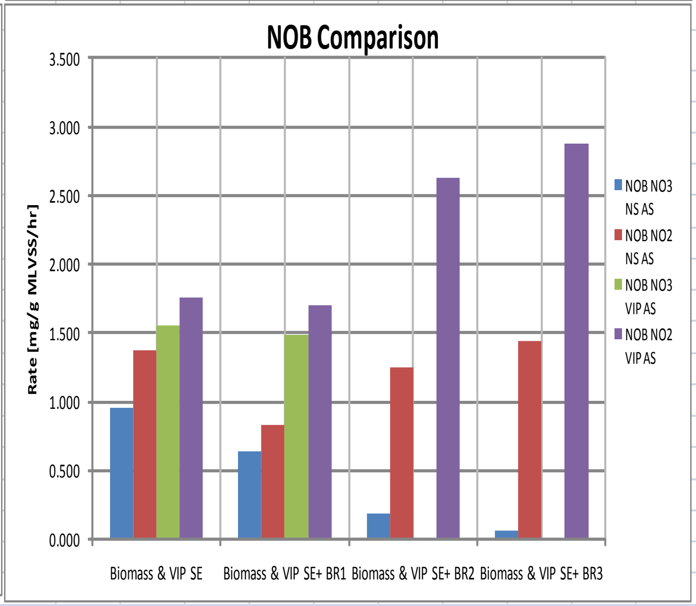




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: VIP Activated sludge VIP SE	4.327	2.778	1.551	1.756
Reactor B: VIP Activated Sludge VIP SE Branch 1	5.245	3.804	1.491	1.706
Reactor C: VIP Activated Sludge VIP SE Branch 2	1.982	1.010	0.000	2.633
Reactor D: VIP Activated Sludge VIP SE Branch 3	2.253	1.351	0.000	2.877





Week 8 – Pump/Pressure Reducing Stations Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

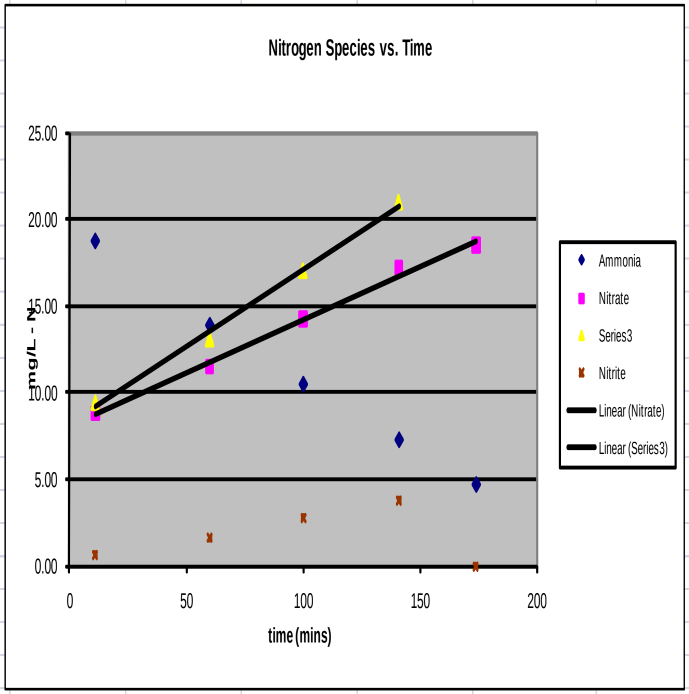
a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 μm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

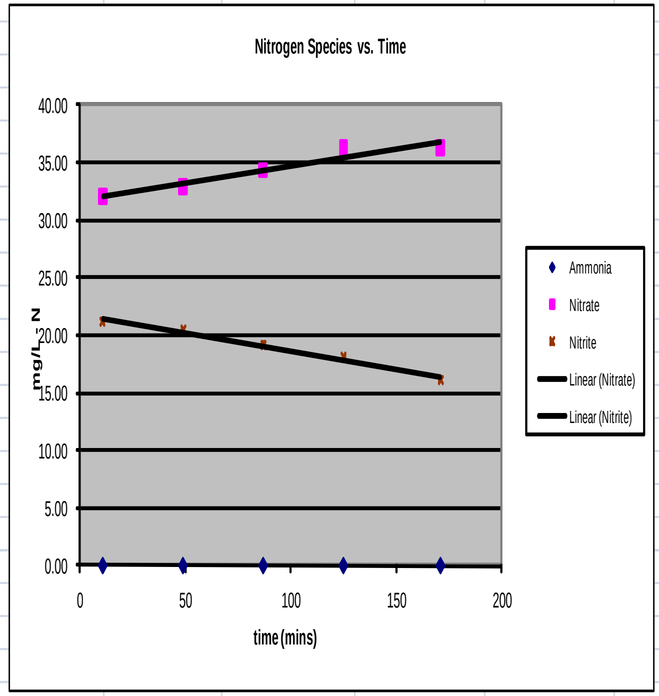
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 μm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

Reactor A: Nansemond Activated Sludge/VIP SE

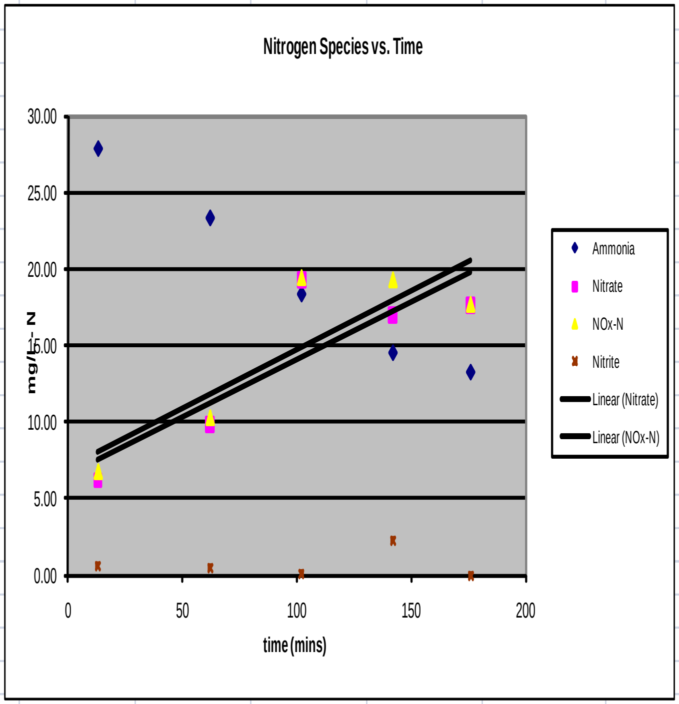
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	24-Oct-08	21:49	11	A1	27.5	16.78	18.70	8.82		0.63		0.27	9.45
Ammonia	24-Oct-08	22:38	60	A2	26.9	13.04	13.85	11.50		1.60		0.38	13.10
Ammonia	24-Oct-08	23:18	100	A3	26.3	8.98	10.45	14.26		2.77		0.51	17.03
Ammonia	24-Oct-08	23:59	141	A4	26.2	5.66	7.25	17.17		3.80		0.78	20.97
Ammonia	24-Oct-08	0:32	174	A5	26.1	2.64	4.68	18.46		0.00		0.97	18.46
Nitrite	25-Oct-08	8:28	11	A6	26	0.00	-	32.10		21.23		3.46	53.33
Nitrite	25-Oct-08	9:06	49	A7	26.1	0.00	-	32.91		20.48		3.29	53.39
Nitrite	25-Oct-08	9:44	87	A8	26.1	0.00	-	34.32		19.18		3.13	53.50
Nitrite	25-Oct-08	10:22	125	A9	26.2	0.00	-	36.31		18.09		5.26	54.39
Nitrite	25-Oct-08	11:08	171	A10	26.3	0.00	-	36.30		16.16		5.08	52.45

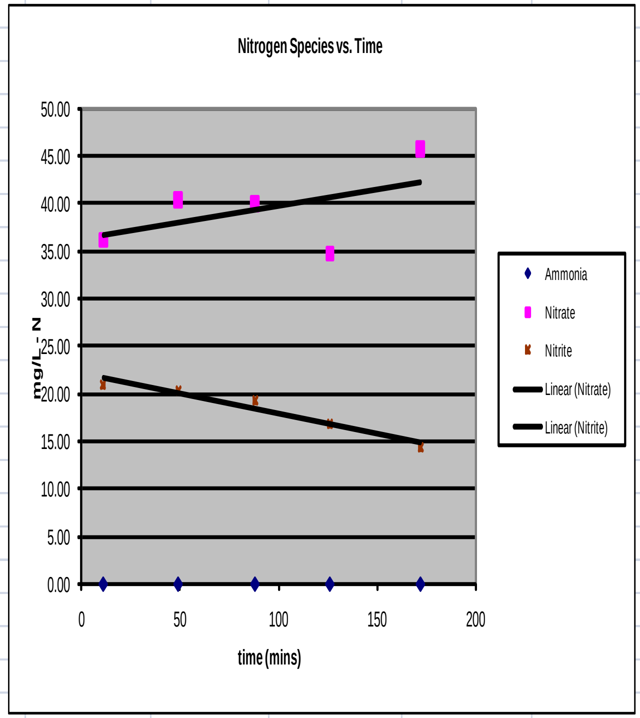




Reactor B: Nansemond Activated Sludge/VIP SE + Cedar Lane PS

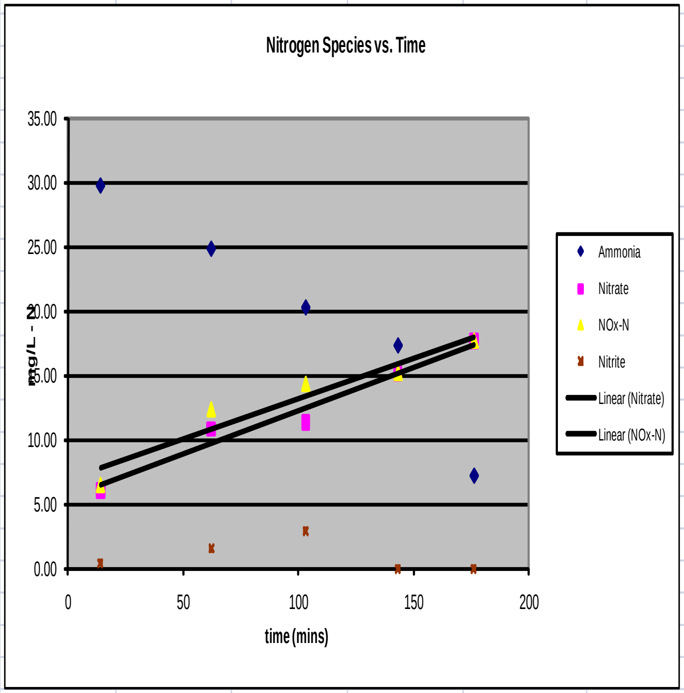
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	24-Oct-08	21:51	13	B1	26.5	29.28	27.90	6.21		0.58		2.64	6.79
Ammonia	24-Oct-08	22:40	62	B2	26.2	24.85	23.35	9.80		0.49		0.25	10.29
Ammonia	24-Oct-08	23:20	102	B3	25.9	14.88	18.35	19.26		0.11		0.01	19.36
Ammonia	24-Oct-08	0:00	142	B4	25.9	14.42	14.50	16.98		2.24		0.02	19.22
Ammonia	24-Oct-08	0:34	176	B5	26	11.58	13.23	17.63		0.00		0.19	17.63
Nitrite	25-Oct-08	8:29	11	B6	25.9	0.00	-	36.15		20.93		1.33	57.08
Nitrite	25-Oct-08	9:07	49	B7	26	0.00	-	40.42		20.29		1.51	60.71
Nitrite	25-Oct-08	9:46	88	B8	26.1	0.00	-	39.97		19.24		1.61	59.22
Nitrite	25-Oct-08	10:24	126	B9	26.2	0.00	-	34.72		16.79		1.94	51.51
Nitrite	25-Oct-08	11:10	172	B10	26.3	0.00	-	45.70		14.29		2.71	59.98

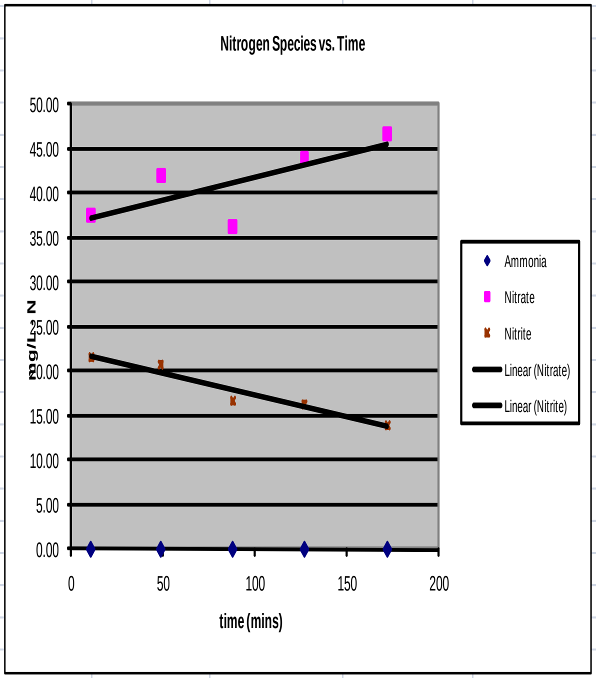




Reactor C: Nansemond Activated Sludge/VIP SE + Gum Road PRS

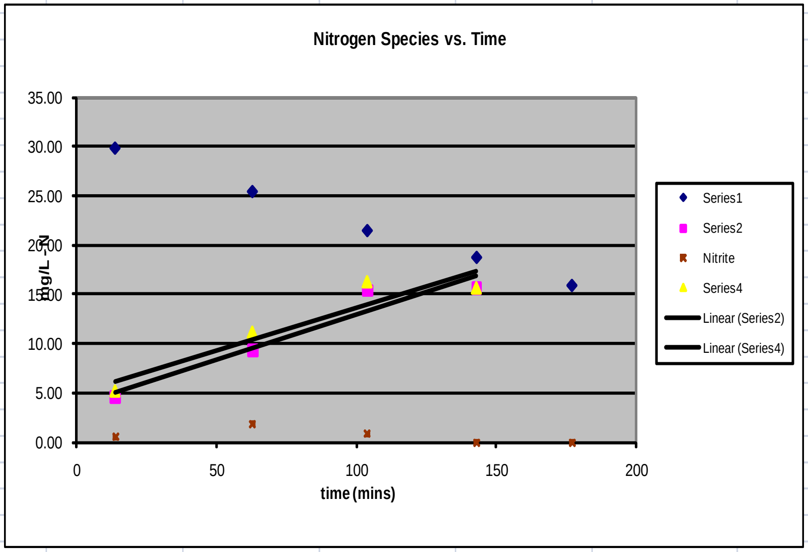
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	24-Oct-08	21:53	14	C1	26.6	30.39	29.70	6.06		0.44		3.38	6.50
Ammonia	24-Oct-08	22:41	62	C2	26.2	24.12	24.80	10.82		1.51		0.37	12.33
Ammonia	24-Oct-08	23:22	103	C3	26	19.80	20.25	11.35		2.93		0.03	14.29
Ammonia	24-Oct-08	0:02	143	C4	25.9	16.41	17.30	15.12		0.00		0.00	15.12
Ammonia	24-Oct-08	0:35	176	C5	26	0.00	7.20	17.60		0.00		0.00	17.60
Nitrite	25-Oct-08	8:30	11	C6	26	0.00	-	37.53		21.57		1.55	59.10
Nitrite	25-Oct-08	9:08	49	C7	26.1	0.00	-	42.05		20.80		1.81	62.85
Nitrite	25-Oct-08	9:47	88	C8	26.2	0.00	-	36.31		16.68		1.78	52.99
Nitrite	25-Oct-08	10:26	127	C9	26.3	0.00	-	43.94		16.33		2.70	60.27
Nitrite	25-Oct-08	11:11	172	C10	26.3	0.00	-	46.71		13.85		3.40	60.56

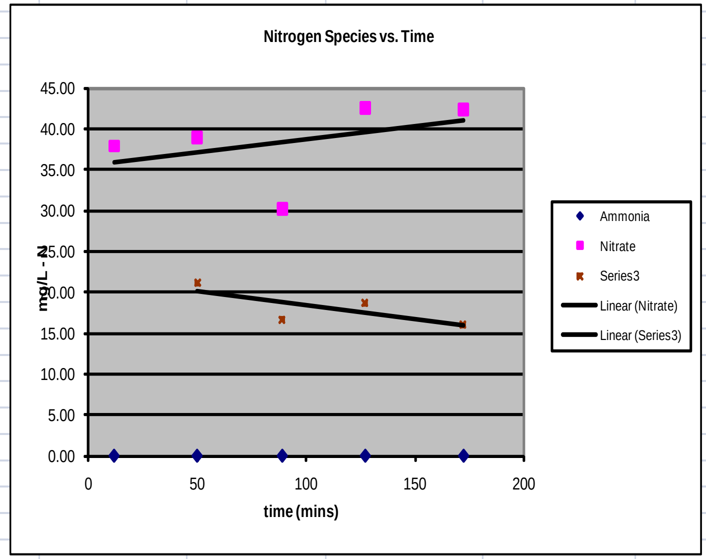




Reactor D: Nansemond Activated Sludge/VIP SE + Pughsville PRS

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	24-Oct-08	21:54	14	D1	26.7	36.19	29.90	4.56		0.55		5.66	5.12
Ammonia	24-Oct-08	22:43	63	D2	26	26.86	25.45	9.26		1.82		2.65	11.08
Ammonia	24-Oct-08	23:24	104	D3	25.8	19.24	21.45	15.38		0.82		0.77	16.20
Ammonia	24-Oct-08	0:03	143	D4	25.8	17.84	18.70	15.57		0.00		0.11	15.57
Ammonia	24-Oct-08	0:37	177	D5	25.9	0.00	15.83	13.76		0.00		0.01	13.76
Nitrite	25-Oct-08	8:32	12	D6	26	0.00	-	37.88		92.64		0.00	130.52
Nitrite	25-Oct-08	9:10	50	D7	26	0.00	-	38.98		21.10		3.17	60.08
Nitrite	25-Oct-08	9:49	89	D8	25.9	0.00	-	30.23		16.62		3.05	46.85
Nitrite	25-Oct-08	10:27	127	D9	25.9	0.00	-	42.49		18.61		5.01	61.11
Nitrite	25-Oct-08	11:12	172	D10	26.3	0.00	-	42.33		15.95		8.39	58.29





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.089	0.061		3.946	2.716		0.441	19.50	2000.00	1356.67
VIP SE	Nitrite		0.030	-0.032		1.306	-1.407	0.122	5.40	2000.00	1356.67
Reactor B: NS											
Activated Sludge	Ammonia	0.077	0.075		3.308	3.234		0.508	21.78	2050.00	1400.00
VIP SE	Nitrite		0.035	-0.042		1.511	-1.814	0.140	5.98	2050.00	1400.00
Cedar Ln PS											
Reactor C: NS											
Activated Sludge	Ammonia	0.063	0.068		2.648	2.866		0.585	24.78	2066.67	1416.67
VIP SE	Nitrite		0.051	-0.050		2.163	-2.106	0.165	7.00	2066.67	1416.67
Gum Rd PRS											
Reactor D: NS											
Activated Sludge	Ammonia	0.087	0.092		3.749	3.988		0.685	29.64	2046.67	1386.67
VIP SE	Nitrite		0.032	-0.033		1.369	-1.446	0.152	6.57	2046.67	1386.67
Pughsville PRS											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 8 – Pump/Pressure Reducing Stations Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

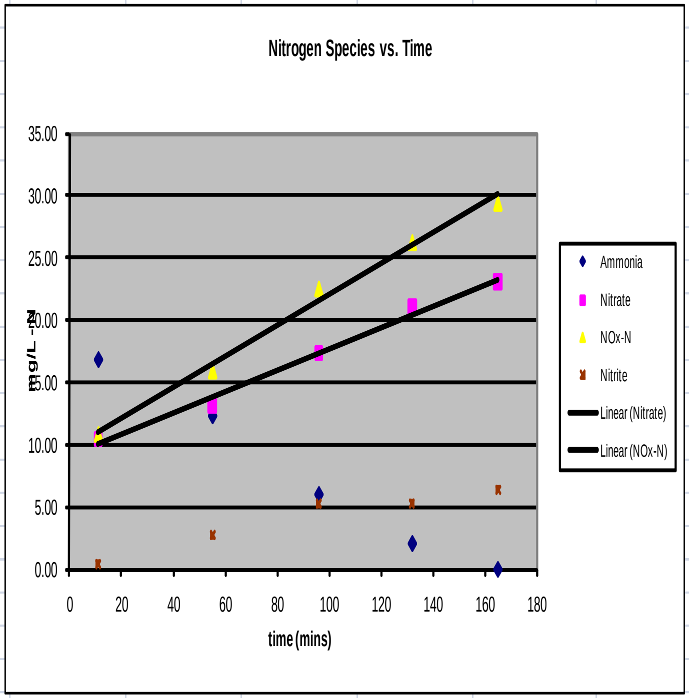
a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 1900 mL of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

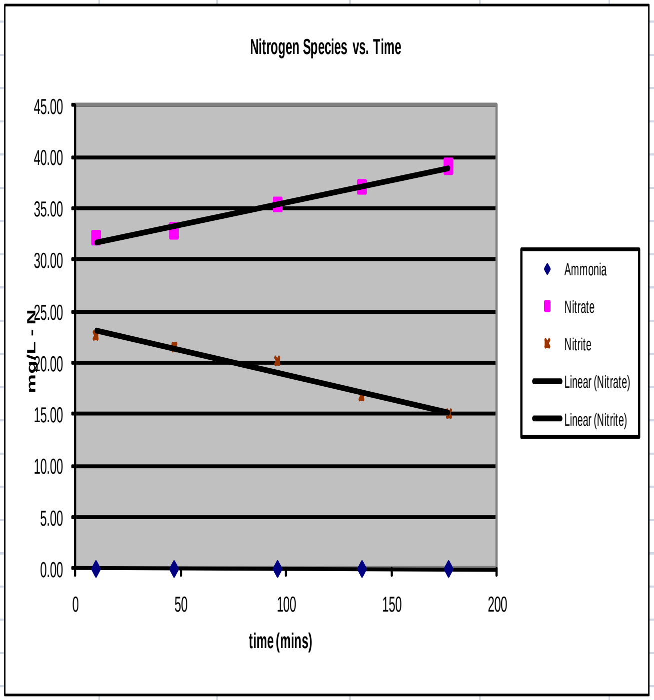
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

Reactor A: VIP Activated Sludge/VIP SE

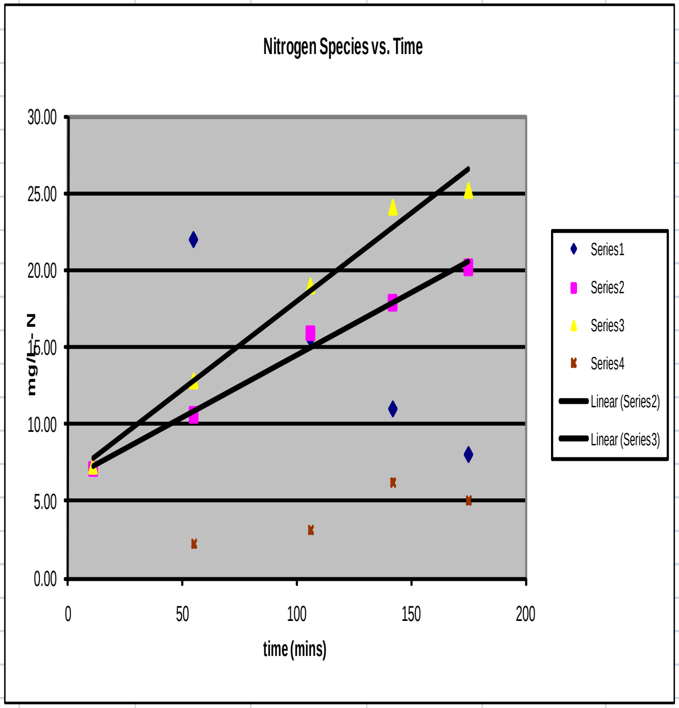
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	25-Oct-08	13:28	11	A1	28.2	11.44	16.80	10.46		0.41		1.53	10.87
Ammonia	25-Oct-08	14:12	55	A2	28.5	6.74	12.30	13.23		2.73		1.53	15.97
Ammonia	25-Oct-08	15:03	96	A3	27.2	2.25	6.00	17.32		5.25		1.92	22.57
Ammonia	25-Oct-08	15:39	132	A4	26.6	0.00	2.07	21.01		5.29		2.41	26.29
Ammonia	25-Oct-08	16:12	165	A5	26.3	0.00	0.00	23.09		6.36		2.68	29.45
Nitrite	25-Oct-08	20:53	10	A6	25.7	0.00	-	32.20		22.65		4.24	54.85
Nitrite	25-Oct-08	21:30	47	A7	25.8	0.00	-	32.86		21.62		4.90	54.48
Nitrite	25-Oct-08	22:19	96	A8	25.8	0.00	-	35.40		20.16		5.79	55.56
Nitrite	25-Oct-08	22:59	136	A9	25.7	0.00	-	37.14		16.72		4.86	53.86
Nitrite	25-Oct-08	23:40	177	A10	25.7	0.00	-	39.11		15.05		5.68	54.16

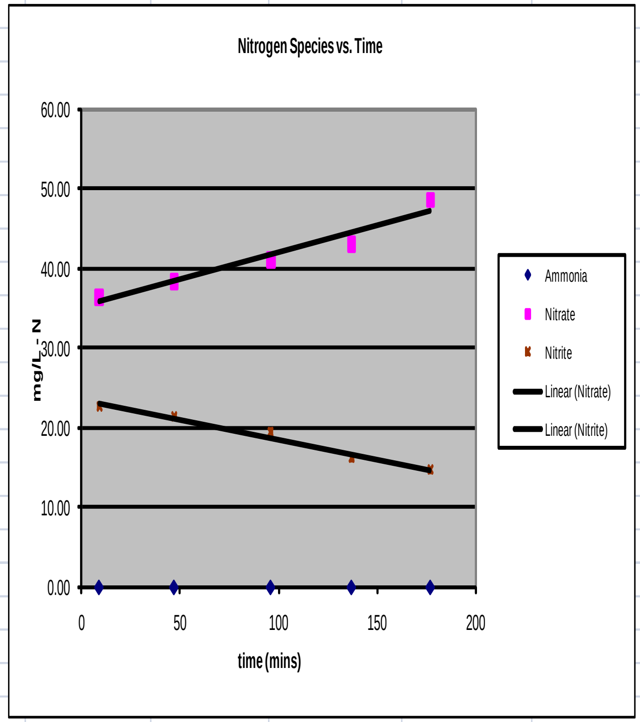




Reactor B: VIP Activated Sludge/VIP SE + Cedar Lane PS

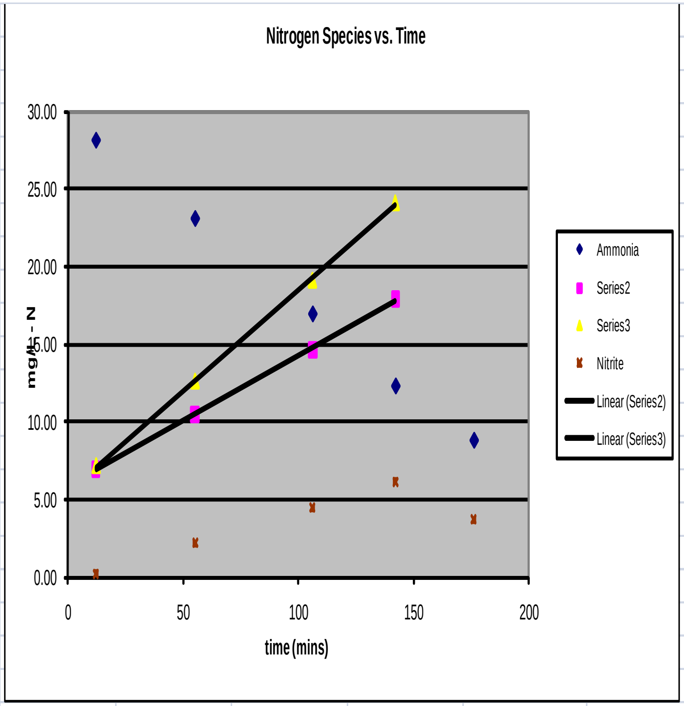
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	25-Oct-08	13:29	11	B1	27.4	21.71	27.40	7.11		0.19		3.59	7.30
Ammonia	25-Oct-08	14:13	55	B2	27.5	13.67	21.95	10.62		2.22		0.44	12.84
Ammonia	25-Oct-08	15:04	106	B3	26.7	11.28	15.55	15.89		3.10		0.00	18.99
Ammonia	25-Oct-08	15:40	142	B4	26.4	6.59	11.00	17.90		6.20		0.18	24.10
Ammonia	25-Oct-08	16:13	175	B5	26.2	3.20	8.05	20.16		5.03		0.47	25.18
Nitrite	25-Oct-08	20:53	9	B6	25.9	0.00	-	36.41		22.70		2.21	59.11
Nitrite	25-Oct-08	21:31	47	B7	26	0.00	-	38.37		21.36		2.70	59.73
Nitrite	25-Oct-08	22:20	96	B8	25.9	0.00	-	41.10		19.57		3.17	60.67
Nitrite	25-Oct-08	23:01	137	B9	25.8	0.00	-	43.02		16.21		3.57	59.24
Nitrite	25-Oct-08	23:41	177	B10	25.8	0.00	-	48.63		14.70		4.05	63.33

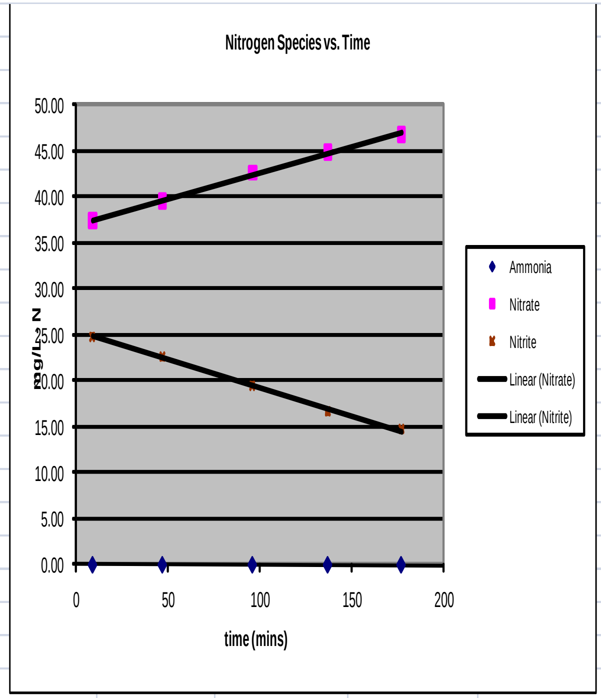




Reactor C: VIP Activated Sludge/VIP SE + Gum Road PRS

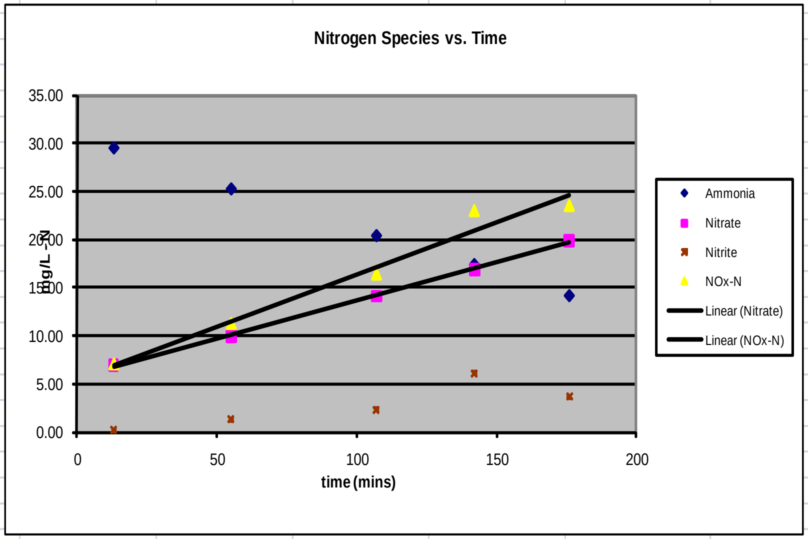
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	25-Oct-08	13:31	12	C1	27.2	20.54	28.10	6.95		0.22		4.15	7.17
Ammonia	25-Oct-08	14:14	55	C2	26.8	15.16	23.05	10.42		2.17		0.25	12.60
Ammonia	25-Oct-08	15:05	106	C3	26.3	10.92	16.90	14.65		4.42		0.00	19.07
Ammonia	25-Oct-08	15:41	142	C4	26.2	7.08	12.25	17.92		6.12		0.00	24.04
Ammonia	25-Oct-08	16:15	176	C5	26.1	3.95	8.75	15.44		3.66		0.03	19.10
Nitrite	25-Oct-08	20:54	9	C6	25.9	0.00	-	37.39		24.83		3.45	62.22
Nitrite	25-Oct-08	21:32	47	C7	26	0.00	-	39.58		22.56		4.49	62.14
Nitrite	25-Oct-08	22:21	96	C8	25.8	0.00	-	42.66		19.50		5.58	62.16
Nitrite	25-Oct-08	23:02	137	C9	25.8	0.00	-	44.83		16.65		6.29	61.48
Nitrite	25-Oct-08	23:42	177	C10	25.8	0.00	-	46.87		14.72		7.00	61.60

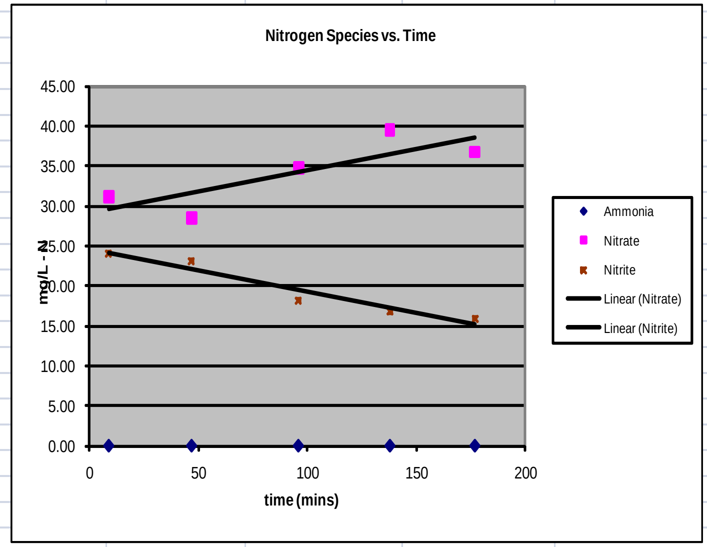




Reactor D: VIP Activated Sludge/VIP SE + Pughsville PRS

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	25-Oct-08	13:33	13	D1	27.3	24.30	29.50	6.93		0.17		6.46	7.09
Ammonia	25-Oct-08	14:15	55	D2	26.8	22.46	25.25	9.96		1.33		1.87	11.29
Ammonia	25-Oct-08	15:07	107	D3	26.4	12.46	20.40	14.12		2.31		0.00	16.43
Ammonia	25-Oct-08	15:42	142	D4	26.3	12.97	17.40	16.88		6.12		0.00	23.01
Ammonia	25-Oct-08	16:16	176	D5	26.2	0.00	14.18	19.88		3.66		0.00	23.54
Nitrite	25-Oct-08	20:55	9	D6	26	0.00	-	31.09		24.03		0.49	55.11
Nitrite	25-Oct-08	21:33	47	D7	26.1	0.00	-	28.53		23.15		2.82	51.68
Nitrite	25-Oct-08	22:22	96	D8	25.9	0.00	-	34.76		18.17		3.65	52.93
Nitrite	25-Oct-08	23:04	138	D9	25.9	0.00	-	39.45		16.77		4.11	56.22
Nitrite	25-Oct-08	23:43	177	D10	25.9	0.00	-	36.72		15.88		6.06	52.61



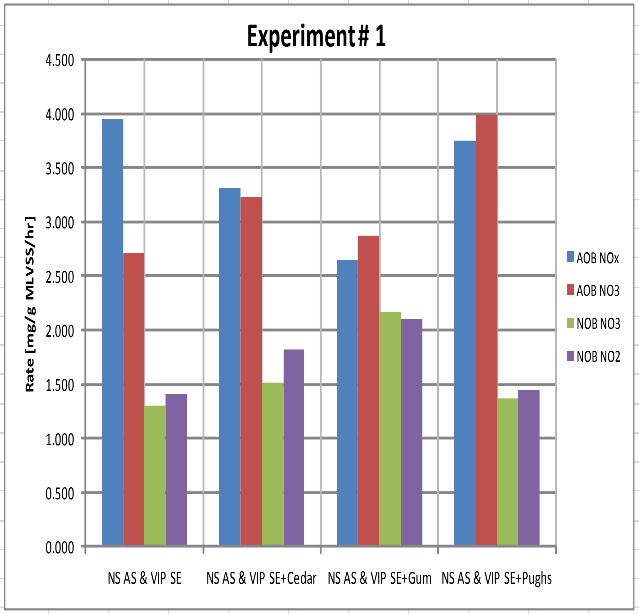


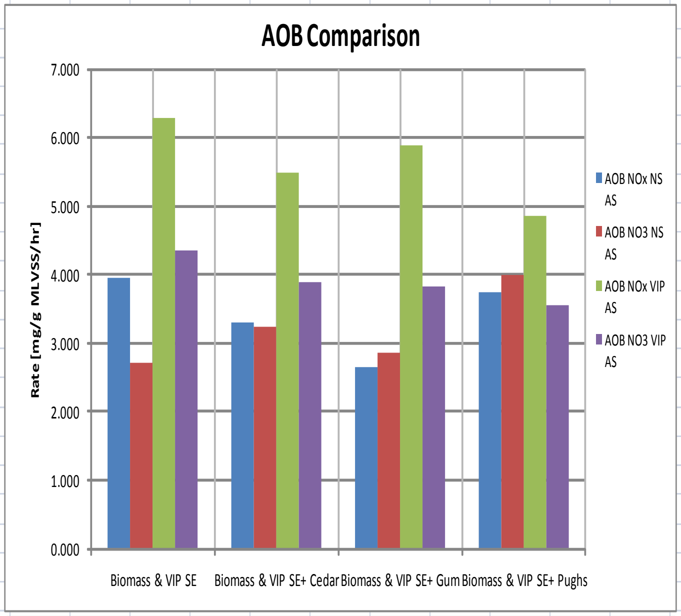
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: VIP											
Activated sludge	Ammonia	0.124	0.086		6.278	4.347		0.441	22.35	1513.33	1183.33
VIP SE	Nitrite		0.043	-0.047		2.176	-2.405	0.122	6.19	1513.33	1183.33
Reactor B: VIP											
Activated Sludge	Ammonia	0.114	0.081		5.485	3.891		0.508	24.39	1613.33	1250.00
VIP SE	Nitrite		0.068	-0.050		3.265	-2.381	0.140	6.70	1613.33	1250.00
Cedar Ln PS											
Reactor C: VIP											
Activated sludge	Ammonia	0.129	0.084		5.894	3.833		0.585	26.66	1626.67	1316.67
VIP SE	Nitrite		0.057	-0.061		2.593	-2.796	0.165	7.54	1626.67	1316.67
Gum Rd PRS											
Reactor D: VIP											
Activated Sludge	Ammonia	0.108	0.079		4.858	3.561		0.685	30.75	1696.67	1336.67
VIP SE	Nitrite		0.053	-0.054		2.391	-2.407	0.152	6.81	1696.67	1336.67
Pughsivlle PRS											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

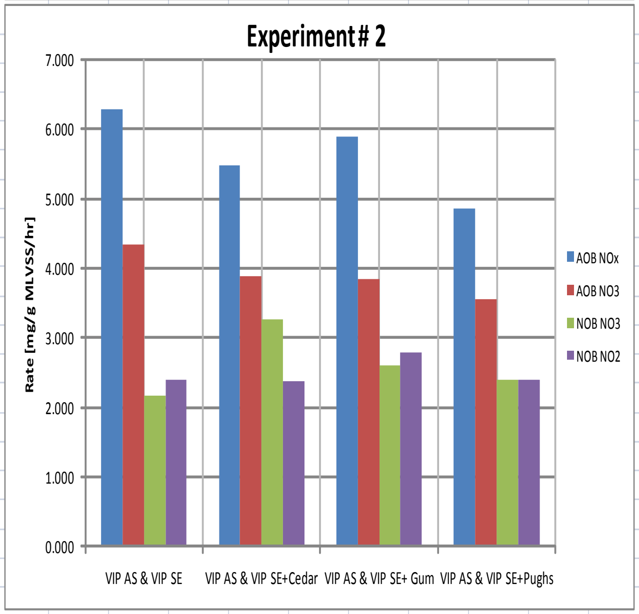
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE	3.946	2.716	1.306	1.407
Reactor B: NS Activated Sludge VIP SE Cedar Lane PS	3.308	3.234	1.511	1.814
Reactor C: NS Activated Sludge VIP SE Gum Road PRS	2.648	2.866	2.163	2.106
Reactor D: NS Activated Sludge VIP SE Pughsville PRS	3.749	3.988	1.369	1.446

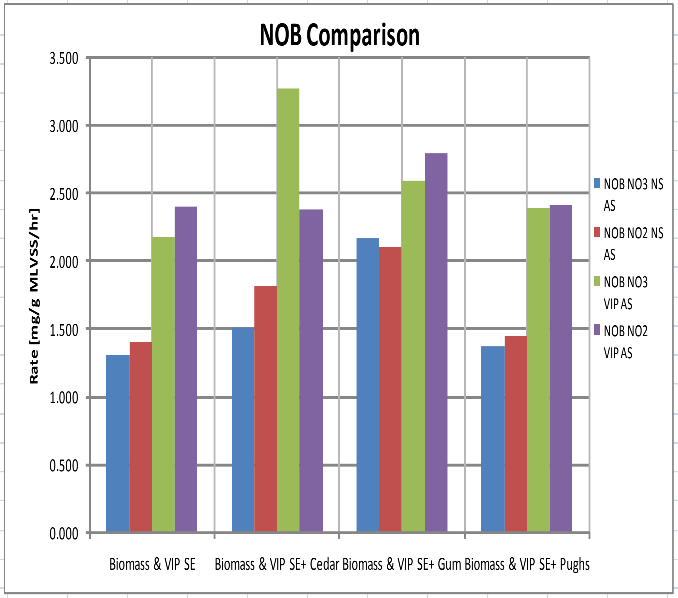




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: VIP Activated sludge VIP SE	6.278	4.347	2.176	2.405
Reactor B: VIP Activated Sludge VIP SE Cedar Lane PS	5.485	3.891	3.265	2.381
Reactor C: VIP Activated Sludge VIP SE Gum Road PRS	5.894	3.833	2.593	2.796
Reactor D: VIP Activated Sludge VIP SE Pughsville PRS	4.858	3.561	2.391	2.407





Week 9 – Pump/Pressure Reducing Stations (RERUN) Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

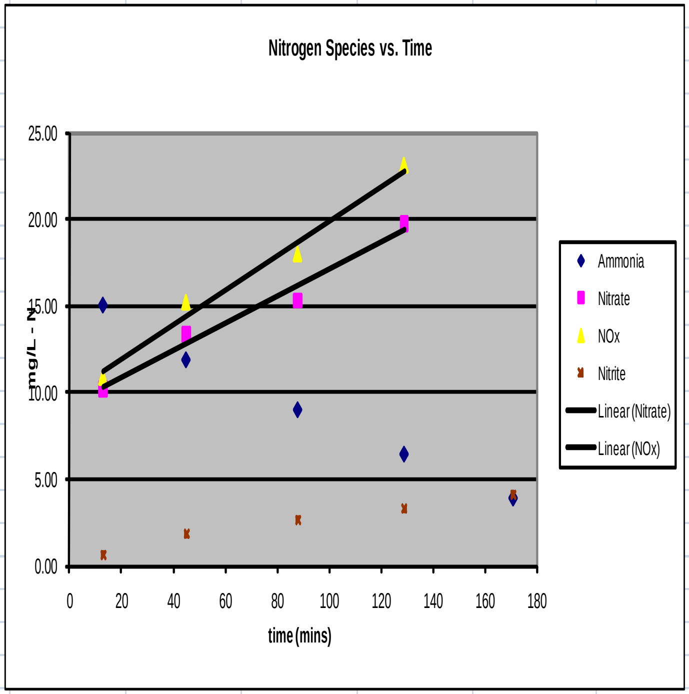
a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

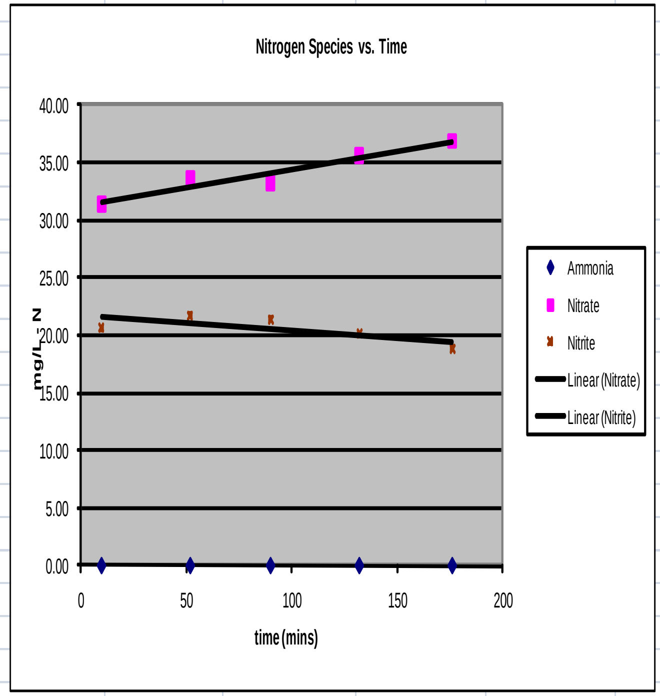
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

Reactor A: Nansemond Activated Sludge/VIP SE

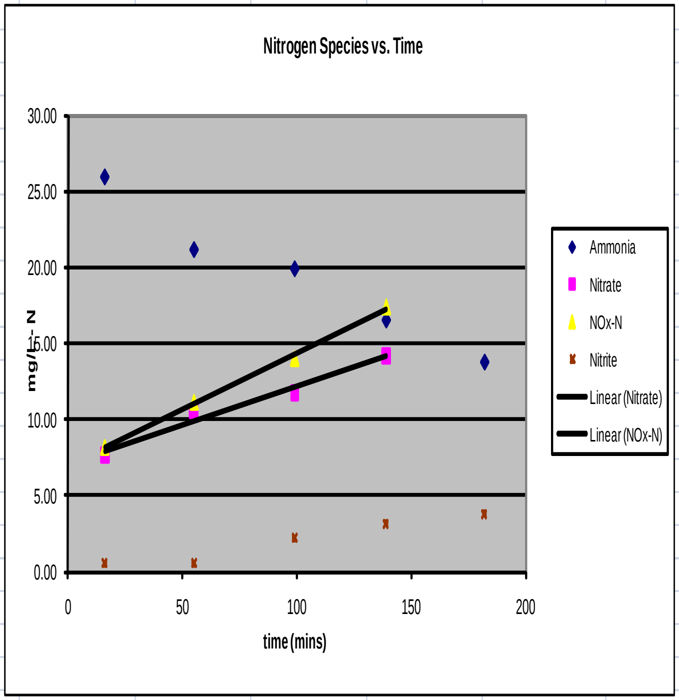
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	21-Nov-08	20:39	13	A1	26	5.70	15.00	10.19		0.66		0.56	10.85
Ammonia	21-Nov-08	21:21	45	A2	25.4	195.14	11.85	13.34		1.85		0.68	15.19
Ammonia	21-Nov-08	22:04	88	A3	23.5	-1.54	8.98	15.31		2.65		0.78	17.96
Ammonia	21-Nov-08	22:45	129	A4	23.2	-4.29	6.42	19.77		3.29		1.02	23.06
Ammonia	21-Nov-08	23:27	171	A5	23.1	-7.24	3.89	18.92		4.13		1.24	23.05
Nitrite	21-Nov-08	7:03	10	A6	23.4	0.00	-	31.39		20.67		3.51	52.06
Nitrite	21-Nov-08	7:45	52	A7	23.3	0.00	-	33.54		21.75		4.39	55.28
Nitrite	21-Nov-08	8:23	90	A8	22.6	0.00	-	33.22		21.38		4.61	54.60
Nitrite	21-Nov-08	9:05	132	A9	22.1	0.00	-	35.60		20.09		4.91	55.69
Nitrite	21-Nov-08	9:49	176	A10	21.9	0.00	-	36.87		18.84		5.10	55.71

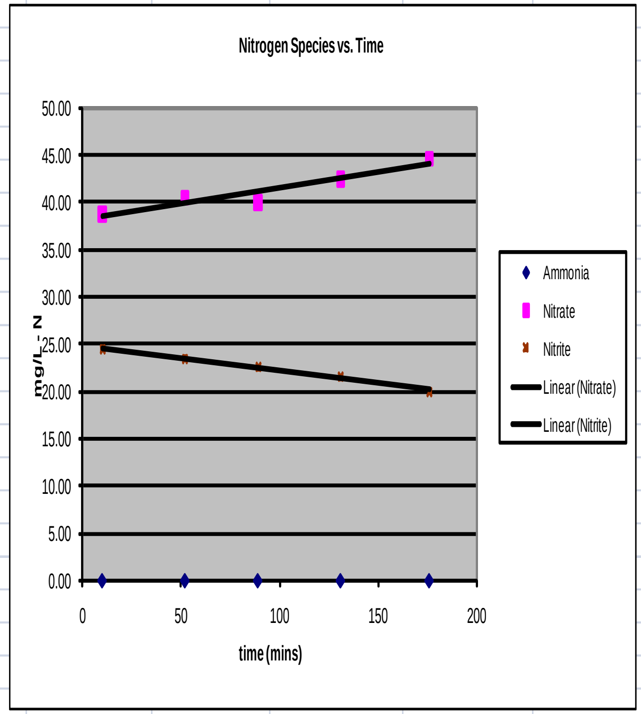




Reactor B: Nansemond Activated Sludge/VIP SE + Cedar Lane PS

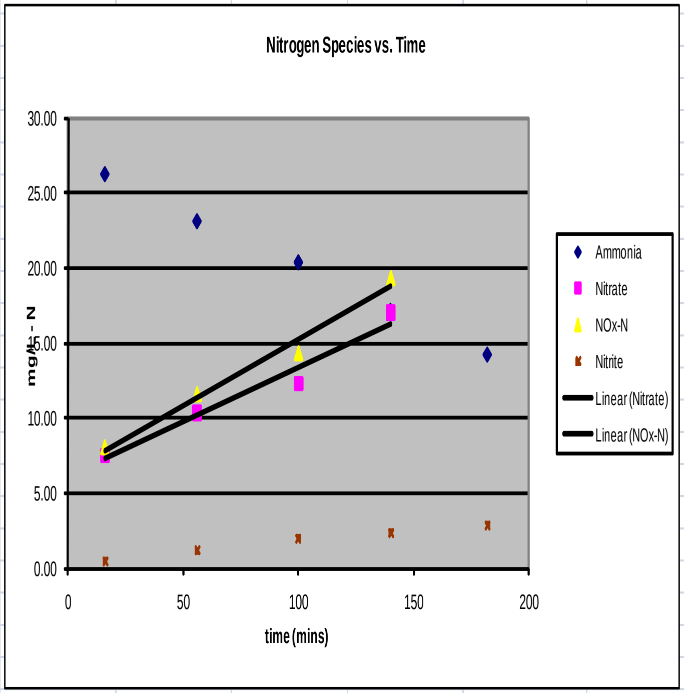
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	21-Nov-08	20:43	16	B1	24.2	22.15	25.90	7.64		0.52		2.10	8.16
Ammonia	21-Nov-08	21:22	55	B2	24.1	15.29	21.15	10.53		0.57		0.54	11.10
Ammonia	21-Nov-08	22:06	99	B3	22.4	11.55	19.90	11.75		2.21		0.42	13.96
Ammonia	21-Nov-08	22:46	139	B4	22.7	5.82	16.55	14.20		3.13		0.43	17.33
Ammonia	21-Nov-08	23:29	182	B5	22.8	5.03	13.80	16.97		3.80		0.50	20.76
Nitrite	21-Nov-08	7:05	10	B6	23.6	0.00	-	38.69		24.51		3.10	63.20
Nitrite	21-Nov-08	7:47	52	B7	23.1	0.00	-	40.47		23.48		3.77	63.96
Nitrite	21-Nov-08	8:24	89	B8	22.5	0.00	-	40.00		22.57		4.26	62.57
Nitrite	21-Nov-08	9:06	131	B9	22	0.00	-	42.47		21.57		4.57	64.04
Nitrite	21-Nov-08	9:51	176	B10	21.8	0.00	-	44.61		20.00		4.81	64.61

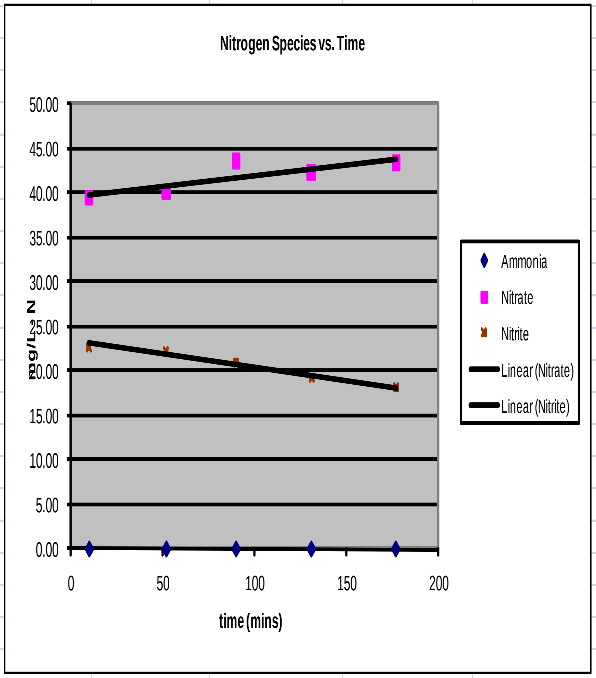




Reactor C: Nansemond Activated Sludge/VIP SE + Gum Road PRS

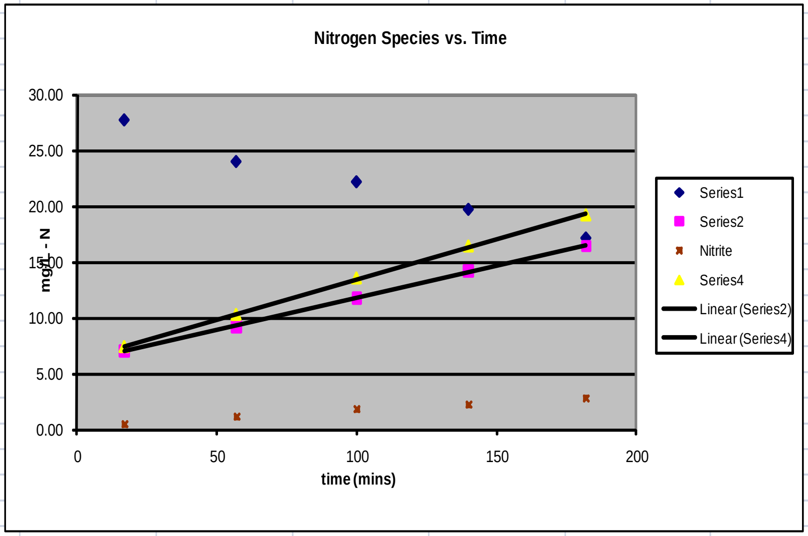
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	21-Nov-08	20:44	16	C1	24.3	18.56	26.30	7.50		0.48		2.95	7.99
Ammonia	21-Nov-08	21:24	56	C2	22.6	13.73	23.15	10.35		1.20		0.79	11.55
Ammonia	21-Nov-08	22:08	100	C3	22.7	11.10	20.40	12.28		2.01		0.47	14.30
Ammonia	21-Nov-08	22:48	140	C4	22.8	8.28	17.15	16.98		2.34		0.00	19.33
Ammonia	21-Nov-08	23:30	182	C5	23	0.00	14.23	17.07		2.89		0.00	19.96
Nitrite	21-Nov-08	7:06	10	C6	23.7	0.00	-	39.47		22.73		2.67	62.20
Nitrite	21-Nov-08	7:48	52	C7	22.7	0.00	-	40.11		22.21		3.15	62.32
Nitrite	21-Nov-08	8:26	90	C8	22.1	0.00	-	43.62		21.02		3.38	64.63
Nitrite	21-Nov-08	9:07	131	C9	22.2	0.00	-	42.34		19.32		3.57	61.65
Nitrite	21-Nov-08	9:53	177	C10	22.4	0.00	-	43.39		18.10		4.06	61.48

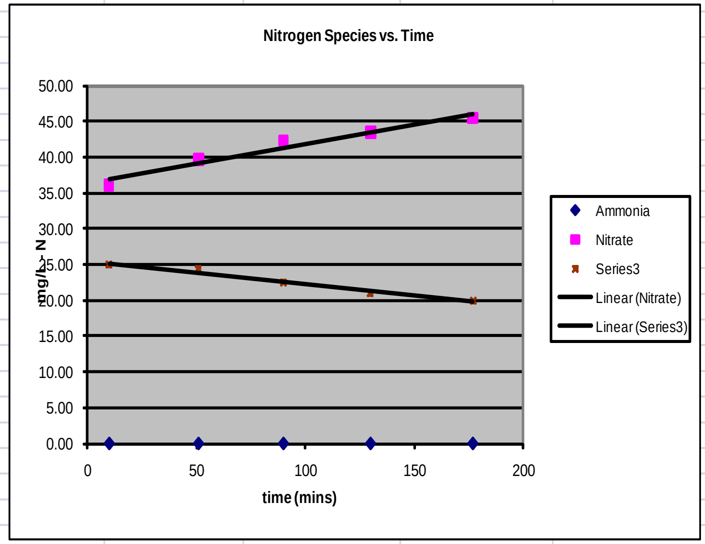




Reactor D: Nansemond Activated Sludge/VIP SE + Pughsville PRS

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	21-Nov-08	20:46	17	D1	24.0	22.97	27.70	6.99		0.45		3.40	7.44
Ammonia	21-Nov-08	21:26	57	D2	22.02	18.46	24.00	9.22		1.10		1.30	10.31
Ammonia	21-Nov-08	22:09	100	D3	22.6	10.75	22.20	11.78		1.80		1.74	13.57
Ammonia	21-Nov-08	22:49	140	D4	22.8	9.15	19.75	14.20		2.22		0.76	16.42
Ammonia	21-Nov-08	23:31	182	D5	22.9	0.00	17.20	16.40		2.80		0.91	19.19
Nitrite	21-Nov-08	7:08	10	D6	22.2	0.00	-	36.12		24.92		0.00	61.04
Nitrite	21-Nov-08	7:49	51	D7	22.2	0.00	-	39.71		24.40		4.51	64.11
Nitrite	21-Nov-08	8:28	90	D8	22.3	0.00	-	42.30		22.54		5.06	64.84
Nitrite	21-Nov-08	9:08	130	D9	22.3	0.00	-	43.50		20.91		5.22	64.41
Nitrite	21-Nov-08	9:55	177	D10	22.4	0.00	-	45.49		19.87		6.24	65.37





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.100	0.078		4.468	3.490		0.405	18.05	1997.27	1346.36
VIP SE	Nitrite		0.032	-0.013		1.417	-0.583	0.129	5.76	1997.27	1346.36
Reactor B: NS											
Activated Sludge	Ammonia	0.074	0.050		3.150	2.162		0.516	22.12	2050.00	1400.00
VIP SE	Nitrite		0.034	-0.027		1.456	-1.142	0.137	5.89	2050.00	1400.00
Cedar Ln PS											
Reactor C: NS											
Activated Sludge	Ammonia	0.088	0.073		3.877	3.200		0.510	22.41	1995.00	1365.00
VIP SE	Nitrite		0.024	-0.029		1.056	-1.294	0.146	6.43	1995.00	1365.00
Gum Rd PRS											
Reactor D: NS											
Activated Sludge	Ammonia	0.072	0.058		3.009	2.418		0.466	19.56	2080.00	1430.00
VIP SE	Nitrite		0.054	-0.033		2.280	-1.377	0.149	6.27	2080.00	1430.00
Pughsville PRS											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 9 – Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

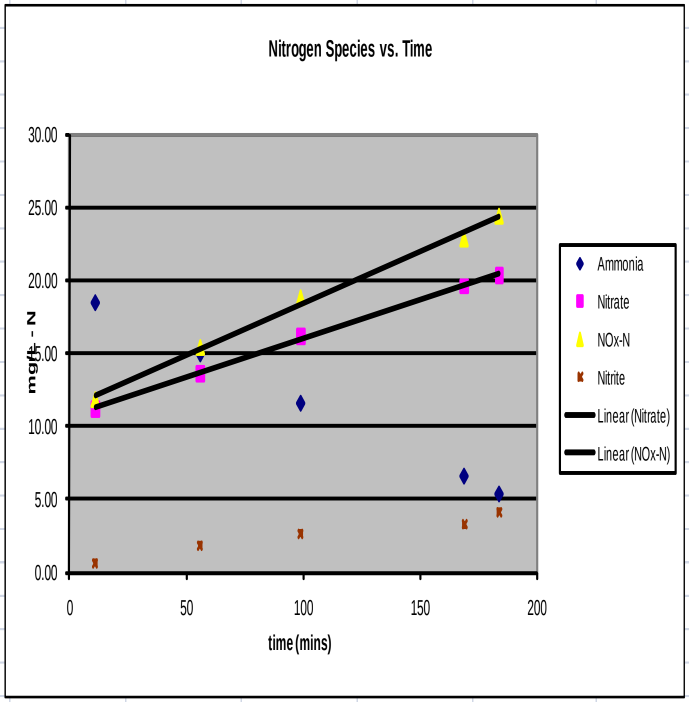
a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 1900 mL of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

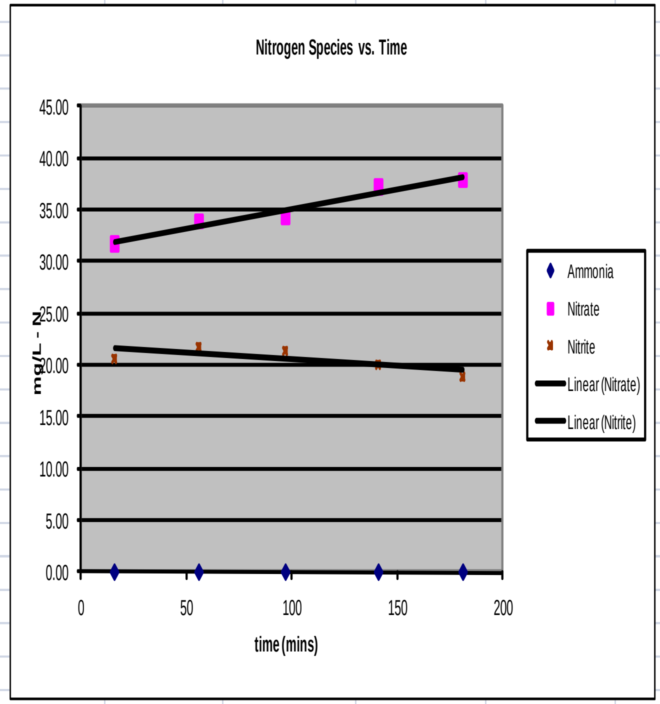
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

Reactor A: VIP Activated Sludge/VIP SE

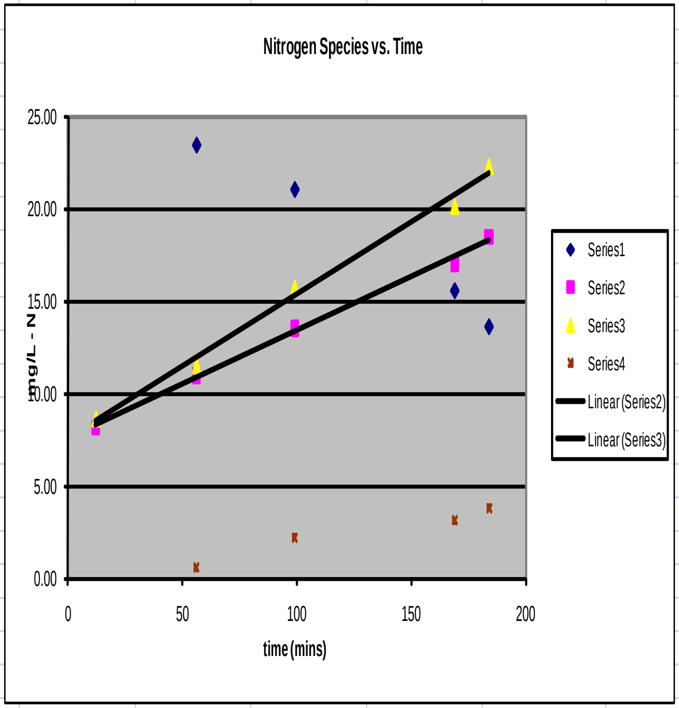
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	22-Nov-08	16:27	11	A1	24.4	5.70	18.50	11.16		0.66		0.56	11.82
Ammonia	22-Nov-08	17:12	56	A2	24.3	195.14	15.00	13.56		1.85		0.68	15.40
Ammonia	22-Nov-08	17:55	99	A3	23.0	-1.54	11.63	16.18		2.65		0.78	18.83
Ammonia	22-Nov-08	19:05	169	A4	23.1	0.00	6.64	19.56		3.29		1.02	22.85
Ammonia	22-Nov-08	19:20	184	A5	23.1	0.00	5.42	20.29		4.13		1.24	24.42
Nitrite	22-Nov-08	23:27	16	A6	22.1	0.00	-	31.65		20.67		3.51	52.33
Nitrite	22-Nov-08	0:07	56	A7	22.1	0.00	-	33.92		21.75		4.39	55.67
Nitrite	22-Nov-08	0:48	97	A8	22.2	0.00	-	34.28		21.38		4.61	55.66
Nitrite	22-Nov-08	1:32	141	A9	22.3	0.00	-	37.16		20.09		4.91	57.25
Nitrite	22-Nov-08	2:12	181	A10	22.2	0.00	-	37.89		18.84		5.10	56.73

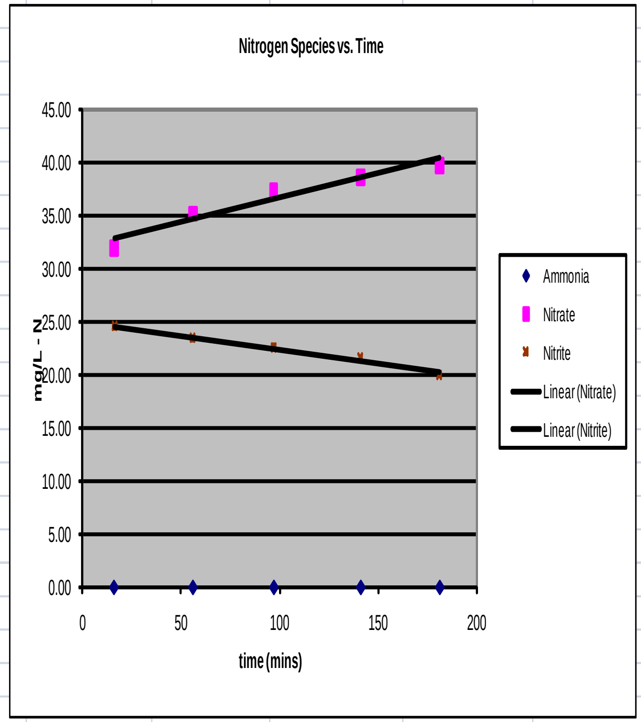




Reactor B: VIP Activated Sludge/VIP SE + Cedar Lane PS

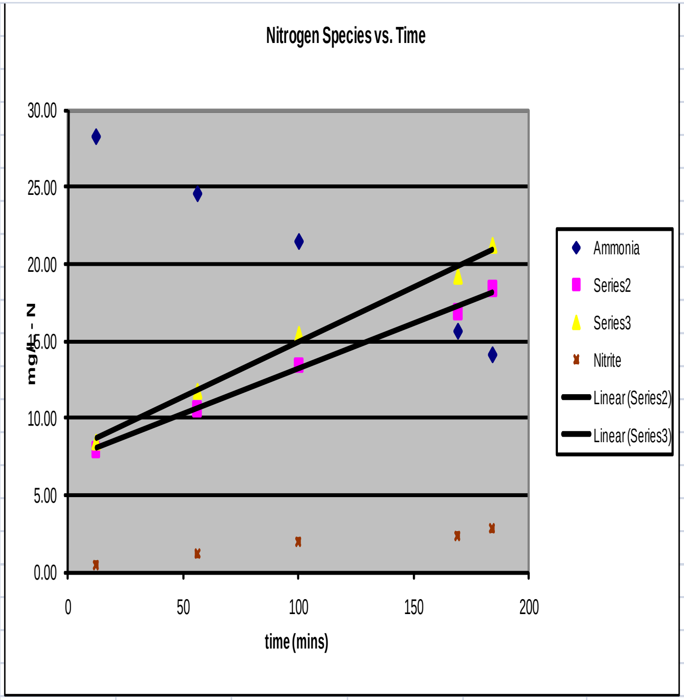
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	22-Nov-08	16:29	12	B1	22.8	22.15	27.10	8.13		0.52		2.10	8.65
Ammonia	22-Nov-08	17:13	56	B2	22.7	15.29	23.40	10.94		0.57		0.54	11.51
Ammonia	22-Nov-08	17:56	99	B3	22.3	11.55	21.00	13.53		2.21		0.00	15.73
Ammonia	22-Nov-08	19:06	169	B4	22.6	5.82	15.53	16.99		3.13		0.43	20.12
Ammonia	22-Nov-08	19:21	184	B5	22.8	5.03	13.58	18.47		3.80		0.50	22.27
Nitrite	22-Nov-08	23:28	16	B6	22.3	0.00	-	31.94		24.51		3.10	56.45
Nitrite	22-Nov-08	0:08	56	B7	22.3	0.00	-	35.15		23.48		3.77	58.64
Nitrite	22-Nov-08	0:49	97	B8	22.3	0.00	-	37.28		22.57		4.26	59.85
Nitrite	22-Nov-08	1:33	141	B9	22.3	0.00	-	38.61		21.57		4.57	60.19
Nitrite	22-Nov-08	2:13	181	B10	22.3	0.00	-	39.75		20.00		4.81	59.75

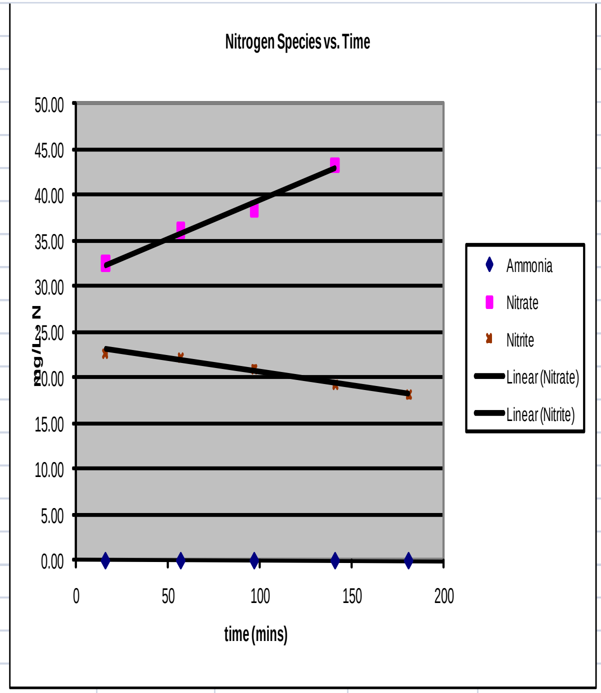




Reactor C: VIP Activated Sludge/VIP SE + Gum Road PRS

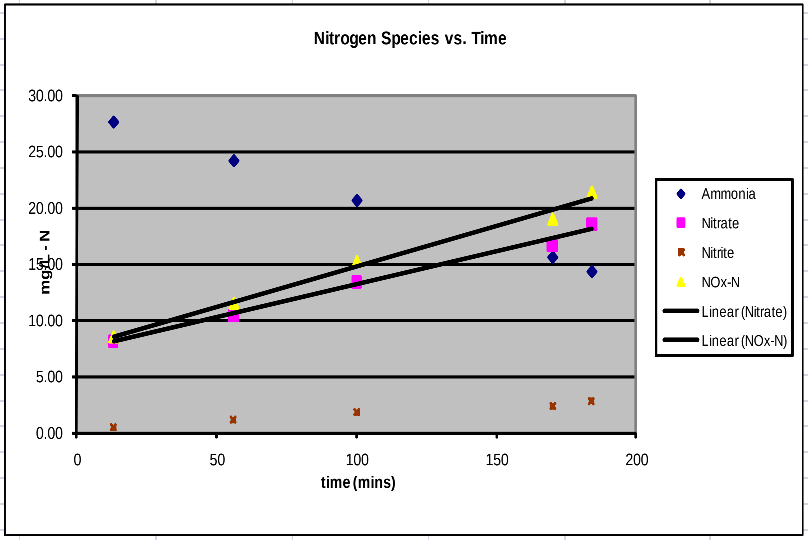
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	22-Nov-08	16:30	12	C1	22.8	18.56	28.20	7.97		0.48		2.95	8.46
Ammonia	22-Nov-08	17:14	56	C2	22.6	13.73	24.50	10.55		1.20		0.79	11.75
Ammonia	22-Nov-08	17:58	100	C3	22.3	11.10	21.40	13.42		2.01		0.00	15.44
Ammonia	22-Nov-08	19:07	169	C4	22.7	8.28	15.58	16.85		2.34		0.00	19.20
Ammonia	22-Nov-08	19:22	184	C5	23	1.84	14.05	18.40		2.80		0.52	21.20
Nitrite	22-Nov-08	23:29	16	C6	22.3	0.00	-	32.48		22.73		5.34	55.21
Nitrite	22-Nov-08	0:10	57	C7	22.3	0.00	-	36.13		22.21		6.30	58.34
Nitrite	22-Nov-08	0:50	97	C8	22.4	0.00	-	38.49		21.02		6.76	59.50
Nitrite	22-Nov-08	1:34	141	C9	22.4	0.00	-	43.29		19.32		7.14	62.61
Nitrite	22-Nov-08	2:14	181	C10	22.4	0.00	-	42.22		18.10		8.11	60.32

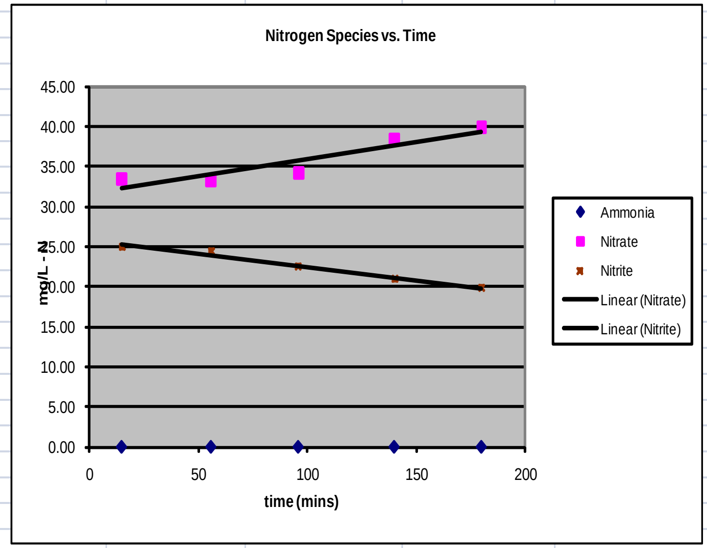




Reactor D: VIP Activated Sludge/VIP SE + Pughsville PRS

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	22-Nov-08	16:32	13	D1	23.2	22.97	27.60	8.09		0.45		3.40	8.53
Ammonia	22-Nov-08	17:15	56	D2	22.7	18.46	24.15	10.41		1.10		1.30	11.51
Ammonia	22-Nov-08	17:59	100	D3	22.3	10.75	20.60	13.40		1.80		0.00	15.20
Ammonia	22-Nov-08	19:09	170	D4	22.7	9.15	15.53	16.61		2.34		0.00	18.95
Ammonia	22-Nov-08	19:23	184	D5	23	0.00	14.25	18.54		2.80		0.00	21.34
Nitrite	22-Nov-08	23:30	15	D6	22.2	0.00	-	33.41		24.92		7.74	58.33
Nitrite	22-Nov-08	0:11	56	D7	22.3	0.00	-	33.27		24.40		9.03	57.67
Nitrite	22-Nov-08	0:51	96	D8	22.3	0.00	-	34.17		22.54		10.12	56.72
Nitrite	22-Nov-08	1:35	140	D9	22.3	0.00	-	38.31		20.91		10.44	59.22
Nitrite	22-Nov-08	2:15	180	D10	22.2	0.00	-	39.83		19.87		12.48	59.70



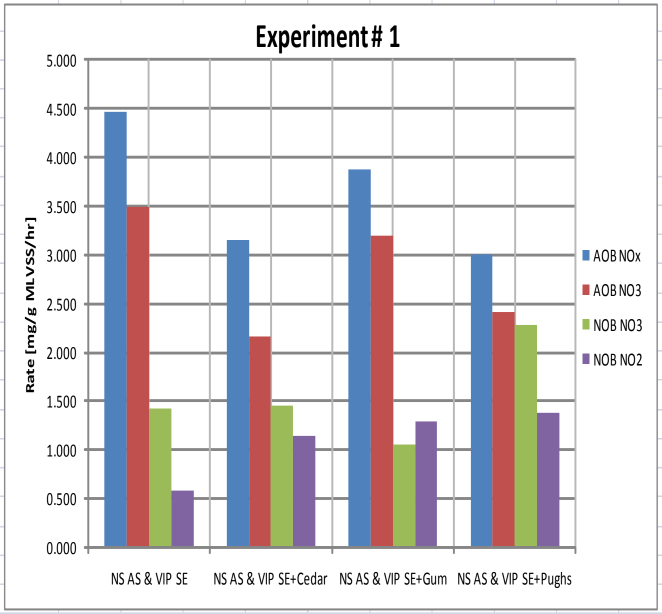


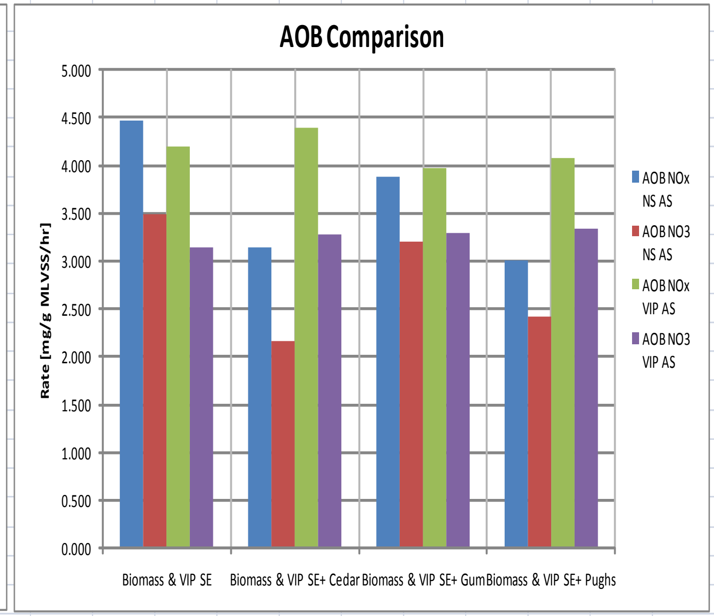
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: VIP											
Activated sludge	Ammonia	0.071	0.053		4.193	3.139		0.405	24.06	1351.54	1010.00
VIP SE	Nitrite		0.038	-0.013		2.251	-0.770	0.129	7.68	1351.54	1010.00
Reactor B: VIP											
Activated Sludge	Ammonia	0.078	0.058		4.394	3.281		0.516	29.22	1420.00	1060.00
VIP SE	Nitrite		0.046	-0.026		2.596	-1.489	0.137	7.78	1420.00	1060.00
Cedar Ln PS											
Reactor C: VIP											
Activated sludge	Ammonia	0.071	0.059		3.975	3.286		0.510	28.46	1420.00	1075.00
VIP SE	Nitrite		0.084	-0.029		4.689	-1.641	0.146	8.17	1420.00	1075.00
Gum Rd PRS											
Reactor D: VIP											
Activated Sludge	Ammonia	0.071	0.059		4.075	3.345		0.466	26.64	1370.00	1050.00
VIP SE	Nitrite		0.043	-0.033		2.480	-1.877	0.149	8.54	1370.00	1050.00
Pughsivlle PRS											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

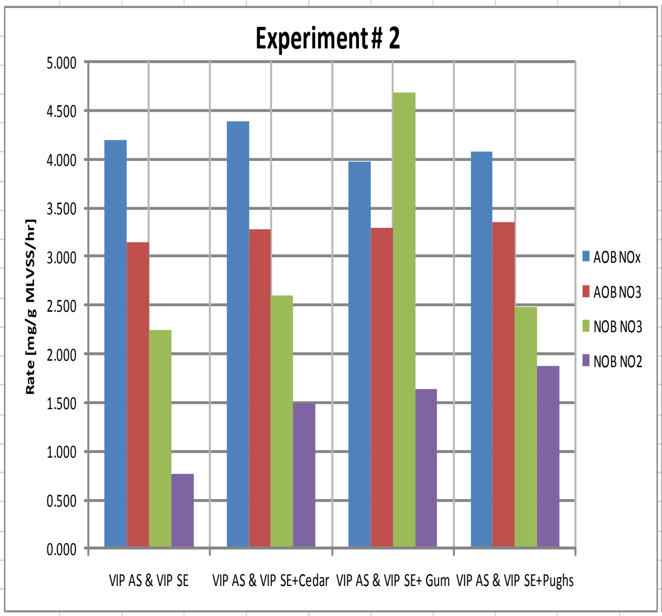
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE	4.468	3.490	1.417	0.583
Reactor B: NS Activated Sludge VIP SE Cedar Lane PS	3.150	2.162	1.456	1.142
Reactor C: NS Activated Sludge VIP SE Gum Road PRS	3.877	3.200	1.056	1.294
Reactor D: NS Activated Sludge VIP SE Pughsville PRS	3.009	2.418	2.280	1.377

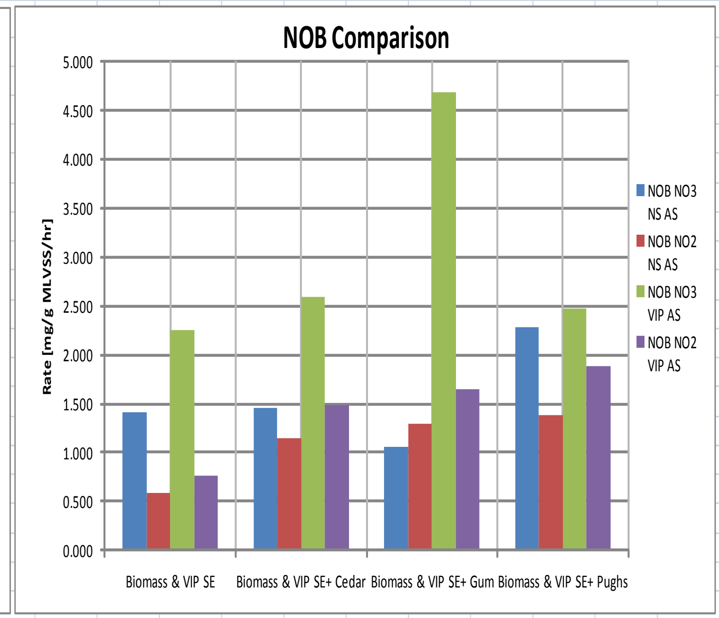




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: VIP Activated sludge VIP SE	4.193	3.139	2.251	0.770
Reactor B: VIP Activated Sludge VIP SE Cedar Lane PS	4.394	3.281	2.596	1.489
Reactor C: VIP Activated Sludge VIP SE Gum Road PRS	3.975	3.286	4.689	1.641
Reactor D: VIP Activated Sludge VIP SE Pughsville PRS	4.075	3.345	2.480	1.877





Week 10 – NS Raw, PCI, PCE Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

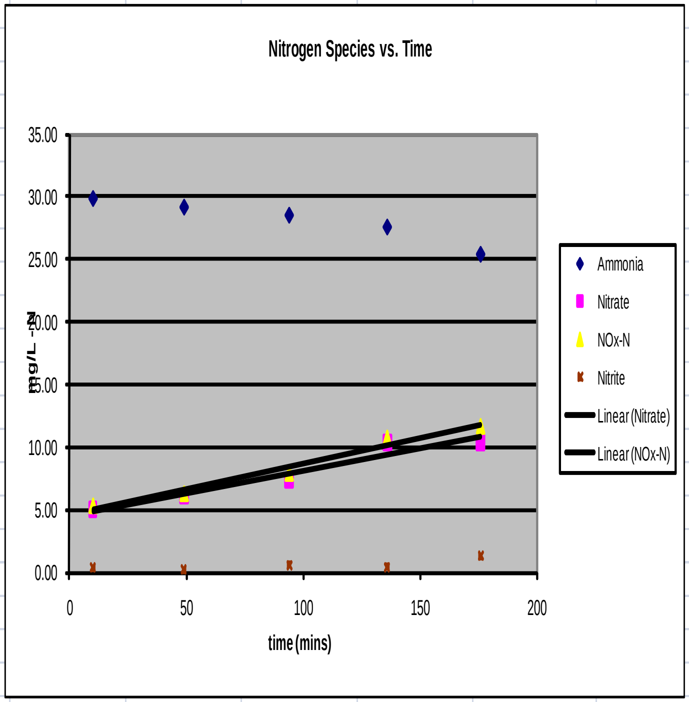
a. Spiked four 3L reactors with 25 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

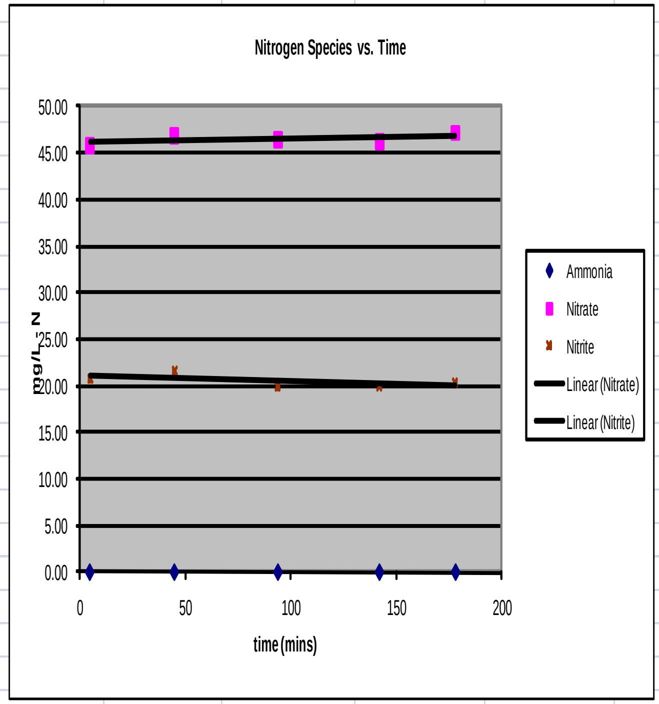
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

Reactor A: Nansemond Activated Sludge/VIP PE

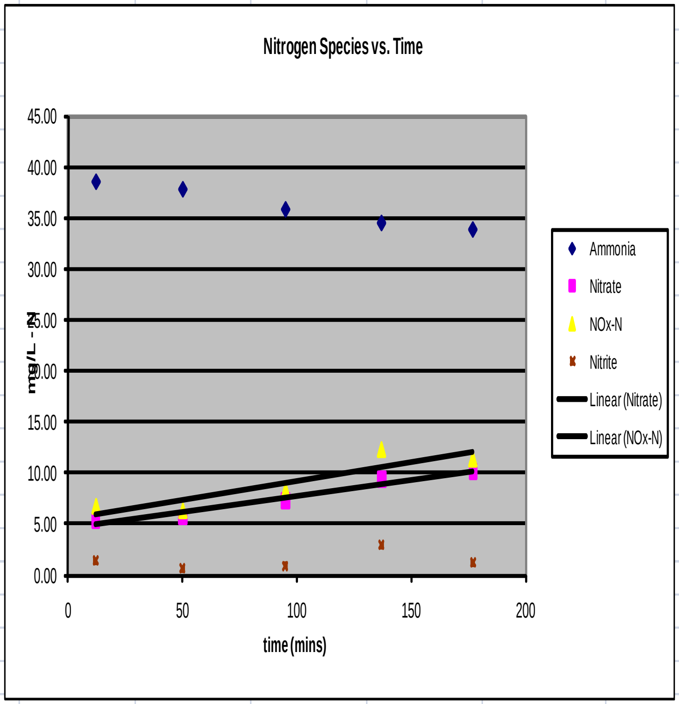
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Dec-08	9:36	10	A1	20.9	25.97	29.90	4.97		0.33		2.03	5.31
Ammonia	13-Dec-08	10:15	49	A2	20.7	23.85	29.20	6.05		0.23		0.65	6.28
Ammonia	13-Dec-08	11:00	94	A3	20.8	92.8506ALT	28.55	7.29		0.62		0.21	7.91
Ammonia	13-Dec-08	11:42	136	A4	20.4	22.56	27.60	10.33		0.44		0.27	10.77
Ammonia	13-Dec-08	12:22	176	A5	20.2	22.35	25.40	10.36		1.33		0.29	11.69
Nitrite	14-Dec-08	9:26	5	A6	20.2	0.00	-	45.79		20.69		5.40	66.47
Nitrite	14-Dec-08	10:06	45	A7	20.3	0.00	-	46.83		21.60		5.76	68.42
Nitrite	14-Dec-08	10:55	94	A8	19.8	0.00	-	46.47		19.90		5.81	66.37
Nitrite	14-Dec-08	11:43	142	A9	19.7	0.00	-	46.21		20.04		5.53	66.25
Nitrite	14-Dec-08	12:19	178	A10	19.6	0.00	-	47.15		20.29		5.77	67.44

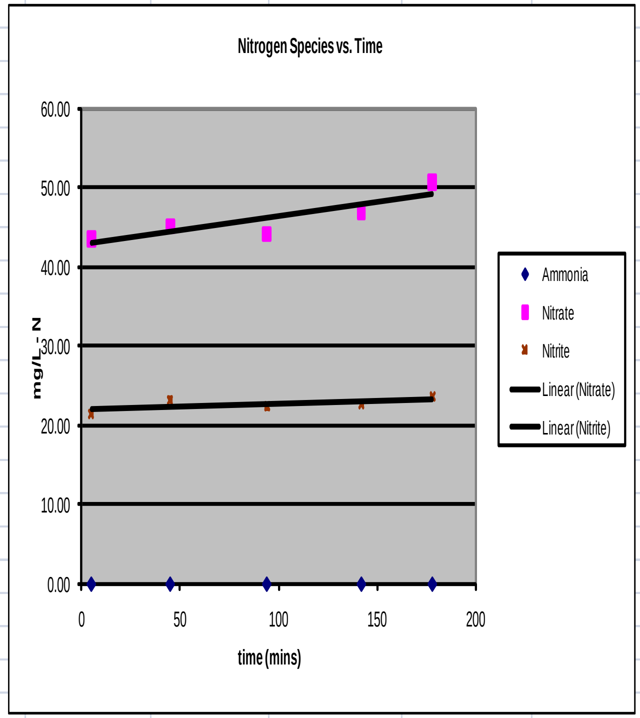




Reactor B: Nansemond Activated Sludge/NS Raw

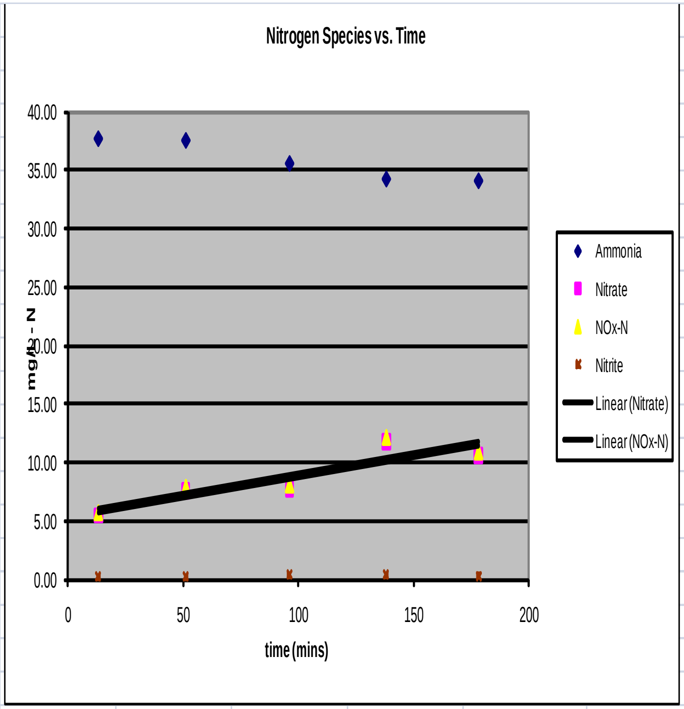
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Dec-08	9:39	12	B1	18.6	98.3510ALT	38.60	5.37		1.38		5.17	6.75
Ammonia	13-Dec-08	10:17	50	B2	19.0	35.57	37.85	5.68		0.63		5.56	6.31
Ammonia	13-Dec-08	11:02	95	B3	19.4	31.48	35.85	7.32		0.95		1.70	8.27
Ammonia	13-Dec-08	11:44	137	B4	19.6	27.03	34.50	9.35		2.95		0.30	12.30
Ammonia	13-Dec-08	12:24	177	B5	19.7	31.08	33.85	10.12		1.23		0.05	11.36
Nitrite	14-Dec-08	9:28	5	B6	20.2	0.00	-	43.57		21.48		4.13	65.05
Nitrite	14-Dec-08	10:08	45	B7	20.3	0.00	-	45.12		23.29		4.44	68.41
Nitrite	14-Dec-08	10:57	94	B8	19.7	0.00	-	44.15		22.38		4.87	66.53
Nitrite	14-Dec-08	11:45	142	B9	19.6	0.00	-	47.06		22.79		5.08	69.85
Nitrite	14-Dec-08	12:21	178	B10	19.6	0.00	-	50.74		23.58		5.58	74.32

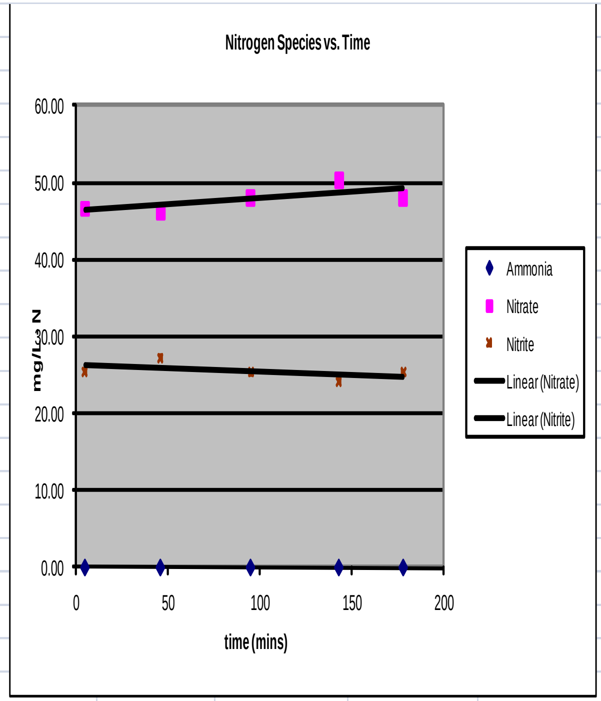




Reactor C: Nansemond Activated Sludge/NS PC Inf.

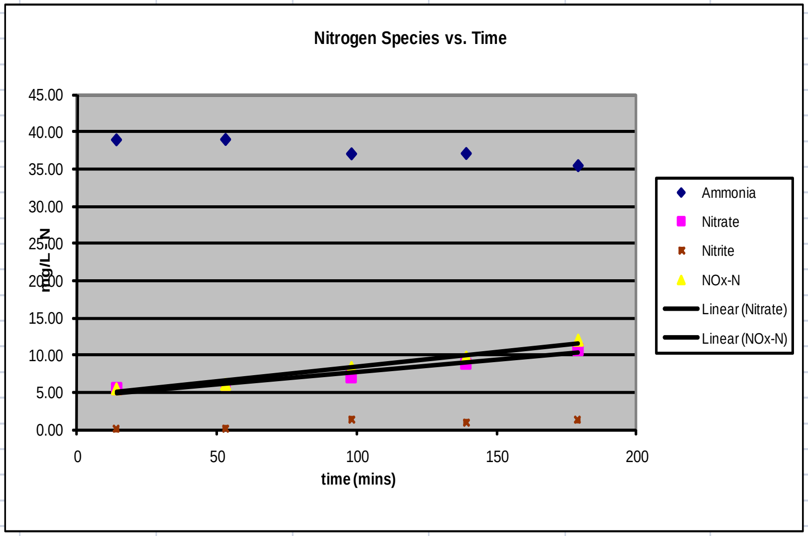
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Dec-08	9:41	13	C1	18.8	31.71	37.70	5.47		0.21		6.41	5.67
Ammonia	13-Dec-08	10:19	51	C2	19.7	29.86	37.55	7.61		0.24		4.99	7.85
Ammonia	13-Dec-08	11:04	96	C3	19.8	32.69	35.55	7.70		0.35		1.79	8.04
Ammonia	13-Dec-08	11:46	138	C4	20	25.56	34.20	11.76		0.35		0.59	12.11
Ammonia	13-Dec-08	12:26	178	C5	20	0.00	34.05	10.57		0.29		0.32	10.87
Nitrite	14-Dec-08	9:29	5	C6	20.4	0.00	-	46.62		25.52		4.97	72.14
Nitrite	14-Dec-08	10:10	46	C7	20.0	0.00	-	46.24		27.29		5.25	73.53
Nitrite	14-Dec-08	10:59	95	C8	19.8	0.00	-	47.98		25.28		5.62	73.26
Nitrite	14-Dec-08	11:47	143	C9	19.8	0.00	-	50.33		24.25		5.86	74.58
Nitrite	14-Dec-08	12:22	178	C10	19.7	0.00	-	48.05		25.39		6.04	73.44

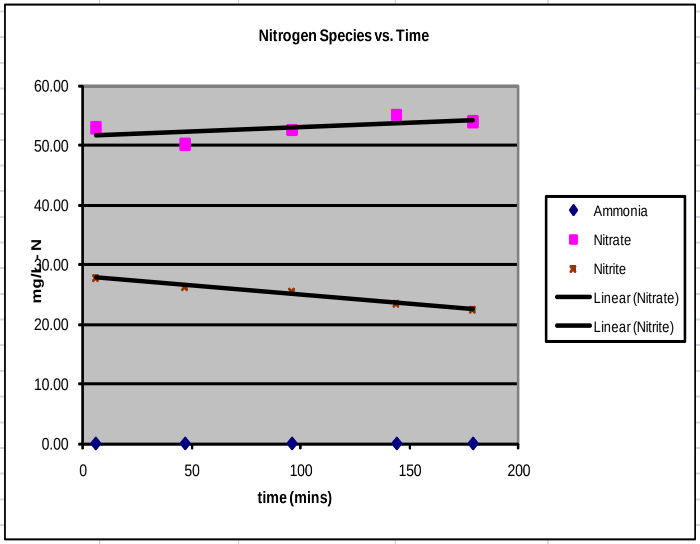




Reactor D: Nansemond Activated Sludge/NS PC Eff.

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	13-Dec-08	9:43	14	D1	19.0	35.97	38.90	5.46		0.06		6.27	5.52
Ammonia	13-Dec-08	10:22	53	D2	19.7	72.77	38.95	5.97		0.15		5.61	6.12
Ammonia	13-Dec-08	11:07	98	D3	19.9	30.73	37.00	7.04		1.32		2.00	8.36
Ammonia	13-Dec-08	11:48	139	D4	19.9	31.57	37.05	8.80		0.95		0.79	9.75
Ammonia	13-Dec-08	12:28	179	D5	20	0.00	35.40	10.78		1.24		0.31	12.02
Nitrite	14-Dec-08	9:31	6	D6	19.4	0.00	-	52.99		27.79		4.19	80.78
Nitrite	14-Dec-08	10:12	47	D7	19.5	0.00	-	50.17		26.21		4.85	76.38
Nitrite	14-Dec-08	11:01	96	D8	19.5	0.00	-	52.51		25.40		5.09	77.91
Nitrite	14-Dec-08	11:49	144	D9	19.7	0.00	-	55.03		23.52		5.41	78.55
Nitrite	14-Dec-08	12:24	179	D10	19.7	0.00	-	53.85		22.46		6.22	76.31





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.041	0.036		1.920	1.676		0.344	16.02	1930.00	1290.00
VIP PE	Nitrite		0.004	-0.006		0.207	-0.259	0.106	4.91	1930.00	1290.00
Reactor B: NS											
Activated Sludge	Ammonia	0.037	0.032		1.629	1.405		0.419	18.54	2025.00	1355.00
NS Raw	Nitrite		0.036	0.008		1.598	0.355	0.168	7.45	2025.00	1355.00
Reactor C: NS											
Activated Sludge	Ammonia	0.035	0.034		1.597	1.567		0.430	19.54	1965.00	1320.00
NS PC Inf	Nitrite		0.016	-0.008		0.750	-0.364	0.108	4.89	1965.00	1320.00
Reactor D: NS											
Activated Sludge	Ammonia	0.040	0.032		1.839	1.488		0.425	19.53	1925.00	1305.00
NS PC Eff	Nitrite		0.016	-0.030		0.717	-1.382	0.120	5.51	1925.00	1305.00

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 10 – Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

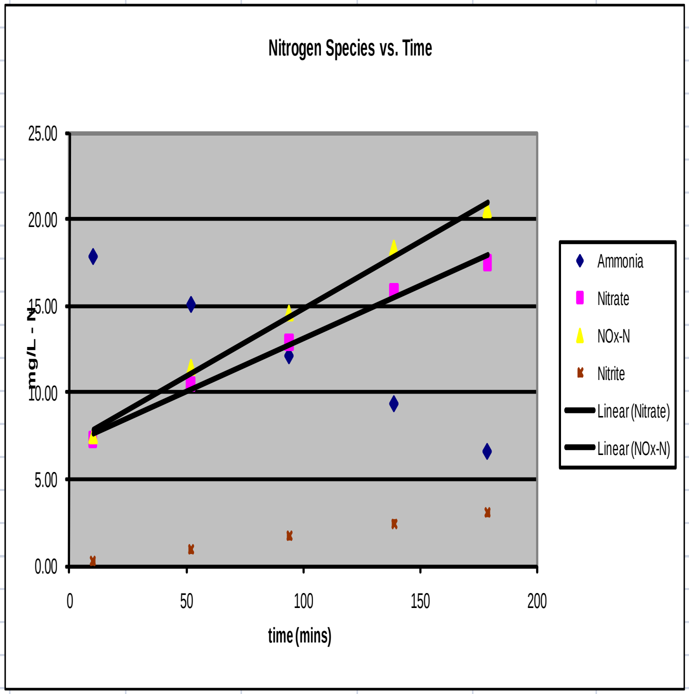
a. Spiked four 3L reactors with 10 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 1900 mL of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

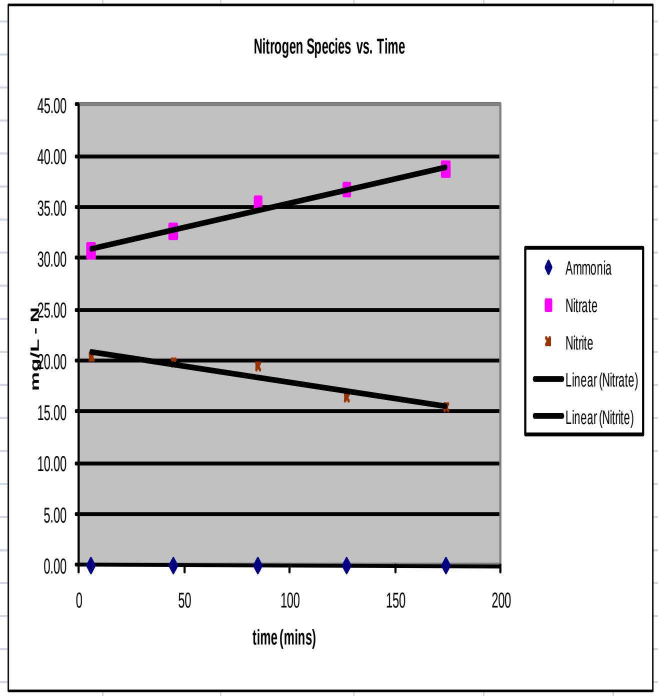
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated 1L of VIP SE and 1L of the associated interceptor lines for each reactor.

Reactor A: VIP Activated Sludge/VIP PE

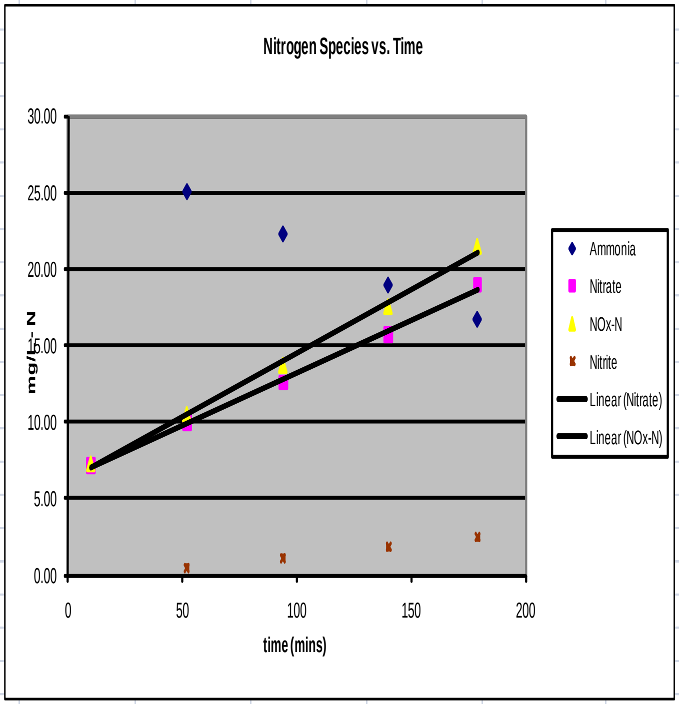
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	14-Dec-08	14:13	10	A1	20.8	16.78	17.80	7.26		0.23		3.32	7.49
Ammonia	14-Dec-08	14:55	52	A2	20.8	33.31	15.05	10.49		0.94		1.58	11.44
Ammonia	14-Dec-08	15:37	94	A3	20.7	101.69	12.10	12.87		1.70		1.11	14.57
Ammonia	14-Dec-08	16:22	139	A4	20.3	0.00	9.35	15.86		2.46		0.93	18.32
Ammonia	14-Dec-08	17:02	179	A5	19.9	0.00	6.61	17.48		3.03		0.96	20.51
Nitrite	14-Dec-08	22:15	6	A6	19.4	0.00	-	30.78		20.40		4.31	51.18
Nitrite	14-Dec-08	22:54	45	A7	19.2	0.00	-	32.61		19.92		2.24	52.53
Nitrite	14-Dec-08	23:34	85	A8	19.4	0.00	-	35.44		19.49		2.43	54.93
Nitrite	14-Dec-08	0:16	127	A9	19.4	0.00	-	36.73		16.44		2.64	53.17
Nitrite	14-Dec-08	1:03	174	A10	19.4	0.00	-	38.72		15.53		2.86	54.25

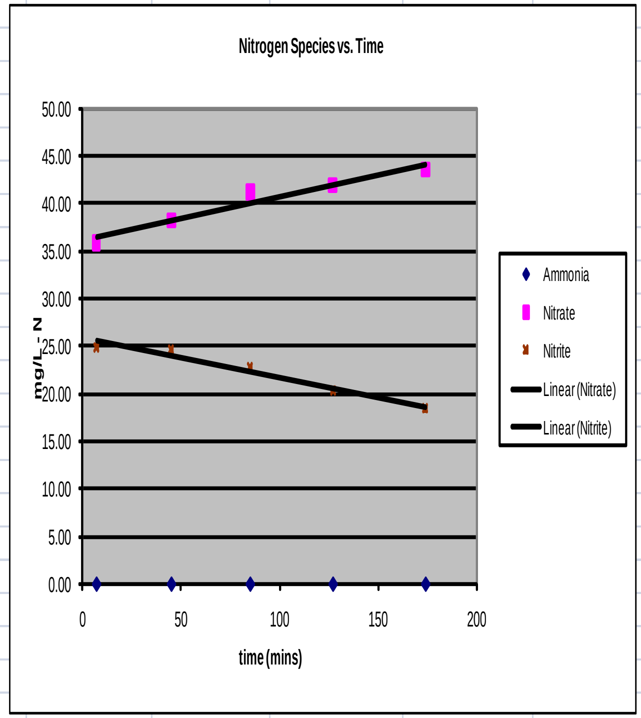




Reactor B: VIP Activated Sludge/NS Raw

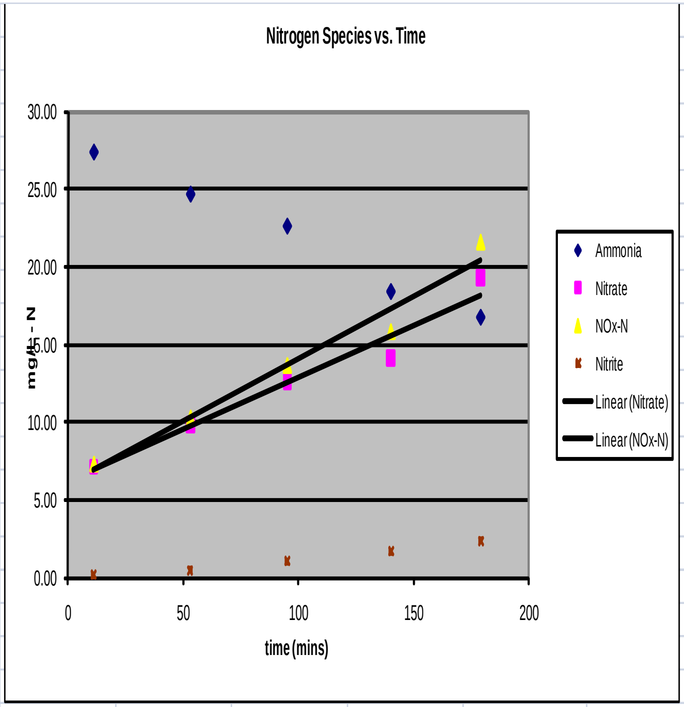
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	14-Dec-08	14:14	10	B1	18.7	136.60	27.30	7.13		0.15		7.43	7.28
Ammonia	14-Dec-08	14:56	52	B2	19.4	24.51	25.05	9.99		0.51		4.96	10.50
Ammonia	14-Dec-08	15:38	94	B3	19.5	107.90	22.30	12.57		1.12		1.58	13.69
Ammonia	14-Dec-08	16:24	140	B4	19.4	17.30	18.98	15.70		1.82		0.04	17.51
Ammonia	14-Dec-08	17:03	179	B5	19.5	16.89	16.75	18.95		2.49		0.00	21.44
Nitrite	14-Dec-08	22:17	7	B6	19.4	0.00	-	35.92		24.88		0.24	60.80
Nitrite	14-Dec-08	22:55	45	B7	19.4	0.00	-	38.22		24.59		0.73	62.81
Nitrite	14-Dec-08	23:35	85	B8	19.5	0.00	-	41.19		22.73		0.88	63.91
Nitrite	14-Dec-08	0:17	127	B9	19.5	0.00	-	41.96		20.34		1.02	62.30
Nitrite	14-Dec-08	1:04	174	B10	19.5	0.00	-	43.60		18.41		1.28	62.01

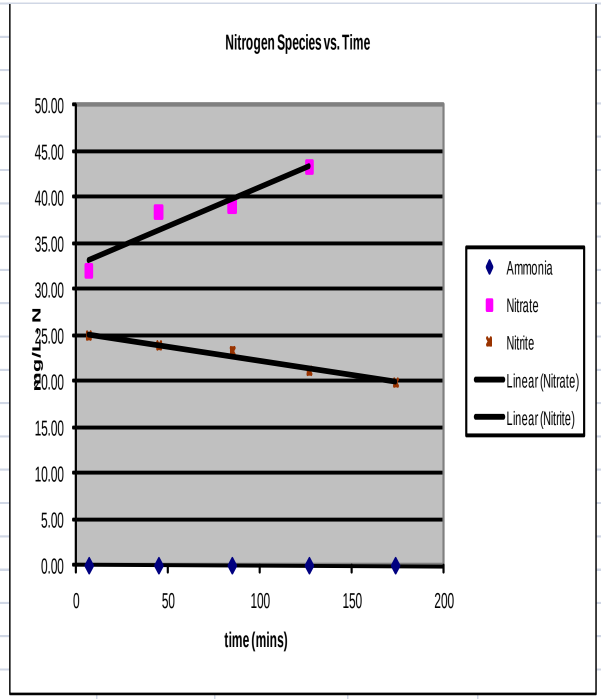




Reactor C: VIP Activated Sludge/NS PC Inf.

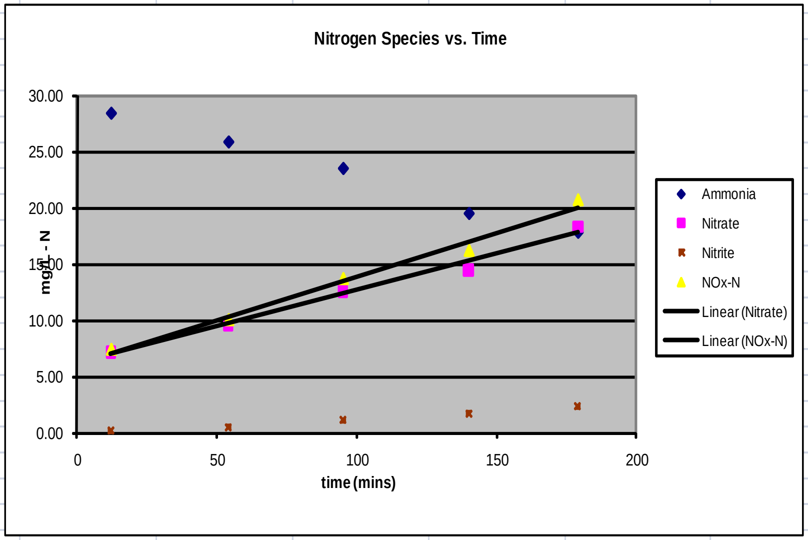
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	14-Dec-08	14:16	11	C1	18.5	107.90	27.40	7.13		0.17		8.65	7.30
Ammonia	14-Dec-08	14:58	53	C2	19.4	21.56	24.70	9.80		0.48		5.34	10.28
Ammonia	14-Dec-08	15:40	95	C3	19.45	21.03	22.65	12.60		1.07		3.26	13.66
Ammonia	14-Dec-08	16:25	140	C4	19.35	94.64	18.45	14.15		1.70		2.02	15.85
Ammonia	14-Dec-08	17:04	179	C5	19.4	15.78	16.80	19.27		2.36		1.45	21.63
Nitrite	14-Dec-08	22:18	7	C6	19.4	0.00	-	32.02		24.96		1.03	56.98
Nitrite	14-Dec-08	22:56	45	C7	19.5	0.00	-	38.39		23.89		1.57	62.28
Nitrite	14-Dec-08	23:36	85	C8	19.6	0.00	-	39.08		23.32		1.91	62.39
Nitrite	14-Dec-08	0:18	127	C9	19.6	0.00	-	43.28		21.07		2.23	64.34
Nitrite	14-Dec-08	1:05	174	C10	19.6	0.00	-	39.84		19.87		2.80	59.71

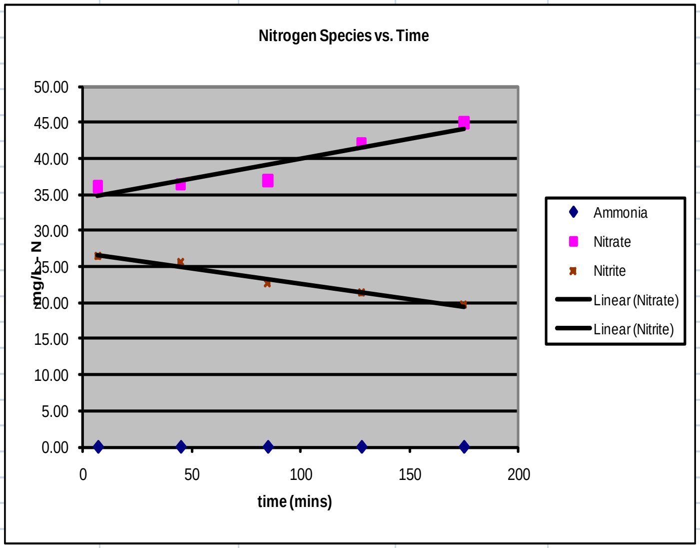




Reactor D: VIP Activated Sludge/NS PC Eff.

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N
Ammonia	14-Dec-08	14:18	12	D1	18.6	25.81	28.40	7.19		0.18		8.63	7.37
Ammonia	14-Dec-08	15:00	54	D2	19.5	22.97	25.85	9.51		0.50		5.38	10.01
Ammonia	14-Dec-08	15:41	95	D3	19.4	20.71	23.50	12.56		1.11		3.05	13.67
Ammonia	14-Dec-08	16:26	140	D4	19.4	42.69	19.50	14.47		1.70		1.63	16.17
Ammonia	14-Dec-08	17:05	179	D5	19.4	0.00	17.83	18.31		2.36		0.93	20.67
Nitrite	14-Dec-08	22:19	7	D6	19.4	0.00	-	36.08		26.39		0.63	62.48
Nitrite	14-Dec-08	22:57	45	D7	19.42	0.00	-	36.42		25.58		0.89	62.00
Nitrite	14-Dec-08	23:37	85	D8	19.5	0.00	-	36.95		22.72		1.28	59.66
Nitrite	14-Dec-08	0:20	128	D9	19.6	0.00	-	42.06		21.39		1.48	63.45
Nitrite	14-Dec-08	1:07	175	D10	19.6	0.00	-	44.87		19.69		1.76	64.56



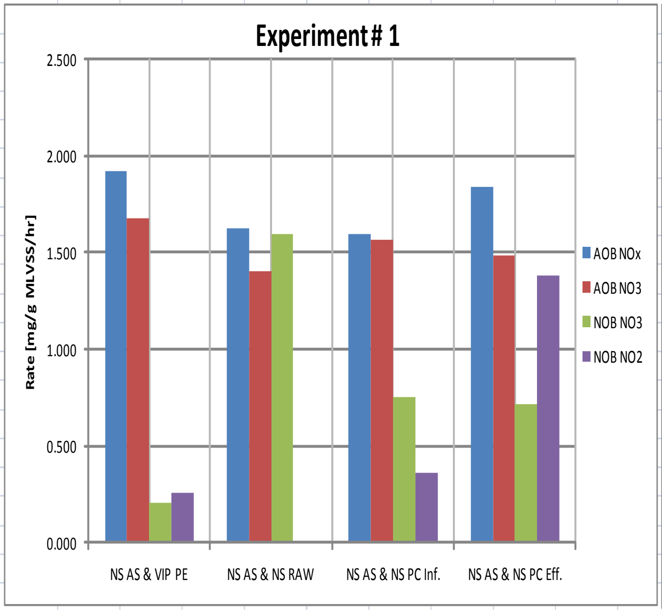


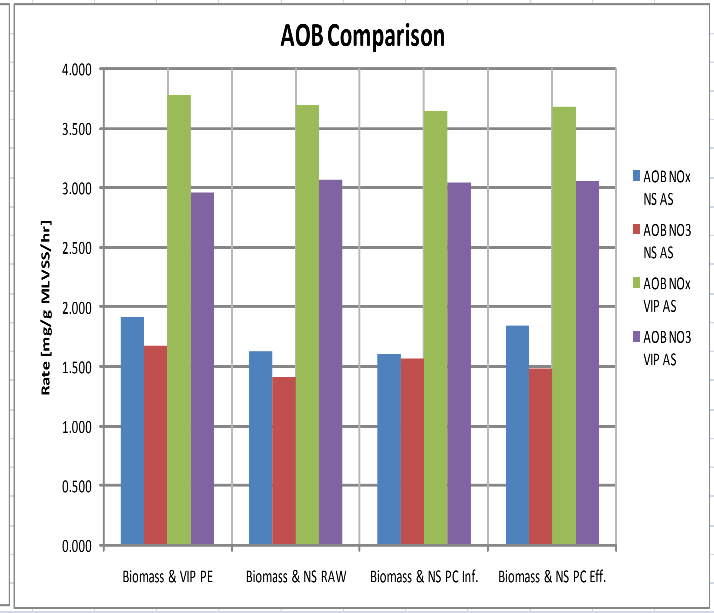
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: VIP											
Activated sludge	Ammonia	0.078	0.061		3.781	2.963		0.344	16.80	1640.00	1230.00
VIP PE	Nitrite		0.048	-0.032		2.325	-1.550	0.106	5.15	1640.00	1230.00
Reactor B: VIP											
Activated Sludge	Ammonia	0.083	0.069		3.697	3.071		0.419	18.67	1770.00	1345.00
NS Raw	Nitrite		0.046	-0.042		2.032	-1.853	0.168	7.50	1770.00	1345.00
Reactor C: VIP											
Activated sludge	Ammonia	0.081	0.067		3.640	3.042		0.430	19.40	1745.00	1330.00
NS PC Inf	Nitrite		0.086	-0.031		3.874	-1.415	0.108	4.86	1745.00	1330.00
Reactor D: VIP											
Activated Sludge	Ammonia	0.078	0.065		3.678	3.053		0.425	20.07	1695.00	1270.00
NS PC Eff	Nitrite		0.056	-0.042		2.650	-1.980	0.120	5.66	1695.00	1270.00

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

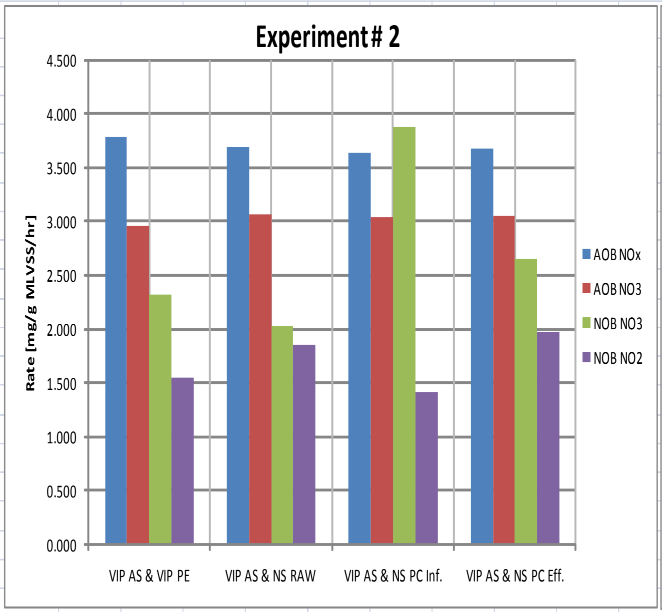
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP PE	1.920	1.676	0.207	0.259
Reactor B: NS Activated Sludge NS Raw	1.629	1.405	1.598	0.000
Reactor C: NS Activated Sludge NS PC Inf	1.597	1.567	0.750	0.364
Reactor D: NS Activated Sludge NS PC Eff	1.839	1.488	0.717	1.382

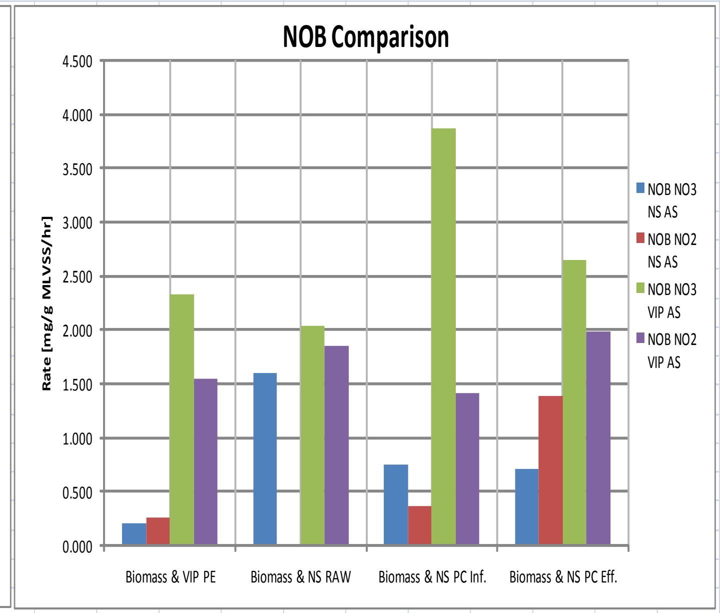




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: VIP Activated sludge VIP PE	3.781	2.963	2.325	1.550
Reactor B: VIP Activated Sludge NS Raw	3.697	3.071	2.032	1.853
Reactor C: VIP Activated Sludge NS PC Inf	3.640	3.042	3.874	1.415
Reactor D: VIP Activated Sludge NS PC Eff	3.678	3.053	2.650	1.980





Week 11 – FeCl3 Addition Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

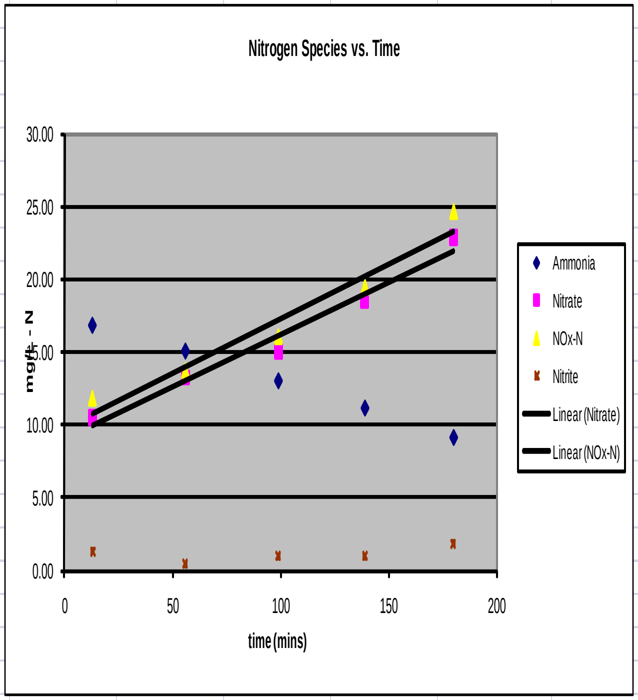
a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 μm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
j. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.

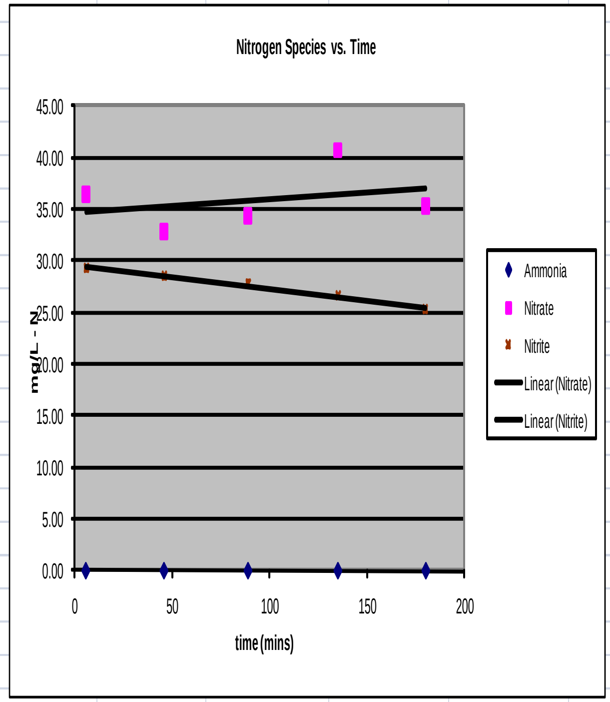
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 μm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
h. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.

Reactor A: Nansemond Activated Sludge/VIP SE

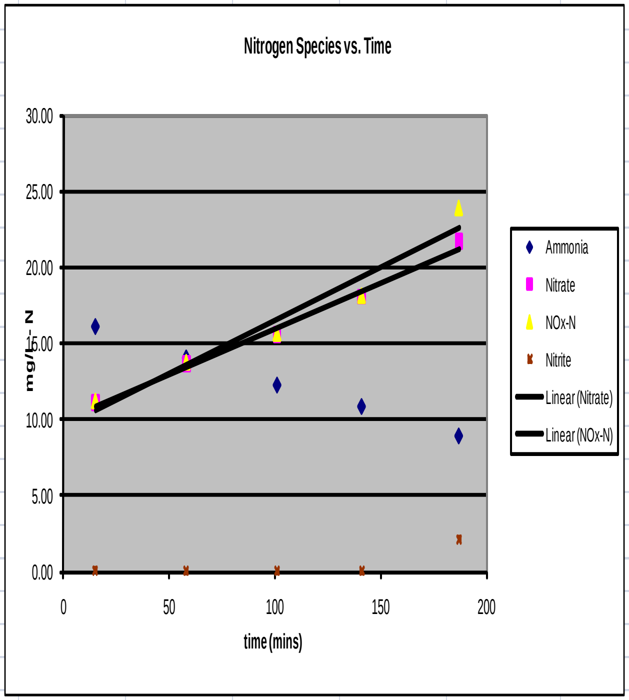
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Jan-09	10:06	13	A1	21.2	16.09	16.80	10.52		1.28		0.21	11.80	0.675
Ammonia	6-Jan-09	10:49	56	A2	20.3	14.22	15.05	13.27		0.43		0.31	13.70	0.725
Ammonia	6-Jan-09	11:32	99	A3	19.7	13.52	13.03	15.03		1.01		0.39	16.04	0.875
Ammonia	6-Jan-09	12:12	139	A4	19.4	11.69	11.18	18.49		0.97		0.48	19.46	0.95
Ammonia	6-Jan-09	12:53	180	A5	19.6	8.48	9.18	22.83		1.82		0.62	24.65	1.07
Nitrite	6-Jan-09	17:15	6	A6	18.6	0.00	-	36.41		29.31		1.46	65.73	1.82
Nitrite	6-Jan-09	17:55	46	A7	18.7	0.00	-	32.86		28.50		1.63	61.36	2.04
Nitrite	6-Jan-09	18:38	89	A8	18.8	0.00	-	34.31		27.88		2.16	62.19	2.5
Nitrite	6-Jan-09	19:24	135	A9	18.8	0.00	-	40.75		26.62		2.42	67.37	2.7
Nitrite	6-Jan-09	20:09	180	A10	18.8	0.00	-	35.26		25.30		2.51	60.56	2.85

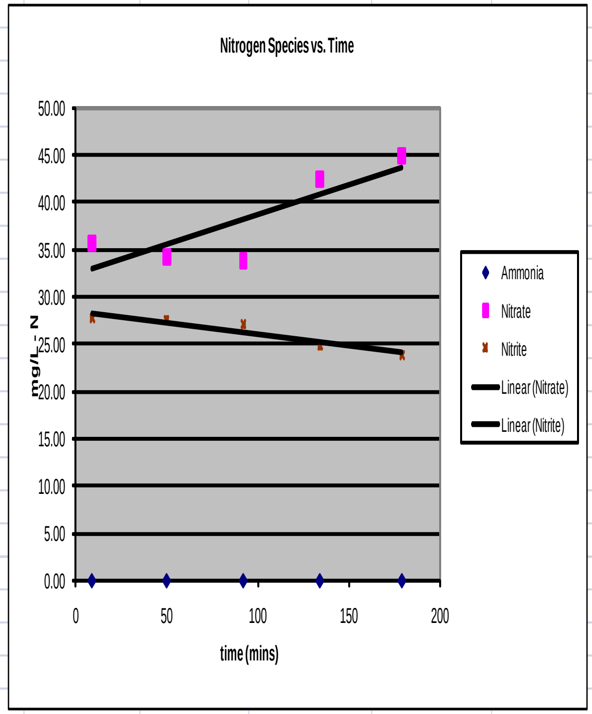




Reactor B: Nansemond Activated Sludge/VIP SE + 20 mg/L Fe

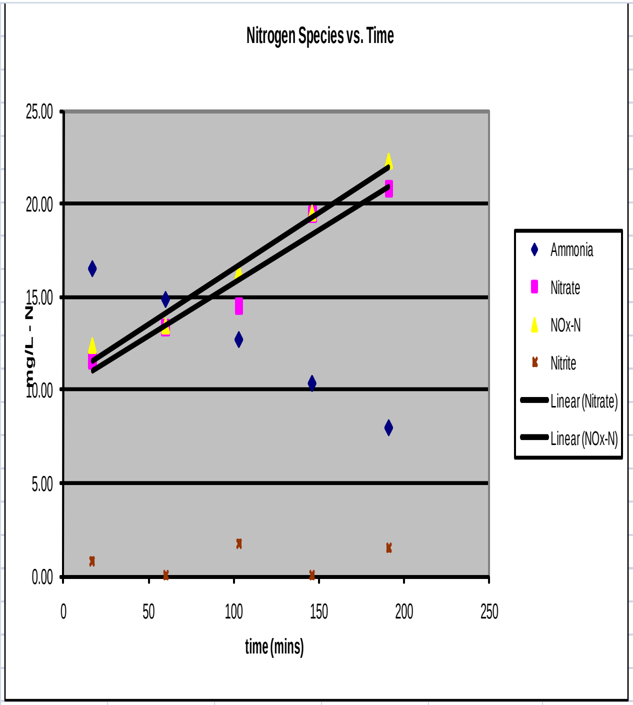
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Jan-09	10:08	15	B1	21.3	12.34	16.10	11.12		0.07		-0.134ALT	11.19	0.45
Ammonia	6-Jan-09	10:51	58	B2	20.3	11.33	14.05	13.67		0.06		-0.306ALT	13.73	0.225
Ammonia	6-Jan-09	11:34	101	B3	19.4	11.27	12.28	15.57		0.05		0.06	15.61	0.525
Ammonia	6-Jan-09	12:14	141	B4	19.6	8.31	10.88	18.04		0.05		0.23	18.10	0.6
Ammonia	6-Jan-09	13:00	187	B5	20	9.10	8.95	21.70		2.16		0.15	23.86	0.66
Nitrite	6-Jan-09	17:19	9	B6	18.8	0.00	-	35.64		27.80		0.78	63.45	1.22
Nitrite	6-Jan-09	18:00	50	B7	18.9	0.00	-	34.29		27.57		1.08	61.86	1.48
Nitrite	6-Jan-09	18:42	92	B8	18.9	0.00	-	33.76		27.08		1.51	60.84	1.875
Nitrite	6-Jan-09	19:24	134	B9	18.9	0.00	-	42.46		24.79		1.79	67.25	2.05
Nitrite	6-Jan-09	20:09	179	B10	19	0.00	-	44.86		23.92		1.90	68.78	2.25

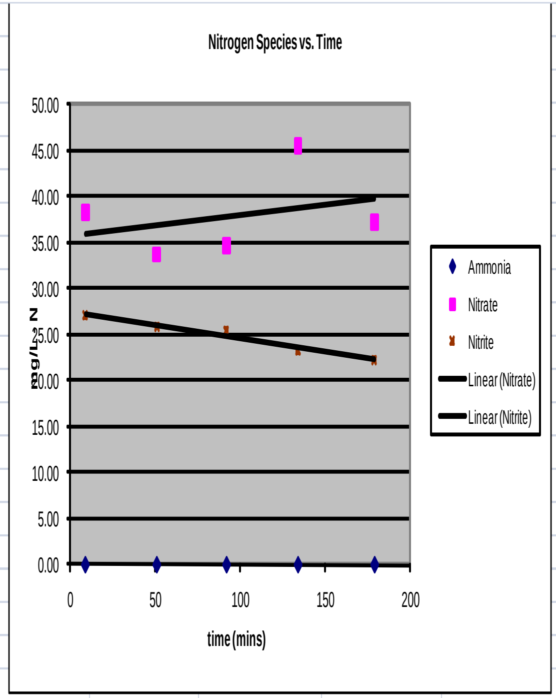




Reactor C: Nansemond Activated Sludge/VIP SE + 35 mg/L Fe

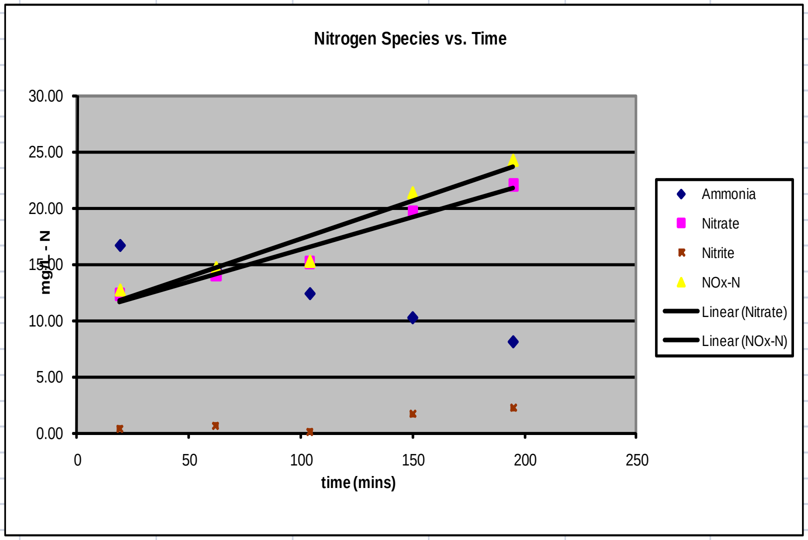
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Jan-09	10:10	17	C1	21.3	16.38	16.50	11.55		0.79		-0.344ALT	12.34	0.275
Ammonia	6-Jan-09	10:53	60	C2	19.5	14.50	14.85	13.35		0.03		-0.279ALT	13.38	0.225
Ammonia	6-Jan-09	11:36	103	C3	19.7	12.55	12.70	14.52		1.76		-0.276ALT	16.28	0.275
Ammonia	6-Jan-09	12:19	146	C4	20.2	9.63	10.35	19.43		0.04		-0.164ALT	19.47	0.625
Ammonia	6-Jan-09	13:04	191	C5	20.5	8.18	7.98	20.77		1.49		-0.119ALT	22.26	0.35
Nitrite	6-Jan-09	17:19	9	C6	18.9	0.00	-	38.36		27.12		0.39	65.48	0.86
Nitrite	6-Jan-09	18:01	51	C7	19.0	0.00	-	33.70		25.89		0.68	59.59	1.12
Nitrite	6-Jan-09	18:42	92	C8	19.0	0.00	-	34.70		25.51		0.97	60.21	1.375
Nitrite	6-Jan-09	19:24	134	C9	19	0.00	-	45.54		23.22		1.15	68.76	1.6
Nitrite	6-Jan-09	20:09	179	C10	19.1	0.00	-	37.20		22.24		1.34	59.44	1.8

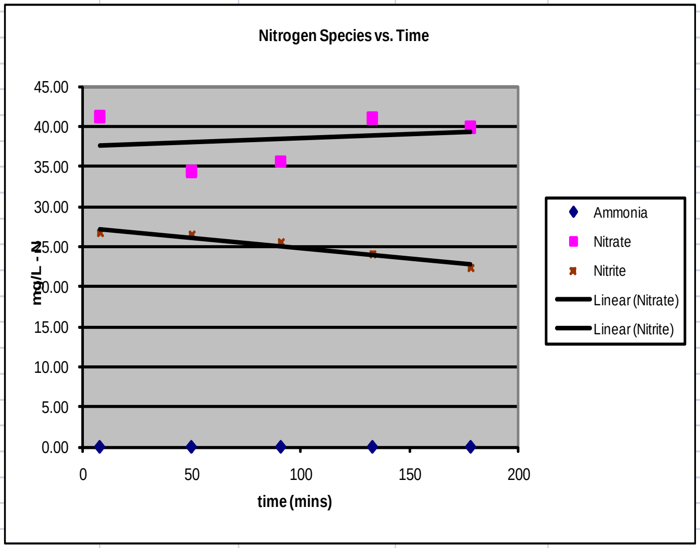




Reactor D: Nansemond Activated Sludge/VIP SE + 50 mg/L Fe

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Jan-09	10:12	19	D1	21.1	17.18	16.70	12.32		0.34		-0.183ALT	12.66	0.3
Ammonia	6-Jan-09	10:55	62	D2	19.4	15.90	14.55	13.97		0.67		-0.243ALT	14.64	0.275
Ammonia	6-Jan-09	11:37	104	D3	19.8	8.80	12.40	15.14		0.07		-0.203ALT	15.21	0.325
Ammonia	6-Jan-09	12:23	150	D4	20.3	10.21	10.25	19.65		1.65		-0.167ALT	21.30	0.675
Ammonia	6-Jan-09	13:08	195	D5	20.4	8.62	8.10	21.99		2.19		-0.104ALT	24.18	0.36
Nitrite	6-Jan-09	17:19	8	D6	18.9	0.00	-	41.24		26.73		0.32	67.96	0.81
Nitrite	6-Jan-09	18:01	50	D7	18.9	0.00	-	34.40		26.41		0.62	60.80	1.04
Nitrite	6-Jan-09	18:42	91	D8	19	0.00	-	35.62		25.46		0.89	61.08	1.325
Nitrite	6-Jan-09	19:24	133	D9	19	0.00	-	41.02		24.06		1.10	65.08	1.5
Nitrite	6-Jan-09	20:09	178	D10	19.1	0.00	-	39.94		22.40		1.25	62.33	1.7





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.075	0.071		3.282	3.115		0.325	14.18	2055.00	1375.00
VIP SE	Nitrite		0.013	-0.023		0.577	-0.991	0.110	4.80	2055.00	1375.00
Reactor B: NS											
Activated Sludge	Ammonia	0.070	0.060		3.233	2.774		0.278	12.90	1935.00	1295.00
VIP SE	Nitrite		0.063	-0.025		2.924	-1.155	0.108	4.98	1935.00	1295.00
20 mg/L Fe											
Reactor C: NS											
Activated Sludge	Ammonia	0.060	0.056		2.869	2.712		0.296	14.22	1895.00	1250.00
VIP SE	Nitrite		0.022	-0.029		1.056	-1.411	0.117	5.63	1895.00	1250.00
35 mg/L Fe											
Reactor D: NS											
Activated Sludge	Ammonia	0.068	0.057		3.202	2.695		0.285	13.46	1950.00	1270.00
VIP SE	Nitrite		0.010	-0.026		0.454	-1.232	0.109	5.16	1950.00	1270.00
50 mg/L Fe											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 11 – Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

a. Spiked four 3L reactors with 20 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 1900 mL of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes th rough millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
j. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.

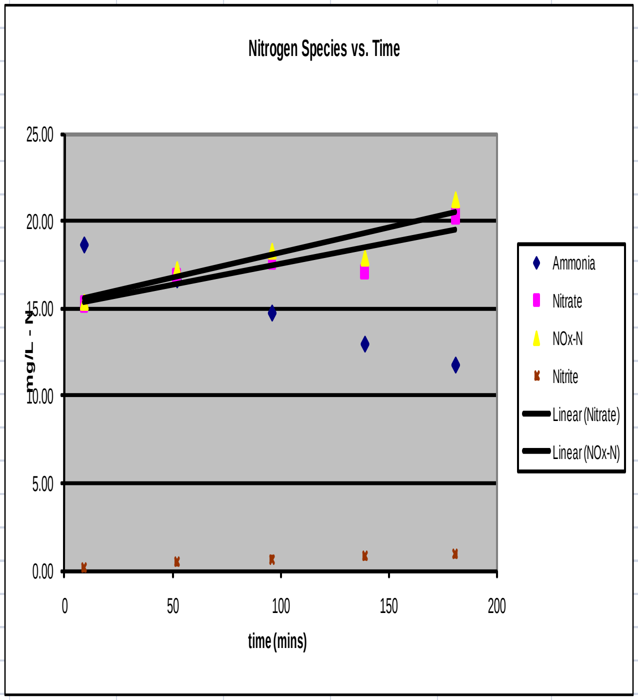
II. NOB

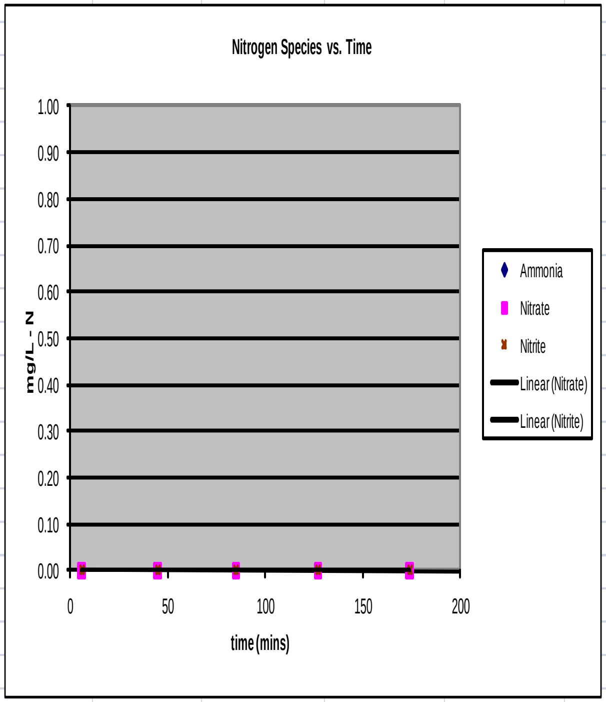
a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
h. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition

NOTE NOB EXPERIMENT WAS NOT RUN DURING DAY 2 EXPERIMENTATION

Reactor A: VIP Activated Sludge/VIP SE

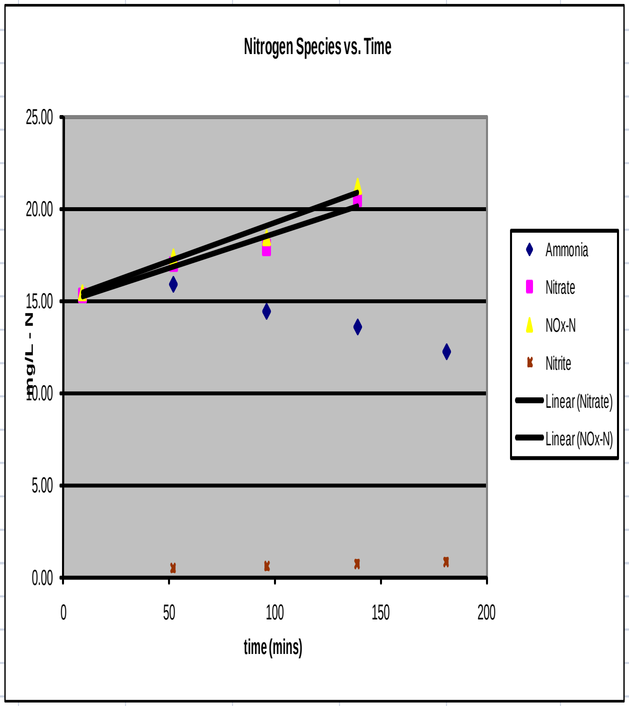
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Jan-09	19:12	9	A1	19.2	19.10	18.60	15.21		0.16		0.88	15.37	1.08
Ammonia	7-Jan-09	19:55	52	A2	19.1	17.96	16.60	16.79		0.46		0.96	17.25	1.15
Ammonia	7-Jan-09	20:39	96	A3	19.0	15.22	14.70	17.64		0.66		0.95	18.30	1.25
Ammonia	7-Jan-09	21:22	139	A4	19.0	13.39	12.93	17.11		0.79		0.99	17.91	1.25
Ammonia	7-Jan-09	22:04	181	A5	18.9	12.05	11.73	20.31		0.94		1.04	21.25	1.225
Nitrite	14-Dec-08	22:15	6	A6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:54	45	A7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:34	85	A8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:16	127	A9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:03	174	A10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0

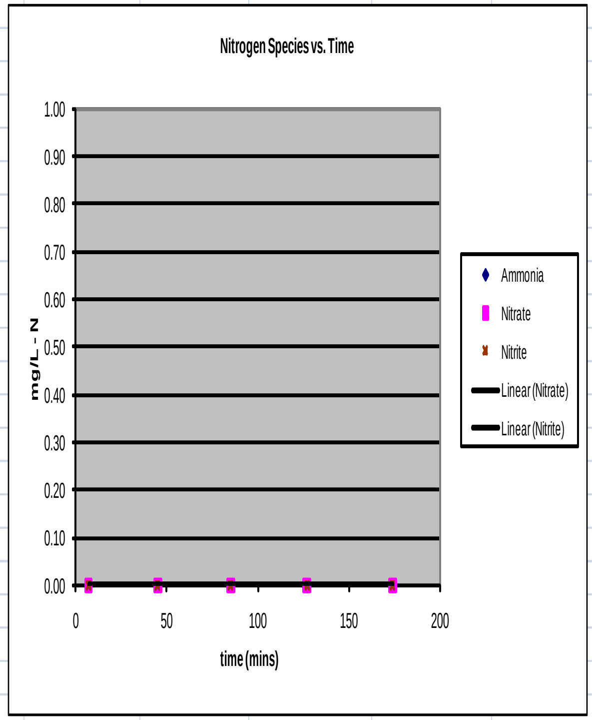




Reactor B: VIP Activated Sludge/VIP SE + 20 mg/L Fe

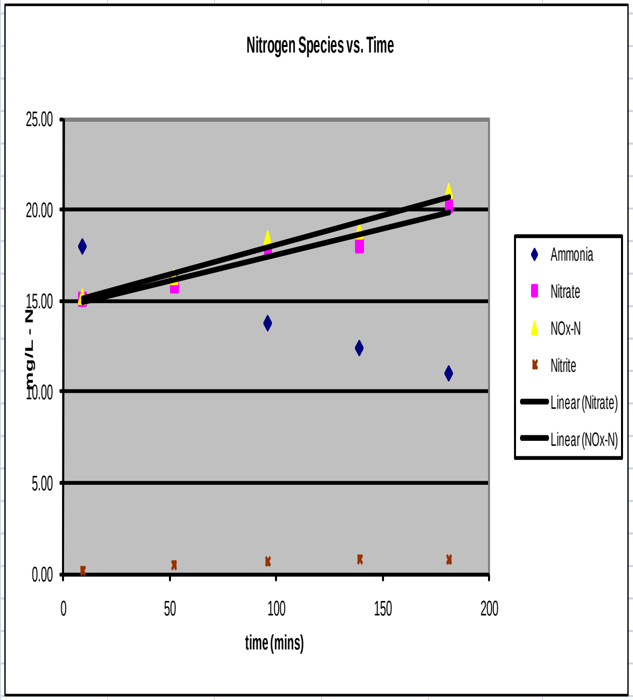
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Jan-09	19:12	9	B1	19.2	19.83	18.00	15.27		0.19		0.07	15.46	0.36
Ammonia	7-Jan-09	19:55	52	B2	18.8	16.15	15.90	16.96		0.43		0.55	17.39	0.775
Ammonia	7-Jan-09	20:39	96	B3	19.0	16.99	14.43	17.87		0.54		0.43	18.42	0.7
Ammonia	7-Jan-09	21:22	139	B4	18.9	13.59	13.58	20.48		0.70		0.26	21.18	0.57
Ammonia	7-Jan-09	22:04	181	B5	18.8	12.86	12.23	20.00		0.84		0.24	20.85	0.51
Nitrite	14-Dec-08	22:17	7	B6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:55	45	B7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:35	85	B8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:17	127	B9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:04	174	B10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0

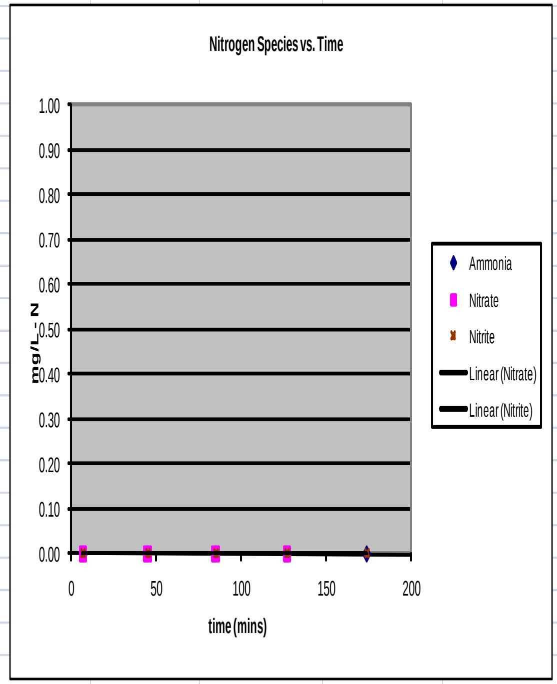




Reactor C: VIP Activated Sludge/VIP SE + 35 mg/L Fe

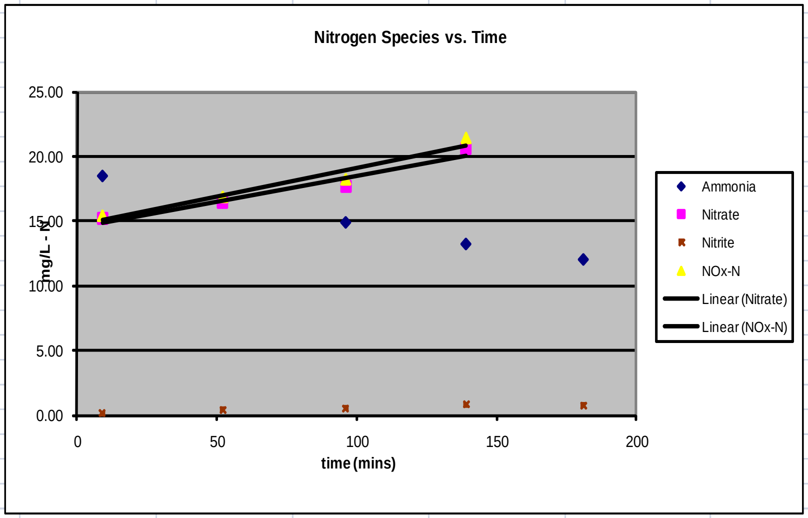
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Jan-09	19:12	9	C1	19.1	19.10	18.00	15.07		0.19		-0.063ALT	15.27	0.24
Ammonia	7-Jan-09	19:55	52	C2	19.0	17.08	16.25	15.86		0.48		-0.066ALT	16.34	0.275
Ammonia	7-Jan-09	20:39	96	C3	18.9	15.63	13.75	17.75		0.66		-0.096ALT	18.41	0.225
Ammonia	7-Jan-09	21:22	139	C4	18.9	13.07	12.38	18.01		0.81		-0.058ALT	18.82	0.25
Ammonia	7-Jan-09	22:04	181	C5	18.9	11.65	10.98	20.25		0.74		-0.046ALT	20.99	0.26
Nitrite	14-Dec-08	22:18	7	C6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:56	45	C7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:36	85	C8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:18	127	C9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:05	174	C10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0

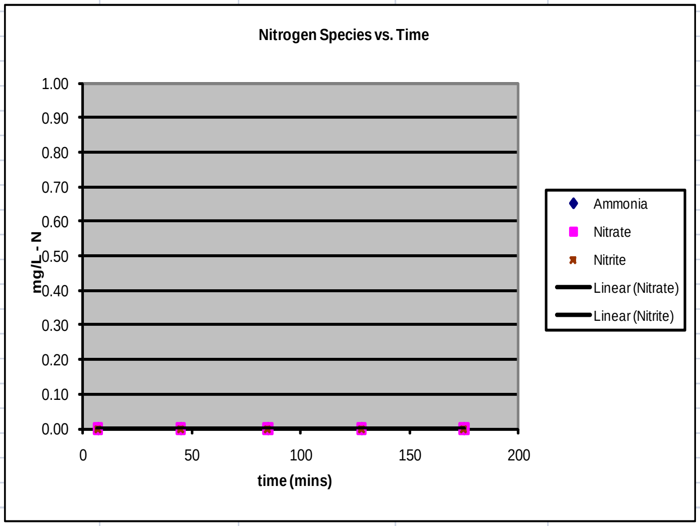




Reactor D: VIP Activated Sludge/VIP SE + 50 mg/L Fe

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Jan-09	19:12	9	D1	19	18.74	18.50	15.24		0.15		-0.023ALT	15.39	0.26
Ammonia	7-Jan-09	19:55	52	D2	19.0	17.15	16.45	16.45		0.40		-0.042ALT	16.85	0.275
Ammonia	7-Jan-09	20:39	96	D3	18.95	15.89	14.90	17.67		0.54		-0.044ALT	18.21	0.25
Ammonia	7-Jan-09	21:22	139	D4	18.9	13.38	13.23	20.61		0.81		-0.043ALT	21.42	0.28
Ammonia	7-Jan-09	22:04	181	D5	18.9	12.56	12.03	19.77		0.74		-0.031ALT	20.50	0.28
Nitrite	14-Dec-08	22:19	7	D6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:57	45	D7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:37	85	D8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:20	128	D9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:07	175	D10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0





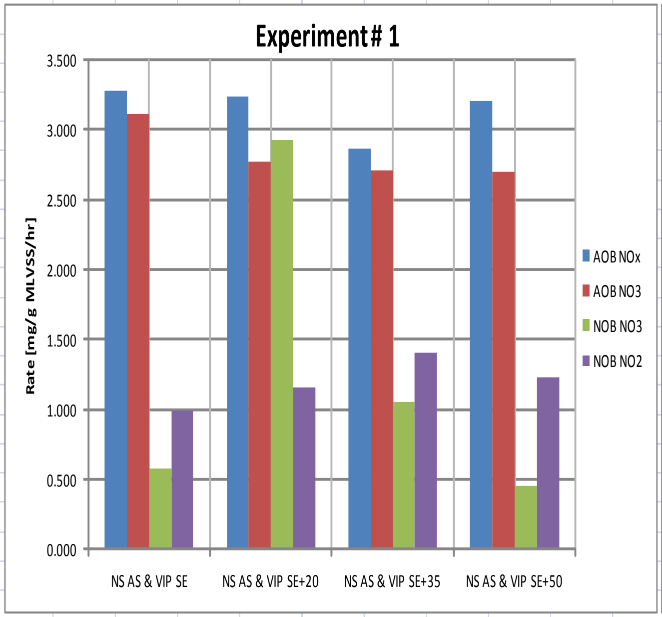
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: VIP											
Activated sludge	Ammonia	0.029	0.024		1.706	1.446		0.325	19.30	1330.00	1010.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.110	6.53	1330.00	1010.00
Reactor B: VIP											
Activated Sludge	Ammonia	0.042	0.038		2.513	2.284		0.278	16.70	1360.00	1000.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.108	6.45	1360.00	1000.00
20 mg/L Fe											
Reactor C: VIP											
Activated sludge	Ammonia	0.032	0.029		1.939	1.741		0.296	17.78	1340.00	1000.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.117	7.04	1340.00	1000.00
35 mg/L Fe											
Reactor D: VIP											
Activated Sludge	Ammonia	0.045	0.040		2.650	2.360		0.285	16.84	1390.00	1015.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.109	6.46	1390.00	1015.00
50 mg/L Fe											

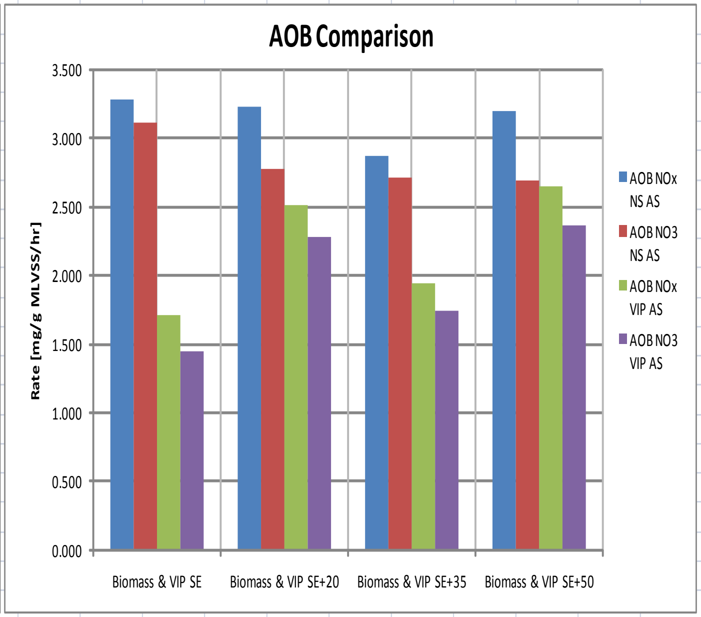
* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

NOTE NOB EXPERIMENT WAS NOT RUN DURING DAY 2 EXPERIMENTATION

Experiment 1

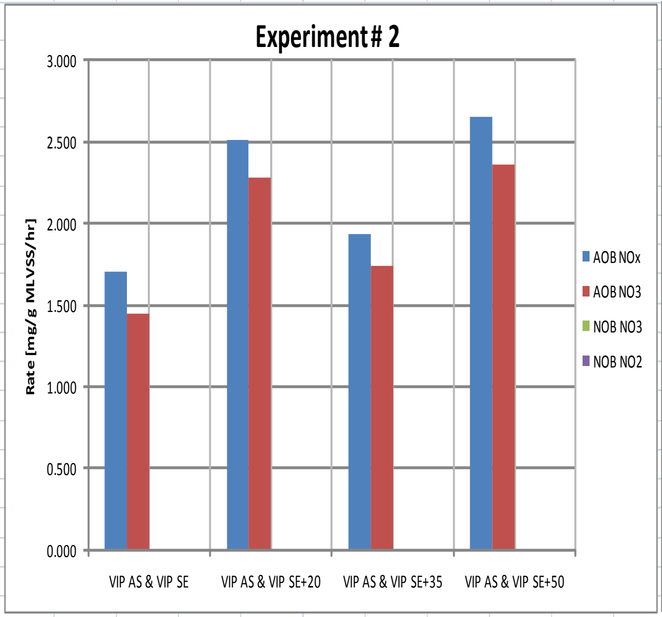
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE	3.282	3.115	0.577	0.991
Reactor B: NS Activated Sludge VIP SE 20 mg/L Fe	3.233	2.774	2.924	1.155
Reactor C: NS Activated Sludge VIP SE 35 mg/L Fe	2.869	2.712	1.056	1.411
Reactor D: NS Activated Sludge VIP SE 50 mg/L Fe	3.202	2.695	0.454	1.232

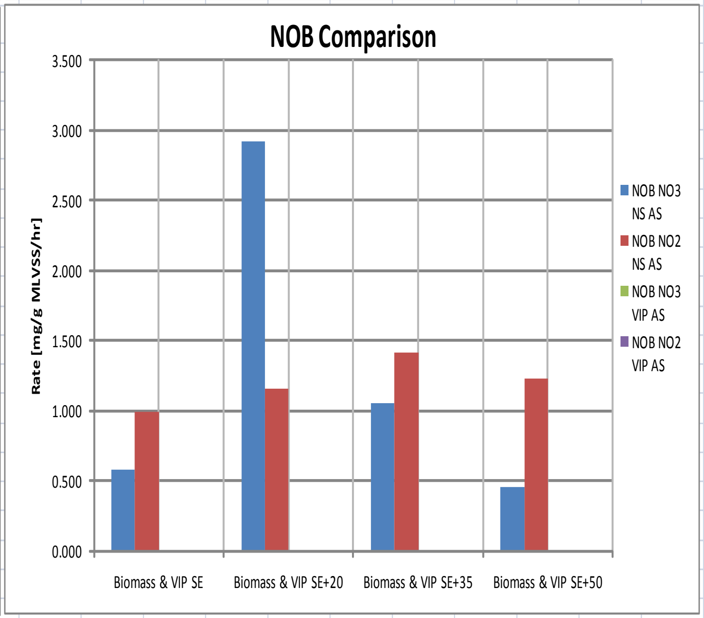




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: VIP Activated sludge VIP SE	1.706	1.446	0.000	0.000
Reactor B: VIP Activated Sludge VIP SE 20 mg/L Fe	2.513	2.284	0.000	0.000
Reactor C: VIP Activated sludge VIP SE 35 mg/L Fe	1.939	1.741	0.000	0.000
Reactor D: VIP Activated Sludge VIP SE 50 mg/L Fe	2.650	2.360	0.000	0.000





Week 12 – FeCl3 Addition RERUN Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

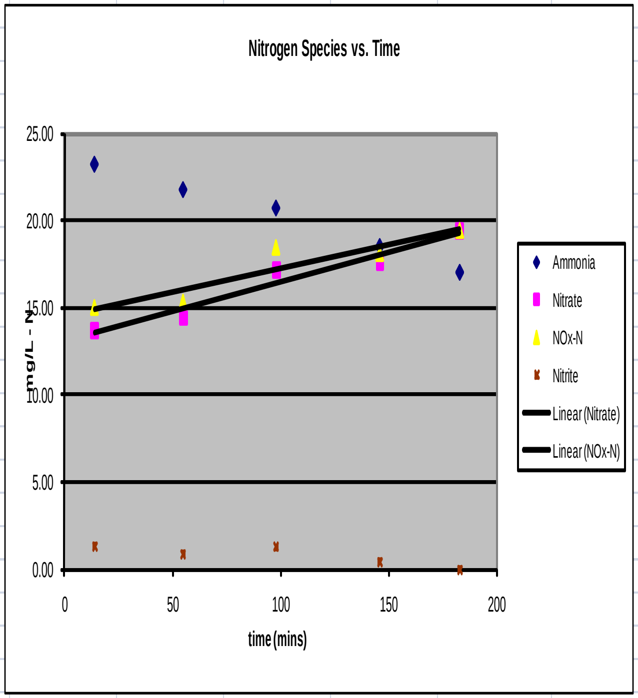
a. Spiked four 3L reactors with 20 mg/L NH_4.
b. Each reactor is running continously by use of stir bars.
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
j. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.

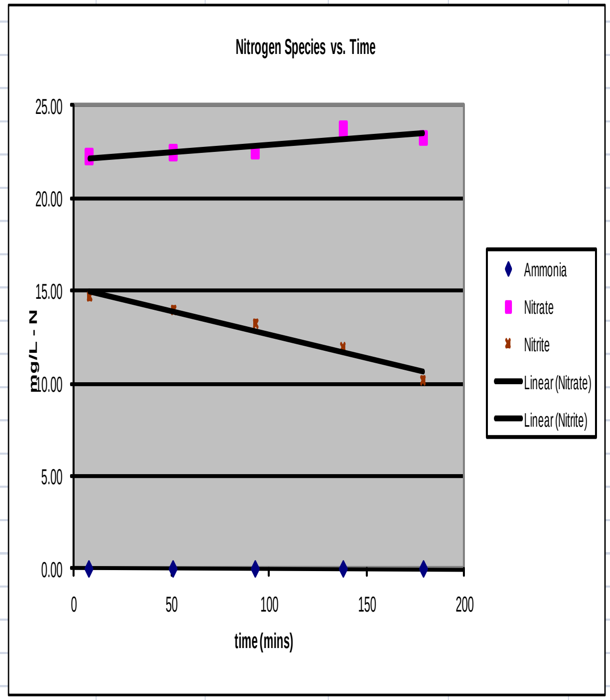
II. NOB

a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars.
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
h. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.

Reactor A: Nansemond Activated Sludge/VIP SE

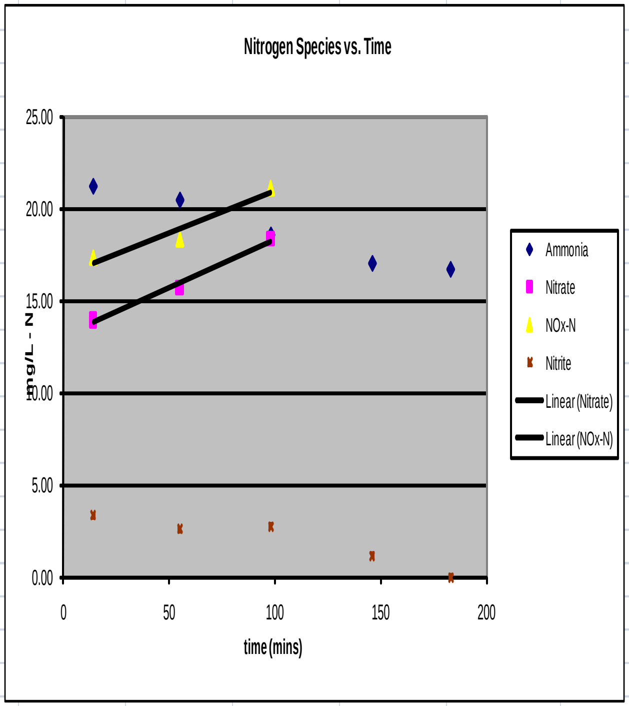
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	9:28	14	A1	18.4	26.19	23.20	13.67		1.30		0.78	14.97	0.68
Ammonia	13-Jan-09	10:09	55	A2	18.2	23.44	21.75	14.39		0.89		0.79	15.28	0.6
Ammonia	13-Jan-09	10:52	98	A3	18.2	28.11	20.70	17.13		1.28		0.87	18.41	0.7625
Ammonia	13-Jan-09	11:40	146	A4	18	19.12	18.50	17.61		0.45		0.97	18.06	0.95
Ammonia	13-Jan-09	12:17	183	A5	18	17.83	17.03	19.37		0.00		1.09	19.37	1.05
Nitrite	13-Jan-09	16:18	8	A6	17.7	0.00	-	22.26		14.69		1.39	36.95	1.35
Nitrite	13-Jan-09	17:01	51	A7	18.375	0.00	-	22.44		13.98		1.96	36.42	1.5
Nitrite	13-Jan-09	17:43	93	A8	18.7	0.00	-	22.51		13.24		2.26	35.75	1.65
Nitrite	13-Jan-09	18:28	138	A9	18.6	0.00	-	23.71		11.93		2.17	35.64	1.8
Nitrite	13-Jan-09	19:09	179	A10	18.6	0.00	-	23.27		10.22		2.42	33.48	1.9

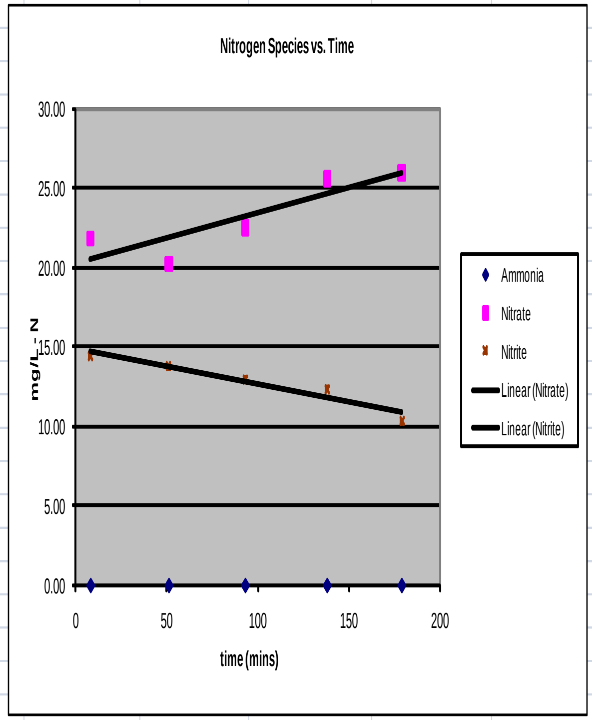




Reactor B: Nansemond Activated Sludge/VIP SE + 20 mg/L Fe

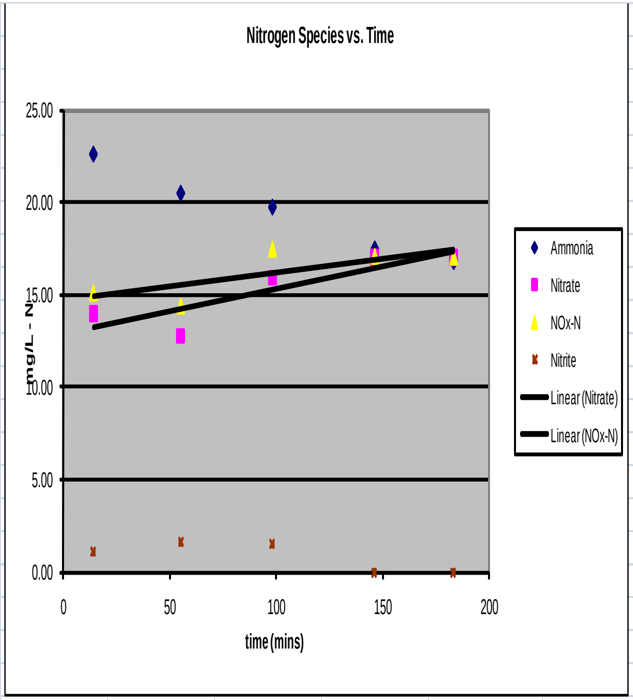
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	9:28	14	B1	18.4	23.83	21.20	13.94		3.34		0.26	17.27	0.12
Ammonia	13-Jan-09	10:09	55	B2	18.3	21.93	20.45	15.71		2.58		0.26	18.29	0.1
Ammonia	13-Jan-09	10:52	98	B3	18.2	20.89	18.55	18.37		2.76		0.27	21.13	0.1375
Ammonia	13-Jan-09	11:40	146	B4	18.1	17.78	17.00	18.60		1.16		0.34	19.75	0.1875
Ammonia	13-Jan-09	12:17	183	B5	18	17.36	16.68	17.76		0.00		0.35	17.76	0.24
Nitrite	13-Jan-09	16:18	8	B6	17.8	0.00	-	21.83		14.47		0.77	36.30	0.25
Nitrite	13-Jan-09	17:01	51	B7	18.6	0.00	-	20.25		13.77		0.43	34.01	0.3
Nitrite	13-Jan-09	17:43	93	B8	18.8	0.00	-	22.49		12.94		1.33	35.44	0.275
Nitrite	13-Jan-09	18:28	138	B9	18.7	0.00	-	25.58		12.38		0.97	37.96	0.32
Nitrite	13-Jan-09	19:09	179	B10	18.8	0.00	-	25.95		10.33		1.05	36.28	0.37

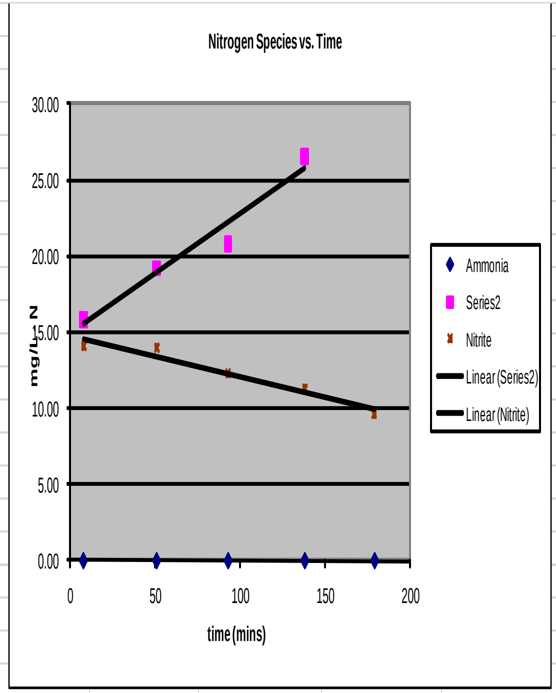




Reactor C: Nansemond Activated Sludge/VIP SE + 35 mg/L Fe

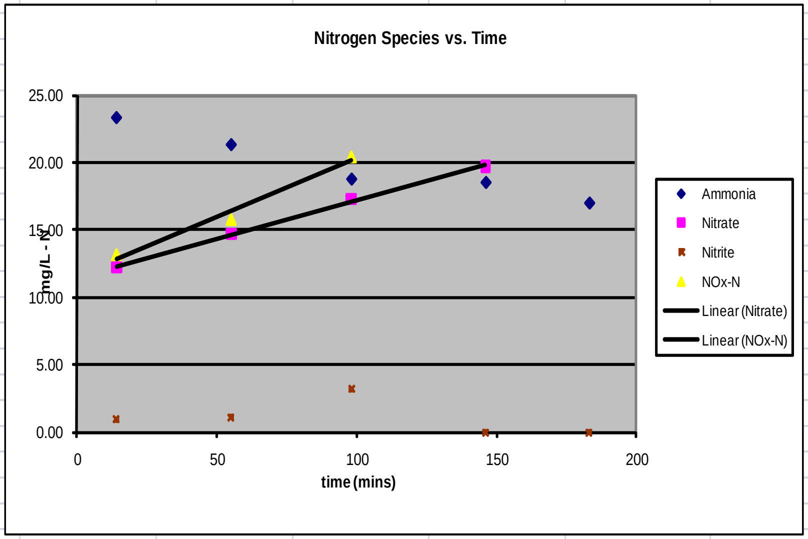
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	9:28	14	C1	18.5	25.93	22.60	13.99		1.07		0.24	15.07	0.08
Ammonia	13-Jan-09	10:09	55	C2	18.3	22.42	20.50	12.78		1.58		0.21	14.36	0.05
Ammonia	13-Jan-09	10:52	98	C3	18.1	20.42	19.75	15.92		1.49		0.21	17.41	0.05
Ammonia	13-Jan-09	11:40	146	C4	18	18.24	17.50	17.02		0.00		0.35	17.02	0.0875
Ammonia	13-Jan-09	12:17	183	C5	18.1	17.58	16.83	16.99		0.00		0.27	16.99	0.16
Nitrite	13-Jan-09	16:18	8	C6	17.9	0.00	-	15.85		14.08		0.36	29.94	0.25
Nitrite	13-Jan-09	17:01	51	C7	18.8	0.00	-	19.20		14.01		0.73	33.21	0.175
Nitrite	13-Jan-09	17:43	93	C8	18.2	0.00	-	20.81		12.30		0.90	33.11	0.175
Nitrite	13-Jan-09	18:28	138	C9	19	0.00	-	26.55		11.35		0.86	37.90	0.167
Nitrite	13-Jan-09	19:09	179	C10	18.9	0.00	-	19.31		9.61		0.85	28.91	0.183

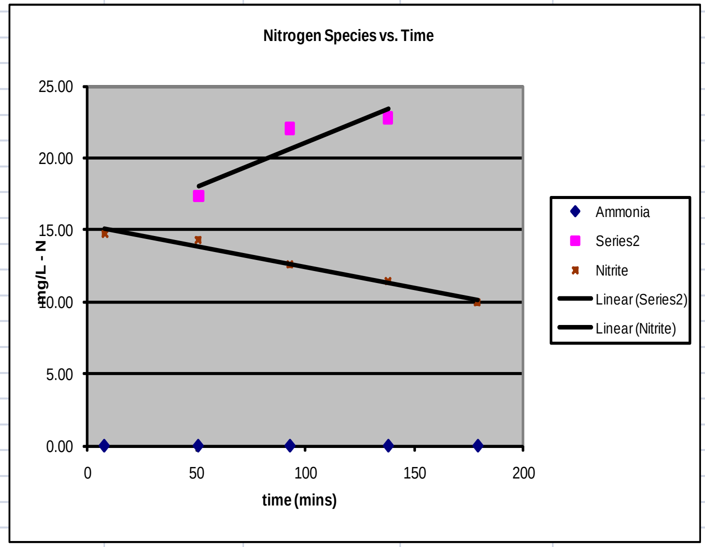




Reactor D: Nansemond Activated Sludge/VIP SE + 50 mg/L Fe

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	9:28	14	D1	18.5	24.11	23.30	12.21		0.92		0.23	13.13	0.1
Ammonia	13-Jan-09	10:09	55	D2	18.24	21.63	21.30	14.69		1.08		0.21	15.77	0.0375
Ammonia	13-Jan-09	10:52	98	D3	18.2	20.15	18.75	17.29		3.16		0.26	20.45	0.0625
Ammonia	13-Jan-09	11:40	146	D4	18.1	18.70	18.50	19.70		0.00		0.21	19.70	0.075
Ammonia	13-Jan-09	12:17	183	D5	18.1	16.96	16.98	19.25		0.00		0.51	19.25	0.08
Nitrite	13-Jan-09	16:18	8	D6	18.0	0.00	-	24.72		14.73		0.63	39.45	0.2
Nitrite	13-Jan-09	17:01	51	D7	17.9	0.00	-	17.35		14.32		0.99	31.66	0.125
Nitrite	13-Jan-09	17:43	93	D8	18.2	0.00	-	22.05		12.57		0.85	34.62	0.125
Nitrite	13-Jan-09	18:28	138	D9	19.1	0.00	-	22.78		11.41		0.92	34.18	0.13
Nitrite	13-Jan-09	19:09	179	D10	18.9	0.00	-	39.92		9.94		0.76	49.86	0.15





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: NS											
Activated sludge	Ammonia	0.027	0.034		1.581	1.999		0.213	12.54	1480.00	1020.00
VIP SE	Nitrite		0.008	-0.026		0.455	-1.508	0.085	5.03	1480.00	1020.00
Reactor B: NS											
Activated Sludge	Ammonia	0.046	0.053		2.707	3.106		0.188	11.04	1500.00	1020.00
VIP SE	Nitrite		0.032	-0.022		1.865	-1.322	0.084	4.95	1500.00	1020.00
20 mg/L Fe											
Reactor C: NS											
Activated Sludge	Ammonia	0.015	0.024		0.929	1.468		0.192	11.71	1445.00	985.00
VIP SE	Nitrite		0.078	-0.027		4.766	-1.646	0.084	5.12	1445.00	985.00
35 mg/L Fe											
Reactor D: NS											
Activated Sludge	Ammonia	0.087	0.057		5.188	3.389		0.193	11.48	1560.00	1010.00
VIP SE	Nitrite		0.062	-0.029		3.676	-1.728	0.087	5.17	1560.00	1010.00
50 mg/L Fe											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 12 – Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

a. Spiked four 3L reactors with 20 mg/L NH_4.
b. Each reactor is running continously by use of stir bars.
c. 1900 mL of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
j. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.

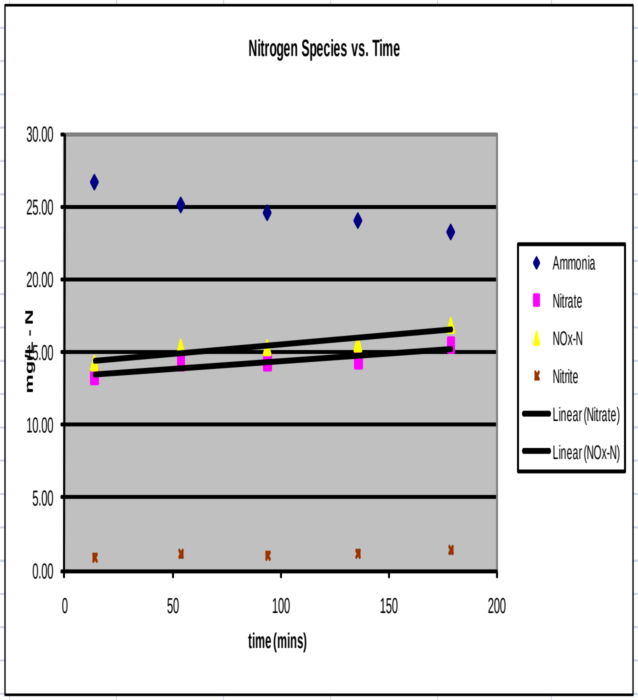
II. NOB

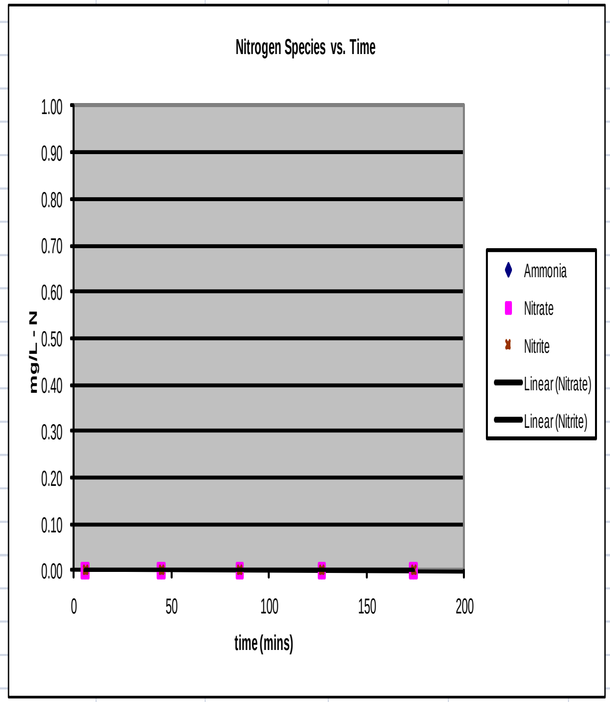
a. Spiked four 3L reactors with 25 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars.
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the 1L Biomass
h. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition

NOTE NOB EXPERIMENT WAS NOT RUN DURING DAY 2 EXPERIMENTATION

Reactor A: VIP Activated Sludge/VIP SE

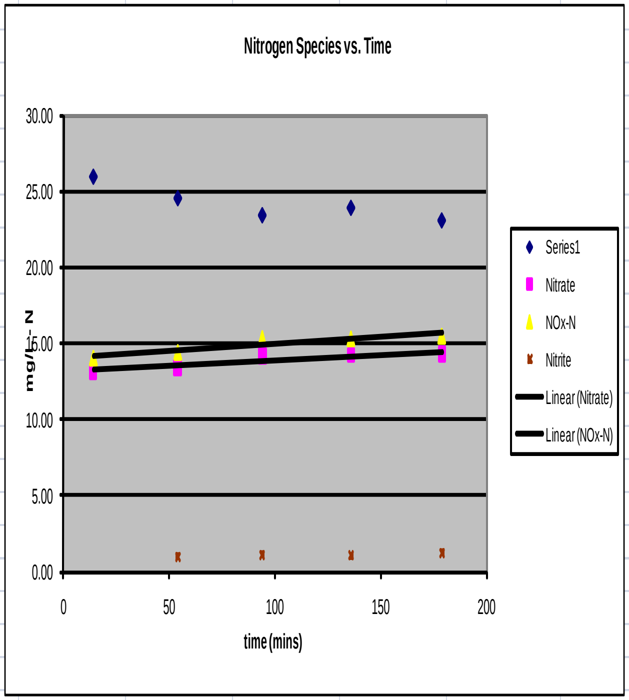
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	22:48	14	A1	18.9	27.86	26.70	13.31		0.94		1.41	14.25	0.075
Ammonia	13-Jan-09	23:28	54	A2	18.3	27.90	25.10	14.25		1.09		1.80	15.33	0.075
Ammonia	14-Jan-09	0:08	94	A3	18.1	25.19	24.55	14.25		1.03		1.58	15.28	0.075
Ammonia	14-Jan-09	0:50	136	A4	18.1	23.57	24.00	14.35		1.18		1.71	15.54	0.100
Ammonia	14-Jan-09	1:33	179	A5	18.0	25.84	23.20	15.44		1.35		1.54	16.79	0.063
Nitrite	14-Dec-08	22:15	6	A6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:54	45	A7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:34	85	A8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:16	127	A9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:03	174	A10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0

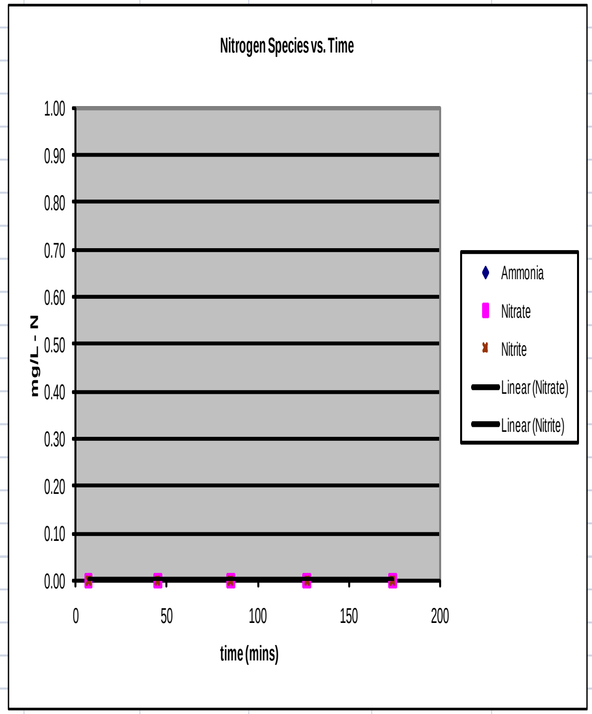




Reactor B: VIP Activated Sludge/VIP SE + 20 mg/L Fe

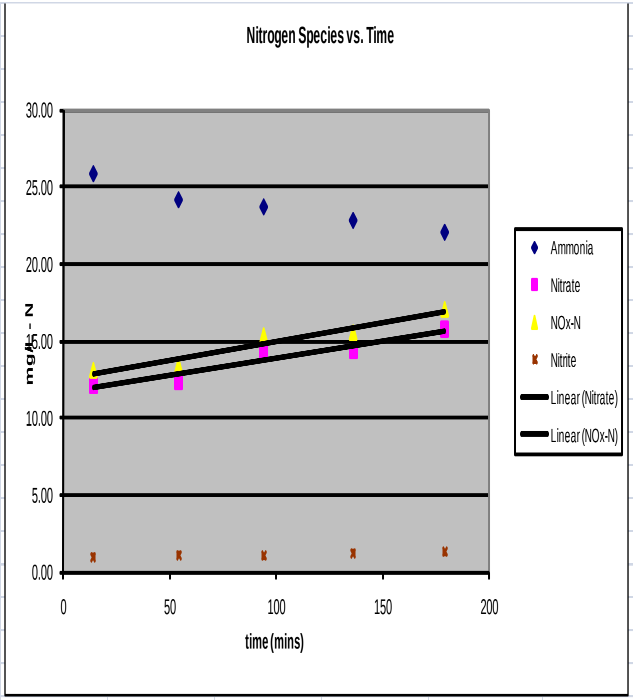
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	22:48	14	B1	18.9	24.30	26.00	13.17		0.87		1.32	14.04	0.0625
Ammonia	13-Jan-09	23:28	54	B2	18.4	28.41	24.55	13.40		1.01		1.52	14.41	0.05
Ammonia	14-Jan-09	0:08	94	B3	18.2	28.06	23.40	14.19		1.14		1.45	15.33	0.0625
Ammonia	14-Jan-09	0:50	136	B4	18.1	24.44	23.90	14.24		1.07		1.53	15.31	0.05
Ammonia	14-Jan-09	1:33	179	B5	18.0	23.29	23.05	14.26		1.21		1.59	15.47	0.04
Nitrite	14-Dec-08	22:17	7	B6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:55	45	B7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:35	85	B8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:17	127	B9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:04	174	B10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0

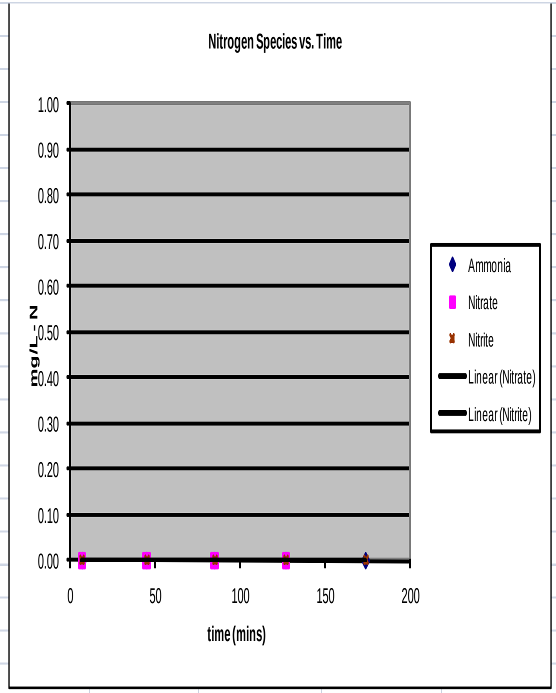




Reactor C: VIP Activated Sludge/VIP SE + 35 mg/L Fe

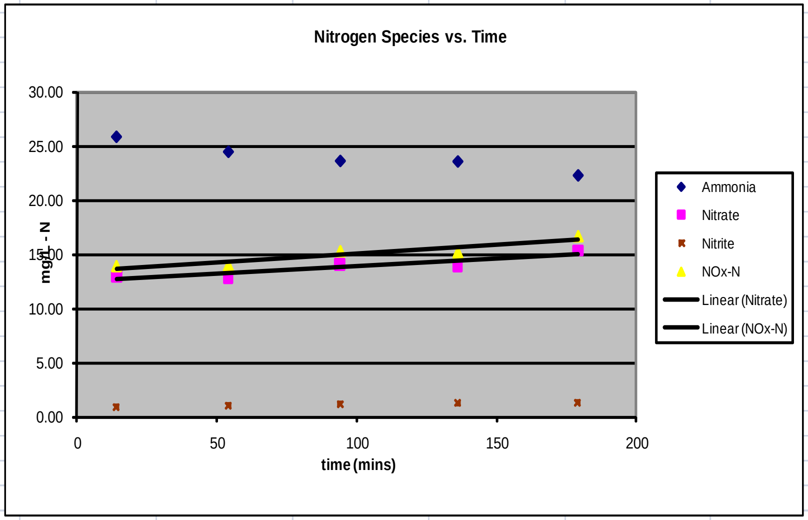
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	22:48	14	C1	19.2	28.42	25.80	12.14		0.95		1.30	13.08	0.0375
Ammonia	13-Jan-09	23:28	54	C2	18.8	25.82	24.15	12.28		1.09		1.67	13.37	0.0375
Ammonia	14-Jan-09	0:08	94	C3	18.5	25.49	23.70	14.32		1.03		1.46	15.35	0.0375
Ammonia	14-Jan-09	0:50	136	C4	18.4	28.16	22.85	14.30		1.24		1.72	15.54	0.03
Ammonia	14-Jan-09	1:33	179	C5	18.4	24.33	22.10	15.75		1.32		1.55	17.06	0.05
Nitrite	14-Dec-08	22:18	7	C6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:56	45	C7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:36	85	C8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:18	127	C9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:05	174	C10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0

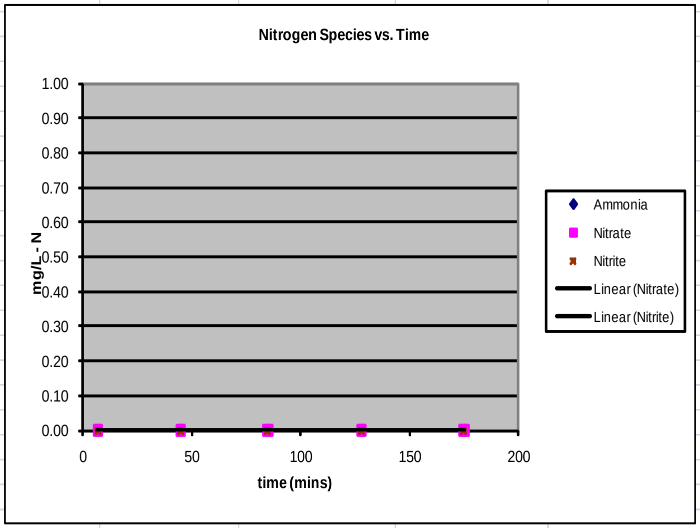




Reactor D: VIP Activated Sludge/VIP SE + 50 mg/L Fe

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	13-Jan-09	22:48	14	D1	19.2	28.03	25.90	12.93		0.90		1.41	13.83	0.0625
Ammonia	13-Jan-09	23:28	54	D2	18.8	26.44	24.50	12.83		1.05		1.67	13.88	0.05
Ammonia	14-Jan-09	0:08	94	D3	18.5	24.19	23.65	14.07		1.16		1.61	15.23	0.05
Ammonia	14-Jan-09	0:50	136	D4	18.4	23.17	23.60	13.86		1.24		1.64	15.10	0.01
Ammonia	14-Jan-09	1:33	179	D5	18.34	25.11	22.30	15.32		1.32		1.62	16.64	0.04
Nitrite	14-Dec-08	22:19	7	D6	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	22:57	45	D7	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	23:37	85	D8	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	0:20	128	D9	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0
Nitrite	14-Dec-08	1:07	175	D10	#DIV/0!	0.00	-	0.00		0.00		0.00	0.00	0





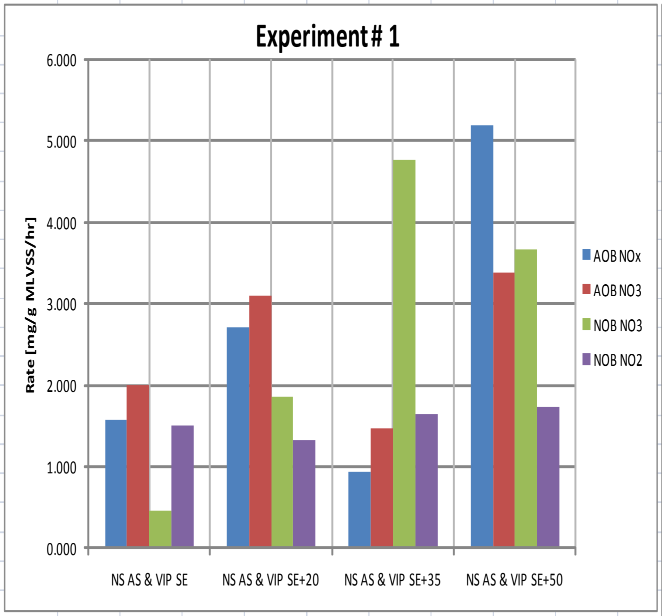
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: VIP											
Activated sludge	Ammonia	0.013	0.011		0.769	0.635		0.213	12.73	1320.00	1005.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.085	5.10	1320.00	1005.00
Reactor B: VIP											
Activated Sludge	Ammonia	0.009	0.007		0.570	0.457		0.188	11.79	1285.00	955.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.084	5.29	1285.00	955.00
20 mg/L Fe											
Reactor C: VIP											
Activated sludge	Ammonia	0.025	0.022		1.536	1.401		0.192	12.01	1310.00	960.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.084	5.25	1310.00	960.00
35 mg/L Fe											
Reactor D: VIP											
Activated Sludge	Ammonia	0.017	0.014		1.033	0.879		0.193	12.02	1325.00	965.00
VIP SE	Nitrite		0.000	0.000		0.000	0.000	0.087	5.41	1325.00	965.00
50 mg/L Fe											

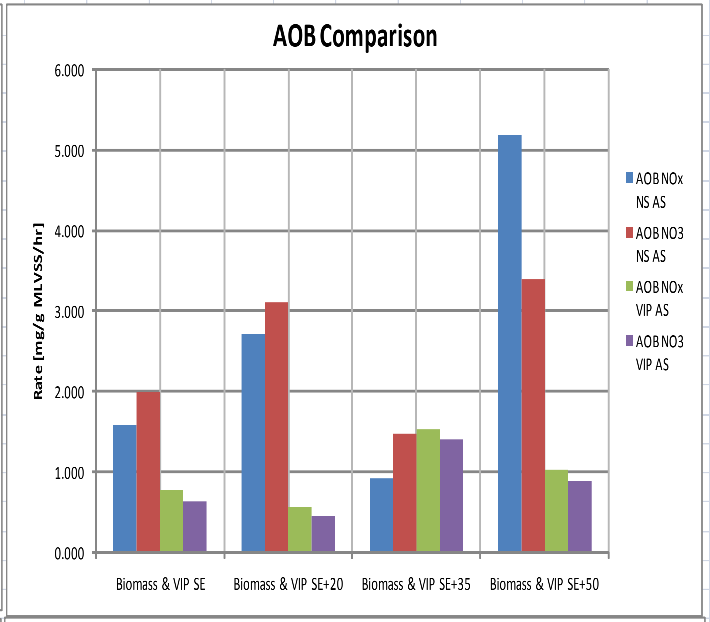
* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

NOTE NOB EXPERIMENT WAS NOT RUN DURING DAY 2 EXPERIMENTATION

Experiment 1

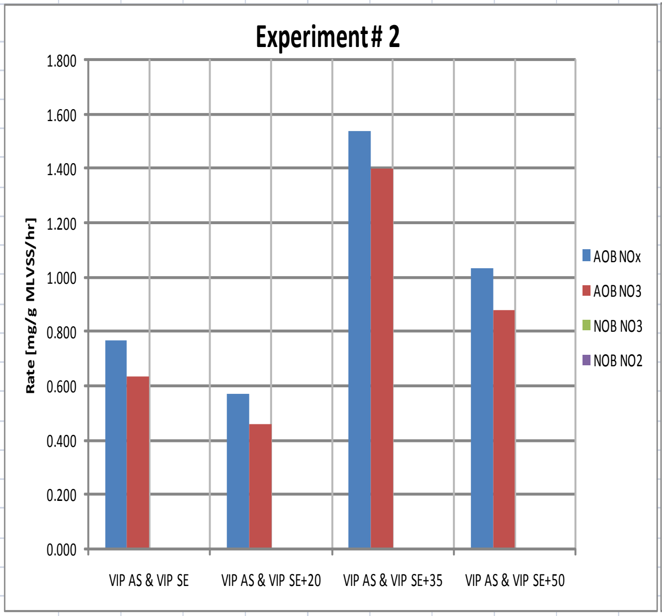
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: NS Activated sludge VIP SE	1.581	1.999	0.455	1.508
Reactor B: NS Activated Sludge VIP SE 20 mg/L Fe	2.707	3.106	1.865	1.322
Reactor C: NS Activated Sludge VIP SE 35 mg/L Fe	0.929	1.468	4.766	1.646
Reactor D: NS Activated Sludge VIP SE 50 mg/L Fe	5.188	3.389	3.676	1.728

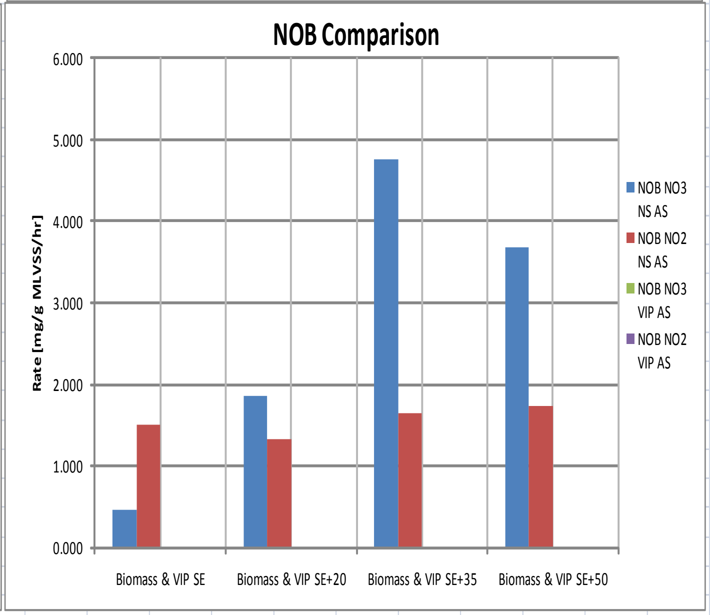




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: VIP Activated sludge VIP SE	0.769	0.635	0.000	0.000
Reactor B: VIP Activated Sludge VIP SE 20 mg/L Fe	0.570	0.457	0.000	0.000
Reactor C: VIP Activated sludge VIP SE 35 mg/L Fe	1.536	1.401	0.000	0.000
Reactor D: VIP Activated Sludge VIP SE 50 mg/L Fe	1.033	0.879	0.000	0.000





Week 13 – FeCl3 Addition with York River Biomass Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

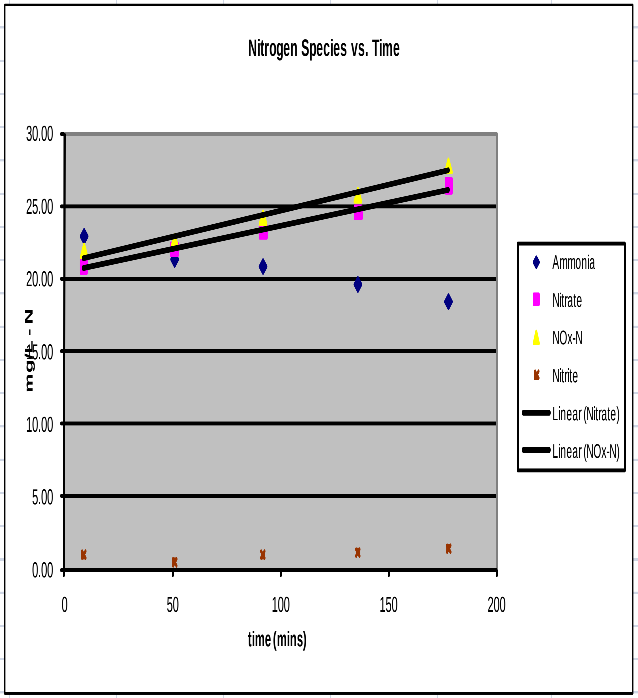
a. Spiked four 3L reactors with 25 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the Biomass
j. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.
k. Alkalinity was added to each reactor according to the Fe dose added to keep the pH from dropping to low.

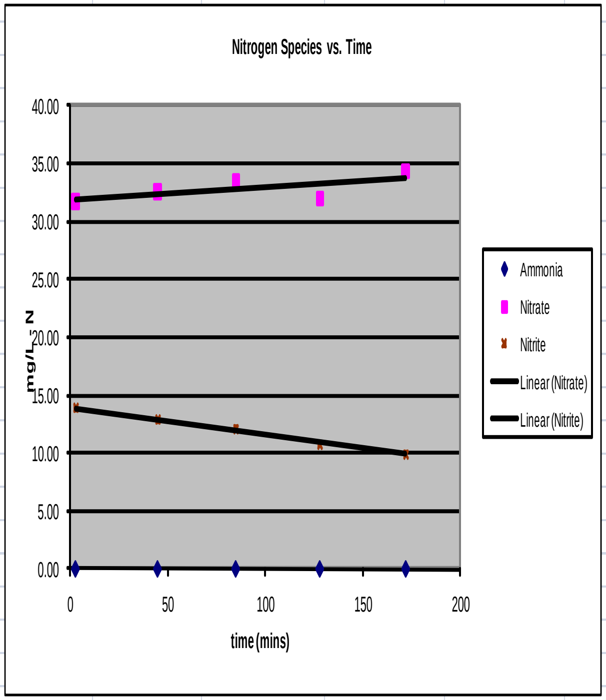
II. NOB

a. Spiked four 3L reactors with 15 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to theL Biomass
h. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.
i. Alkalinity was added to each reactor according to the Fe dose added to keep the pH from dropping to low.

Reactor A: YR A.S. / YR SE

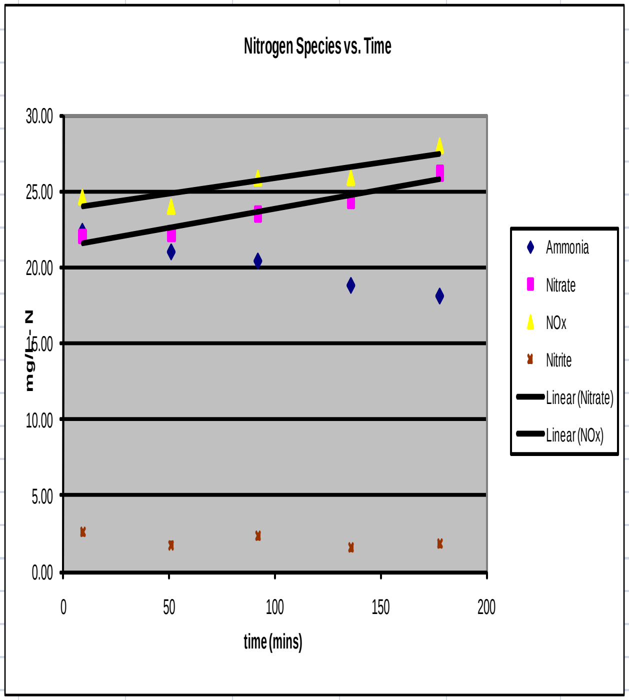
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Feb-09	21:06	9	A1	12.7	23.46	22.90	20.84		1.01		0.27	21.85	0.18
Ammonia	6-Feb-09	21:48	51	A2	12.5	21.75	21.30	21.99		0.54		0.24	22.53	0.14
Ammonia	6-Feb-09	22:29	92	A3	12.3	20.66	20.80	23.21		0.95		0.24	24.16	0.09
Ammonia	6-Feb-09	23:13	136	A4	12.2	20.06	19.55	24.54		1.21		0.28	25.75	0.11
Ammonia	6-Feb-09	23:55	178	A5	12.1	16.84	18.35	26.36		1.44		10.17	27.80	0.13
Nitrite	7-Feb-09	10:55	3	A6	14.9	0.00	-	31.75		13.85		10.47	45.60	0.175
Nitrite	7-Feb-09	11:37	45	A7	15.35	0.00	-	32.56		12.87		2.00	45.42	0.15
Nitrite	7-Feb-09	12:17	85	A8	14.1	0.00	-	33.39		12.13		2.55	45.51	0.14
Nitrite	7-Feb-09	13:00	128	A9	13.3	0.00	-	31.98		10.77		2.29	42.75	0.14
Nitrite	7-Feb-09	13:44	172	A10	13.2	0.00	-	34.37		9.96		2.51	44.32	0.14

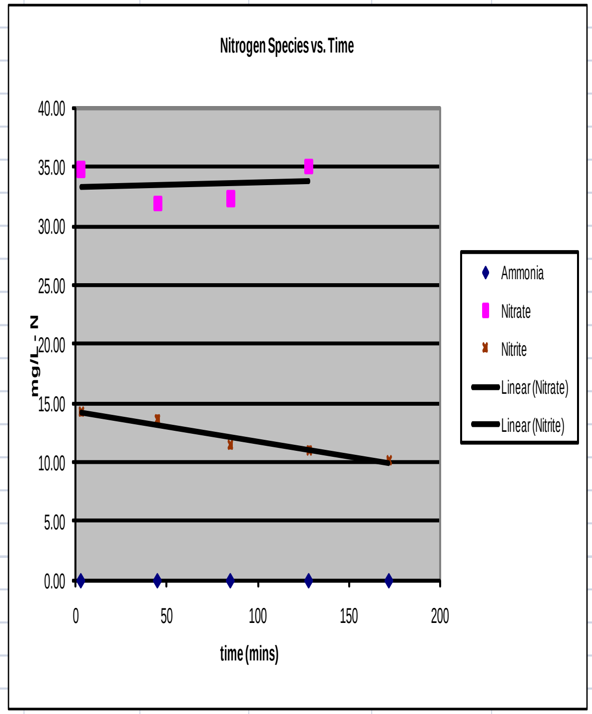




Reactor B: YR A.S./YR SE + 20 mg/L Fe

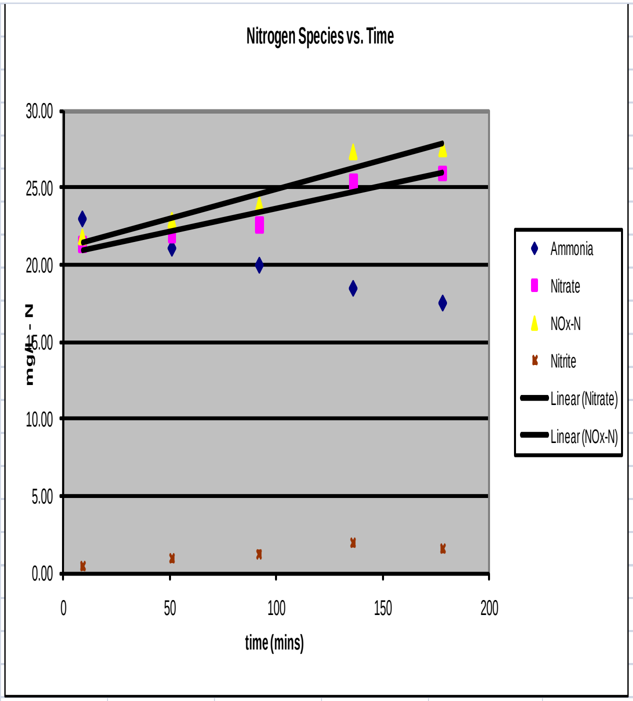
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Feb-09	21:06	9	B1	12.5	21.79	22.30	22.03		2.57		0.18	24.60	0.06
Ammonia	6-Feb-09	21:48	51	B2	12.2	22.47	20.95	22.24		1.74		0.17	23.98	0.05
Ammonia	6-Feb-09	22:29	92	B3	12.1	21.41	20.35	23.50		2.35		0.21	25.85	0.07
Ammonia	6-Feb-09	23:13	136	B4	12.0	18.89	18.75	24.33		1.54		0.47	25.87	0.05
Ammonia	6-Feb-09	23:55	178	B5	11.9	18.22	18.05	26.16		1.81		2.30	27.98	0.06
Nitrite	7-Feb-09	10:55	3	B6	14.7	0.00	-	34.77		14.29		10.87	49.06	0.125
Nitrite	7-Feb-09	11:37	45	B7	15.16	0.00	-	31.89		13.65		2.22	45.55	0.08
Nitrite	7-Feb-09	12:17	85	B8	14.0	0.00	-	32.36		11.42		2.83	43.79	0.09
Nitrite	7-Feb-09	13:00	128	B9	13.2	0.00	-	35.04		11.03		2.50	46.07	0.1
Nitrite	7-Feb-09	13:44	172	B10	13	0.00	-	30.91		10.16		2.41	41.08	0.12

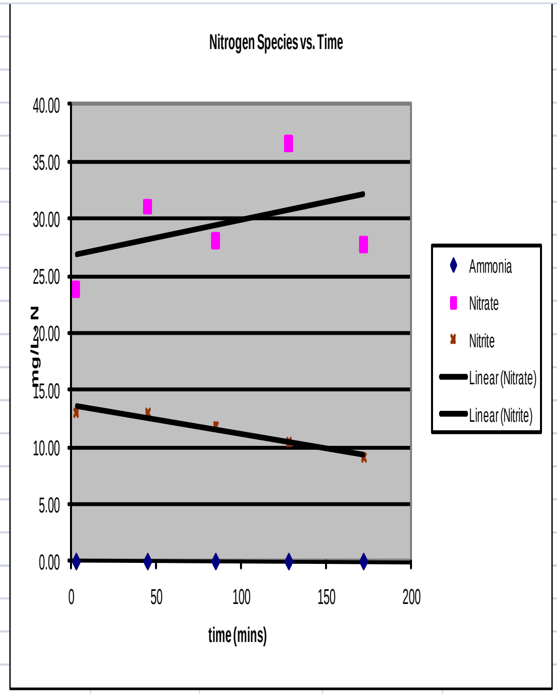




Reactor C: YR A.S./YR SE + 35 mg/L Fe

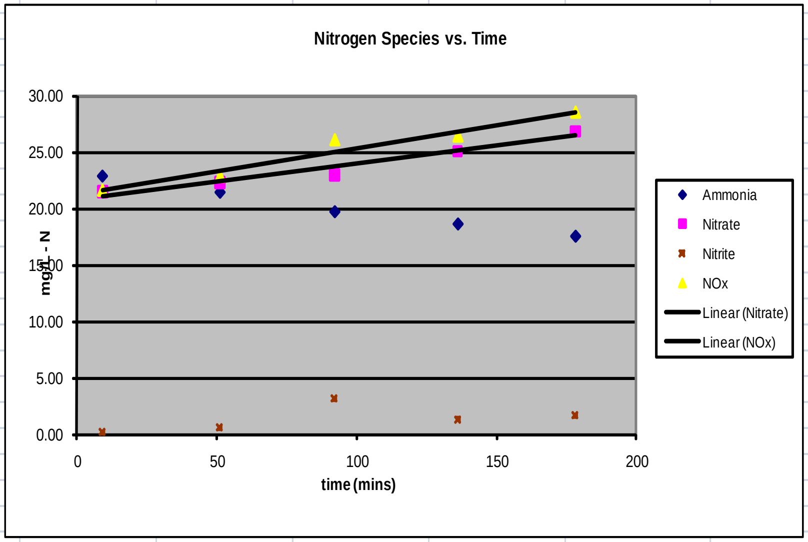
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Feb-09	21:06	9	C1	12.5	22.30	23.00	21.34		0.40		0.18	21.74	0.16
Ammonia	6-Feb-09	21:48	51	C2	12.2	21.43	21.10	21.90		0.92		0.18	22.82	0.06
Ammonia	6-Feb-09	22:29	92	C3	12.1	20.50	20.00	22.59		1.26		0.23	23.85	0.05
Ammonia	6-Feb-09	23:13	136	C4	12	18.59	18.50	25.30		1.94		0.23	27.24	0.06
Ammonia	6-Feb-09	23:55	178	C5	11.9	17.66	17.55	25.92		1.52		9.52	27.44	0.04
Nitrite	7-Feb-09	10:55	3	C6	15.3	0.00	-	23.80		13.10		3.79	36.91	0.075
Nitrite	7-Feb-09	11:37	45	C7	14.7	0.00	-	31.06		12.97		2.69	44.03	0.05
Nitrite	7-Feb-09	12:17	85	C8	15.4	0.00	-	28.07		11.85		2.05	39.92	0.05
Nitrite	7-Feb-09	13:00	128	C9	14.3	0.00	-	36.64		10.45		2.65	47.09	0.06
Nitrite	7-Feb-09	13:44	172	C10	13.6	0.00	-	27.79		9.12		2.23	36.90	0.05

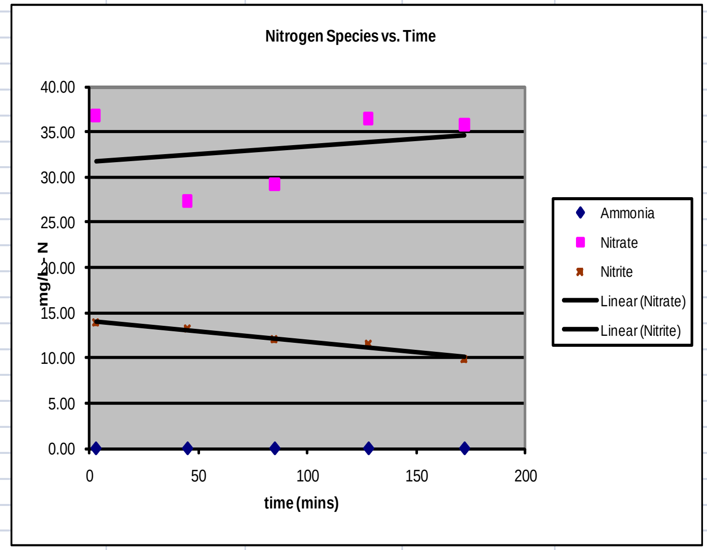




Reactor D: YR A.S./YR SE + 50 mg/L Fe

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	6-Feb-09	21:06	9	D1	12.5	23.49	22.90	21.46		0.19		0.16	21.65	0.06
Ammonia	6-Feb-09	21:48	51	D2	12.2	23.31	21.45	22.27		0.60		0.17	22.87	0.05
Ammonia	6-Feb-09	22:29	92	D3	12.1	18.52	19.70	22.95		3.14		0.23	26.08	0.06
Ammonia	6-Feb-09	23:13	136	D4	12	19.06	18.60	25.07		1.35		2.47	26.41	0.07
Ammonia	6-Feb-09	23:55	178	D5	11.9	19.13	17.50	26.83		1.68		7.99	28.51	0.06
Nitrite	7-Feb-09	10:55	3	D6	14.7	0.00	-	36.77		13.86		4.62	50.63	0.05
Nitrite	7-Feb-09	11:37	45	D7	15.1	0.00	-	27.34		13.23		2.55	40.57	0.04
Nitrite	7-Feb-09	12:17	85	D8	15.2	0.00	-	29.18		12.04		2.38	41.22	0.05
Nitrite	7-Feb-09	13:00	128	D9	14.1	0.00	-	36.50		11.52		2.50	48.01	0.05
Nitrite	7-Feb-09	13:44	172	D10	13.4	0.00	-	35.78		9.85		2.24	45.63	0.06





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia	0.036	0.032		2.437	2.189		0.133	9.10	1353.33	880.00
YR SE	Nitrite		0.011	-0.023		0.758	-1.602	0.051	3.50	1353.33	880.00
Reactor B: YR											
Activated Sludge	Ammonia	0.020	0.024		1.381	1.656		0.120	8.11	1413.33	886.67
YR SE	Nitrite		0.003	-0.026		0.219	-1.742	0.060	4.07	1413.33	886.67
20 mg/L Fe											
Reactor C: YR											
Activated Sludge	Ammonia	0.037	0.030		2.557	2.028		0.110	7.52	1400.00	880.00
YR SE	Nitrite		0.032	-0.025		2.165	-1.702	0.047	3.20	1400.00	880.00
35 mg/L Fe											
Reactor D: YR											
Activated Sludge	Ammonia	0.041	0.032		2.746	2.159		0.122	8.24	1470.00	890.00
YR SE	Nitrite		0.017	-0.023		1.173	-1.560	0.047	3.20	1470.00	890.00
50 mg/L Fe											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 13 – Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

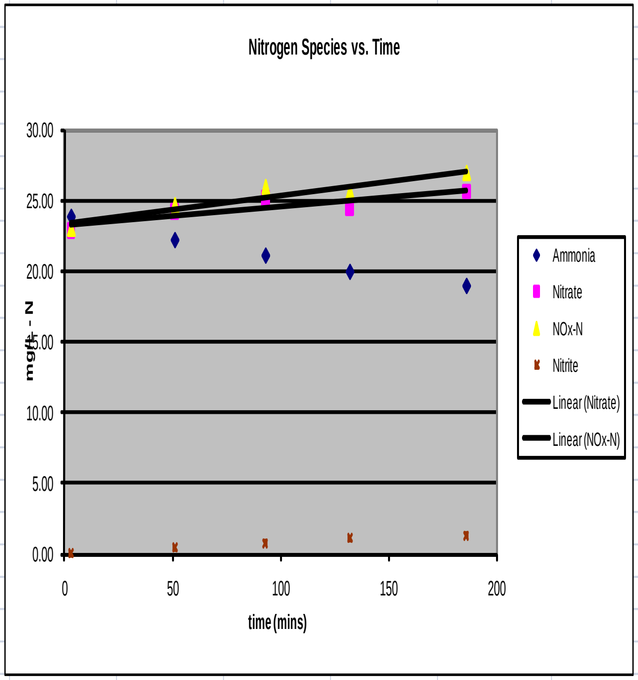
a. Spiked four 3L reactors with 25 mg/L NH_4 .
b. Each reactor is running continously by use of stir bars .
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to the Biomass
j. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.
k. Alkalinity was added to each reactor according to the Fe dose added to keep the pH from dropping to low.

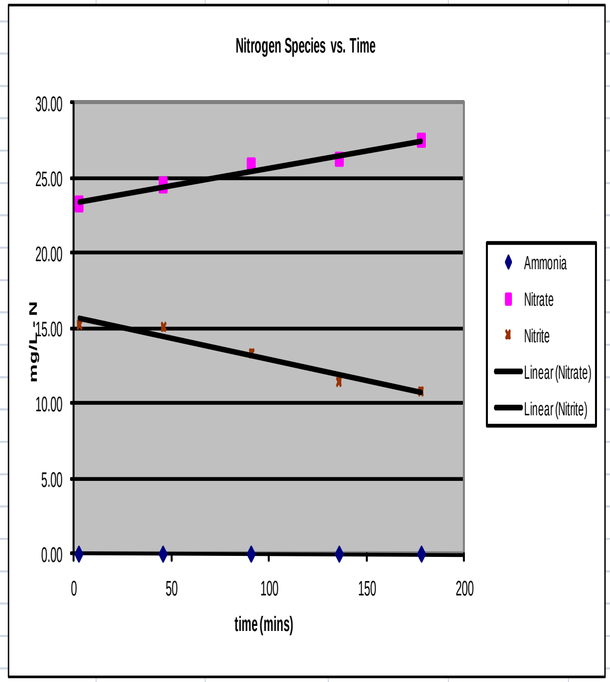
II. NOB

a. Spiked four 3L reactors with 15 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars .
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of $FeCl_3$ calculated based on an as Fe basis relative to theL Biomass
h. A two hour period was allowed after $FeCl_3$ addition to monitor pH adjustment due to $FeCl_3$ addition.
i. Alkalinity was added to each reactor according to the Fe dose added to keep the pH from dropping to low.

Reactor A: YR A.S./YR SE

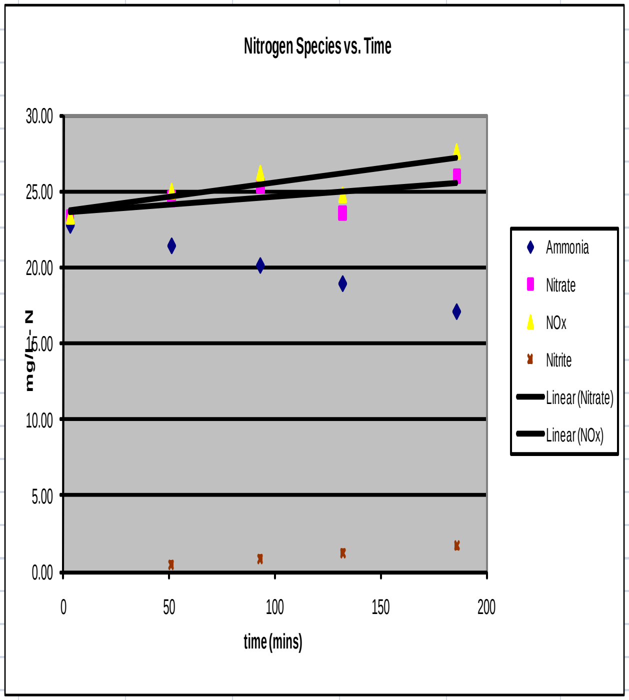
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Feb-09	16:53	3	A1	12.5	24.52	23.90	22.90		0.07		0.31	22.96	0.16
Ammonia	7-Feb-09	17:41	51	A2	13.1	22.25	22.25	24.19		0.44		3.72	24.63	0.13
Ammonia	7-Feb-09	18:23	93	A3	13.3	22.25	21.15	25.15		0.78		0.30	25.92	0.15
Ammonia	7-Feb-09	19:02	132	A4	13.4	20.24	20.00	24.49		1.08		1.43	25.57	0.15
Ammonia	7-Feb-09	19:56	186	A5	13.5	20.87	19.00	25.62		1.30		1.43	26.91	0.14
Nitrite	8-Feb-09	9:31	3	A6	12.4	0.00	-	23.27		15.30		1.29	38.57	0.13
Nitrite	8-Feb-09	10:14	46	A7	12.9	0.00	-	24.53		15.12		1.27	39.65	0.16
Nitrite	8-Feb-09	10:59	91	A8	14.0	0.00	-	25.87		13.39		1.27	39.26	0.15
Nitrite	8-Feb-09	11:44	136	A9	14.4	0.00	-	26.27		11.50		1.25	37.78	0.16
Nitrite	8-Feb-09	12:26	178	A10	14.4	0.00	-	27.53		10.88		1.05	38.41	0.15

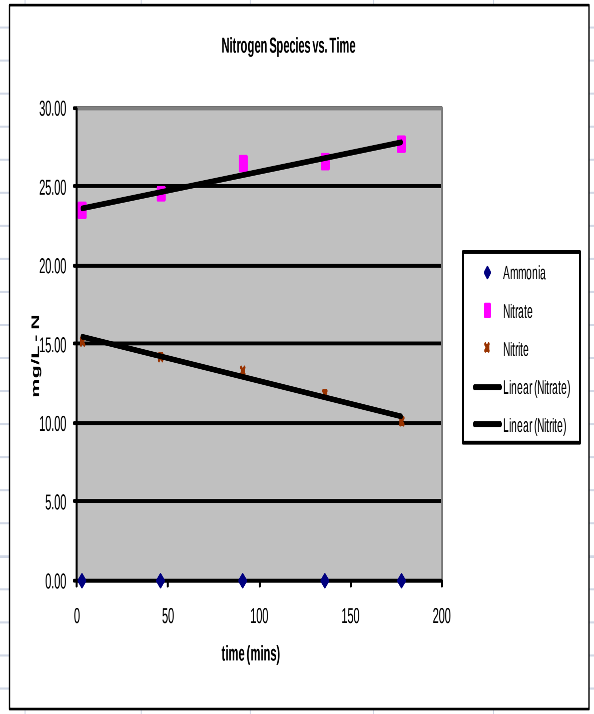




Reactor B: YR A.S./YR SE + 20 mg/L Fe

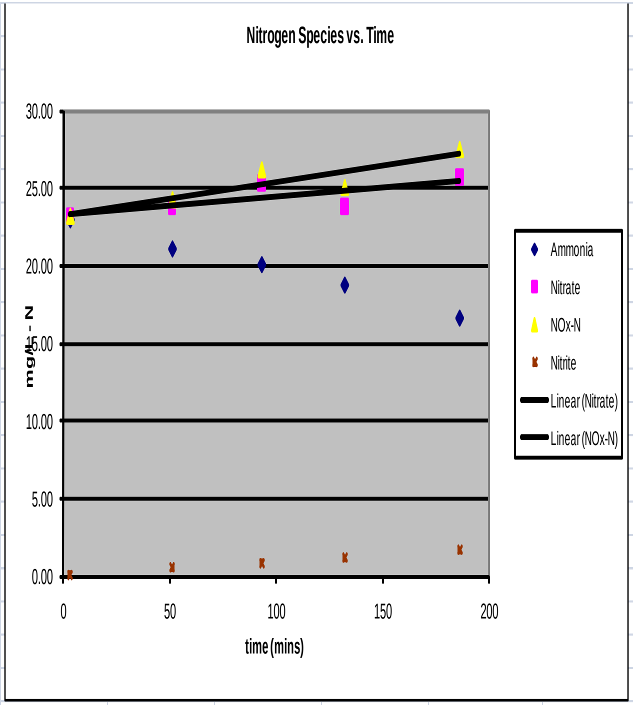
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Feb-09	16:53	3	B1	12.5	23.29	22.80	23.30		0.07		0.22	23.37	0.05
Ammonia	7-Feb-09	17:41	51	B2	13.1	22.01	21.45	24.55		0.50		0.39	25.04	0.59
Ammonia	7-Feb-09	18:23	93	B3	13.4	21.11	20.15	25.35		0.87		1.18	26.23	0.06
Ammonia	7-Feb-09	19:02	132	B4	13.5	19.91	18.95	23.56		1.22		1.45	24.78	0.08
Ammonia	7-Feb-09	19:56	186	B5	13.6	18.14	17.10	25.97		1.68		1.31	27.65	0.06
Nitrite	8-Feb-09	9:31	3	B6	12.36666667	0.00	-	23.48		15.22		1.31	38.70	0.08
Nitrite	8-Feb-09	10:14	46	B7	13.12	0.00	-	24.54		14.21		1.21	38.75	0.05
Nitrite	8-Feb-09	10:59	91	B8	13.9	0.00	-	26.49		13.31		1.31	39.81	0.07
Nitrite	8-Feb-09	11:44	136	B9	14.4	0.00	-	26.58		11.87		1.09	38.44	0.06
Nitrite	8-Feb-09	12:26	178	B10	14.35	0.00	-	27.68		10.07		1.01	37.75	0.07

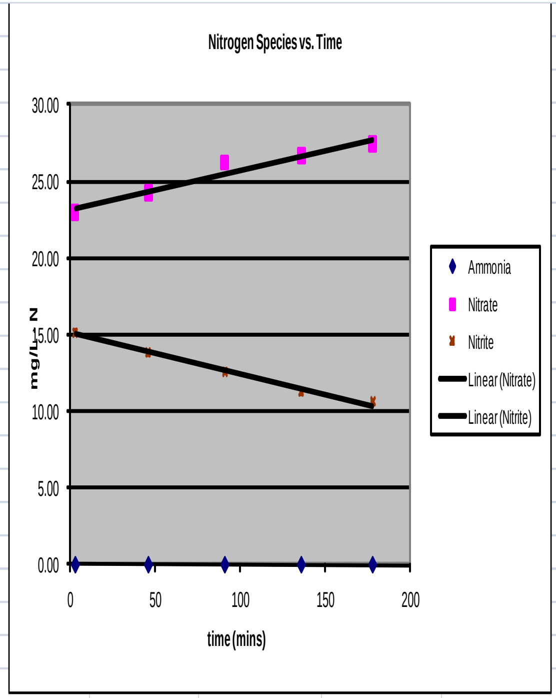




Reactor C: YR A.S./YR SE + 35 mg/L Fe

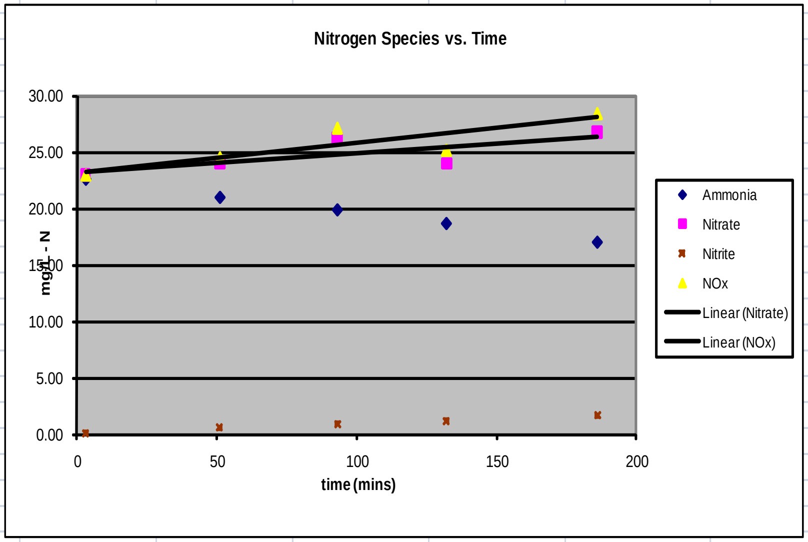
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Feb-09	16:53	3	C1	12.5	23.99	22.90	23.16		0.07		0.99	23.23	0.05
Ammonia	7-Feb-09	17:41	51	C2	13.2	21.41	21.05	23.76		0.51		0.28	24.27	0.04
Ammonia	7-Feb-09	18:23	93	C3	13.55	20.66	20.05	25.31		0.85		1.26	26.16	0.04
Ammonia	7-Feb-09	19:02	132	C4	13.7	19.48	18.75	23.86		1.19		1.57	25.05	0.04
Ammonia	7-Feb-09	19:56	186	C5	13.7	17.44	16.65	25.75		1.69		1.42	27.44	0.05
Nitrite	8-Feb-09	9:31	3	C6	#DIV/0!	0.00	-	22.97		15.14		1.30	38.11	0.05
Nitrite	8-Feb-09	10:14	46	C7	#DIV/0!	0.00	-	24.28		13.84		1.34	38.12	0.05
Nitrite	8-Feb-09	10:59	91	C8	#DIV/0!	0.00	-	26.24		12.63		1.07	38.87	0.05
Nitrite	8-Feb-09	11:44	136	C9	#DIV/0!	0.00	-	26.65		11.29		1.10	37.94	0.05
Nitrite	8-Feb-09	12:26	178	C10	#DIV/0!	0.00	-	27.42		10.61		1.05	38.02	0.06

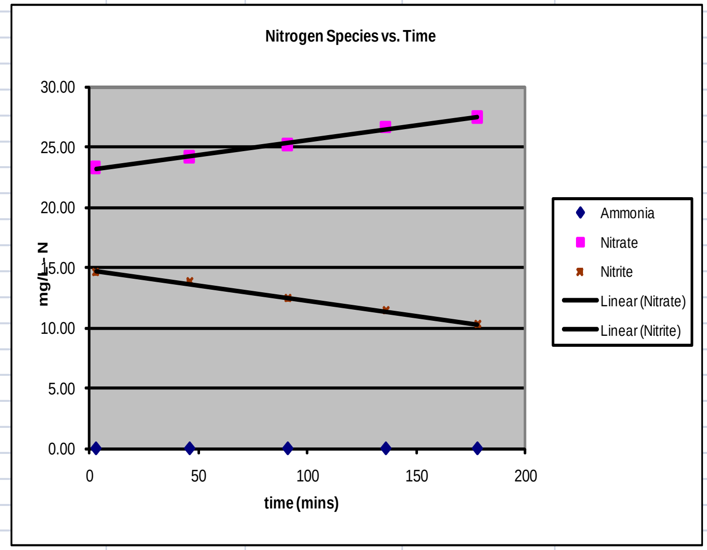




Reactor D: YR A.S./YR SE + 50 mg/L Fe

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	7-Feb-09	16:53	3	D1	12.4	22.84	22.60	22.93		0.08		0.21	23.01	0.02
Ammonia	7-Feb-09	17:41	51	D2	13.2	21.48	21.00	23.99		0.55		0.23	24.53	0.05
Ammonia	7-Feb-09	18:23	93	D3	13.5	20.74	19.90	26.23		0.91		1.67	27.13	0.04
Ammonia	7-Feb-09	19:02	132	D4	13.6	19.18	18.70	24.01		1.19		1.62	25.20	0.04
Ammonia	7-Feb-09	19:56	186	D5	13.6	16.97	17.05	26.73		1.69		1.53	28.42	0.05
Nitrite	8-Feb-09	9:31	3	D6	#DIV/0!	0.00	-	23.33		14.62		1.31	37.94	0.05
Nitrite	8-Feb-09	10:14	46	D7	#DIV/0!	0.00	-	24.15		13.80		1.19	37.95	0.05
Nitrite	8-Feb-09	10:59	91	D8	#DIV/0!	0.00	-	25.19		12.44		1.07	37.62	0.05
Nitrite	8-Feb-09	11:44	136	D9	#DIV/0!	0.00	-	26.65		11.43		1.11	38.08	0.06
Nitrite	8-Feb-09	12:26	178	D10	#DIV/0!	0.00	-	27.43		10.26		1.04	37.69	0.06



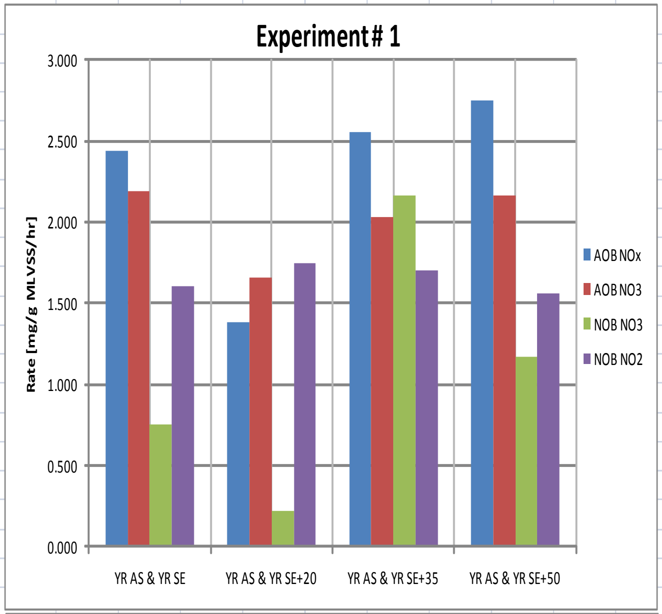


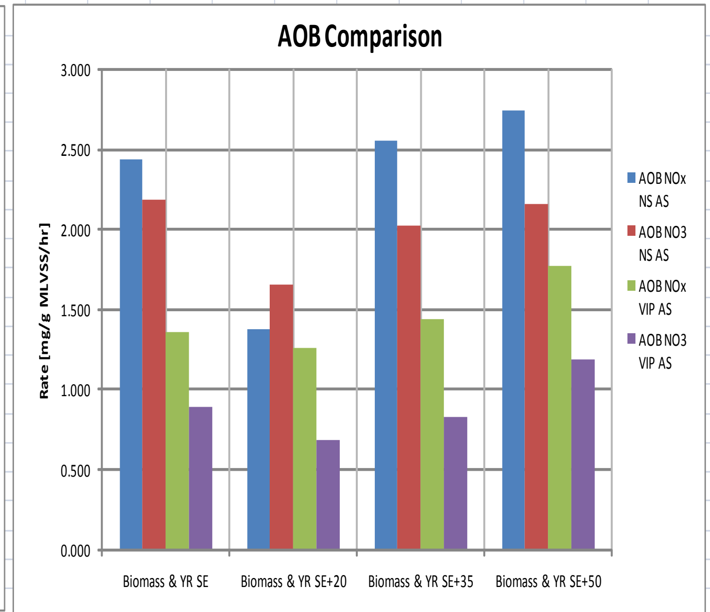
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia	0.020	0.013		1.363	0.891		0.133	9.13	1373.33	876.67
YR SE	Nitrite		0.023	-0.028		1.596	-1.940	0.051	3.52	1373.33	876.67
Reactor B: YR											
Activated Sludge	Ammonia	0.019	0.010		1.265	0.681		0.120	7.93	1406.67	906.67
YR SE	Nitrite		0.024	-0.029		1.570	-1.901	0.060	3.98	1406.67	906.67
20 mg/L Fe											
Reactor C: YR											
Activated Sludge	Ammonia	0.021	0.012		1.436	0.833		0.110	7.58	1410.00	873.33
YR SE	Nitrite		0.026	-0.026		1.761	-1.814	0.047	3.22	1410.00	873.33
35 mg/L Fe											
Reactor D: YR											
Activated Sludge	Ammonia	0.026	0.018		1.771	1.187		0.122	8.27	1440.00	886.67
YR SE	Nitrite		0.024	-0.025		1.647	-1.706	0.047	3.21	1440.00	886.67
50 mg/L Fe											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

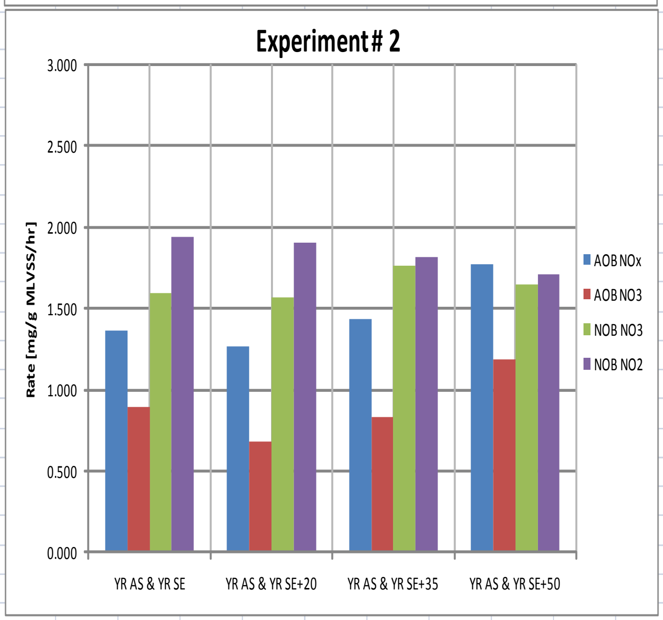
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: YR Activated sludge YR SE	2.437	2.189	0.758	1.602
Reactor B: YR Activated Sludge YR SE 20 mg/L Fe	1.381	1.656	0.219	1.742
Reactor C: YR Activated Sludge YR SE 35 mg/L Fe	2.557	2.028	2.165	1.702
Reactor D: YR Activated Sludge YR SE 50 mg/L Fe	2.746	2.159	1.173	1.560

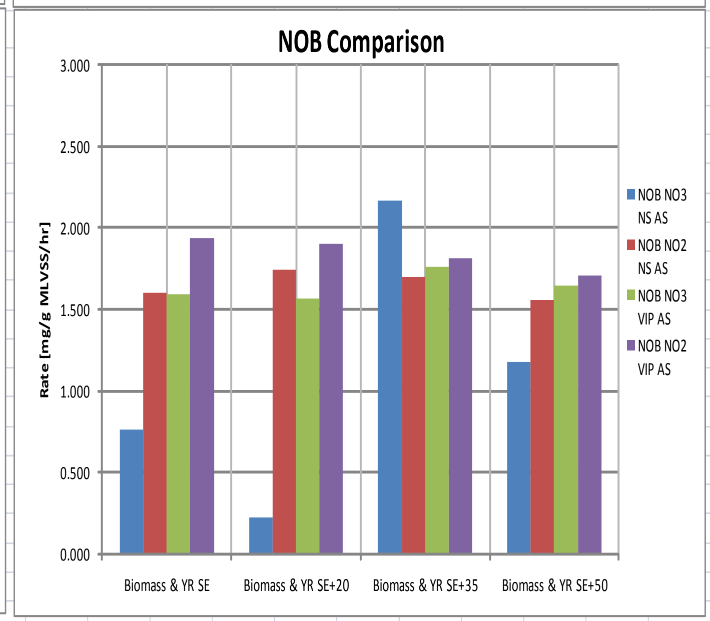




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: YR Activated sludge YR SE	1.363	0.891	1.596	1.940
Reactor B: YR Activated Sludge YR SE 20 mg/L Fe	1.265	0.681	1.570	1.901
Reactor C: YR Activated Sludge YR SE 35 mg/L Fe	1.436	0.833	1.761	1.814
Reactor D: YR Activated Sludge YR SE 50 mg/L Fe	1.771	1.187	1.647	1.706





Week 14 – NTP Raw, PCI, PCE Composite Samples Day 1 AOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB Experimentation:

I. AOB

a. Spiked four 3L reactors with 25 mg/L NH_4 .

b. Each reactor is running continously by use of stir bars .

c. 2 L of the diluent source is added to the reactors.

d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.

e. Constant DO and pH were monitored and logged throughout the experiment.

f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.

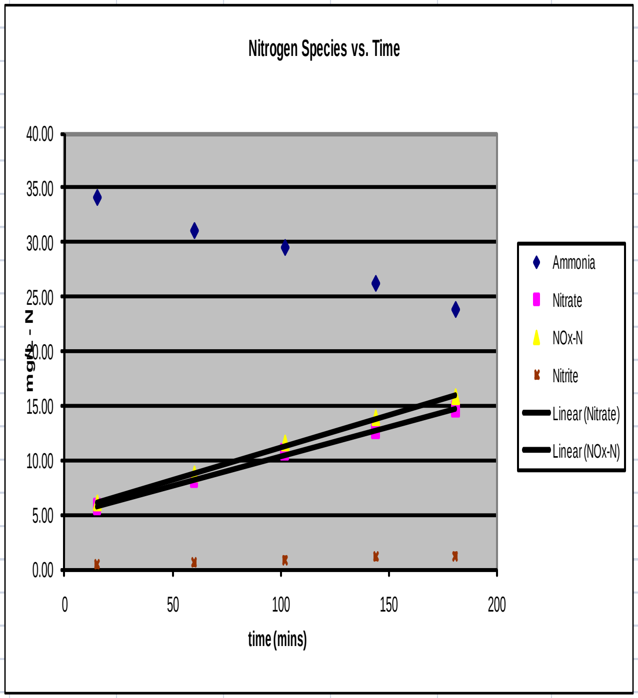
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

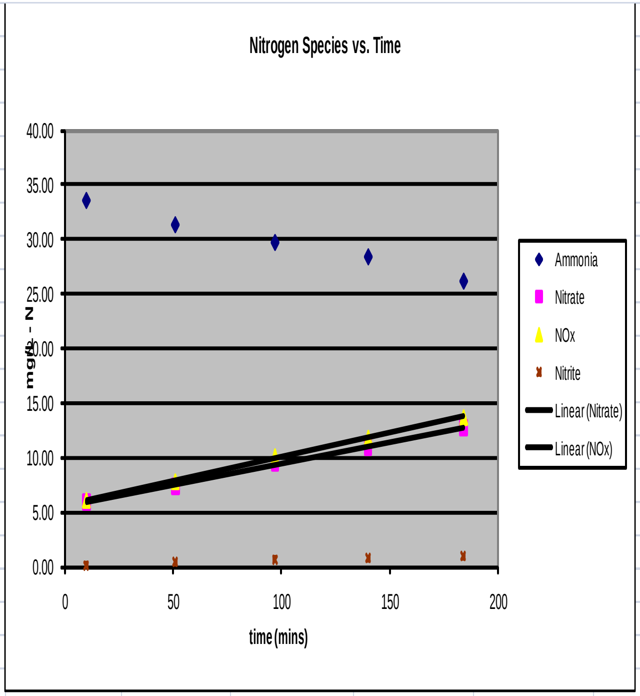
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters

i. Reactors B, C, and D in the diluent source incorporated 2L of the associated composite samples taken for each day respectively.

Reactor A: YR A.S. / YR PE

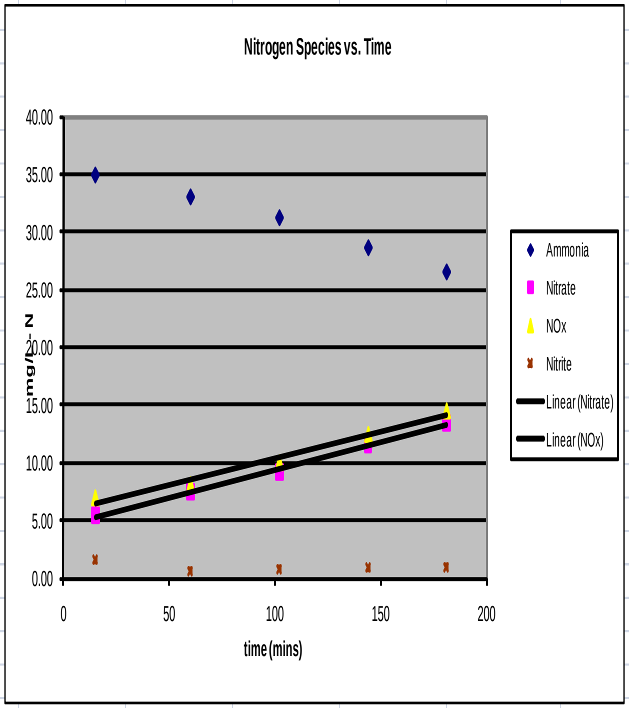
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-M	20-Mar-09	21:09	15	A1	19.7	38.48	34.20	5.71		0.37		0.95	6.08	
Ammonia-M	20-Mar-09	21:54	60	A2	17.75	35.30	31.15	8.13		0.61		0.93	8.74	
Ammonia-M	20-Mar-09	22:36	102	A3	17.3	33.41	29.60	10.77		0.82		0.90	11.59	
Ammonia-M	20-Mar-09	23:18	144	A4	16.55	26.44	26.30	12.78		1.12		0.93	13.90	
Ammonia-M	20-Mar-09	23:55	181	A5	17	27.52	23.90	14.66		1.17		1.03	15.83	
Ammonia-T	21-Mar-09	1:33	10	A6	20.1	36.13	33.50	5.90		0.14		1.03	6.04	
Ammonia-T	21-Mar-09	2:14	51	A7	18.3	35.92	31.30	7.33		0.44		1.04	7.77	
Ammonia-T	21-Mar-09	3:00	97	A8	16.9	33.04	29.70	9.39		0.69		1.04	10.08	
Ammonia-T	21-Mar-09	3:43	140	A9	16.3	29.25	28.40	10.98		0.80		1.60	11.78	
Ammonia-T	21-Mar-09	4:27	184	A10	16.1	28.98	26.20	12.76		0.92		1.74	13.67	

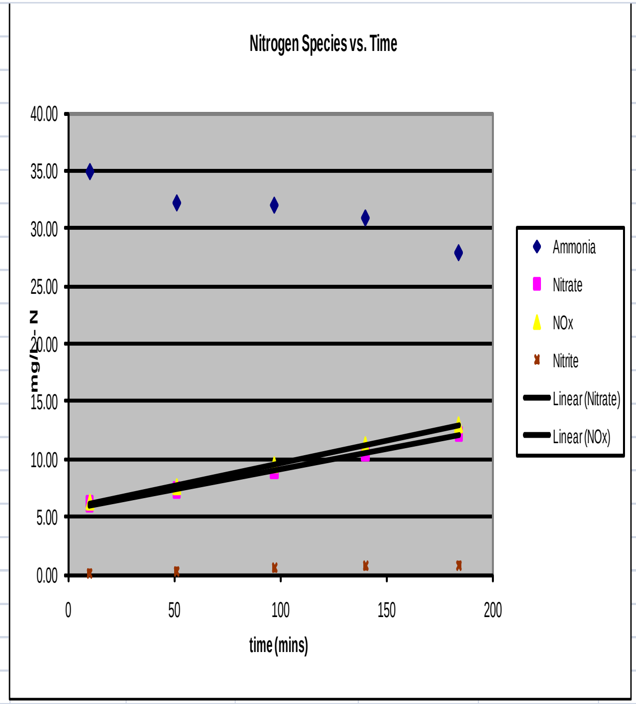




Reactor B: YR A.S. / NS RWI

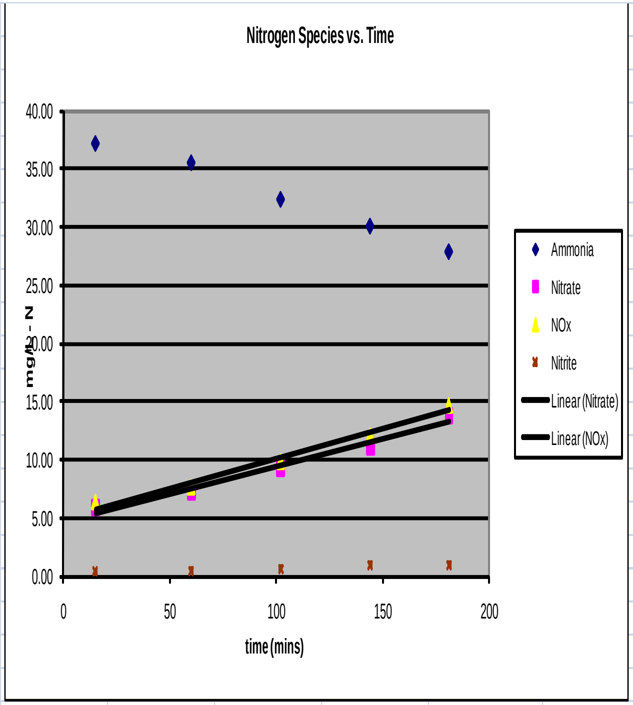
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-M	20-Mar-09	21:09	15	B1	17.5	39.12	35.00	5.48		1.54		2.52	7.03	
Ammonia-M	20-Mar-09	21:54	60	B2	16.2	39.33	33.10	7.46		0.68		2.34	8.14	
Ammonia-M	20-Mar-09	22:36	102	B3	15.8	36.34	31.30	9.22		0.80		2.22	10.02	
Ammonia-M	20-Mar-09	23:19	144	B4	15.8	31.18	28.70	11.56		0.86		2.16	12.42	
Ammonia-M	20-Mar-09	23:55	181	B5	16.7	30.51	26.60	13.45		0.98		2.12	14.43	
Ammonia-T	21-Mar-09	1:33	10	B6	17.5	40.28	34.90	6.18		0.12		2.38	6.29	
Ammonia-T	21-Mar-09	2:14	51	B7	16.42	39.36	32.20	7.29		0.34		2.31	7.63	
Ammonia-T	21-Mar-09	3:00	97	B8	15.9	36.48	32.00	8.96		0.57		2.89	9.53	
Ammonia-T	21-Mar-09	3:43	140	B9	15.7	31.53	30.90	10.57		0.70		2.91	11.27	
Ammonia-T	21-Mar-09	4:27	184	B10	15.7	32.08	27.90	12.18		0.81		2.76	12.99	

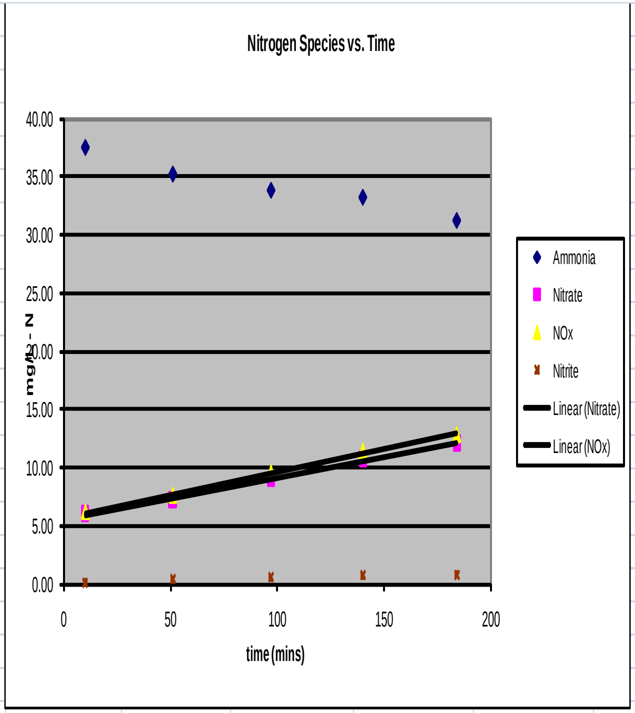




Reactor C: YR A.S. / NS PCI

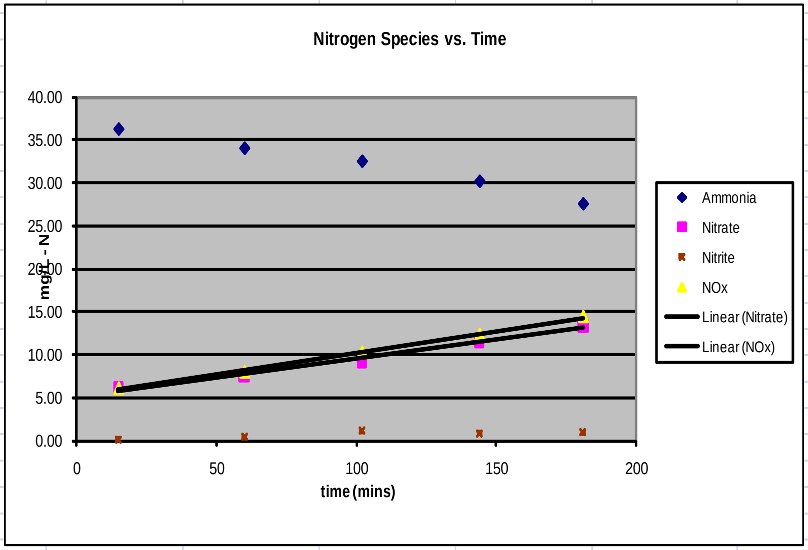
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-M	20-Mar-09	21:11	15	C1	17.2	39.96	37.20	5.93		0.41		3.58	6.34	
Ammonia-M	20-Mar-09	21:55	60	C2	15.9	39.26	35.55	7.14		0.49		3.39	7.63	
Ammonia-M	20-Mar-09	22:37	102	C3	16.8	36.78	32.40	9.19		0.65		3.19	9.84	
Ammonia-M	20-Mar-09	23:20	144	C4	16.9	30.77	30.10	11.14		0.95		3.10	12.09	
Ammonia-M	20-Mar-09	23:57	181	C5	16.84	31.95	27.90	13.79		0.93		3.02	14.72	
Ammonia-T	21-Mar-09	1:35	10	C6	17	37.86	37.50	6.03		0.12		4.37	6.15	
Ammonia-T	21-Mar-09	2:15	51	C7	16.2	39.06	35.20	7.25		0.34		4.13	7.59	
Ammonia-T	21-Mar-09	3:03	97	C8	16.5	35.33	33.80	8.97		0.56		4.86	9.53	
Ammonia-T	21-Mar-09	3:46	140	C9	16	37.14	33.20	10.77		0.68		4.68	11.45	
Ammonia-T	21-Mar-09	4:28	184	C10	15.8	34.66	31.20	12.06		0.80		4.53	12.86	

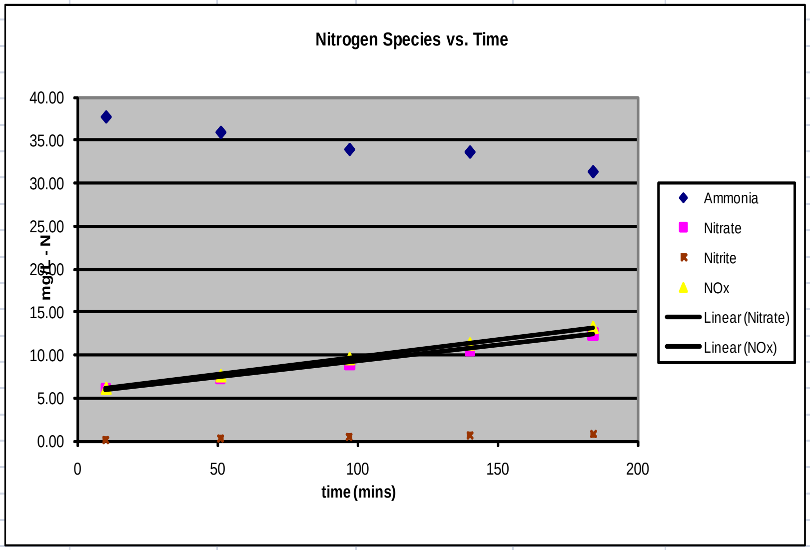




Reactor D: YR A.S. / NS PCE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-M	20-Mar-09	21:11	15	D1	17.2	41.36	36.20	6.08		0.10		3.20	6.17	
Ammonia-M	20-Mar-09	21:55	60	D2	16.18	38.91	34.00	7.60		0.41		3.04	8.01	
Ammonia-M	20-Mar-09	22:37	102	D3	16.8	36.14	32.50	9.14		1.11		2.90	10.25	
Ammonia-M	20-Mar-09	23:20	144	D4	16.9	32.65	30.20	11.46		0.83		2.82	12.29	
Ammonia-M	20-Mar-09	23:57	181	D5	16.8	30.13	27.60	13.37		0.99		2.68	14.36	
Ammonia-T	21-Mar-09	1:35	10	D6	17.8	44.04	37.70	6.05		0.13		4.65	6.18	
Ammonia-T	21-Mar-09	2:15	51	D7	17.1	41.96	35.90	7.30		0.36		4.43	7.66	
Ammonia-T	21-Mar-09	3:03	97	D8	16.9	36.83	33.90	9.08		0.57		5.15	9.64	
Ammonia-T	21-Mar-09	3:46	140	D9	16.1	29.97	33.60	10.68		0.68		5.13	11.36	
Ammonia-T	21-Mar-09	4:28	184	D10	15.9	34.78	31.30	12.49		0.78		4.89	13.27	





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia-M	0.059	0.054		3.883	3.551		0.382	24.98	1240.00	916.67
YR PE	Ammonia-T	0.044	0.040		2.888	2.602		0.362	23.69	1240.00	916.67
Reactor B: YR											
Activated Sludge	Ammonia-M	0.046	0.048		2.758	2.903		0.348	21.00	1343.33	993.33
NS RWI	Ammonia-T	0.039	0.034		2.355	2.060		0.358	21.65	1343.33	993.33
Reactor C: YR											
Activated Sludge	Ammonia-M	0.051	0.047		3.117	2.896		0.420	25.81	1323.33	976.67
NS PCI	Ammonia-T	0.040	0.036		2.432	2.193		0.392	24.11	1323.33	976.67
Reactor D: YR											
Activated Sludge	Ammonia-M	0.050	0.044		3.012	2.688		0.453	27.54	1360.00	986.67
NS PCE	Ammonia-T	0.041	0.037		2.489	2.265		0.390	23.69	1360.00	986.67

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 14 – Day 2 AOB

Sample Data Report for Nansemond Nitrification Inhibition Study

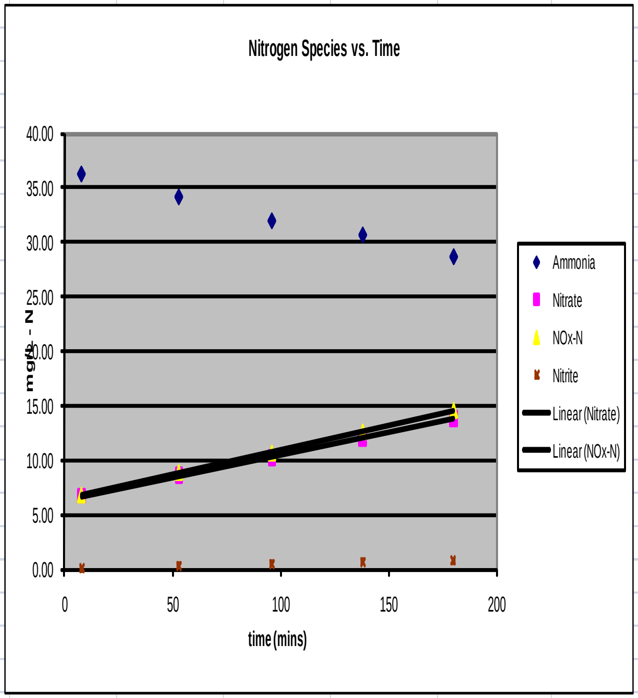
AOB & NOB Experimentation:

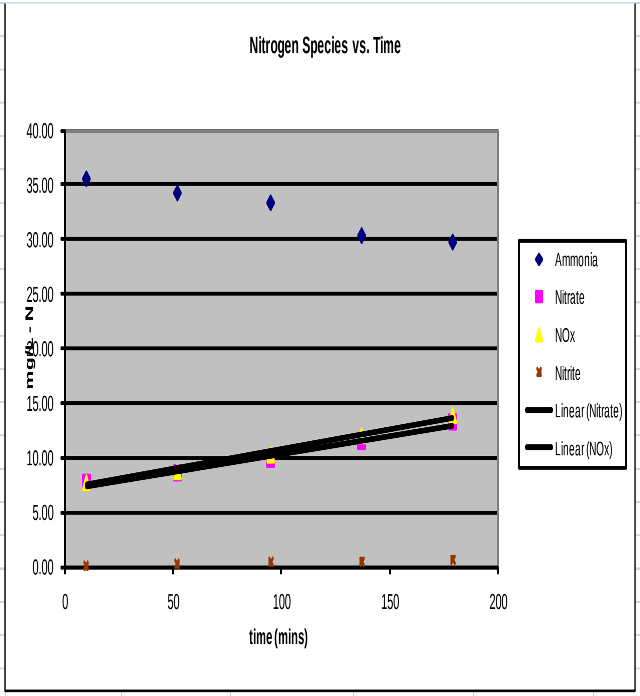
I. AOB

a. Spiked four 3L reactors with 25 mg/L NH_4.
b. Each reactor is running continously by use of stir bars.
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated 2L of the associated composite samples taken for each day respectively.

Reactor A: YR A.S. / YR PE

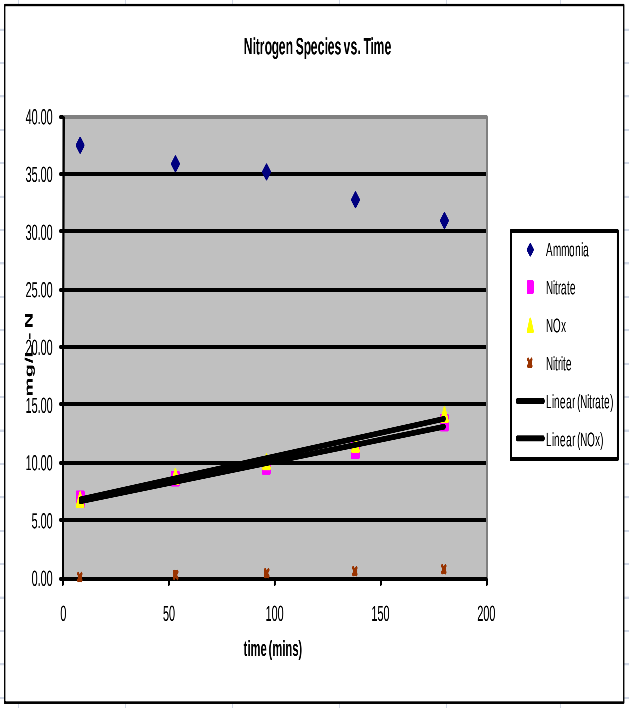
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-W	21-Mar-09	5:50	8	A1	17.2	43.17	36.20	6.73		0.07		3.99	6.80	
Ammonia-W	21-Mar-09	6:35	53	A2	17.1	37.57	34.10	8.59		0.30		0.66	8.89	
Ammonia-W	21-Mar-09	7:18	96	A3	16.9	36.42	31.90	10.19		0.49		0.62	10.68	
Ammonia-W	21-Mar-09	8:00	138	A4	16.5	32.98	30.60	12.00		0.63		0.59	12.64	
Ammonia-W	21-Mar-09	8:42	180	A5	15.8	32.08	28.60	13.82		0.80		0.66	14.62	
Ammonia-TR	21-Mar-09	9:58	10	A6	15.8	37.74	35.60	7.71		0.06		1.72	7.77	
Ammonia-TR	21-Mar-09	10:40	52	A7	15.7	37.88	34.30	8.56		0.21		1.43	8.77	
Ammonia-TR	21-Mar-09	11:23	95	A8	15.7	33.40	33.40	9.92		0.37		1.60	10.29	
Ammonia-TR	21-Mar-09	12:05	137	A9	15.6	35.36	30.40	11.52		0.52		1.58	12.04	
Ammonia-TR	21-Mar-09	12:47	179	A10	15.6	33.25	29.80	13.22		0.66		1.21	13.88	

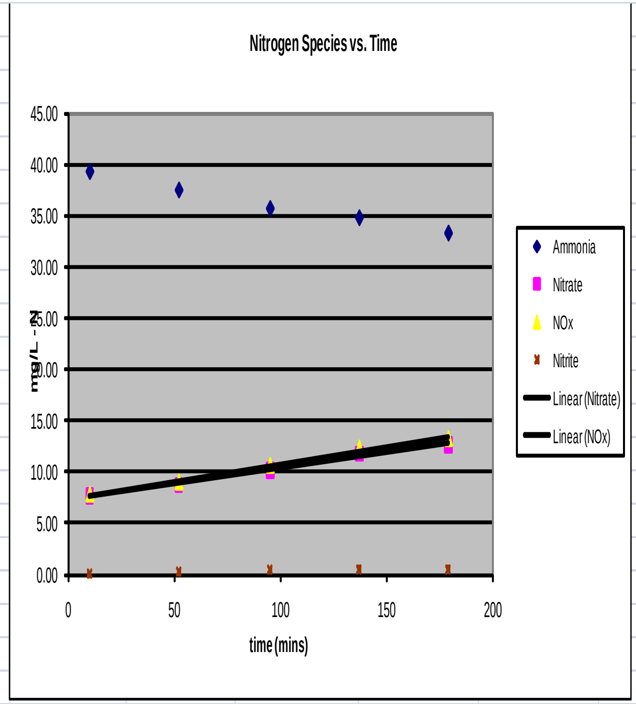




Reactor B: YR A.S. / NS RWI

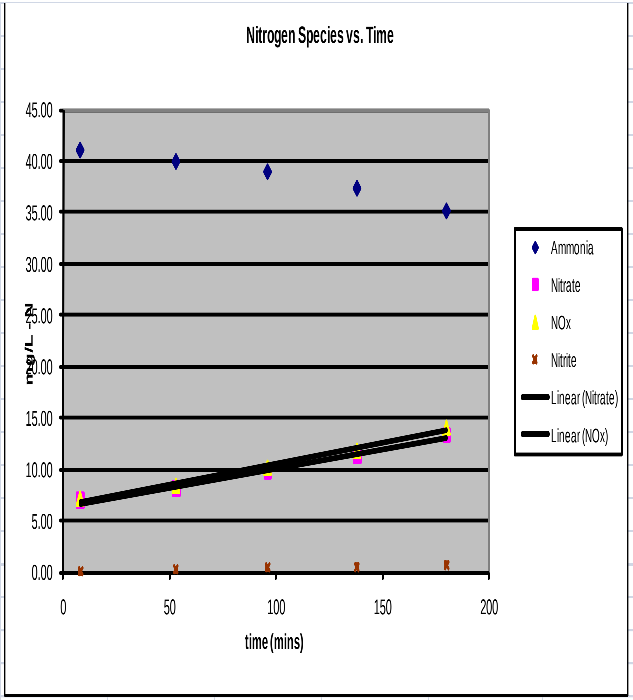
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-W	21-Mar-09	5:50	8	B1	15.6	43.96	37.40	6.76		0.07		2.33	6.82	
Ammonia-W	21-Mar-09	6:35	53	B2	15.8	42.47	35.80	8.57		0.27		2.21	8.85	
Ammonia-W	21-Mar-09	7:18	96	B3	15.8	37.69	35.10	9.67		0.42		2.03	10.10	
Ammonia-W	21-Mar-09	8:00	138	B4	15.7	36.95	32.70	11.02		0.57		2.01	11.60	
Ammonia-W	21-Mar-09	8:42	180	B5	15.9	34.37	30.90	13.49		0.69		1.96	14.18	
Ammonia-TR	21-Mar-09	9:58	10	B6	16.2	43.61	39.20	7.70		0.09		3.10	7.78	
Ammonia-TR	21-Mar-09	10:40	52	B7	16.1	40.10	37.40	8.71		0.25		4.57	8.96	
Ammonia-TR	21-Mar-09	11:23	95	B8	15.8	65.54	35.60	10.19		0.40		3.17	10.59	
Ammonia-TR	21-Mar-09	12:05	137	B9	15.54	35.54	34.70	11.79		0.51		2.89	12.30	
Ammonia-TR	21-Mar-09	12:47	179	B10	15.62	33.87	33.20	12.64		0.57		2.59	13.21	

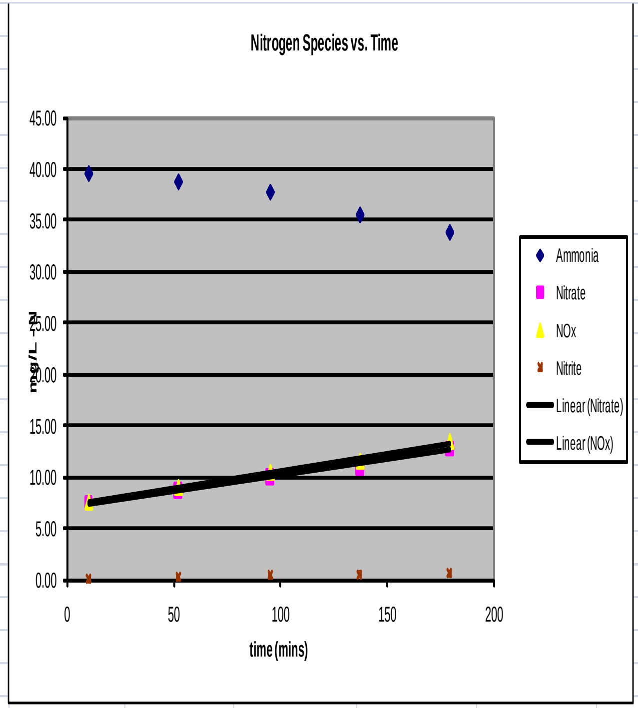




Reactor C: YR A.S. / NS PCI

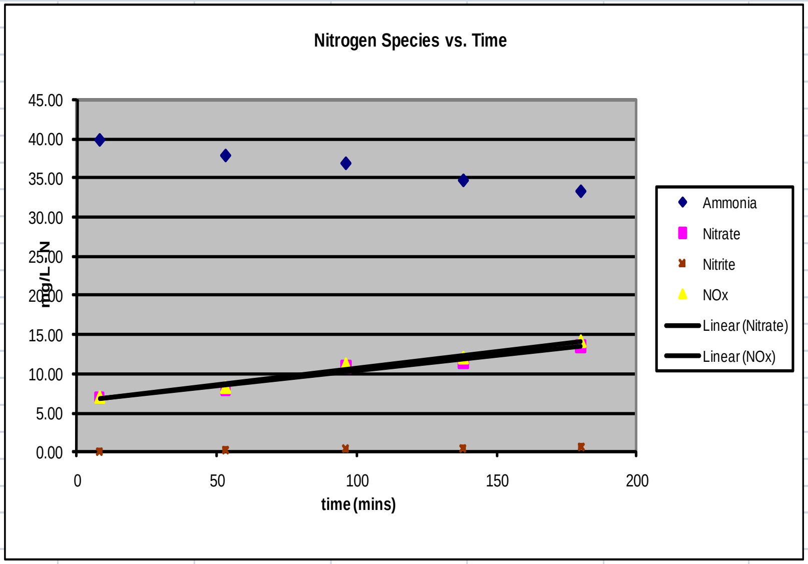
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-W	21-Mar-09	5:50	8	C1	15.5	50.08	41.00	6.99		0.07		4.82	7.06	
Ammonia-W	21-Mar-09	6:35	53	C2	16.0	46.11	39.90	8.07		0.26		4.60	8.33	
Ammonia-W	21-Mar-09	7:18	96	C3	15.8	41.33	38.90	9.71		0.41		4.49	10.12	
Ammonia-W	21-Mar-09	8:00	138	C4	15.7	37.90	37.30	11.27		0.55		4.22	11.81	
Ammonia-W	21-Mar-09	8:42	180	C5	15.7	39.84	35.10	13.35		0.73		4.09	14.08	
Ammonia-TR	21-Mar-09	9:58	10	C6	16.1	43.76	39.50	7.49		0.08		4.42	7.57	
Ammonia-TR	21-Mar-09	10:40	52	C7	15.9	44.92	38.70	8.74		0.25		4.48	8.99	
Ammonia-TR	21-Mar-09	11:23	95	C8	15.8	43.77	37.70	10.07		0.39		4.31	10.45	
Ammonia-TR	21-Mar-09	12:05	137	C9	15.8	39.55	35.50	11.00		0.50		3.97	11.50	
Ammonia-TR	21-Mar-09	12:47	179	C10	15.8	37.21	33.80	12.78		0.61		4.05	13.40	

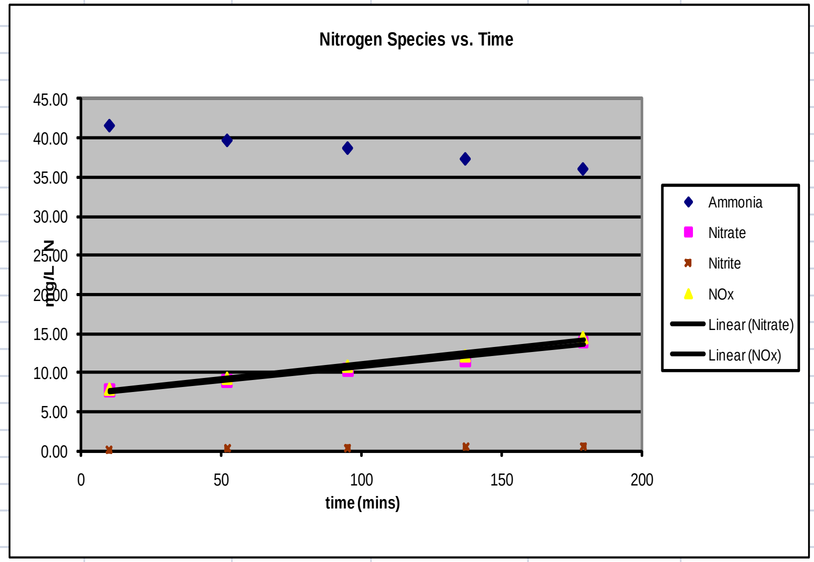




Reactor D: YR A.S. / NS PCE

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia-W	21-Mar-09	5:50	8	D1	15.85	44.29	39.90	6.95		0.08		3.54	7.03	
Ammonia-W	21-Mar-09	6:35	53	D2	16.2	41.59	37.90	8.03		0.28		3.31	8.31	
Ammonia-W	21-Mar-09	7:18	96	D3	15.9	33.96	36.90	10.83		0.44		3.14	11.27	
Ammonia-W	21-Mar-09	8:00	138	D4	15.7	35.51	34.70	11.56		0.55		3.06	12.10	
Ammonia-W	21-Mar-09	8:42	180	D5	15.6	36.37	33.30	13.49		0.73		3.31	14.22	
Ammonia-TR	21-Mar-09	9:58	10	D6	16.24	44.29	41.60	7.72		0.09		5.15	7.81	
Ammonia-TR	21-Mar-09	10:40	52	D7	16	49.64	39.70	8.97		0.27		5.06	9.23	
Ammonia-TR	21-Mar-09	11:23	95	D8	15.8	39.33	38.70	10.40		0.41		5.20	10.81	
Ammonia-TR	21-Mar-09	12:05	137	D9	15.8	37.33	37.30	11.63		0.53		4.43	12.16	
Ammonia-TR	21-Mar-09	12:47	179	D10	15.7	38.92	36.00	13.91		0.62		4.12	14.53	



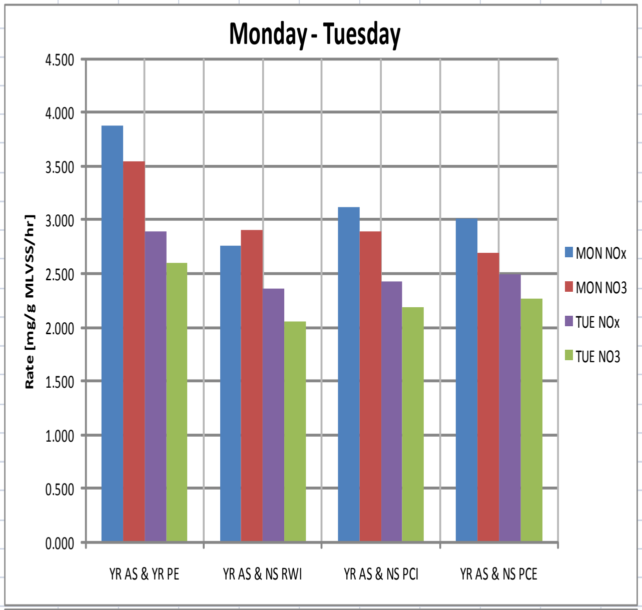


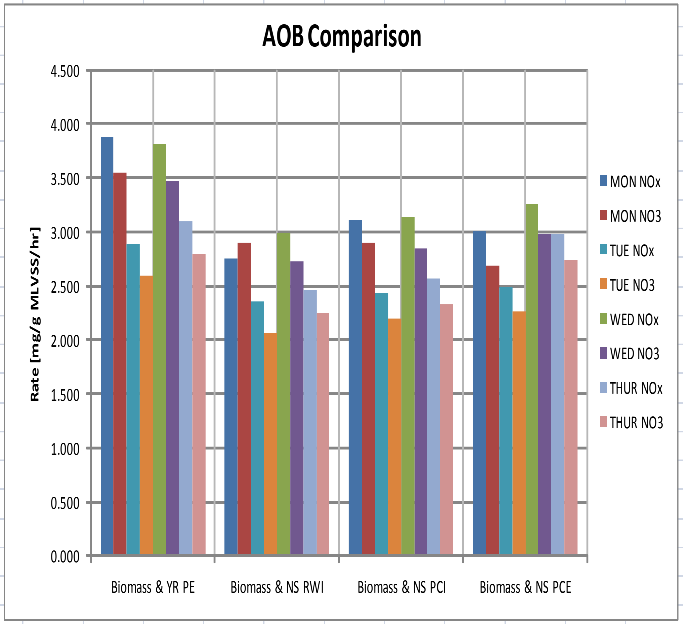
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia-W	0.045	0.041		3.817	3.463		0.382	32.25	976.67	710.00
YR PE	Ammonia-TR	0.037	0.033		3.093	2.795		0.362	30.59	976.67	710.00
Reactor B: YR											
Activated Sludge	Ammonia-W	0.041	0.037		2.988	2.724		0.348	25.54	1093.33	816.67
NS RWI	Ammonia-TR	0.034	0.031		2.466	2.253		0.358	26.33	1093.33	816.67
Reactor C: YR											
Activated Sludge	Ammonia-W	0.041	0.037		3.137	2.848		0.420	32.32	1070.00	780.00
NS PCI	Ammonia-TR	0.033	0.030		2.573	2.335		0.392	30.19	1070.00	780.00
Reactor D: YR											
Activated Sludge	Ammonia-W	0.042	0.039		3.259	2.976		0.453	34.83	1060.00	780.00
NS PCE	Ammonia-TR	0.039	0.036		2.977	2.735		0.390	29.97	1060.00	780.00

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Monday & Tuesday

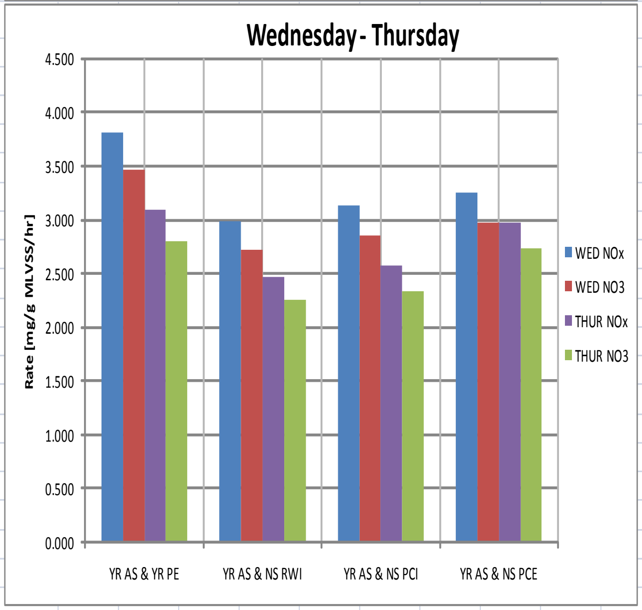
	MON NOx	MON NO3	TUE NO3	TUE NOx
Reactor A: YR Activated sludge YR PE	3.883	3.551	2.602	2.888
Reactor B: YR Activated Sludge NS RWI	2.758	2.903	2.060	2.355
Reactor C: YR Activated Sludge NS PCI	3.117	2.896	2.193	2.432
Reactor D: YR Activated Sludge NS PCE	3.012	2.688	2.265	2.489





Wednesday & Thursday

	WED NOx	WED NO3	THUR NO3	THUR NOx
Reactor A: YR Activated sludge YR PE	3.817	3.463	2.795	3.093
Reactor B: YR Activated Sludge NS RWI	2.988	2.724	2.253	2.466
Reactor C: YR Activated Sludge NS PCI	3.137	2.848	2.335	2.573
Reactor D: YR Activated Sludge NS PCE	3.259	2.976	2.735	2.977



Week 15 – QACs Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

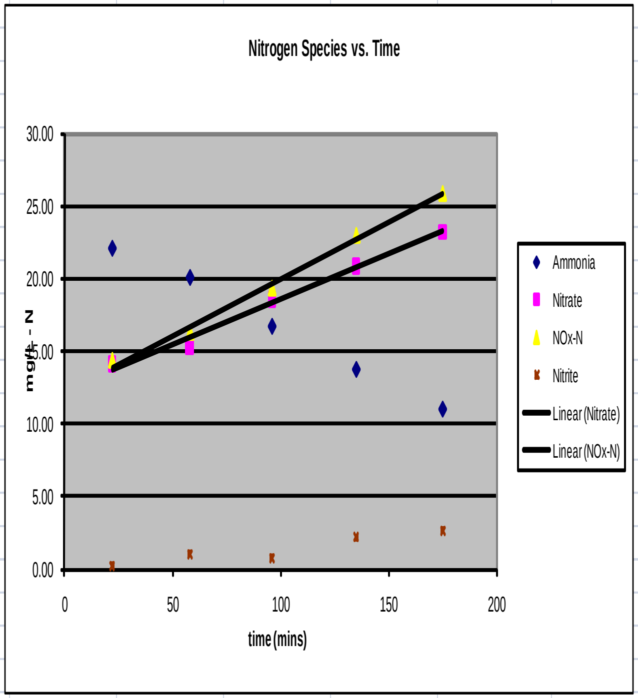
a. Spiked four 3L reactors with 25 mg/L NH_4.
b. Each reactor is running continously by use of stir bars.
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of Nature Fresh Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

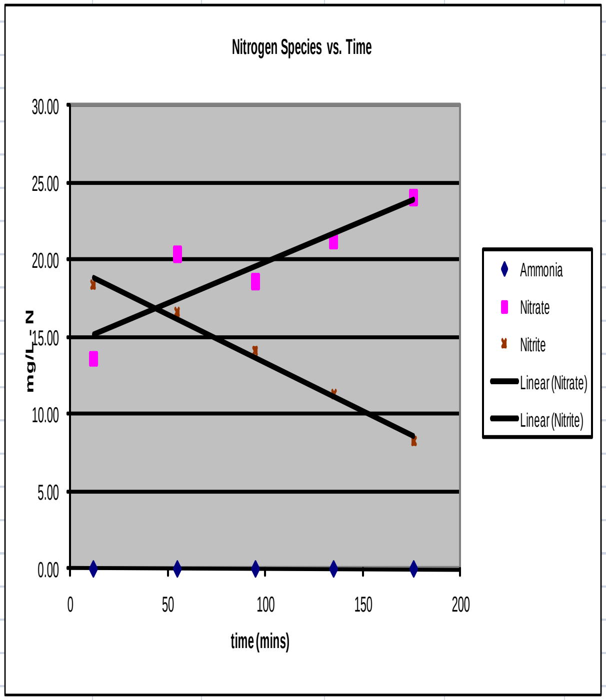
II. NOB

a. Spiked four 3L reactors with 15 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars.
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of Nature Fresh Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

Reactor A: YR A.S. / YR SE

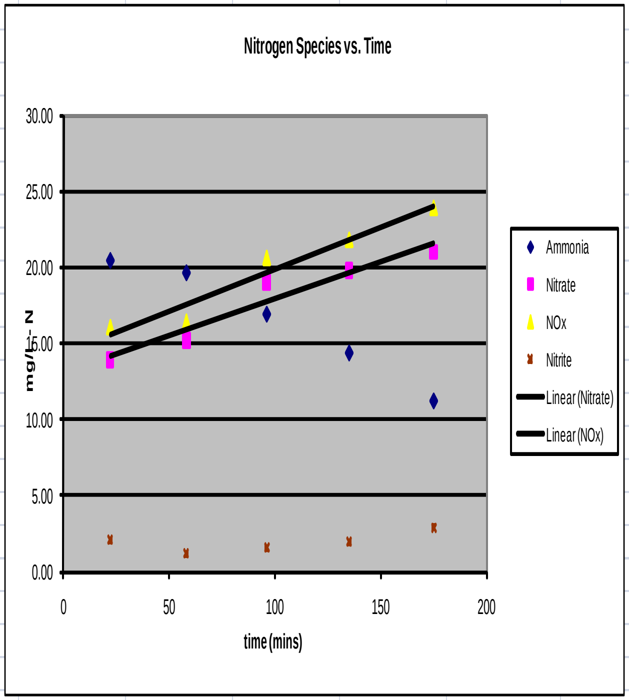
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	13:52	22	A1	21.2	25.16	22.10	14.10		0.25		5.32	14.35	
Ammonia	19-May-09	14:28	58	A2	21.8	22.27	20.10	15.25		1.03		5.25	16.28	
Ammonia	19-May-09	15:06	96	A3	22	17.32	16.75	18.53		0.80		3.34	19.34	
Ammonia	19-May-09	15:45	135	A4	22.3	15.21	13.80	20.83		2.16		3.08	22.99	
Ammonia	19-May-09	16:25	175	A5	22.2	10.78	11.08	23.21		2.68		2.90	25.89	0.78
Nitrite	19-May-09	18:17	12	A6	21	0.00	-	13.61		18.38		2.61	31.99	
Nitrite	19-May-09	19:00	55	A7	21.5	0.00	-	20.40		16.63		3.47	37.03	
Nitrite	19-May-09	19:40	95	A8	21.7	0.00	-	18.62		14.17		3.13	32.80	
Nitrite	19-May-09	20:20	135	A9	21.9	0.00	-	21.19		11.32		2.36	32.51	
Nitrite	19-May-09	21:01	176	A10	21.9	0.00	-	24.06		8.27		2.19	32.34	0.92

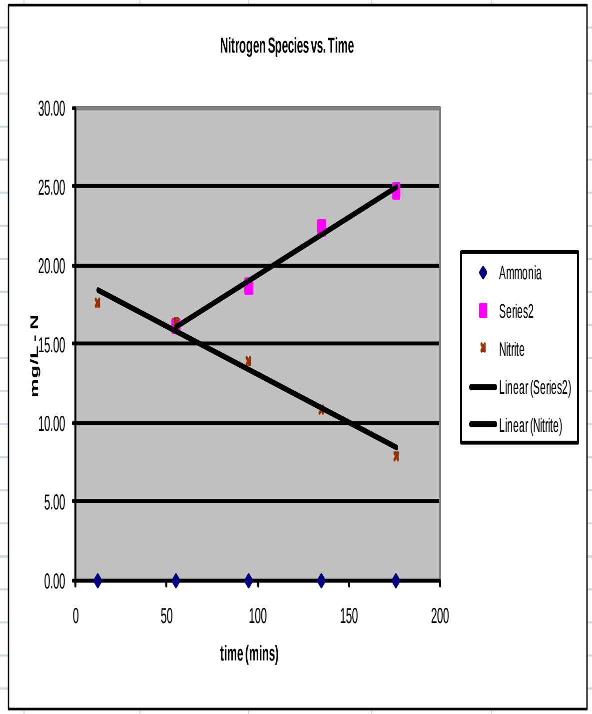




Reactor B: YR A.S./YR SE + 0.574 mL NF

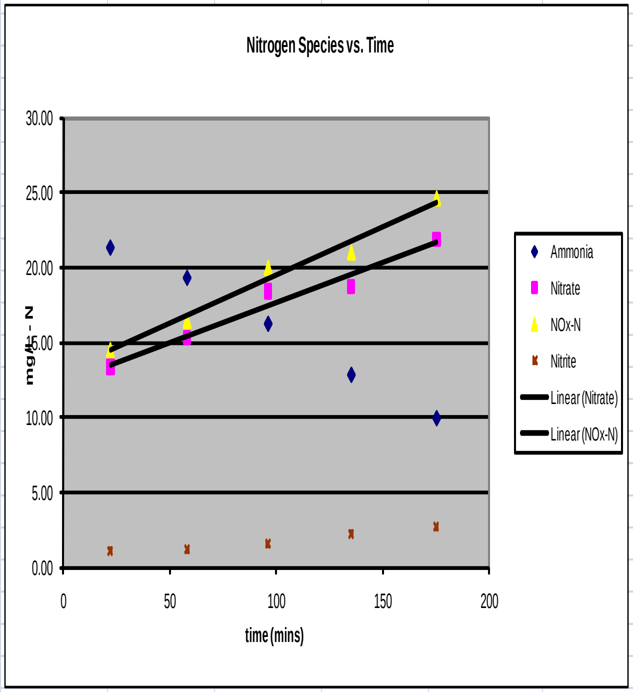
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	13:52	22	B1	21.3	23.20	20.40	13.93		2.08		5.18	16.01	
Ammonia	19-May-09	14:28	58	B2	21.9	22.19	19.60	15.17		1.20		4.51	16.37	
Ammonia	19-May-09	15:06	96	B3	22.1	18.32	16.90	19.02		1.58		3.26	20.60	
Ammonia	19-May-09	15:45	135	B4	22.4	13.24	14.38	19.82		1.97		3.81	21.79	
Ammonia	19-May-09	16:25	175	B5	22.2	11.42	11.25	20.99		2.91		2.77	23.90	0.9
Nitrite	19-May-09	18:17	12	B6	21.1	0.00	-	18.39		17.62		2.17	36.01	
Nitrite	19-May-09	19:00	55	B7	21.6	0.00	-	16.17		16.41		2.77	32.58	
Nitrite	19-May-09	19:40	95	B8	21.8	0.00	-	18.69		13.90		3.44	32.59	
Nitrite	19-May-09	20:20	135	B9	22	0.00	-	22.39		10.88		2.01	33.27	
Nitrite	19-May-09	21:01	176	B10	22	0.00	-	24.74		7.91		1.70	32.65	0.84

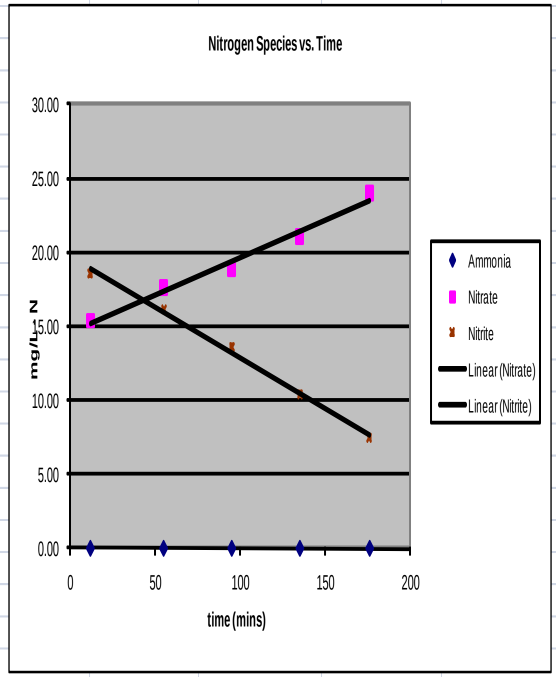




Reactor C: YR A.S./YR SE + 14 mL NF

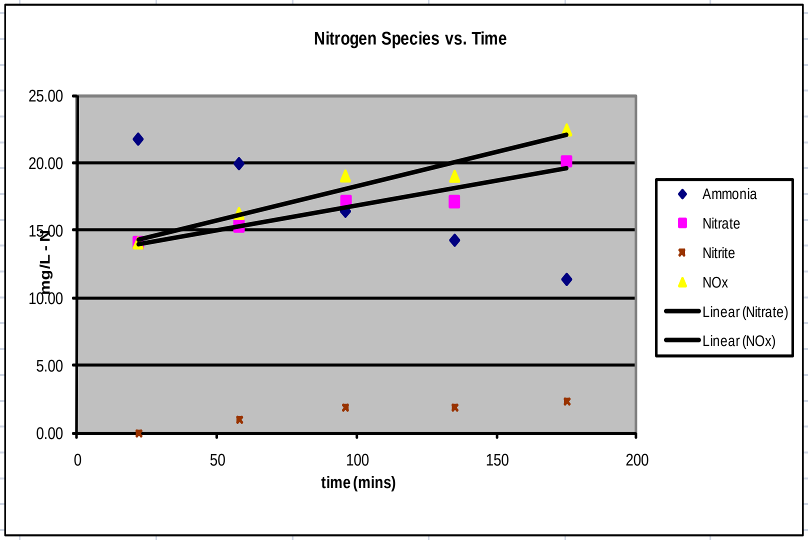
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	13:52	22	C1	21.1	23.07	21.30	13.39		1.10		5.64	14.49	
Ammonia	19-May-09	14:31	58	C2	22.2	20.04	19.30	15.30		1.14		3.69	16.44	
Ammonia	19-May-09	15:09	96	C3	22.4	16.83	16.25	18.43		1.54		2.89	19.98	
Ammonia	19-May-09	15:46	135	C4	22.5	12.54	12.88	18.73		2.26		3.87	20.99	
Ammonia	19-May-09	16:27	175	C5	22.4	9.79	10.00	21.88		2.70		3.05	24.59	0.84
Nitrite	19-May-09	18:19	12	C6	21.2	0.00	-	15.40		18.53		2.54	33.93	
Nitrite	19-May-09	19:02	55	C7	21.7	0.00	-	17.61		16.09		2.98	33.70	
Nitrite	19-May-09	19:41	95	C8	21.4	0.00	-	18.81		13.61		2.66	32.42	
Nitrite	19-May-09	20:21	135	C9	21.8	0.00	-	21.02		10.46		2.10	31.49	
Nitrite	19-May-09	21:03	176	C10	21.8	0.00	-	23.96		7.47		2.04	31.43	0.88

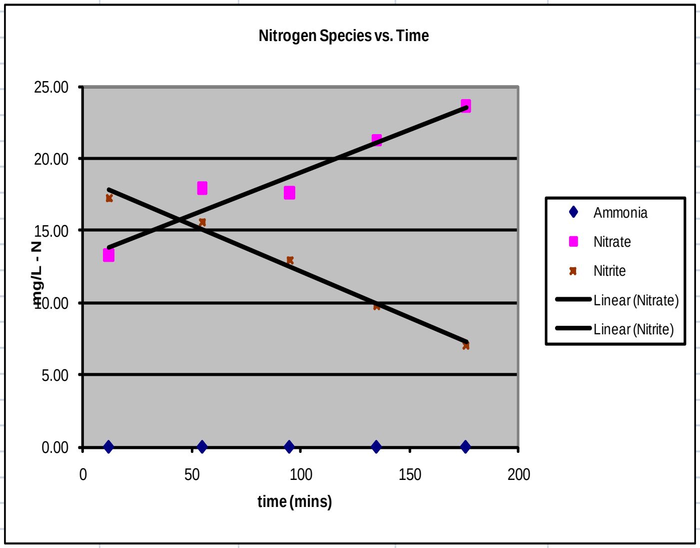




Reactor D: YR A.S./YR SE + 63 mL NF

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	13:52	22	D1	21.1	22.53	21.70	14.07		0.00		3.85	14.07	
Ammonia	19-May-09	14:31	58	D2	22.2	20.95	19.90	15.28		0.97		2.57	16.25	
Ammonia	19-May-09	15:09	96	D3	22.4	17.29	16.40	17.18		1.86		2.60	19.04	
Ammonia	19-May-09	15:46	135	D4	22.4	15.70	14.28	17.14		1.88		2.74	19.01	
Ammonia	19-May-09	16:27	175	D5	22.4	11.49	11.40	20.11		2.34		2.52	22.45	0.76
Nitrite	19-May-09	18:19	12	D6	21.0	0.00	-	13.26		17.21		1.96	30.47	
Nitrite	19-May-09	19:02	55	D7	21.1	0.00	-	17.90		15.57		2.26	33.47	
Nitrite	19-May-09	19:41	95	D8	21.3	0.00	-	17.61		12.95		2.12	30.56	
Nitrite	19-May-09	20:21	135	D9	21.8	0.00	-	21.24		9.78		1.44	31.02	
Nitrite	19-May-09	21:03	176	D10	21.9	0.00	-	23.63		7.05		1.58	30.68	0.78





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia	0.078	0.062		4.850	3.872		0.402	25.07	1476.67	963.33
YR SE	Nitrite		0.053	-0.062		3.389	-3.960	0.147	9.29	1470.00	946.67
Reactor B: YR											
Activated Sludge	Ammonia	0.055	0.049		3.536	3.120		0.376	23.98	1433.33	940.00
YR SE	Nitrite		0.073	-0.061		4.543	-3.801	0.141	8.81	1486.67	963.33
0.574 mL NF											
Reactor C: YR											
Activated Sludge	Ammonia	0.065	0.053		4.109	3.387		0.419	26.63	1430.00	943.33
YR SE	Nitrite		0.050	-0.068		3.261	-4.403	0.168	10.88	1416.67	926.67
14 mL NF											
Reactor D: YR											
Activated Sludge	Ammonia	0.051	0.036		3.758	2.689		0.382	28.15	1250.00	813.33
YR SE	Nitrite		0.059	-0.064		4.048	-4.375	0.180	12.33	1360.00	876.67
63 mL NF											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Week 15 – Day 2 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

a. Spiked four 3L reactors with 25 mg/L NH_4 .

b. Each reactor is running continously by use of stir bars.

c. 2 L of the diluent source is added to the reactors.

d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20L to 9 L.

e. Constant DO and pH were monitored and logged throughout the experiment.

f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.

g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters

i. Reactors B, C, and D in the diluent source incorporated varying concentrations of Blue Works Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

II. NOB

a. Spiked four 3L reactors with 15 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.

b. Each reactor is running continously by use of stir bars.

c. Constant DO and pH were monitored and logged throughout the experiment.

d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.

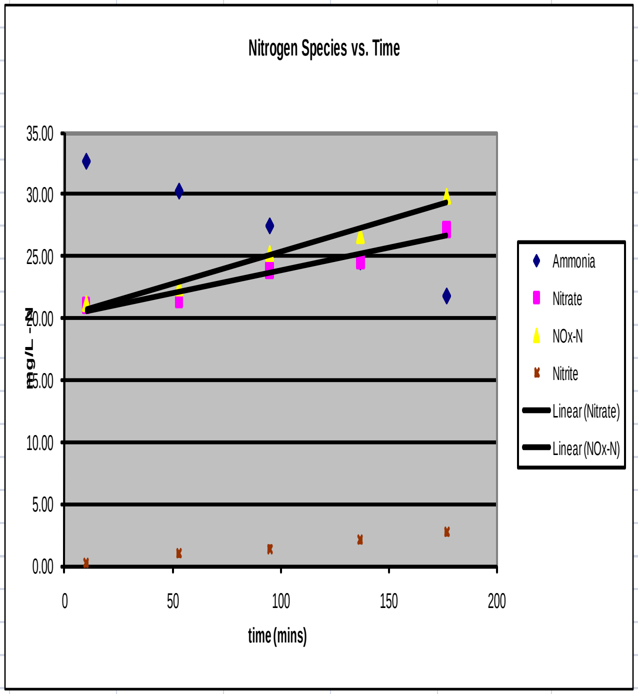
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.

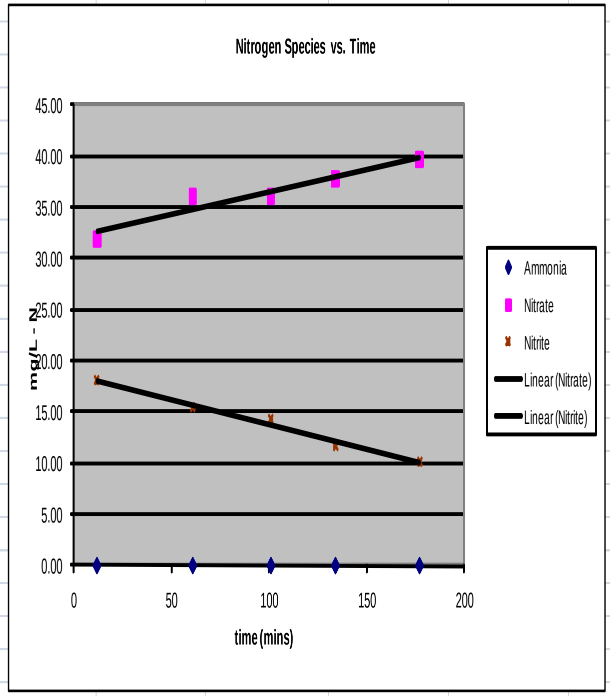
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.

g. Reactors B, C, and D in the diluent source incorporated varying concentrations of Blue Works Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

Reactor A: YR A.S./YR SE

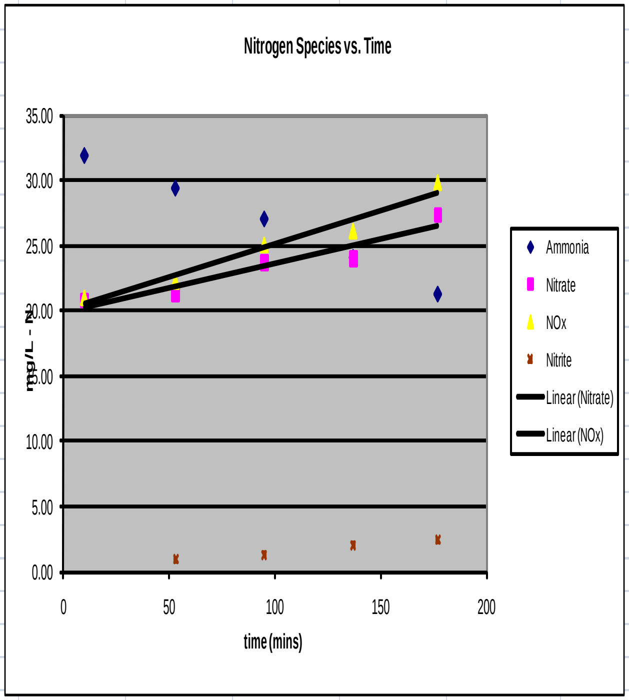
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	20-May-09	11:53	10	A1	20.6	68.22	32.70	21.03		0.17		9.14	21.20	
Ammonia	20-May-09	12:36	53	A2	21.0	326.24	30.30	21.49		0.97		5.51	22.46	
Ammonia	20-May-09	13:18	95	A3	21.3	55.82	27.50	23.87		1.35		4.45	25.21	
Ammonia	20-May-09	14:00	137	A4	21.6	298.77	24.60	24.59		2.05		3.12	26.64	
Ammonia	20-May-09	14:40	177	A5	21.9	57.13	21.85	27.12		2.67		2.81	29.79	0.86
Nitrite	20-May-09	20:19	12	A6	22.1	0.00	-	31.93		18.11		3.36	50.04	
Nitrite	20-May-09	21:08	61	A7	22.1	0.00	-	36.04		15.52		3.73	51.56	
Nitrite	20-May-09	21:48	101	A8	22.2	0.00	-	36.13		14.27		3.28	50.40	
Nitrite	20-May-09	22:21	134	A9	22.2	0.00	-	37.85		11.68		2.85	49.53	
Nitrite	20-May-09	23:04	177	A10	22.3	0.00	-	39.70		10.16		2.12	49.85	1.2

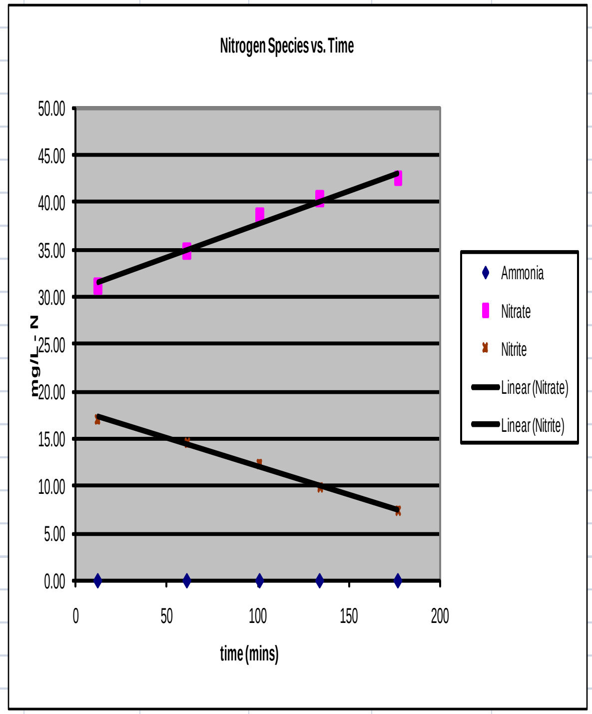




Reactor B: YR A.S./YR SE + 0.574 mL BW

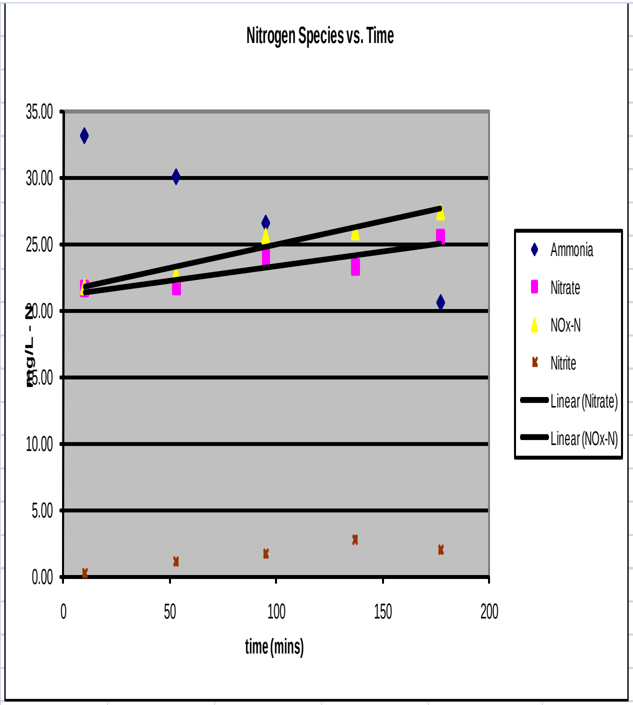
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	20-May-09	11:53	10	B1	20.6	68.26	31.90	20.80		0.16		7.00	20.96	
Ammonia	20-May-09	12:36	53	B2	20.9	65.08	29.40	21.25		0.96		4.17	22.21	
Ammonia	20-May-09	13:18	95	B3	21.3	57.77	27.05	23.68		1.33		3.90	25.02	
Ammonia	20-May-09	14:00	137	B4	21.6	62.20	24.10	24.02		2.04		3.80	26.07	
Ammonia	20-May-09	14:40	177	B5	21.9	166.67	21.30	27.31		2.45		3.30	29.76	0.9
Nitrite	20-May-09	20:19	12	B6	22.3	0.00	-	31.18		17.03		2.34	48.21	
Nitrite	20-May-09	21:08	61	B7	22.3	0.00	-	34.83		14.57		2.87	49.40	
Nitrite	20-May-09	21:48	101	B8	22.3	0.00	-	38.51		12.38		3.44	50.89	
Nitrite	20-May-09	22:21	134	B9	22.4	0.00	-	40.34		9.93		2.51	50.27	
Nitrite	20-May-09	23:04	177	B10	22.3	0.00	-	42.59		7.47		1.83	50.06	1.02

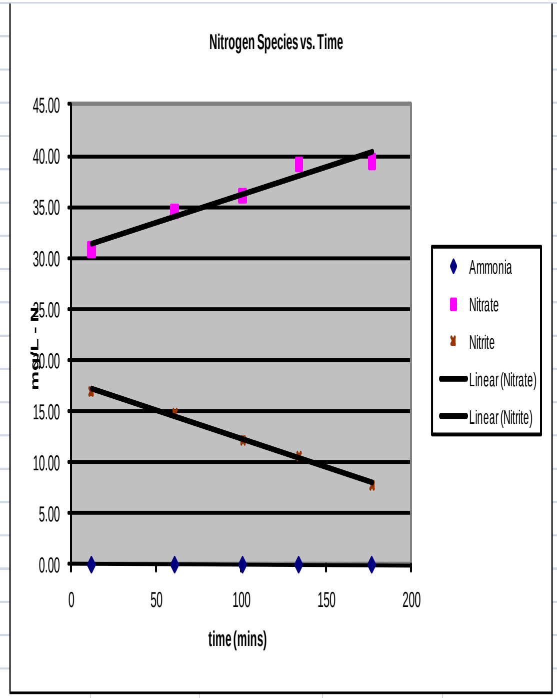




Reactor C: YR A.S./YR SE + 14 mL BW

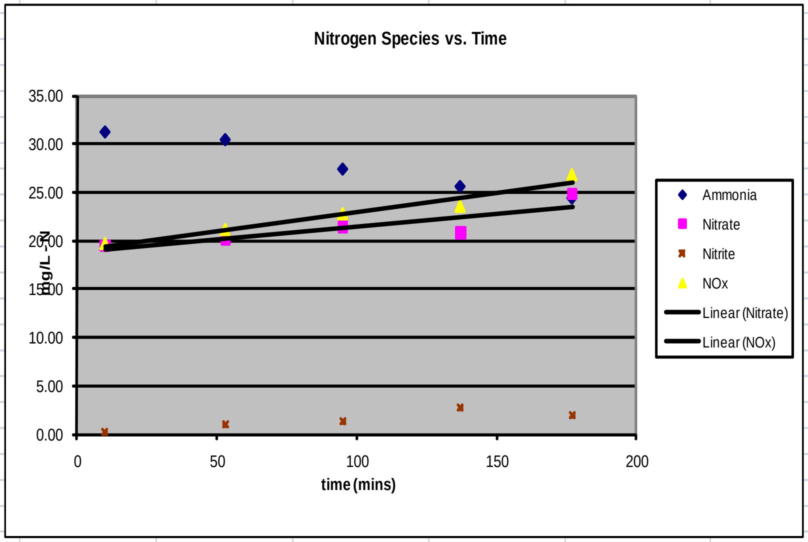
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	20-May-09	11:54	10	C1	20.8	68.92	33.10	21.61		0.18		5.38	21.79	
Ammonia	20-May-09	12:38	53	C2	21.3	293.96	30.00	21.69		1.06		4.19	22.74	
Ammonia	20-May-09	13:19	95	C3	21.9	53.13	26.50	23.94		1.69		3.15	25.63	
Ammonia	20-May-09	14:02	137	C4	22.1	56.10	23.40	23.22		2.72		3.85	25.94	
Ammonia	20-May-09	14:42	177	C5	22.1	45.79	20.50	25.52		1.92		3.18	27.45	0.94
Nitrite	20-May-09	20:21	12	C6	22.3	0.00	-	30.81		16.93		3.08	47.74	
Nitrite	20-May-09	21:10	61	C7	22.3	0.00	-	34.57		14.82		3.07	49.39	
Nitrite	20-May-09	21:50	101	C8	22.3	0.00	-	36.11		12.16		2.99	48.27	
Nitrite	20-May-09	22:22	134	C9	22.3	0.00	-	39.15		10.61		2.42	49.77	
Nitrite	20-May-09	23:06	177	C10	22.4	0.00	-	39.40		7.84		1.90	47.24	1

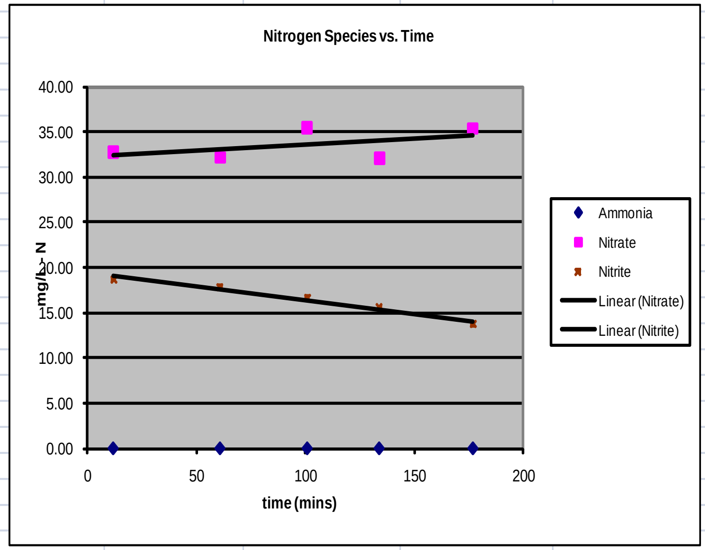




Reactor D: YR A.S./YR SE + 63 mL BW

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by IC	~~NOx-N by AQ2 SEAL~~	Nitrite by AQ2 SEAL	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate IC + Nitrite SEAL	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	20-May-09	11:54	10	D1	20.8	74.51	31.20	19.50		0.18		2.32	19.67	
Ammonia	20-May-09	12:38	53	D2	21.2	61.96	30.40	20.13		1.00		3.49	21.13	
Ammonia	20-May-09	13:19	95	D3	21.8	57.44	27.35	21.41		1.33		2.69	22.74	
Ammonia	20-May-09	14:02	137	D4	21.9	57.84	25.55	20.78		2.72		2.97	23.51	
Ammonia	20-May-09	14:42	177	D5	22	48.02	24.35	24.83		1.92		2.79	26.75	0.96
Nitrite	20-May-09	20:21	12	D6	22.5	0.00	-	32.79		18.71		3.19	51.50	
Nitrite	20-May-09	21:10	61	D7	22.4	0.00	-	32.17		17.81		2.97	49.97	
Nitrite	20-May-09	21:50	101	D8	22.4	0.00	-	35.46		16.66		2.66	52.12	
Nitrite	20-May-09	22:22	134	D9	22.4	0.00	-	32.03		15.56		1.96	47.59	
Nitrite	20-May-09	23:06	177	D10	22.5	0.00	-	35.33		13.72		2.47	49.05	1.02



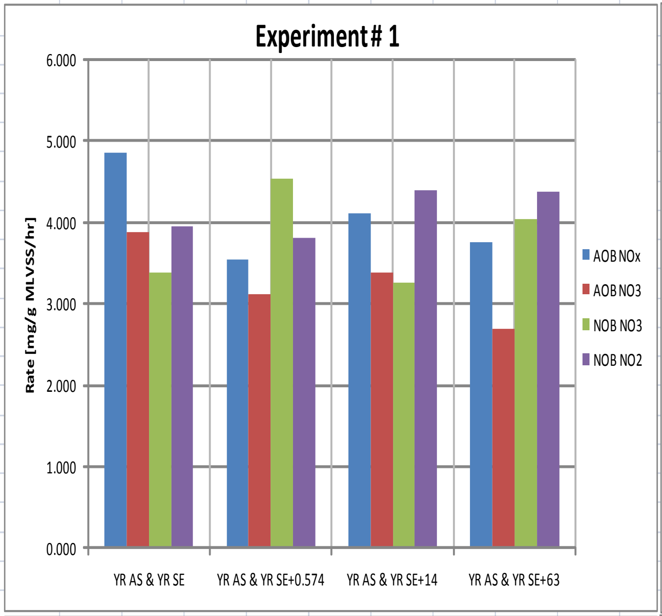


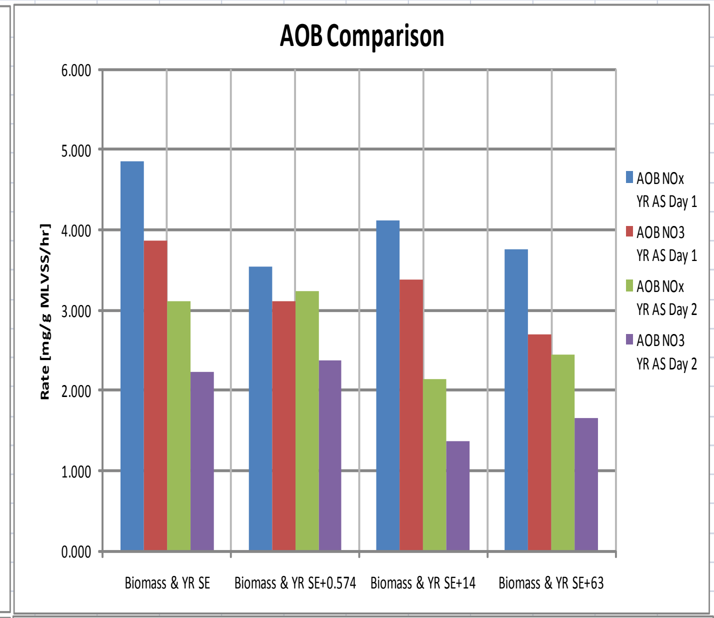
Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia	0.051	0.036		3.113	2.224		0.402	24.56	1553.33	983.33
YR SE	Nitrite		0.043	-0.049		2.671	-3.000	0.147	9.01	1530.00	976.67
Reactor B: YR											
Activated Sludge	Ammonia	0.051	0.038		3.236	2.381		0.376	23.73	1493.33	950.00
YR SE	Nitrite		0.070	-0.059		4.376	-3.644	0.141	8.78	1513.33	966.67
0.574 mL BW											
Reactor C: YR											
Activated Sludge	Ammonia	0.035	0.022		2.141	1.376		0.419	25.81	1526.67	973.33
YR SE	Nitrite		0.054	-0.055		3.501	-3.588	0.168	10.88	1486.67	926.67
14 mL BW											
Reactor D: YR											
Activated Sludge	Ammonia	0.039	0.027		2.441	1.664		0.382	23.61	1493.33	970.00
YR SE	Nitrite		0.013	-0.030		0.850	-2.009	0.180	12.01	1436.67	900.00
63 mL BW											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

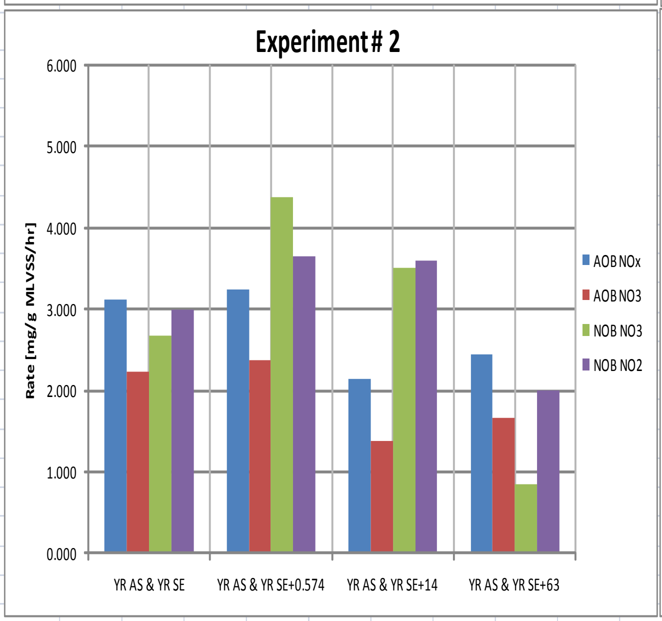
	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: YR Activated sludge YR SE	4.850	3.872	3.389	3.960
Reactor B: YR Activated Sludge YR SE 0.574 mL NF	3.536	3.120	4.543	3.801
Reactor C: YR Activated Sludge YR SE 14 mL NF	4.109	3.387	3.261	4.403
Reactor D: YR Activated Sludge YR SE 63 mL NF	3.758	2.689	4.048	4.375

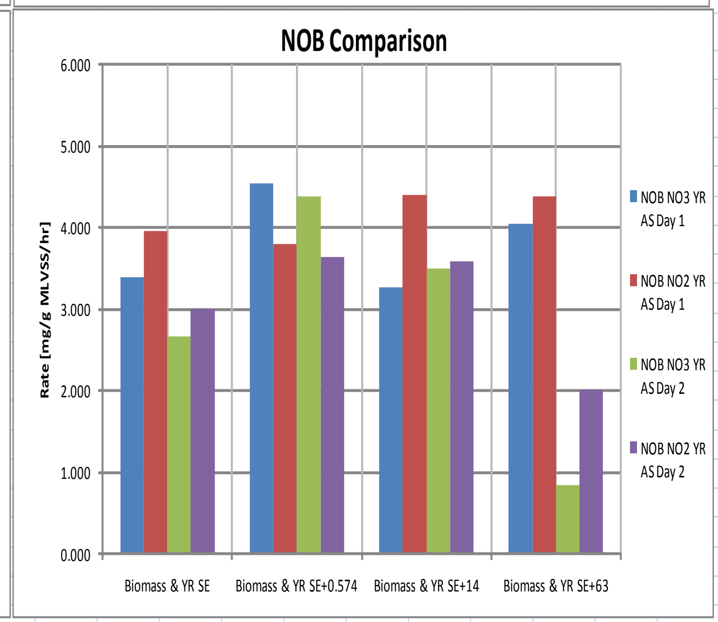




Experiment 2

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: YR Activated sludge YR SE	3.113	2.224	2.671	3.000
Reactor B: YR Activated Sludge YR SE 0.574 mL BW	3.236	2.381	4.376	3.644
Reactor C: YR Activated Sludge YR SE 14 mL BW	2.141	1.376	3.501	3.588
Reactor D: YR Activated Sludge YR SE 63 mL BW	2.441	1.664	0.850	2.009





Week 16 – QAC Product B Day 1 AOB/NOB

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

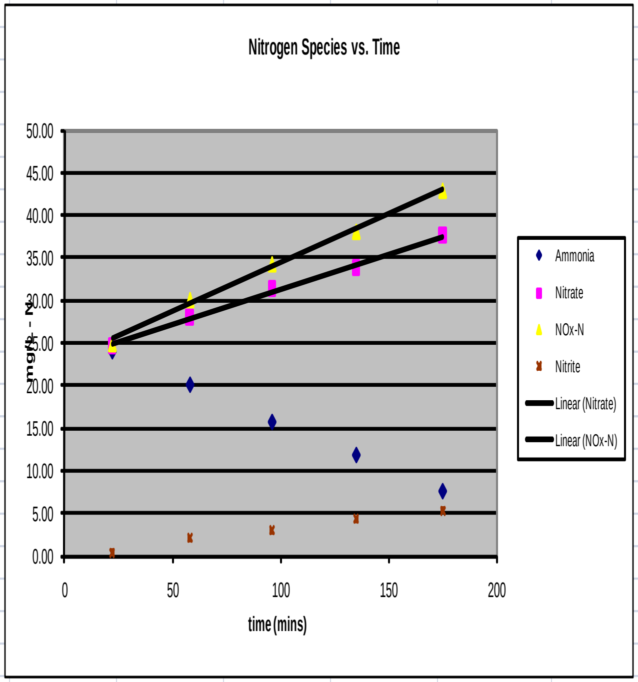
a. Spiked four 3L reactors with 25 mg/L NH_4.
b. Each reactor is running continously by use of stir bars.
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of Blue Works Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

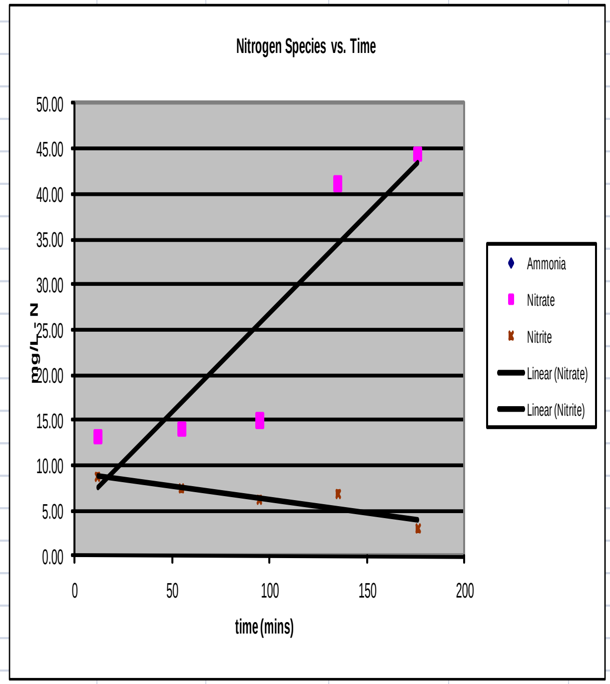
II. NOB

a. Spiked four 3L reactors with 20 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars.
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 µm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of Blue Works Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

Reactor A: YR A.S. / YR SE

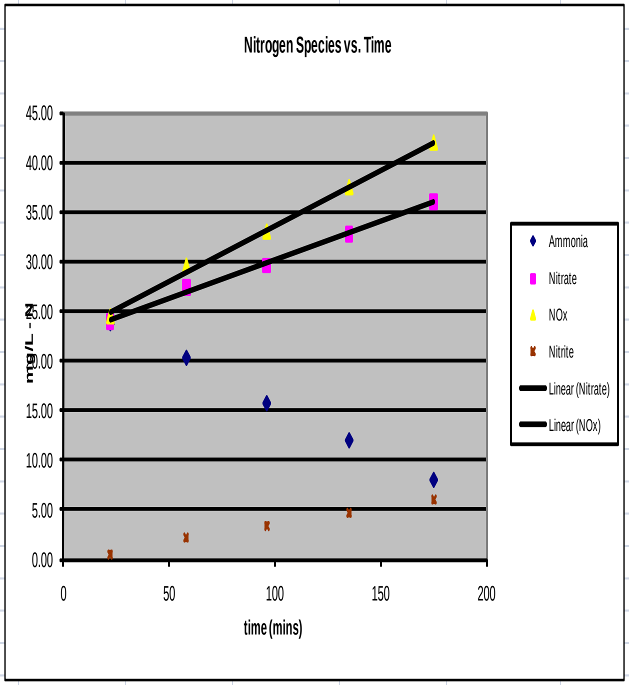
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~		NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~		mg/L NOx-N	mg/L PO4-P
Ammonia	17-Jun-09	11:02	22	A1	22.6		24.00	24.60		0.34			24.94	
Ammonia	17-Jun-09	11:44	58	A2	22.45		20.10	28.00		2.12			30.12	
Ammonia	17-Jun-09	12:26	96	A3	22.4		15.75	31.40		2.92			34.32	
Ammonia	17-Jun-09	13:11	135	A4	22.4		11.90	33.80		4.34			38.14	
Ammonia	17-Jun-09	13:57	175	A5	22.425		7.68	37.60		5.36			42.96	
Nitrite	17-Jun-09	14:52	12	A6	22.6		-	13.22		8.80			22.02	
Nitrite	17-Jun-09	15:34	55	A7	22.4		-	14.06		7.40			21.46	
Nitrite	17-Jun-09	16:20	95	A8	22.4		-	15.04		6.30			21.34	
Nitrite	17-Jun-09	17:02	135	A9	22.4		-	41.20		6.90			48.10	
Nitrite	17-Jun-09	17:46	176	A10	22.4		-	44.40		3.05			47.45	

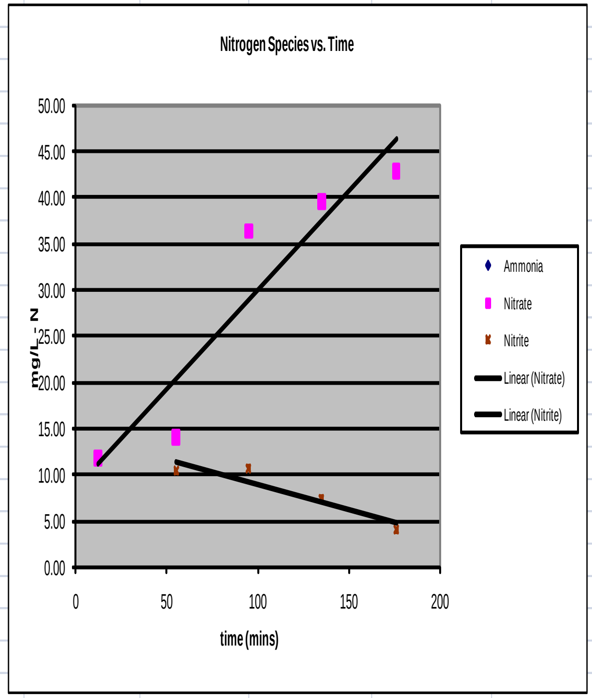




Reactor B: YR A.S./YR SE + 15 mL BW

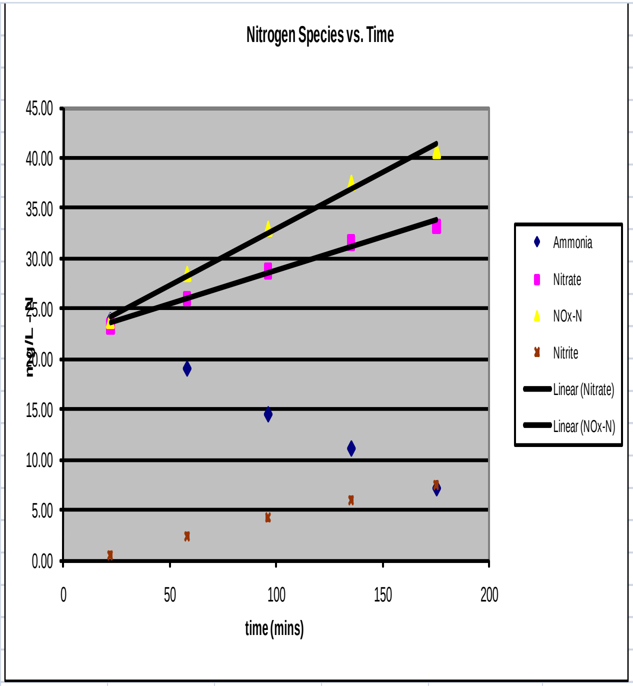
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	11:02	22	B1	22.7		23.80	24.00		0.48			24.48	
Ammonia	19-May-09	11:44	58	B2	22.6		20.30	27.40		2.17			29.57	
Ammonia	19-May-09	12:26	96	B3	22.5		15.70	29.60		3.40			33.00	
Ammonia	19-May-09	13:11	135	B4	22.5		11.95	32.80		4.68			37.48	
Ammonia	19-May-09	13:57	175	B5	22.5		7.95	36.00		5.96			41.96	
Nitrite	19-May-09	14:52	12	B6	22.6		-	11.74		7.60			19.34	
Nitrite	19-May-09	15:34	55	B7	22.5		-	14.06		10.40			24.46	
Nitrite	19-May-09	16:20	95	B8	22.3		-	36.40		10.70			47.10	
Nitrite	19-May-09	17:02	135	B9	22.4		-	39.60		7.40			47.00	
Nitrite	19-May-09	17:46	176	B10	22.44		-	42.80		4.05			46.85	

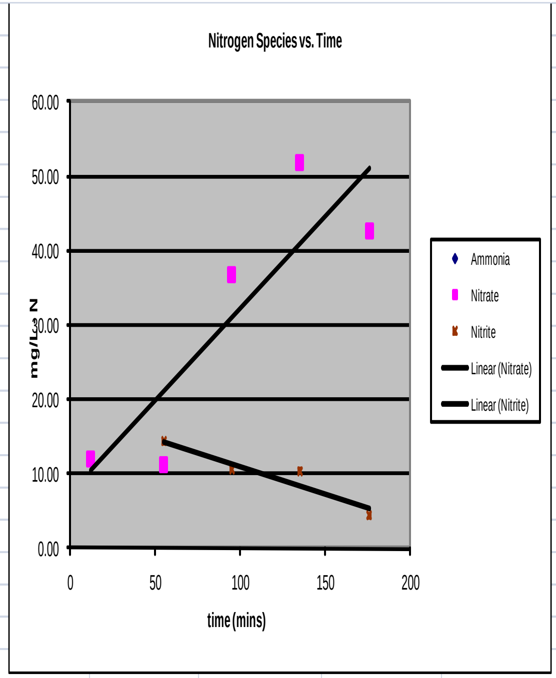




Reactor C: YR A.S./YR SE + 30 mL BW

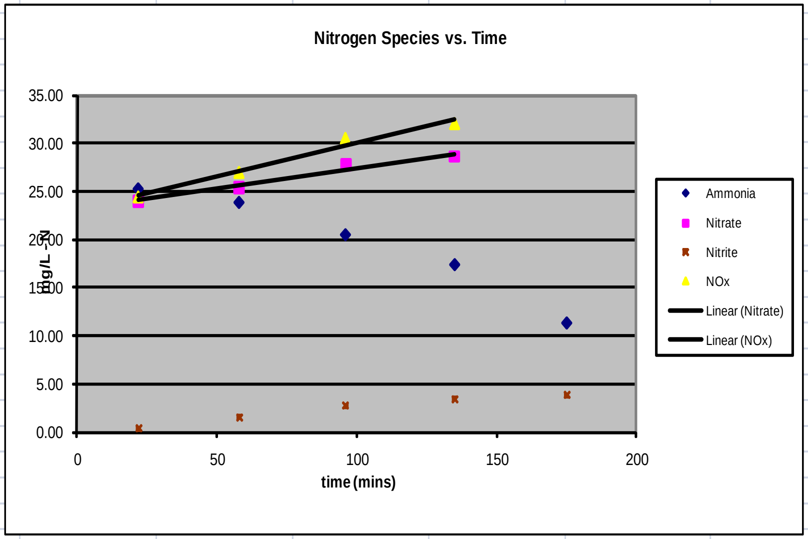
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	11:04	22	C1	22.6		23.80	23.20		0.52			23.72	
Ammonia	19-May-09	11:46	58	C2	22.5		19.00	26.00		2.43			28.43	
Ammonia	19-May-09	12:28	96	C3	22.5		14.45	28.80		4.16			32.96	
Ammonia	19-May-09	13:13	135	C4	22.6		11.05	31.60		5.96			37.56	
Ammonia	19-May-09	13:59	175	C5	22.7		7.10	33.20		7.56			40.76	
Nitrite	19-May-09	14:55	12	C6	22.5		-	12.04		8.00			20.04	
Nitrite	19-May-09	15:36	55	C7	22.3		-	11.18		14.30			25.48	
Nitrite	19-May-09	16:22	95	C8	22.4		-	36.80		10.60			47.40	
Nitrite	19-May-09	17:04	135	C9	22.4		-	51.80		10.40			62.20	
Nitrite	19-May-09	17:48	176	C10	22.4		-	42.60		4.40			47.00	

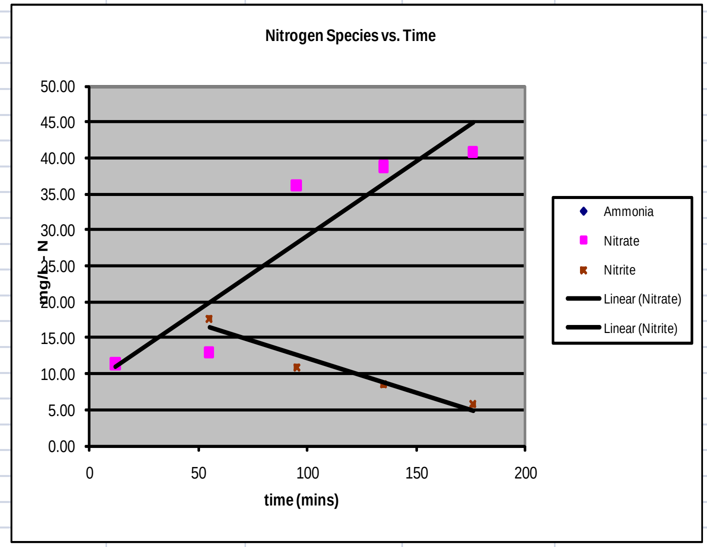




Reactor D: YR A.S./YR SE + 60 mL BW

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	19-May-09	11:04	22	D1	22.6		25.20	24.00		0.39			24.39	
Ammonia	19-May-09	11:46	58	D2	22.6		23.80	25.40		1.55			26.95	
Ammonia	19-May-09	12:28	96	D3	22.575		20.45	27.80		2.71			30.51	
Ammonia	19-May-09	13:13	135	D4	22.8		17.35	28.60		3.46			32.06	
Ammonia	19-May-09	13:59	175	D5	22.9		11.30	25.80		3.80			29.60	
Nitrite	19-May-09	14:55	12	D6	22.4		-	11.38		7.20			18.58	
Nitrite	19-May-09	15:36	55	D7	22.3		-	12.94		17.70			30.64	
Nitrite	19-May-09	16:22	95	D8	22.3		-	36.20		10.90			47.10	
Nitrite	19-May-09	17:04	135	D9	22.4		-	38.80		8.50			47.30	
Nitrite	19-May-09	17:48	176	D10	22.4		-	40.80		5.70			46.50	



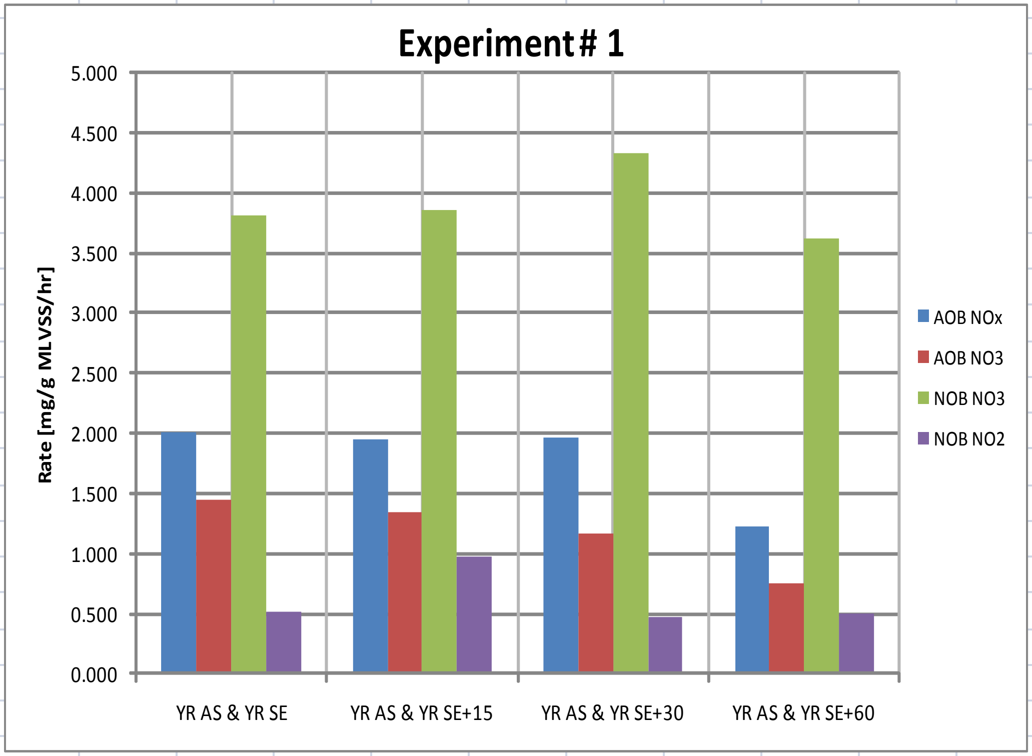


Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia	0.115	0.083		2.005	1.447		0.485	8.46	5460.00	3439.80
YR SE	Nitrite		0.218	-0.029		3.809	-0.514	0.235	4.10	5460.00	3439.80
Reactor B: YR											
Activated Sludge	Ammonia	0.112	0.077		1.951	1.339		0.458	8.00	5460.00	3439.80
YR SE	Nitrite		0.221	-0.056		3.862	-0.969	0.268	4.68	5460.00	3439.80
15 mL BW											
Reactor C: YR											
Activated Sludge	Ammonia	0.113	0.067		1.965	1.164		0.431	7.53	5460.00	3439.80
YR SE	Nitrite		0.249	-0.027		4.335	-0.466	0.282	4.92	5460.00	3439.80
30 mL BW											
Reactor D: YR											
Activated Sludge	Ammonia	0.070	0.043		1.227	0.749		0.275	4.80	5460.00	3439.80
YR SE	Nitrite		0.207	-0.029		3.615	-0.507	0.326	5.69	5460.00	3439.80
60 mL BW											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: YR Activated sludge YR SE	2.005	1.447	3.809	0.514
Reactor B: YR Activated Sludge YR SE 15 mL BW	1.951	1.339	3.862	0.969
Reactor C: YR Activated Sludge YR SE 30 mL BW	1.965	1.164	4.335	0.466
Reactor D: YR Activated Sludge YR SE 60 mL BW	1.227	0.749	3.615	0.507



Week 17 – QAC Product B Higher Concentration

Sample Data Report for Nansemond Nitrification Inhibition Study

AOB & NOB Experimentation:

I. AOB

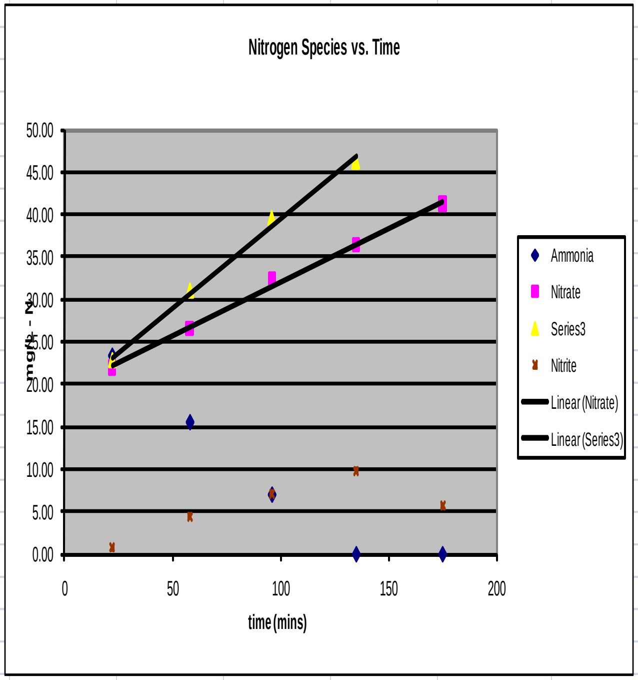
a. Spiked four 3L reactors with 25 mg/L NH_4.
b. Each reactor is running continously by use of stir bars.
c. 2 L of the diluent source is added to the reactors.
d. 1 L of concentrated biomass is added to the reactors. For this weeks experiments the biomass was concentrated from 20 L to 9 L.
e. Constant DO and pH were monitored and logged throughout the experiment.
f. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
g. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
h. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 μm filters
i. Reactors B, C, and D in the diluent source incorporated varying concentrations of Blue Works Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

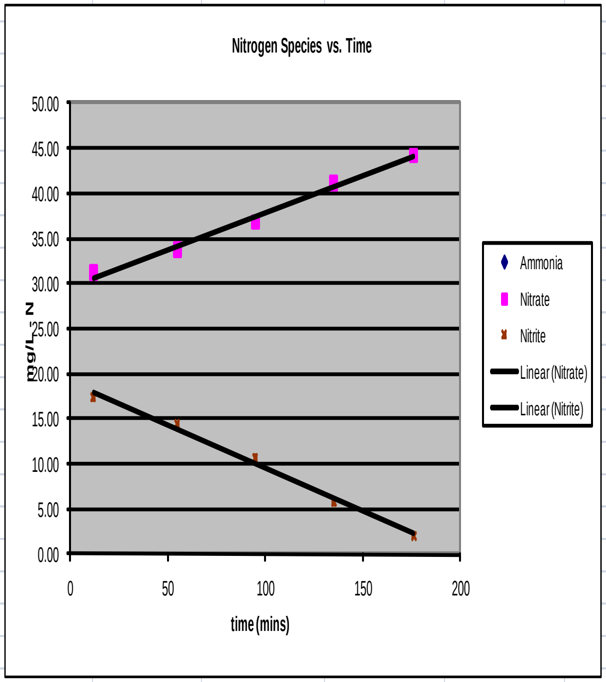
II. NOB

a. Spiked four 3L reactors with 20 mg/L NO_2^- after ammonia levels were <1 mg/L NH_3-N which was checked through the use of HACH TNT 831 Ammonia method. In addition all reactors were allowed to run overnight to consume all present ammonia.
b. Each reactor is running continously by use of stir bars.
c. Constant DO and pH were monitored and logged throughout the experiment.
d. Oxygen/air blend was sparged into the reactors to maintain DO levels through solenoid valves.
e. LabView software was used to manage DO and pH recording as well as program and implement the solenoid valves.
f. 5 samples were collected over a period of 3 hours through sampling ports on the reactors and filtered into sample tubes through millipore 0.45 μm filters.
g. Reactors B, C, and D in the diluent source incorporated varying concentrations of Blue Works Chemical Toilet Additive based on different assumptions (See Additive Dose Calculation worksheet)

Reactor A: YR A.S. / YR SE

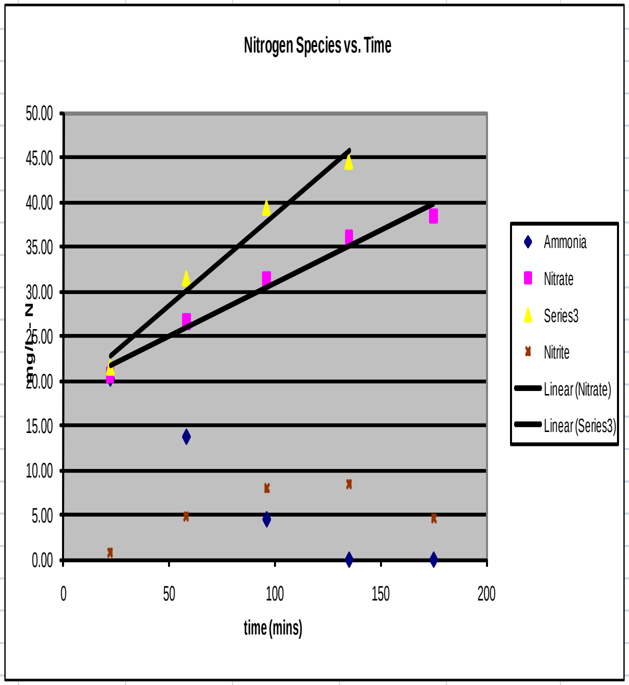
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~		NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~		mg/L NOx-N	mg/L PO4-P
Ammonia	23-Jun-09	14:00	22	A1	22.6		23.30	22.00		0.73			22.73	
Ammonia	23-Jun-09	14:43	58	A2	23.2		15.50	26.60		4.38			30.98	
Ammonia	23-Jun-09	15:26	96	A3	23.5		7.00	32.40		7.16			39.56	
Ammonia	23-Jun-09	16:07	135	A4	24		0.00	36.40		9.85			46.25	
Ammonia	23-Jun-09	16:48	175	A5	24.2		0.00	41.20		5.70			46.90	
Nitrite	24-Jun-09	8:33	12	A6	22.9		-	31.20		17.40			48.60	
Nitrite	24-Jun-09	9:15	55	A7	23.6		-	33.80		14.40			48.20	
Nitrite	24-Jun-09	9:56	95	A8	24.3		-	36.80		10.70			47.50	
Nitrite	24-Jun-09	10:47	135	A9	24.9		-	41.20		5.80			47.00	
Nitrite	24-Jun-09	11:29	176	A10	25		-	44.20		2.05			46.25	

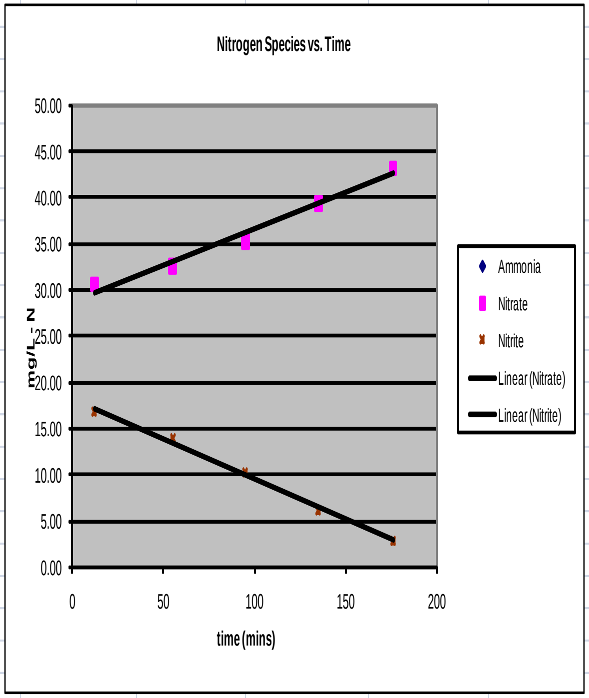




Reactor B: YR A.S./YR SE + 60 mL BW

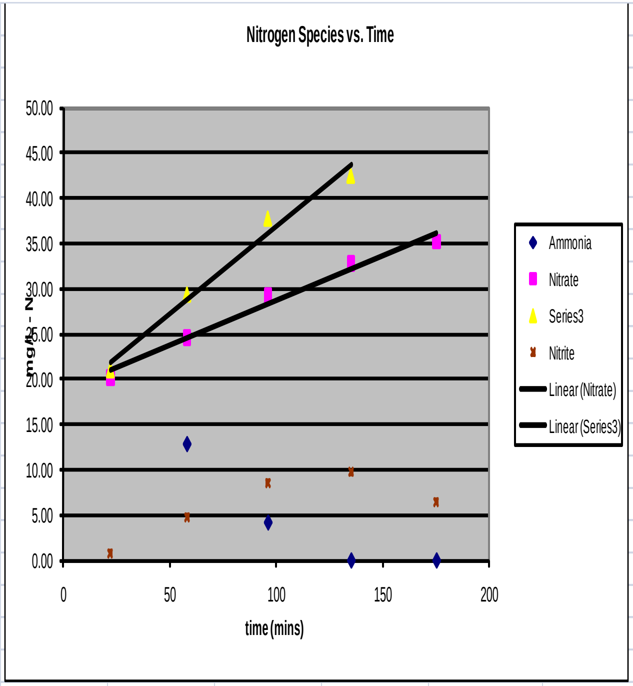
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	23-Jun-09	14:00	22	B1	22.6		20.20	20.60		0.84			21.44	
Ammonia	23-Jun-09	14:43	58	B2	23.4		13.70	26.60		4.82			31.42	
Ammonia	23-Jun-09	15:26	96	B3	23.7		4.50	31.40		7.92			39.32	
Ammonia	23-Jun-09	16:07	135	B4	24.1		0.00	36.00		8.50			44.50	
Ammonia	23-Jun-09	16:48	175	B5	24.4		0.00	38.40		4.60			43.00	
Nitrite	24-Jun-09	8:33	12	B6	22.925		-	30.60		16.80			47.40	
Nitrite	24-Jun-09	9:15	55	B7	23.7		-	32.60		13.90			46.50	
Nitrite	24-Jun-09	9:56	95	B8	24.4		-	35.20		10.20			45.40	
Nitrite	24-Jun-09	10:47	135	B9	25		-	39.40		6.10			45.50	
Nitrite	24-Jun-09	11:29	176	B10	25.1		-	43.20		2.85			46.05	

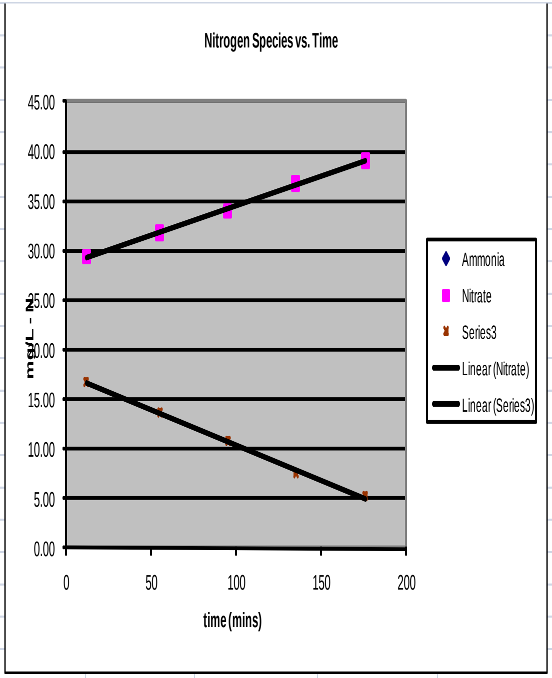




Reactor C: YR A.S./YR SE + 120 mL BW

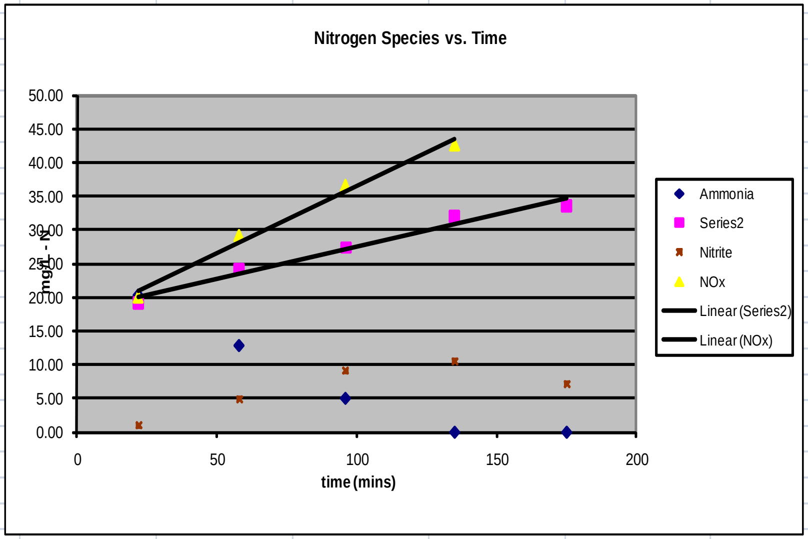
Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	23-Jun-09	14:02	22	C1	22.6		20.30	20.20		0.81			21.01	
Ammonia	23-Jun-09	14:45	58	C2	23.9		12.90	24.60		4.80			29.40	
Ammonia	23-Jun-09	15:28	96	C3	24.5		4.21	29.20		8.60			37.80	
Ammonia	23-Jun-09	16:09	135	C4	24.7		0.00	32.80		9.75			42.55	
Ammonia	23-Jun-09	16:49	175	C5	24.8		0.00	35.20		6.50			41.70	
Nitrite	24-Jun-09	8:35	12	C6	22.9		-	29.40		16.80			46.20	
Nitrite	24-Jun-09	9:16	55	C7	24.0		-	31.80		13.70			45.50	
Nitrite	24-Jun-09	9:58	95	C8	23.3		-	34.00		10.90			44.90	
Nitrite	24-Jun-09	10:48	135	C9	24.5		-	36.80		7.60			44.40	
Nitrite	24-Jun-09	11:31	176	C10	24.7		-	39.00		5.30			44.30	

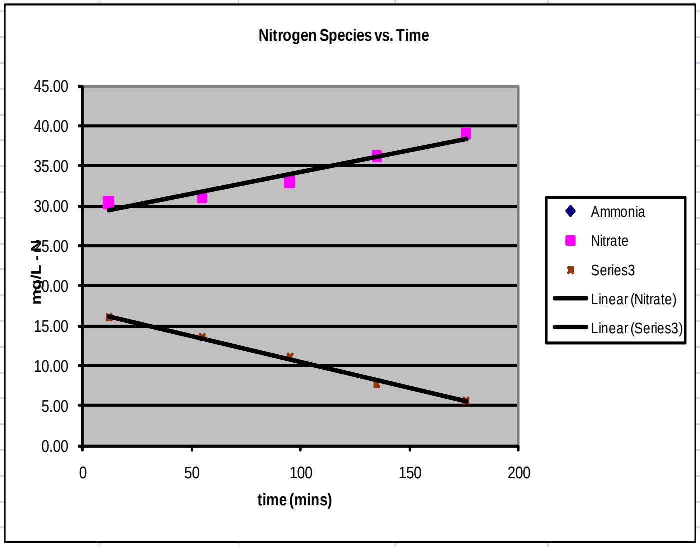




Reactor D: YR A.S./YR SE + 180 mL BW

Nitrogen Source Spiked	Date	Sample Time	Time since initial spike	Sample Number	Temperature	Ammonia by AQ2 SEAL	Ammonia by HACH TNT	Nitrate by HACH TNT	~~NOx-N by AQ2 SEAL~~	Nitrite by HACH PP	~~Nitrate by AQ2 SEAL~~	Phosphate by AQ2 SEAL	NOx-N by Nitrate HACH + Nitrite HACH	Phosphate by HACH TNT
	dd-mmm-yy	h:mm	min		°C	mg/L NH3-N	mg/L NH3-N	mg/L NO3-N	~~mg/L NOx-N~~	mg/L NO2-N	~~mg/L NO3-N~~	mg/l P	mg/L NOx-N	mg/L PO4-P
Ammonia	23-Jun-09	14:02	22	D1	22.5		20.40	19.14		0.92			20.06	
Ammonia	23-Jun-09	14:45	58	D2	23.9		12.90	24.20		4.94			29.14	
Ammonia	23-Jun-09	15:28	96	D3	24.5		5.05	27.40		9.12			36.52	
Ammonia	23-Jun-09	16:09	135	D4	24.7		0.00	32.00		10.50			42.50	
Ammonia	23-Jun-09	16:49	175	D5	24.8		0.00	33.60		7.20			40.80	
Nitrite	24-Jun-09	8:35	12	D6	22.5		-	30.40		16.00			46.40	
Nitrite	24-Jun-09	9:16	55	D7	22.9		-	31.20		13.50			44.70	
Nitrite	24-Jun-09	9:58	95	D8	23.1		-	33.00		11.10			44.10	
Nitrite	24-Jun-09	10:48	135	D9	24.5		-	36.20		7.60			43.80	
Nitrite	24-Jun-09	11:31	176	D10	24.7		-	39.00		5.60			44.60	





Summary	Experiment	NOx Slope	NO_3 Slope	NO_2 Slope	Nit Rate NOx*	Nit Rate NO_3*	Nit Rate NO_2*	OUR	SOUR	MLSS	MLVSS
		mg/L/min	mg/L/min	mg/L/min	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/g MLVSS/hr	mg/L/min	mg/g MLVSS/hr	mg/L	mg/L
Reactor A: YR											
Activated sludge	Ammonia	0.210	0.126		6.382	3.827		0.713	21.69	3180.00	1971.60
YR SE	Nitrite		0.082	-0.096		2.295	-2.701	0.212	5.96	3340.00	2137.60
Reactor B: YR											
Activated Sludge	Ammonia	0.204	0.117		6.205	3.564		0.692	21.07	3180.00	1971.60
YR SE	Nitrite		0.078	-0.087		2.198	-2.454	0.233	6.54	3340.00	2137.60
60 mL BW											
Reactor C: YR											
Activated Sludge	Ammonia	0.193	0.099		5.881	3.028		0.770	23.44	3180.00	1971.60
YR SE	Nitrite		0.059	-0.071		1.664	-2.002	0.252	7.08	3340.00	2137.60
120 mL BW											
Reactor D: YR											
Activated Sludge	Ammonia	0.198	0.096		6.018	2.909		0.734	22.33	3180.00	1971.60
YR SE	Nitrite		0.054	-0.065		1.524	-1.836	0.276	7.74	3340.00	2137.60
180 mL BW											

* Nitrification rates are normalized with respect to the MLVSS concentrations in their respective reactors

Experiment 1

	AOB Nox	AOB NO3	NOB NO3	NOB NO2
Reactor A: YR Activated sludge YR SE	6.382	3.827	2.295	2.701
Reactor B: YR Activated Sludge YR SE 60 mL BW	6.205	3.564	2.198	2.454
Reactor C: YR Activated Sludge YR SE 120 mL BW	5.881	3.028	1.664	2.002
Reactor D: YR Activated Sludge YR SE 180 mL BW	6.018	2.909	1.524	1.836