15

# EXTERNAL NITRIFICATION IN BIOLOGICAL NUTRIENT REMOVAL ACTIVATED SLUDGE SYSTEMS

by

Rajan Moodley
Bsc(Eng)(UCT)



Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Engineering at the University of Cape Town.

Department of Civil Engineering
University of Cape Town

September 1999

# ACKNOWLEDGMENTS

The writer wish to express his appreciation and gratitude to the following persons for their contribution to the research work contained in this report:

- Professor G A Ekama and Associate Professor M C Wentzel for their untiring and relentless guidance and support during the experimental investigation and writing up.

- Mr Taliep Lakay, Laboratory Manager, for his invaluable help in running and maintenance of analytical equipment in the laboratory and his immense insight in operating laboratory-scale activated sludge systems.

- Mr Percival Wilsnach, Laboratory Assistant, for his unfailing willingness to assist in tackling any problem encountered during the investigation.

- Charles Nicholas and Denis Botha, Technical Officers, for so ably constructing, maintaining and servicing equipment in the laboratory.

- Mr Peter Tapscott, formerly Scientific Officer at the Scientific Services Branch, Cape Metropolitan Council, for his very important contribution of filament identification during the investigation.

- Ms. Amina Rawat for her support and motivation during the investigation.

Acknowledgment is also due to the Water Research Commission Steering Committee under the chairmanship of Mr Greg Steenveld, for their guidance in this research and to the Water Research Commission, Water Sanitation Services SA (Pty) Ltd; a subsidiary of Lyonnaise Des Eaux : Center for International Water and Environmental Research and the National Research Foundation (formerly Foundation for Research Development) for financial support.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# LIST OF SYMBOLS

| SYMBOL | DESCRIPTION |
|---|---|
| $\mu_{nm}$ | Maximum Specific growth rate of nitrifiers (/d) |
| AVSS | Active volatile suspended solids |
| BEPR | Biological excess phosphorous removal |
| $b_{hT}$ | Specific Endogenous mass loss rate for heterotrophic organisms at T °C (/d) |
| $b_{nT}$ | Specific Endogenous respiration rate for heterotrophic organisms at T °C (/d) |
| COD | Chemical oxygen demand |
| CTL | UCT control system |
| $D_{p1}$ | Denitrification potential of main anoxic reactor |
| DSVI | Diluted sludge volume index |
| Ext(nit) | External nitrification BNRAS system |
| $f_{av,OHO}$ | Active fraction of the sludge with respect to the OHOs |
| $f_{bs}$ | Fraction RBCOD of the influent with respect to the biodegradable COD concentration |
| $f_{cv}$ | COD to VSS ratio of the volatile sludge mass |
| $f_{S,up}$ | Unbiodegradable particulate COD fraction in the influent |
| $f_{S,us}$ | Unbiodegradable soluble COD fraction in the influent |
| $f_{XBG,P}$ | Fraction of PAO biological active mass that is phosphorous |
| K | General parameter for denitrification rate ($mgNO_3/mgAVSS/d$). Subscripts 1 and 2 refer respectively to the 1st and 2nd rates in the anoxic reactor |
| MUCT | Modified UCT system configuration |
| N | Nitrogen |
| $N_2$ | Nitrogen gas |

| | |
|---|---|
| $NaHCO_3$ | Sodium hydrogen carbonate |
| $NH_4$ | Saline ammonia |
| $NO_2^-$ | Nitrite |
| $NO_3^-$ | Nitrate |
| $NO_x^-$ | Nitrite + Nitrate |
| OHO | Ordinary heterotrophic organism |
| OUR | Oxygen utilization rate (mgO/l/h) |
| P | Phosphorus |
| PAO | Poly-phosphate accumulating organism |
| RBCOD | Readily biodegradable COD |
| $R_s$ | Sludge age (days) |
| SBCOD | Slowly biodegradable COD |
| SCFA | Short chain fatty acids |
| $S_{ti}$ | Total COD concentration in the influent (mgCOD/l) |
| TKN | Total Kjeldahl Nitrogen |
| TP | Total Phosphorous |
| TSS | Total suspended solids |
| UCT | University of Cape Town |
| VFA | Volatile fatty acids |
| VSS | Volatile suspended solids |
| $Y_h$ | Heterotrophic organism yield coefficient = 0.45 mgVSS/mgCOD |
| $Y_n$ | Nitrifier organism yield coefficient = 0.10 mgVSS/mgN |
| WRC | Water Research Commission |

*I dedicate the fruits of this work*
*at THY lotus feet and those of my parents,*
*without whom this would not have been possible.*

# SYNOPSIS

## INTRODUCTION

In conventional nitrification-denitrification biological excess phosphorous removal (NDBEPR) activated sludge systems, such as the UCT system for example, both nitrification and phosphorous uptake (P uptake) occur simultaneously in the, usually large, aerobic reactor. In the UCT system the nitrate load to the anoxic reactor is limited by the a-recycle (i.e. system constraint recycle from the aerobic to the anoxic reactor) and the internal aerobic nitrification performance. The latter process, is mediated by the nitrifiers having a slow growth rate of 0.45/d, governs the sludge age of the biological nutrient removal activated sludge (BNRAS) system and thus results in long (20 - 25 day) sludge ages and large aerobic mass fraction requirements to nitrify completely. However, if stable nitrification could be achieved outside the BNRAS external nitrification (EN) system then nitrification and the suspended solids sludge age become uncoupled allowing greater flexibility into the BNRAS system. EN has the benefits of (i) reducing the sludge age by at least half (i.e.to 8 - 10 days) (ii) reducing the aerobic volume requirements by at least a third or alternatively doubling the wastewater that can be treated (iii) allowing increase in either or both the anaerobic and anoxic reactor volumes which should improve BEPR (Wentzel *et al.*,1990) and denitrification and thus N removal (WRC, 1984) respectively (iv) allowing a constant, higher load of nitrate to the anoxic reactor which is less constrained by the systems operating and design parameters (v) making the system more robust because the sensitive nitrifiers are not affected by perturbations in the BNRAS system since the very long sludge age EN biofilm/suspended nitrifying biomass is independent of the BNRAS systems sludge mass and sludge age (vi) improves the sludge settleability of the system due to the absence of the poor floc-forming nitrification biomass and the improved denitrification in the larger anoxic mass fraction.

## AIMS AND OBJECTIVES

Simultaneous external nitrification and anoxic phosphate uptake was studied in a BNR activated sludge systems with varying aerobic mass fractions. The aims of the experiments were to; (i) establish a stable population of slow-growing nitrifiers on a fixed media external nitrification system (later changed to a suspended medium due to *Psychoda* larvae infestation of the fixed media stone column), (ii) double the volume of the wastewater treated to test one of the claimed benefits of the external nitrification system, (iii) promote conditions to achieve anoxic phosphate uptake, (iv) increase the aerobic mass fraction in an attempt to qualify its effect on anoxic P uptake, and (v) study the effect of increased aerobic mass fraction on the sludge settleability of the BNRAS system.

### SYSTEM SET-UP AND MONITORING

The aims of the investigation were achieved by installing an internal settler and a fixed media (and later a suspended media) external nitrification system between the anaerobic and anoxic reactors of a BNRAS system. To establish and fully utilize the denitrification potential of the BNRAS anoxic reactor, nitrate was also dosed as a concentrated solution of 0.5 to 1.25 mg/l at 0.5 l/d directly to main anoxic reactor. A pre-anoxic reactor was also set-up ahead of the anaerobic reactor to ensure a near zero nitrate concentration entering the anaerobic reactor. This modified DEPHANOX system (after Bortone *et al.*, 1996) referred to as Configuration 1, has the benefits of (i) efficient utilization of organic substrate for both phosphorus and nitrogen removal, reducing the competition between ordinary heterotrophic organism (OHOs) denitrifiers and polyphosphate accumulating organisms (PAOs) (ii) not exposing the sensitive aerobic nitrifiers of the fixed/suspended media to either anaerobic or anoxic conditions as in conventional BNR activated sludge systems (iii) promoting the potential for anoxic P uptake because of the constant high load of nitrate and improved denitrification in the large anoxic reactor and (v) reducing the aerobic P uptake because of the reduced aerobic mass fraction.

During the first stage of the investigation external nitrification was achieved with the stone column fixed media system, which covered the period from day1 to day 205. During this time a number of changes were made to Configuration 1, (a) which resulted in Configuration 2 (day 31 to day 154),(b) Configuration 3 (day 155 to day 205). From day 206 to day 373 the fixed media stone column was replaced with a suspended nitrification activated sludge system (Configuration 4) because of the poor nitrification performance due to *Psychoda* larvae infestation of the stone column. To monitor the performance and operation of these different system configurations samples were drawn virtually daily from each of the reactors, internal tank supernatant, the external nitrified outflow and the final effluent for TKN, FSA, $NO_2/NO_3$, COD and P analysis throughout the 373 day investigation.

## RESULTS

### Mass balances

To establish the reliability of the experimental data, COD and N mass balances were performed on the BNRAS external nitrification system. In these balances, the mass entering the system is reconciled with the mass leaving the system and the reliability of the data is directly proportional to the mass balance deviation from 100%. The average COD and N mass balances were 80% and 91% respectively. Although considerably lower than 100%, these do not differ appreciable from COD and N balances observed in other investigations on BNR systems (Pilson *et al.*, 1995; Hu *et al.*, 1999).

### COD and N removal performance

The concentrated solution of nitrate dosed directly to the main anoxic reactor increased the influent TKN/COD ratio from around 0.08 to 0.14 mgN/mgCOD and produced a effluent total N concentration <20 mgN/l. The average percentage COD and N removals in the EN BNRAS system were 91% and 72% respectively. The main reason for the low N removal was poor nitrification in the fixed media stone column leading to high effluent TKN concentrations. The overall average $0.45_{\mu m}$ membrane filtered effluent COD concentration from the BNRAS external nitrification system was 52 mgCOD/l, giving an unbiodegradable soluble fraction $f_{S,us}$ of 0.075. The filtered effluent TKN concentration was not measured and thus the unbiodegradable soluble TKN fraction ($f_{nu}$) was not determined, however, the overall unfiltered effluent TKN concentration was 18 mgN/l.

### Oxygen utilization rate and mixed liquor concentrations

The average oxygen utilization rate (OUR) for sewage batches 1 to 20 (days 1 to 154; Configurations 1 and 2) was 35 mgO/l aerobic reactor/h and 38 mgO/l aerobic reactor/h for sewage batches 21 to 37 (days 155 to 373; Configurations 3 and 4). This increased OUR was due to the increased aerobic mass fraction for Configuration 3 and 4 which supported nitrifiers in the aerobic reactor of the BNRAS system, and also because in Configuration 3 the fixed media stone column nitrified poorly, significant nitrification took place in the aerobic reactor. The mean TSS and VSS concentrations in the BNRAS external nitrification system were 2628 mgTSS/l and 2163 mgVSS/l respectively, giving and average VSS/TSS ratio of 0.82.

**External nitrifier performance**

In this investigation the primary aim was to establish a stable nitrifier population on a fixed media such that nitrification could be "restricted"to the fixed media system, thus enabling nitrification and the suspended solids sludge age to be uncoupled. However, due to the limitation imposed by the flow rate to the external nitrification system of about 76% of the flow leaving the anaerobic reactor, with 24% of the flow bypassing the external nitrification system, the maximum nitrification completion could be at best 76%, if the nitrifier outflow ammonia concentration was zero. Initially the fixed media stone column (SC) nitrifier produced a low effluent ammonia concentration of 3mgN/l which represented an 88% nitrification (Configuration 1) efficiency. However, due to *Psychoda* mothfly larvae infestation the nitrification efficiency fell below 50% and produced a wide and varied effluent SC ammonia concentration between 8 and 62mgN/l. In order to re-establish the external nitrification efficiency and prevent *Psychoda* infestation, a suspended medium external nitrifier replaced the fixed media SC to facilitate the nitrification process (Configuration 4). The suspended medium external nitrifier produced a low BNRAS effluent ammonia concentration of 9mgN/l.

**BEPR and denitrification**

The effluent P concentration in the EN BNRAS system were kept above 5 mg/l by dosing P to the influent. This allowed the system P removal capacity of 10.4mgP/l influent or alternatively 0.015mgP/mgCOD to be measured. The average P release of 18 mg P/l influent took place in the anaerobic reactor and the P uptake was facilitated in both the aerobic and main anoxic reactors with 15.5 and 15.4mg /l influent respectively. The latter translates into 50% and 49% P uptake taking place in the aerobic and main anoxic reactors respectively. In this investigation, a too low nitrate load on the main anoxic reactor during sewage batches 7 to 23 (days 63 to 188) appeared to have a detrimental effect on the anoxic P uptake. and ultimately the P removal was reduced to 8.3 mgP/l. Increasing the aerobic mass fraction (Configurations 3 and 4) improved BEPR and surprisingly, also stabilized anoxic P uptake. This is in agreement with the literature: In an investigation to select DPAOs, Bortone *et al.* (1996) operated an anaerobic/anoxic sequencing batch reactor (SBR). They found that this system did not stimulate BEPR. However, when a short aerobic period was included in the SBR cycle, stable BEPR with anoxic P uptake (and aerobic P uptake) was obtained. Thus it would appear that an aerobic period may be essential for stable anoxic P uptake. Recognizing that the anoxic P uptake DPAOs are facultative organisms, including an aerobic reactor would provide opportunity for aerobic metabolism by these organisms, in addition to the anoxic metabolism. Biochemically, aerobic metabolism provides a higher energy yield for the organism than anoxic metabolism, and this higher energy yield may provide the biological niche for DPAOs to stably exist in the system.

Because substantial anoxic P uptake (46%) was observed in the BNRAS external nitrification system, denitrification was therefore mediated by both the ordinary heterotrophic organisms (OHOs) and the polyphosphate accumulating organisms (PAOs). The relative contribution of the PAOs to the denitrification rate was assumed to be the percentage anoxic uptake times the nitrate equivalent of the readily biodegradable COD taken up by the PAOs in the anaerobic reactor (determined from the Wentzel et al., 1990 steady state BEPR model), viz: %Ax Pupt*RBCOD taken up by PAOs/8.6 where 8.6 is the COD utilized per mg nitrate denitrified. With this approach it was found that the relative contribution of the PAOs to the denitrification rate is quite small - only 17% of the total rate because they utilize relatively little COD compared with the OHOs. The average OHO and PAO denitrification rates($K_2''_{OHO}$ and $K_2''_{PAO}$) were found to be 0.1206 $mgNO_3$-N/(mgOHOAVSS.d) and 0.0496 $mgNO_3$-N/(mgPAOAVSS.d). If the observed nitrate removal in the anoxic reactor (overloaded with nitrate) were attributed to the OHOs then the uncorrected specific denitrification rate ($K_2'$) is 0.1379 $mgNO_3$-N/(mgOHOAVSS.d). This $K_2'$ is rate has the same bases as the $K_2'$ rates measured in earlier investigations by Clayton *et al.* (1989) and Sneyders *et al.* (1998) in which no anoxic P uptake was observed and Musvoto *et al.* (1992), Pilson *et al.* (1995) and Mellin *et al.* (1995) in which significant anoxic P uptake was observed.

To determine the unbiodegradable particulate fraction $f_{S,up}$ of the influent sewage fed to the system, the appropriate $f_{S,up}$ was selected so that the system VSS mass calculated with the BEPR model of Wentzel *et al.* (1990) was equal to that measured using the measured readily biodegradable (RB) COD concentration and the influent characteristics of the sewage ($f_{S,us}$, $S_{ti}$)

and the system parameters as input. An average $f_{S,up}$ value of 0.11was found for the BNRAS external nitrification system. The active ordinary heterotrophic (OHO) and polyphosphate accumulating (PAO) organism fractions of the VSS which are required to define the OHO denitrification rate ($K_2'$) and the P content of the PAOs ($f_{XBG,P}$),are also obtained from the calculation procedure. The $f_{XBG,P}$ fraction was obtained by adjusting the $f_{XBG,P}$ value (mgP/mgPAOAVSS) in the model until the calculated P removal equaled the measured P removal. An average $f_{XBG,P}$ value of 0.312 mgP/mgPAOAVSS was found for the EN BNRAS system. In comparing the $f_{XBG,P}$ fraction obtained in this investigation with those obtained in earlier investigations it was confirmed that a lower $f_{XBG,P}$ value is obtained when significant (> 40%) anoxic P uptake (as in this investigation) is observed than when aerobic P uptake is observed.

**Filament identification and sludge settleability**

The most frequently dominant Anoxic Aerobic (AA, low F/M) filament was *M. parvicella*, while type 1851 and type 0092 were also identified as secondary filaments. Type 021N also occurred but being a septic sewage filament ( Jenkins *et al.*, 1984) this was probably due to aging sewage during storage. Apart from type 021N, these filaments are almost always observed in full scale NDBEPR systems (Blackbeard *et al.*, 1998).

The average $NO_x$ concentrations leaving the anoxic reactor in the EN BNRAS system was 2.8 $mgNO_x$-N/l. The stone column external nitrification system (Configuration 3) was replaced with the activated sludge system (Configuration 4) which lead to a significant improved nitrification efficiency, the aerobic mass fraction was increased to 30% at the expense of the anoxic mass fraction (30%), the sludge age was increased from 8 to 10 days and a 1: 1 mixed liquor a-recycle from the aerobic to the anoxic reactor was installed. All these changes led to increased nitrate load on the main anoxic reactor and a decreased denitrification potential leading to high nitrate and nitrite concentration in the outflow of the anoxic to the aerobic reactor. According to the hypothesis of Casey *et al.*, (1994) for proliferation of Nitrosomonas filaments, these high concentrations will impact sludge settleability evident in the latter stage of this investigation.

The mean DSVI in the EN BNRAS system was 94 ml/g (standard deviation 27). This DSVI is ideal (between 80 and 100 ml/g). The fluctuations in the DSVI from ~125 ml/g at the start of the investigation to 80 ml/g mi-way through the investigation and finally to ~150 ml/g at the end of the investigation is a direct result of change in the external nitrification system and the increase in the aerobic mass fraction and sludge age (Configuration 4). This period was also the time in which aerobic nitrification was significant which meant that the BNRAS external nitrification system now supported nitrifiers leading to higher effluent $NO_x$ concentrations. This observation i.e. an increase in the $NO_x$ concentration leaving the anoxic reactor with the increase in aerobic mass fraction and with the simultaneous increase in the DSVI, supports the hypothesis of Casey *et al*. (1994).

## CONCLUSIONS

Evaluation of the external nitrification biological nutrient removal activated sludge system (BNRASS) at laboratory-scale indicates that the scheme holds considerable potential for a step increase in system intensification through the reductions in sludge age and oxygen demand and significant improvement in sludge settleability. Because the BNRASS is not required to nitrify, its anoxic fraction can be considerably enlarged at the expense of the aerobic mass fraction creating conditions that (i) allow it to achieve high N removal with domestic wastewaters with high TKN/COD ratios and (ii) promote anoxic P uptake polyphosphate accumulating organisms (PAOs). The only negative factors are the slightly reduced BEPR (if anoxic P uptake is a requirement) and *Psychoda* larvae infestation of the fixed media external nitrification system at laboratory scale because of the ideal conditions conducive to rapid infestation.

# CHAPTER 1

## INTRODUCTION

The biological nutrient removal (BNR) activated sludge system (ASS) has become an established technology in wastewater treatment practice. This development has been facilitated by an improved understanding of the nitrification and denitrification (ND) and biological excess phosphorus removal (BEPR) processes. However, implementation of BNR has brought with it a new set of difficulties (Ekama and Wentzel, 1997), the main ones being (i) the long sludge age required for nitrification, (ii) filamentous organism bulking and (iii) the treatment /disposal of supernatants generated from the sludge and solids handling. This research project focuses on the long sludge age requirement for nitrification and investigates means by which nitrification can be successfully achieved external to the BNR activated sludge system to reduce the sludge age.



In the BNR activated sludge (BNRAS) system, the requirement to nitrify governs selection of the two linked parameters, sludge age and the aerated mass fraction. The need for nitrogen (N) and phosphorus (P) removal sets a requirement for a part of the sludge to be unaerated, for anaerobic[1] conditions to stimulate P removal and anoxic[1] conditions for N removal. In N and P removal plants, the unaerated sludge mass fraction usually needs to be high i.e. > 40%, causing the aerated mass fraction to be reduced, i.e. < 60 %. To compensate, to ensure near complete nitrification, long sludge ages have to be selected. For example, with a maximum specific growth rate of nitrifiers at 20° C ($\mu_{nm20}$) of around 0.45/d, to guarantee nitrification at the minimum temperature of 14 ° C, the system sludge age must be around 20 to 25 days if 50 to 60 % of the sludge mass in the system is unaerated. Such long sludge ages result in large biological reactors per Ml wastewater (WW) treated. If nitrification can be made independent of the suspended solids sludge age, then the selection of the sludge age will no longer be governed by the requirement to nitrify, but rather by the N removal (denitrification) and P removal (BEPR) processes. For both these processes, a reduction in sludge age increases respectively the N and P removal per

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[1]In this research, the term anaerobic is applied to a zone in which no nitrate/nitrite and dissolved oxygen (DO) is present or enters it, and anoxic to one where nitrate/nitrite is present or enters, but no DO is present or enters.

mass of organic load (WRC, 1984; Wentzel *et al.*, 1990), provided the sludge age remains longer than some lower limit to prevent "wash-out" of P removal and denitrifying organisms. Indications are that, if nitrification and the sludge age of the suspended solids can be uncoupled, then the sludge age can be reduced to less than half, from about 20-25 days to about 8-10 days. This will result in a reduction in the biological reactor volume requirement per Ml treated of about 1/3rd, or alternatively in an increase in the treatment capacity of some 50% (provided secondary settling tank area requirements are appropriately accommodated).

BNRAS systems have been found to promote the growth of a specific group of filamentous microorganisms, previously called low F/M (Jenkins *et al.*, 1984) but renamed anoxic/aerobic (AA) (Casey *et al.*, 1994) because of their frequent occurrence in biological N removal systems. These filamentous organisms cause sludges to settle poorly, resulting in an increase in the required surface area of secondary settling tanks. If the settleability of BNR sludges can be improved, then the flow through existing secondary settling tanks can be increased considerably, or, alternatively for a proposed system the secondary settling tank area can be considerably reduced, both options providing significant economic benefit. Casey *et al.* (1994) have identified two main causes for AA filament proliferation in BNRAS systems; (i) Aerated sludge mass fractions in the range 20 to 70 % and (ii)
incomplete denitrification ($NO_x$ > 1.0 mgN/l) in the anoxic reactor preceding the aerobic reactor. The uncoupling of nitrification and sludge age will introduce greater flexibility into the BNRASS configuration and should allow elimination of the two conditions identified above which promote AA filament growth.



One method to uncouple the suspended solids sludge age from the requirement to nitrify is to remove nitrification from the BNR activated sludge system to an external fixed media system for attached nitrifier growth. From the above, such an external nitrification system therefore holds promise of a significant system intensification by reducing the systems suspended solids sludge age and improving sludge settleability while retaining BNR. Because there are many wastewater treatment plants in South Africa where there are both old trickling filters and new BNRAS systems, there are many opportunities to implement the external nitrification scheme to realize the potential savings through increased wastewater treatment capacity of the scheme.

The primary objective of this investigation is to evaluate the external nitrification scheme at laboratory scale. In Chapter 2 a literature review is presented so that the objectives of this investigation is placed in context of the current research into external nitrification in BNR activated sludge systems. In Chapter 3 the experimental investigation is described in detail and in Chapter 4 the conclusions of the investigation are presented.

# CHAPTER 2

## LITERATURE REVIEW

### 2.1 INTRODUCTION

The function of the single-sludge activated sludge systems has expanded from chemical oxygen demand (COD) removal to include, progressively, nitrification, denitrification and phosphorous removal, all biologically mediated in order to comply with more stringent effluent legislation. Not only have these expansions increased the complexity of the system configuration and its operation, but concomitantly the number of biological processes influencing the effluent quality and the number of compounds involved in these processes have increased.

The expansion in function of the activated-sludge system has been accomplished by manipulating the system configuration (through the incorporation of multiple in-series reactors, some aerated and others not, with various inter-reactor recycles) and the wastewater characteristics (through for example, primary sedimentation or acid fermentation of primary sludge). The objectives of these manipulations is to create environmental conditions in the activated sludge system that are conducive to the optimal growth and action of organisms that naturally perform the biological reactions necessary to treat the wastewater viz: aerobic zones for organic material breakdown and nitrification, anoxic zones for denitrification, and an anaerobic-aerobic sequence of zones, with the influent fed to the anaerobic zone, for BEPR. For the purpose of design, in the highly diverse mixed cultures that develop in these activated sludge systems, only the mass behaviour of the populations or groups of organisms is considered. The principal organism groups their functions, and the zones in which these functions are performed are summarized in Table 2.1.

From Table 2.1, for the design of nitrification-denitrification BEPR (NDBEPR) activated-sludge systems, three organism groups and their interactions must be taken into account (Wentzel *et al.*,

**Table 2.1** Principal organism groups included in models for activated sludge systems, their functions, and the zones in which these functions are performed.

| Organism | Biological Process | Zone |
|---|---|---|
| 1. Ordinary heterotrophs | COD removal (organic degradation; dissolved oxygen uptake) | Aerobic |
| (OHOs) | Ammonification (organic -N→$NH_4^+$) | Aerobic |
| | Denitrification (organic degradation; $NO_3^-$ → $NO_2^-$ →$N_2$) | Anoxic |
| | Fermentation (F-RBCOD[a] → SCFA) | Anaerobic |
| 2. Poly-P heterotrophs | P release (SCFA[b] uptake; PHA[c] storage) | Anaerobic |
| (PAOs) | P release (SCFA uptake; PHA storage) | Anoxic |
| | P uptake (PHA degradation; denitrification?) | Anoxic |
| | P uptake; P removal (PHA degradation; dissolved oxygen uptake) | Aerobic |
| 3. Autotrophs (nitrifiers, ANOs) | Nitrification ($NH_4^+$ →$NO_2^-$ →$NO_3^-$ ; dissolved oxygen uptake) | Aerobic |

[a] Fermentable readily biodegradable COD

[b] Short-chain fatty acid.

[c] Polyhydroxyalkanoate.



1992): (1) heterotrophic organisms unable to accumulate polyphosphate (poly-P), termed ordinary heterotrophic organisms (OHOs); (2) heterotrophic organisms able to accumulate poly-P, generally called poly-P accumulating organisms (PAOs) (and variously phosphotrophs, bio-P organisms, or poly-P organisms);and (3) autotrophic organisms mediating nitrification, termed autotrophic nitrifier organisms (ANOs). The main focus of this review is on the autotrophic organism group which mediates nitrification.

## 2.2 NITRIFICATION

Nitrification is carried out by two different consecutive microbial processes, nitritification and nitratification. In nitritification, free and saline ammonia (FSA) is converted to nitrite due to its oxidation by the ammonia oxidizing bacteria traditionally deemed to be *Nitrosomonas*. In nitratification, the nitrate oxidising bacteria, traditionally deemed to be *Nitrobacter*, but recently identified to be *Nitrosospira*, convert nitrite to nitrate. The ammonia and nitrite oxidizers are aerobic and autotrophic bacteria and are characterized by low specific growth rates. Thus the requirement to nitrify governs the sludge age of biological nutrient removal activated sludge systems (BNRAS). For maximum specific growth rate of nitrifiers of 0.45/d ( i.e. $\mu_{nm}$ at 20°C ), to ensure nitrification the sludge age must be between 20 to 25 days with at least 40 to 50% of the sludge mass in the system aerated. The long sludge age leads to large volume reactors being required as well as the additional cost for the provision of oxygen to aerate these large reactors.

To uncouple the suspended solids sludge age from the requirement to nitrify, the activated sludge system can be modified in two ways, by including (i) internal and (ii) external fixed media for attached nitrifier growth. The nitrifiers grow on the fixed media establishing a population permanently resident in the nitrification system. These nitrifiers are not subjected to either the unaerated-aerated reactor interchanges or to the suspended solids sludge age with the result that the latter can be reduced to less than half, i.e from 20 to 25 days to 8 to 10 days, without losing nitrification .

## 2.3 Internal Fixed Media Systems

Randall *et al.* (1996) integrated into the aerobic zone of a single-sludge anoxic-aerobic treatment plant rope-like Ringlace fixed-film media which were installed in a volume of 475m$^3$ for a pilot investigation. The purpose of the integrated fixed-film media was to upgrade the short hydraulic retention time (HRT) basin (6 hrs nominal) for efficient, year round nitrogen removal without construction to increase the basin volume. The integrated Ringlace media increased the nitrification rate per unit volume to 225%, attaining a value of 1.75kg/d $NH_3$-N nitrified per linear meter Ringlace media at 15°C. The media also increased denitrification in the aerobic media section to the extent that between 30 and 88% of the nitrates formed in this section were denitrified within it.

The results of Randall *et al.* (1996) showed that optimum nitrification and denitrification only occurred in the fixed-film media when the supply of biodegradable COD to the fixed-film media section was sufficient to ensure biofilm growth, and when the ammonium-N supply was sufficient to maintain a substantial nitrifier population on the Ringlace media biofilm. This means that the successful denitrification/nitrification process efficiencies are dependent on the influent biodegradable COD and ammonia concentrations respectively. The results also showed that it is difficult to obtain optimum nitrification rates on Ringlace media when the sludge age of the suspended solids is too short and results in washout of nitrifiers from the fixed film Ringlace media. Randall *et al.* (1996) observed that the nitrification efficiency decreased at high ammonia concentrations (i.e. > 5mg/l) due to the simultaneously higher COD concentrations which stimulated heterotrophic bacterial growth that overgrew the nitrifiers and reduced their efficiency. This overgrowth of heterotrophic bacteria was possibly the reason for the high denitrification rates in the aerobic media section; possibly the biofilm was so thick and overgrown by heterotrophic bacteria that oxygen was utilized on the surface of the biofilm and could not penetrate deep into the biofilm, thus allowing the underlying biofilm to become anoxic and denitrify the nitrates generated in the aerobic media section. Supposedly, if this explains the occurrence of denitrification in the aerobic media section, it would imply that even though the nitrification efficiency quoted earlier (225%) was high, it does not mean that the nitrate produced was high (i.e. only 0.047 mg$NO_3$-N/l per linear meter) since the nitrification efficiency was good only at low influent ammonia concentrations thus enabling the high denitrification efficiency.

From this research it would seem that internal fixed-film media would only be beneficial if : (1) the aerobic reactor is sufficiently large to accommodate the fixed-film media without hindering COD removal; (2) the influent biodegradable COD and ammonia concentrations are sufficiently high to promote denitrification and nitrification respectively, but, that the COD and ammonia concentration are not too high to cause a decrease in the nitrification efficiency. The effectiveness of the internal fixed media has not been as good as expected, the influent wastewater has to be carefully monitored; it yields a rather low cost/benefit ratio and the effect of the internal fixed media on BEPR has not been investigated. To resolve these difficulties, a BNRAS system in which nitrification is removed from the BNRAS system to an external fixed media system is proposed.

## 2.4 External Nitrifying Trickling Filters

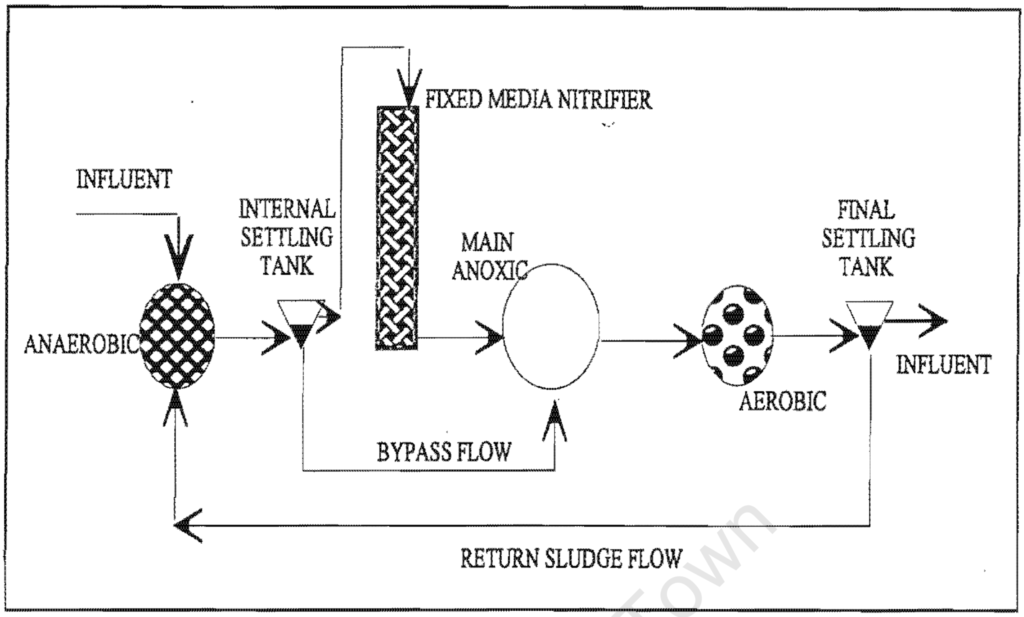
Trickling filters, in contrast with suspended activated sludge processes provide a support medium for biofilm growth. They are the most suitable external artificial environment for nitrification, since they allow the nitrifying bacteria to cultivate a 'permanent' population which remains in the filter for long periods of time i.e. long sludge age.

Tertiary nitrifying trickling filters which are employed for nitrification only and negligible organic material removal, are fairly common in USA (Lutz *et al.*, 1990). While certain problems with macro fauna (snails, worms, larvae, and flies), which reduce nitrification rates, have been encountered, high removals of ammonia have been economically achieved in tertiary nitrifying trickling filters (Parker *et al.*, 1989; 1995; 1996). Therefore, while some full scale trials would need to be done to determine how rock media trickling filters can be adapted to fulfill the external nitrification function, from USA experience this is not expected to be a major problem in implementing the external nitrification scheme.

## 2.5 The Dephanox System

The DEPHANOX system (Figure 2.1) is one in which nitrification takes place externally to the BNRAS system (Bortone *et al.*, 1996; Sorm *et al.*, 1996). In this system the influent wastewater is discharged to the anaerobic reactor to maximize BEPR. After the anaerobic reactor, the sludge mass is separated from the liquid in an internal settling tank and discharged to the anoxic reactor. The internal settling tank overflow, which is has a high free and saline ammonia (FSA) concentration and low soluble COD concentration, is passed through a fixed medium reactor wherein nitrification takes place. The nitrified outflow from the fixed medium reactor is discharged to the anoxic reactor for denitrification. From the anoxic reactor, the mixed liquor passes to the last reactor which is aerobic. After the aerobic reactor, the activated sludge is separated from the treated wastewater in a final secondary settling tank. The final settling tank overflow is the final effluent and the settled sludge is returned to the anaerobic reactor.

**Figure 2.1** The DEPHANOX biological nutrient removal system (after Bortone *et al.*, 1996; Sorm *et al.*, 1996)






It appears that the DEPHANOX system was developed with the specific objective of stimulating denitrification by BEPR organisms, generally called denitrifying phosphate accumulating organisms (DPAOs). This has the advantage that the influent wastewater substrate sequestered by the PAOs in the anaerobic reactor (and therefore implicated in BEPR) also is used for denitrification (and therefore N removal). Some laboratory and pilot scale experimental work has been done on the DEPHANOX system by Bortone *et al.* (1996) and Sorm *et al.* (1996). They found considerable P uptake in the anoxic reactor, indicating that DPAOs did participate in the denitrification process. Also, improved sludge settleability (SVIs ~ 50 ml/g) have been consistently observed in the laboratory scale DEPHANOX system of Sorm *et al.* (1996). Thus, it would appear that the DEPHANOX system holds considerable promise, producing nutrient (N and P) removal and a sludge that settles well. However, the BNRAS system intensification benefit of the system does not appear to have been a consideration in the development of and investigation into this system. Therefore, while aspects of anoxic P uptake will be examined, the system intensification benefit of the external nitrification system is the main focus of this investigation.

## 2.6 The Proposed External Nitrification System

In the proposed external nitrification system, based on the DEPHANOX system, but with some modifications (discussed in detail in Chapter 3, Section 3.1), nitrification takes place outside the suspended sludge BNRAS activated sludge system in a fixed media trickling filter (i.e. a stone column). This has the potential to reduce the sludge age of the BNRAS system significantly, from 20 - 25 days to 8-10 days. Further, removing nitrification from the aerobic reactor of the BNRAS system has a number of additional benefits:

1. Minimum aerobic mass fraction for nitrification is not required.
2. Aerobic reactor volume (and accordingly mass fraction) does not have to be maintained to accommodate internal fixed media.
3. Aeration for nitrification in the aerobic reactor is not required, only for COD utilization.

As a consequence of 1 and 2 above, the aerated mass fraction in the proposed system is no longer controlled by nitrification and therefore the unaerated mass fraction can be large (>60%). This would have two main benefits:

1. The anaerobic mass fraction can be increased, which should improve BEPR (Wentzel *et al.*, 1990).
2. The anoxic mass fraction can be increased, to improve denitrification and thus N removal (WRC, 1984) to the point where complete denitrification may be possible.

The possibility of complete denitrification at short sludge ages holds promise to ameliorate AA filament bulking (Casey *et al.*, 1994). As noted above this will be particularly beneficial as it will significantly increase the treatment capacity of an existing system, or reduce secondary settling tank surface area for a proposed system.

## 2.7 Opportunities For Implementation Of The Proposed System

External nitrification could be achieved at wastewater treatment plants (WWTPs) where old trickling filter (TF) plants have been extended with a BNRAS system. There are many such WWTPs, particularly in South Africa. For example East Rand Water (ERWAT) treats in excess of 500Ml/d, more than 50 % (270Ml/d) of which in old trickling filter plants. Some 200 Ml/d is treated in 3 combined TF/BNRAS plants, of which 102 Ml/d is treated in old TFs with chemical P removal, the balance in BNRAS systems. Also, 168Ml/d is treated in TF only plants, which at some time in the future need to be extended. In the South Eastern Highveld region, some 10 TF/BNRAS plants treat more than 100Ml/d, 25% of which is treated in old TFs. Then there are Krugersdorp, Daspoort (Guateng), Rooival (Guateng), Darvill (Kwazulu/Natal), and Athlone and Milnerton (W Cape) treating around 450 Ml/d with TF treatment capacity in excess of 200Ml/d. At these WWTPs where the special standard for phosphate needs to be met, to retain the benefit of the old TF, a proportion of the influent is passed through the TF and the effluents are (Figure 2.2):

1 Discharged to the BNRAS system for biological N and P removal (e.g. van Hyssteen *et al.*, 1990). This in effect increases the TKN/COD and P/COD ratios of the WW discharged to the BNRAS system and increases the effluent nitrate and phosphate concentrations.

2. Chemically treated to precipitate the P before discharge as final effluent or to the BNRAS system. This is not only costly, but also reduces the alkalinity of the water and only reduces the effective P/COD ratio of the wastewater on the BNRAS system, the nitrogen returned is not reduced.

3. Irrigated on land at WWTP. This practice is being closely monitored by the Department of Water Affairs and Forestry in South Africa and is expected to be substantially disallowed because it leads to a significant loss of valuable surface water.

If, instead of the above three strategies, the nitrification process is removed from the BNRAS system and transferred to the TF, all the WW flow can be discharged to the BNRAS system (Figure 2.3): A side-stream of mixed liquor is taken from the end of the anaerobic zone and passed through the TF 'humus' tanks (upgraded to internal settling tanks ) to remove the activated sludge solids. The underflow sludge is discharged to the beginning of the anoxic zone and the overflow is passed onto the TF for nitrification. The nitrified TF effluent is then discharged to the anoxic zone for denitrification. In this way the TF assists the BNRASS in its area of weakness, i.e. nitrification, rather than taking away from it's strength, i.e. biological N and P removal with influent organics.

**Figure 2.2:** Conventional integration of trickling filters with biological nutrient removal activated sludge removal systems.

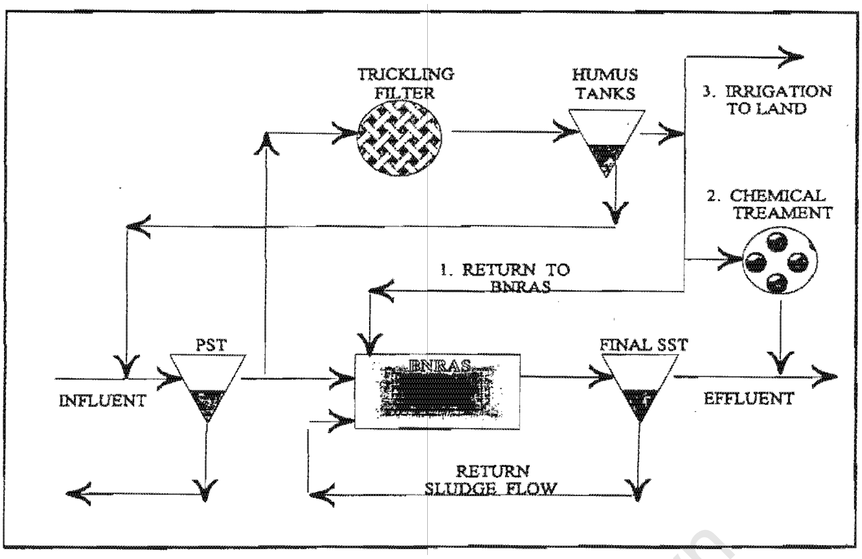
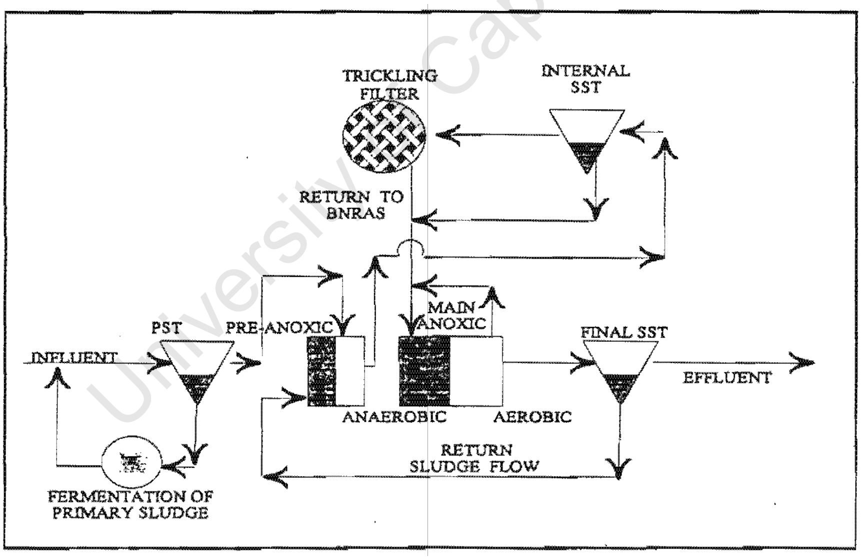



**Figure 2.3:** Proposed integration of trickling filters with biological removal activated sludge systems: nitrification is achieved externally on nitrifying trickling filters.






Furthermore, the oxygen demand in the aerobic reactor is markedly reduced because nitrification no longer takes place there. Indeed, not only is nitrification oxygen demand obtained 'free' outside the BNRAS system, but also the oxygen equivalent of the nitrate generated in the TF helps to reduce the carbonaceous oxygen demand in the BNRAS system, by about 1/3rd. In fact, with external nitrification, the reduction in oxygen demand in the BNRAS system is much greater than if 1/3rd of the wastewater is bypassed to the trickling filter as in existing TF/BNRAS systems. Therefore, by changing the TF to a nitrifying system, the treatment capacity of the BNRAS plant is increased without having to increase the aeration capacity. If a TF plant is not available, it may be possible to construct an artificial external fixed media system, the cost of which may be offset by the increase in WW treatment capacity.

At short sludge ages and small aerobic mass fractions, nitrifiers would not ordinarily be supported in the BNRAS system. However, it will not be possible to completely exclude nitrifiers from the system because nitrifiers are likely to be seeded into the system from the TF effluent. Therefore, the potential for nitrification in the aerobic reactor will always exist in the system. The potential nitrate concentration in the aerobic reactor will be governed by the ammonia concentration that enters it. Provided the TF nitrifies well, this ammonia concentration will be mainly from the ammonia which bypasses the TF via the internal settling tank underflow, and therefore will be relatively low. If the TF does not nitrify well, the residual ammonia concentration from it is high , and then, if sufficient nitrifiers are present in the aerobic reactor, the nitrate concentration will be high, with the result that a significant nitrate concentration will be present in the final effluent and underflow from the final settling tank. To protect the BEPR against this potential nitrate ingress to the anaerobic reactor, a pre-anoxic reactor is placed in the underflow to denitrify the nitrate (Figure 2.3). If sufficient nitrifiers are not present in the aerobic reactor, then the ammonia concentration in the aerobic reactor will only be partially nitrified with the result that the return sludge nitrate concentration will be relatively low, but the effluent TKN concentration will be high, the concentration depending on the nitrification efficiency of the TF.



## 2.8 Previous Research Into External Nitrification

To examine the performance of an external nitrification BNRAS system Hu *et al.*, (1999) undertook a 250 day laboratory investigation with a 10 day sludge age, 48% anoxic and 19% aerobic mass fraction suspended solids system and found that :-

(1) Good COD (~ 90%) and N (~90%) mass balances were obtained over the system;

(2) Overall COD removal was excellent at 92% including an approximate 15% COD removal in the stone column nitrification system.

(3) Including the nitrate dose to the main anoxic reactor, which increased the effective influent TKN/COD ratio to about 0.14mgN/mgCOD, the system produced an effluent

total N (TKN + $NO_x$) concentration of <10 mgN/l. Nitrification was virtually complete in the stone column and the denitrification in the anoxic reactor was 58 mgN/l influent.

(4) The P removal was 10.6mgP/l and considerable anoxic P uptake (>50% in the latter half of the investigation) took place in the main anoxic reactor. The BEPR was about 2/3rds of that expected from the aerobic P uptake BEPR model of Wentzel *et al.* (1990, 1992) and is probably a consequence of reduced energy capture by denitrifying PAOs (DPAOs) when nitrate serves as electron acceptor compared with oxygen (Payne, 1981; Murnleitner *et al.*, 1997).

(5) The oxygen utilization rate (OUR) was very low - 29 mgO/(l.h) in the 19 % aerobic mass fraction. This is about 2.5 times lower than that in a conventional nitrification BNRAS system and arises because the nitrification OUR was obtained 'free' in the fixed media stone column system as well as the high denitrification which reduced the heterotrophic oxygen demand.

(6) A very good settling sludge ( DSVI ~ 60 ml/g) was consistently obtained in the BNRAS system. Filamentous organisms *Microthrix parvicella* and types 0092, 0041 and 0675, which are common in conventional BNRAS systems, were identified at low levels in the mixed liquor.

## 2.9 Research Objectives

The significant anoxic P uptake in the system and the reduction in BEPR this appeared to cause, led to an evaluation of the importance of the reduced aerobic mass fraction. Inclusion of anoxic P uptake PAOs in, and exclusion of aerobic P uptake PAOs from, the biocenosis of the BNRAS system mixed liquor are not essential for achieving external nitrification in the BNR scheme. In fact, inclusion and maximization of aerobic P uptake would appear desirable to maximize BEPR. In earlier investigations by Bortone *et al.* (1996), an anaerobic /anoxic sequencing batch reactor (SBR) was operated and they found that this system did not simulate BEPR unless a short aerobic period was included in the SBR. Thus, it would appear that in order to achieve stable (albeit reduced) anoxic phosphate uptake (and aerobic P uptake) an aerobic period may be essential for anoxic P uptake. However, conditions that promote aerobic P uptake BEPR are also conducive to nitrifier growth. Although exclusion of nitrifiers from the mixed liquor of the BNRAS system was originally considered essential, this is would not be necessary as long as virtual complete external nitrification is obtained, to limit nitrification in the main aerobic reactor. In fact, complete exclusion of nitrifiers may not prove possible because, although conditions in the BNRAS system may not be conducive to their growth, nitrifiers are likely to be continually seeded into the system from the external nitrification system. Accepting nitrification in the BNRAS system, with complete nitrification in the external nitrification fixed/suspended media system, the nitrification in the BNRAS system will be limited by ammonia bypassing the tricking filters with the internal settling tank underflow to the anoxic reactor. However, should complete nitrification not be obtained in the external nitrification system, then the ammonia from the external nitrifier will be nitrified in the aerobic reactor of the BNRAS system. If the aerobic reactor nitrate concentration becomes too high due to poor nitrification in the external nitrification system, the pre-anoxic reactor will become overloaded with nitrate resulting in nitrate discharge into the anaerobic reactor and reduced BEPR. The occurrence of such a scenario can be minimized by the inclusion of an a-recycle from the aerobic to the main anoxic reactor of the BNRAS system, as employed in this investigation. On the other hand, if nitrification were not included in the BNRAS system, then the ammonia would leave via the effluent, which is a less desirable situation where a low ammonia (<1,0 mgN/l) concentration standard needs to be met.



Recognizing the advantages of including aerobic P uptake in the system (higher BEPR per influent RBCOD), the fact that including nitrification in the system is not entirely undesirable (provided the external nitrification system nitrifiers virtually completely) and acknowledging that an aerobic period is essential for BEPR and stable anoxic P uptake (Bortone *et al.*, 1996), it was decided to investigate the effect of increasing the aerobic mass fraction and stimulating aerobic P uptake in the external nitrification BNRAS system. Initially, the external nitrification BNRAS system with a fixed media stone column and small aerobic mass fraction was set up to establish a datum, and then the aerobic mass fraction was increased. In this manner, simultaneously, external nitrification and anoxic phosphate uptake was studied in the BNR activated sludge systems with varying aerobic mass fractions. The aims of the experiments were to:

(i) firstly establish a stable population of slow-growing nitrifiers on a fixed media external nitrification system (later changed to a suspended medium due to *Psychoda* larvae infestation of the fixed media stone column),

(ii) double the volume of the wastewater treated thereby testing one of the claimed benefits of external nitrification system due to the shortened sludge age and improved sludge settleabilty,

(iii) promote conditions to achieve aerobic phosphate uptake,

(iv) increase the aerobic mass fraction in an attempt to qualify its effect on anoxic P uptake, and

(v) study the effect of the increased aerobic mass fraction on the sludge settleability of the BNRAS system.

The BNRAS external nitrification experimental laboratory set up and control are discussed in detail in Chapter 3.

# CHAPTER 3

## EXPERIMENTAL INVESTIGATION

### 3.1 EXPERIMENTAL SET-UP AND CONTROL

To achieve the aims of this investigation, i.e. external nitrification in a BNRAS system, either one or a combination of two techniques can be employed. Firstly, by installing a settler and a fixed media external nitrification system between the anaerobic and anoxic reactors, as shown in Figure 3.1, and or secondly by dosing nitrate directly to the anoxic reactor. To set up the laboratory system as close as possible to the envisioned application of the system, the first approach was adopted. However, in order to increase the nitrate load and ensure that the anoxic reactor was overloaded with nitrate, i.e. to maintain the nitrate load on the main anoxic reactor in excess of its denitrification potential thus allowing some nitrate to enter the aerobic reactor, nitrate was dosed directly into the main anoxic reactor as a concentrated solution of 0.5 to 1.25 mgN/ml.

With this in mind, the system shown in Figure 3.1 was set up, with the design parameters as given in Table 3.1. The system sludge age, temperature and unaerated mass fraction were initially 10 days, 20 °C, and 0.85 respectively. To avoid any interference of nitrate on the P release process in the anaerobic reactor, a 0.1 mass fraction pre-anoxic reactor was set up ahead of the anaerobic reactor to denitrify nitrate in the return sludge. This pre-anoxic reactor was necessary to ensure a near zero nitrate concentration in the flow entering the anaerobic reactor since (i) the main anoxic reactor was dosed nitrate such that its denitrification potential was exceeded allowing a low concentration (<5mg$NO_3$-N/l) of nitrate in the outflow of this reactor and/or (ii) to denitrify nitrate generated from the residual ammonia from the internal settling tank underflow and/or the external nitrification system that may be nitrified in the aerobic reactor.



**Figure 3.1:** Schematic layout of External Nitrification BNRAS system

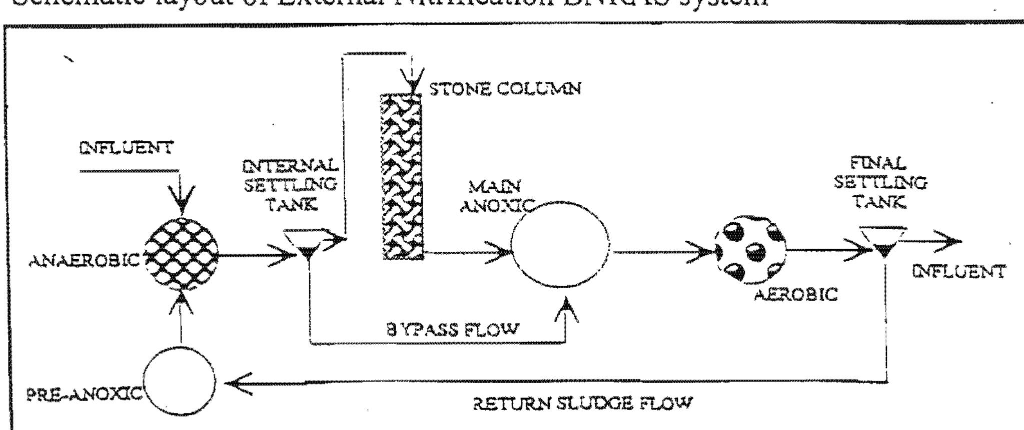


**Table 3.1:** External Nitrification BNRAS system design and operating parameters.

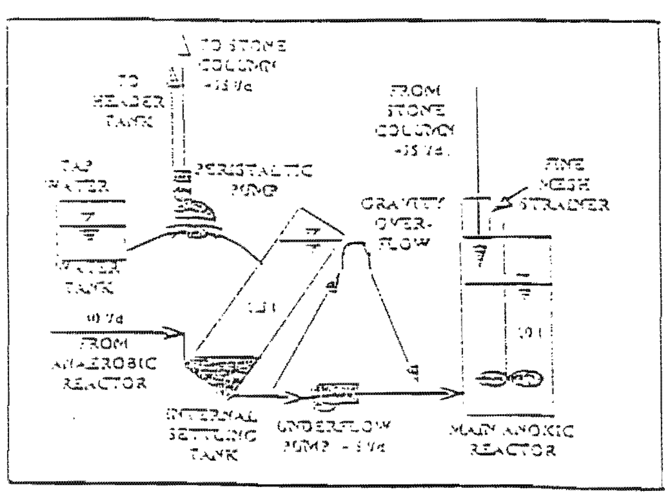
| System Parameter | Configuration 1 | Configuration 2 | Configuration 3 | Configuration 4 |
|---|---|---|---|---|
| | Changed to ↗ | Changed to ↗ | Changed to ↗ | |
| **Period:** | 24/2-16/3 | 17/3-27/7 | 28/7-16/9 | 16/9-1/4/99 |
| No of Days | 30 (1-30) | 124 (31-154) | 51 (155-205) | 164 (206-373) |
| Sewage Batch | 1 to 3 | 4 to 20 | 22 to 25 | 26 to 37 |
| **Operating:** | | | | |
| Sludge age (days) | 10 | 8 | 10 | 10 |
| Waste (l/d) | 2 | 2.5 | 2 | 2 |
| Temperature ( $^0$C ) | 20 | 20 | 20 | 20 |
| pH of anaerobic reactor | 7.2-8.2 | 7.2-8.2 | 7.2-8.2 | 7.2-8.2 |
| pH of aerobic reactor | 7.2-8.2 | 7.2-8.2 | 7.2-8.2 | 7.2-8. |
| DO in aerobic reactor (mgO/l) | 2.0 - 5.0 | 2.0 - 5.0 | 2.0 - 5.0 | 2.0 - 5.0 |
| **Influent:Mitchell's Plain (raw) unsettled wastewater** | | | | |
| Influent Feed (l/d) | 20 | 40 | 30 | 30 |
| COD (mgCOD/l) | 709 | 677 | 646 | 716 |
| RBCOD (mgCOD/l) | 103 | 91 | 73 | 98 |
| TKN/COD ratio | 0.08 - 0.11 | 0.07 - 0.12 | 0.07 - 0.14 | 0.04 - 0.15 |
| $NO_3$dose/l Inf/ COD | 0.03 -0.04 | 0.01 - 0.03 | 0.02 - 0.03 | 0.02 (batch 28) |
| Total P (mg/l Influent) | 18.2 - 26.1 | 15.6 - 32.6 | 19.4 - 28.9 | 20.1 - 29.5 |
| Total P Removal(mgP/l) | 9 | 8 | 13 | 12 |
| TP Rem/ Inf COD | 0.013 | 0.012 | 0.021 | 0.017 |
| Ext Nitrification System | Stone Column | Stone Column | Stone Column | Suspended AS. |
| **Reactor Volumes Mass Fractions:** | | | | |
| Total System Volume(l) | 20 | 20 | 20 | 20 |
| Anaerobic Vol (l) | 5 ; 0.25 | 5 ; 0.25 | 5 ; 0.25 | 5 ; 0.25 |
| Main Anoxic Vol (l) | 10 ; 0.5 | 9 ; 0.45 | 6 ; 0.30 | 6; 0.30 |
| Aerobic Vol (l) | 3 ; 0.15 | 3 ; 0.15 | 6 ; 0.30 | 6 ; 0.30 |
| Effective Pre Ano Vol | 2 ; 0.10 | 3 ; 0.15 | 3 ; 0.15 | 3 ; 0.15 |
| Unaerated | 17 ; 0.85 | 17 ; 0.85 | 14 ; 0.70 | 14 ; 0.70 |
| | | | | |
| **Recycles flows and Ratios (l/d; ratio w.r.t to influent flow)** | | | | |
| s- recycle (l/d) | 10 ; 0.50 | 20 ; 0.50 | 15 ; 0.50 | 15 ; 0.50 |
| a - recycle (l/d) | none ; 0.00 | none ; 0.00 | 30 ; 1.00 | 30 ; 1.00 |
| Flow to Ext Nitrifier | 30 ; 1.50 | 50 ; 1.25 | 35 ; 1.17 | 32 ; 1.07 |
| Bypass flow (l/d) | 10 ; 0.50 | 10 ; 0.25 | 10 ; 0.33 | 13 ; 0.43 |

The activated sludge reactors and settling tanks were those usually used in laboratory investigations and were made from clear acrylic plastic as described in detail by Clayton *et al* (1989). The external nitrification system was a fixed medium reactor. It comprised a 100 mm diameter, 1.5 m tall clear acrylic plastic column filled with 9 - 13 mm granite stones, and will be referred to as the stone column (SC). The base of the stone column was closed off and placed in a 200 mm diameter, 100 mm high plastic mini settling tank. Four 10 mm diameter holes were drilled 20 mm above the base of the stone column to allow the nitrified effluent to flow into the plastic mini settling tank as well as to allow for the inflow of air. A small fan was set at the top of the stone column and switched on for 15 seconds every 10 minutes to renew the air in the column since the column was to small to generate its own natural upflow of air. The nitrified effluent was passed through a 0.5 mm fine mesh strainer to remove solids, in particular mothfly larvae which appeared to adversely affect the laboratory scale stone column function and the activated sludge system (discussed in detail below).

The flow to the stone column was drawn from the internal settling tank supernatant with a peristaltic pump as shown in Figure 3.2 below. To provide control and monitoring of the flow to the column, a parallel channel in the peristaltic pump discharged tap water to a tank with an hydraulic head equal to that of the stone column. Of the 40 l/d passing through the internal settling tank (20 l/d influent plus a 1:1 underflow s recycle ratio) between 30 to 35 l/d was pumped to the stone column. The underflow sludge was pumped to the anoxic reactor at about 5 l/d. A gravity overflow from the settling tank to the anoxic reactor absorbed flow variations in the two pumps. The entire experimental was set up on a specially constructed frame at the base of which was a drip tray, to collect as much as possible sludge lost due to blockages or leaks and return these to the system so as to minimize sludge losses.



**Figure 3.2:** Detail of stone column flow control and measurement



During the first stage of the investigation external nitrification was achieved with the stone column fixed media system, which covered a period of 205 days. During this time a number of changes were made to the design and operating parameters which resulted in periods over which testing of the system was not carried out. The changes that were made are given in Table 3.2 and the design and operating parameters in Table 3.1.

During the first stage, comprising three configurations (see Table 3.1 for details), the system received 25 batches of sewage. These batches of raw sewage were collected approximately every two weeks, and after maceration, stored in stainless steel tanks in a cold room at 4°C, and served as feed until the next sewage batch was collected. To feed the laboratory system, a sample of sewage was drawn daily after thorough mixing and then diluted with tap water from a concentration of approximately 1200mg COD/l to a target influent concentration of 700 mg COD/l. The diluted influent was buffered by addition of sodium hydrogen carbonate ($NaHCO_3$). About 7 mgP/l as potassium dihydrogen phosphate ($KH_2PO_4$) was dosed to the influent to avoid P limitation and to ensure that the final effluent phosphorus concentration from the system remained above 5 mgP/l. After dilution and thorough mixing, a 250ml sample was drawn from the diluted influent. A measured volume of 20 l was then placed in the systems influent feed drums (20 l each), which were kept in a refrigerator at approximately 8°C. The influent flow to the system was pumped from the influent feed drums by a constant flow pump over a 24 hr period. Feeding the system daily in this way i.e. over a 24 hr period in daily batches, provided a check that the daily influent was fed to the system. At the end of the 24 hr period, whatever remaining wastewater (usually < 100 ml) was collected with the solids that may have settled out, and poured into the anaerobic reactor. The nitrate dosed to the main anoxic reactor was done using a constant flow pump delivering 500 ml/d. The dose concentration of the $NaNO_3$ was made up daily and varied from 0.5 to 1.25 mg$NO_3$-N/ml depending on the nitrate mass dose required daily.

The external nitrification BNRAS system, i.e. Configuration 1, was taken over from earlier investigations into external nitrification in biological nutrient removal activated sludge systems ( Hu *et al.*,1999). This system in the form of Configuration 1, was later changed to Configurations 2 and 3 in accordance with the design and operating conditions in Table 3.1. During the investigation, a conventional UCT system was operated and fed the same sewage (and also numbered the same) as the external nitrification system with which to compare the nutrient removal. Details of this system, day to day results, and data evaluation are given in Appendices D and E.

**Table 3.2:** Changes and Stoppages to the system

| Item | From day | To day | Reason |
|---|---|---|---|
| Nitrate dose | 1 | 215 | To supplement stone column (SC) nitrification and assess the denitrification potential of main anoxic reactor. |
| Influent | 23 | 25 | Increased influent flow from 20l/d to 40 l/d to observe an aim of this investigation. |
| Sludge age | 23 | 25 | Reduced from 10 days to 8 days in order to minimize the likelihood of internal nitrification |
| Sewage | 110 | 119 | Sewage batches 14 and 15 toxic. Nitrification very poor at this time. |
| Sewage | 140 | 147 | Sewage toxic |
| Stone Column (SC) | 110 | 205 | Larvae infestation (*Psychoda*), scoured biofilm during draining after periodic flooding to control *Psychoda.* |
| Influent | 148 | 149 | Decreased influent flow from 40 l/d to 30 l/d in order to reduce flow rate through the stone column. |
| Stone Column | 155 | 168 | Replaced existing SC (1.5m) with longer SC (2m) to increase retention time. Approx. 2 weeks for sludge growth. |
| a-recycle | 185 | | Added 1:1 aerobic to main anoxic recycle to minimize nitrate recycled to anaerobic reactor |
| External Nitrifier | 205 | | Changed external nitrification system from fixed media stone column to suspended nitrification activated sludge system |
| Settling | 236 | 244 | Poor settling sludge (not bulking) accumulated and filled up in final settler. |
| Samples | 284 | 294 | Samples were mistakenly discarded. |
| Blockages and settling | 316 | 348 | System beset with problems: frequent blockages and sludge loss, poor settling and sludge accumulation in final settler |
| End of Investigation | | 373 | |

## 3.2 DATA ACQUISITION AND SYSTEM PERFORMANCE MONITORING

To monitor the systems performance and operation, samples were drawn virtually daily from each of the reactors, the internal settling tank supernatant, the stone column nitrified outflow and the final effluent for analysis throughout the 373 day duration of the investigation. Generally, samples were not taken from the system (i) on the first day of a new sewage batch (because the system requires at least two days to adjust to the new sewage batch), and (ii) on days which the system did not operate properly, e.g. on days when one or more of the reactors, especially the pre-anoxic, got blocked causing sludge losses. In most cases the spilled sludge was collected and returned to the system. However, these spillages can be a major contribution to poor COD balances. Table 3.3 shows the parameters that were measured and the analytical methods that were applied. In addition to the above samples taken, the diluted sludge volume index (DSVI) was measured on sludge drawn from the aerobic reactor and the oxygen utilization rate (OUR) was monitored continuously online with the DO controller/OUR meter developed by Randall *et al.* (1991).

**Table 3.3:** Sampling position and parameter measurement

| Test | COD[1] | TKN[2] | FSA[3] | NO3[4] | NO2[4] | Tot P[5] | OUR[6] | DSVI[7] | VSS/TSS[8] | pH[9] | RBCOD[10] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pre Anoxic | | | | ¥ | ¥ | ¥ | | | § | | |
| Influent | ø | ø | ø | | | ø | | | | | ¥ |
| Anaerobic | | | | ¥ | ¥ | ¥ | | | § | § | |
| S/Col Influent | ø | ø | ø | ¥ | ¥ | ¥ | | | | | |
| S/Col Effluent | ø | ø | ø | ¥ | ¥ | ¥ | | | | | |
| Anoxic | | | | ¥ | ¥ | ¥ | | | § | | |
| Aerobic | ø | ø | | ¥ | ¥ | ¥ | § | § | § | § | |
| Final Effluent | ø | ø | ø | ¥ | ¥ | ¥ | | | | | ¥ |

§ Measurement taken (filtering not applicable).
ø Unfiltered Sample
¥ Filtered through Schleicher & Schüll 0.45μm glass fibre membrane.
[1,2,3] Method according to Standard Methods (1985)
[4] According to Technicon Auto Analyser Industrial Method No 33.69W
[5] Sulphuric acid/persulphate digestion at 100°C followed by molybdate-vanadate colour development for ortho-phospate (Standard Methods,1985- Method424C III)
[6] With Yellow Springs DO probe and the automated method of Randall *et al.*(1991)
[7] According to Lee *et al.* (1983) or Ekama and Marias (1984).
[8] By separation with centrifugation, drying in a crucible at 105°C and incineration at 600°C.
[9] With Hanna Instruments pH meter No HI 9023.
[10] For RBCOD concentration, 1litre sample was subjected to 10ml of 0.25M Aluminium Sulphate flocculant concentration and allowed to settle for at least 10 min before filtration (Mamais *et al.*, 1993 ; Mbewe *et al.*, 1998)

The day to day results of the measured parameters are listed and are shown plotted in Figures A1 to A28 in Appendix A. A summary of these measured parameters with their corresponding

Figure numbers are shown in Table 3.4.

After 30 days of testing (day 30), having fed three batches of sewage and obtaining an average COD and N mass balance of 90 % and 99 % respectively, and an average P removal of 0.013 mgP/mgCOD, it was decided to commence with the first aim of this investigation, i.e. high influent flow treated per litre system volume.

**Table 3.4:** Summary of measured parameters with corresponding Figure numbers.

| Test | | Test | |
|---|---|---|---|
| COD | Figure A1 to Figure A2 | Total P | Figure A15 to Figure A22 |
| TKN | Figure A3 to Figure A4 | Solids | Figure A23 to Figure A26 |
| Ammonia | Figure A5 to Figure A6 | mgO/d | Figure A27 |
| Nitrate | Figure A7 to Figure A10 | mgO/d | Figure A28 |



The first change made to the system was doubling of the influent feed from 20 l/d to 40 l/d. Consequently, the s-recycle doubled from 10 l/d to 20 l/d and the flow to the stone column from 30 l/d to 50 l/d. The main anoxic volume was reduced from 10 l to 9 l and the effective pre-anoxic volume was increased from 2 l to 3 l, thus changing their corresponding mass fractions. It was also decided to run this newly configured system, referred to as configuration 2, at an 8 day sludge age. A summary of the changes made to Configuration 1 can be found in Table 3.1.

Configuration 2 was run for a period of 124 days during which 17 batches of sewage were fed. Although having obtained an average COD and N mass balances of 79 % and 97 % respectively and a P removal of 0.012 mgP/mgCOD, the system required changes because it was failing in the fundamental aim i.e. external nitrification. The stone column nitrification efficiency (given by 1 minus the outflow FSA/inflow FSA concentration ratio) had dropped from a high average value of 88 % completion (Configuration 1) to a low average value of 44 % (Configuration 2), i.e. a 50 % reduction in nitrification efficiency. The poor performance was due to mainly three factors. The first factor, which also had a negative impact on the P removal, was due to bad (toxic) sewage batches fed to the system viz, batches 10, 14, 15, 19 and 21 the results of which were discarded as not useful to this investigation. The second, a more direct effect, was due to fly larvae (*Psychoda*)[2] infestation of the stone column and subsequently the main anoxic and aerobic reactors. The larvae foraged the nitrifier biofilm off the stones and severely reduced the nitrification efficiency of the stone column. The effect of the larvae on the suspended sludge system was not clear but the denitrification efficiency and P uptake in the main anoxic reactor had declined.

In an effort to control the larvae infestation, periodic flooding of the stone column was carried out every 14 to 16 days (i.e. within a complete lifecycle from egg to emergence as an adult moth fly) in order to drown the adult flies and thus minimize the possibility of mating and laying of eggs and thereby hopefully achieving an improvement in nitrification efficiency. However, the periodic flooding resulted in a poorer nitrification performance due to the nitrifying biofilm being scoured off the stones during the draining periods and flowing out of the stone column after flooding. Poppelan (1998), states that at best this method is about 60 % effective in controlling *Psychoda* infestation. Although fine mesh sieves (0.5mm) were used at both the inlet and outlet of the stone column and periodic flooding of the stone column was carried out, the fly larvae infestation could not be effectively controlled.



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[2]Trickling filters present an almost perfect habitat for many insect species, and have become a specialised niche for a number of them (Poppelan,1998). The four most commonly quoted nuisance species are *Sylvicola fenestralis, Metriocnemus hygropetricus, Lymnophyes minimus and Psychoda alternata.* Of these four species, *Psychoda* is of most interest as it is the only one which has so far been implicated as having potential effects on human health. *Psychoda* larvae are not truly aquatic, and should be described as hygropetric (alternate wet and dry cycles). This immediately explains why *Psychoda* has been so successful in colonizing trickling filters, where wet and dry periods alternate with regularity. The key to success for *Psychoda* is the presence of a thick biofilm, preferably algal or fungal, but also bacterial, on the filter media, which serves as both food and as protection against dehydration. Therefore, outbreaks of *Psychoda* are associated with heavily loaded or overloaded trickling filters. Psychodidae measure between 3 to 5 mm as adults. The adults are weak fliers, and do not migrate far from their place of origin. Adults are capable of mating and laying eggs when they emerge. However, this sort of behavior is usually seen only under stress (i.e. laboratory) conditions. The adult female lays between 50 to 140 eggs in a wet environment such as water, sludge or biofilm. The eggs hatch after one to two days. The larvae develop to the pupal phase in four stages, known as 'instars'. All four instars are feeding stages; the pupal stage is a non-feeding but still mobile resting stage. The duration of the four instar stages is temperature dependent, and, under optimum conditions, the first and second instars will be two days each, the third instar two or three days, and the fourth instar between five and eight days. The pupal stage is short but can vary from one to three days. The laboratory stone column is a better habitat for *Psychoda* infestation than real full scale TF because (i) temperature is constant and (ii) light penetrates into the entire media volume. The problem of *Psychoda* infestations scavenging the nitrifier biofilm causing a reduced nitrification efficiency is therefore not as serious a problem in full scale TFs as in laboratory ones.

The third factor influencing the performance of the stone column was the retention time. It was speculated that the high volume flow passing through the 1.5 m tall stone column was too short and did not allow for sufficient time for nitrification to reach completion.

To overcome these problems encountered with the stone column system, it was replaced with a taller, 80 mm diameter, 2 m tall stone column. This new stone column also had at its base a strainer to prevent excessive sludge leaving the stone column. An improved settling tray which prevented sludge loss from the stone from entering the main anoxic reactor and improved the air flow into the column. This taller stone column was selected to increase the retention time. Furthermore, to decrease the flow to the stone column, the influent flow was decreased to 30 l/d and as a result the s-recycle and the stone column flow were decreased to 15 l/d and 35 l/d respectively[3]. Up to this stage in the investigation the objective of the system was to obtain as much anoxic P uptake as possible while trying to keep the aerobic uptake and nitrification in the aerobic reactor as low as possible. Because of the difficulty of obtaining stable anoxic P uptake, the objective shifted such that the principal aim, i.e. external nitrification, could be achieved with aerobic P uptake. Other reasons for this shift in focus were (i) the poor phosphorus removal obtained with configuration 2 due to lower BEPR with anoxic P uptake compared to aerobic P uptake, and (ii) because anoxic P uptake is not a prerequisite for external nitrification. Therefore an external nitrification BNR system was set up to encourage aerobic P uptake BEPR, which from past experience is more stable and thus improves the overall BEPR performance of the system. Accordingly, the main anoxic reactor volume was decreased from 9 l to 6 l and the aerobic reactor volume increased from 3 l to 6 l. Also, the sludge age was increased to 10 days to stabilize the phosphate uptake and biological excess P removal (BEPR). This increased sludge age increased the likelihood of nitrification in the aerobic reactor, thus an a-recycle was introduced from the aerobic reactor to the main anoxic reactor to reduce the nitrate dosed to the anoxic reactor and hence the nitrate concentration in the aerobic reactor to thereby minimize nitrate recycled to the anaerobic reactor.

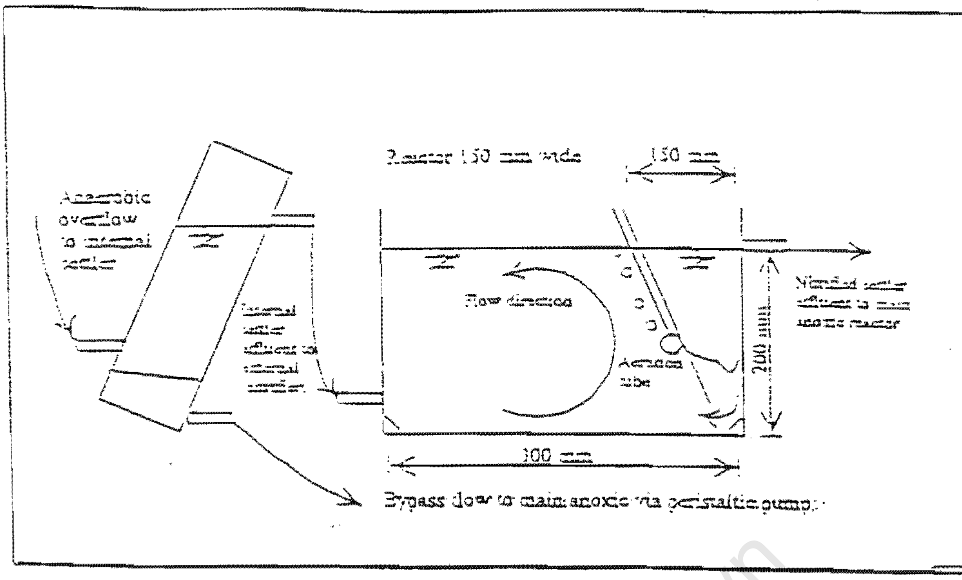
[3] It should be noted that the decrease in influent flow was necessitated by the poor stone column nitrification performance, and not for the suspended sludge system. Therefore, this reduction was not a failure of the increased treatment capacity objective of the external nitrification biological nutrient removal system.

The effect of all the changes made to Configuration 2 can be seen in Table 3.1. This modified system, called Configuration 3, was operated for a period of 51 days over which 5 sewage batches were fed to the system. An average COD and nitrogen mass balance of 94 % and 95 % respectively, and an average P removal of 0.021 mgP/mgCOD was attained over this period, which is significantly higher than earlier in the investigation and closer to that expected from aerobic P uptake BEPR performance (Ekama and Wentzel., 1999), even though the P uptake was still significant in the main anoxic reactor.

During the operation of Configuration 3, the stone column was still not performing as required. This was due to the same problem encountered as in Configuration 2 i.e. *Psychoda* larvae infestation and hydraulic overloading. In Configuration 3, the stone column nitrification efficiency had dropped by greater than 50 % of that of the previous stone column to a very low and unacceptable value of 17.5 %.

Having not achieved sufficiently high external nitrification efficiencies (>70 %) through the use of a fixed media stone column external nitrification system, it was decided to change the system to a suspended medium activated sludge external nitrification system. The suspended medium activated sludge external nitrification system comprised of a 20 cm long by 15 cm wide rectangular tank with a 5 l volume. The settling compartment was constructed within the tank by a sloping (30° to the vertical ) baffle plate (see Figure 3.3). A small gap between the baffle plate and the bottom corner of tank allowed the settled sludge to return to the reactor compartment. Aeration was supplied by a porous T-section tube attached on the reactor side of the baffle plate, which created a rotational flow pattern and provided mixing in the tank. The flow pattern (see Figure 3.3), being upwards at the aeration end and downwards at the settling compartment end assisted the return of sludge into the reactor. No sludge was intentionally wasted from the reactor; thus the sludge age was very long and was established by the sludge loss with the outflow from the settling compartment to the main anoxic reactor with a volume of 6 l, the nominal and 'actual' retention times in the reactor/settler at 30 l/d influent flow and 0.5 : 1 recycle ratio were 4.8h and 3.2h respectively. The details of the new design and operating parameters of Configuration 4 are given in Table 3.1. Unfiltered COD samples of the reactor inflow and outflow allowed determination of the COD reduction through the reactor.

**Figure 3.3:** Details of external suspended medium nitrifier.



An immediate improvement was noticed in the nitrification efficiency of the suspended medium external nitrification system and hence it was decided to keep this system for the remainder of the investigation (164 days and sewage batches 26 to 37). The nitrification efficieny had increased to 66 % while the average P removal dropped slightly to 0.017 mgP/mgCOD. The average COD and nitrogen mass balance for Configuration 4 were 81 % and 89 % respectively.

## 3.3 COD REMOVAL AND MASS BALANCE PERFORMANCE

To establish the accuracy of the experimental data, COD mass balances were performed on the system. For each of the sewage batches, the average values of the measured parameters (Table 3.5 and Appendix A) over the sewage batch were used to determine the COD balance. The COD balance was determined for each batch sewage batch because the influent TKN and RBCOD concentrations varied from sewage batch to sewage batch.

In the COD balance, the COD entering the system via the influent flow is compared to the COD leaving the system via the (i) the final effluent flow (ii) oxygen utilised (iii) sludge wasted (iv) nitrate and nitrite denitrified (v) COD utilized in the external nitrification (EN) system. The method for calculating the COD balance is given in Appendix B. The reliability of the experimental data is directly proportional to the mass balance deviation from 100 %. This implies that the closer the COD balance to 100 % the more reliable the data, in particular, the reliability of the unbiodegradable particulate COD fraction, $f_{S,up}$ and ordinary heterotrophic (OHO) and polyphosphate accumulating (PAO) organisms fractions of the VSS (i.e $f_{av,OHO}$ and $f_{av,PAO}$) estimates.

The averages of the measured parameters of the 37 sewage batches (5 sewage batches excluded due to toxic effects, giving 32 batches analyzed) are listed in Appendix C. Also given in Appendix C are the averages of all the measured parameters for the four system configurations time periods viz; Configuration 1, sewage batches 1 to 3; Configuration 2, sewage batches 4 to 20; Configuration 3, sewage batches 22 to 25; and Configuration 4, sewage batches 26-37). The results of the COD mass balance and its components are given in Table 3.5 and are shown plotted in Figures 3.4 and 3.5. In Figure 3.5 the six components making up the COD balance are shown as a stacked bar viz. effluent COD (Effluent, 10%), COD in waste sludge (Waste, 31%), COD removal in the external nitrification system (Extnit, 12%), COD ( $e^-$ ) passed on to oxygen (Oxygen, 13%), and nitrate (Mod Recov, 14%) as electron acceptors and the COD not recovered or unaccounted for in the COD balance (Unacc, 20%). The percentages given in brackets are the mean values for the investigation.



**Figure 3.4 :** COD mass balance of BNRAS system for 37 sewage batches.

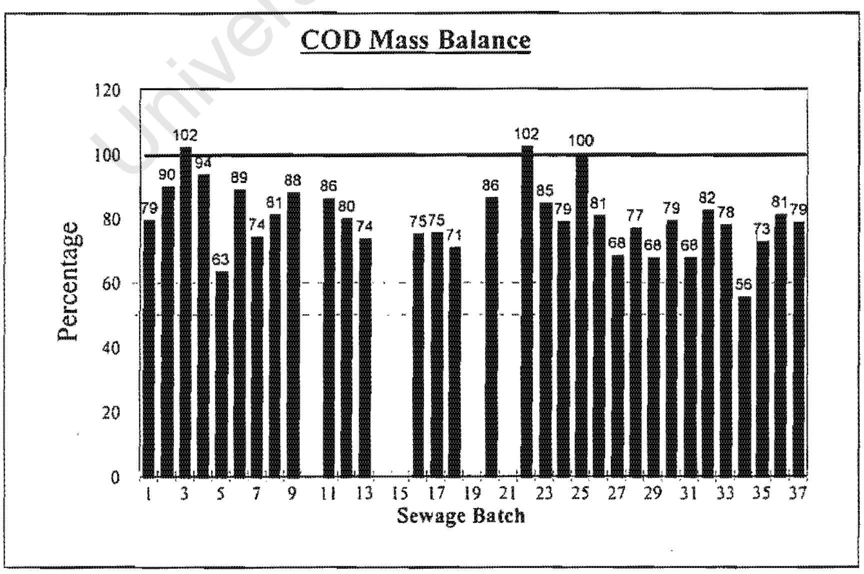


**Figure 3.5 :** COD mass balance components of BNRAS for 37 sewage batches.

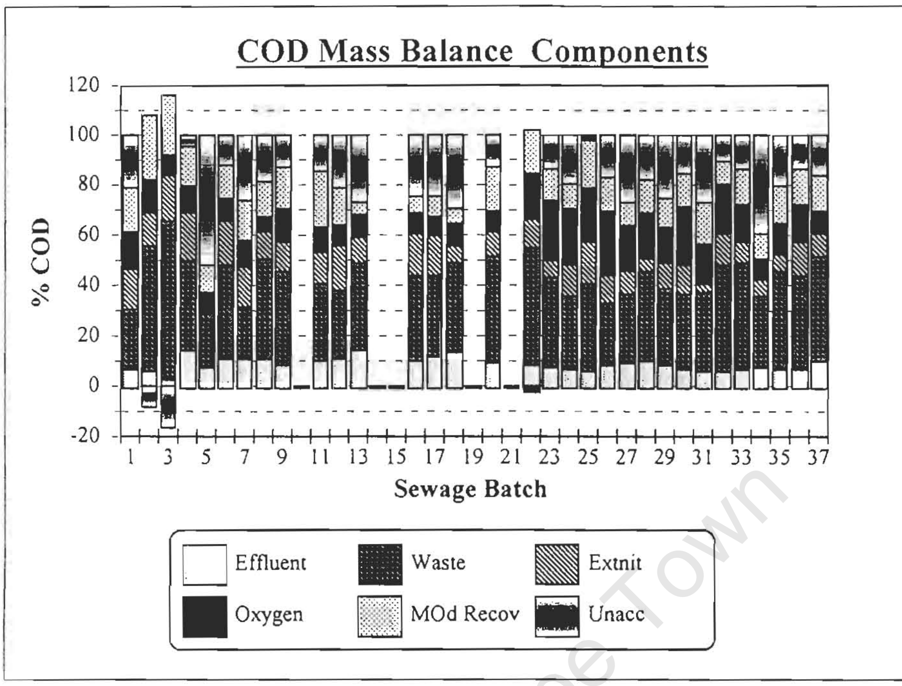



**Figure 3.6 :** Average sewage batch Influent and Effluent COD concentrations

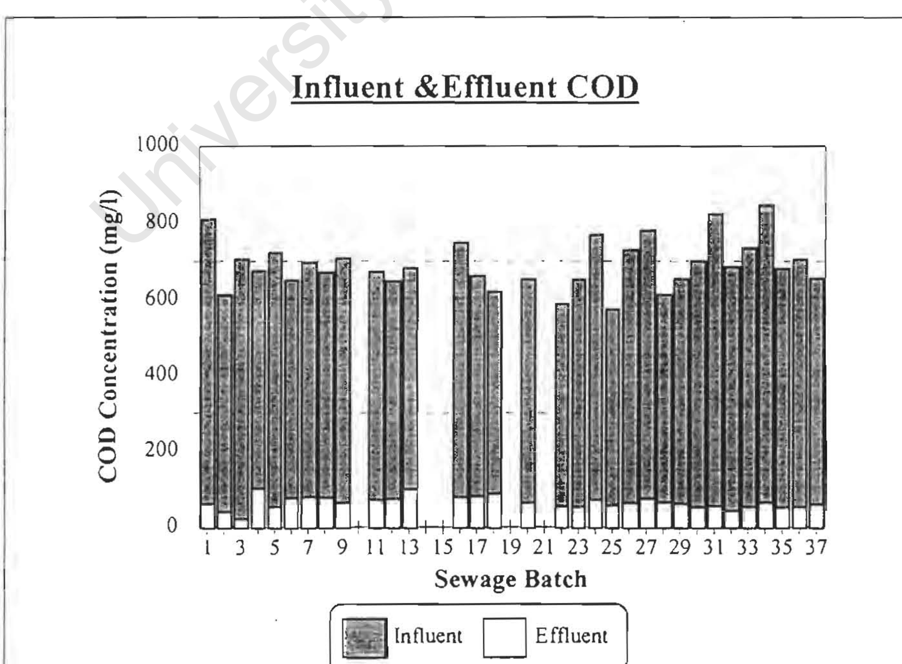


**Table 3.5 :** Components of COD mass balance and % COD Removal

| Average of Batch | Influent mgCOD | Effluent mgCOD | Waste mgCOD | Extnit mgCOD | Oxygen$_c$ mgO | Denit Recov mgO | COD Out mgCOD | COD Rem % | MBCOD % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 16200 | 1212 | 3886 | 2535 | 2376 | 2859 | 12868 | 93 | 79 |
| 2 | 12236 | 810 | 4835 | 1670 | 633 | 3035 | 10983 | 93 | 90 |
| 3 | 14104 | 414 | 7155 | 2513 | 998 | 3321 | 14401 | 97 | 102 |
| **Config 1** | **14810** | **812** | **5292** | **2239** | **1336** | **3072** | **12751** | **94** | **90** |
| 4 | 26981 | 4033 | 9641 | 5178 | 2262 | 4146 | 25260 | 85 | 94 |
| 5 | 28861 | 2105 | 6298 | 4241 | 2320 | 3319 | 18284 | 93 | 63 |
| 6 | 26009 | 3021 | 9730 | 4523 | 2513 | 3323 | 23108 | 88 | 88 |
| 7 | 27838 | 3109 | 5779 | 4526 | 2956 | 4293 | 20662 | 89 | 74 |
| 8 | 26824 | 3065 | 10764 | 2902 | 1127 | 3889 | 21746 | 89 | 81 |
| 9 | 28288 | 2557 | 10608 | 3182 | 3774 | 4761 | 24882 | 91 | 87 |
| 11 | 26903 | 2840 | 8375 | 3481 | 2318 | 6158 | 23174 | 89 | 88 |
| 12 | 25861 | 2940 | 7190 | 4339 | 2270 | 3901 | 20640 | 89 | 80 |
| 13 | 27285 | 3942 | 9541 | 2760 | 2356 | 1458 | 20056 | 86 | 74 |
| 16 | 29920 | 3120 | 10125 | 5100 | 2480 | 1657 | 22482 | 90 | 75 |
| 17 | 26440 | 3200 | 8700 | 4100 | 1886 | 2073 | 19958 | 88 | 75 |
| 18 | 24800 | 3480 | 8750 | 1800 | 2028 | 1511 | 17569 | 86 | 71 |
| 20 | 19584 | 1897 | 8330 | 1958 | 1343 | 3367 | 16896 | 90 | 86 |
| **Config 2** | **27168** | **3188** | **8792** | **3844** | **2303** | **3374** | **21485** | **89** | **79** |
| 22 | 17640 | 1590 | 8220 | 2170 | 3159 | 2908 | 18047 | 91 | 102 |
| 23 | 19557 | 1572 | 6697 | 1011 | 4978 | 2280 | 16537 | 92 | 85 |
| 24 | 23079 | 2145 | 6475 | 2502 | 4604 | 2464 | 18190 | 91 | 79 |
| 25 | 17238 | 1704 | 6003 | 2887 | 3489 | 3187 | 17269 | 90 | 100 |
| **Config 3** | **19379** | **1753** | **6849** | **2142** | **4057** | **2710** | **17511** | **91** | **91** |
| 26 | 21858 | 1913 | 4429 | 2360 | 5958 | 2980 | 17640 | 91 | 81 |
| 27 | 23403 | 2227 | 5088 | 2180 | 4502 | 2005 | 16002 | 90 | 68 |
| 28 | 18360 | 1971 | 5173 | 940 | 3512 | 2053 | 14117 | 89 | 77 |
| 29 | 19619 | 1819 | 4715 | 1996 | 2672 | 2522 | 13255 | 91 | 68 |
| 30 | 21013 | 1573 | 5059 | 2283 | 4990 | 2714 | 16618 | 93 | 79 |
| 31 | 24713 | 1670 | 6193 | 777 | 2893 | 4186 | 16719 | 93 | 68 |
| 32 | 20580 | 1260 | 6980 | 2688 | 4165 | 1853 | 16946 | 94 | 82 |
| 33 | 22029 | 1603 | 7497 | 1847 | 3218 | 2995 | 17160 | 93 | 78 |
| 34 | 25394 | 1968 | 5758 | 1665 | 2202 | 2504 | 14096 | 92 | 56 |
| 35 | 20433 | 1544 | 6272 | 1380 | 2638 | 3035 | 14868 | 92 | 73 |
| 36 | 21128 | 1580 | 6113 | 2634 | 3986 | 2809 | 17124 | 93 | 81 |
| 37 | 19665 | 1815 | 6700 | 1888 | 2089 | 2972 | 15464 | 91 | 79 |
| **Config 4** | **21516** | **1745** | **5831** | **1887** | **3652** | **2719** | **15834** | **92** | **74** |
| **Overall** | **22620** | **2178** | **7096** | **2688** | **2927** | **3270** | **18159** | **91** | **80** |



In Figure 3.6 and Table 3.5 it can be seen that the average COD mass balance over the entire investigation period was 80 %. Although lower than 100 %, this value is significantly below the COD mass balances in other investigations with nutrient removal systems namely Pilson *et al* (1995) 84 % and 94 %, Sneyders *et al* (1998) 92 % and 92 % and Hu *et al* (1999) 91 %. The main reason why the COD balance is lower in this investigation than in other investigations is the sludge spillages that occurred in the system in particular during Configurations 2 and 4.

Looking at Figure 3.5 it can be seen that the largest contribution the COD balance is made by the waste sludge (31%) leaving the system. This is followed by the oxygen utilised and denitrification both at 13 and 14 % respectively. This result is interesting in that it shows that nearly the same amount of COD was utilised with nitrate as electron acceptor as was utilised with oxygen as electron acceptor. However, this is in part due to the dosing of nitrate to the anoxic reactor which increased the TKN/COD ratio of the wastewater from around 0.09 to 0.14. The 12% COD utilized in the external nitrification system is surprisingly low in comparison to the 15 % (with no larvae infestation)observed by Hu et al.,(1999). 10 % of the COD leaves the system via the final effluent, and 20 % is unaccounted for.

From Table 3.5, the system's COD removal efficiency was very good over the entire investigation period with an average COD removal of 91%. The influent COD concentration ranged between 575 and 846 with a mean of 691 mgCOD/l. The unfiltered effluent COD concentration ranged between 21 and 101 with a mean of 64 mgCOD/l. The filtered effluent COD concentration was measured by either filtering the through a 0.45μm Schleicher & Schüll membrane filter or first flocculating the unfiltered effluent using 10ml/l effluent 0.25M aluminum sulphate solution and then filtering the effluent in the same manner as described above. The average floc-filtered effluent COD concentration ranged between 20 and 100 with a mean of 41 mgCOD/l. The 0.45μm membrane filtered effluent COD (non-flocculated) concentration ranged between 26 and 73 with a mean of 50 mgCOD/l. This value was accepted to correspond to the unbiodegradable soluble COD in the influent and gives an average unbiodegradable soluble COD fraction ($f_{S,us}$) of 0.073. Figure 3.6 shows the systems mean unfiltered influent and effluent concentrations for the 37 sewage batches and shows that the COD removal performance of the system was not only good, but also stable throughout the investigation.

The low oxygen demand in the system is reflected in the low OUR in the aerobic reactor namely 36 mgO/(l.h) in ~20 % of the system volume. This is because the nitrification OUR no longer needs to be supplied in the suspended medium system and the nitrate produced "free" in the external nitrification system reduces the carbonaceous OUR. Nitrate dosing to the main anoxic reactor reduced the carbonaceous OUR further by 1.42 mgO/(l.h) per 1mgNO$_3$-N/l influent dosed. The OUR in an equivalent internal nitrification BNRAS system with 20 % aerobic mass fraction, 90% COD balance, 10 day sludge age, complete nitrification, 90 % nitrate denitrification leading to a 50 % recovery in nitrification OUR is about 2 times higher at ~ 75 mgO/(l.h).Thus, not nitrifying in the BNRAS system but rather utilising an external nitrifier to generate nitrate, clearly leads to a significant decrease in the OUR in the BNRAS system.

### 3.3.1 The Effect of Different Configurations on COD Balance and Removal

For each Configuration i.e. 1, 2, 3, and 4, the average COD mass balance and removal performance shown in Table 3.5 were calculated from the sewage batch means fed to system during each configuration The initial BNRAS system (configuration 1)had a reasonable COD mass balance of 90 % and a COD removal of 94 %. As can be seen in Table 3.5 and Figure 3.5, sewage batches 2 and 3 are characteristic of a high COD concentration in the waste flow which accounts for the good COD mass balance and COD removal in Configuration 1. These results are similar to the results of Hu *et al.* (1999), who conducted investigations into external nitrification in BNRAS systems with small aerobic mass fractions i.e. Configuration 1. Hu *et al.* (1999) obtained a COD balance of 89% and a COD removal of 92% in the BNRAS system shown in Figure 3.1 and design and operating parameters listed in Table 3.1, Configuration 1.

With a significant number of changes as well as the ongoing problems with *Psychoda* infestations causing poor nitrification and sludge spillages, the Configuration 2 yielded an 80 % COD mass balance. Examining the UCT system results (Appendices D and E), it can be see in Figure E2 that initially a good COD mass balance was obtained in the UCT system but as the investigation progressed poorer COD mass balances was obtained due to frequent sludge spillages. The average COD mass balance for the UCT system was also 80%. Thus the poor performance of the external nitrification system at this stage in the investigation was not due to the system characteristics but due to general system operational problems perhaps caused by the influent wastewater characteristics.

The Configuration 3 showed some improvement with the COD balance increasing to an average of 91 % mainly due to less frequent sludge spillages. However, while the system showed improvement in the COD balance, the system was still experiencing the same problem as Configuration 2 i.e. low external nitrification, but due to the larger aerobic mass fraction Configuration 3 had high internal nitrification (in the main aerobic reactor). However, the impact of this on the BEPR was not too large due to the a 1:1 a-recycle ratio from the aerobic to the anoxic reactor and the reduced nitrate dose to the anoxic reactor.

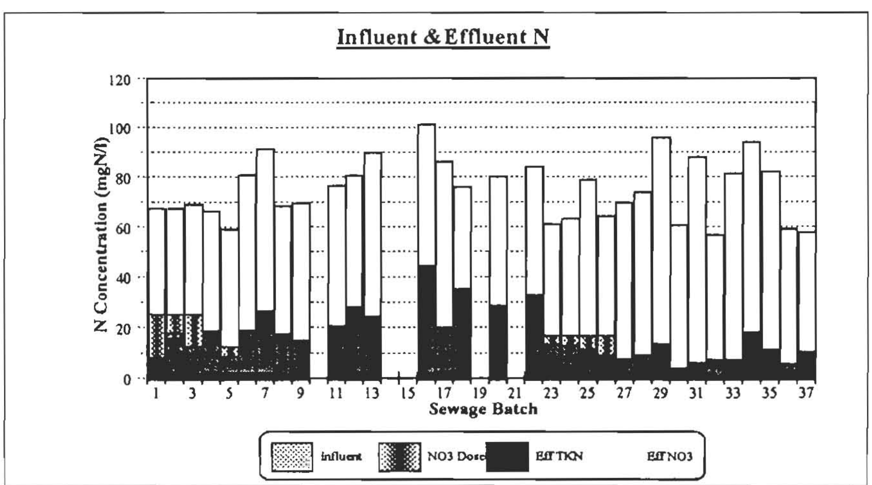
Configuration 4 showed a marked decrease in COD balance to 80%, again the result of frequent ( 2/3 per week) sludge spillages. However, the internal nitrification (in the main aerobic reactor) was reduced due to the replacement of the stone column external nitrification system with a suspended medium activated sludge system with resultant improved external nitrification performance.

## 3.4 NITROGEN REMOVAL AND MASS BALANCE PERFORMANCE

### 3.4.1 Influent and Effluent Nitrogen Concentrations

For the 37 sewage batches, the nitrogen components in the influent and effluent flows are shown in Figure 3.7 below. It can be seen that the influent TKN concentration varied between 56 and 101 mgN/l and the dosed nitrate concentration between 0 and 25 mg $NO_3$-N/l influent. This yielded a range of influent TKN/COD ratios between 0.06 to 0.17 mgN/mgCOD for this investigation. This influent TKN/COD range is wide and embraces most raw and settled wastewaters and demonstrates that the system is robust and well suited to unfavorable influent TKN/COD ratios while still ensuring (i) good BEPR and (ii) a low effluent N concentration. Indeed, the system requires high influent TKN/COD ratios to ensure a sufficiently high nitrate load on the main anoxic reactor to stimulate anoxic P uptake (see Section 3.5 below). From Figure 3.7 it can be seen that the N removal performance varied substantially over the investigation period. The effluent nitrogen concentration (TKN + $NO_2$ + $NO_3$) varied between 8 and 47 mgN/l with an average of 23 mg/l. This translates to a N removal performance which varied between 36 and 89 % and an average of 72%. The low 36% removal occurred in sewage batch 16and is result of the lag in the recovery of the system to the toxic sewage feed in batches 14 and 15. The overall low N removal performance was due to the generally poor external nitrification performance, discussed in Section 3.4.3 below.

**Figure 3.7:** Average sewage batch influent and effluent nitrogen concentrations.



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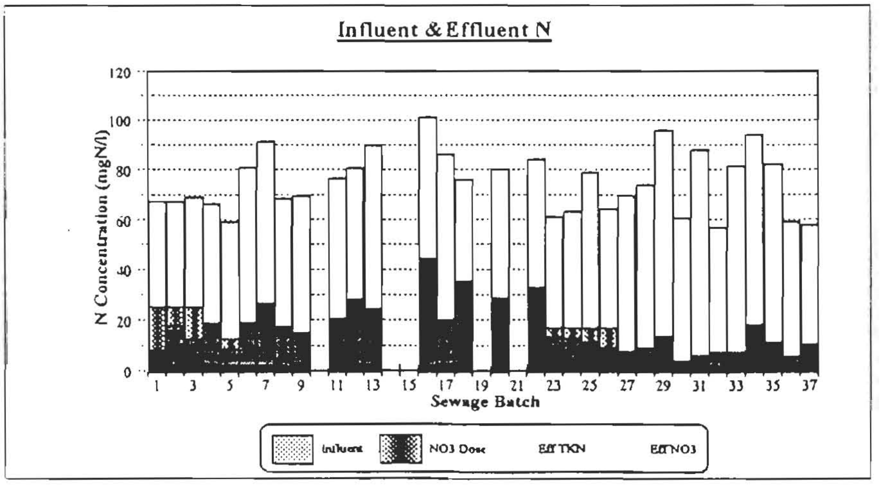

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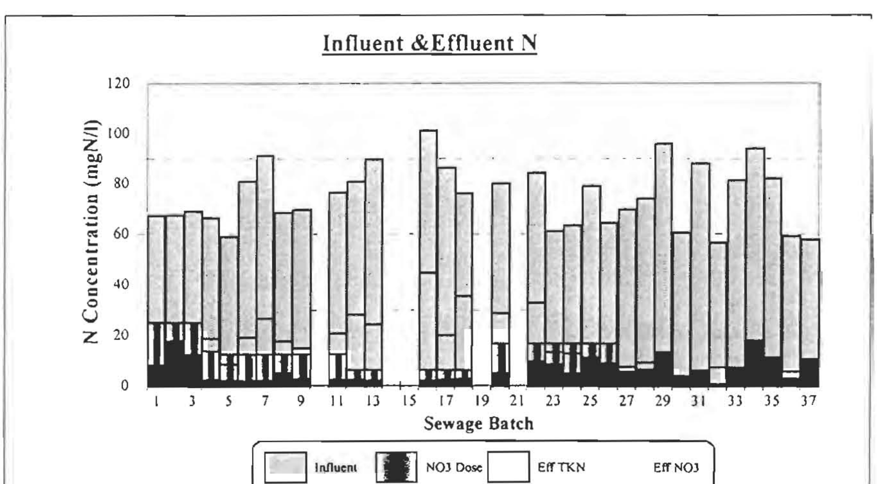


### 3.4.2 Nitrogen Mass Balance

Similarly to the COD mass balance, Nitrogen mass balances (for details see Appendix B) were performed on the system for the 32 sewage batches analyzed. Again, the averages of the measured parameters of each of the sewage batches as well as the averages for the 4 different system configurations calculated as averages of the sewage batches are listed in Appendix C.

In the Nitrogen balance, the Nitrogen entering the system via the influent flow and nitrate dose is reconciled with the Nitrogen leaving the system via the (i) the final TKN and $NO_x$ ($NO_2$ +$NO_3$) in the effluent flow (ii) N in the sludge wasted (iii) nitrate and nitrite denitrified and (iv) N removed in the external nitrification system. The N mass balance was calculated by separate determination of the net production or reduction of nitrate and nitrite in each reactor and each settling tank by means of a reactor nitrite and nitrate mass balance. This was done by subtracting the mass of nitrate or nitrite entering the reactor from that leaving the reactor, so that a negative value indicates a net reduction (i.e. denitrification) and a positive value indicates net production (i.e. nitrification). Details of the mass balance calculation procedure are given in Appendix B. The reliability of the experimental data is directly proportional to the mass balance deviation from 100%. This implies that the closer the N balance to 100 % the more reliable the data. The results of the Nitrogen mass balance and its components are given in Table 3.6 and are shown plotted in Figures 3.8 and 3.9 respectively.

**Figure 3.8:** Nitrogen mass balance for BNRAS system for 37 sewage batches

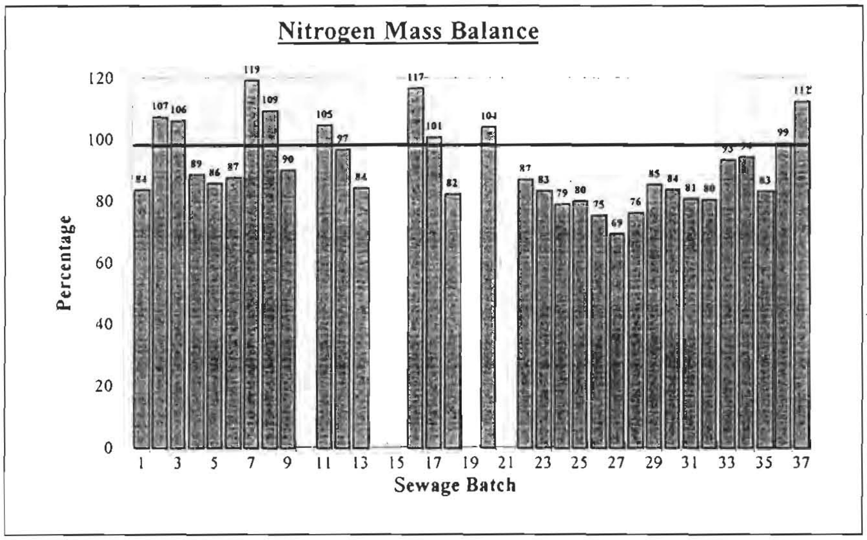
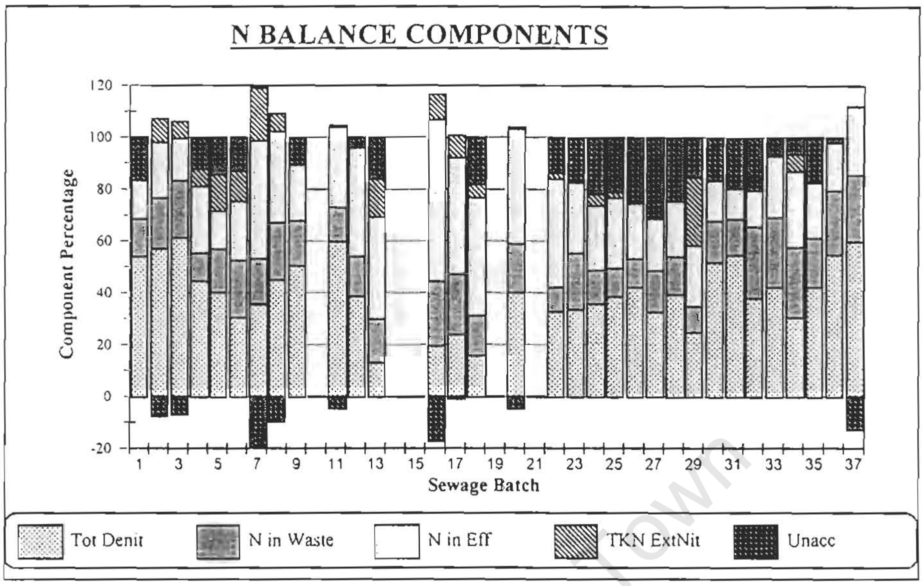


**Figure 3.9:** Nitrogen mass balance components of BNRAS for 37 sewage batches




In Figure 3.8 (and Table 3.6) it can be seen that the average N mass balance over the entire investigation period was 91 %. Although lower than 100 %, this value is similar to N mass balances in other investigations with nutrient removal systems namely Pilson *et al.* (1995) 99 % and 94 %, Sneyders *et al.* (1998) 88 % and 90 % and Hu *et al.* (1999) 86 %.

From Figure 3.9 it can be seen that in the investigation overall, the largest contribution the N balance is made by the nitrate and nitrite denitrified in the main and pre-anoxic reactors of 38%. The reason for such a high denitrification N removal is the large main anoxic reactor volume and the dosing of nitrate during the investigation in order to realize this reactors full denitrification potential. The next largest contribution to the N balance is the N that leaves the system via the final effluent (30%) of which 25 % is TKN and 5% nitrate. The high N in the effluent is as a result of the poor nitrification performance of the stone column external nitrification system because of the 25% TKN, 80% is FSA (20% of influent N) and 20% Organic N (5% of influent). Unlike in the COD balance where the largest fraction of COD leaves the system in the wasted sludge, the nitrogen in the wasted sludge only accounts for 18% of the N leaving the system. Of this, 15% is TKN and 3% nitrate. Finally, 5% of the influent N was removed in the external nitrification system leaving 9% unaccounted for.

**Table 3.6:** Components of Nitrogen mass balance

| Average of Batch | Total Denitrification mgN/d | N in Waste mgN/d | N in Effluent mgN/d | TKN ExtNit mgN/d | Total TKN Out mgN/d | Inf TKN mgN/d | Nitrate dose mgN/d | MB % | N Removal % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1000 | 279 | 262 | 0 | 1541 | 1345 | 500 | 84 | 91 |
| 2 | 1061 | 361 | 397 | 162 | 1982 | 1349 | 500 | 107 | 97 |
| 3 | 1161 | 408 | 312 | 111 | 1992 | 1378 | 500 | 106 | 95 |
| **Config 1** | **1074** | **349** | **324** | **91** | **1838** | **1357** | **500** | **99** | **95** |
| 4 | 1450 | 341 | 833 | 214 | 2837 | 2704 | 500 | 89 | 72 |
| 5 | 1160 | 478 | 425 | 385 | 2448 | 2356 | 500 | 86 | 85 |
| 6 | 1162 | 821 | 838 | 448 | 3268 | 3237 | 500 | 87 | 76 |
| 7 | 1501 | 734 | 1865 | 835 | 4935 | 3646 | 500 | 119 | 49 |
| 8 | 1360 | 642 | 1050 | 182 | 3233 | 2461 | 500 | 109 | 66 |
| 9 | 1665 | 572 | 714 | 0 | 2951 | 2781 | 500 | 90 | 78 |
| 11 | 2153 | 458 | 1108 | 0 | 3720 | 3058 | 500 | 105 | 67 |
| 12 | 1364 | 533 | 1465 | 0 | 3362 | 3231 | 250 | 97 | 55 |
| 13 | 510 | 644 | 1538 | 536 | 3228 | 3584 | 250 | 84 | 59 |
| 16 | 579 | 746 | 1844 | 265 | 3435 | 2697 | 250 | 117 | 34 |
| 17 | 725 | 714 | 1358 | 234 | 3031 | 2759 | 250 | 101 | 53 |
| 18 | 528 | 518 | 1499 | 158 | 2704 | 3043 | 250 | 82 | 53 |
| 20 | 1177 | 557 | 1280 | 0 | 3015 | 2402 | 500 | 104 | 52 |
| **Config 2** | **1180** | **600** | **1212** | **271** | **3263** | **2959** | **400** | **97** | **61** |
| 22 | 1017 | 275 | 1260 | 75 | 2628 | 2528 | 500 | 87 | 61 |
| 23 | 797 | 502 | 641 | 0 | 1940 | 1834 | 500 | 83 | 78 |
| 24 | 862 | 325 | 604 | 97 | 1888 | 1898 | 500 | 79 | 76 |
| 25 | 111 | 325 | 778 | 70 | 2287 | 2367 | 500 | 80 | 81 |
| **Config 3** | **947** | **357** | **821** | **61** | **2185** | **2157** | **500** | **82** | **57** |
| 26 | 1042 | 266 | 518 | 0 | 1825 | 1929 | 500 | 75 | 86 |
| 27 | 701 | 335 | 410 | 0 | 1446 | 2091 | - | 69 | 89 |
| 28 | 882 | 882 | 323 | 482 | 1686 | 2221 | - | 76 | 88 |
| 29 | 718 | 303 | 677 | 754 | 2452 | 2876 | - | 85 | 91 |
| 30 | 949 | 297 | 272 | 0 | 1518 | 1817 | - | 84 | 92 |
| 31 | 1464 | 362 | 300 | 0 | 2126 | 2640 | - | 81 | 96 |
| 32 | 648 | 478 | 239 | 0 | 1365 | 1699 | - | 80 | 87 |
| 33 | 1047 | 665 | 651 | 0 | 2273 | 2438 | - | 93 | 86 |
| 34 | 875 | 763 | 838 | 180 | 2657 | 2851 | - | 94 | 89 |
| 35 | 1061 | 467 | 514 | 0 | 2042 | 2462 | - | 83 | 93 |
| 36 | 982 | 439 | 327 | 0 | 1748 | 1772 | - | 99 | 86 |
| 37 | 1039 | 450 | 453 | 0 | 1942 | 1729 | - | 112 | 86 |
| **Config 4** | **951** | **429** | **466** | **78** | **1923** | **2208** | **42** | **86** | **88** |
| **Overall** | **1055** | **481** | **802** | **147** | **2484** | **2257** | **443** | **91** | **75** |

### 3.4.3 The Effect of Different Configurations on Nitrogen Balance

Configuration 1 had an excellent average nitrogen mass balance of 99 %. With the significant number of changes as well as a number of ongoing problems, Configuration 2 yielded a 97 % N mass balance. This high value is unusual as the second configuration was beset with sludge spillages, as well as *Psychoda* infestation, which generally had a significant adverse affect on the COD mass balance of the system. It also should be noted that Configuration 2 was the period in which the greatest percentage of nitrogen could not be accounted for, as shown in Figure 3.9. The negative values plotted for the unaccounted nitrogen implies a N mass balance of greater than 100%, which increased the average value of the nitrogen mass balance over this period. From Figure E5[4], it can be seen that a good N mass balance was also obtained in the UCT system at this stage in the investigation i.e. days 4 to 161. It can also be seen in Figure E5 that sewage batches 14,15,16 and 19 had extremely high N mass balances due to the poor influent wastewater characteristics and were omitted in the average N mass balance calculation. The average N mass balance for the UCT system was 99%.

Configuration 3 showed a decline in the nitrogen balance to an average of 82 %. This decrease in the nitrogen mass balance was due to the system still experiencing sludge spillage problems and low external nitrification. The reasons for the poor external nitrification performance were the persistent *Psychoda* infestation in the stone column and the high flow rate through the stone column placing the nitrification process under considerable strain leading to significantly reduced nitrification efficiency in the stone column, which in turn reduced the denitrification in the main anoxic reactor. The problem of poor external nitrification was overcome by increasing the nitrate dose from 8.3 $mgNO_3$-N/l to 16.6 $mgNO_3$-N/l influent to the anoxic reactor.

The *Psychoda* infestation and the frequent sludge spillages did not allow the system to reach steady state with respect to nitrification and denitrification and this is evident in Figure 3.10, where it can be seen that from sewage batches 13 to 25 the nitrification and consequently denitrification were the poorest recorded in the investigation. With the change from a fixed

[4] During the same time as this investigation, a control conventional UCT system was operated in parallel receiving the same sewage batches (and numbered identically) as the external nitrification system of this investigation. The results of the external nitrification system are compared with this UCT system. The day to day data of this UCT system are given in Appendix D and the systems operating and design parameters and data evaluation in Appendix E.

media external nitrification system to a suspended external activated sludge nitrification system the problem of *Psychoda* infestation was overcome and Configuration 4 (sewage batches 26 to 37) showed an increase in the nitrogen mass balance to 86%. This system also showed a significant improvement in external nitrification and improved internal denitrification (Fig 3.10).

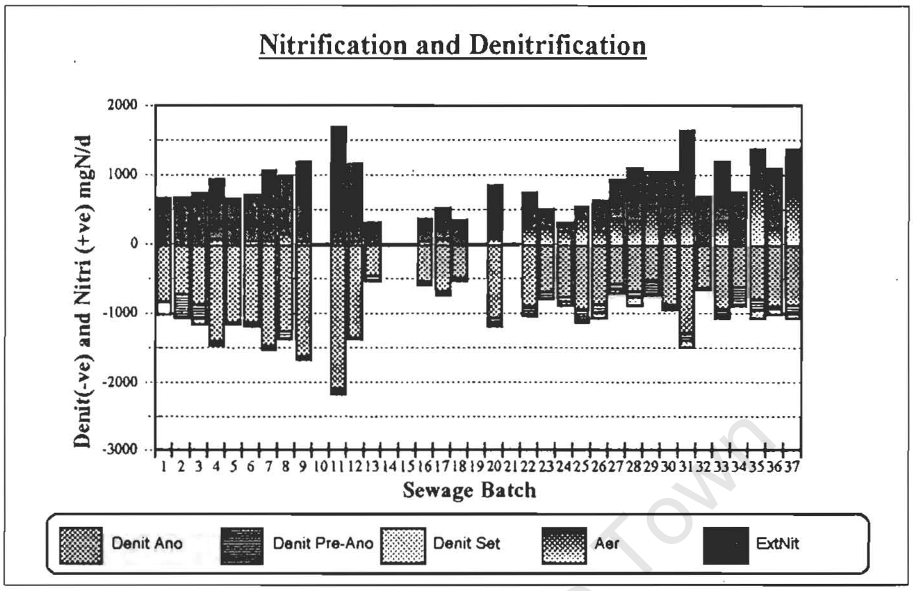
### 3.4.4 Nitrification

In this system, nitrification was achieved externally in the external fixed media/suspended nitrification system. The BNRAS effluent free and saline ammonia (FSA) was thus controlled by (i) the flow to the external nitrifier and (ii) the efficiency of the external nitrification system. This can be seen in Table 3.7 and Figure 3.10, which gives the nitrate + nitrite ($NO_x$) mass balance results over the aerobic, main and pre-anoxic reactors as well as the external nitrification system. In the investigation overall, 73% of the nitrate generated was produced by the external nitrification system while 27% was produced by nitrification of the residual ammonia in the aerobic reactor. Pumping an average of only 76% of the anaerobic overflow to the external nitrification system meant that at best nitrification could be 76% complete if the external nitrification systems FSA concentration was zero. On the measured results, the average nitrification efficiency was 51% i.e. the 73% nitrate generated in the external nitrification system was as a result of a nitrification efficiency of only 51% by the external nitrification system. An average N mass of 147 mgN/d (4.9 mgN/l at 30 l/d influent flow) was removed in the external nitrifier for 'biofilm' growth. However, this average value may not be representative of the N requirement for biofilm growth since it includes Configuration 2 where the average N removed is 261 mg/d and coincides with the period when the larvae infestation was at its worst. The N removal in the external nitrifier of Configurations 1, 3 and 4 were 91, 61 and 78 mgN/d respectively. From this it can be deduced that a far lower N requirement is needed for biofilm growth and maintenance than the 147 mgN/l average value, because in only 17 of the 32 sewage batches was a N removal observed across the external nitrifier.

**Table 3.7:** Nitrate and Nitrite mass balances across each reactor and settler.

| Average of Sewage Batch | Nitrification ($mgNO_3$-N)/d) | | Denitrification ($mgNO_3$-N)/d) | | | |
|---|---|---|---|---|---|---|
| | Main Aerobic | Ext Nitrifier | Main Anoxic | Pre-Anoxic | Anaerobic | Final Settler |
| 1 | | 667 | -838 | -153 | -9 | |
| 2 | | 673 | -726 | -316 | -19 | |
| 3 | | 738 | -869 | -212 | -21 | -60 |
| **Config 1** | **0** | **693** | **-811** | **-227** | **-16** | **-20** |
| 4 | 73 | 860 | -1401 | -39 | | |
| 5 | | 652 | -1124 | -37 | | |
| 6 | 61 | 651 | 1128 | -34 | | |
| 7 | 60 | 1004 | -1463 | -26 | | -12 |
| 8 | 184 | 803 | -1259 | -97 | | -4 |
| 9 | 52 | 1133 | -1615 | -50 | | |
| 11 | 44 | 1650 | -2089 | -43 | | -21 |
| 12 | 44 | 1119 | -1351 | -8 | | -5 |
| 13 | 24 | 283 | -470 | -39 | | |
| 16 | 59 | 309 | -539 | -24 | | -16 |
| 17 | 69 | 452 | -868 | -31 | | -8 |
| 18 | 34 | 309 | -493 | -35 | | |
| 20 | 91 | 748 | -1076 | -65 | | |
| **Config 2** | **66** | **767** | **-1135** | **-39** | | **-7** |
| 22 | 222 | 515 | -900 | -114 | -3 | |
| 23 | 268 | 232 | -687 | -110 | | |
| 24 | 195 | 116 | -773 | -71 | | -18 |
| 25 | 413 | 124 | -940 | -166 | | -8 |
| **Config 3** | **275** | **247** | **-825** | **-115** | -3 | -9 |
| 26 | 211 | 414 | -883 | -115 | | -44 |
| 27 | 396 | 534 | -579 | -80 | | -42 |
| 28 | 356 | 744 | -688 | -88 | | -105 |
| 29 | 570 | 479 | -521 | -196 | | |
| 30 | 274 | 767 | -872 | -58 | | -19 |
| 31 | 550 | 1090 | -1293 | -99 | | -72 |
| 32 | 16 | 670 | -628 | -6 | | -14 |
| 33 | 366 | 825 | -936 | -111 | | |
| 34 | | 749 | 627 | -248 | | |
| 35 | 901 | 472 | -788 | -166 | | -107 |
| 36 | 262 | 833 | -896 | -42 | | -44 |
| 37 | 790 | 586 | -889 | -122 | | -28 |
| **Config 4** | **443** | **680** | **-800** | **-111** | | **40** |
| **Overall** | **244** | **663** | **-938** | **-94** | -3 | **22** |

**Figure 3.10 :** Nitrification and Denitrification in the BNRAS system (nitrification is plotted as +ve and denitrification as -ve)




### 3.4.5 Denitrification

The calculation of the denitrification potential for the completely mixed anoxic reactor is not possible unless the anoxic reactor receives a nitrate load greater than its denitrification potential i.e. only when the anoxic reactor is overloaded and nitrate and/or nitrite ( i.e. >1mg$NO_3$-N/l) flows out of the anoxic reactor. Under this circumstance, the denitrification performance is equal to its denitrification potential i.e. the maximum nitrate/nitrite load that can be denitrified. If the anoxic reactor is under-loaded (i.e. < 1mg$NO_3$-N/l), then negligible quantities of $NO_3$ will leave this reactor and although the denitrification performance can be calculated, this would be less than the denitrification potential. The $NO_3$ concentrations exiting the anoxic reactors of the external nitrification system and UCT control systems were at times greater than 1mg$NO_3$-N/l and therefore allowed the denitrification potential and hence the specific denitrification rate, $K_2'$, to be calculated. In this investigation the nitrate reduction rate and the nitrate denitrification rate are considered to be equal because nitrite was not observed at significantly high concentrations as to effect major differences in the two above mentioned rates. The difference between nitrate reduction rate and nitrate denitrification rate is that in the former, the product is nitrite i.e. ionic and with the latter the product is $N_2$ i.e. gaseous. Nitrate reduction is therefore regarded as the rate of disappearance of nitrate from the mixed liquor while accepting only two electrons to form nitrite. Nitrate denitrification is the rate of nitrate disappearance from the mixed liquor whilst accepting five electrons to form $N_2$ gas.

Stern and Marais (1974) found that when the nitrate versus time slopes [$mgNO_3$-N/(l.d)] were divided by the VSS concentration to obtain specific denitrification rates [$mgNO_3$-N/(mgVSS.d)], a decrease in the rate was observed as sludge age increased. When however, the slopes were divided by the Active VSS concentration, they were found to be independent of sludge age (i.e. $mgNO_3$-N/(mgAVSS.d)). They concluded that this was because the Active VSS relates the biological rate of denitrification to the particular component of the VSS mass that is responsible for this rate. This approach has been found to work reasonably well for N removal plants, because from a modeling perspective, the active mass (AVSS) comprises only one heterotrophic organism group i.e. "ordinary" heterotrophic organisms (OHOs) (Ekama and Wentzel, 1999). However, for N and P removal plants, the active heterotrophic organism mass comprises two distinct active heterotrophic organism groups namely, (1) the OHOs mentioned above and (2) the polyphosphate accumulating organisms (PAOs) which effect the biological excess P removal.

In earlier research on biological N and P removal systems, the PAO group was observed not to contribute significantly to denitrification and most of the P uptake was confined to the aerobic reactor (Wentzel *et al.*,1990; Ekama and Wentzel, 1999). However, over the past 5 years significant P uptake has been observed indicating that under these conditions the PAOs may be contributing to the denitrification in the anoxic reactor (Kerrn-Jesspersen and Henze, 1993; Kuba *et al.,* 1993). Also significant P uptake has been observed in external nitrification systems by Sorm *et al.* (1996) and Hu *et al.* (1999). Sorm *et al.* (1996) found from anoxic batch tests of an external nitrification BNRAS system that P uptake with simultaneous denitrification occurred and they concluded that the observed $NO_3$-N reduction could also include a contribution by the OHO denitrifiers. However, they observed that the phosphate uptake ceased when $NO_3$-N was reduced to zero in the mixed liquor. This behaviour is expected because when nitrate is no longer available as an electron acceptor utilization of internally stored PHB by the PAOs can no longer continue, resulting in a cessation of P uptake by them.

For this investigation it was decided that, because the PAOs do participate in the denitrification process when anoxic P uptake takes place, the OHO and PAO contribution to the denitrification in the anoxic reactor should be separated in the same manner so that, the appropriate nitrate removal rates due to the OHO mass could be specified in terms of only the OHO mass i.e. due cognizance must be taken of the contribution of the PAOs to the nitrate removal rate. To do this, the measured nitrate removal rate (i.e. denitrification potential) was adjusted by an amount which was speculated to be the contribution by the denitrifying PAOs. The adjustment was made by reducing the measured nitrate removal rate by the product of the observed anoxic P uptake (expressed as a percentage of the total P uptake) and the nitrate equivalent of the COD sequestered[5] by the PAOs. This manipulation of the nitrate removal rate assumes that; (1) the stoichiometry and metabolic processes of the PAOs are the same under both aerobic and anoxic conditions and (2) the percentage anoxic P uptake is directly proportional to the denitrification performance of the PAOs i.e. all the PAOs responsible for anoxic P uptake are also responsible for the contribution made to the nitrate removal. This adjustment was necessary in order to compare previously observed denitrification rates (i.e. $K_2'$) in NDBEPR systems in which the P uptake took place under aerobic conditions only (i.e. $K'_2$ rate due to OHOs only). The adjusted denitrification rate ($K_2''$) can therefore be specified in terms of only the active ordinary heterotrophic mass [i.e mgNO3-N/(mgOHOAVSS.d)]. The denitrification rate ($K_2'$) without adjustment was also calculated to be able to compare the $K_2'$ rates with those reported by Ekama and Wentzel (1999), who did not make this adjustment to the nitrate removal rate. The nitrate removal rate, adjusted for PAO activity or not, is divided by the mass of VSS (mgVSS) in the system divided by the influent flow ($Q_i$, l/d) i.e mgVSS/l influent and the OHO active fraction of the VSS mass $f_{av,OHO}$ where the $f_{av,OHO}$ is calculated from the BEPR model of Wentzel *et al.*, (1990) viz:-

$$K_2' or K_2'' = \frac{D_p - f_{PAOs} * (\% AnoP_{up} * S_{seq} / 8.6)}{(X_v . f_{av,OHO} . f_{x1})} \qquad \text{mgNO}_3\text{-N/(mgAVSS.l inf)} \qquad (3.1)$$

| | | |
|---|---|---|
| where: $D_p$ | = | Denitrification potential (measured) mgN/l influent |
| $f_{PAOs}$ | = | 1 when denitrification by PAOs is considered ($K_2''$) and |
| $f_{PAOs}$ | = | 0 when denitrification by PAOs is ignored ($K_2'$) |
| $\%AnoP_{up}$ | = | Percentage Anoxic P uptake |
| $S_{seq}$ | = | COD sequestered by PAOs mgCOD/l influent |
| $X_v$ | = | VSS mass in system per l influent |
| $f_{av,OHO}$ | = | OHO fraction of VSS mass (see Section 3.5.3.1 below for calculation method |
| $f_{x1}$ | = | Anoxic sludge mass fraction |

[5] The COD sequestered by the poly-P organisms is calculated using the model of Wentzel *et al.*, (1990)

| | | |
|---|---|---|
| 8.6[6] | = | mgCOD utilized per mgNO3-N denitrified. |
| | = | $(1-f_{cv}Y_h)/2.86$ where |
| 2.86 | = | oxygen equivalent of nitrate as electron acceptor |

Using Equation (3.1) and substituting the appropriate sewage batch average values of the measured parameters, the denitrification rates were calculated for the sewage batches in which the nitrate concentrations leaving the main anoxic reactor were greater than 1mg$NO_3$-N/l. The denitrification rates are shown listed in Table 3.8 below.

**Table 3.8** Calculated denitrification rates for sewage batches with > 1mgNO3-N/l in the main anoxic reactor outflow.

| Sewage Batch | Dp mg$NO_3$-N/l | %Ano P up | Seq mgCOD/l | D'p mg$NO_3$-N/l | fx1 | $Xa_{OHO}$ mgAVSS/l | $K_2'$ mg$NO_3$-N/mgOHOAVSS | $K_2''_{OHO}$ | $Xa_{PAO}$ mgAVSS/l | $K_2''_{PAO}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 42 | 0.64 | 64 | 37 | 0.50 | 751 | 0.1115 | 0.0987 | 207 | 0.0465 |
| 2 | 36 | 0.65 | 59 | 32 | 0.50 | 475 | 0.1528 | 0.1339 | 191 | 0.0471 |
| 3 | 43 | 0.78 | 56 | 38 | 0.50 | 612 | 0.1419 | 0.1252 | 181 | 0.0563 |
| 8 | 31 | 0.50 | 78 | 27 | 0.45 | 553 | 0.1265 | 0.1083 | 212 | 0.0475 |
| 11 | 52 | 0.31 | 84 | 49 | 0.45 | 583 | 0.1992 | 0.1877 | 230 | 0.0291 |
| 12 | 34 | 0.62 | 69 | 29 | 0.45 | 520 | 0.1445 | 0.1233 | 187 | 0.0587 |
| 13 | 12 | 0.35 | 83 | 8 | 0.45 | 537 | 0.0486 | 0.0347 | 226 | 0.0331 |
| 18 | 12 | 0.31 | 60 | 10 | 0.45 | 595 | 0.0460 | 0.0379 | 193 | 0.0252 |
| 20 | 36 | 0.43 | 77 | 32 | 0.30 | 536 | 0.2230 | 0.1989 | 248 | 0.0522 |
| 22 | 30 | 0.35 | 38 | 28 | 0.30 | 358 | 0.2793 | 0.2647 | 123 | 0.0427 |
| 23 | 23 | 0.20 | 65 | 21 | 0.30 | 589 | 0.1296 | 0.1212 | 208 | 0.0238 |
| 25 | 31 | 0.60 | 52 | 28 | 0.30 | 466 | 0.2240 | 0.1983 | 166 | 0.0720 |
| 26 | 29 | 0.46 | 60 | 26 | 0.30 | 744 | 0.1318 | 0.1173 | 193 | 0.0557 |
| 27 | 19 | 0.29 | 56 | 17 | 0.30 | 810 | 0.0795 | 0.0717 | 179 | 0.0350 |
| 28 | 23 | 0.37 | 43 | 21 | 0.30 | 657 | 0.1163 | 0.1069 | 139 | 0.0446 |
| 29 | 17 | 0.50 | 78 | 13 | 0.30 | 636 | 0.0911 | 0.0675 | 249 | 0.0603 |
| 31 | 43 | 0.46 | 104 | 38 | 0.30 | 885 | 0.1623 | 0.1414 | 333 | 0.0555 |
| 33 | 31 | 0.49 | 84 | 26 | 0.30 | 732 | 0.1421 | 0.1203 | 270 | 0.0591 |
| 34 | 21 | 0.62 | 91 | 14 | 0.30 | 868 | 0.0803 | 0.0550 | 292 | 0.0753 |
| 35 | 26 | 0.57 | 81 | 21 | 0.30 | 691 | 0.1267 | 0.1006 | 261 | 0.0691 |
| **Average 1** | **41** | **0.69** | **60** | **36** | **0.50** | **613** | **0.1354** | **0.1193** | **193** | **0.0499** |
| Averages above are for sewage batches 1 to 3 i.e. Configuration 1 | | | | | | | | | | |
| **Average 2** | **28** | **0.45** | **64** | **25** | **0.45** | **544.81** | **0.1130** | **0.0984** | **178** | **0.0387** |
| Averages above are for sewage batches 4 to 19 i.e. Configuration 2 | | | | | | | | | | |
| **Average 3** | **27** | **0.43** | **64** | **24** | **0.30** | **536.89** | **0.2110** | **0.1947** | **205** | **0.0461** |
| Averages above are for sewage batches 22 to 25 i.e. Configuration 3 | | | | | | | | | | |
| **Average 4** | **27** | **0.43** | **76** | **22** | **0.30** | **729.55** | **0.1163** | **0.0976** | **245** | **0.0568** |
| Averages above are for sewage batches 26 to 37 i.e. Configuration 4 | | | | | | | | | | |
| **Average 5** | **29** | **0.46** | **68** | **25** | **0.38** | **611.85** | **0.1379** | **0.1207** | **208** | **0.0494** |
| Averages above are for sewage batches 1 to 37 i.e. average over entire investigation. | | | | | | | | | | |



[6]It is recognized that the bioenergetics of aerobic metabolism is not the same as anoxic metabolism because under aerobic conditions the organisms obtain 3 moles ATP per e⁻ equivalent whereas under anoxic conditions they obtain only 2 ATP per e⁻ equivalent (Payne, 1981). This changes the $Y_H$ coefficient from a theoretical 0.42 mgVSS/mgCOD for aerobic conditions to 0.35 mgVSS/mgCOD for anoxic conditions i.e. 83% of the aerobic value. Accepting the $Y_H$ = 0.45 mgVSS/mgCOD, the COD/VSS ratio ($f_{cv}$) as 1.48 mgCOD/mgVSS and the same reduction in yield makes the COD utilized per mgNO3-N denitrified 6.4 under anoxic conditions compared to 8.6 mgCOD/mg NO3-N under aerobic conditions.

**Table 3.9** Comparison of anoxic denitrification rates $K_2'$ at 20°C obtained by Clayton *et al.* (1989), Musvoto *et al.* (1992), Pilson *et al.* (1995) and Sneyders *et al.* (1998) with those obtained in this investigation.

| System | Nitrate Denitrification Rate $K_2'$ | | | $f_{S,up}$ | Active |
|---|---|---|---|---|---|
| | Mean | Max | Min | | $(f_{av,OHO})$ |
| Clayton (1989) | 0.255 | - | - | 0.150 | 0.210 |
| Musvoto (1992) | 0.335 | 0.517 | 0.193 | 0.287 | 0.130 |
| Pilson (1995) | 0.181 | 0.300 | 0.111 | 0.111 | 0.327 |
| Mellin (1995) | 0.254 | 0.410 | 0.150 | 0.140 | 2.880 |
| Sneyders CTL (1998) | 0.071 | 0.088 | 0.050 | 0.062 | 0.435 |
| Without adjustment ($K_2'$) | 0.138 | 0.274 | 0.046 | 0.115 | 0.497 |
| With adjustment ($K_2''$) | 0.121 | 0.265 | 0.035 | 0.115 | 0.497 |

Table 3.9 shows a comparison between the denitrification rates ($K_2'$) observed in this investigation with those obtained by other researches also using NDBEPR laboratory scale activated sludge systems. In Table 3.9, the denitrification rate *without* adjustment is directly comparable to the rates obtained in earlier investigations because the calculation method is the same. It can be seen that the denitrification rates ($K_2'$) obtained in this study are above those obtained by Sneyders *et al.* (1998) and below those obtained by Clayton *et al.* (1989), Musvoto *et al.* (1992), Pilson *et al.* (1995) and Mellin *et al.*, (1995). This is the consequence of the high active fraction of the OHOs ($f_{av,OHO}$) which is used to calculate the denitrification rate, which in turn is a consequence of the very low $f_{S,up}$ value.

In comparing the $K_2'$ rates obtained in the different investigations, Mellin *et al.*, (1995) showed that the rates were directly proportional to the unbiodegradable particulate COD fraction ($f_{S,up}$) and inversely related to the active OHO faction of the VSS ($f_{av,OHO}$). The higher the calculated $f_{S,up}$, the lower the $f_{av,OHO}$ and the higher the $K_2'$. The $K_2'$ rates of this investigation also fit this pattern (Table 3.9) in that the $f_{S,up}$ is low, and hence the $f_{av,OHO}$ is high and the $K_2'$ rate is low. Comparing the unadjusted ($K_2'$) and adjusted ($K_2''$) rates, which gives an indication of the contribution of the PAOs to the denitrification rate, it can be seen that $K_2''$ is not much lower than $K_2'$ which indicates that the contribution of PAOs to the denitrification is not very large because the proportion of biodegradable organics utilized by them in the anoxic reactor is small compared with that utilized by the OHOs.

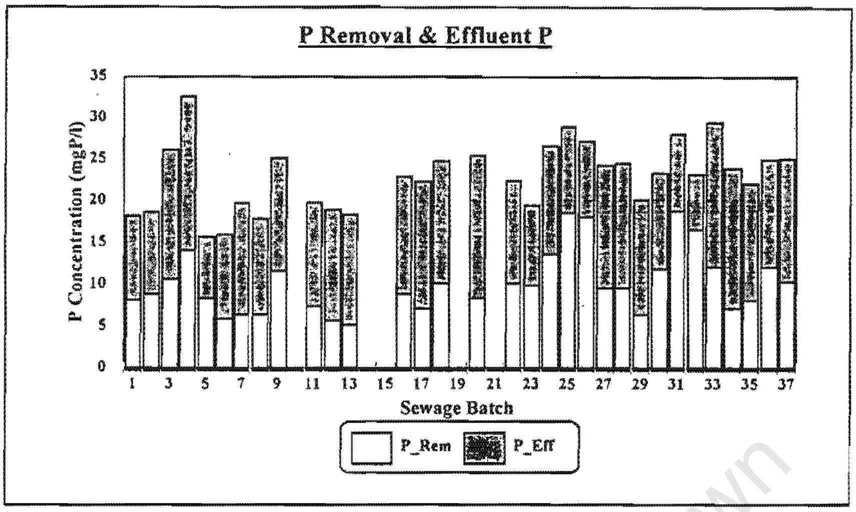
## 3.5 BIOLOGICAL EXCESS PHOSPHORUS REMOVAL (BEPR) PERFORMANCE

### 3.5.1 P Removal and Effluent P Concentrations

Another objective of this investigation was to assess the biological excess phosphorus removal (BEPR) performance of the external nitrification BNRAS system. The last column in Table 3.10 lists, for each sewage batch, the P removal of the system and is shown plotted together with the effluent P concentration in Figure 3.11, where the total height of the stacked bar represents the influent P concentration. In comparing the P removal for the two modes of P uptake i.e. aerobic or anoxic, the average P removal was 9.33, 13.28 and 11.94 mgP/l for the first, third and fourth configurations respectively, in which anoxic P uptake was dominant. The configuration 2 in which aerobic P uptake was dominant showed a lower average P removal of 8.28 mgP/l. However, it should be noted that the lower aerobic P removal period was the same period in which the external nitrification and internal denitrification were poor (see Section 3.4.3, Figure 3.10) leading to high nitrate recycle to the anaerobic reactor. From earlier investigations on BEPR in conventional BNRAS systems (see Ekama and Wentzel, 1997 for details), it was noted that when the main anoxic reactor was underloaded with nitrate, then P uptake tended to be confined/dominant in the aerobic reactor, whereas if the nitrate load exceeded the denitrification potential so that nitrate was present in the anoxic reactor outflow, significant anoxic P uptake was observed. Accordingly, nitrate was dosed directly into the main anoxic reactor from sewage batch 1 to 26 and remained between 0.5 to 1.25 mg$NO_3$-N/ml taking due cognizance to avoid nitrate overload of this reactor and hence a high nitrate recycle to the anaerobic reactor reducing the P release and hence the P removal in the BNRAS system.

The overall average P removal of the system was 10.4 mgP/l influent for the average influent COD concentration of 691 mgCOD/l. Although not very high, this value compares closely to other investigations with nutrient removal systems, namely Musvoto *et al.* (1992) 12.2 and 11.3 mgP/l for 1000 mgCOD/l influent (with significant anoxic P uptake), Pilson *et al.* (1995) 12.0 and 10.7 mg P/l for 1000 mg COD/l (with significant anoxic P uptake), Mellin *et al.* (1998) 11.4 mgP/l and 727 mdCOD/l (with significant anoxic P uptake), Sneyders *et al.* (1997) 13.1 and 16.8 mgP/l for 660 and 807 mgCOD/l (with no anoxic P uptake) all in conventional UCT type systems and ( and Hu *et al.* (1999) 8.8 mgP/l for 717 mgCOD/l in an external nitrification BNR system (with significant anoxic P uptake).

**Figure 3.11:** Average Effluent P concentration and system P removal for the 32 sewage batches.





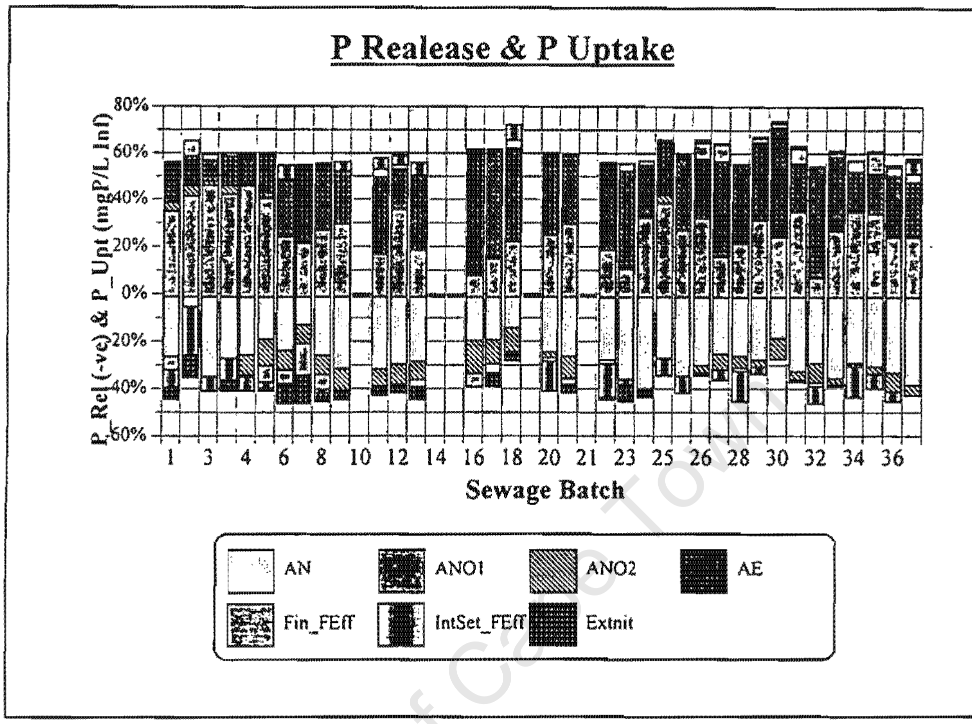

### 6.5.2 P Balance over each Reactor and Settler

From the averages of the influent, effluent and reactor concentrations for the 32 sewage batches the net P release or P uptake was calculated by conducting a TP balance (mass P in - mass P out) over each reactor and settler in the BNRAS system. A net positive TP balance indicates P uptake and a negative TP balance indicates P release. The net effect, i.e. uptake or release, for each of the reactors, the internal and final settlers and the external nitrification system for the 32 sewage batches are listed in Table 3.10 and are shown plotted in Figure 3.12. The total height of the stacked bar, either positive or negative shows the net P uptake or P release respectively of the BNRAS external nitrification system. From Figure 3.12 it can be seen that the most P release was obtained in the anaerobic (AN) reactor with an average value of 74% of the total P release of the system. This is followed by an average P release of 12% in the pre-anoxic reactor, 8% and 6% in the internal settler and external nitrification system respectively. The 8% average P release in the internal settler is probably due to leakage of some RBCOD out of the anaerobic reactor and stimulating P release in the sludge bed that forms at the bottom of the internal settling tank.

**Table 3.10:** Average P release or uptake for each reactor and settler as well as net P removal for the 32 sewage batches.

| Average of Batch | AN mg P/l | Main ANO mg P/l | Pre_ANO mg P/l | AE mg P/l | Fin_FitEff mg P/l | IntSet_FilEff mg P/l | Extnit mg P/l | P_Rem mg P/l |
|---|---|---|---|---|---|---|---|---|
| 1 | -14.57 | 19.78 | 1.97 | 9.02 | -3.01 | -4.16 | -2.43 | 8.21 |
| 2 | -1.37 | 10.65 | 1.09 | 3.05 | 1.57 | -5.13 | -2.25 | 9.11 |
| 3 | -18.68 | 24.97 | 0.95 | 4.65 | 1.55 | -2.76 | 0.00 | 10.68 |
| **Config 1** | **-11.54** | **18.47** | **1.33** | **5.57** | **0.04** | **-4.02** | **-1.56** | **9.33** |
| 4 | -19.57 | 35.56 | -6.66 | 8.71 | -0.45 | -3.60 | 1.63 | 14.32 |
| 5 | -8.18 | 17.72 | -4.86 | 8.01 | -2.97 | -1.16 | -0.11 | 8.52 |
| 6 | -9.60 | 9.88 | -3.27 | 9.82 | -2.45 | 2.32 | -2.91 | 6.11 |
| 7 | -4.74 | 7.99 | -2.93 | 12.01 | -4.91 | -0.13 | -3.77 | 6.54 |
| 8 | -12.81 | 13.77 | -4.00 | 13.69 | -3.16 | -0.71 | -1.35 | 6.50 |
| 9 | -25.03 | 24.42 | -7.40 | 17.91 | 0.00 | 2.41 | -2.44 | 11.82 |
| 11 | -13.00 | 7.32 | -3.07 | 13.17 | 1.72 | 1.64 | -1.29 | 7.52 |
| 12 | -8.37 | 10.35 | -2.45 | 4.91 | 0.62 | 0.83 | -0.86 | 5.72 |
| 13 | -9.73 | 6.70 | -2.67 | 10.76 | -1.03 | 1.72 | -1.65 | 5.42 |
| 16 | -7.40 | 3.36 | -5.34 | 19.89 | -1.81 | 0.26 | 0.00 | 8.95 |
| 17 | -5.41 | 4.46 | -2.79 | 12.71 | -1.14 | -0.31 | -1.12 | 7.30 |
| 18 | -3.10 | 4.97 | -2.24 | 8.78 | 0.86 | 1.21 | -0.72 | 10.33 |
| 20 | -12.15 | 12.89 | -1.15 | 14.08 | -0.77 | -5.74 | 2.81 | 8.52 |
| **Config 2** | **-10.70** | **12.26** | **-3.76** | **11.88** | **-1.19** | **-0.10** | **-0.91** | **8.28** |
| 22 | -21.01 | 15.04 | 0.09 | 27.38 | -1.29 | -10.91 | -0.20 | 10.33 |
| 23 | -23.14 | 7.04 | 0.06 | 27.11 | 1.50 | -1.48 | -3.89 | 10.12 |
| 24 | -35.48 | 29.49 | 0.68 | 19.38 | 0.98 | -0.60 | -2.29 | 13.87 |
| 25 | -18.39 | 26.73 | 2.38 | 10.89 | 0.18 | -4.76 | 4.58 | 18.81 |
| **Config 3** | **-24.50** | **19.57** | **0.80** | **21.19** | **0.34** | **-4.44** | **0.45** | **13.28** |
| 26 | -17.02 | 18.75 | -1.80 | 14.26 | 4.34 | -0.42 | 3.22 | 18.25 |
| 27 | -9.25 | 6.10 | -2.54 | 15.29 | 2.48 | -1.40 | -0.21 | 9.88 |
| 28 | -13.28 | 11.49 | -2.44 | 16.60 | -0.77 | -6.24 | 1.79 | 9.85 |
| 29 | -8.56 | 9.87 | -0.94 | 10.35 | 0.58 | -0.67 | -2.02 | 6.64 |
| 30 | -7.13 | 9.69 | -3.02 | 18.07 | 0.75 | 0.08 | -0.99 | 12.03 |
| 31 | -25.07 | 27.49 | -2.63 | 15.78 | 5.26 | -0.53 | -2.24 | 18.93 |
| 32 | -36.06 | 9.66 | -10.42 | 58.10 | -1.66 | -8.30 | -5.51 | 16.78 |
| 33 | -36.27 | 28.29 | -2.80 | 32.28 | 1.99 | -0.55 | -6.56 | 12.23 |
| 34 | -9.498 | 11.64 | -0.49 | 5.53 | 1.48 | -4.06 | -0.39 | 7.38 |
| 35 | -17.80 | 20.39 | -1.84 | 9.68 | 5.53 | -3.04 | -4.62 | 8.30 |
| 36 | -29.23 | 21.93 | -7.24 | 23.29 | 3.46 | -3.32 | -3.93 | 12.36 |
| 37 | -34.96 | 23.05 | -3.45 | 20.68 | 3.95 | 4.98 | -5.79 | 10.59 |
| **Config 4** | **-20.34** | **16.53** | **-3.30** | **19.99** | **2.28** | **-1.96** | **-2.27** | **11.94** |
| **Overall** | **-16.12** | **15.36** | **-2.54** | **15.49** | **0.42** | **-1.70** | **-1.42** | **10.37** |

**Figure 3.12:** Components of average P release (-ve) or P uptake (+ve) for the 32 sewage batches

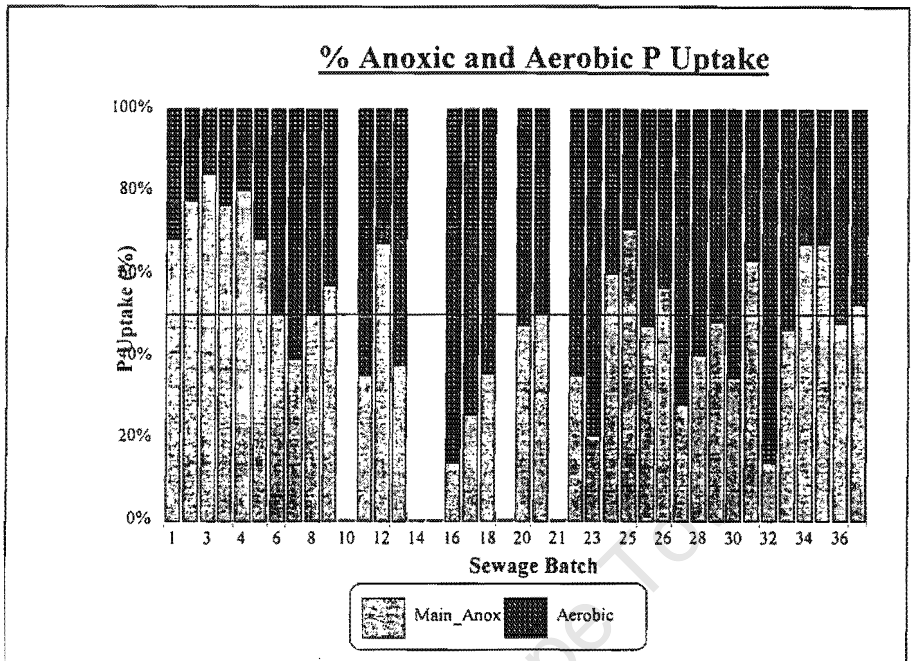



This P release in the internal settling tank is not undesirable but is actually beneficial to the BNRAS system in that it increases the P release of the system without increasing the anaerobic fraction of the system[7]. However, it should be noted that there were instances where P uptake was observed in both the internal settler and the external nitrification system, but not necessarily occurring simultaneously.

Figure 3.13. shows the anoxic/aerobic percentage P uptake relative for the 32 sewage batches. Although the anoxic P uptake reached around 60 % towards the end of the investigation (batches 25-37, Figure 3.13), the P removal had not yet stabilized and fluctuated between 6.7 to 18.9 mgP/l. From Figure 3.13 it can be noted that anoxic P uptake was 50% or greater in 18 of the 32 sewage batches i.e. during the investigation for 56% of the time P uptake in the anoxic reactor dominated. With regard to P uptake (Figure 3.13), initially (i.e. batches 1 to 5) this was achieved in the main anoxic reactor with an average P uptake of 22 mgP/l over this period.

[7]Indeed in the DEPHANOX II (Bortone *et al.*, 1997) system the first reactor is a combined anaerobic reactor -settling tank to (i) increase the anaerobic mass fraction per unit volume and (ii) reduce the cost of the internal settling tank in the system.

**Figure 3.13:** Average Anoxic/Aerobic P Uptake for the 32 sewage batches






In sewage batch 6, the P uptake was equal in the main anoxic and aerobic reactors with a value of 9.8 mgP/l. From batches 7 to 23, P uptake was predominantly achieved in the aerobic reactor with an average of 15.2 mgP/l. In batches 23 to 37, P uptake the main anoxic reactor was once again dominant in with an average value of 24 mgP/l. This variation in the P uptake process is dependent on the changes made to the system at batches 4, 22 and 26, i.e. at the time when the systems configuration was changed from Configuration 1 to Configuration 2, Configuration 2 to Configuration 3 and finally from Configuration 3 to Configuration 4. The most significant changes made to the systems were (i) doubling the influent flow, reducing the anoxic reactor volume by 1 l and reducing the sludge age from 10 days to 8 days in Configuration 2 (i.e sewage batches 4 to 20) and (ii) reducing the influent flow by 10 l/d, reducing the anoxic reactor by a further 2 l and concomitantly increasing the aerobic reactor by 2 l and increasing the sludge age from 8 days to 10 days in Configuration 3 ( i.e. sewage batches 22 to 25) and (iii) replacing the stone column with an activated sludge external nitrification system in Configuration 4 (sewage batches 26 to 37). From the changes made, the one which seemed to most influence the reactor in which P uptake took place was the nitrate load on the anoxic reactor. From sewage batches 1 to 5 and 24 to 37, anoxic P uptake was dominant whereas for sewage batches 6 to 23, aerobic

P uptake was dominant. During sewage batches 6 to 23 the nitrate load on the anoxic reactor tended to be low due to poor nitrification in the stone column external nitrification (see Section 3.4.3 above). However, other factors such as the anoxic and aerobic mass fractions may also have influenced the percentage anoxic uptake but is suspected that these are small compared with the anoxic reactor nitrate load. It would therefore appear that to maximize anoxic P uptake, it is necessary to have a nitrate load on the anoxic reactor that exceeds this reactors denitrification potential. This requires the system to have (i) excellent nitrification performance in the external nitrification system and (ii) a high influent TKN/COD ratio.

Up to sewage batch 22 the focus of the investigation was to maximize anoxic P uptake in the large anoxic mass fraction and minimize aerobic uptake in the small aerobic mass fraction BNRAS system. Knowledge of the kinetics and ideal environmental conditions for maximum anoxic P uptake is still limited. Bortone *et al.* (1997) noted that only when an aerobic zone was included in a anaerobic/anoxic sequencing batch reactor (SBR), did the system stimulate anoxic P uptake BEPR. Thus, it would appear that in order to achieve stable anoxic P uptake, an aerobic period may be essential. However, the ratio of aerobic /anoxic mass fractions was not known for optimum anoxic P uptake. In an attempt to qualify the effect of the aerobic mass fraction on anoxic P uptake, the aerobic mass fraction of Configuration 2 was increased to form Configuration 3 (see Table 3.1). Thus the focus from sewage batch 22 shifted from trying to maximize anoxic P uptake because of its (i) instability as a biological process and (ii) lower BEPR than aerobic P uptake ( according to Ekama and Wentzel, 1999 and this investigation), to exploiting aerobic P uptake BEPR in the external nitrification system and studying the effects of the increased aerobic mass fraction on the BEPR of the system. However, it was realized that the conditions that promote aerobic P uptake BEPR, and hence more stable and greater BEPR in the system, would also encourage internal nitrification, which, if the external nitrification system did not achieve efficient nitrification (> 80%), would lead to high nitrate recycle to the anaerobic reactor and consequently reduced BEPR. Thus Configuration 2 was changed to form Configuration 3 by making the main anoxic and aerobic reactors with equal volumes and thus equal mass fractions. Interestingly, anoxic P uptake still dominated the total P uptake process. As a result of the poor nitrification efficiency in the external nitrification system (see Section 3.4.4) the nitrate recycled to the anaerobic reactor in Configuration 3 due to internal nitrification (in the main aerobic reactor) decreased the BEPR to 8.8 mgP/l. From sewage batch 26, the fixed media stone column was abandoned and replaced with a suspended medium external nitrification system for Configuration 4. This change to the external nitrification system showed an improvement in external nitrification and a decline in internal nitrification and hence the nitrate recycled to the anaerobic reactor decreased, improving the BEPR of Configuration 4 to 12.4 mg/l with 60% and 34% P uptake in the main anoxic and aerobic reactors respectively.

### 3.5.3 Comparison of Measured and Calculated P removal

The BEPR performance in the BNRAS system was assessed by comparing the observed P removal with that theoretically calculated by the steady state BEPR model of Wentzel *et al.* (1990) which forms a sub-set of the UCTPHO (Wentzel *et al.*, 1992) and IAWQ ASM №2 (Henze *et al.*, 1995). In order to calculate the predicted BEPR from the steady state BEPR model, the VSS constituent fractions need to be determined, including the two active heterotrophic organism fractions of the VSS to be determined (i.e. PAOs, $f_{av,PAO}$ and OHOs, $f_{av,OHO}$). To determine the PAO and OHO fractions, the proportion of the readily biodegradable (RB) COD that the PAOs obtain in the anaerobic reactor ($S_{seq}$) needs to be determined. To do this, the volatile fatty acids (VFA) concentration in the influent needs to be known and also the proportion of the influent RBCOD converted to VFA in the anaerobic reactor by the ordinary heterotrophic organisms (OHOs). The PAOs obtain that part of the influent biodegradable COD which is VFA and the part of the RBCOD converted to VFA in the anaerobic reactor, while the OHOs obtain the balance of the biodegradable COD i.e. that part of the RBCOD not converted to VFA in the anaerobic reactor and all of the SBCOD, except for the approximately 13% of the COD that is utilized in the external nitrification system for sludge production (measured average COD reduction in external nitrification System). The difficulty in determining the substrate that the PAO and OHO active fractions obtain is further compounded by the fact that the unbiodegradable particulate COD fraction of the influent ($f_{S,up}$) which also becomes part of the VSS in the system is unknown and determines the proportion of the total influent COD which is biodegradable. As a result, the determination of $f_{S,up}$ and the PAO and OHO active fractions is done simultaneously using the measured MLVSS concentrations as benchmarks (for additional details see Mellin *et al.*,1998, Pilson *et al.*,1995 or Ekama and Wentzel,1999).

3.5.3.1 Determination of $f_{S,up}$

The approach that is used to calculated $f_{S,up}$, $f_{av,OHO}$ and $f_{av,PAO}$ follows the BEPR steady state model of Wentzel *et al.* (1990) shown schematically in Figure 3.14. The model is structured such that the heterotrophic organism mass is divided into two groups; the OHOs and the PAOs, the difference being their stoichiometric and kinetic constants, the main ones being the P content and endogenous respiration rate. With the influent unbiodegradable soluble COD fraction $f_{S,us}$ known from the filtered effluent COD concentration ($f_{S,us}$ = filtered effluent COD/total influent COD), it involves an iterative process where an estimate of the unbiodegradable particulate fraction ($f_{S,up}$) is made, from which the influent biodegradable COD is calculated by difference. The split of the biodegradable COD between the PAOs and OHOs is calculated iteratively from the measured influent RBCOD concentration and the known system design parameters that govern RBCOD conversion, i.e. anaerobic mass fraction and sludge age as demonstrated by Wentzel *et al.* (1990). With the proportions of the biodegradable COD obtained by the PAOs and OHOs known, the mass of the active and endogenous VSS generated by these two organism groups are calculated. Also, from the initial estimate of $f_{S,up}$, the inert VSS is calculated. By adding the 5 calculated constituent components of the VSS mass (shown in Figure 3.14), the total VSS mass of the system is known. The correct estimate of the $f_{S,up}$ is that value which gives the calculated VSS mass equal to the measured VSS mass taking due account of the COD reduction in the external nitrification system. The OHO and PAO active VSS fractions $f_{av,OHO}$ and $f_{av,PAO}$ respectively are then determined from the ratio of the masses of OHO and PAO VSS to the total VSS. This calculation procedure assumes a 100% COD balance. An error in the COD balance may be the result of too low VSS mass in the system due to (i) steady state conditions not existing or (ii) sludge losses from spillages. The latter happened several times in this investigation, but its effect was reduced because as much as possible of the spilled sludge was returned to the system from the specially designed sludge spillage drip tray below the system. Low VSS mass in the system leads to low $f_{S,up}$ fractions and high $f_{av,OHO}$ and $f_{av,PAO}$ fractions. This is the main reason for the large variation in $f_{S,up}$ fractions and denitrification rates $K_2'$ in NDBEPR systems (see Table 3.9 and Ekama and Wentzel, 1999).

Once the sludge VSS has been fractionated by reconciling the calculated and measured VSS masses, the P content of the PAOs ($f_{XBG,P}$) is estimated so that the calculated sum of the P contents of the 5 constituent fractions of the VSS yield the measured P removal. The correct value of $f_{XBG,P}$ is that value for which the calculated P removal is the same as the measured P removal. The results of the spreadsheet calculations for the 32 analyzed sewage batches fed to the external nitrification system are shown in Appendix C. In the steady state model of Wentzel *et al.* (1990), which is based on aerobic P uptake, the fraction of the PAO P content ($f_{XBG,P}$) is 0.38 mgP/mgPAOVASS. The calculated $f_{XBG,P}$ fraction for each sewage batch is listed in Table 3.11a and shown plotted in Figure 3.15a. The same procedure was applied to the conventional UCT system results, details of which are given in Appendix E (see Table 3.11b).

**Figure 3.14:** Diagrammatic representation of utilisation of the Total influent COD in the model of Wentzel *et al.* (1990).

<table>
<tr><td colspan="6">Total COD - known</td></tr>
<tr><td colspan="4">Total biodegradable COD - Unknown?</td><td colspan="2">Total unbiodegradable COD - Unknown?</td></tr>
<tr><td colspan="2">Measured from influent - known</td><td colspan="2">Unknown?</td><td>Unknown?</td><td>Measured from effluent - known</td></tr>
<tr><td colspan="2">RBCOD</td><td colspan="2">SBCOD</td><td>UPCOD ($f_{S,up}$)[1]</td><td>USCOD ($f_{S,us}$)</td></tr>
<tr><td colspan="2">Unknown?</td><td colspan="2">Unknown?</td><td>Unknown?</td><td>Determined from filtered effluent COD concentration</td></tr>
<tr><td colspan="2">COD obtained by PAOs</td><td colspan="2">COD obtained by OHOs</td><td></td><td rowspan="8">[1]Varied until calculated VSS = measured VSS masses.<br><br>[2]Varied until calculated BEPR =measured BEPR.</td></tr>
<tr><td>Active polyP VSS mass</td><td>Endo-genous polyP VSS mass</td><td>Active ordinary heterotroph VSS mass</td><td>Endogenous ordinary heterotroph mass</td><td>Inert VSS mass</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td colspan="5">Components contributing to Total Total VSS mass (must equal measured value)</td></tr>
<tr><td>$f_{XBG,P}$[2]</td><td>0.03</td><td>0.03</td><td>0.03</td><td>0.03</td></tr>
<tr><td colspan="5">P content of VSS constituents</td></tr>
<tr><td>$\Delta P_{GB}$</td><td>$\Delta P_{GE}$</td><td>$\Delta P_{HB}$</td><td>$\Delta P_{HE}$</td><td>$\Delta P_{I}$</td></tr>
<tr><td colspan="5"><u>Total P removal (must equal measured value)</u></td></tr>
</table>

Table 3.11a: Calculated $f_{S,up}$ and $f_{XBG,P}$ fractions using Wentzel *et al.* (1990) BEPR model.

| Sewage Batch | $S_{bsi}$ [2] | $f_{S,us}$ | $f_{XBG,P}$ | $f_{S,up}$ | MXv(calc) mgVSS/d | ΔP(calc) mgP/l inf | MXv(meas) mgVSS/d | ΔP(meas) mgP/l inf | $f_{av,OHO}$ | $f_{av,PAO}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1[1] | 92 | 0.07 | 0.233 | -2.134 | 26769.3 | 8.209 | 21536.7 | 8.212 | 0.56 | 0.15 |
| 2 | 103 | 0.07 | 0.283 | 0.142 | 28403.4 | 9.114 | 28415.0 | 9.112 | 0.33 | 0.13 |
| 3[1] | 92 | 0.03 | 0.385 | 0.079 | 28240.4 | 10.643 | 28280.0 | 10.676 | 0.43 | 0.13 |
| **Config 1** | **96** | **0.06** | **0.300** | **0.111** | **27813.4** | **9.34** | **26077.2** | **9.33** | **0.44** | **0.14** |
| 4 | 89 | 0.09 | 0.491 | 0.021 | 39633.5 | 14.301 | 39622.0 | 14.315 | 0.53 | 0.19 |
| 5 | 41 | 0.05 | 0.451 | -2.135 | 41381.8 | 8.512 | 37192.2 | 8.524 | 0.66 | 0.08 |
| 6 | 37 | 0.11 | 0.173 | 0.183 | 50964.7 | 6.122 | 51021.7 | 6.113 | 0.38 | 0.06 |
| 7 | 57 | 0.05 | 0.119 | 0.181 | 56391.9 | 6.531 | 56310.8 | 6.544 | 0.37 | 0.08 |
| 8 | 102 | 0.09 | 0.107 | 0.063 | 47977.8 | 6.500 | 47970.0 | 6.501 | 0.46 | 0.18 |
| 9 | 143 | 0.03 | 0.201 | 0.147 | 60555.9 | 11.770 | 60524.4 | 11.824 | 0.33 | 0.19 |
| 11 | 110 | 0.05 | 0.154 | -2.135 | 42199.9 | 7.525 | 41580.0 | 7.519 | 0.55 | 0.22 |
| 12[1] | 92 | 0.07 | 0.118 | 0.019 | 39093.3 | 5.712 | 39162.9 | 5.717 | 0.53 | 0.19 |
| 13 | 109 | 0.08 | 0.058 | 0.076 | 49697.9 | 5.414 | 49665.0 | 5.424 | 0.43 | 0.18 |
| 16 | 73 | 0.06 | 0.248 | 0.104 | 51522.9 | 8.928 | 51571.7 | 8.954 | 0.44 | 0.12 |
| 17[1] | 92 | 0.09 | 0.146 | 0.122 | 49202.2 | 7.271 | 49243.3 | 7.301 | 0.39 | 0.15 |
| 18 | 78 | 0.10 | 0.384 | 0.020 | 46934.4 | 10.332 | 46896.7 | 10.332 | 0.51 | 0.16 |
| 20 | 102 | 0.09 | 0.184 | 0.128 | 47302.0 | 8.504 | 47235.8 | 8.524 | 0.34 | 0.16 |
| **Config 2** | **85** | **0.07** | **0.221** | **0.094** | **47963.0** | **8.25** | **47563.4** | **8.26** | **0.44** | **0.15** |
| 22 | 63 | 0.05 | 0.408 | 0.354 | 56868.7 | 10.341 | 56888.3 | 10.332 | 0.19 | 0.06 |
| 23 | 86 | 0.06 | 0.288 | 0.118 | 47899.5 | 10.096 | 47825.6 | 10.122 | 0.39 | 0.13 |
| 24 | 124 | 0.07 | 0.326 | -2.134 | 43248.7 | 13.884 | 39520.6 | 13.869 | 0.51 | 0.22 |
| 25 | 71 | 0.08 | 0.925[3] | 0.090 | 34992.8 | 18.829 | 34989.2 | 18.810 | 0.40 | 0.14 |
| **Config 3** | **86** | **0.07** | **0.341** | **0.187** | **45752.4** | **13.28** | **44805.9** | **13.28** | **0.37** | **0.14** |
| 26 | 82 | 0.08 | 0.772 | -2.134 | 39420.2 | 18.237 | 26970.2 | 18.249 | 0.57 | .015 |
| 27 | 70 | 0.07 | 0.348 | -2.134 | 41839.4 | 9.854 | 30554.3 | 9.876 | 0.58 | 0.13 |
| 28 | 58 | 0.07 | 0.494 | -2.134 | 33786.1 | 9.868 | 26766.7 | 9.852 | 0.58 | 0.12 |
| 29 | 100 | 0.05 | 0.150 | -2.134 | 36465.0 | 6.614 | 27683.3 | 6.638 | 0.52 | 0.21 |
| 30 | 84 | .006 | 0.412 | -2.134 | 38025.4 | 12.014 | 25868.3 | 12.034 | 0.55 | 0.17 |
| 31 | 123 | 0.03 | 0.448 | -2.134 | 50289.1 | 18.944 | 38921.7 | 18.935 | 0.53 | 0.20 |
| 32 | 131 | 0.04 | 0.414 | 0.062 | 43801.6 | 16.789 | 43798.3 | 16.783 | 0.39 | 0.22 |
| 33 | 104 | 0.08 | 0.330 | -2.134 | 41396.2 | 12.267 | 21330.0 | 12.234 | 0.53 | 0.20 |
| 34 | 115 | 0.07 | 0.118 | -2.134 | 48175.8 | 7.380 | 29638.9 | 7.377 | 0.54 | 0.18 |
| 35 | 101 | 0.05 | 0.198 | -2.134 | 39298.7 | 8.306 | 38949.2 | 8.299 | 0.53 | 0.20 |
| 36 | 102 | 0.10 | 0.332 | 0.094 | 46642.3 | 12.354 | 46655.0 | 12.357 | 0.39 | 0.16 |
| 37 | 124 | 0.10 | 0.248 | 0.044 | 39852.4 | 10.577 | 39904.0 | 10.592 | 0.42 | 0.23 |
| **Config 4** | **98** | **0.07** | **0.348** | **0.067** | **41675.5** | **12.39** | **34625.0** | **12.4** | **0.49** | **0.18** |
| **Overall** | **92** | **0.07** | **0.291** | **0.115** | **43384.4** | **10.37** | **39904.0** | **10.37** | **0.46** | **0.16** |

[1] The influent RBCOD concentration used for these sewage batches were not measured, the average of 92 mgCOD/l was used for the fXBG,P calculation.
[2] Determined from the difference of the floc filtered influent and effluent COD concentrations.
[3] Not included in average.

**Figure 3.15a:** Polyphosphate accumulating organism(PAO) P content ($f_{XBG,P}$mgP/mgPAOAVSS).

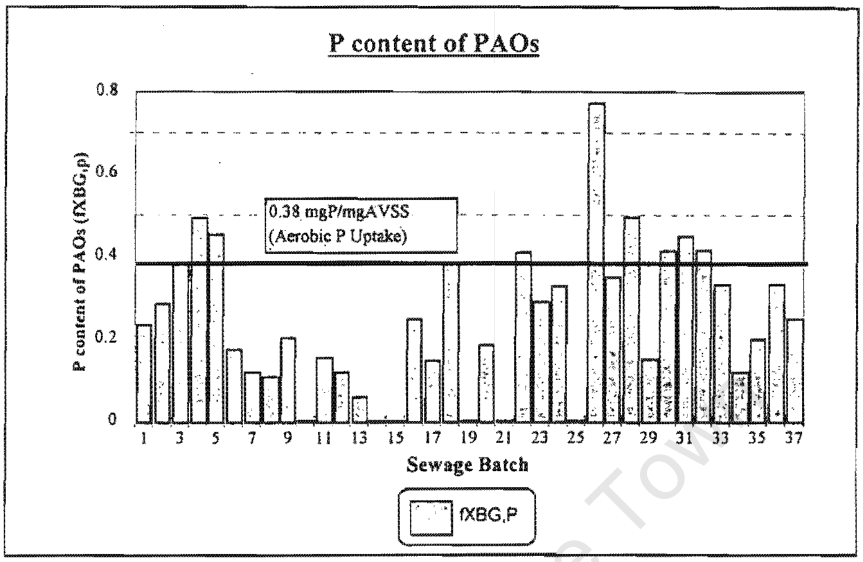



**Figure 3.15b:** Polyphosphate accumulating organism (PAO) P content ($f_{XBG,P}$ mgP/mgPAOAVSS) in UCT system for sewage batches 2 to 21.

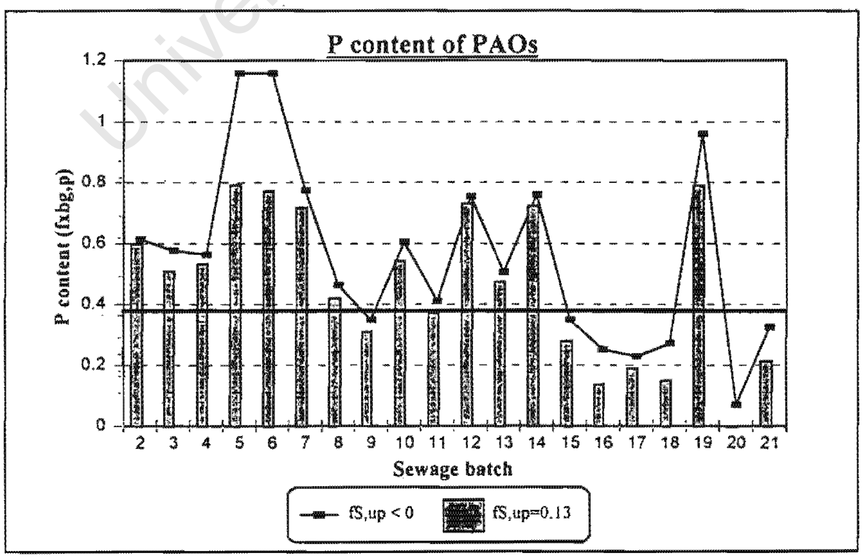


**Table 3.11b:** Calculated $f_{XBG,P}$ fractions for fixed $f_{S,up}$ of 13% in Wentzel *et al.* (1990) BEPR model.

| Sewage Batch | $S_{bsi}$[2] | $f_{S,us}$ | $f_{XBG,P}$ | $f_{S,up}$ | MXv(calc) | ΔP(calc) | ΔP(meas) | $f_{av,OHO}$ | $f_{av,PAO}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | mgVSS/d | mgP/l inf | mgP/l inf | | |
| 1[1] | 92 | 0.07 | 0.175 | 0.13 | 35371.44 | 8.20 | 8.212 | 0.36 | 0.11 |
| 2 | 103 | 0.07 | 0.287 | 0.13 | 27805.01 | 9.11 | 9.112 | 0.35 | 0.14 |
| 3[1] | 92 | 0.03 | 0.369 | 0.13 | 30996.79 | 10.67 | 10.676 | 0.37 | 0.11 |
| **Config 1** | **96** | **0.06** | **0.277** | **0.13** | **26077.22** | **9.32** | **9.33** | **0.36** | **0.12** |
| 4 | 89 | 0.09 | 0.475 | 0.13 | 47666.45 | 14.30 | 14.315 | 0.37 | 0.15 |
| 5 | 41 | 0.05 | 0.361 | 0.13 | 53169.81 | 8.52 | 8.524 | 0.44 | 0.06 |
| 6 | 37 | 0.11 | 0.243 | 0.13 | 44200.26 | 6.11 | 6.113 | 0.42 | 0.07 |
| 7 | 57 | 0.05 | 0.151 | 0.13 | 52134.03 | 6.55 | 6.544 | 0.42 | 0.09 |
| 8 | 102 | 0.09 | 0.091 | 0.13 | 52435.89 | 6.48 | 6.501 | 0.37 | 0.16 |
| 9 | 143 | 0.03 | 0.203 | 0.13 | 58721.34 | 11.80 | 11.824 | 0.37 | 0.20 |
| 11 | 110 | 0.05 | 0.121 | 0.13 | 53300.00 | 7.51 | 7.519 | 0.37 | 0.17 |
| 12[1] | 92 | 0.07 | 0.085 | 0.13 | 47605.18 | 5.70 | 5.717 | 0.38 | 0.15 |
| 13 | 109 | 0.08 | 0.041 | 0.13 | 54432.83 | 5.41 | 5.424 | 0.37 | 0.16 |
| 16 | 73 | 0.06 | 0.235 | 0.13 | 54525.14 | 8.96 | 8.954 | 0.41 | 0.11 |
| 17[1] | 92 | 0.09 | 0.151 | 0.13 | 48565.87 | 7.28 | 7.301 | 0.37 | 0.15 |
| 18 | 78 | 0.10 | 0.351 | 0.13 | 58389.34 | 10.34 | 10.332 | 0.35 | 0.13 |
| 20 | 102 | 0.09 | 0.189 | 0.13 | 46099.64 | 8.50 | 8.524 | 0.33 | 0.16 |
| **Config 2** | **85** | **0.07** | **0.209** | **0.13** | **52020.51** | **8.25** | **8.26** | **0.38** | **0.13** |
| 22 | 63 | 0.05 | 0.495 | 0.13 | 40500.54 | 10.34 | 10.332 | 0.37 | 0.10 |
| 23 | 86 | 0.06 | 0.285 | 0.13 | 48607.33 | 10.413 | 10.122 | 0.35 | .013 |
| 24 | 124 | 0.07 | 0.299 | 0.13 | 54991.83 | 13.84 | 13.869 | 0.33 | 0.17 |
| 25 | 71 | 0.08 | 0.955 | 0.13 | 37182.82 | 18.81 | 18.810 | 0.35 | 0.13 |
| **Config 3** | **86** | **0.07** | **0.359** | **0.13** | **45320.63** | **13.28** | **13.28** | **0.35** | **0.13** |
| 26 | 82 | 0.08 | 0.748 | 0.13 | 49850.12 | 18.25 | 18.249 | 0.36 | 0.11 |
| 27 | 70 | 0.07 | 0.286 | 0.13 | 54453.91 | 9.87 | 9.876 | 0.37 | 0.10 |
| 28 | 58 | 0.07 | 0.431 | 0.13 | 44558.11 | 9.85 | 9.852 | 0.38 | 0.09 |
| 29 | 100 | 0.05 | 0.111 | 0.13 | 47168.56 | 6.66 | 6.638 | 0.34 | 0.15 |
| 30 | 84 | .006 | 0.371 | 0.13 | 49383.06 | 12.04 | 12.034 | 0.36 | 0.13 |
| 31 | 123 | 0.03 | 0.413 | 0.13 | 65084.42 | 18.91 | 18.935 | 0.35 | 0.15 |
| 32 | 131 | 0.04 | 0.405 | 0.13 | 49396.97 | 16.78 | 16.783 | 0.32 | 0.19 |
| 33 | 104 | 0.08 | 0.297 | 0.13 | 52924.08 | 12.22 | 12.234 | 0.34 | 0.15 |
| 34 | 115 | 0.07 | 0.071 | 0.13 | 62179.61 | 7.38 | 7.377 | 0.35 | 0.14 |
| 35 | 101 | 0.05 | 0.155 | 0.13 | 51204.70 | 8.29 | 8.299 | 0.34 | 0.15 |
| 36 | 102 | 0.10 | 0.337 | 0.13 | 47694.24 | 12.36 | 12.357 | 0.33 | 0.16 |
| 37 | 124 | 0.10 | 0.231 | 0.13 | 46916.92 | 10.6 | 10.592 | 0.31 | 0.19 |
| **Config 4** | **98** | **0.07** | **0.360** | **0.13** | **50773.11** | **12.40** | **12.4** | **0.35** | **0.14** |
| **Overall** | **92** | **0.07** | **0.294** | **0.13** | **48956.76** | **10.37** | **10.37** | **0.36** | **0.14** |

[1] The influent RBCOD concentration used for these sewage batches were not measured, the average of 92 mgCOD/l was used for the $f_{XBG,P}$ calculation.

[2] Determined from the difference of the floc filtered influent and effluent COD concentrations.

**Table 3.11c:** Calculated $f_{Sup}$, and $f_{XBG,P}$ fractions for sewage batches 2 to 21 of the UCT system using Wentzel *et al.* (1990) model.

| Sewage Batch | $S_{bsi}$[2] | $f_{S,us}$ | $f_{XBG,P}$[3] | $f_{S,up}$ | MXv(calc) mgVSS/d | ΔP(calc) mgP/l inf | MXv(meas mgVSS/d | ΔP(meas) mgP/l inf | $f_{av,OHO}$ | $f_{av,PAO}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2[1] | 103 | 0.08 | 0.612 | 0.068 | 33083.5 | 18.82 | 33070.7 | 18.85 | 0.43 | 0.14 |
| 3 | 92 | 0.04 | 0.563 | 0.0[4] | 32945.4 | 16.58 | 30212.4 | 16.58 | 0.58 | 0.13 |
| 4[1] | 89 | 0.05 | 0.563 | 0.030 | 27702.2 | 17.45 | 27735.5 | 17.45 | 0.56 | 0.13 |
| 5 | 40 | 0.05 | 1.297 | 0.053 | 28044.7 | 17.65 | 28003.3 | 17.67 | 0.57 | 0.06 |
| 6 | 37 | 0.05 | 7.075 | 0.031 | 27799.4 | 5.2 | 27744.0 | 17.19 | 0.65 | |
| 7 | 57 | 0.03 | 0.775 | 0.043 | 28636.0 | 14.9 | 28656.3 | 14.88 | 0.58 | 0.07 |
| 8 | 102 | 0.05 | 0.405 | 0.0[4] | 26452.6 | 16.37 | 25082.7 | 16.37 | 0.60 | 0.16 |
| 9 | 143 | 0.03 | 0.340 | 0.0[4] | 29532.9 | 17.00 | 26746.7 | 16.96 | 0.57 | 0.20 |
| 10 | 92 | 0.05 | 0.595 | 0.0[4] | 25911.3 | 15.72 | 24712.3 | 15.73 | 0.63 | 0.12 |
| 11 | 110 | 0.07 | 0.405 | 0.0[4] | 24525.6 | 14.55 | 24041.8 | 14.55 | 0.59 | 0.17 |
| 12[1] | 92 | 0.04 | 0.7555 | 0.044 | 26.862.9 | 19.49 | 26835.7 | 19.51 | 0.54 | 0.12 |
| 13 | 109 | 0.06 | 0.502 | 0.0[4] | 24774.0 | 17.62 | 23654.3 | 17.60 | 0.58 | 0.18 |
| 14 | 92 | 0.05 | 0.756 | 0.0[4] | 25023.3 | 20.58 | 23800.0 | 20.57 | 0.61 | 0.14 |
| 15 | 92 | 0.09 | 0.334 | 0.0[4] | 26381.7 | 11.53 | 24491.3 | 11.55 | 0.62 | 0.13 |
| 16 | 73 | 0.08 | 0.235 | 0.0[4] | 24545.3 | 7.33 | 23358.0 | 7.34 | 0.65 | 0.09 |
| 17[1] | 92 | 0.08 | 0.214 | 0.0[4] | 26550.6 | 12.55 | 21964.0 | 12.53 | 0.53 | 0.25 |
| 18 | 78 | 0.06 | 0.220 | 0.0[4] | 30474.7 | 8.22 | 23003.4 | 8.21 | 0.58 | 0.13 |
| 19 | 92 | 0.10 | 0.960 | 0.212 | 23727.9 | 17.69 | 23698.0 | 17.72 | 0.25 | 0.13 |
| 20 | 102 | 0.06 | 0.048 | 0.0[4] | 38004.7 | 4.96 | 26350.0 | 4.97 | 0.55 | 0.17 |
| 21 | 92 | 0.08 | 0.301 | 0.0[4] | 28616.8 | 9.71 | 18657.5 | 9.71 | 0.57 | 0.14 |
| **Average** | **92** | **0.08** | **0.495** | **0.069** | **29403.3** | **15.01** | **26027.0** | **15.00** | **0.56** | **0.14** |



[1] The influent RBCOD concentration used for these sewage batches were not measured, the average of 92 mgCOD/l was used for the $f_{XBG,P}$ calculation.

[2] Determined from the difference of the floc filtered influent and effluent COD concentrations.

[3].The $f_{XBG,P}$ fraction of the UCT system was only determined while the system was monitored i.e. up to and including sewage batch 21.

[4]. The $f_{S,up}$ value to match the measured VSS mass is negative due to sludge spillages and low COD mass balances - see Appendix E. A minimum $f_{S,up}$ value of 0.0 was accepted.

3.5.3.2 Dependency of $f_{XBG,P}$ fraction on influent RBCOD concentration and $f_{S,up}$

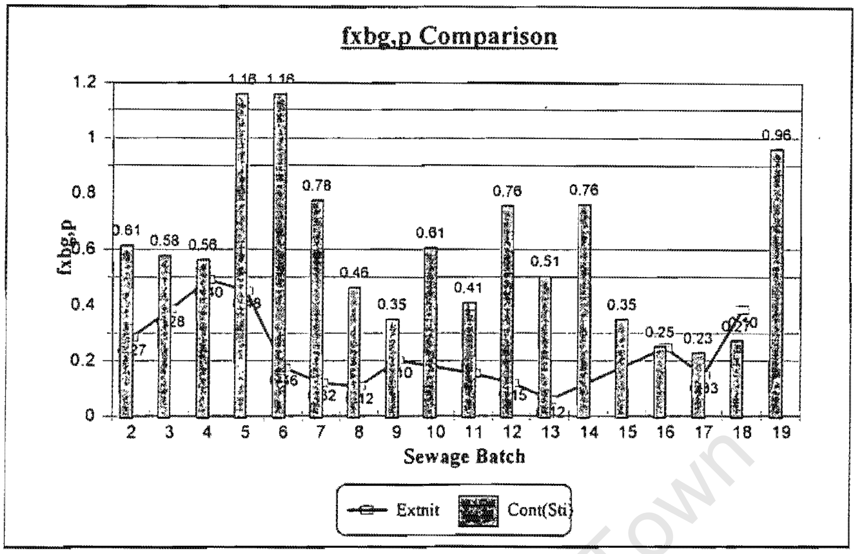
In Figure 3.15a and Table 3.11a it can be seen that the $f_{XBG,P}$ fraction varies considerably between 0.057 and 0.991 mgP/mgPAOAVSS. The cause of the large variation in the $f_{XBG,P}$ fraction is due to the large variation in the influent RBCOD of the wastewater since the determination of the $f_{XBG,P}$ fraction is almost directly proportional to the influent RBCOD concentration (overall average of the influent RBCOD in this investigation was 92 with a standard deviation of 25 mgCOD/l). This is expected since the model of Wentzel *et al.* (1990) uses the influent RBCOD concentration to calculate the COD sequestered by the PAOs which in turn determines the PAO mass which is responsible for the largest proportion of the P removal (~2/3$^{rds}$). Fig 3.15b shows the $f_{XBG,P}$ fraction determined with the same method for the period which the parallel UCT system was monitored (i.e. up to sewage batch 19) using the model of Wentzel *et al.* (1990).

Although from the steady state model, a direct relationship between RBCOD concentration and PAO mass and P removal is expected with a constant P content of PAOs ($f_{XBG,P}$). This is because the effect (i.e either a high or low $f_{XBG,P}$ fraction) of a change in influent RBCOD concentration does not manifest immediately but gradually as the PAO mass (and hence P removal) adjusts up or down in response to the influent RBCOD concentration change to establish a new steady state. This adjustment can take one or more sludge ages depending on the magnitude of the influent RBCOD concentration change. Because the BEPR model assumes steady state conditions a decrease (increase) in influent RBCOD concentration will result in an increase (decrease) in $f_{XBG,P}$ because now a lower (higher) theoretical PAO mass has to account for a higher (lower) P removal from the higher (lower) influent RBCOD concentration from the previous sewage batch.

Despite the significant variation in $f_{XBG,P}$ for reasons given above, from Figs 3.15a and 3.17, it can be seen that the overall $f_{XBG,P}$ value for the UCT system (0.495) is greater than for the external nitrification system (0.291 mgP/mgPAOAVSS).

While generally the $f_{XBG,P}$ value in the UCT system may be higher than in the external nitrification system because the COD balance ( and measured VSS mass) was lower than the external nitrification system, the magnitude of the difference in $f_{XBG,P}$ cannot be accounted for by only the difference in COD balance.

**Figure 3.17**: Comparison of P content of PAOs of BNRAS external nitrification and UCT control system

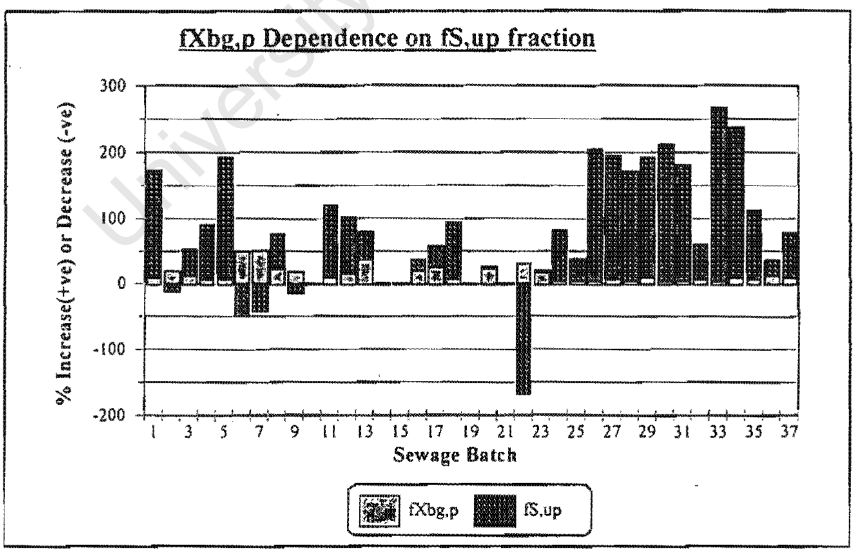



It can therefore be concluded that even at 100% COD balance in both systems, the $f_{XBG,P}$ value is lower in the external nitrification system than the UCT system. This is in conformity with observations in earlier investigations (Ekama and Wentzel, 1999)- systems that exhibit significant anoxic P uptake (> 40%) show lower BEPR ( at about 2/3$^{rds}$) than systems exhibiting aerobic P uptake BEPR. In this investigation the UCT system exhibited 100% aerobic P uptake BEPR (see mass balance for the UCT system in Appendix E), while in the external nitrification system, the P uptake took place in both the main anoxic (56%) and aerobic (42%) reactors respectively. The lower BEPR with anoxic P uptake can be explained biochemically. Aerobic metabolism provides a higher yield (3 ATPs per $e^-$ pair transferred) for the PAOs and hence higher P removal than anoxic metabolism (2 ATPs per $e^-$ pair transferred).

For the same wastewater source, one expects a relatively constant $f_{S,up}$ fraction. For N removal systems fed the Mitchells Plein wastewater this is the case- Ubisi *et al.* (1997), Mbewe *et al.* (1995), Warburton *et al.* (1991) and Mellin *et al.* (1998) all found $f_{S,up}$ values around 0.10 to 0.13. However, this is not the case for NDBEPR systems - Clayton *et al.* (1989), Musvoto *et al.* (1992), Kaschula *et al.* (1993), Pilson *et al.* (1995), Sneyders *et al.* (1997) and Mellin *et al.* (1998) found widely varying $f_{S,up}$ values from 0.04 to 0.35 mgCOD/mgCOD for the Mitchells Plein wastewater as is evident in this investigation. These widely varying $f_{S,up}$ values lead to widely varying OHO active fractions and $K_2$' denitrification rates (Ekama and Marais, 1999). In order to establish the sensitivity of the $f_{XBG,P}$ fraction to the calculated $f_{S,up}$ fraction, a constant $f_{S,up}$ value of 0.13 was accepted for all 32 sewage batches analyzed, substituted for the $f_{S,up}$ fraction in the Wentzel *et al.* (1990) model and the $f_{XBG,P}$ fraction was recalculated for the external nitrification system and UCT control system . This approach ignores the measured VSS as the benchmark for the $f_{S,up}$ value (see Table 3.11b). The calculated $f_{XBG,P}$ for constant and calculated $f_{S,up}$ are compared graphically for the external nitrification system in Fig3.18 showing the percentage change of both the $f_{XBG,P}$ and $f_{S,up}$ fractions. From Figures 3.18 and 3.15b it can be seen that a large change in the $f_{S,up}$ fraction from the initial value to 0.13 is not accompanied by a large change in the $f_{XBG,P}$ fraction, showing that the $f_{XBG,P}$ fraction is insensitive to the $f_{S,up}$ fraction. The insensitivity of the $f_{XBG,P}$ fraction to the $f_{S,up}$ fraction is not unexpected because the BEPR, P removal and $f_{XBG,P}$ are theoretically linked at steady state to the influent RBCOD concentration i.e. this concentration was not changed with varying $f_{S,up}$. The relative difference in $f_{XBG,P}$ between the UCT control and external nitrification system, both fed the same wastewater for 21 sewage batches, is therefore not a consequence of the $f_{S,up}$ variation, but rater a consequence of system behaviour.



**Figure 3.18:** $f_{Xbg,p}$ fraction dependence on $f_{Sup}$ fraction for the external nitrification system.



## 3.6 FILAMENT IDENTIFICATION AND SLUDGE SETTLEABILITY

### 3.6.1 Filament Identification

Approximately every four weeks samples of mixed liquor were taken from the aerobic reactors of the external nitrification and UCT control systems for microscopic analysis and filamentous organism identification (see Appendix F for details). This was done to compare the filaments occurring in the laboratory scale systems in this investigation and to ascertain whether or not the same type and relative abundance of filaments are similar to that found in full scale plants. During the investigation, the filament identifications were done 13 times (i.e. from day 1 to day 373, over 37 sewage batches) on both systems. However, as mentioned above the UCT system was tested and monitored for all the system compounds only for a part of this time i.e. days 4 to 167 spanning sewage batches 2 to 21 inclusive. For the 13 identifications on each system, the % frequency of dominance and occurrence were calculated as the number of times a particular filament was dominant (most abundant filament) and occurred (observed). The results are summarized in Table 3.12. Comparing the filaments identified in the external nitrification and UCT control systems (see Appendix F) with those identified by Blackbeard *et al.* (1988) in full scale nutrient removal plants in South Africa, it appears that the frequent occurrence of *M. parvicella*, type 0092 and type 1851 at both laboratory and full scale provides sufficient evidence that the filament types of the external nitrification and UCT systems are similar to full scale plants and are all of the low F/M (after Jenkins *et al.*,1984) or Anoxic-Aerobic (AA after Casey *et al.*, 1994) types.

From Table 3.12, the most frequently dominant filament in both the external nitrification (EN) and UCT system was *M. pavicella* (69 and 85% respectively). From the survey of nutrient removal plants in South Africa by Blackbeard *et al.* (1988), *M. parvicella* occurred in 76% of plants and was dominant in 33%. The next most frequently dominant filaments in the EN system was type 1851 being the dominant filament in the system 25% of the sampling time; type 1851 was never observed (0%) to be the dominant filament in the UCT system.

Low F/M (AA) filaments that were observed to be present (occurrence) in the sludge most frequently

**Table 3.12:** The Dominance and Occurrence of filamentous organisms in the external nitrification and UCT systems

| Filament Type | Dominance (%) | | Occurrence (%) | |
|---|---|---|---|---|
| | Ext | UCT | Ext | UCT |
| *M. Parvicella* | 69 | 85 | 81 | 92 |
| Type 1851 | 25 | 0 | 44 | 31 |
| Type 021N | 6 | 8 | 25 | 8 |
| Type 0092 | 0 | 0 | 13 | 15 |
| Type 1701 | 0 | 8 | 6 | 15 |
| *S.Natans* | 6 | 0 | 6 | 0 |
| *H. hydrosis* | 0 | 8 | 6 | 23 |
| *Thiothrix* | 0 | 0 | 0 | 8 |
| Nocardia sp | 0 | 0 | 0 | 8 |



in the EN and UCT systems were *M.* parvicella, which occurred in 81% and 92% of samples, type 1851 in 44% and 30% and type 0092 in 13% and 15 % respectively. Thus the most important filaments in the EN and UCT systems were the low F/M (AA) types.

H.hydrosis occurred in 23% of the samples analyzed for the UCT system. Jenkins *et al.* (1984) associates this filament with Low Dissolved Oxygen (DO), low F/M and Nutrient deficiency. The measured concentrations of nutrients (N & P) in the influent fed to the UCT system were sufficient
(i.e N>50mgN/l and P>17mgP/l) and therefore nutrient deficiency was unlikely to have occured. Further, the DO in the aerobic reactor was maintained between 2 and 5 mgO/l and hence categorization as a low DO filament by Jenkins *et al.* (1984) is inappropriate. *H.hydrosis* can therefore reasonably be categorized as low F/M (Jenkins *et al.*, 1984). Casey *et al.* (1993) did not include *H. hydrosis* as an AA filament and from the filament survey of South African plants; *H.hydrosis* occurred in 21% of plants but was dominant in only 6%.

Type 021N was dominant in 6% and 8% of samples and occurred in 25% and 8% of samples from the EN and UCT systems respectively and *Thiothrix* was never dominant in either system but occurred in 8% of samples from the UCT system. Type 021N and *Thiothrix* are sulphur accumulating organisms and are seldomly observed in full scale nutrient removal plants and are observed more frequently in lab scale systems. Type 021N is often associated with septic wastewaters in South Africa and its presence in the biocenosis is probably due to the storage period of the influent being too long i.e. up to two weeks albeit at 4°C. As mentioned above nutrient deficiency was unlikely and type 021N is not classified as an AA filament by Casey *et al.* (1993), which suggests that the occurrence of this filament in both systems (i.e dominant in both the EN and UCT systems during the same sewage batch) was either a consequence of the conditions under which the influent was stored or under which the systems were operated (i.e. cleaning of pipes and reactors etc.), but the former being the most likely reason. Although this filament type is not listed frequently occurring in South African full scale plants (Blackbeard *et al.*, 1988) it has been reported frequently in laboratory systems prior to this investigation (Musvoto *et al.*, 1992; Kaschula *et al.*, 1993; Casey *et al.*, Pilson *et al.*, 1995; Sneyders *et al.*, 1998).



### 3.6.2 Sludge Settleability

The expansion of the single-sludge activated sludge systems from chemical oxygen demand (COD) removal to include, progressively, nitrification, denitrification, and phosphorous removal, all biologically has brought with it a new set of difficulties. As mentioned earlier one of these difficulties is the occurrence of filamentous bulking. These filaments (named AA filaments by Casey *et al.*, 1994) produce a poor settling sludge which severely limits the treatment capacity of nutrient removal plants through decreased efficiency in the separation of solids from the liquid phase in the secondary settling tank.

From earlier research Casey *et al.* (1994) proposed an hypothesis for the proliferation of anoxic-aerobic (AA) filamentous organisms in nitrification-denitrification (ND) and nitrification-denitrification biological excess phosphorus removal (NDBEPR) systems. Their hypothesis is as follows:

"The majority of heterotrophic organisms can be classified by their morphological characteristics as either filamentous or floc-forming organisms. The floc-forming organisms are aerobic-facultative; under aerobic conditions they utilize oxygen and under anoxic conditions they denitrify $NO_3^-$ or $NO_2^-$ to $N_2$ via the gaseous denitrification intermediates NO and $N_2O$. The filamentous organisms are also aerobic-facultative but are nitrate reducers only; under anoxic conditions they reduce $NO_3^-$ to $NO_2^-$ only.

"When sludge is exposed to alternating anoxic-aerobic conditions ($NO_3^-$ and/or $NO_2^-$ present throughout anoxic period), nitrate and nitrite is denitrified during the anoxic period to nitrogen gas with some nitric oxide (NO) also being produced. When a floc-forming with intracellular NO is subjected to aerobic conditions, the NO inhibits the utilization of oxygen. Also, while NO is present under aerobic conditions, the floc-formers continue to respire with $NO_3^-$ or $NO_2^-$ due to the intracellular inhibition by NO of the enzymes mediating the transfer of electrons to oxygen . Under anoxic conditions, the filamentous organisms do not produce NO as an intermediate and hence do not accumulate NO intracellularly. Consequently, these organisms are not inhibited in their utilization of oxygen (and hence substrate) under subsequent aerobic conditions.

"With intracellular NO present, and inhibition induced, floc-formers are placed at a disadvantage with respect to the filaments in competition for substrate under aerobic conditions. Consequently, the filamentous organisms utilize a greater proportion of the substrate under aerobic conditions than they would if the floc-formers were not inhibited. With floc-forming organisms inhibited, the filamentous organisms increase their relative mass in the sludge with each exposure to aerobic conditions, leading to the condition referred to as a bulking sludge."

While it is difficult to measure the gaseous intermediates of denitrification (e.g. NO), the ionic reactants nitrate and nitrite can be measured and indirectly it is the nitrate and nitrite concentrations in the anoxic reactor preceding an aerobic reactor which provides the best indication of the extent of denitrification and consequently the extent to which the oxygen uptake by floc-formers is inhibited on their passing from anoxic to aerobic conditions.

From the results of this investigation, the nitrate plus nitrite concentrations (mg$NO_x$-N/l) leaving the main anoxic reactor of the external nitrification and UCT control system were found to be 2.77 $NO_x$-N/l and 1.27 $NO_x$-N/l respectively. The high $NO_x$ concentration leaving the main anoxic reactor of the external nitrification system was intentional and maintained by the dosing of nitrate directly to this reactor in order to establish the denitrification potential of the reactor. Although >1 mg$NO_x$-N/l left the anoxic reactors of both the external nitrification and UCT systems, a reasonably good settlingsludge was observed in both systems.

The mean diluted sludge volume index (DSVI) and the $NO_x$ concentrations leaving the main anoxic reactor measured during the 37 sewage batches are shown plotted in Figure 3.19. From sewage batch 1, the system had a reasonably good settling sludge (DSVI ~ 125 ml/g). The DSVI progressively improved from sewage batch 6 to 27 at which time it averaged around 70 ml/g. From sewage batch 28 to the end of the investigation the DSVI steadily increased from 80 ml/g to 150 ml/g. The increase in the DSVI, although still below a bulking sludge (i.e.150 ml/g), is a direct result of change in the external nitrification system and the increase in the aerobic mass fraction and sludge age. The stone column external nitrification system was replaced with the activated sludge system which lead to a significant improved nitrification efficiency, the aerobic mass fraction was increased to 30% (observed by Casey *et al.*, 1994 to be the aerobic mass fraction at which AA filament proliferation is at a maximum) at the expense of the anoxic mass fraction (30%), the sludge age was increased from 8 to 10 days and a 1: 1 mixed liquor a-recycle from the aerobic to the anoxic reactor was installed. All these changes led to increased nitrate load on the main anoxic reactor and a decreased denitrification potential leading to high nitrate and nitrite concentration in the outflow of the anoxic to the aerobic reactor (see Fig.3.19). This is evident in Appendix C which shows that this period in investigation was the time during which the $NO_x$ concentration was generally > 1.0 mgN/l. This observation i.e. an increase in the $NO_x$ concentration leaving the anoxic reactor with the increase in aerobic mass fraction and with the simultaneous increase in the DSVI, supports the hypothesis of Casey *et al.* (1994). This period was also the time in which aerobic nitrification was significant which meant that the BNRAS external nitrification system now supported nitrifiers leading to higher effluent $NO_x$ concentrations. This is evident in Figure 3.20 which shows the relationship between the DSVI and the effluent $NO_x$ concentration: it can be seen that the DSVI follows the increase in effluent

$NO_x$ concentration. The overall average DSVI of the investigation was 94ml/g and falls in the range of an ideal settling sludge i.e. 80 to 100ml/g.

Generally throughout the investigation the sludge settled very rapidly in the settler and did not form significant sludge beds in either the internal or final settling tanks. A problem with the sludge, especially the day or two after a new sewage batch was fed, was that it did not clarify well and left a fine turbidity in the effluent. This investigation confirmed that the external nitrification BNRAS system consistently produced a good settling sludge. Indeed the system improved the sludge settleability as the investigation progressed and the improved settling characteristics and smaller settling tank requirements which allowed an increase in the treatment capacity of the system, as demonstrated from sewage 4 to 20 of this investigation into the BNRAS external nitrification system.



**Figure 3.19:** Relationship of the Diluted Sludge Volume Index (DSVI) and Anoxic nitrate and nitrite concentration of sewage batches 1 to 37

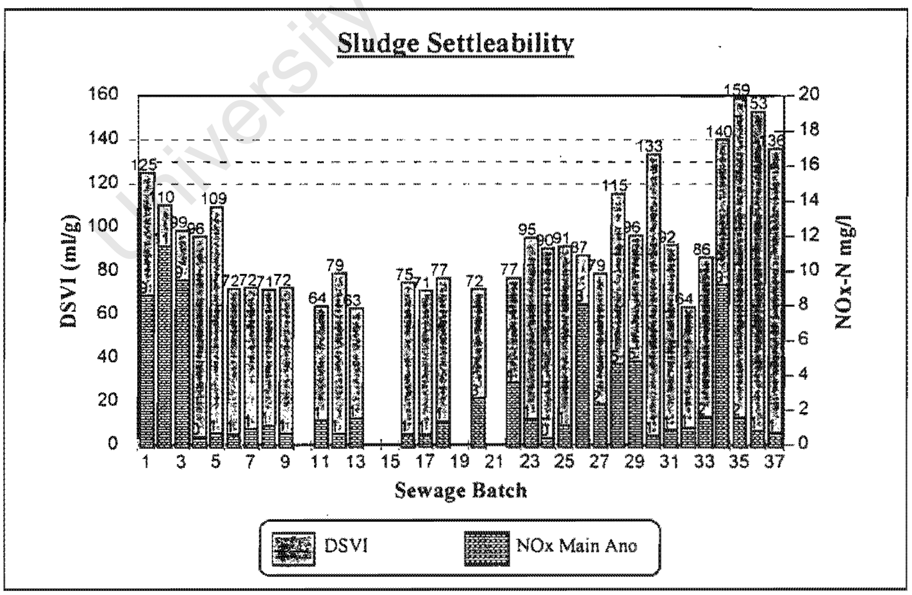
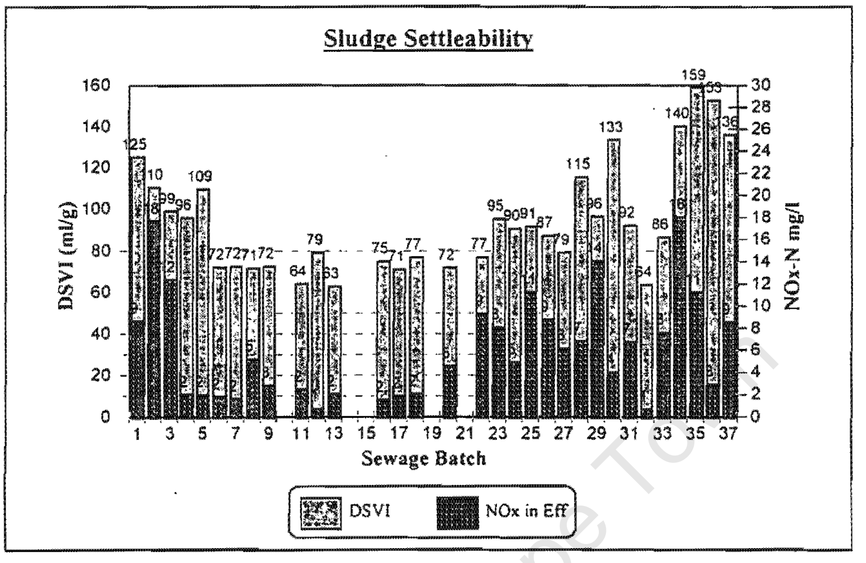


**Figure 3.20:** Relationship of Dilutes Sludge Volume Index (DSVI) and effluent nitrate and nitrite concentration for sewage batches 1 to 37.



# CHAPTER 4

## CONCLUSIONS AND DISCUSSION

### 4.1 INTRODUCTION AND OBJECTIVES OF INVESTIGATION

The expansion of the activated sludge system to progressively include nitrification denitrification has brought with it a new set of difficulties (Ekama and Wentzel, 1999;1999b), the main ones being the long sludge age required for nitrification, filamentous organism bulking and the treatment /disposal of supernatants generated from the sludge and solids handling. The focus of this investigation was on nitrification and in particular external nitrification.

In the BNR activated sludge (BNRAS) system, the requirement to nitrify governs selection of the two linked parameters, sludge age and the aerated mass fraction. The need for nitrogen (N) and phosphorus (P) removal sets a requirement for a part of the sludge to be unaerated, for anaerobic conditions to stimulate P removal and anoxic conditions for N removal. In N and P removal plants, the unaerated sludge mass fraction usually needs to be high i.e. > 40%, causing the aerated mass fraction to be reduced , i.e. <60 %. To compensate, to ensure near complete nitrification, long sludge ages have to be selected i.e. 20 to 25 days. Such long sludge ages result in large biological reactors per Ml wastewater (WW) treated. If nitrification can be made independent of the suspended solids sludge age, then the selection of the sludge age will no longer be governed by the requirement to nitrify, but rather by the N removal (denitrification) and P removal (BEPR) processes. For both these processes, a reduction in sludge age increases respectively the N and P removal per mass of organic load (WRC, 1994; Wentzel *et al.*, 1990), provided the sludge age remains longer than some lower limit to prevent "wash-out" of P removal and denitrifying organisms. Indications are that, if nitrification and the sludge age of the suspended solids can be uncoupled, then the sludge age can be reduced to less than half, from about 20-25 days to about 8-10 days. This will result in a reduction in the biological reactor volume requirement per Ml treated of about 1/3rd, or alternatively in an increase in the treatment capacity of some 50% (provided secondary settling tank area requirements are appropriately accommodated).

With the above discussion as motivation for BNRAS system intensification, the external nitrification system was investigated with the specific objectives being to:

1) Establish a stable population of slow-growing nitrifiers on a fixed media external nitrification system.
2) Double the volume of the wastewater treated thereby testing one of the benefits of external nitrification because of the now shortened sludge age.
3) Promote conditions to achieve anoxic phosphate uptake
4) Increase the aerobic mass fraction in an attempt to qualify the effect of the aerobic mass fraction on anoxic P uptake.
5) Study the effect of increased aerobic mass fraction on the sludge settleability of the BNRAS system.

To achieve the aims of this investigation , i.e. external nitrification in a BNRAS system, either one or a combination of two ways can be employed. Firstly, by installing a settler and a fixed media external nitrification system between the anaerobic and anoxic reactors, and/or secondly by dosing nitrate directly to the anoxic reactor. To set up the laboratory system as close as possible to the envisioned application of the system, the first approach was adopted. However, in order to increase the nitrate load and ensure that the anoxic reactor was overloaded with nitrate was dosed directly into the main anoxic reactor as a concentrated solution of 0.5 to 1.25 mgN/ml, i.e. to maintain the nitrate load on the main anoxic reactor slightly in excess of its denitrification potential thus allowing some nitrate to enter the aerobic reactor. The system sludge age, temperature and unaerated mass fraction were initially 10 days, 20 °C, and 0.85 respectively. To avoid any interference of nitrate on the P release process in the anaerobic reactor, a 0.1 mass fraction pre-anoxic reactor was set up ahead of the anaerobic reactor to denitrify nitrate in the return sludge. This pre-anoxic reactor was necessary to ensure a near zero nitrate concentration in the flow entering the anaerobic reactor.

During the investigation, which took place over a 373 day continuos period during which time 37 sewage batches were fed, 4 different configurations were tested viz:

1) From day 1 to 30 (sewage batches 1 to 3) Configuration 1 as defined above.

2) From day 31 to 154 (sewage batches 4 to 20) Configuration 2 in which the influent flow

was doubled from 20 l/d to 40 l/d and sludge age reduced from 10 to 8 days.

3) From day 155 to 205 (sewage batches 21 to 25) Configuration 3 in which the influent was decreased to 30 l/d, the aerobic mass fraction increased to 30% at the expense of the anoxic reactor (30%), replaced existing stone column (1.5m) replaced with a longer stone column (2m) to increase retention time, an a-recycle of 1:1 from aerobic to anoxic reactor added and the sludge age increased from 8 to 10 days.

4) From day 206 to 373 (sewage batches 26 to 37) Configuration 4 in which the fixed media stone column external nitrifier was replaced with a suspended nitrification activated sludge system.

The evaluation and results of this investigation, which took place over a 373 day period are summarized below in Sections 4.2 to 4.5 and followed by a discussion in Section 4.6:

## 4.2 System COD and N Removal Performance

1. Over the 373 day investigation during which 37 sewage batches were fed to the system the average COD balance in the external nitrification (EN) biological nutrient removal activated sludge (BNRAS) system was 80%, and the average N balance 91%. Although considerably lower than 100%, these are not considerably lower than the COD and N balances observed in other investigations on nutrient removal systems. The low COD balances were mainly the consequence of sludge losses due to mixed liquor spillages, resulting in low VSS masses in the system. The low COD masses in the system affects the unbiodegradable particulate COD fraction determination and specific denitrification rate, making these lower (see 9 and 12 below)

2. The concentrated solution of nitrate dosed (0.5 to 1.25mg$NO_3$-N/ml) directly at 0.5 l/d to the main anoxic reactor increased the influent TKN/COD ratio from around 0.08 to 0.14 mgN/mgCOD. The system produced an average effluent total N concentration <20 mgN/l.

3. The average percentage COD removal in the EN BNRAS system was 91%. Of the 100%

of the influent COD, 10% passed out of the system via the effluent, 31% via the waste sludge, 12% in the external nitrifier, 14% via nitrate denitrified and 13% via oxygen utilized, with 20 % unaccounted for.

4. The average percentage N removal in the EN BNRAS system was 72%. Of the 100% influent TKN, 5% and 25% passed out of the system via the effluent as nitrate and TKN respectively, 18% via the waste sludge, 5% in the external nitrifier and 38% via denitrification, with 9% unaccounted for. The main reason for such low N removal is poor nitrification in the fixed media stone column leading to high effluent TKN concentrations (see 11 below).

5. The overall average 0.45 μm membrane filtered effluent COD concentration from the EN BNRAS system was 52 mgCOD/l, giving an influent unbiodegradable soluble fraction $f_{S,us}$ of 0.075.

6. The filtered effluent TKN concentration was not measured and thus the unbiodegradable soluble TKN fraction ($f_{nu}$) was not determined. However, the overall average unfiltered effluent TKN concentration was 18 mgN/l (see 4 above and 9 below)

7. The average oxygen utilization rate (OUR) for sewage batches 1 to 20 was 35 mgO/l aerobic reactor/h and 38 mgO/l aerobic reactor/h for sewage batches 21 to 37. This increased OUR was due to the increased aerobic mass fraction for Configuration 3 and 4 which supported nitrifiers in the BNRAS system, and because in Configuration 3 the fixed media stone column nitrified poorly, significant nitrification took place in the aerobic reactor. This oxygen demand is significantly below (~50%) that in a conventional BNR system because (i) most of the nitrification oxygen demand is obtained "free" in the external nitrification system and (ii) the nitrate so generated reduces the carbonaceous oxygen demand.

8. The average TSS and VSS concentrations in the EN BNRAS were system 2628 mgTSS/l and 2163 mgVSS/l respectively, giving an average VSS/TSS ratio of 0.82.

9. To determine the unbiodegradable particulate fraction $f_{S,up}$ of the influent sewage fed to the system, the appropriate $f_{S,up}$ was selected so that the system VSS mass calculated with the BEPR model of Wentzel *et al.* (1990) was equal to that measured using the measured readily biodegradable (RB) COD concentration and the influent characteristics of the sewage ($f_{S,us}$, $S_{ti}$) and the system parameters as input. An average $f_{S,up}$ value of 0.11was found for the EN BNRAS system. The active ordinary heterotrophic (OHO) and polyphosphate accumulating (PAO) organism fractions of the VSS which are required to define the OHO denitrification rate ($K_2'$)and the P content of the PAOs ($f_{XBG,P}$),were also obtained from the calculation procedure (see 12 and 16 below).

## 4.3 NITRIFICATION AND DENITRIFICATION

10. In this investigation the primary aim was to establish a stable nitrifier population on a fixed media such that nitrification could be "restricted" to the fixed media system thus enabling nitrification and the suspended solids sludge age to be uncoupled. However, due to the limitation imposed by the flow rate to the external nitrification system (in this investigation about 76%, with 24% of the flow bypassing the external nitrification system as internal settling tank underflow) the maximum nitrification completion was 76%, if the external nitrification system outflow ammonia concentration was zero.

11. Initially the fixed media stone column (SC) nitrifier produced a low effluent ammonia concentration of 3mgN/l which represented an 88% nitrification efficiency in the external nitrification system. However, due to *Psychoda* mothfly larvae infestation the nitrification efficiency fell below 50% and produced a wide and varied effluent ammonia concentration, between 8 and 62mgN/l. In order to re-establish the external nitrification efficiency and prevent *Psychoda* infestation, a suspended medium external nitrifier replaced the fixed media SC to facilitate the nitrification process. The suspended medium external nitrifier produced a low effluent ammonia concentration of 9mgN/l and produced an average nitrification efficiency of 72%. It was also noticed that the period while the continually aerated suspended medium nitrifier was employed, was the only

period in which measurable (>=0.01 mg$NO_2$-N/l) nitrite concentrations were recorded in the outflow of the external nitrification system..

12. In the EN BNRAS system an average of 29mgN/l nitrate was denitrified in the main anoxic reactor and usually there was nitrate running out of the anoxic reactor so the denitrification rates could be calculated from this reactor's nitrate removal.

13. Because substantial anoxic P uptake (56%) was observed in the EN BNRAS system, denitrification was therefore mediated by both the ordinary heterotrophic organisms (OHOs) and the polyphosphate accumulating organisms (PAOs). The relative contribution of the PAOs to the denitrification rate was assumed to be the percentage anoxic uptake times the nitrate equivalent of the readily biodegradable COD taken up by the PAOs in the anaerobic reactor (determined from the Wentzel et al., 1990 steady state BEPR model -see 9 above), viz: %Ax Pupt*RBCOD taken up by PAOs/8.6 where 8.6 is the COD utilized per mg nitrate denitrified. With this approach it was found that the relative contribution of the PAOs to the denitrification rate is quite small - only 17% of the total rate, because they utilize relatively little COD compared with the OHOs. The average OHO and PAO denitrification rates ($K_2''_{OHO}$ and $K_2''_{PAO}$) were found to be 0.1206 mg$NO_3$-N/(mgOHOAVSS.d) and 0.0496 mg$NO_3$-N/(mgPAOAVSS.d). If the observed nitrate removal in the anoxic reactor (overloaded with nitrate ) were attributed to the OHOs then the uncorrected specific denitrification rate ($K_2'$) is 0.1379 mg$NO_3$-N/(mgOHOAVSS.d). This $K_2'$ rate has the same bases as the $K_2'$ rates measured in earlier investigations by Clayton *et al.* (1989) and Sneyders *et al.* (1998) in which no anoxic P uptake was observed and found the $K_2'$ denitrification rate to be 0.255 and 0.0711 mgNO3-N/(mgOHOAVSS.d) respectively. In investigations by Musvoto *et al.* (1992), Pilson *et al.* (1995) and Mellin *et al* (1995) significant anoxic P uptake was observed and they found the $K_2'$ denitrification rate to be 0.335, 0.181 and 0.254 mgNO3-N/(mgOHOAVSS.d) respectively.

## 4.4 BIOLOGICAL EXCESS PHOSPHOROUS REMOVAL

14. The effluent P concentration in the EN BNRAS system were kept above 5 mg/l by dosing P to the influent. This allowed the system average P removal capacity of 10.4 mgP/l influent or alternatively 0.015 mgP/mg influent COD to be measured.

15. An average P release of 31 mg P/l took place in the anaerobic reactor and the P uptake took place in both the aerobic and main anoxic reactors with averages 13 and 21mgP/l respectively. The latter translates into 43% and 56% P uptake taking place in the aerobic and main anoxic reactors respectively. In this investigation, a too low nitrate load on the main anoxic reactor during sewage batches 7 to 23 appeared to have a detrimental effect on the anoxic P uptake. The low nitrate load on the anoxic reactor was caused by a low nitrification efficiency in the external nitrification system (Configurations 2 and 3) which, with the larger aerobic mass fraction, resulted in the support of nitrifiers in the activated sludge system and significant internal nitrification. This in turn led to a high nitrate recycle to the anaerobic reactor (to much for the pre-anoxic to denitrify), and ultimately the P removal was reduced to 8.1 mgP/l.

16. From the model of Wentzel *et al.* (1990) the P content of the PAOs ($f_{XBG,P}$) was determined by adjusting the $f_{XBG,P}$ value(mgP/mgPAOAVSS) in the model until the calculated P removal equaled the measured P removal. An average $f_{XBG,P}$ value of 0.312 mgP/mgPAOAVSS was found for the EN BNRAS system. In earlier investigations by Clayton *et al.* (1989) and Sneyders *et al.* (1998) in which no anoxic P uptake was observed, the $f_{XBG,P}$ fraction was found to be 0.388 and 0.471 mgP/mgPAOAVSS respectively. In investigations by Musvoto *et al.* (1992), Pilson *et al.* (1995) and Mellin *et al* (1995) in which significant anoxic P uptake was observed, the $f_{XBG,P}$ fraction was found to be 0.144, 0.136 and 0.280 mgP/mgPAOAVSS respectively. Comparing the $f_{XBG,P}$ fraction obtained in this investigation with those obtained in earlier investigations we see that the $f_{XBG,P}$.is lower when anoxic P uptake is observed than when aerobic P uptake is observed.

## 4.5 FILAMENT IDENTIFICATION AND SLUDGE SETTLEABILTY

The AA filament bulking hypothesis of Casey *et al*. (1994) describes how a bulking sludge is the result of the nitrate and nitrite concentration ($NO_x$) leakage from the anoxic reactor to the aerobic reactor. If these concentrations are high (>1 mgN/l) in conjunction with low aerobic mass fraction (<0.70), then a bulking sludge with DSVI > 150 ml/g would prevail. The filament analyses were carried out on the EN BNRAS system approximately every 4 weeks during the 373 day investigation.

17. The most frequently dominant Anoxic Aerobic (AA, low F/M) filament was *M. parvicella*, while type 1851 and type 0092 were also identified as secondary filaments. Type 021N also occurred but being a septic sewage filament ( Jenkins *et al.*, 1984) this was probably due to aging sewage during storage. Apart from type 021N, these filaments are almost always observed in full scale NDBEPR systems (Blackbeard *et al.*, 1998)

18. The average $NO_x$ concentrations leaving the anoxic reactor in the EN BNRAS system was 2.8 $mgNO_x$-N/l. The stone column external nitrification system (Configuration 3) was replaced with the activated sludge system (Configuration 4) which led to a significantly improved nitrification efficiency, the aerobic mass fraction was increased to 30% at the expense of the anoxic mass fraction (30%), the sludge age was increased from 8 to 10 days and a 1: 1 mixed liquor a-recycle from the aerobic to the anoxic reactor was installed. All these changes led to increased nitrate load on the main anoxic reactor and a decreased denitrification potential leading to high nitrate and nitrite concentration in the outflow of the anoxic to the aerobic reactor.

19. The mean DSVI in the EN BNRAS system was 94 ml/g (standard deviation 27). This DSVI is ideal (between 80 and 100 ml/g). The fluctuations in the DSVI from ~125 ml/g at the start of the investigation to 80 ml/g mi-way through the investigation and finally to ~150 ml/g at the end of the investigation is a direct result of change in the external nitrification system and the increase in the aerobic mass fraction and sludge age. This period was also the time in which internal aerobic nitrification was significant which

meant that the BNRAS system now supported nitrifiers leading to higher effluent $NO_x$ concentrations (see 18 above). This observation i.e. an increase in the $NO_x$ concentration leaving the anoxic reactor with the increase in aerobic mass fraction and with the simultaneous increase in the DSVI, supports the hypothesis of Casey *et al.* (1994).

## 4.6 DISCUSSION

The external nitrification biological nutrient removal activated sludge system (BNRASS) allows a step increase in system intensification. Evaluation of the system at laboratory-scale indicates that the scheme holds considerable potential for BNR through the reductions in sludge age and oxygen demand and significant improvement in sludge settleability. Because the BNRASS is not required to nitrify, its anoxic fraction can be considerably enlarged at the expense of the aerobic mass fraction creating conditions that (i) allow it to achieve high N removal with domestic wastewaters with high TKN/COD ratios and (ii) promote anoxic P uptake polyphosphate accumulating organisms (PAOs) to develop in the BNRASS.

The behaviour observed in the laboratory-scale external nitrification BNRASS indicates significant (>56%) anoxic P uptake and reduced aerobic P uptake. To stimulate anoxic BEPR behaviour, it appears that (i) a high nitrate load and large anoxic mass fraction are required to ensure that the denitrifying PAOs (DPAOs) are not restricted in their P uptake and denitrification process (ii) a small aerobic mass fraction is required to limit aerobic PAO activity. The first requirement needs a high influent TKN/COD ratio. If this is too low (<0.14 mgN/mgCOD for the system design parameters) then insufficient nitrate is generated in the fixed media system for the denitrification potential of the anoxic reactor. From this investigation, too low a nitrate load on the anoxic reactors appears detrimental to the development of anoxic P uptake. A possible solution is to increase the TKN/COD ratio of the wastewater by including enhanced primary sedimentation. In fact, enhanced primary sedimentation may prove essential for this scheme, to facilitate acid fermentation of the primary sludge to generate additional volatile fatty acids (VFA) and readily biodegradable (RB)COD. These additional VFA and RBCOD are required to counter the observation that, in agreement with previous observations on conventional activated sludge systems (Ekama and Wentzel, 1997), the anoxic P uptake was reduced compared to aerobic P uptake, resulting in a similarly reduced BEPR per mass organic load. Including primary sedimentation and acid fermentation of the primary sludge will reduce the overall COD load on the system (and hence reduce the system volume and oxygen demand), and increase the TKN/COD ratio and VFA/RBCOD concentration, which would stimulate more DPAO growth in the system at the expense of the OHOs.

As an alternative to increasing the TKN/COD ratio of the wastewater, it is possible to reduce the anoxic mass fraction and correspondingly increase the aerobic mass fraction. Increasing the aerobic mass fraction will favour aerobic P uptake BEPR behaviour. In evaluating the performance of the external nitrification system with small aerobic mass fractions (Hu *et al.*, 1999), it appeared that anoxic P uptake caused BEPR to be reduced compared to aerobic P uptake. Also, denitrification in the large anoxic reactor was complete, with an "excess" denitrification potential for the influent wastewater TKN (nitrate had to dosed to the anoxic reactor to fully utilize the denitrification potential); from a denitrification point of view the anoxic reactor was in effect overdesigned. Further, in attempting to develop anoxic P uptake enhanced cultures (Hu *et al.*, in prep), it was not found possible to develop a stable culture, and the anoxic P uptake process was considered unreliable and unstable for reliable implementation at ful scale .

This lead to a re-evaluation of the importance of the reduced aerobic mass fraction. Inclusion of anoxic P uptake PAOs in, and exclusion of aerobic P uptake PAOs from, the biocenosis of the BNRASS mixed liquor are not essential for achieving BNR in the external nitrification scheme. In fact, inclusion and maximization of aerobic P uptake would appear desirable to maximize BEPR. However, conditions that promote aerobic P uptake BEPR, are also conducive to nitrifier growth and hence internal nitrification. Although exclusion of nitrifiers from the mixed liquor of the BNRASS was considered essential, this is not necessary as long as virtual complete nitrification in the external fixed/suspended media nitrification system is obtained to limit nitrification in the main aerobic reactor. In fact, complete exclusion of nitrifiers may not prove possible because although conditions in the BNRASS may not be conducive to their growth, they are likely to be seeded into the system from the external nitrification system. Accepting nitrification in the BNRASS and complete external nitrification, the nitrification in the BNRASS will be limited by the ammonia bypassing the external nitrification system with the internal settling tank underflow. Nitrate, if any, produced in the aerobic reactor is prevented from entering the anaerobic reactor with the underflow recycle by denitrification in the pre-anoxic reactor. However, should complete nitrification not be obtained in the external nitrification system, then the residual ammonia will be nitrified in the aerobic reactor of the BNRASS. If the aerobic reactor nitrate concentration is too high, the pre-anoxic will become overloaded with nitrate, resulting in nitrate discharge to the anaerobic reactor and a reduction in BEPR. However, if nitrification were not included in the BNR activated sludge system, the ammonia would leave the system via the effluent, which is a less desirable situation.

Recognizing the advantages of including aerobic uptake in the system, and in fact that including nitrification in the system is not entirely undesirable, the emphasis on large anoxic mass fractions to maximize anoxic P uptake process in the system has changed to the possibility of increasing the aerobic reactor mass fraction, to stimulate aerobic P uptake. Initial research on this aspect appears promising, in that increasing the aerobic mass fraction appears to improve BEPR and surprisingly, also stabilize anoxic P uptake. This is in agreement with the literature: In an investigation to select DPAOs, Bortone *et al.* (1996) operated an anaerobic/anoxic sequencing batch reactor (SBR). They found that this system did not stimulate BEPR. However, when a short aerobic period was included in the SBR cycle, stable BEPR with anoxic P uptake (and aerobic P uptake) was obtained. Thus it would appear that an aerobic period may be essential for stable anoxic P uptake. Recognizing that the anoxic P uptake DPAOs are facultative organisms, including an aerobic reactor would provide opportunity for aerobic metabolism by these organisms, in addition to the anoxic metabolism. Biochemically, aerobic metabolism provides a higher energy yield for the organism than anoxic metabolism, and this higher energy yield may provide the biological niche for DPAOs to stably exist in the system.

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# APPENDICES

APPENDIX A

Daily Results of the External Nitrification BNRAS System.
Figures A1 to A28 : Graphs of Daily Results.

APPENDIX B

Nitrogen Mass Balance.
COD Mass Balance.

APPENDIX C

Average Sewage Batch Results of External Nitrification System.
fS,up and fXBG,P Calculations for each Sewage Batch.

APPENDIX D

Design and Operating Parameters of the UCT Control System.
Daily Results of UCT Control System (monitored and measured by Mr. T Lakay.
Figures D1 to D18 : Graphs of Daily Results.

APPENDIX E

Average Sewage Batch Results of UCT Control System.
Figures E1 to E14 : Graphs of Average Sewage Batch Results.

APPENDIX F

Filament Identification in the External Nitrification and UCT Systems.

# APPENDIX A

- Daily Results of the External Nitrification BNRAS System.

- Figures A1 to A28 : Graphs of Daily Results.

# A.1

Daily Tests on Modified Dephenox BNRAS External Nitrification System

| Day No | 1998 | | Carbonaceous Oxygen Demand | | | | | | RBCOD Floc | | RBCOD | Free & Saline Ammonia | | | | Total Kjedahl Nitrogen | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sys. Inf | Reactor 3 | Fin_UEff | xtNit_FEff | IntSet_FEff | Fin_FEff | Floc Inf. | Floc Eff. | | Influent | Fin_UEff | xtNit_UEff | IntSet_UEff | Influent | Reactor 3 | Fin_UEff | xtNit_UEff | ntSet_UEff |
| | | | mgCOD/l | mgCOD/l | mgCOD/l | mgCOD/l | mgCOD/l | mgCOD/l | mgCOD/l | mgCOD/l | mgCOD/l | mgN/l | mgN/l | mgN/l | mgN/l | mgN/l | mgN/l | mgN/l | mgN/l | mgN/l |
| 1 | 24-Feb | Tuesday | 954 | 1876 | 56 | 71 | 183 | | | | | 46 | 7 | 4 | 25 | 77 | 129 | 7 | 12 | 25 |
| 2 | 25-Feb | Wednesday | 825 | 2105 | 63 | 96 | 208 | | | | | 40 | 4 | 1 | 23 | 61 | 126 | 3 | 3 | 29 |
| 3 | 26-Feb | Thursday | 650 | 1849 | 63 | 69 | 98 | | | | | 38 | 3 | 4 | 22 | 63 | 140 | 1 | 2 | 29 |
| End of Batch 1 | | | 810 | 1943 | 61 | 79 | 163 | | | | | 42 | 5 | 3 | 23 | 67 | 132 | 4 | 6 | 28 |
| 4 | 27-Feb | Friday | 610 | 1585 | 26 | 39 | 96 | | | | | 46 | 2 | 4 | 25 | 67 | 114 | 3 | 3 | 31 |
| 5 | 28-Feb | Saturday | 642 | 2520 | 49 | 45 | 130 | | | | | 47 | 2 | 3 | 27 | 66 | 129 | 4 | 3 | 29 |
| 6 | 01-Mar | Sunday | 642 | 2195 | 85 | 61 | 110 | | | | | 48 | 2 | 3 | 26 | 64 | 137 | 3 | 4 | 28 |
| 7 | 02-Mar | Monday | 646 | 2073 | 55 | 49 | 118 | | 165 | 45 | 120 | 48 | 2 | 3 | 24 | 63 | 136 | 3 | 4 | 27 |
| 8 | 03-Mar | Tuesday | 545 | 1626 | 16 | 24 | 77 | | 116 | 20 | 96 | 45 | 2 | 3 | 24 | 67 | 105 | 2 | 7 | 30 |
| 9 | 04-Mar | Wednesday | 541 | 1361 | 37 | 51 | 96 | | | | | 48 | 2 | 3 | 22 | 63 | 120 | 3 | 5 | 31 |
| 10 | 05-Mar | Thursday | 577 | 4227 | 33 | 33 | 89 | | 120 | 20 | 100 | 50 | 1 | 2 | 26 | 69 | 179 | 2 | 7 | 32 |
| 11 | 06-Mar | Friday | 597 | 2540 | 43 | 67 | 91 | | | | | 55 | 1 | 3 | 27 | 69 | 175 | | | 33 |
| 12 | 07-Mar | Saturday | 561 | 2398 | 8 | 49 | 89 | | | | | 55 | 2 | 3 | 28 | 69 | 181 | 2 | 4 | 33 |
| 13 | 08-Mar | Sunday | 593 | 2682 | 37 | 41 | 81 | | | | | 56 | 2 | 4 | 29 | 70 | 183 | 1 | 3 | 34 |
| 14 | 09-Mar | Monday | 618 | 2885 | 55 | 47 | 136 | | 165 | 67 | 98 | 55 | 2 | 4 | 29 | 71 | 176 | 2 | 3 | 35 |
| 15 | 10-Mar | Tuesday | 620 | 2668 | 50 | 60 | 101 | | | | | 53 | 1 | 3 | 25 | 70 | 169 | 2 | 3 | 33 |
| 16 | 11-Mar | Wednesday | 620 | 2358 | 43 | 41 | 112 | | | | | 53 | 2 | 3 | 26 | 69 | 172 | 2 | 4 | 32 |
| 17 | 12-Mar | Thursday | 753 | 2730 | 29 | 62 | 120 | | 151 | 50 | 101 | 49 | 3 | 3 | 24 | 68 | 162 | 1 | 2 | 33 |
| End of Batch 2 | | | 612 | 2418 | 41 | 48 | 103 | | 143 | 40 | 103 | 51 | 2 | 3 | 26 | 67 | 153 | 2 | 4 | 31 |
| 18 | 13-Mar | Friday | 711 | 3619 | 30 | 37 | 128 | | | | | 44 | 1 | 1 | 25 | 70 | 208 | 2 | 2 | 31 |
| 19 | 14-Mar | Saturday | 662 | 3598 | 8 | 37 | 91 | | | | | 46 | 2 | 3 | 25 | 73 | 220 | 2 | 3 | 32 |
| 20 | 15-Mar | Sunday | 769 | 3681 | 8 | 50 | 132 | | | | | 48 | 3 | 4 | 26 | 63 | 153 | 4 | 4 | 32 |
| 21 | 16-Mar | Monday | 678 | 3412 | 17 | 6 | 114 | | | | | 50 | 3 | 4 | 27 | 67 | 174 | 5 | 5 | 32 |
| 22 | 17-Mar | Tuesday | | | | | | | | | | | | | | | | | | |
| End of Batch 3 | | | 705 | 3578 | 21 | 33 | 116 | | | | | 47 | 3 | 3 | 26 | 69 | 188 | 3 | 4 | 32 |
| 23 | 18-Mar | Wednesday | | | | | | | | | | | | | | | | | | |
| 24 | 19-Mar | Thursday | | | | | | | | | | | | | | | | | | |
| 25 | 20-Mar | Friday | | | | | | | | | | | | | | | | | | |
| 26 | 21-Mar | Saturday | | | | | | | | | | | | | | | | | | |
| 27 | 22-Mar | Sunday | | | | | | | | | | | | | | | | | | |
| 28 | 23-Mar | Monday | 658 | 3638 | 69 | 61 | 184 | | 125 | 4 | 121 | 53 | 16 | 20 | 30 | 64 | 241 | 21 | 24 | 43 |
| 29 | 24-Mar | Tuesday | 670 | 3373 | 106 | 92 | 137 | | 192 | 88 | 104 | 49 | 16 | 18 | 36 | 69 | 207 | 18 | 21 | 46 |
| 30 | 25-Mar | Wednesday | 695 | 4558 | 127 | 92 | 235 | | 127 | 84 | 43 | 46 | 15 | 17 | 39 | 66 | 253 | 17 | 21 | 42 |
| End of Batch 4 | | | 675 | 3856 | 101 | 82 | 185 | | 148 | 59 | 89 | 49 | 16 | 18 | 32 | 66 | 234 | 19 | 22 | 43 |
| 31 | 26-Mar | Thursday | | | | | | | | | | | | | | | | | | |
| 32 | 27-Mar | Friday | 760 | 2310 | 51 | 55 | 174 | 22 | 141 | 100 | 41 | 43 | 8 | 11 | 25 | 61 | 192 | 9 | 13 | 31 |
| 33 | 28-Mar | Saturday | 752 | 2616 | 78 | 86 | 172 | 69 | | | | 43 | 8 | 10 | 24 | 62 | 178 | 8 | 12 | 33 |
| 34 | 29-Mar | Sunday | 693 | 2412 | 37 | 49 | 151 | 33 | | | | 40 | 7 | 8 | 22 | 58 | 181 | 9 | 11 | 34 |
| 35 | 30-Mar | Monday | 679 | 2739 | 45 | 61 | 94 | 29 | | | | 37 | 6 | 8 | 23 | 55 | 135 | 8 | 10 | 31 |
| 36 | 31-Mar | Tuesday | | | | | | | | | | | | | | | | | | |
| 37 | 01-Apr | Wednesday | | | | | | | | | | | | | | | | | | |
| 38 | 02-Apr | Thursday | | | | | | | | | | | | | | | | | | |
| End of Batch 5 | | | 722 | 2519 | 53 | 63 | 148 | 38 | 141 | 100 | 41 | 41 | 7 | 9 | 24 | 59 | 171 | 9 | 11 | 32 |
| 39 | 03-Apr | Friday | | | | | | | | | | | | | | | | | | |
| 40 | 04-Apr | Saturday | | | | | | | | | | | | | | | | | | |
| 41 | 05-Apr | Sunday | | | | | | | | | | | | | | | | | | |
| 42 | 06-Apr | Monday | 633 | 2771 | 72 | 83 | 174 | 95 | | | | 64 | 18 | 20 | 40 | 79 | 293 | 19 | 25 | 45 |
| 43 | 07-Apr | Tuesday | 612 | 4322 | 54 | 95 | 178 | | 64 | 27 | 37 | 63 | 17 | 18 | 37 | 81 | 309 | 20 | 27 | 43 |
| 44 | 08-Apr | Wednesday | 620 | 3557 | 66 | 58 | 124 | 62 | | | | 60 | 17 | 18 | 41 | 82 | 328 | 19 | 25 | 51 |
| 45 | 09-Apr | Thursday | 736 | 4917 | 110 | 89 | 211 | 63 | | | | 58 | 16 | 18 | 46 | 81 | 312 | 19 | 28 | 54 |
| End of Batch 6 | | | 650 | 3893 | 76 | 81 | 172 | 73 | 64 | 27 | 37 | 61 | 17 | 18 | 41 | 81 | 310 | 19 | 26 | 48 |
| 46 | 10-Apr | Friday | 673 | 2398 | 53 | 83 | 179 | | 65 | 12 | 53 | 71 | 46 | 27 | 63 | 86 | 290 | 41 | 37 | 72 |
| 47 | 11-Apr | Saturday | 683 | 2438 | 65 | 69 | 158 | | 89 | 28 | 61 | 73 | 49 | 32 | 66 | 99 | 302 | 40 | 35 | 74 |
| 48 | 12-Apr | Sunday | | | | | | | | | | | | | | | | | | |
| 49 | 13-Apr | Monday | | | | | | | | | | | | | | | | | | |
| 50 | 14-Apr | Tuesday | | | | | | | | | | | | | | | | | | |
| 51 | 15-Apr | Wednesday | 715 | 1869 | 81 | 24 | 134 | 33 | | | | 76 | 46 | 35 | 37 | 92 | 297 | 49 | 38 | 70 |
| 52 | 16-Apr | Thursday | 711 | 2540 | 112 | 75 | 185 | | | | | 73 | 47 | 33 | 66 | 88 | 274 | 56 | 14 | 72 |
| End of Batch 7 | | | 696 | 2311 | 78 | 64 | 164 | 33 | 77 | 20 | 57 | 73 | 47 | 32 | 63 | 91 | 291 | 47 | 31 | 72 |
| 53 | 17-Apr | Friday | 768 | 4674 | 122 | 43 | 152 | | 152 | 53 | 100 | 70 | 43 | 34 | 57 | 94 | 384 | 50 | 25 | 67 |
| 54 | 18-Apr | Saturday | | | | | | | | | | | | | | | | | | |
| 55 | 19-Apr | Sunday | 718 | 4376 | 54 | 70 | 116 | | 134 | 29 | 105 | 53 | 20 | 19 | 36 | 68 | 276 | 26 | 22 | 43 |
| 56 | 20-Apr | Monday | 706 | 4149 | 99 | 93 | 204 | 93 | | | | 52 | 19 | 17 | 35 | 66 | 259 | 24 | 24 | 42 |
| 57 | 21-Apr | Tuesday | 660 | 3880 | 64 | 114 | 147 | | 153 | 31 | 122 | 45 | 16 | 17 | 33 | 67 | 270 | 21 | 22 | 43 |
| 58 | 22-Apr | Wednesday | 652 | 3571 | 68 | 83 | 157 | 58 | | | | 49 | 17 | 18 | 33 | 69 | 228 | 19 | 22 | 44 |
| 59 | 23-Apr | Thursday | 632 | 3591 | 62 | 87 | 140 | | 149 | 39 | 109 | 45 | 14 | 17 | 35 | 65 | 213 | 19 | 22 | 44 |
| 60 | 24-Apr | Friday | | | | | | | | | | | | | | | | | | |
| 61 | 25-Apr | Saturday | 644 | 4300 | 87 | 66 | 128 | 58 | | | | 48 | 16 | 14 | 33 | 62 | 409 | 18 | 20 | 43 |
| 62 | 26-Apr | Sunday | 677 | 5263 | 76 | 99 | 173 | | 118 | 41 | 76 | 45 | 13 | 13 | 32 | 61 | 404 | 16 | 17 | 41 |
| 63 | 27-Apr | Monday | | | | | | | | | | | | | | | | | | |
| 64 | 28-Apr | Tuesday | 578 | 4747 | 58 | 107 | 124 | 29 | | | | 46 | 14 | 13 | 32 | 64 | 406 | 18 | 20 | 45 |
| 65 | 29-Apr | Wednesday | | | | | | | | | | | | | | | | | | |
| End of Batch 8 | | | 671 | 4306 | 77 | 85 | 149 | 59 | 141 | 39 | 102 | 50 | 19 | 18 | 36 | 68 | 316 | 23 | 22 | 46 |
| 66 | 30-Apr | Thursday | 734 | 4243 | 41 | 57 | 151 | | 167 | 24 | 143 | 42 | 7 | 8 | 27 | 70 | 217 | 14 | 15 | 37 |
| 67 | 01-May | Friday | 710 | 4447 | 98 | 24 | 98 | | | | | 41 | 8 | 8 | 28 | 69 | 227 | 16 | 19 | 39 |
| 68 | 02-May | Saturday | 677 | 4039 | 53 | 29 | 73 | | | | | 42 | 8 | 9 | 31 | 70 | 238 | 15 | 17 | 43 |
| End of Batch 9 | | | 707 | 4243 | 64 | 37 | 107 | | 167 | 24 | 143 | 42 | 8 | 8 | 29 | 70 | 227 | 15 | 17 | 40 |
| 69 | 03-May | Sunday | | | | | | | | | | | | | | | | | | |
| 70 | 04-May | Monday | | | | | | | | | | | | | | | | | | |
| 71 | 05-May | Tuesday | | | | | | | | | | | | | | | | | | |
| 72 | 06-May | Wednesday | | | | | | | | | | | | | | | | | | |
| 73 | 07-May | Thursday | | | | | | | | | | | | | | | | | | |
| 74 | 08-May | Friday | | | | | | | | | | | | | | | | | | |
| End of Batch10 | | | | | | | | | | | | | | | | | | | | |
| 75 | 09-May | Saturday | 734 | 4243 | 41 | 57 | 151 | | 167 | 24 | 143 | 42 | 7 | 8 | 27 | 70 | 217 | 14 | 15 | 37 |
| 76 | 10-May | Sunday | 710 | 4447 | 98 | 24 | 98 | | | | | 41 | 8 | 8 | 28 | 69 | 227 | 16 | 19 | 39 |
| 77 | 11-May | Monday | 677 | 4039 | 53 | 29 | 73 | | | | | 42 | 8 | 9 | 31 | 70 | 238 | 15 | 17 | 43 |
| 78 | 12-May | Tuesday | 702 | 1785 | 74 | 74 | 176 | | 187 | 25 | 162 | 60 | 27 | 30 | 39 | 69 | 127 | 31 | 34 | 49 |
| 79 | 13-May | Wednesday | 714 | 3181 | 80 | 135 | 152 | | 174 | 57 | 117 | 67 | 29 | 25 | 41 | 120 | 199 | 30 | 33 | 50 |
| 80 | 14-May | Thursday | | | | | | | | | | | | | | | | | | |
| 81 | 15-May | Friday | 558 | 2893 | 70 | 88 | 166 | | 144 | 35 | 109 | 50 | 22 | 24 | 43 | 59 | 160 | 27 | 30 | 47 |
| 82 | 16-May | Saturday | | | | | | | | | | | | | | | | | | |
| 83 | 17-May | Sunday | 665 | 2832 | 80 | 37 | 168 | 33 | | | | 57 | 28 | 13 | 40 | 69 | 207 | 27 | 20 | 52 |
| 84 | 18-May | Monday | 669 | 3365 | 64 | 66 | 144 | | 129 | 51 | 78 | 66 | 28 | 10 | 43 | 67 | 115 | 32 | 14 | 51 |
| 85 | 19-May | Tuesday | 624 | 3345 | 80 | 144 | 152 | | 125 | 74 | 51 | 53 | 28 | 4 | 42 | 95 | 231 | 33 | 9 | 58 |
| End of Batch 11 | | | 673 | 3350 | 71 | 73 | 142 | 33 | 154 | 44 | 110 | 53 | 21 | 14 | 37 | 76 | 191 | 25 | 21 | 47 |
| 86 | 20-May | Wednesday | 600 | 3182 | 53 | 67 | 137 | 47 | | | | 49 | 21 | 23 | 43 | 71 | 215 | 28 | 23 | 40 |
| 87 | 21-May | Thursday | | | | | | | | | | | | | | | | | | |
| 88 | 22-May | Friday | 718 | 3264 | 61 | 110 | 151 | | 220 | 51 | 169 | 74 | 36 | 38 | 57 | 88 | 196 | 45 | 35 | 63 |
| 89 | 23-May | Saturday | 706 | 2897 | 41 | 94 | 165 | 37 | | | | 73 | 33 | 37 | 50 | 90 | 231 | 46 | 38 | 58 |
| 90 | 24-May | Sunday | 596 | 2836 | 88 | 137 | 194 | 63 | | | | 72 | 34 | 38 | 61 | 87 | 234 | 42 | 46 | 72 |
| 91 | 25-May | Monday | 698 | 1836 | 94 | 118 | 216 | | 120 | 55 | 65 | 60 | 38 | 34 | 62 | 92 | 118 | 43 | 46 | 66 |
| 92 | 26-May | Tuesday | | | | | | | | | | | | | | | | | | |
| 93 | 27-May | Wednesday | | | | | | | | | | | | | | | | | | |
| 94 | 28-May | Thursday | 612 | 2856 | 65 | 71 | 180 | 29 | | | | 63 | 37 | 33 | 56 | 88 | 227 | 42 | 45 | 63 |
| 95 | 29-May | Friday | 649 | 2570 | 80 | 49 | 151 | | 122 | 29 | 94 | 58 | 24 | 27 | 42 | 80 | 211 | 38 | 37 | 51 |
| 96 | 30-May | Saturday | 673 | 3427 | 86 | 12 | 171 | 59 | | | | 52 | 23 | 21 | 37 | 74 | 209 | 27 | 23 | 43 |
| 97 | 31-May | Sunday | 595 | 2894 | 105 | 77 | 138 | 55 | | | | 44 | 20 | 21 | 38 | 68 | 238 | 25 | 27 | 42 |
| 98 | 01-Jun | Monday | 619 | 2975 | 63 | 83 | 164 | | 176 | 45 | 132 | 47 | 19 | 21 | 39 | 70 | 224 | 27 | 28 | 45 |
| 99 | 02-Jun | Tuesday | | | | | | | | | | | | | | | | | | |
| 100 | 03-Jun | Wednesday | | | | | | | | | | | | | | | | | | |
| 101 | 04-Jun | Thursday | | | | | | | | | | | | | | | | | | |
| 102 | 05-Jun | Friday | | | | | | | | | | | | | | | | | | |
| End of Batch 12 | | | 647 | 2876 | 74 | 82 | 169 | 48 | 160 | 45 | 92 | 59 | 28 | 29 | 48 | 81 | 211 | 37 | 35 | 54 |
| 103 | 06-Jun | Saturday | | | | | | | | | | | | | | | | | | |
| 104 | 07-Jun | Sunday | 708 | 4250 | 83 | 103 | 146 | 47 | | | | 60 | 29 | 7 | 46 | 101 | 286 | 34 | 34 | 54 |
| 105 | 08-Jun | Monday | 708 | 4250 | 83 | 103 | 146 | 47 | | | | 60 | 29 | 7 | 46 | 101 | 286 | 34 | 34 | 54 |
| 106 | 09-Jun | Tuesday | | | | | | | | | | | | | | | | | | |
| 107 | 10-Jun | Wednesday | | | | | | | | | | | | | | | | | | |
| 108 | 11-Jun | Thursday | 781 | 3537 | 144 | 78 | 164 | | 162 | 53 | 109 | 63 | 33 | 32 | 46 | 81 | 227 | 40 | 38 | 57 |
| 109 | 12-Jun | Friday | 530 | 3207 | 54 | 115 | 169 | 66 | | | | 48 | 25 | 28 | 37 | 75 | 220 | 37 | 35 | 43 |
| End of Batch13 | | | 682 | 3816 | 99 | 101 | 156 | 53 | 162 | 53 | 109 | 58 | 29 | 18 | 44 | 90 | 254 | 36 | 36 | 52 |
| 110 | 13-Jun | Saturday | | | | | | | | | | | | | | | | | | |
| 111 | 14-Jun | Sunday | | | | | | | | | | | | | | | | | | |
| 112 | 15-Jun | Monday | | | | | | | | | | | | | | | | | | |
| 113 | 16-Jun | Tuesday | | | | | | | | | | | | | | | | | | |
| 114 | 17-Jun | Wednesday | | | | | | | | | | | | | | | | | | |
| End of Batch14 | | | | | | | | | | | | | | | | | | | | |
| 115 | 18-Jun | Thursday | | | | | | | | | | | | | | | | | | |
| 116 | 19-Jun | Friday | | | | | | | | | | | | | | | | | | |
| 117 | 20-Jun | Saturday | | | | | | | | | | | | | | | | | | |
| 118 | 21-Jun | Sunday | | | | | | | | | | | | | | | | | | |
| 119 | 22-Jun | Monday | | | | | | | | | | | | | | | | | | |
| End of Batch15 | | | | | | | | | | | | | | | | | | | | |

# A.2

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Carbonaceous Oxygen Demand | | | | | | RBCOD Floc | | RBCOD | Free & Saline Ammonia | | | | Total Kjeldahl Nitrogen | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Syn Inf mgCOD/l | Reactor 3 mgCOD/l | Fin_UEff mgCOD/l | ExtNit_FEff mgCOD/l | IntSet_FEff mgCOD/l | Fin_FEff mgCOD/l | Floc Inf mgCOD/l | Floc Eff mgCOD/l | mgCOD/l | Influent mgN/l | Fin_UEff mgN/l | ExtNit_UEff mgN/l | IntSet_UEff mgN/l | Influent mgN/l | Reactor 3 mgN/l | Fin_UEff mgN/l | ExtNit_UEff mgN/l | IntSet_UEff mgN/l |
| 120 | 23-Jun | Tuesday | | | | | | | | | | | | | | | | | | |
| 121 | 24-Jun | Wednesday | 760 | 3500 | 78 | 94 | 198 | | 148 | 52 | 96 | 81 | 67 | 60 | 66 | 106 | 258 | 74 | 63 | 80 |
| 122 | 25-Jun | Thursday | | | | | | | | | | | | | | | | | | |
| 123 | 26-Jun | Friday | 736 | 4600 | 78 | 84 | 184 | | 86 | 36 | 50 | 66 | 45 | 51 | 67 | 97 | 337 | 60 | 61 | 78 |
| 124 | 27-Jun | Saturday | | | | | | | | | | | | | | | | | | |
| 125 | 28-Jun | Sunday | | | | | | | | | | | | | | | | | | |
| End of Batch16 | | | 748 | 4050 | 78 | 89 | 191 | | 117 | 44 | 73 | 74 | 56 | 55 | 67 | 101 | 298 | 67 | 62 | 79 |
| 126 | 29-Jun | Monday | 708 | 3940 | 64 | 84 | 140 | 62 | | | | 64 | 43 | 39 | 57 | 88 | 283 | 48 | 42 | 78 |
| 127 | 30-Jun | Tuesday | | | | | | | | | | | | | | | | | | |
| 128 | 01-Jul | Wednesday | 584 | 3320 | 76 | 56 | 136 | | 148 | 40 | 108 | 69 | 38 | 46 | 60 | 101 | 351 | 44 | 51 | 63 |
| 129 | 02-Jul | Thursday | 652 | 3020 | 86 | 96 | 180 | | 178 | 38 | 140 | 76 | 38 | 46 | 57 | 106 | 350 | 43 | 51 | 63 |
| 130 | 03-Jul | Friday | | | | | | | | | | | | | | | | | | |
| 131 | 04-Jul | Saturday | | | | | | | | | | | | | | | | | | |
| 132 | 05-Jul | Sunday | | | | | | | | | | | | | | | | | | |
| 133 | 06-Jul | Monday | 700 | 3640 | 94 | 86 | 194 | 62 | | | | 41 | 24 | 25 | 33 | 50 | 147 | 25 | 30 | 39 |
| 134 | 07-Jul | Tuesday | | | | | | | | | | | | | | | | | | |
| End of Batch17 | | | 661 | 3480 | 83 | 80 | 163 | 62 | 163 | 39 | | 62 | 36 | 39 | 52 | 86 | 283 | 40 | 43 | 61 |
| 135 | 08-Jul | Wednesday | | | | | | | | | | | | | | | | | | |
| 136 | 09-Jul | Thursday | 608 | 3840 | 96 | 140 | 164 | | 136 | 58 | 78 | 60 | 36 | 34 | 46 | 70 | 129 | 38 | 43 | 49 |
| 137 | 10-Jul | Friday | | | | | | | | | | 69 | 31 | 35 | 44 | 78 | 259 | 34 | 35 | 46 |
| 138 | 11-Jul | Saturday | 632 | 3160 | 78 | 94 | 142 | 64 | | | | 56 | 22 | 35 | 45 | 80 | 311 | 34 | 39 | 50 |
| 139 | 12-Jul | Sunday | | | | | | | | | | | | | | | | | | |
| 140 | 13-Jul | Monday | | | | | | | | | | | | | | | | | | |
| 141 | 14-Jul | Tuesday | | | | | | | | | | | | | | | | | | |
| 142 | 15-Jul | Wednesday | | | | | | | | | | | | | | | | | | |
| 143 | 16-Jul | Thursday | | | | | | | | | | | | | | | | | | |
| 144 | 17-Jul | Friday | | | | | | | | | | | | | | | | | | |
| 145 | 18-Jul | Saturday | | | | | | | | | | | | | | | | | | |
| 146 | 19-Jul | Sunday | | | | | | | | | | | | | | | | | | |
| 147 | 20-Jul | Monday | | | | | | | | | | | | | | | | | | |
| End of Batch 18 | | | 620 | 3500 | 87 | 117 | 153 | 64 | 136 | 38 | 78 | 61 | 30 | 35 | 45 | 76 | 233 | 35 | 39 | 48 |
| 148 | 21-Jul | Tuesday | | | | | | | | | | | | | | | | | | |
| 149 | 22-Jul | Wednesday | | | | | | | | | | | | | | | | | | |
| End of Batch 19 | | | | | | | | | | | | | | | | | | | | |
| 150 | 23-Jul | Thursday | | | | | | | | | | | | | | | | | | |
| 151 | 24-Jul | Friday | 734 | 3631 | 73 | 90 | 159 | 57 | | | | 64 | 34 | 41 | 53 | 70 | 262 | 39 | 46 | 64 |
| 152 | 25-Jul | Saturday | 616 | 2938 | 57 | 71 | 120 | | 139 | 39 | 100 | 59 | 35 | 41 | 48 | 88 | 330 | 39 | 44 | 61 |
| 153 | 26-Jul | Sunday | | | | | | | | | | | | | | | | | | |
| 154 | 27-Jul | Monday | 608 | 3427 | 59 | 88 | 153 | | 133 | 29 | 104 | 60 | 38 | 38 | 51 | 82 | 251 | 36 | 42 | 56 |
| End of Batch 20 | | | 653 | 3332 | 63 | 83 | 144 | 57 | 136 | 34 | 102 | 61 | 36 | 40 | 50 | 80 | 281 | 38 | 44 | 60 |
| 155 | 28-Jul | Tuesday | | | | | | | | | | | | | | | | | | |
| 156 | 29-Jul | Wednesday | | | | | | | | | | | | | | | | | | |
| 157 | 30-Jul | Thursday | | | | | | | | | | | | | | | | | | |
| 158 | 31-Jul | Friday | | | | | | | | | | | | | | | | | | |
| 159 | 01-Aug | Saturday | | | | | | | | | | | | | | | | | | |
| 160 | 02-Aug | Sunday | | | | | | | | | | | | | | | | | | |
| 151 | 03-Aug | Monday | End of Bat | | | | | | | | | | | | | | | | | |
| 162 | 04-Aug | Tuesday | | | | | | | | | | | | | | | | | | |
| 163 | 05-Aug | Wednesday | | | | | | | | | | | | | | | | | | |
| 164 | 06-Aug | Thursday | | | | | | | | | | | | | | | | | | |
| 165 | 07-Aug | Friday | | | | | | | | | | | | | | | | | | |
| 166 | 08-Aug | Saturday | | | | | | | | | | | | | | | | | | |
| 167 | 09-Aug | Sunday | | | | | | | | | | | | | | | | | | |
| 168 | 10-Aug | Monday | | | | | | | | | | | | | | | | | | |
| 169 | 11-Aug | Tuesday | 564 | 4060 | 70 | 72 | 176 | 50 | | | | 67 | 26 | 29 | 34 | 81 | 116 | 34 | 36 | 47 |
| 170 | 12-Aug | Wednesday | 612 | 4160 | 36 | 102 | 122 | | 154 | 28 | 126 | 71 | 28 | 30 | 38 | 87 | 141 | 31 | 32 | 56 |
| 171 | 13-Aug | Thursday | | | | | | | | | | | | | | | | | | |
| 172 | 14-Aug | Friday | | | | | | | | | | | | | | | | | | |
| 173 | 15-Aug | Saturday | | | | | | | | | | | | | | | | | | |
| 174 | 16-Aug | Sunday | | | | | | | | | | | | | | | | | | |
| 175 | 17-Aug | Monday | | | | | | | | | | | | | | | | | | |
| End of Batch 22 | | | 588 | 4110 | 53 | 87 | 149 | 50 | 154 | 28 | 63 | 69 | 27 | 30 | 37 | 84 | 129 | 33 | 34 | 51 |
| 176 | 18-Aug | Tuesday | 608 | 3500 | 68 | 100 | 116 | 38 | | | | 44 | 9 | 20 | 27 | 59 | 208 | 10 | 25 | 31 |
| 177 | 19-Aug | Wednesday | 680 | 3180 | 60 | 80 | 116 | | 194 | 42 | 152 | 37 | 6 | 22 | 25 | 64 | 221 | 7 | 27 | 33 |
| 178 | 20-Aug | Thursday | 624 | 2460 | 40 | 78 | 118 | 48 | | | | 39 | 11 | 16 | 28 | 57 | 245 | 16 | 27 | 34 |
| 179 | 21-Aug | Friday | | | | | | | | | | | | | | | | | | |
| 180 | 22-Aug | Saturday | 687 | 3698 | 59 | 85 | 122 | 53 | | | | 39 | 11 | 16 | 28 | 57 | 245 | 16 | 27 | 34 |
| 181 | 23-Aug | Sunday | | | | | | | | | | | | | | | | | | |
| 182 | 24-Aug | Monday | 642 | 3536 | 30 | 61 | 85 | 28 | | | | 41 | 7 | 20 | 24 | 65 | 253 | 12 | 27 | 34 |
| 183 | 25-Aug | Tuesday | 671 | 3719 | 57 | 114 | 134 | | 53 | 33 | 20 | 41 | 14 | 22 | 29 | 64 | 266 | 18 | 31 | 33 |
| 184 | 26-Aug | Wednesday | | | | | | | | | | | | | | | | | | |
| 185 | 27-Aug | Thursday | | | | | | | | | | | | | | | | | | |
| 186 | 28-Aug | Friday | | | | | | | | | | | | | | | | | | |
| 187 | 29-Aug | Saturday | | | | | | | | | | | | | | | | | | |
| 188 | 30-Aug | Sunday | | | | | | | | | | | | | | | | | | |
| End of Batch 23 | | | 652 | 3349 | 52 | 86 | 115 | 42 | 123 | 37 | 86 | 40 | 9 | 19 | 27 | 61 | 240 | 13 | 27 | 33 |
| 189 | 31-Aug | Monday | 691 | 3678 | 77 | 83 | 128 | 53 | | | | 43 | 10 | 22 | 30 | 63 | 214 | 14 | 28 | 34 |
| 190 | 01-Sep | Tuesday | 703 | 2987 | 71 | 89 | 146 | | 158 | 35 | 124 | 31 | 10 | 26 | 30 | 52 | 167 | 15 | 32 | 35 |
| 191 | 02-Sep | Wednesday | 711 | 2723 | 69 | 73 | 134 | 49 | | | | 40 | 9 | 24 | 30 | 64 | 157 | 14 | 30 | 36 |
| 192 | 03-Sep | Thursday | 671 | 2784 | 87 | 87 | 205 | 67 | | | | 43 | 12 | 27 | 32 | 63 | 139 | 16 | 32 | 38 |
| 193 | 04-Sep | Friday | | | | | | | | | | | | | | | | | | |
| 194 | 05-Sep | Saturday | | | | | | | | | | | | | | | | | | |
| 195 | 06-Sep | Sunday | 1071 | 4015 | 53 | 51 | 128 | 39 | | | | 46 | 15 | 30 | 35 | 75 | 235 | 18 | 35 | 46 |
| 196 | 07-Sep | Monday | | | | | | | | | | | | | | | | | | |
| End of Batch 24 | | | 769 | 3237 | 72 | 77 | 148 | 52 | 158 | 35 | 124 | 41 | 11 | 36 | 31 | 63 | 182 | 15 | 31 | 38 |
| 197 | 08-Sep | Tuesday | | | | | | | | | | | | | | | | | | |
| 198 | 09-Sep | Wednesday | | | | | | | | | | | | | | | | | | |
| 199 | 10-Sep | Thursday | 539 | 2920 | 69 | 57 | 142 | | 75 | 45 | 30 | 55 | 11 | 37 | 40 | 84 | 161 | 14 | 40 | 47 |
| 200 | 11-Sep | Friday | 629 | 3366 | 63 | 41 | 134 | | 142 | 30 | 112 | 48 | 11 | 35 | 34 | 74 | 227 | 15 | 39 | 42 |
| 201 | 12-Sep | Saturday | | | | | | | | | | | | | | | | | | |
| 202 | 13-Sep | Sunday | 556 | 2718 | 39 | 73 | 142 | 47 | | | | 61 | 11 | 34 | 37 | 78 | 210 | 15 | 39 | 45 |
| 203 | 14-Sep | Monday | | | | | | | | | | sludge in tr | | | | | | | | |
| 204 | 15-Sep | Tuesday | | | | | | | | | | | | | | | | | | |
| 205 | 16-Sep | Wednesday | | | | | | | | | | | | | | | | | | |
| End of Batch 25 | | | 575 | 3001 | 57 | 57 | 139 | 47 | 108 | 38 | 71 | 55 | 11 | 35 | 37 | 79 | 199 | 15 | 39 | 45 |
| 206 | 17-Sep | Thursday | | | | | | | | | | | | | | | | | | |
| 207 | 18-Sep | Friday | | | | | | | | | | | | | | | | | | |
| 208 | 19-Sep | Saturday | | | | | | | | | | | | | | | | | | |
| 209 | 20-Sep | Sunday | 648.72 | 2244 | 16.32 | 22.44 | 120.36 | 51 | | | | 37.52 | 3.08 | 6.3 | 25.9 | 68.6 | 191.8 | 10.78 | 12.11 | 30.24 |
| 210 | 21-Sep | Monday | 767.04 | 1897.2 | 71.4 | 148.92 | 189.72 | | 67.64 | 32.64 | 51 | 38.08 | 7.21 | 27.79 | 30.38 | 76.16 | 117.6 | 8.82 | 33.32 | 44.94 |
| 211 | 22-Sep | Tuesday | 779.28 | 2019.6 | 67.32 | 153 | 246.84 | | 128.52 | 38.76 | 89.76 | 46.06 | 3.36 | 20.37 | 38.92 | 72.8 | 96.6 | 9.52 | 30.52 | 49 |
| 212 | 23-Sep | Wednesday | 844.56 | 3304.8 | 81.6 | 81.6 | 183.6 | 73.44 | | | | 54.32 | 4.55 | 19.18 | 28.07 | 68.04 | 162.4 | 6.44 | 22.33 | 34.86 |
| 213 | 24-Sep | Thursday | | | | | | | | | | | | | | | | | | |
| 214 | 25-Sep | Friday | 668 | 1840 | 74 | 78 | 134 | | 150 | 44 | 106 | 49.98 | 10.99 | 9.52 | 14.98 | 75.32 | 160.3 | 19.53 | 15.05 | 12.67 |
| 215 | 26-Sep | Saturday | 664 | 1980 | 72 | 100 | 152 | 60 | | | | 57.82 | 7.35 | 10.64 | 29.68 | 89.18 | 136.5 | 8.26 | 9.38 | 35 |
| 216 | 27-Sep | Sunday | | | | | | | | | | | | | | | | | | |
| 217 | 28-Sep | Monday | | | | | | | | | | | | | | | | | | |
| 218 | 29-Sep | Tuesday | | | | | | | | | | | | | | | | | | |
| 219 | 30-Sep | Wednesday | | | | | | | | | | | | | | | | | | |
| End of Batch 26 | | | 728.6 | 2214.2667 | 63.773333 | 97.326667 | 171.08667 | 61.48 | 120.72 | 38.466667 | 82.253333 | 40.54 | 5.32 | 13.4 | 23.99 | 64.3 | 123.6 | 9.05 | 17.53 | 29.53 |
| 220 | 01-Oct | Thursday | | | | | | | | | | | | | | | | | | |
| 221 | 02-Oct | Friday | 685.44 | 1672.8 | 85.68 | 118.32 | 199.92 | | 69.36 | 28.56 | 40.8 | 55.72 | 5.25 | 8.68 | 31.78 | 64.4 | 116.2 | 6.16 | 13.51 | 38.64 |
| 222 | 03-Oct | Saturday | 681.36 | 2386.8 | 102 | 175.44 | 195.84 | | 173.4 | 53.04 | 120.36 | 51.24 | 3.36 | 8.26 | 27.02 | 60.62 | 121.8 | 7.56 | 12.53 | 35.42 |
| 223 | 04-Oct | Sunday | 730.32 | 2162.4 | 67.32 | 146.88 | 187.68 | 55.08 | | | | 67.48 | 18.13 | 23.73 | 36.26 | 97.72 | 269.5 | 20.72 | 30.24 | 50.68 |
| 224 | 05-Oct | Monday | 709.92 | 2488.8 | 83.64 | 177.48 | 177.48 | | 132.6 | 46.92 | 85.68 | 47.88 | 3.92 | 8.54 | 26.53 | 68.18 | 128.8 | 5.88 | 20.3 | 37.1 |
| 225 | 06-Oct | Tuesday | | | | | | | | | | | | | | | | | | |
| 226 | 07-Oct | Wednesday | | | | | | | | | | | | | | | | | | |
| 227 | 08-Oct | Thursday | 505.92 | 2509.2 | 61.2 | 122.4 | 187.68 | 48.96 | | | | 48.72 | 3.92 | 19.11 | 32.2 | 64.4 | 149.1 | 6.44 | 24.29 | 41.65 |
| 228 | 09-Oct | Friday | 848.64 | 2652 | 83.64 | 77.52 | 183.6 | | 91.84 | 44.88 | 48.96 | 50.12 | 3.36 | 27.09 | 33.74 | 67.76 | 149.8 | 4.9 | 29.82 | 35.84 |
| 229 | 10-Oct | Saturday | 587.52 | 2611.2 | 67.32 | 81.6 | 179.52 | | 126.48 | 32.64 | 97.84 | 46.48 | 2.66 | 24.5 | 30.24 | 62.3 | 166.6 | 6.58 | 32.62 | 41.16 |
| 230 | 11-Oct | Sunday | 1085.28 | 2996.8 | 58.8336 | 81.6 | 150.96 | | 106.08 | 40.8 | 65.28 | 48.3 | 2.8 | 21 | 28 | 75.74 | 166.6 | 6.02 | 25.55 | 32.9 |
| 231 | 12-Oct | Monday | 983.28 | 3284.4 | 67.32 | 59.16 | 157.08 | | 99.96 | 63.24 | 36.72 | 47.04 | 3.92 | 19.46 | 28.28 | 67.76 | 172.2 | 6.23 | 24.15 | 34.58 |
| 232 | 13-Oct | Tuesday | 983.28 | 2774.4 | 65.28 | 55.08 | 157.08 | 59.16 | | | | 46.2 | 3.5 | 14.7 | 29.96 | 68.18 | 161 | 4.76 | 16.24 | 33.6 |
| 233 | 14-Oct | Wednesday | | | | | | | | | | | | | | | | | | |
| 234 | 15-Oct | Thursday | | | | | | | | | | | | | | | | | | |
| End of Batch 27 | | | 780.096 | 2543.88 | 74.22336 | 109.548 | 177.684 | 54.4 | 114.55143 | 44.29714 | 70.23429 | 50.918 | 5.082 | 17.507 | 30.401 | 69.706 | 160.16 | 7.525 | 22.925 | 38.157 |
| 235 | 16-Oct | Friday | 616.08 | 2101.2 | 40.8 | 59.16 | 157.08 | | 67.32 | 10.2 | 57.12 | 50.68 | 6.02 | 21.35 | 34.44 | 77.7 | 124.6 | 8.4 | 30.59 | 39.2 |
| 236 | 17-Oct | Saturday | | | | | | | | | | | | | | | | | | |
| 237 | 18-Oct | Sunday | | | | | | | | | | | | | | | | | | |
| 238 | 19-Oct | Monday | | | | | | | | | | | | | | | | | | |
| 239 | 20-Oct | Tuesday | | | | | | | | | | | | | | | | | | |
| 240 | 21-Oct | Wednesday | | | | | | | | | | | | | | | | | | |
| 241 | 22-Oct | Thursday | | | | | | | | | | | | | | | | | | |
| 242 | 23-Oct | Friday | | | | | | | | | | | | | | | | | | |
| 243 | 24-Oct | Saturday | | | | | | | | | | | | | | | | | | |
| 244 | 25-Oct | Sunday | | | | | | | | | | | | | | | | | | |
| 245 | 26-Oct | Monday | 669.12 | 2937.6 | 87.72 | 187.68 | 195.84 | | 97.92 | 40.8 | 57.12 | 51.66 | 5.32 | 9.24 | 31.64 | 81.34 | 193.2 | 7.28 | 13.16 | 40.88 |
| 246 | 27-Oct | Tuesday | | | | | | | | | | | | | | | | | | |
| 247 | 28-Oct | Wednesday | | | | | | | | | | | | | | | | | | |
| 248 | 29-Oct | Thursday | 558.96 | 2917.2 | 40.8 | 89.76 | 110.16 | | 102 | 26.52 | 75.48 | 57.96 | 8.61 | 19.88 | 33.39 | 64.12 | 120.4 | 14.56 | 22.89 | 37.87 |
| 249 | 30-Oct | Friday | | | | | | | | | | | | | | | | | | |
| 250 | 31-Oct | Saturday | | | | | | | | | | | | | | | | | | |
| 251 | 01-Nov | Sunday | 701.76 | 2550 | 106.08 | 122.4 | 106.08 | | 114.24 | 102 | 12.24 | 54.32 | 7.14 | 7.7 | 35.56 | 82.6 | 196 | 11.48 | 14.28 | 37.59 |
| 252 | 02-Nov | Monday | 514.08 | 2427.6 | 53.04 | 97.92 | 134.64 | | 126.48 | 36.72 | 89.76 | 50.82 | 3.36 | 7.98 | 28.14 | 64.4 | 127.4 | 4.34 | 14 | 37.24 |
| 253 | 03-Nov | Tuesday | | | | | | | | | | | | | | | | | | |
| 254 | 04-Nov | Wednesday | | | | | | | | | | | | | | | | | | |
| End of Batch 28 | | | 612 | 2586.72 | 65.688 | 111.384 | 140.76 | ERR | 101.592 | 43.248 | 58.344 | 53.088 | 6.09 | 13.33 | 32.634 | 74.032 | 152.32 | 9.212 | 18.984 | 38.556 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Carbonaceous Oxygen Demand | | | | | | RBCOD Floc | | RBCOD | Free & Saline Ammonia | | | | Total Kjedahl Nitrogen | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sys. Inf mgCOD/l | Reactor 3 mgCOD/l | Fin_UEff mgCOD/l | ExtNit_FEff mgCOD/l | IntSet_FEff mgCOD/l | Fin_FEff mgCOD/l | Floc Inf. mgCOD/l | Floc Eff. mgCOD/l | mgCOD/l | Influent mgN/l | Fin_UEff mgN/l | xtNit_UEff mgN/l | IntSet_UEff mgN/l | Influent mgN/l | Reactor 3 mgN/l | Fin_UEff mgN/l | xtNit_UEf mgN/l | IntSet_UEff mgN/l |
| 255 | 05-Nov | Thursday | 726.24 | 2652 | 65.28 | 110.16 | 187.68 | | 108.12 | 40.8 | 67.32 | 70 | 10.92 | 22.19 | 50.54 | 140 | 142.8 | 13.72 | 35 | 76.02 |
| 256 | 06-Nov | Friday | 718.08 | 2611.2 | 67.32 | 124.44 | 238.68 | | 73.44 | 38.76 | 34.68 | 66.92 | 10.5 | 14 | 56.35 | 87.08 | 128.8 | 14.28 | 22.68 | 63.14 |
| 257 | 07-Nov | Saturday | 734.4 | 2468.4 | 65.28 | 110.16 | 163.2 | | 171.36 | 34.68 | 136.68 | 66.08 | 6.16 | 7.98 | 30.94 | 85.12 | 131.6 | 9.38 | 11.76 | 36.54 |
| 258 | 08-Nov | Sunday | | | | | | | | | | | | | | | | | | |
| 259 | 09-Nov | Monday | | | | | | | | | | | | | | | | | | |
| 260 | 10-Nov | Tuesday | 522.24 | 2142 | 73.44 | 110.16 | 191.76 | | 171.36 | 36.72 | 134.64 | 63 | 1.89 | 6.3 | 47.11 | 105.84 | 138.6 | 6.16 | 9.38 | 60.2 |
| 261 | 11-Nov | Wednesday | 530.4 | 2162.4 | 44.88 | 110.16 | 126.48 | | 138.72 | 30.6 | 108.12 | 65.66 | 3.22 | 6.44 | 40.32 | 89.46 | 130.2 | 6.44 | 15.05 | 49.98 |
| 262 | 12-Nov | Thursday | 807.84 | 2284.8 | 57.12 | 122.4 | 183.6 | | 136.68 | 38.76 | 97.92 | 58.94 | 1.4 | 8.12 | 37.66 | 81.06 | 167.3 | 2.45 | 13.79 | 56.42 |
| 263 | 13-Nov | Friday | 538.56 | 2182.8 | 51 | 102 | 134.64 | | 146.88 | 28.56 | 118.32 | 61.46 | 5.74 | 11.34 | 36.19 | 82.6 | 130.2 | 7 | 16.59 | 51.8 |
| End of Batch 29 | | | 653.9657 | 2357.657 | 60.61714 | 112.7829 | 175.1486 | ERR | 135.2229 | 35.55429 | 99.66857 | 64.58 | 5.69 | 10.91 | 42.73 | 95.88 | 138.5 | 8.49 | 17.75 | 56.3 |
| 264 | 14-Nov | Saturday | | | | | | | | | | | | | | | | | | |
| 265 | 15-Nov | Sunday | | | | | | | | | | | | | | | | | | |
| 266 | 16-Nov | Monday | 718.08 | 2652 | 65.28 | 130.56 | 187.68 | 63.24 | | | | 45.64 | 2.8 | 4.34 | 25.2 | 75.04 | 175 | 5.6 | 7.84 | 27.23 |
| 267 | 17-Nov | Tuesday | 807.84 | 2652 | 53.04 | 89.76 | 163.2 | | 130.56 | 30.6 | 99.96 | 34.72 | 1.4 | 4.9 | 23.87 | 59.64 | 138.6 | 3.36 | 5.32 | 29.12 |
| 268 | 18-Nov | Wednesday | 640.56 | 2305.2 | 38.76 | 65.28 | 150.96 | 20.4 | | | | 37.38 | 1.4 | 3.78 | 23.94 | 56.28 | 135.8 | 3.36 | 5.6 | 29.89 |
| 269 | 19-Nov | Thursday | 522.24 | 2652 | 55.08 | 59.16 | 161.16 | | 124.44 | 36.72 | 87.72 | 32.76 | 3.85 | 4.2 | 24.78 | 59.92 | 126 | 6.86 | 6.23 | 30.24 |
| 270 | 20-Nov | Friday | 840.48 | 2244 | 51 | 75.48 | 173.4 | | 124.44 | 30.6 | 93.84 | 38.64 | 3.92 | 5.88 | 27.65 | 60.06 | 147 | 5.46 | 7.14 | 31.36 |
| 271 | 21-Nov | Saturday | 742.56 | 2386.8 | 48.96 | 89.76 | 183.6 | 42.84 | | | | 42 | 2.1 | 3.92 | 28.7 | 56.28 | 138.6 | 4.62 | 5.74 | 31.08 |
| 272 | 22-Nov | Sunday | | | | | | | | | | | | | | | | | | |
| 273 | 23-Nov | Monday | | | | | | | | | | | | | | | | | | |
| 274 | 24-Nov | Tuesday | | | | | | | | | | | | | | | | | | |
| 275 | 25-Nov | Wednesday | 667.92 | 2691.92 | 48.576 | 99.176 | 151.8 | 30.36 | | | | 48.44 | 1.96 | 6.44 | 28.56 | 61.6 | 141.4 | 5.6 | 6.44 | 34.16 |
| 276 | 26-Nov | Thursday | 663.872 | 2651.44 | 58.696 | 170.016 | 178.112 | | 95.128 | 42.504 | 52.624 | 40.6 | 1.4 | 6.3 | 25.06 | 55.72 | 149.8 | 5.6 | 10.64 | 30.24 |
| End of Batch 30 | | | 780.44 | 2529.42 | 52.42 | 97.40 | 168.74 | 39.21 | 118.64 | 35.11 | 83.54 | 40.02 | 2.35 | 4.97 | 25.97 | 60.57 | 144.03 | 5.06 | 6.87 | 30.42 |
| 277 | 27-Nov | Friday | | | | | | | | | | | | | | | | | | |
| 278 | 28-Nov | Saturday | | | | | | | | | | | | | | | | | | |
| 279 | 29-Nov | Sunday | | | | | | | | | | | | | | | | | | |
| 280 | 30-Nov | Monday | | | | | | | | | | | | | | | | | | |
| 281 | 01-Dec | Tuesday | | | | | | | | | | | | | | | | | | |
| 282 | 02-Dec | Wednesday | 821.744 | 2793.12 | 46.552 | 109.296 | 133.584 | 26.312 | | | | 52.92 | 2.1 | 5.46 | 32.48 | 66.78 | 175 | 5.04 | 11.2 | 44.24 |
| 283 | 03-Dec | Thursday | 825.792 | 3400.32 | 64.768 | 129.536 | 153.824 | | 159.896 | 36.432 | 123.464 | 56.56 | 1.82 | 8.26 | 41.3 | 109.2 | 170.8 | 1.47 | 3.5 | 29.54 |
| 284 | 04-Dec | Friday | | | | | | | | | | | | | | | | | | |
| 285 | 05-Dec | Saturday | | | | | | | | | | | | | | | | | | |
| 286 | 06-Dec | Sunday | | | | | | | | | | | | | | | | | | |
| End of Batch 31 | | | 823.768 | 3096.72 | 55.66 | 119.416 | 143.704 | 26.312 | 159.896 | 36.432 | 123.464 | 54.74 | 1.96 | 6.86 | 36.89 | 87.99 | 172.9 | 3.255 | 7.35 | 36.89 |
| 287 | 07-Dec | Monday | | | | | | | | | | | | | | | | | | |
| 288 | 08-Dec | Tuesday | | | | | | | | | | | | | | | | | | |
| 289 | 09-Dec | Wednesday | | | | | | | | | | | | | | | | | | |
| 290 | 10-Dec | Thursday | | | | | | | | | | | | | | | | | | |
| 291 | 11-Dec | Friday | | | | | | | | | | | | | | | | | | |
| 292 | 12-Dec | Saturday | | | | | | | | | | | | | | | | | | |
| 293 | 13-Dec | Sunday | | | | | | | | | | | | | | | | | | |
| 294 | 14-Dec | Monday | | | | | | | | | | | | | | | | | | |
| 295 | 15-Dec | Tuesday | 576 | 3320 | 48 | 64 | 144 | | 150 | 24 | 126 | 35.56 | 2.1 | 6.09 | 24.78 | 55.72 | 196 | 5.18 | 7.98 | 30.52 |
| 296 | 16-Dec | Wednesday | 584 | 3320 | 34 | 60 | 132 | | 132 | 12 | 140 | 35.56 | 4.9 | 5.6 | 23.8 | 56 | 280 | 9.1 | 20.16 | 30.66 |
| 297 | 17-Dec | Thursday | 792 | 3500 | 42 | 66 | 182 | | 182 | 38 | 144 | 33.2 | 2.24 | 6.23 | 24.78 | 58.8 | 196 | 5.81 | 7.98 | 30.52 |
| 298 | 18-Dec | Friday | 792 | 3820 | 44 | 84 | 152 | | 152 | 40 | 112 | 55.16 | 4.48 | 5.6 | 26.46 | 56 | 280 | 9.1 | 20.16 | 29.4 |
| 299 | 19-Dec | Saturday | | | | | | | | | | | | | | | | | | |
| 300 | 20-Dec | Sunday | | | | | | | | | | | | | | | | | | |
| 301 | 21-Dec | Monday | | | | | | | | | | | | | | | | | | |
| 302 | 22-Dec | Tuesday | | | | | | | | | | | | | | | | | | |
| End of Batch 32 | | | 686 | 3490 | 42 | 68.5 | 152.5 | ERR | 159 | 28.5 | 130.5 | 44.87 | 3.43 | 5.88 | 24.955 | 56.63 | 238 | 7.2975 | 14.07 | 30.275 |
| 303 | 23-Dec | Wednesday | | | | | | | | | | | | | | | | | | |
| 304 | 24-Dec | Thursday | 764 | 3660 | 54 | 100 | 160 | | 170 | 46 | 124 | 56.84 | 11.76 | 23.38 | 36.68 | 86.8 | 550.2 | 12.88 | 28.14 | 43.26 |
| 305 | 25-Dec | Friday | 768 | 4560 | 48 | 92 | 172 | 44 | | | | 59.64 | 11.76 | 17.22 | 38.36 | 61.04 | 145.6 | 15.12 | 23.66 | 40.46 |
| 306 | 26-Dec | Saturday | 752 | 4640 | 40 | 92 | 168 | | 140 | 44 | 96 | 57.12 | 7.56 | 11.76 | 34.72 | 60.76 | 294 | 11.62 | 17.08 | 41.16 |
| 307 | 27-Dec | Sunday | | | | | | | | | | | | | | | | | | |
| 308 | 28-Dec | Monday | 800 | 4520 | 64 | 96 | 168 | | 136 | 56 | 100 | 58.8 | 8.82 | 12.88 | 37.94 | 69.44 | 330.4 | 12.74 | 19.18 | 42.14 |
| 309 | 29-Dec | Tuesday | 704 | 2840 | 84 | 124 | 164 | 68 | | | | 59.92 | 5.74 | 11.76 | 30.8 | 80.08 | 348.6 | 11.48 | 20.02 | 48.16 |
| 310 | 30-Dec | Wednesday | 688 | 2960 | 60 | 124 | 164 | | 144 | 32 | 112 | 50.96 | 4.62 | 6.3 | 31.64 | 78.96 | 315 | 7.7 | 17.64 | 49 |
| 311 | 31-Dec | Thursday | | | | | | | | | | | | | | | | | | |
| 312 | 01-Jan | Friday | | | | | | | | | | | | | | | | | | |
| 313 | 02-Jan | Saturday | | | | | | | | | | | | | | | | | | |
| 314 | 03-Jan | Sunday | | | | | | | | | | | | | | | | | | |
| 315 | 04-Jan | Monday | 664 | 3060 | 24 | 80 | 116 | | 104 | 18 | 86 | 79.52 | 3.92 | 10.5 | 38.71 | 131.88 | 295.4 | 6.02 | 14 | 48.44 |
| End of Batch 33 | | | 734.2857 | 3748.571 | 53.42857 | 101.1429 | 158.8571 | 56 | 142.8 | 39.2 | 103.6 | 60.4 | 7.74 | 13.4 | 35.55 | 81.28 | 325.6 | 11.08 | 19.96 | 44.66 |
| 316 | 05-Jan | Tuesday | 924 | 3240 | 52 | 108 | 120 | | 86 | 34 | 52 | 58.38 | 3.5 | 8.4 | 33.46 | 83.44 | 200.2 | 6.02 | 9.52 | 48.44 |
| 317 | 06-Jan | Wednesday | | | | | | | | | | | | | | | | | | |
| 318 | 07-Jan | Thursday | | | | | | | | | | | | | | | | | | |
| 319 | 08-Jan | Friday | | | | | | | | | | | | | | | | | | |
| 320 | 09-Jan | Saturday | | | | | | | | | | | | | | | | | | |
| 321 | 10-Jan | Sunday | | | | | | | | | | | | | | | | | | |
| 322 | 11-Jan | Monday | | | | | | | | | | | | | | | | | | |
| 323 | 12-Jan | Tuesday | | | | | | | | | | | | | | | | | | |
| 324 | 13-Jan | Wednesday | 756 | 2720 | 72 | 118 | 202 | 64 | | | | 67.76 | 6.23 | 16.38 | 44.1 | 91 | 210 | 9.59 | 20.23 | 55.44 |
| 325 | 14-Jan | Thursday | 820 | 2820 | 60 | 154 | 218 | | 180 | 44 | 136 | 49.56 | 4.9 | 16.24 | 44.87 | 95.06 | 224 | 2.94 | 24.08 | 61.6 |
| 326 | 15-Jan | Friday | | | | | | | | | | | | | | | | | | |
| 327 | 16-Jan | Saturday | | | | | | | | | | | | | | | | | | |
| 328 | 17-Jan | Sunday | | | | | | | | | | | | | | | | | | |
| 329 | 18-Jan | Monday | | | | | | | | | | | | | | | | | | |
| 330 | 19-Jan | Tuesday | | | | | | | | | | | | | | | | | | |
| 331 | 20-Jan | Wednesday | | | | | | | | | | | | | | | | | | |
| 332 | 21-Jan | Thursday | 963.424 | 3096.72 | 64.768 | 135.608 | 143.704 | 34.648 | 143.704 | 50.6 | 93.104 | 68.88 | 12.32 | 30.8 | 46.9 | 96.04 | 658 | 17.22 | 39.76 | 54.18 |
| 333 | 22-Jan | Friday | | | | | | | | | | | | | | | | | | |
| 334 | 23-Jan | Saturday | | | | | | | | | | | | | | | | | | |
| 335 | 24-Jan | Sunday | | | | | | | | | | | | | | | | | | |
| 336 | 25-Jan | Monday | | | | | | | | | | | | | | | | | | |
| End of Batch 34 | | | 846.4747 | 2878.907 | 65.58933 | 135.8693 | 187.9013 | 59.324 | 161.852 | 47.3 | 114.552 | 62.06667 | 7.816667 | 21.14 | 45.29 | 94.03333 | 364 | 9.916667 | 28.02333 | 57.07333 |
| 337 | 26-Jan | Tuesday | 799.68 | 3175.2 | 52.92 | 84.28 | 139.16 | | 131.32 | 45.08 | 86.24 | 52.64 | 4.34 | 21.63 | 56.7 | 88.48 | 274.4 | 6.16 | 33.04 | 46.13 |
| 338 | 27-Jan | Wednesday | 693.84 | 3175.2 | 41.16 | 66.64 | 113.68 | | 117.6 | 31.36 | 86.24 | 67.06 | 3.71 | 19.04 | 36.75 | 78.4 | 196 | 4.9 | 31.36 | 39.2 |
| 339 | 28-Jan | Thursday | 627.2 | 3606.4 | 60.76 | 101.92 | 164.64 | | 160.72 | 37.24 | 123.48 | 61.04 | 2.66 | 20.37 | 38.78 | 81.2 | 239.4 | 6.72 | 37.66 | 45.08 |
| 340 | 29-Jan | Friday | 603.68 | 2587.2 | 50.96 | 62.72 | 70.56 | | 121.52 | 11.76 | 109.76 | 59.08 | 5.32 | 20.02 | 26.25 | 80.22 | 169.4 | 5.88 | 40.46 | 45.08 |
| 341 | 30-Jan | Saturday | | | | | | | | | | | | | | | | | | |
| 342 | 31-Jan | Sunday | | | | | | | | | | | | | | | | | | |
| 343 | 01-Feb | Monday | | | | | | | | | | | | | | | | | | |
| 344 | 02-Feb | Tuesday | | | | | | | | | | | | | | | | | | |
| End of Batch 35 | | | 681.1 | 3136 | 51.45 | 78.89 | 122.01 | ERR | 132.79 | 31.36 | 101.43 | 59.955 | 4.0075 | 20.265 | 39.62 | 82.075 | 219.8 | 5.915 | 35.63 | 43.8725 |
| 345 | 03-Feb | Wednesday | | | | | | | | | | | | | | | | | | |
| 346 | 04-Feb | Thursday | | | | | | | | | | | | | | | | | | |
| 347 | 05-Feb | Friday | | | | | | | | | | | | | | | | | | |
| 348 | 06-Feb | Saturday | | | | | | | | | | | | | | | | | | |
| 349 | 07-Feb | Sunday | | | | | | | | | | 42.84 | 5.39 | 5.88 | 26.74 | 61.6 | 186.2 | 7.28 | 9.38 | 32.9 |
| 350 | 08-Feb | Monday | 744.8 | 2430.4 | 47.04 | 78.4 | 168.56 | | 166.6 | 47.04 | 119.56 | | | | | | | | | |
| 351 | 09-Feb | Tuesday | | | | | | | | | | 42.28 | 5.18 | 5.74 | 27.3 | 60.48 | 198.8 | 8.82 | 10.36 | 35 |
| 352 | 10-Feb | Wednesday | 701.68 | 3175.2 | 56.84 | 72.52 | 154.84 | | 133.28 | 41.16 | 92.12 | 41.3 | 4.34 | 5.74 | 26.81 | 61.74 | 212.8 | 6.58 | 11.62 | 39.76 |
| 353 | 11-Feb | Thursday | 697.76 | 2861.6 | 39.2 | 70.56 | 121.52 | | 135.24 | 3.92 | 131.32 | 33.6 | 6.72 | 11.62 | 23.52 | 60.2 | 210 | 9.1 | 11.62 | 28.84 |
| 354 | 12-Feb | Friday | 717.36 | 3253.6 | 45.08 | 56.84 | 131.32 | | 80.36 | 41.16 | 39.2 | | | | | | | | | |
| 355 | 13-Feb | Saturday | | | | | | | | | | 41.02 | 6.44 | 10.78 | 25.2 | 57.68 | 224 | 9.8 | 10.78 | 34.31 |
| 356 | 14-Feb | Sunday | 788 | 3300 | 80 | 120 | 236 | 72 | | | | | | | | | | | | |
| 357 | 15-Feb | Monday | 576 | 3320 | 48 | 64 | 144 | | 150 | 24 | 126 | 53.2 | 2.24 | 4.48 | 24.78 | 55.72 | 196 | 5.18 | 7.07 | 30.52 |
| 358 | 16-Feb | Tuesday | 608 | 3440 | 46 | 72 | 144 | | 164 | 24 | 140 | 35.56 | 2.8 | 5.6 | 22.54 | 56 | 280 | 9.1 | 20.16 | 23.8 |
| End of Batch 36 | | | 704.2667 | 3056.8 | 52.69333 | 77.05333 | 159.3733 | 72 | 133.096 | 31.456 | 101.64 | 41.4 | 4.73 | 7.12 | 25.27 | 59.06 | 215.4 | 7.98 | 11.57 | 32.19 |
| 359 | 17-Feb | Wednesday | | | | | | | | | | | | | | | | | | |
| 360 | 18-Feb | Thursday | | | | | | | | | | 29.4 | 6.3 | 7.98 | 17.78 | 52.36 | 200.2 | 8.61 | 12.04 | 31.22 |
| 361 | 19-Feb | Friday | 608 | 3080 | 58 | 74 | 130 | | 158 | 34 | 124 | 30.8 | 4.62 | 5.04 | 28 | 53.102 | 194.6 | 5.74 | 9.1 | 28.84 |
| 362 | 20-Feb | Saturday | 612 | 3760 | 40 | 84 | 128 | 74 | | | | | | | | | | | | |
| 363 | 21-Feb | Sunday | | | | | | | | | | | | | | | | | | |
| 364 | 22-Feb | Monday | | | | | | | | | | 48.02 | 4.9 | 11.76 | 27.37 | 60.76 | 200.2 | 6.02 | 17.78 | 33.74 |
| 365 | 23-Feb | Tuesday | 676 | 3040 | 94 | 96 | 172 | | 152 | 28 | 124 | 31.08 | 4.2 | 12.39 | 23.52 | 51.8 | 287 | 4.76 | 20.44 | 35 |
| 366 | 24-Feb | Wednesday | 584 | 3080 | 52 | 96 | 136 | 72 | | | | 52.36 | 4.06 | 16.66 | 26.32 | 58.1 | 200.2 | 6.86 | 21.42 | 31.92 |
| 367 | 25-Feb | Thursday | 616 | 3240 | 46 | 64 | 128 | 58 | | | | | | | | | | | | |
| 368 | 26-Feb | Friday | | | | | | | | | | 46.2 | 4.34 | 12.46 | 26.25 | 54.32 | 221.2 | 7.28 | 15.61 | 32.48 |
| 369 | 27-Feb | Saturday | 780 | 3660 | 104 | 134 | 198 | | 226 | 98 | 128 | 50.4 | 4.34 | 13.65 | 28.14 | 69.72 | 203 | 8.05 | 17.22 | 32.2 |
| 370 | 28-Feb | Sunday | 732 | 3380 | 44 | 60 | 128 | | 150 | 30 | 120 | | | | | | | | | |
| 371 | 01-Mar | Monday | | | | | | | | | | | | | | | | | | |
| 372 | 02-Mar | Tuesday | 636 | 3060 | 46 | 46 | 106 | 46 | | | | 56 | 5.04 | 11.76 | 25.48 | 57.96 | 198.8 | 6.44 | 17.22 | 30.8 |
| 373 | 03-Mar | Wednesday | 580 | 3480 | 98 | 122 | 126 | | 184 | 92 | 92 | 26.88 | 4.9 | 9.8 | 17.36 | 50.82 | 200.2 | 6.44 | 15.47 | 30.66 |
| End of Batch 37 | | | 655.5 | 3350 | 60.5 | 81.75 | 140.75 | 62.5 | 171.5 | 47.5 | 124 | 44.42 | 4.54 | 12.64 | 24.92 | 57.64 | 215.8 | 6.55 | 17.88 | 32.4 |

**Daily Tests on Modified Dephanox BNRAS External Nitrification System**

| Day No | 1998 | | Anaerobic Mass TSS | VSS | ISS | Anoxic 1 Mass TSS | VSS | ISS | Anoxic 2 Mass TSS | VSS | ISS | Aerobic Mass TSS | VSS | ISS | Waste Mass TSS | VSS | ISS | DSVI | COD/VSS | TKN/VSS | TKN/COD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24-Feb | Tuesday | 1250 | 1064 | 186 | 1802 | 1472 | 330 | 3180 | 2658 | 522 | 1396 | 1164 | 232 | NO | NO | NO | 107 | 1.61 | 0.11 | 0.05 |
| 2 | 25-Feb | Wednesday | 1570 | 1328 | 242 | 1570 | 1310 | 260 | 1798 | 1504 | 294 | 1468 | 1254 | 214 | NO | NO | NO | 136 | 1.68 | 0.10 | 0.05 |
| 3 | 26-Feb | Thursday | 1370 | 1166 | 204 | 1620 | 1362 | 258 | 2958 | 2450 | 508 | 1520 | 1274 | 246 | NO | NO | NO | 132 | 1.45 | 0.11 | 0.06 |
| End of Batch 1 | | | 1397 | 1186 | 211 | 1664 | 1381 | 283 | 2645 | 2204 | 441 | 1461 | 1231 | 231 | 0 | 0 | 0 | 125 | 1.58 | 0.11 | 0.05 |
| 4 | 27-Feb | Friday | 1148 | 966 | 182 | 1576 | 1298 | 278 | 2934 | 2398 | 536 | 1380 | 1132 | 248 | NO | NO | NO | 152 | 1.40 | 0.10 | 0.08 |
| 5 | 28-Feb | Saturday | 1136 | 976 | 160 | 1442 | 1234 | 208 | 2512 | 2082 | 430 | 1282 | 1118 | 164 | NO | NO | NO | 140 | 2.25 | 0.12 | 0.07 |
| 6 | 01-Mar | Sunday | 758 | 626 | 132 | 1212 | 966 | 246 | 1968 | 1560 | 408 | 1768 | 1396 | 372 | NO | NO | NO | 107 | 1.57 | 0.10 | 0.08 |
| 7 | 02-Mar | Monday | 908 | 766 | 142 | 1392 | 1160 | 232 | 2112 | 1734 | 378 | 1800 | 1456 | 344 | NO | NO | NO | 111 | 1.42 | 0.09 | 0.07 |
| 8 | 03-Mar | Tuesday | 886 | 716 | 170 | 1316 | 1080 | 236 | 2298 | 1874 | 424 | 1734 | 1406 | 328 | NO | NO | NO | 104 | 1.16 | 0.07 | 0.08 |
| 9 | 04-Mar | Wednesday | 886 | 620 | 266 | 1292 | 1058 | 234 | 1990 | 1618 | 372 | 1102 | 586 | 516 | NO | NO | NO | 163 | 2.32 | 0.21 | 0.09 |
| 10 | 05-Mar | Thursday | 952 | 738 | 214 | 1390 | 1148 | 242 | 2000 | 1694 | 306 | 2940 | 2378 | 562 | NO | NO | NO | 95 | 1.78 | 0.08 | 0.09 |
| 11 | 06-Mar | Friday | 970 | 818 | 152 | 1258 | 1060 | 198 | 2828 | 2310 | 518 | 2230 | 1786 | 444 | NO | NO | NO | 94 | 1.42 | 0.10 | 0.09 |
| 12 | 07-Mar | Saturday | 934 | 784 | 150 | 1228 | 1010 | 218 | 2670 | 2164 | 506 | 2376 | 1914 | 462 | NO | NO | NO | 84 | 1.25 | 0.09 | 0.10 |
| 13 | 08-Mar | Sunday | 1102 | 918 | 184 | 1358 | 1110 | 248 | 2894 | 2362 | 532 | 2426 | 1956 | 470 | NO | NO | NO | 93 | 1.37 | 0.09 | 0.09 |
| 14 | 09-Mar | Monday | 884 | 740 | 144 | 1206 | 1002 | 204 | 2050 | 1684 | 366 | 2420 | 1944 | 476 | NO | NO | NO | 107 | 1.48 | 0.09 | 0.09 |
| 15 | 10-Mar | Tuesday | 946 | 804 | 142 | 1290 | 1074 | 216 | 2086 | 1726 | 360 | 2506 | 2026 | 480 | NO | NO | NO | 92 | 1.32 | 0.08 | 0.08 |
| 16 | 11-Mar | Wednesday | 880 | 728 | 152 | 1188 | 982 | 206 | 2624 | 2132 | 492 | 2014 | 1636 | 378 | NO | NO | NO | 109 | 1.44 | 0.10 | 0.09 |
| 17 | 12-Mar | Thursday | 840 | 716 | 124 | 1110 | 946 | 164 | 2036 | 1684 | 352 | 2446 | 1998 | 448 | NO | NO | NO | 90 | 1.37 | 0.08 | 0.07 |
| End of Batch 2 | | | 945 | 780 | 165 | 1304 | 1081 | 224 | 2357 | 1930 | 427 | 2030 | 1624 | 407 | 0 | 0 | 0 | 110 | 1.54 | 0.10 | 0.08 |
| 18 | 13-Mar | Friday | | | | | | | | | | | | | | | | | | | |
| 19 | 14-Mar | Saturday | 868 | 736 | 132 | 1200 | 1006 | 194 | 2878 | 2314 | 564 | 1608 | 1308 | 300 | NO | NO | NO | 124 | 2.75 | 0.17 | 0.07 |
| 20 | 15-Mar | Sunday | 1126 | 964 | 162 | 1512 | 1264 | 248 | 1578 | 1314 | 264 | 1990 | 1624 | 366 | NO | NO | NO | 101 | 2.27 | 0.09 | 0.06 |
| 21 | 16-Mar | Monday | 1224 | 1074 | 150 | 1392 | 1248 | 144 | 2240 | 1910 | 330 | 2238 | 1916 | 322 | NO | NO | NO | 71 | 1.78 | 0.09 | 0.07 |
| 22 | 17-Mar | Tuesday | 1190 | 1044 | 146 | 1424 | 1252 | 172 | 2538 | 2178 | 360 | 2064 | 1764 | 300 | NO | NO | NO | 97 | 0.00 | 0.00 | ERR |
| End of Batch 3 | | | 1073 | 925 | 148 | 1368 | 1173 | 195 | 2232 | 1846 | 386 | 1945 | 1616 | 329 | 0 | 0 | 0 | 99 | 2.27 | 0.12 | 0.07 |
| 23 | 18-Mar | Wednesday | | | | | | | | | | | | | | | | | | | |
| 24 | 19-Mar | Thursday | | | | | | | | | | | | | | | | | | | |
| 25 | 20-Mar | Friday | | | | | | | | | | | | | | | | | | | |
| 26 | 21-Mar | Saturday | 1428 | 1234 | 194 | 1600 | 1380 | 220 | 4034 | 3450 | 584 | 2234 | 2002 | 232 | NO | NO | NO | 98 | 0.00 | 0.00 | |
| 27 | 22-Mar | Sunday | 1706 | 1492 | 214 | 1846 | 1566 | 280 | 4546 | 3844 | 702 | 2420 | 2026 | 394 | NO | NO | NO | 103 | 0.00 | 0.00 | |
| 28 | 23-Mar | Monday | 1686 | 1440 | 246 | 1840 | 1546 | 294 | 4426 | 3826 | 600 | 2746 | 2296 | 450 | NO | NO | NO | 87 | 1.58 | 0.10 | 0.08 |
| 29 | 24-Mar | Tuesday | 1776 | 1528 | 248 | 1728 | 1490 | 238 | 4784 | 4058 | 726 | 2362 | 1978 | 384 | NO | NO | NO | 110 | 1.71 | 0.10 | 0.07 |
| 30 | 25-Mar | Wednesday | 1498 | 1380 | 118 | 1566 | 1332 | 234 | 4058 | 3444 | 614 | 3004 | 2504 | 500 | NO | NO | NO | 80 | 1.82 | 0.10 | 0.07 |
| End of Batch 4 | | | 1619 | 1415 | 204 | 1716 | 1463 | 253 | 4370 | 3724 | 645 | 2553 | 2161 | 392 | 0 | 0 | 0 | 96 | 1.02 | 0.06 | 0.07 |
| 31 | 26-Mar | Thursday | | | | | | | | | | | | | | | | | | | |
| 32 | 27-Mar | Friday | 1260 | 1096 | 164 | 1642 | 1436 | 206 | 3626 | 3094 | 532 | 1684 | 1442 | 242 | 1328 | 1364 | -36 | 93 | 1.60 | 0.13 | 0.06 |
| 33 | 28-Mar | Saturday | 1444 | 1210 | 234 | 1406 | 1200 | 206 | 3514 | 2906 | 608 | 1822 | 1750 | 72 | 1408 | 1240 | 168 | 181 | 1.50 | 0.10 | 0.06 |
| 34 | 29-Mar | Sunday | | | | | | | | | | | | | | | | | | | |
| 35 | 30-Mar | Monday | 1624 | 1428 | 196 | 1650 | 1408 | 242 | 4054 | 3424 | 630 | 3438 | 2894 | 544 | 1638 | 1450 | 188 | 52 | 0.95 | 0.05 | 0.05 |
| 36 | 31-Mar | Tuesday | | | | | | | | | | | | | | | | | | | |
| 37 | 01-Apr | Wednesday | | | | | | | | | | | | | | | | | | | |
| 38 | 02-Apr | Thursday | | | | | | | | | | | | | | | | | | | |
| End of Batch 5 | | | 1443 | 1245 | 198 | 1566 | 1348 | 218 | 3731 | 3141 | 590 | 2315 | 2029 | 286 | 1458 | 1351 | 107 | 109 | 1.35 | 0.09 | 0.06 |
| 39 | 03-Apr | Friday | | | | | | | | | | | | | | | | | | | |
| 40 | 04-Apr | Saturday | | | | | | | | | | | | | | | | | | | |
| 41 | 05-Apr | Sunday | | | | | | | | | | | | | | | | | | | |
| 42 | 06-Apr | Monday | 1478 | 1280 | 198 | 1618 | 1374 | 244 | 3480 | 3148 | 332 | 3808 | 3428 | 380 | 1676 | 1662 | 14 | 53 | 0.81 | 0.09 | 0.10 |
| 43 | 07-Apr | Tuesday | 1216 | 1040 | 176 | 1442 | 1216 | 226 | 3576 | 3010 | 566 | 3204 | 2664 | 540 | 1624 | 1614 | 10 | 66 | 1.62 | 0.12 | 0.10 |
| 44 | 08-Apr | Wednesday | 1306 | 1160 | 146 | 1500 | 1278 | 222 | 4066 | 3682 | 384 | 2336 | 1966 | 370 | 1742 | 1714 | 28 | 94 | 1.81 | 0.17 | 0.10 |
| 45 | 09-Apr | Thursday | 1430 | 1218 | 212 | 1506 | 1242 | 264 | 4142 | 3484 | 658 | 3704 | 3074 | 630 | 2586 | 2176 | 410 | 76 | 1.60 | 0.10 | 0.08 |
| End of Batch 6 | | | 1358 | 1174 | 183 | 1517 | 1277 | 239 | 3816 | 3331 | 485 | 3263 | 2783 | 480 | 1907 | 1792 | 116 | 72 | 1.46 | 0.12 | 0.09 |
| 46 | 10-Apr | Friday | 1476 | 1282 | 194 | 1816 | 1566 | 250 | 5388 | 4598 | 790 | 3448 | 2886 | 562 | 2186 | 1728 | 458 | | 0.83 | 0.10 | 0.11 |
| 47 | 11-Apr | Saturday | 1504 | 646 | 858 | 2052 | 1774 | 278 | 1682 | 1466 | 216 | 3606 | 3004 | 602 | 2112 | 1740 | 372 | | 0.81 | 0.10 | 0.11 |
| 48 | 12-Apr | Sunday | | | | | | | | | | | | | | | | | | | |
| 49 | 13-Apr | Monday | | | | | | | | | | | | | | | | | | | |
| 50 | 14-Apr | Tuesday | | | | | | | | | | | | | | | | | | | |
| 51 | 15-Apr | Wednesday | 2198 | 1938 | 260 | 1364 | 1390 | 174 | 2318 | 2060 | 258 | 3994 | 3424 | 570 | 2188 | 1952 | 236 | 73 | 0.55 | 0.09 | 0.11 |
| 52 | 16-Apr | Thursday | 1954 | 1738 | 216 | 2050 | 1882 | 168 | 6200 | 3366 | 2834 | 3440 | 2972 | 468 | 2898 | 2350 | 548 | 70 | 0.83 | 0.09 | 0.10 |
| End of Batch 7 | | | 1783 | 1401 | 382 | 1870 | 1653 | 217 | 3897 | 2873 | 1024 | 3622 | 3071 | 551 | 2346 | 1943 | 403 | 72 | 0.76 | 0.09 | 0.11 |
| 53 | 17-Apr | Friday | 1970 | 1754 | 216 | 2190 | 1850 | 340 | 5394 | 4450 | 944 | 3318 | 2782 | 536 | 1180 | 1906 | -726 | 60 | 1.68 | 0.14 | 0.09 |
| 54 | 18-Apr | Saturday | | | | | | | | | | | | | | | | | | | |
| 55 | 19-Apr | Sunday | 2006 | 1706 | 300 | 2410 | 2028 | 382 | 6826 | 5740 | 1086 | 2400 | 2154 | 246 | 3826 | 2954 | 872 | 83 | 2.03 | 0.13 | 0.07 |
| 56 | 20-Apr | Monday | 2062 | 1756 | 306 | 2626 | 2212 | 414 | 5722 | 4796 | 926 | 3192 | 2642 | 550 | 3156 | 2484 | 672 | 72 | 1.57 | 0.10 | 0.07 |
| 57 | 21-Apr | Tuesday | 2296 | 1978 | 318 | 2632 | 2220 | 412 | 7132 | 5958 | 1174 | 3260 | 2702 | 558 | 2822 | 2218 | 604 | 64 | 1.44 | 0.10 | 0.07 |
| 58 | 22-Apr | Wednesday | 2024 | 1762 | 262 | 2354 | 1992 | 362 | 5740 | 4820 | 920 | 2964 | 2464 | 500 | 2734 | 2240 | 494 | 74 | 1.45 | 0.09 | 0.08 |
| 59 | 23-Apr | Thursday | 2276 | 1918 | 358 | 2724 | 2274 | 450 | 7312 | 6050 | 1262 | 2990 | 2442 | 548 | 3310 | 2680 | 630 | 67 | 1.47 | 0.09 | 0.07 |
| 60 | 24-Apr | Friday | 1970 | 1722 | 248 | 2812 | 2406 | 406 | 5470 | 4602 | 868 | 2612 | 2220 | 392 | 2774 | 2108 | 666 | 77 | 0.00 | 0.00 | |
| 61 | 25-Apr | Saturday | 2024 | 1762 | 262 | 2354 | 1992 | 362 | 5740 | 4820 | 920 | 2964 | 2464 | 500 | 2734 | 2240 | 494 | 74 | 1.83 | 0.17 | 0.08 |
| 62 | 26-Apr | Sunday | 2752 | 2370 | 382 | 3030 | 2522 | 508 | 7388 | 6136 | 1252 | 3494 | 2860 | 634 | 3590 | 2990 | 600 | 66 | 1.84 | 0.14 | 0.07 |
| 63 | 27-Apr | Monday | 1970 | 1722 | 248 | 2812 | 2406 | 406 | 5470 | 4602 | 868 | 2612 | 2220 | 392 | 2774 | 2108 | 666 | 92 | 0.00 | 0.00 | |
| 64 | 28-Apr | Tuesday | 1452 | 1224 | 228 | 3484 | 2986 | 498 | 6996 | 5876 | 1120 | 4612 | 3832 | 780 | 2628 | 2102 | 526 | 56 | 1.24 | 0.11 | 0.08 |
| 65 | 29-Apr | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 8 | | | 2073 | 1789 | 284 | 2675 | 2263 | 413 | 6290 | 5259 | 1031 | 3129 | 2617 | 512 | 2866 | 2366 | 500 | 72 | 1.32 | 0.10 | 0.07 |
| 66 | 30-Apr | Thursday | 2940 | 2558 | 382 | 3008 | 2548 | 460 | 8170 | 6780 | 1390 | 3868 | 3160 | 708 | 3420 | 2754 | 666 | 72 | 1.34 | 0.07 | 0.06 |
| 67 | 01-May | Friday | 3008 | 2564 | 444 | 3178 | 2700 | 478 | 9560 | 7962 | 1598 | 4072 | 3356 | 716 | 4094 | 3476 | 618 | | 1.33 | 0.07 | 0.06 |
| 68 | 02-May | Saturday | 2582 | 2168 | 414 | 2794 | 2348 | 446 | 7930 | 6582 | 1348 | 3566 | 3388 | 178 | 3614 | 2860 | 754 | | 1.19 | 0.07 | 0.06 |
| End of Batch 9 | | | 2843 | 2430 | 413 | 2993 | 2532 | 461 | 8553 | 7108 | 1445 | 3835 | 3301 | 534 | 3709 | 3030 | 679 | 72 | 1.29 | 0.07 | 0.06 |
| 69 | 03-May | Sunday | | | | | | | | | | | | | | | | | | | |
| 70 | 04-May | Monday | | | | | | | | | | | | | | | | | | | |
| 71 | 05-May | Tuesday | | | | | | | | | | | | | | | | | | | |
| 72 | 06-May | Wednesday | | | | | | | | | | | | | | | | | | | |
| 73 | 07-May | Thursday | | | | | | | | | | | | | | | | | | | |
| 74 | 08-May | Friday | | | | | | | | | | | | | | | | | | | |
| End of Batch10 | | | | | | | | | | | | | | | | | | | | | |
| 75 | 09-May | Saturday | 2940 | 2558 | 382 | 3008 | 2548 | 460 | 8170 | 6780 | 1390 | 3868 | 3160 | 708 | 3420 | 2754 | 666 | 72 | 1.34 | 0.07 | 0.06 |
| 76 | 10-May | Sunday | 3008 | 2564 | 444 | 3178 | 2700 | 478 | 9560 | 7962 | 1598 | 4072 | 3356 | 716 | 4094 | 3476 | 618 | 54 | 1.33 | 0.07 | 0.06 |
| 77 | 11-May | Monday | 2582 | 2168 | 414 | 2794 | 2348 | 446 | 7930 | 6582 | 1348 | 3566 | 3388 | 178 | 3614 | 2860 | 754 | 45 | 1.19 | 0.07 | 0.06 |
| 78 | 12-May | Tuesday | 1100 | 964 | 136 | 4854 | 3996 | 858 | 2130 | 1638 | 492 | 1586 | 1202 | 384 | 2560 | 2250 | 310 | 76 | 1.49 | 0.11 | 0.08 |
| 79 | 13-May | Wednesday | 1852 | 1506 | 346 | 3264 | 2706 | 558 | 5748 | 5016 | 732 | 2632 | 2208 | 424 | 3538 | 2952 | 586 | 68 | 1.44 | 0.09 | 0.09 |
| 80 | 14-May | Thursday | | | | | | | | | | | | | | | | | | | |
| 81 | 15-May | Friday | 1922 | 1530 | 392 | 2134 | 1714 | 420 | 5342 | 1226 | 4116 | 2626 | 0 | 2626 | 2606 | 1628 | 978 | 69 | | | 0.09 |
| 82 | 16-May | Saturday | | | | | | | | | | | | | | | | | | | |
| 83 | 17-May | Sunday | 1924 | 1738 | 186 | 2224 | 1896 | 328 | 5450 | 1226 | 4224 | 2702 | 2266 | 436 | 3118 | 2586 | 532 | 67 | 1.26 | 0.09 | 0.09 |
| 84 | 18-May | Monday | 1980 | 1884 | 96 | 2208 | 1852 | 356 | 5562 | 4644 | 918 | 2866 | 2398 | 468 | 2742 | 2238 | 504 | 63 | 1.40 | 0.05 | 0.10 |
| 85 | 19-May | Tuesday | 1950 | 1694 | 256 | 2338 | 2056 | 282 | 6142 | 5196 | 946 | 2928 | 2434 | 494 | 2686 | 3072 | -386 | 61 | 1.37 | 0.09 | 0.09 |
| End of Batch 11 | | | 2140 | 1845 | 295 | 2889 | 2424 | 465 | 6226 | 4474 | 1752 | 2983 | 2268 | 715 | 3153 | 2646 | 507 | 64 | 1.35 | 0.08 | 0.08 |
| 86 | 20-May | Wednesday | 1796 | 1562 | 234 | 2246 | 1886 | 360 | 5320 | 4454 | 866 | 2742 | 2208 | 534 | 2288 | 1766 | 522 | 73 | 1.44 | 0.10 | 0.08 |
| 87 | 21-May | Thursday | | | | | | | | | | | | | | | | | | | |
| 88 | 22-May | Friday | 2160 | 1870 | 290 | 13674 | 2088 | 11586 | 5804 | 4948 | 856 | 3020 | 2496 | 524 | 2702 | 2268 | 434 | 60 | 1.31 | 0.08 | 0.10 |
| 89 | 23-May | Saturday | 1984 | 1666 | 318 | 2296 | 1958 | 338 | 12066 | 10998 | 1068 | 2544 | 2138 | 406 | NO | NO | NO | 79 | 1.35 | 0.11 | 0.10 |
| 90 | 24-May | Sunday | 1886 | 1658 | 228 | 1900 | 1340 | 560 | 4564 | 3844 | 720 | 2370 | 2004 | 366 | 2306 | 1672 | 634 | 76 | 1.41 | 0.12 | 0.12 |
| 91 | 25-May | Monday | 2352 | 2088 | 264 | 1562 | 1194 | 368 | 5022 | 4098 | 924 | 1648 | 1360 | 288 | NO | NO | NO | 121 | 1.37 | 0.09 | 0.09 |
| 92 | 26-May | Tuesday | | | | | | | | | | | | | | | | | | | |
| 93 | 27-May | Wednesday | | | | | | | | | | | | | | | | | | | |
| 94 | 28-May | Thursday | 1812 | 1520 | 292 | 1966 | 1644 | 322 | 5220 | 4348 | 872 | 2962 | 2444 | 518 | 2810 | 2348 | 462 | 74 | 1.17 | 0.09 | 0.10 |
| 95 | 29-May | Friday | 1550 | 1388 | 162 | 1768 | 1404 | 364 | 5050 | 4120 | 930 | 2346 | 1938 | 408 | 2064 | 1650 | 414 | 81 | 1.33 | 0.11 | 0.09 |
| 96 | 30-May | Saturday | 1750 | 1442 | 308 | 1952 | 1586 | 366 | 4594 | 3786 | 808 | 2520 | 2012 | 508 | 1500 | 1866 | -634 | 79 | 1.70 | 0.10 | 0.08 |
| 97 | 31-May | Sunday | 1588 | 1474 | 114 | 1976 | 1648 | 328 | 4854 | 5578 | -724 | 2574 | 2144 | 430 | NO | NO | NO | 78 | 1.33 | 0.11 | 0.07 |
| 98 | 01-Jun | Monday | 7980 | 7618 | 362 | 2208 | 1906 | 302 | 5562 | 4724 | 838 | 2866 | 2618 | 248 | NO | NO | NO | 70 | 1.14 | 0.09 | 0.08 |
| 99 | 02-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 100 | 03-Jun | Wednesday | | | | | | | | | | | | | | | | | | | |
| 101 | 04-Jun | Thursday | | | | | | | | | | | | | | | | | | | |
| 102 | 05-Jun | Friday | | | | | | | | | | | | | | | | | | | |
| End of Batch 12 | | | 2486 | 2229 | 257 | 3155 | 1665 | 1489 | 5806 | 5090 | 716 | 2559 | 2136 | 423 | 1467 | 1157 | 310 | 79 | 1.36 | 0.10 | 0.09 |
| 103 | 06-Jun | Saturday | 1812 | 1520 | 292 | 1966 | 1644 | 322 | 5220 | 4348 | 872 | 2866 | 2618 | 248 | | | | 70 | 0.00 | 0.00 | |
| 104 | 07-Jun | Sunday | 2508 | 2164 | 344 | 1858 | 1586 | 272 | 4014 | 3356 | 658 | 3750 | 3110 | 640 | 2628 | 2154 | 474 | 53 | 1.37 | 0.09 | 0.08 |
| 105 | 08-Jun | Monday | 2508 | 2164 | 344 | 1858 | 1586 | 272 | 4014 | 3356 | 658 | 3750 | 3110 | 640 | 2628 | 2154 | 474 | 53 | 1.37 | 0.09 | 0.08 |
| 106 | 09-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 107 | 10-Jun | Wednesday | | | | | | | | | | | | | | | | | | | |
| 108 | 11-Jun | Thursday | 2212 | 1868 | 344 | 2336 | 1984 | 352 | 6494 | 5422 | 1072 | 2842 | 2346 | 496 | 2746 | 2220 | 526 | 70 | 1.52 | 0.10 | 0.08 |
| 109 | 12-Jun | Friday | 1760 | 1514 | 246 | 2100 | 1800 | 300 | 5872 | 4988 | 884 | 2700 | 2270 | 430 | 2962 | 2440 | 522 | 74 | 1.41 | 0.10 | 0.09 |
| End of Batch13 | | | 2247 | 1927 | 320 | 2038 | 1739 | 299 | 5098 | 4281 | 818 | 3261 | 2709 | 552 | 2741 | 2242 | 499 | 63 | 1.42 | 0.09 | 0.09 |
| 110 | 13-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 111 | 14-Jun | Sunday | | | | | | | | | | | | | | | | | | | |
| 112 | 15-Jun | Monday | | | | | | | | | | | | | | | | | | | |
| 113 | 16-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 114 | 17-Jun | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch14 | | | | | | | | | | | | | | | | | | | | | |
| 115 | 18-Jun | Thursday | | | | | | | | | | | | | | | | | | | |
| 116 | 19-Jun | Friday | | | | | | | | | | | | | | | | | | | |
| 117 | 20-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 118 | 21-Jun | Sunday | | | | | | | | | | | | | | | | | | | |
| 119 | 22-Jun | Monday | | | | | | | | | | | | | | | | | | | |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Anaerobic Mass TSS | VSS | ISS | Anoxic 1 Mass TSS | VSS | ISS | Anoxic 2 Mass TSS | VSS | ISS | Aerobic Mass TSS | VSS | ISS | Waste Mass TSS | VSS | ISS | DSVI | COD/VSS | TKN/VSS | TKN/COD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | 23-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 121 | 24-Jun | Wednesday | 2624 | 2284 | 340 | 2942 | 2542 | 400 | 14550 | 5894 | 8656 | 2942 | 2496 | 446 | 3114 | 2658 | 456 | 75 | 1.40 | 0.10 | 0.11 |
| 122 | 25-Jun | Thursday | | | | | | | | | | | | | | | | | | | |
| 123 | 26-Jun | Friday | 2392 | 2070 | 322 | 2636 | 2288 | 348 | 6700 | 5740 | 960 | 3780 | 3130 | 650 | 3128 | 2588 | 540 | | 1.47 | 0.11 | 0.09 |
| 124 | 27-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 125 | 28-Jun | Sunday | | | | | | | | | | | | | | | | | | | |
| End of Batch16 | | | 2508 | 2177 | 331 | 2789 | 2415 | 374 | 10625 | 5817 | 4808 | 3361 | 2813 | 548 | 3121 | 2623 | 498 | 75 | 1.44 | 0.11 | 0.10 |
| 126 | 29-Jun | Monday | 2830 | 2468 | 362 | 2738 | 2394 | 344 | 3422 | 2942 | 480 | 3524 | 2980 | 544 | 3400 | 3002 | 398 | 68 | 1.32 | 0.09 | 0.09 |
| 127 | 30-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 128 | 01-Jul | Wednesday | 2272 | 1958 | 314 | 2644 | 2264 | 380 | 7232 | 6120 | 1112 | 2992 | 2528 | 464 | 2692 | 2294 | 396 | 74 | 1.31 | 0.14 | 0.12 |
| 129 | 02-Jul | Thursday | 2214 | 1904 | 310 | 2556 | 2182 | 374 | 6838 | 5770 | 1068 | 3194 | 2674 | 520 | 2734 | 2318 | 416 | 69 | 1.13 | 0.13 | 0.12 |
| 130 | 03-Jul | Friday | | | | | | | | | | | | | | | | | | | |
| 131 | 04-Jul | Saturday | | | | | | | | | | | | | | | | | | | |
| 132 | 05-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 133 | 06-Jul | Monday | 2324 | 1830 | 494 | 2568 | 2210 | 358 | 6938 | 6490 | 448 | 3014 | 2562 | 452 | 2704 | 1802 | 902 | 73 | 1.42 | 0.06 | 0.06 |
| 134 | 07-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch17 | | | 2410 | 2040 | 370 | 2627 | 2262 | 364 | 6108 | 5331 | 777 | 3181 | 2686 | 495 | 2883 | 2355 | 528 | 71 | 1.30 | 0.11 | 0.10 |
| 135 | 08-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| 136 | 09-Jul | Thursday | 2178 | 1698 | 480 | 2424 | 1910 | 514 | 7204 | 4022 | 3182 | 3106 | 2878 | 228 | 2564 | 2342 | 222 | 71 | 1.33 | 0.04 | 0.10 |
| 137 | 10-Jul | Friday | 2060 | 1978 | 82 | 2456 | 2090 | 366 | 4840 | 3854 | 986 | 2662 | 2238 | 424 | 2620 | 2202 | 418 | 83 | 0.00 | 0.12 | |
| 138 | 11-Jul | Saturday | | | | | | | | | | | | | | | | | | | |
| 139 | 12-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 140 | 13-Jul | Monday | | | | | | | | | | | | | | | | | | | |
| 141 | 14-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| 142 | 15-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| 143 | 16-Jul | Thursday | | | | | | | | | | | | | | | | | | | |
| 144 | 17-Jul | Friday | | | | | | | | | | | | | | | | | | | |
| 145 | 18-Jul | Saturday | | | | | | | | | | | | | | | | | | | |
| 146 | 19-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 147 | 20-Jul | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 18 | | | 2119 | 1838 | 281 | 2440 | 2000 | 440 | 6022 | 3938 | 2084 | 2884 | 2558 | 326 | 2592 | 2272 | 320 | 77 | 0.67 | 0.08 | 0.10 |
| 148 | 21-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| 149 | 22-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 19 | | | | | | | | | | | | | | | | | | | | | |
| 150 | 23-Jul | Thursday | 2578 | 2088 | 490 | 2562 | 2256 | 306 | 6498 | 6084 | 414 | 3250 | 2848 | 402 | 2972 | 2232 | 740 | 62 | 0.00 | 0.00 | |
| 151 | 24-Jul | Friday | 2338 | 1980 | 358 | 2390 | 2074 | 316 | 6128 | 5118 | 1010 | 2822 | 2390 | .432 | 2716 | 2230 | 486 | 71 | 1.52 | 0.11 | 0.09 |
| 152 | 25-Jul | Saturday | 2554 | 2210 | 344 | 2614 | 2240 | 374 | 6938 | 5846 | 1092 | 3218 | 2656 | 562 | 2806 | 2366 | 440 | 71 | 1.11 | 0.12 | 0.10 |
| 153 | 26-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 154 | 27-Jul | Monday | 2526 | 2178 | 348 | 2666 | 2274 | 392 | 6372 | 5342 | 1030 | 2894 | 2412 | 482 | 3278 | 2684 | 594 | 83 | 1.42 | 0.10 | 0.10 |
| End of Batch 20 | | | 2499 | 2114 | 385 | 2558 | 2211 | 347 | 6484 | 5598 | 886 | 3046 | 2576 | 470 | 2943 | 2378 | 565 | 72 | 1.01 | 0.08 | 0.09 |
| 155 | 28-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| 156 | 29-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| 157 | 30-Jul | Thursday | | | | | | | | | | | | | | | | | | | |
| 158 | 31-Jul | Friday | | | | | | | | | | | | | | | | | | | |
| 159 | 01-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 160 | 02-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 161 | 03-Aug | Monday | End of Batch 20 | | | | | | | | | | | | | | | | | | |
| 162 | 04-Aug | Tuesday | | | | | | | | | | | | | | | | | | | |
| 163 | 05-Aug | Wednesday | | | | | | | | | | | | | | | | | | | |
| 164 | 06-Aug | Thursday | | | | | | | | | | | | | | | | | | | |
| 165 | 07-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 166 | 08-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 167 | 09-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 168 | 10-Aug | Monday | | | | | | | | | | | | | | | | | | | |
| 169 | 11-Aug | Tuesday | 3494 | 2934 | 560 | 3902 | 3140 | 762 | 10288 | 8426 | 1862 | 3738 | 3084 | 654 | 3784 | 3072 | 712 | 70 | 1.32 | 0.04 | 0.12 |
| 170 | 12-Aug | Wednesday | 3720 | 3170 | 550 | 3520 | 2958 | 562 | 8736 | 7312 | 1424 | 3802 | 3122 | 680 | 3706 | 2992 | 714 | 84 | 1.33 | 0.05 | 0.12 |
| 171 | 13-Aug | Thursday | | | | | | | | | | | | | | | | | | | |
| 172 | 14-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 173 | 15-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 174 | 16-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 175 | 17-Aug | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 22 | | | 3607 | 3052 | 555 | 3711 | 3049 | 662 | 9512 | 7869 | 1643 | 3770 | 3103 | 667 | 3745 | 3032 | 713 | 77 | 1.32 | 0.04 | 0.12 |
| 176 | 18-Aug | Tuesday | 2796 | 2362 | 434 | 3064 | 2562 | 502 | 7862 | 6464 | 1398 | 3218 | 2674 | 544 | 3454 | 2748 | 706 | 87 | 1.31 | 0.08 | 0.07 |
| 177 | 19-Aug | Wednesday | 2610 | 2212 | 398 | 2868 | 2400 | 468 | 7530 | 6188 | 1342 | 2868 | 2382 | 486 | 3042 | 2500 | 542 | 105 | 1.34 | 0.09 | 0.05 |
| 178 | 20-Aug | Thursday | 2668 | 2192 | 476 | 2312 | 1982 | 330 | 7920 | 6614 | 1306 | 2458 | 2046 | 412 | 2774 | 2296 | 478 | 122 | 1.20 | 0.12 | 0.06 |
| 179 | 21-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 180 | 22-Aug | Saturday | 2718 | 2426 | 292 | 3112 | 2656 | 456 | 8026 | 6770 | 1256 | 3142 | 2736 | 406 | 2988 | 2588 | 400 | 95 | 1.35 | 0.09 | 0.06 |
| 181 | 23-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 182 | 24-Aug | Monday | 2930 | 2482 | 448 | 2950 | 2500 | 450 | 7876 | 6536 | 1340 | 3134 | 2582 | 552 | 2878 | 2352 | 526 | 96 | 1.37 | 0.10 | 0.06 |
| 183 | 25-Aug | Tuesday | 2592 | 2260 | 332 | 2872 | 2436 | 436 | 10086 | 8506 | 1580 | 3942 | 3232 | 710 | 4566 | 3770 | 796 | 66 | 1.15 | 0.08 | 0.06 |
| 184 | 26-Aug | Wednesday | | | | | | | | | | | | | | | | | | | |
| 185 | 27-Aug | Thursday | | | | | | | | | | | | | | | | | | | |
| 186 | 28-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 187 | 29-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 188 | 30-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| End of Batch 23 | | | 2719 | 2322 | 397 | 2863 | 2423 | 440 | 8217 | 6846 | 1370 | 3127 | 2609 | 518 | 3284 | 2709 | 575 | 95 | 1.29 | 0.09 | 0.06 |
| 189 | 31-Aug | Monday | 1814 | 1570 | 244 | 2292 | 1872 | 420 | 5296 | 4282 | 1014 | 3230 | 2538 | 692 | NO | NO | NO | 71 | 1.45 | 0.08 | 0.06 |
| 190 | 01-Sep | Tuesday | 1926 | 1616 | 310 | 2124 | 1722 | 402 | 5450 | 4394 | 1056 | 2392 | 1912 | 480 | NO | NO | NO | 84 | 1.56 | 0.09 | 0.04 |
| 191 | 02-Sep | Wednesday | 1908 | 1602 | 306 | 2060 | 1966 | 94 | 5676 | 4446 | 1230 | 2256 | 1770 | 486 | NO | NO | NO | 89 | 1.54 | 0.09 | 0.06 |
| 192 | 03-Sep | Thursday | 1710 | 1438 | 272 | 1690 | 1246 | 444 | 4898 | 3876 | 1022 | 1910 | 1488 | 422 | NO | NO | NO | 94 | 1.87 | 0.09 | 0.05 |
| 193 | 04-Sep | Friday | | | | | | | | | | | | | | | | | | | |
| 194 | 05-Sep | Saturday | 2022 | 1670 | 352 | 2150 | 1722 | 428 | 6080 | 4766 | 1314 | 3130 | 2434 | 696 | NO | NO | NO | 73 | 0.00 | 0.00 | |
| 195 | 06-Sep | Sunday | 2008 | 1680 | 328 | 2298 | 1856 | 442 | 5614 | 4462 | 1152 | 2432 | 2792 | -360 | NO | NO | NO | 132 | 1.44 | 0.08 | 0.04 |
| 196 | 07-Sep | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 24 | | | 1898 | 1596 | 302 | 2102 | 1731 | 372 | 5502 | 4371 | 1131 | 2558 | 2156 | 403 | 0 | 0 | 0 | 90 | 1.31 | 0.07 | 0.05 |
| 197 | 08-Sep | Tuesday | | | | | | | | | | | | | | | | | | | |
| 198 | 09-Sep | Wednesday | | | | | | | | | | | | | | | | | | | |
| 199 | 10-Sep | Thursday | 2094 | 1656 | 438 | 2430 | 1872 | 558 | 5478 | 4142 | 1336 | 2516 | 1962 | 554 | NO | NO | NO | 91 | 1.49 | 0.08 | 0.10 |
| 200 | 11-Sep | Friday | 2262 | 1810 | 452 | 2418 | 1864 | 554 | 6856 | 5282 | 1574 | 2360 | 1832 | 528 | NO | NO | NO | 102 | 1.84 | 0.12 | 0.08 |
| 201 | 12-Sep | Saturday | 2172 | 1734 | 438 | 2332 | 1796 | 536 | 6340 | 4934 | 1406 | 2528 | 1936 | 592 | NO | NO | NO | 95 | 0.00 | 0.00 | |
| 202 | 13-Sep | Sunday | 2118 | 1788 | 330 | 2274 | 1834 | 440 | 6518 | 5080 | 1438 | 2448 | 1904 | 544 | NO | NO | NO | 78 | 1.43 | 0.11 | 0.11 |
| 203 | 14-Sep | Monday | | | | | | | | | | | | | | | | | | | |
| 204 | 15-Sep | Tuesday | | | | | | | | | | | | | | | | | | | |
| 205 | 16-Sep | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 25 | | | 2162 | 1747 | 415 | 2363 | 1842 | 522 | 6298 | 4859 | 1439 | 2463 | 1909 | 554 | 0 | 0 | 0 | 91 | 1.19 | 0.08 | 0.10 |
| 206 | 17-Sep | Thursday | | | | | | | | | | | | | | | | | | | |
| 207 | 18-Sep | Friday | | | | | | | | | | | | | | | | | | | |
| 208 | 19-Sep | Saturday | | | | | | | | | | | | | | | | | | | |
| 209 | 20-Sep | Sunday | 1452 | 1158 | 294 | 1768 | 1330 | 438 | 3158 | 2328 | 830 | 2248 | 1708 | 540 | | | | 71 | 1.31 | 0.11 | 0.09 |
| 210 | 21-Sep | Monday | 2498 | 2068 | 430 | 1498 | 1246 | 252 | 6610 | 5216 | 1394 | 1592 | 1274 | 318 | | | | 82 | 1.49 | 0.09 | 0.06 |
| 211 | 22-Sep | Tuesday | 3060 | 2556 | 504 | 1432 | 1134 | 298 | 7672 | 6022 | 1650 | 1712 | 1358 | 354 | | | | 88 | 1.49 | 0.07 | 0.05 |
| 212 | 23-Sep | Wednesday | 1844 | 1526 | 318 | 2034 | 1636 | 398 | 6002 | 4782 | 1220 | 2900 | 2143 | 757 | | | | 55 | | 0.08 | |
| 213 | 24-Sep | Thursday | | | | | | | | | | | | | | | | | | | |
| 214 | 25-Sep | Friday | 1344 | 1054 | 290 | 1748 | 1322 | 426 | 3002 | 2420 | 582 | 1654 | 1274 | 380 | | | | 121 | 1.55 | 0.13 | 0.08 |
| 215 | 26-Sep | Saturday | 1738 | 1394 | 344 | 1416 | 1122 | 294 | 4528 | 3418 | 1110 | 1414 | 1070 | 344 | | | | 106 | | 0.13 | |
| 216 | 27-Sep | Sunday | | | | | | | | | | | | | | | | | | | |
| 217 | 28-Sep | Monday | | | | | | | | | | | | | | | | | | | |
| 218 | 29-Sep | Tuesday | | | | | | | | | | | | | | | | | | | |
| 219 | 30-Sep | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 26 | | | 1989 | 1626 | 363 | 1653 | 1302 | 351 | 5162 | 4031 | 1131 | 1920 | 1471 | 449 | | | | 87 | 1.46 | 0.10 | 0.07 |
| 220 | 01-Oct | Thursday | | | | | | | | | | | | | | | | | | | |
| 221 | 02-Oct | Friday | 1040 | 898 | 142 | 1250 | 1054 | 196 | 2590 | 2126 | 464 | 1270 | 1064 | 206 | | | | 94 | 1.57 | 0.11 | 0.07 |
| 222 | 03-Oct | Saturday | 1178 | 1110 | 68 | 1482 | 1172 | 310 | 5994 | 5102 | 892 | 1676 | 1392 | 284 | | | | 84 | 1.71 | 0.09 | 0.05 |
| 223 | 04-Oct | Sunday | 1280 | 1106 | 174 | 1402 | 1164 | 238 | 3688 | 3138 | 550 | 1588 | 1284 | 304 | | | | 88 | 1.68 | 0.21 | 0.12 |
| 224 | 05-Oct | Monday | 1308 | 1110 | 198 | 1464 | 1216 | 248 | 3304 | 2944 | 560 | 2044 | 1692 | 352 | | | | 68 | | 0.08 | |
| 225 | 06-Oct | Tuesday | | | | | | | | | | | | | | | | | | | |
| 226 | 07-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 227 | 08-Oct | Thursday | 1738 | 1554 | 184 | 1940 | 1664 | 276 | 4924 | 4142 | 782 | 1954 | 1614 | 340 | | | | 77 | 1.55 | 0.09 | 0.06 |
| 228 | 09-Oct | Friday | 1758 | 1494 | 264 | 1902 | 1620 | 282 | 4704 | 3882 | 822 | 1856 | 1554 | 302 | | | | 86 | 1.71 | 0.10 | 0.06 |
| 229 | 10-Oct | Saturday | 1932 | 1632 | 300 | 2032 | 1726 | 306 | 5240 | 4412 | 828 | 1998 | 1652 | 346 | | | | 80 | 1.58 | 0.10 | 0.05 |
| 230 | 11-Oct | Sunday | 1984 | 1704 | 280 | 2152 | 1844 | 308 | 4726 | 3936 | 790 | 2284 | 1898 | 386 | | | | 70 | 1.53 | 0.09 | 0.06 |
| 231 | 12-Oct | Monday | 1800 | 1620 | 180 | 2040 | 1722 | 318 | 5984 | 4998 | 986 | 2488 | 2148 | 340 | | | | 80 | 1.53 | 0.08 | 0.05 |
| 232 | 13-Oct | Tuesday | 1740 | 1448 | 292 | 1956 | 1614 | 342 | 4374 | 3528 | 846 | 2990 | 2368 | 622 | | | | 60 | | 0.07 | |
| 233 | 14-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 234 | 15-Oct | Thursday | | | | | | | | | | | | | | | | | | | |
| End of Batch 27 | | | 1576 | 1368 | 208 | 1762 | 1480 | 282 | 4573 | 3821 | 752 | 2015 | 1667 | 348 | | | | 79 | 1.61 | 0.10 | 0.07 |
| 235 | 16-Oct | Friday | 0 | 0 | 0 | 1684 | 1390 | 294 | 5568 | 4732 | 836 | 1530 | 1094 | 436 | | | | 92 | | 0.11 | |
| 236 | 17-Oct | Saturday | | | | | | | | | | | | | | | | | | | |
| 237 | 18-Oct | Sunday | | | | | | | | | | | | | | | | | | | |
| 238 | 19-Oct | Monday | | | | | | | | | | | | | | | | | | | |
| 239 | 20-Oct | Tuesday | | | | | | | | | | | | | | | | | | | |
| 240 | 21-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 241 | 22-Oct | Thursday | | | | | | | | | | | | | | | | | | | |
| 242 | 23-Oct | Friday | | | | | | | | | | | | | | | | | | | |
| 243 | 24-Oct | Saturday | | | | | | | | | | | | | | | | | | | |
| 244 | 25-Oct | Sunday | | | | | | | | | | | | | | | | | | | |
| 245 | 26-Oct | Monday | 1668 | 1428 | 240 | 1660 | 1388 | 272 | 4596 | 3846 | 750 | 2238 | 1860 | 378 | | | | 89 | | 0.10 | |
| 246 | 27-Oct | Tuesday | | | | | | | | | | | | | | | | | | | |
| 247 | 28-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 248 | 29-Oct | Thursday | 1246 | 1006 | 240 | 1502 | 1346 | 156 | 3866 | 3140 | 726 | 2254 | 1944 | 410 | | | | 111 | | 0.07 | |
| 249 | 30-Oct | Friday | | | | | | | | | | | | | | | | | | | |
| 250 | 31-Oct | Saturday | | | | | | | | | | | | | | | | | | | |
| 251 | 01-Nov | Sunday | 674 | 424 | 250 | 0 | 0 | 0 | 3508 | 2530 | 978 | 1002 | 648 | 354 | -734 | 468 | -1202 | 200 | 3.94 | 0.30 | 0.08 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Anaerobic Mass TSS | Anaerobic Mass VSS | Anaerobic Mass ISS | Anoxic 1 Mass TSS | Anoxic 1 Mass VSS | Anoxic 1 Mass ISS | Anoxic 2 Mass TSS | Anoxic 2 Mass VSS | Anoxic 2 Mass ISS | Aerobic Mass TSS | Aerobic Mass VSS | Aerobic Mass ISS | Waste Mass TSS | Waste Mass VSS | Waste Mass ISS | DSVI | COD/VSS | TKN/VSS | TKN/COD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255 | 05-Nov | Thursday | 2670 | 1648 | 1022 | 1574 | 1344 | 230 | 3662 | 2990 | 672 | 2138 | 1758 | 380 | | | | 108 | 1.51 | 0.08 | 0.05 |
| 256 | 06-Nov | Friday | 936 | 412 | 524 | 934 | 800 | 134 | 4152 | 3748 | 404 | 2064 | 1666 | 398 | | | | 82 | 1.57 | 0.08 | 0.05 |
| 257 | 07-Nov | Saturday | 1028 | 896 | 132 | 1350 | 1132 | 218 | 2266 | 1886 | 380 | 1982 | 1502 | 480 | | | | 101 | | 0.09 | |
| 258 | 08-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 259 | 09-Nov | Monday | | | | | | | | | | | | | | | | | | | |
| 260 | 10-Nov | Tuesday | 900 | 826 | 74 | 1106 | 300 | 806 | 3816 | 3132 | 684 | 1838 | 912 | 926 | | | | 87 | 2.35 | 0.15 | 0.06 |
| 261 | 11-Nov | Wednesday | 2510 | 2488 | 22 | 1246 | 1062 | 184 | 5818 | 5490 | 328 | 1710 | 1432 | 278 | | | | 99 | 1.31 | 0.09 | 0.06 |
| 262 | 12-Nov | Thursday | 940 | 760 | 180 | 1292 | 992 | 300 | 3648 | 3052 | 596 | 1982 | 1648 | 334 | | | | 101 | 1.39 | 0.10 | 0.07 |
| 263 | 13-Nov | Friday | 1140 | 1020 | 120 | 1726 | 1332 | 394 | 3920 | 3244 | 676 | 2290 | 1652 | 638 | | | | 96 | | 0.08 | |
| End of Batch 29 | | | 1446 | 1150 | 296 | 1318 | 995 | 324 | 3897 | 3363 | 534 | 2001 | 1510 | 491 | | | | 96 | 1.66 | 0.10 | 0.06 |
| 264 | 14-Nov | Saturday | | | | | | | | | | | | | | | | | | | |
| 265 | 15-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 266 | 16-Nov | Monday | 1062 | 706 | 356 | 1446 | 1258 | 188 | 3044 | 2592 | 452 | 2102 | 1730 | 372 | | | | 105 | 1.53 | 0.10 | 0.07 |
| 267 | 17-Nov | Tuesday | 634 | 478 | 156 | 868 | 688 | 180 | 2000 | 1456 | 544 | 1092 | 786 | 306 | | | | 201 | 3.37 | 0.18 | 0.05 |
| 268 | 18-Nov | Wednesday | 1012 | 804 | 208 | 964 | 728 | 236 | 2890 | 2304 | 586 | 1230 | 878 | 352 | | | | 179 | 2.63 | 0.15 | 0.06 |
| 269 | 19-Nov | Thursday | 1294 | 1150 | 144 | 1590 | 1344 | 246 | 3872 | 3324 | 548 | 2010 | 1726 | 284 | | | | 109 | 1.54 | 0.07 | 0.05 |
| 270 | 20-Nov | Friday | 1792 | 1296 | 496 | 1376 | 1244 | 132 | 3522 | 2986 | 536 | 1918 | 1586 | 332 | | | | 115 | 1.41 | 0.09 | 0.07 |
| 271 | 21-Nov | Saturday | 1444 | 1154 | 290 | 1446 | 1134 | 312 | 3416 | 2818 | 598 | 1730 | 1392 | 338 | | | | 127 | | 0.10 | |
| 272 | 22-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 273 | 23-Nov | Monday | | | | | | | | | | | | | | | | | | | |
| 274 | 24-Nov | Tuesday | | | | | | | | | | | | | | | | | | | |
| 275 | 25-Nov | Wednesday | 1640 | 420 | 1220 | 1934 | 1630 | 304 | 5130 | 4300 | 830 | 2038 | 1710 | 328 | | | | 108 | 1.57 | 0.08 | 0.05 |
| 276 | 26-Nov | Thursday | 1898 | 1620 | 278 | 1478 | 1318 | 160 | 9142 | 7586 | 1556 | 1790 | 1480 | 310 | | | | 123 | | 0.10 | |
| End of Batch 30 | | | 1347 | 953 | 394 | 1388 | 1168 | 220 | 4127 | 3421 | 706 | 1739 | 1411 | 328 | | | | 133 | 2.01 | 0.11 | 0.06 |
| 277 | 27-Nov | Friday | | | | | | | | | | | | | | | | | | | |
| 278 | 28-Nov | Saturday | | | | | | | | | | | | | | | | | | | |
| 279 | 29-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 280 | 30-Nov | Monday | 1868 | 1526 | 342 | 2040 | 1662 | 378 | 5628 | 4620 | 1008 | 2308 | 1910 | 398 | | | | | | | |
| 281 | 01-Dec | Tuesday | | | | | | | | | | | | | | | | | | | |
| 282 | 02-Dec | Wednesday | 1788 | 1540 | 248 | 2092 | 1750 | 342 | 5344 | 4292 | 1052 | 2574 | 1940 | 634 | | | | 101 | 1.44 | 0.09 | 0.06 |
| 283 | 03-Dec | Thursday | 1936 | 1666 | 290 | 2326 | 1632 | 694 | 5868 | 4958 | 910 | 2886 | 2306 | 580 | | | | 83 | | 0.07 | |
| 284 | 04-Dec | Friday | | | | | | | | | | | | | | | | | | | |
| 285 | 05-Dec | Saturday | | | | | | | | | | | | | | | | | | | |
| 286 | 06-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| End of Batch 31 | | | 1872 | 1603 | 269 | 2209 | 1691 | 518 | 5606 | 4625 | 981 | 2730 | 2123 | 607 | | | | 92 | 1.44 | 0.08 | 0.06 |
| 287 | 07-Dec | Monday | | | | | | | | | | | | | | | | | | | |
| 288 | 08-Dec | Tuesday | | | | | | | | | | | | | | | | | | | |
| 289 | 09-Dec | Wednesday | | | | | | | | | | | | | | | | | | | |
| 290 | 10-Dec | Thursday | | | | | | | | | | | | | | | | | | | |
| 291 | 11-Dec | Friday | | | | | | | | | | | | | | | | | | | |
| 292 | 12-Dec | Saturday | | | | | | | | | | | | | | | | | | | |
| 293 | 13-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| 294 | 14-Dec | Monday | | | | | | | | | | | | | | | | | | | |
| 295 | 15-Dec | Tuesday | 1996 | 1628 | 368 | 3540 | 3070 | 470 | 5890 | 4628 | 1262 | 2086 | 1600 | 486 | | | | 86 | 2.08 | 0.12 | 0.06 |
| 296 | 16-Dec | Wednesday | 2020 | 1712 | 308 | 6394 | 3480 | 1114 | 6854 | 4622 | 2232 | 2304 | 2274 | 30 | 2822 | 2520 | 302 | 74 | 1.46 | 0.12 | 0.08 |
| 297 | 17-Dec | Thursday | 2498 | 2058 | 440 | 3130 | 2530 | 380 | 7178 | 5718 | 1460 | 4026 | 3066 | 960 | | | | 43 | 1.14 | 0.06 | 0.06 |
| 298 | 18-Dec | Friday | 2198 | 1860 | 338 | 7314 | 2662 | 4652 | 10064 | 8338 | 1726 | 3238 | 2616 | 622 | | | | 49 | | 0.11 | |
| 299 | 19-Dec | Saturday | | | | | | | | | | | | | | | | | | | |
| 300 | 20-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| 301 | 21-Dec | Monday | | | | | | | | | | | | | | | | | | | |
| 302 | 22-Dec | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 32 | | | 2178 | 1815 | 363 | 5145 | 3440 | 1704 | 7497 | 5827 | 1670 | 2913 | 2389 | 525 | 2822 | 2520 | 302 | 64 | 1.56 | 0.10 | 0.07 |
| 303 | 23-Dec | Wednesday | | | | | | | | | | | | | | | | | | | |
| 304 | 24-Dec | Thursday | 2036 | 1674 | 362 | 2726 | 1886 | 840 | 6984 | 5486 | 1498 | 3168 | 2632 | 536 | | | | 51 | 1.39 | 0.21 | 0.15 |
| 305 | 25-Dec | Friday | 2564 | 2300 | 264 | 2620 | 2120 | 500 | 7190 | 5722 | 1468 | 2514 | 2396 | 118 | | | | 64 | 1.90 | 0.06 | 0.03 |
| 306 | 26-Dec | Saturday | 1934 | 1634 | 300 | 2022 | 1712 | 310 | 5194 | 4340 | 854 | 2028 | 1686 | 342 | | | | 99 | | 0.17 | |
| 307 | 27-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| 308 | 28-Dec | Monday | 1798 | 1622 | 176 | 1708 | 1418 | 290 | 5980 | 4992 | 988 | 2518 | 578 | 1940 | | | | 93 | 7.82 | 0.57 | 0.07 |
| 309 | 29-Dec | Tuesday | 2030 | 1424 | 606 | 1706 | 1432 | 274 | 4610 | 3884 | 726 | 2246 | 1852 | 394 | | | | 116 | 1.53 | 0.19 | 0.12 |
| 310 | 30-Dec | Wednesday | 2012 | 1648 | 364 | 2114 | 1634 | 480 | 5882 | 4616 | 1266 | 2072 | 1590 | 482 | 3994 | 3342 | 652 | 145 | | 0.20 | |
| 311 | 31-Dec | Thursday | | | | | | | | | | | | | | | | | | | |
| 312 | 01-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 313 | 02-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 314 | 03-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 315 | 04-Jan | Monday | 1762 | 1440 | 322 | 2450 | 1868 | 582 | | | | 2606 | 2064 | 542 | | | | 123 | | 0.14 | |
| End of Batch 33 | | | 2019 | 1067 | 218 | 1395 | 1097 | 298 | 3258 | 2640 | 618 | 1559 | 1163 | 396 | 3994 | 3342 | 652 | 86 | 3.16 | 0.22 | 0.09 |
| 316 | 05-Jan | Tuesday | 2082 | 1670 | 412 | 2500 | 1954 | 546 | 7218 | 5590 | 1628 | 3078 | 2448 | 630 | 4218 | 3610 | 608 | 84 | | 0.08 | |
| 317 | 06-Jan | Wednesday | | | | | | | | | | | | | | | | | | | |
| 318 | 07-Jan | Thursday | | | | | | | | | | | | | | | | | | | |
| 319 | 08-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 320 | 09-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 321 | 10-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 322 | 11-Jan | Monday | | | | | | | | | | | | | | | | | | | |
| 323 | 12-Jan | Tuesday | | | | | | | | | | | | | | | | | | | |
| 324 | 13-Jan | Wednesday | 2068 | 1480 | 588 | 1812 | 1540 | 272 | 4856 | 4174 | 682 | 2082 | 1742 | 340 | 3006 | 2582 | 424 | 115 | 1.56 | 0.12 | 0.08 |
| 325 | 14-Jan | Thursday | 1332 | 1198 | 154 | 1676 | 1494 | 182 | 4884 | 4194 | 690 | 1814 | 1484 | 330 | 2856 | 2623 | 233 | 134 | | 0.15 | |
| 326 | 15-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 327 | 16-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 328 | 17-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 329 | 18-Jan | Monday | | | | | | | | | | | | | | | | | | | |
| 330 | 19-Jan | Tuesday | | | | | | | | | | | | | | | | | | | |
| 331 | 20-Jan | Wednesday | | | | | | | | | | | | | | | | | | | |
| 332 | 21-Jan | Thursday | 1634 | 1396 | 238 | 2242 | 1904 | 338 | 4482 | 3720 | 762 | 1988 | 1624 | 364 | 1558 | 1368 | 190 | 131 | | 0.41 | |
| 333 | 22-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 334 | 23-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 335 | 24-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 336 | 25-Jan | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 34 | | | 1685 | 1358 | 327 | 1910 | 1646 | 264 | 4741 | 4029 | 711 | 1961 | 1617 | 345 | 2473 | 2191 | 282 | 140 | 1.56 | 0.19 | 0.08 |
| 337 | 26-Jan | Tuesday | 2434 | 2106 | 328 | 2238 | 1916 | 322 | 6100 | 5132 | 968 | 2594 | 2184 | 410 | | | | | | | |
| 338 | 27-Jan | Wednesday | 2232 | 1958 | 274 | 2578 | 2206 | 372 | 6232 | 5278 | 934 | 2560 | 2148 | 412 | 318 | 296 | 22 | 148 | 1.48 | 0.09 | 0.06 |
| 339 | 28-Jan | Thursday | 2416 | 1976 | 440 | 2696 | 2220 | 476 | 6494 | 5664 | 830 | 3042 | 2596 | 446 | 2106 | 272 | 1834 | 145 | 1.39 | 0.09 | 0.07 |
| 340 | 29-Jan | Friday | 2620 | 2230 | 390 | 2236 | 1870 | 366 | 8296 | 6812 | 1484 | 1964 | 1570 | 394 | 1914 | 128 | 1786 | 183 | | 0.11 | |
| 341 | 30-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 342 | 31-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 343 | 01-Feb | Monday | | | | | | | | | | | | | | | | | | | |
| 344 | 02-Feb | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 35 | | | 2426 | 2068 | 358 | 2437 | 2053 | 384 | 6780 | 5721 | 1059 | 2540 | 2125 | 415 | 1446 | 232 | 1214 | 159 | 1.43 | 0.10 | 0.06 |
| 345 | 03-Feb | Wednesday | | | | | | | | | | | | | | | | | | | |
| 346 | 04-Feb | Thursday | | | | | | | | | | | | | | | | | | | |
| 347 | 05-Feb | Friday | | | | | | | | | | | | | | | | | | | |
| 348 | 06-Feb | Saturday | | | | | | | | | | | | | | | | | | | |
| 349 | 07-Feb | Sunday | 1864 | 1630 | 234 | 1932 | 1626 | 306 | 5108 | 4272 | 836 | 1984 | 1610 | 374 | | | | | | | |
| 350 | 08-Feb | Monday | | | | | | | | | | | | | | | | | | | |
| 351 | 09-Feb | Tuesday | 2206 | 1716 | 490 | 2202 | 1822 | 380 | 5670 | 4700 | 970 | 2610 | 2124 | 486 | 766 | 692 | 74 | 138 | | 0.09 | |
| 352 | 10-Feb | Wednesday | 1954 | 1712 | 242 | 2392 | 2012 | 380 | 6384 | 5334 | 1050 | 2500 | 2000 | 500 | 672 | 582 | 90 | 144 | 1.59 | 0.11 | 0.07 |
| 353 | 11-Feb | Thursday | 2068 | 1768 | 300 | 2232 | 1816 | 416 | 5972 | 4968 | 1004 | 2610 | 2298 | 312 | 1004 | 880 | 124 | 176 | 1.25 | 0.09 | 0.07 |
| 354 | 12-Feb | Friday | | | | | | | | | | | | | | | | | | | |
| 355 | 13-Feb | Saturday | 2360 | 2010 | 350 | 2662 | 2204 | 458 | 6188 | 5040 | 1148 | 2574 | 2050 | 524 | | | | | | | |
| 356 | 14-Feb | Sunday | 2230 | 1874 | 356 | 2266 | 1818 | 448 | 6734 | 5474 | 1260 | 2594 | 2006 | 588 | | | | | | | |
| 357 | 15-Feb | Monday | 2068 | 1546 | 522 | 2618 | 1294 | 1324 | 7044 | 5420 | 1624 | 2552 | 1610 | 942 | | | | | | | |
| 358 | 16-Feb | Tuesday | 2372 | 1372 | 1000 | 2462 | 1702 | 760 | 1092 | 770 | 322 | 6740 | 4964 | 1776 | | | | | | | |
| End of Batch 36 | | | 2140 | 1704 | 437 | 2346 | 1787 | 559 | 5524 | 4497 | 1027 | 3020 | 2333 | 688 | 814 | 718 | 96 | 153 | 1.42 | 0.10 | 0.07 |
| 359 | 17-Feb | Wednesday | | | | | | | | | | | | | | | | | | | |
| 360 | 18-Feb | Thursday | 2330 | 1910 | 420 | 2804 | 2274 | 530 | 3946 | 3726 | 220 | | | | | | | | | | |
| 361 | 19-Feb | Friday | 2390 | 1986 | 404 | 2376 | 1850 | 526 | 8612 | 6918 | 1694 | 4192 | 2288 | 1904 | 684 | 588 | 96 | 86 | 1.48 | 0.09 | 0.06 |
| 362 | 20-Feb | Saturday | | | | | | | | | | | | | | | | | | | |
| 363 | 21-Feb | Sunday | | | | | | | | | | | | | | | | | | | |
| 364 | 22-Feb | Monday | 2908 | 2580 | 328 | 2302 | 2040 | 262 | 10354 | 8746 | 1608 | 2632 | 2214 | 418 | 576 | 586 | -10 | 99 | | 0.09 | |
| 365 | 23-Feb | Tuesday | 2166 | 1998 | 168 | 2640 | 2288 | 352 | 6954 | 5728 | 1226 | 2604 | 2188 | 416 | | | | | | | |
| 366 | 24-Feb | Wednesday | 1964 | 1624 | 340 | 2346 | 1896 | 450 | 6346 | 5132 | 1214 | 2804 | 2204 | 600 | | | | | | | |
| 367 | 25-Feb | Thursday | | | | | | | | | | | | | | | | | | | |
| 368 | 26-Feb | Friday | 2072 | 1694 | 378 | 2322 | 1816 | 506 | 6946 | 5494 | 1452 | 2334 | 1830 | 504 | 398 | 368 | 30 | 146 | | 0.12 | |
| 369 | 27-Feb | Saturday | 1900 | 1592 | 308 | 2130 | 1730 | 420 | 6044 | 4752 | 1292 | 1954 | 1540 | 414 | -174 | -254 | 80 | 164 | 2.51 | 0.13 | 0.05 |
| 370 | 28-Feb | Sunday | | | | | | | | | | | | | | | | | | | |
| 371 | 01-Mar | Monday | | | | | | | | | | | | | | | | | | | |
| 372 | 02-Mar | Tuesday | | | | | | | | | | | | | | | | | | | |
| 373 | 03-Mar | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 37 | | | 2202 | 1898 | 304 | 2352 | 1954 | 398 | 7329 | 5970 | 1358 | 2466 | 1995 | 470 | 267 | 233 | 33 | 136 | 1.99 | 0.11 | 0.06 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Measured Nitrate Values mgNO3-N/l | | | | | | | Measured Nitrite Values mgNO2-N/l | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Anaerobic | Main_Ano | Pre_Ano | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | Anaerobic | Main_Ano | Pre_Ano | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff |
| 1 | 24-Feb | Tuesday | 0.36 | 8.32 | 1.19 | 7.13 | 11.88 | 0.59 | 21.86 | | | | | | | |
| 2 | 25-Feb | Wednesday | 0.20 | 7.43 | 0.95 | 6.30 | 6.30 | 0.27 | 23.05 | | | | | | | |
| 3 | 26-Feb | Thursday | 0.25 | 9.98 | 0.83 | 9.86 | 7.72 | 0.14 | 22.81 | | | | | | | |
| End of Batch 1 | | | 0.27 | 8.57 | 0.99 | 7.76 | 8.63 | 0.34 | 22.57 | | | | | | | |
| 4 | 27-Feb | Friday | 0.21 | 11.29 | 0.49 | 15.33 | 12.48 | 0.15 | 22.57 | | | | | | | |
| 5 | 28-Feb | Saturday | 0.21 | 13.13 | 1.06 | 19.96 | 20.44 | 0.15 | 23.05 | | | | | | | |
| 6 | 01-Mar | Sunday | 0.36 | 10.69 | 1.51 | 24.83 | 25.19 | 0.24 | 25.43 | | | | | | | |
| 7 | 02-Mar | Monday | 0.42 | 11.64 | 2.22 | 26.85 | 26.73 | 0.27 | 26.14 | | | | | | | |
| 8 | 03-Mar | Tuesday | 0.77 | 10.56 | 2.11 | 13.78 | 17.13 | 0.26 | 20.09 | | | | | | | |
| 9 | 04-Mar | Wednesday | 0.66 | 11.40 | 1.78 | 14.42 | 15.46 | 0.26 | 20.35 | | | | | | | |
| 10 | 05-Mar | Thursday | 0.44 | 13.14 | 2.06 | 15.46 | 16.74 | 0.27 | 21.64 | | | | | | | |
| 11 | 06-Mar | Friday | 0.26 | 10.56 | 1.98 | 15.07 | 16.36 | 0.30 | 24.21 | | | | | | | |
| 12 | 07-Mar | Saturday | 0.32 | 12.11 | 2.32 | 18.16 | 15.97 | 0.26 | 24.47 | | | | | | | |
| 13 | 08-Mar | Sunday | 0.44 | 9.72 | 1.57 | 15.07 | 14.42 | 0.21 | 23.70 | | | | | | | |
| 14 | 09-Mar | Monday | 0.41 | 9.47 | 1.52 | 12.36 | 15.07 | 0.17 | 18.03 | | | | | | | |
| 15 | 10-Mar | Tuesday | 0.40 | 10.88 | 2.00 | 14.04 | 16.36 | 0.17 | 21.89 | | | | | | | |
| 16 | 11-Mar | Wednesday | 0.55 | 11.08 | 2.09 | 17.39 | 16.61 | 0.27 | 24.99 | | | | | | | |
| 17 | 12-Mar | Thursday | 0.45 | 14.17 | 2.58 | 15.46 | 17.64 | 0.35 | 20.86 | | | | | | | |
| End of Batch 2 | | | 0.42 | 11.42 | 1.83 | 17.01 | 17.61 | 0.24 | 22.67 | | | | | | | |
| 18 | 13-Mar | Friday | 0.44 | 10.63 | 1.75 | 13.78 | 11.98 | 0.22 | 19.83 | | | | | | | |
| 19 | 14-Mar | Saturday | 0.38 | 11.02 | 1.97 | 18.10 | 14.73 | 0.30 | 24.96 | | | | | | | |
| 20 | 15-Mar | Sunday | 0.31 | 8.32 | 1.90 | 12.82 | 11.47 | 0.23 | 29.23 | | | | | | | |
| 21 | 16-Mar | Monday | 0.34 | 7.98 | 1.46 | 10.79 | 11.35 | 0.22 | 25.41 | | | | | | | |
| 22 | 17-Mar | Tuesday | | | | | | | | | | | | | | |
| End of Batch 3 | | | 0.37 | 9.49 | 1.77 | 13.87 | 12.38 | 0.25 | 24.86 | | | | | | | |
| 23 | 18-Mar | Wednesday | | | | | | | | | | | | | | |
| 24 | 19-Mar | Thursday | | | | | | | | | | | | | | |
| 25 | 20-Mar | Friday | | | | | | | | | | | | | | |
| 26 | 21-Mar | Saturday | | | | | | | | | | | | | | |
| 27 | 22-Mar | Sunday | 0.22 | 0.56 | 0.09 | 2.36 | 2.14 | 0.49 | 16.19 | | | | | | | |
| 28 | 23-Mar | Monday | 0.39 | 0.56 | 0.07 | 2.47 | 2.36 | 0.24 | 16.19 | | | | | | | |
| 29 | 24-Mar | Tuesday | 0.19 | 0.28 | 0.04 | 2.47 | 2.25 | 0.28 | 18.21 | | | | | | | |
| 30 | 25-Mar | Wednesday | 0.19 | 0.34 | 0.04 | 1.35 | 1.24 | 0.13 | 19.34 | | | | | | | |
| End of Batch 4 | | | 0.25 | 0.44 | 0.06 | 2.16 | 2.00 | 0.29 | 17.48 | | | | | | | |
| 31 | 26-Mar | Thursday | | | | | | | | | | | | | | |
| 32 | 27-Mar | Friday | 0.21 | 1.03 | 0.16 | 1.41 | 1.74 | 0.18 | 13.01 | | | | | | | |
| 33 | 28-Mar | Saturday | 0.24 | 0.65 | 0.20 | 0.76 | 1.52 | 0.24 | 10.19 | | | | | | | |
| 34 | 29-Mar | Sunday | 0.26 | 0.49 | 0.08 | 0.43 | 2.60 | 0.14 | 15.83 | | | | | | | |
| 35 | 30-Mar | Monday | 0.23 | 0.49 | 0.10 | 0.65 | 2.06 | 0.16 | 13.88 | | | | | | | |
| 36 | 31-Mar | Tuesday | | | | | | | | | | | | | | |
| 37 | 01-Apr | Wednesday | | | | | | | | | | | | | | |
| 38 | 02-Apr | Thursday | | | | | | | | | | | | | | |
| End of Batch 5 | | | 0.23 | 0.66 | 0.13 | 0.81 | 1.98 | 0.18 | 13.23 | | | | | | | |
| 39 | 03-Apr | Friday | | | | | | | | | | | | | | |
| 40 | 04-Apr | Saturday | | | | | | | | | | | | | | |
| 41 | 05-Apr | Sunday | | | | | | | | | | | | | | |
| 42 | 06-Apr | Monday | 0.39 | 0.92 | 0.16 | 3.36 | 1.74 | 0.16 | 13.88 | | | | | | | |
| 43 | 07-Apr | Tuesday | 0.15 | 0.38 | 0.04 | 0.87 | 1.95 | 0.16 | 11.06 | | | | | | | |
| 44 | 08-Apr | Wednesday | 0.20 | 0.49 | 0.13 | 0.65 | 1.74 | 0.29 | 14.75 | | | | | | | |
| 45 | 09-Apr | Thursday | | | | | | | | | | | | | | |
| End of Batch 6 | | | 0.25 | 0.60 | 0.11 | 1.63 | 1.81 | 0.21 | 13.23 | | | | | | | |
| 46 | 10-Apr | Friday | 0.37 | 0.77 | 0.25 | 2.12 | 2.12 | 0.23 | 11.59 | | | | | | | |
| 47 | 11-Apr | Saturday | 0.22 | 0.87 | 0.18 | 1.74 | 1.74 | 0.25 | 18.15 | | | | | | | |
| 48 | 12-Apr | Sunday | | | | | | | | | | | | | | |
| 49 | 13-Apr | Monday | | | | | | | | | | | | | | |
| 50 | 14-Apr | Tuesday | | | | | | | | | | | | | | |
| 51 | 15-Apr | Wednesday | 0.19 | 1.26 | 0.50 | 1.74 | 1.16 | 0.23 | 29.16 | | | | | | | |
| 52 | 16-Apr | Thursday | 0.25 | 0.77 | 0.29 | 1.64 | 1.45 | 0.24 | 31.28 | | | | | | | |
| End of Batch 7 | | | 0.26 | 0.92 | 0.31 | 1.81 | 1.62 | 0.24 | 22.55 | | | | | | | |
| 53 | 17-Apr | Friday | 0.22 | 1.09 | 0.24 | 5.94 | 5.74 | 0.29 | 19.79 | | | | | | | |
| 54 | 18-Apr | Saturday | | | | | | | | | | | | | | |
| 55 | 19-Apr | Sunday | 0.25 | 0.94 | 0.36 | 6.33 | 5.74 | 0.31 | 19.39 | | | | | | | |
| 56 | 20-Apr | Monday | 0.22 | 1.58 | 0.38 | 6.23 | 5.74 | 0.33 | 16.22 | | | | | | | |
| 57 | 21-Apr | Tuesday | 0.29 | 1.34 | 0.38 | 5.94 | 6.23 | 0.33 | 16.82 | | | | | | | |
| 58 | 22-Apr | Wednesday | 0.33 | 1.24 | 0.39 | 6.33 | 5.94 | 0.36 | 16.22 | | | | | | | |
| 59 | 23-Apr | Thursday | 0.23 | 1.09 | 0.32 | 6.53 | 6.33 | 0.32 | 13.85 | | | | | | | |
| 60 | 24-Apr | Friday | | | | | | | | | | | | | | |
| 61 | 25-Apr | Saturday | 0.28 | 0.99 | 0.28 | 6.63 | 5.94 | 0.37 | 18.99 | | | | | | | |
| 62 | 26-Apr | Sunday | 0.23 | 0.74 | 0.38 | 1.48 | 2.57 | 0.42 | 22.95 | | | | | | | |
| 63 | 27-Apr | Monday | | | | | | | | | | | | | | |
| 64 | 28-Apr | Tuesday | 0.26 | 0.69 | 0.28 | 1.98 | 2.57 | 0.36 | 19.39 | | | | | | | |
| 65 | 29-Apr | Wednesday | | | | | | | | | | | | | | |
| End of Batch 8 | | | 0.25 | 1.08 | 0.33 | 5.27 | 5.20 | 0.34 | 18.18 | | | | | | | |
| 66 | 30-Apr | Thursday | 0.28 | 0.08 | 0.25 | 1.42 | 3.60 | 0.50 | 25.95 | | | | | | | |
| 67 | 01-May | Friday | 0.27 | 0.82 | 0.33 | 1.64 | 2.73 | 0.24 | 23.55 | | | | | | | |
| 68 | 02-May | Saturday | 0.28 | 1.04 | 0.41 | 2.07 | 2.18 | 0.28 | 27.04 | | | | | | | |
| End of Batch 9 | | | 0.28 | 0.65 | 0.33 | 1.71 | 2.83 | 0.34 | 25.51 | | | | | | | |
| 69 | 03-May | Sunday | | | | | | | | | | | | | | |
| 70 | 04-May | Monday | | | | | | | | | | | | | | |
| 71 | 05-May | Tuesday | | | | | | | | | | | | | | |
| 72 | 06-May | Wednesday | | | | | | | | | | | | | | |
| 73 | 07-May | Thursday | | | | | | | | | | | | | | |
| 74 | 08-May | Friday | | | | | | | | | | | | | | |
| End of Batch10 | | | | | | | | | | | | | | | | |
| 75 | 09-May | Saturday | 0.31 | 0.09 | 0.27 | 1.55 | 3.93 | 0.55 | 28.32 | | | | | | | |
| 76 | 10-May | Sunday | 0.30 | 0.89 | 0.36 | 1.78 | 2.97 | 0.26 | 25.70 | | | | | | | |
| 77 | 11-May | Monday | 0.31 | 1.13 | 0.45 | 2.26 | 2.38 | 0.31 | 29.51 | | | | | | | |
| 78 | 12-May | Tuesday | 0.50 | 7.44 | 0.30 | 12.14 | 6.19 | 0.38 | 20.70 | | | | | | | |
| 79 | 13-May | Wednesday | 0.31 | 0.63 | 0.31 | 1.31 | 1.78 | 0.37 | 25.70 | | | | | | | |
| 80 | 14-May | Thursday | | | | | | | | | | | | | | |
| 81 | 15-May | Friday | 1.36 | 0.95 | 0.26 | 1.78 | 1.07 | 0.37 | 21.42 | | | | | | | |
| 82 | 16-May | Saturday | | | | | | | | | | | | | | |
| 83 | 17-May | Sunday | 0.75 | 0.48 | 0.31 | 1.67 | 1.07 | 0.32 | 43.08 | | | | | | | |
| 84 | 18-May | Monday | 0.39 | 0.48 | 0.30 | 1.31 | 1.55 | 0.51 | 49.26 | | | | | | | |
| 85 | 19-May | Tuesday | 0.43 | 0.42 | 0.30 | 1.67 | 1.31 | 0.29 | 56.64 | | | | | | | |
| End of Batch 11 | | | 0.54 | 1.39 | 0.32 | 2.83 | 2.47 | 0.37 | 33.37 | | | | | | | |
| 86 | 20-May | Wednesday | 0.24 | 0.47 | 0.24 | 0.79 | 0.47 | 0.35 | 25.50 | | | | | | | |
| 87 | 21-May | Thursday | | | | | | | | | | | | | | |
| 88 | 22-May | Friday | 0.99 | 0.87 | 0.30 | 1.10 | 0.79 | 0.30 | 23.93 | | | | | | | |
| 89 | 23-May | Saturday | 0.98 | 0.47 | 0.47 | 1.10 | 0.63 | 0.44 | 20.78 | | | | | | | |
| 90 | 24-May | Sunday | 0.63 | 0.47 | 0.43 | 0.79 | 0.79 | 0.36 | 23.30 | | | | | | | |
| 91 | 25-May | Monday | 0.71 | 0.55 | 0.38 | 0.63 | 0.31 | 0.41 | 25.19 | | | | | | | |
| 92 | 26-May | Tuesday | | | | | | | | | | | | | | |
| 93 | 27-May | Wednesday | | | | | | | | | | | | | | |
| 94 | 28-May | Thursday | 0.80 | 0.79 | 0.24 | 0.31 | 0.47 | 0.30 | 24.56 | | | | | | | |
| 95 | 29-May | Friday | 0.33 | 0.47 | 0.49 | 0.31 | 0.47 | 0.35 | 21.41 | | | | | | | |
| 96 | 30-May | Saturday | 1.16 | 0.31 | 0.31 | 0.79 | 0.63 | 0.39 | 22.67 | | | | | | | |
| 97 | 31-May | Sunday | 0.38 | 0.47 | 0.25 | 0.31 | 0.79 | 0.16 | 19.21 | | | | | | | |
| 98 | 01-Jun | Monday | 0.55 | 1.34 | 0.17 | 2.05 | 2.05 | 0.24 | 20.46 | | | | | | | |
| 99 | 02-Jun | Tuesday | | | | | | | | | | | | | | |
| 100 | 03-Jun | Wednesday | | | | | | | | | | | | | | |
| 101 | 04-Jun | Thursday | | | | | | | | | | | | | | |
| 102 | 05-Jun | Friday | | | | | | | | | | | | | | |
| End of Batch 12 | | | 0.68 | 0.62 | 0.33 | 0.82 | 0.74 | 0.33 | 22.70 | | | | | | | |
| 103 | 06-Jun | Saturday | 0.29 | 0.89 | 0.05 | 1.59 | 1.64 | 0.25 | 6.30 | 0.07 | 0.03 | 0.02 | 0.12 | 0.07 | 0.10 | 0.08 |
| 104 | 07-Jun | Sunday | 0.27 | 0.90 | 0.04 | 1.81 | 1.84 | 0.25 | 5.17 | 0.07 | 0.02 | 0.02 | 0.13 | 0.09 | 0.05 | 0.08 |
| 105 | 08-Jun | Monday | 0.27 | 1.43 | 0.03 | 1.60 | 1.62 | 0.24 | 4.93 | 0.06 | 0.16 | 0.02 | 0.11 | 0.09 | 0.04 | 0.08 |
| 106 | 09-Jun | Tuesday | | | | | | | | | | | | | | |
| 107 | 10-Jun | Wednesday | | | | | | | | | | | | | | |
| 108 | 11-Jun | Thursday | 0.24 | 1.08 | 0.09 | 1.93 | 1.93 | 0.22 | 3.36 | 0.07 | 0.06 | 0.02 | 0.10 | 0.13 | 0.04 | 0.09 |
| 109 | 12-Jun | Friday | 0.43 | 2.07 | 0.03 | 2.40 | 2.37 | 0.32 | 9.93 | 0.16 | 0.21 | 0.08 | 0.11 | 0.14 | 0.14 | 0.11 |
| End of Batch13 | | | 0.38 | 1.37 | 0.05 | 1.94 | 1.94 | 0.26 | 5.90 | 0.09 | 0.11 | 0.03 | 0.11 | 0.11 | 0.06 | 0.09 |
| 110 | 13-Jun | Saturday | | | | | | | | | | | | | | |
| 111 | 14-Jun | Sunday | | | | | | | | | | | | | | |
| 112 | 15-Jun | Monday | | | | | | | | | | | | | | |
| 113 | 16-Jun | Tuesday | | | | | | | | | | | | | | |
| 114 | 17-Jun | Wednesday | | | | | | | | | | | | | | |
| End of Batch14 | | | | | | | | | | | | | | | | |
| 115 | 18-Jun | Thursday | | | | | | | | | | | | | | |
| 116 | 19-Jun | Friday | | | | | | | | | | | | | | |
| 117 | 20-Jun | Saturday | | | | | | | | | | | | | | |
| 118 | 21-Jun | Sunday | | | | | | | | | | | | | | |
| 119 | 22-Jun | Monday | | | | | | | | | | | | | | |
| End of Batch15 | | | | | | | | | | | | | | | | |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Measured Nitrate Values mgNO3-N/l | | | | | | | Measured Nitrite Values mgNO2-N/l | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Anaerobic | Man_Ano | Pre_Ano | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | Anaerobic | Man_Ano | Pre_Ano | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff |
| 120 | 23-Jun | Tuesday | | | | | | | | | | | | | | |
| 121 | 24-Jun | Wednesday | 0.36 | 0.53 | 0.33 | 2.24 | 1.45 | 0.24 | 5.52 | | | | | | | |
| 122 | 25-Jun | Thursday | | | | | | | | | | | | | | |
| 123 | 26-Jun | Friday | 0.34 | 0.66 | 0.28 | 1.72 | 1.58 | 0.29 | 7.36 | | | | | | | |
| 124 | 27-Jun | Saturday | | | | | | | | | | | | | | |
| 125 | 28-Jun | Sunday | | | | | | | | | | | | | | |
| End of Batch16 | | | 0.35 | 0.59 | 0.30 | 1.78 | 1.51 | 0.26 | 6.44 | | | | | | | |
| 126 | 29-Jun | Monday | 0.30 | 0.53 | 0.46 | 1.84 | 1.71 | 0.26 | 8.94 | | | | | | | |
| 127 | 30-Jun | Tuesday | | | | | | | | | | | | | | |
| 128 | 01-Jul | Wednesday | 0.32 | 0.59 | 0.36 | 2.37 | 2.24 | 0.32 | 6.31 | | | | | | | |
| 129 | 02-Jul | Thursday | 0.28 | 0.66 | 0.29 | 1.84 | 1.84 | 0.24 | 7.63 | | | | | | | |
| 130 | 03-Jul | Friday | | | | | | | | | | | | | | |
| 131 | 04-Jul | Saturday | | | | | | | | | | | | | | |
| 132 | 05-Jul | Sunday | | | | | | | | | | | | | | |
| 133 | 06-Jul | Monday | 0.39 | 0.46 | 0.28 | 1.97 | 1.71 | 0.34 | 14.47 | | | | | | | |
| 134 | 07-Jul | Tuesday | | | | | | | | | | | | | | |
| End of Batch17 | | | 0.33 | 0.56 | 0.35 | 2.01 | 1.87 | 0.29 | 9.34 | | | | | | | |
| 135 | 08-Jul | Wednesday | | | | | | | | | | | | | | |
| 136 | 09-Jul | Thursday | 0.41 | 1.05 | 0.79 | 1.97 | 1.97 | 0.17 | 7.36 | | | | | | | |
| 137 | 10-Jul | Friday | 0.39 | 1.05 | 0.07 | 2.24 | 2.24 | 0.25 | 6.05 | | | | | | | |
| 138 | 11-Jul | Saturday | 0.38 | 1.84 | 0.05 | 1.97 | 1.97 | 0.24 | 5.79 | | | | | | | |
| 139 | 12-Jul | Sunday | | | | | | | | | | | | | | |
| 140 | 13-Jul | Monday | | | | | | | | | | | | | | |
| 141 | 14-Jul | Tuesday | | | | | | | | | | | | | | |
| 142 | 15-Jul | Wednesday | | | | | | | | | | | | | | |
| 143 | 16-Jul | Thursday | | | | | | | | | | | | | | |
| 144 | 17-Jul | Friday | | | | | | | | | | | | | | |
| 145 | 18-Jul | Saturday | | | | | | | | | | | | | | |
| 146 | 19-Jul | Sunday | | | | | | | | | | | | | | |
| 147 | 20-Jul | Monday | | | | | | | | | | | | | | |
| End of Batch 18 | | | 0.39 | 1.32 | 0.30 | 2.06 | 2.06 | 0.22 | 6.40 | | | | | | | |
| 148 | 21-Jul | Tuesday | | | | | | | | | | | | | | |
| 149 | 22-Jul | Wednesday | | | | | | | | | | | | | | |
| End of Batch 19 | | | | | | | | | | | | | | | | |
| 150 | 23-Jul | Thursday | 0.80 | 1.78 | 0.21 | 6.31 | 5.13 | 0.29 | 22.62 | | | | | | | |
| 151 | 24-Jul | Friday | 0.50 | 2.63 | 0.21 | 4.21 | 4.87 | 0.24 | 17.36 | | | | | | | |
| 152 | 25-Jul | Saturday | 0.69 | 4.27 | 0.18 | 6.18 | 4.47 | 0.25 | 22.88 | | | | | | | |
| 153 | 26-Jul | Sunday | | | | | | | | | | | | | | |
| 154 | 27-Jul | Monday | 0.57 | 1.97 | 0.21 | 4.60 | 3.55 | 0.25 | 23.67 | | | | | | | |
| End of Batch 20 | | | 0.64 | 2.66 | 0.20 | 5.33 | 4.50 | 0.26 | 21.63 | | | | | | | |
| 155 | 28-Jul | Tuesday | | | | | | | | | | | | | | |
| 156 | 29-Jul | Wednesday | | | | | | | | | | | | | | |
| 157 | 30-Jul | Thursday | | | | | | | | | | | | | | |
| 158 | 31-Jul | Friday | | | | | | | | | | | | | | |
| 159 | 01-Aug | Saturday | | | | | | | | | | | | | | |
| 160 | 02-Aug | Sunday | | | | | | | | | | | | | | |
| 161 | 03-Aug | Monday | | | | | | | | | | | | | | |
| 162 | 04-Aug | Tuesday | | | | | | | | | | | | | | |
| 163 | 05-Aug | Wednesday | | | | | | | | | | | | | | |
| 164 | 06-Aug | Thursday | | | | | | | | | | | | | | |
| 165 | 07-Aug | Friday | | | | | | | | | | | | | | |
| 166 | 08-Aug | Saturday | | | | | | | | | | | | | | |
| 167 | 09-Aug | Sunday | | | | | | | | | | | | | | |
| 168 | 10-Aug | Monday | | | | | | | | | | | | | | |
| 169 | 11-Aug | Tuesday | 0.43 | 3.31 | 1.61 | 7.83 | 8.65 | 0.86 | 12.15 | | | | | | | |
| 170 | 12-Aug | Wednesday | 0.53 | 3.87 | 1.66 | 9.94 | 9.85 | 1.20 | 19.33 | | | | | | | |
| 171 | 13-Aug | Thursday | | | | | | | | | | | | | | |
| 172 | 14-Aug | Friday | | | | | | | | | | | | | | |
| 173 | 15-Aug | Saturday | | | | | | | | | | | | | | |
| 174 | 16-Aug | Sunday | | | | | | | | | | | | | | |
| 175 | 17-Aug | Monday | | | | | | | | | | | | | | |
| End of Batch 22 | | | 0.48 | 3.59 | 1.63 | 8.88 | 9.25 | 1.03 | 15.74 | | | | | | | |
| 176 | 18-Aug | Tuesday | 0.73 | 3.87 | 2.03 | 14.45 | 15.83 | 1.03 | 21.91 | | | | | | | |
| 177 | 19-Aug | Wednesday | 0.78 | 1.13 | 1.43 | 15.28 | 16.29 | 0.66 | 14.36 | | | | | | | |
| 178 | 20-Aug | Thursday | 0.89 | 2.58 | 1.43 | 12.61 | 16.11 | 0.74 | 10.68 | | | | | | | |
| 179 | 21-Aug | Friday | | | | | | | | | | | | | | |
| 180 | 22-Aug | Saturday | 0.04 | 0.14 | 0.31 | 4.23 | 3.59 | 0.23 | 0.37 | | | | | | | |
| 181 | 23-Aug | Sunday | 0.06 | 0.18 | 0.03 | 2.21 | 1.93 | 0.36 | 0.74 | | | | | | | |
| 182 | 24-Aug | Monday | 0.07 | 0.18 | 0.03 | 1.57 | 1.57 | 0.12 | 0.55 | | | | | | | |
| 183 | 25-Aug | Tuesday | 0.04 | 0.14 | 0.04 | 1.20 | 1.10 | 0.07 | 1.10 | | | | | | | |
| 184 | 26-Aug | Wednesday | | | | | | | | | | | | | | |
| 185 | 27-Aug | Thursday | | | | | | | | | | | | | | |
| 186 | 28-Aug | Friday | | | | | | | | | | | | | | |
| 187 | 29-Aug | Saturday | | | | | | | | | | | | | | |
| 188 | 30-Aug | Sunday | | | | | | | | | | | | | | |
| End of Batch 23 | | | 0.31 | 1.46 | 0.75 | 7.36 | 8.06 | 0.46 | 7.10 | | | | | | | |
| 189 | 31-Aug | Monday | 0.17 | 0.18 | 0.33 | 6.15 | 6.44 | 0.48 | 4.92 | | | | | | | |
| 190 | 01-Sep | Tuesday | 0.41 | 0.36 | 0.18 | 4.34 | 5.43 | 0.41 | 4.63 | | | | | | | |
| 191 | 02-Sep | Wednesday | 0.19 | 0.47 | 0.10 | 5.29 | 0.72 | 0.18 | 3.62 | | | | | | | |
| 192 | 03-Sep | Thursday | 0.21 | 0.47 | 0.11 | 5.14 | 4.63 | 1.04 | 3.48 | | | | | | | |
| 193 | 04-Sep | Friday | | | | | | | | | | | | | | |
| 194 | 05-Sep | Saturday | 0.33 | 0.33 | 0.09 | 5.65 | 6.30 | 0.62 | 3.33 | | | | | | | |
| 195 | 06-Sep | Sunday | 0.17 | 0.43 | 0.13 | 5.21 | 5.86 | 0.73 | 3.33 | | | | | | | |
| 196 | 07-Sep | Monday | | | | | | | | | | | | | | |
| End of Batch 24 | | | 0.25 | 0.37 | 0.16 | 5.30 | 4.90 | 0.58 | 3.89 | | | | | | | |
| 197 | 08-Sep | Tuesday | | | | | | | | | | | | | | |
| 198 | 09-Sep | Wednesday | | | | | | | | | | | | | | |
| 199 | 10-Sep | Thursday | 0.81 | 1.48 | 0.14 | 8.98 | 10.64 | 0.32 | 2.61 | | | | | | | |
| 200 | 11-Sep | Friday | 0.18 | 1.45 | 0.13 | 11.58 | 11.29 | 1.47 | 5.07 | | | | | | | |
| 201 | 12-Sep | Saturday | 0.19 | 1.38 | 0.09 | 11.95 | 11.29 | 1.25 | 5.79 | | | | | | | |
| 202 | 13-Sep | Sunday | 0.22 | 0.00 | 0.24 | 13.18 | 11.73 | 1.81 | 5.50 | | | | | | | |
| 203 | 14-Sep | Monday | | | | | | | | | | | | | | |
| 204 | 15-Sep | Tuesday | | | | | | | | | | | | | | |
| 205 | 16-Sep | Wednesday | | | | | | | | | | | | | | |
| End of Batch 25 | | | 0.35 | 1.08 | 0.15 | 11.42 | 11.24 | 1.21 | 4.74 | | | | | | | |
| 206 | 17-Sep | Thursday | | | | | | | | | | | | | | |
| 207 | 18-Sep | Friday | | | | | | | | | | | | | | |
| 208 | 19-Sep | Saturday | | | | | | | | | | | | | | |
| 209 | 20-Sep | Sunday | 0.37 | 9.54 | 3.42 | 7.78 | 8.30 | 1.05 | 17.39 | 0.17 | 0.35 | 0.45 | 0.36 | 0.36 | 0.15 | 3.22 |
| 210 | 21-Sep | Monday | 0.11 | 9.58 | 2.07 | 7.56 | 6.71 | 0.32 | 10.77 | 0.09 | 0.10 | 0.40 | 2.95 | 2.14 | 0.10 | 3.04 |
| 211 | 22-Sep | Tuesday | 0.54 | 16.10 | 1.00 | 6.34 | 6.66 | 1.10 | 12.98 | 0.29 | 0.28 | 0.49 | 3.04 | 3.13 | 0.74 | 2.68 |
| 212 | 23-Sep | Wednesday | 0.27 | 1.77 | 4.30 | 5.49 | 7.86 | 0.15 | 11.80 | 0.14 | 0.38 | 0.49 | 6.97 | 4.91 | 0.13 | 3.04 |
| 213 | 24-Sep | Thursday | | | | | | | | | | | | | | |
| 214 | 25-Sep | Friday | 0.35 | 3.74 | 0.99 | 4.55 | 3.88 | 0.25 | 5.01 | 0.20 | 0.07 | 0.40 | 4.83 | 3.13 | 0.29 | 4.47 |
| 215 | 26-Sep | Saturday | 0.38 | 6.76 | 0.51 | 6.45 | 4.46 | 0.91 | 4.78 | 0.13 | 0.24 | 2.99 | 2.41 | 0.89 | 0.70 | 4.29 |
| 216 | 27-Sep | Sunday | | | | | | | | | | | | | | |
| 217 | 28-Sep | Monday | | | | | | | | | | | | | | |
| 218 | 29-Sep | Tuesday | | | | | | | | | | | | | | |
| 219 | 30-Sep | Wednesday | | | | | | | | | | | | | | |
| End of Batch 26 | | | 0.33 | 7.85 | 2.05 | 6.36 | 6.31 | 0.63 | 10.45 | 0.17 | 0.24 | 0.87 | 3.43 | 2.43 | 0.35 | 3.46 |
| 220 | 01-Oct | Thursday | | | | | | | | | | | | | | |
| 221 | 02-Oct | Friday | | 4.98 | 1.89 | 12.36 | 11.33 | 0.12 | 25.57 | 1.13 | 0.89 | 0.42 | | | 1.05 | 1.83 |
| 222 | 03-Oct | Saturday | | 2.68 | 0.48 | 4.33 | 3.19 | 0.28 | 25.65 | 1.05 | 0.71 | 0.05 | | | 0.32 | 1.75 |
| 223 | 04-Oct | Sunday | | 1.83 | 1.11 | 6.49 | 4.41 | 0.19 | 26.00 | 0.79 | 0.54 | 0.08 | | | 0.20 | 1.81 |
| 224 | 05-Oct | Monday | 0.31 | 3.19 | 1.10 | 7.73 | 5.36 | 0.15 | 29.30 | 0.00 | 0.00 | 0.07 | | | 0.27 | 2.01 |
| 225 | 06-Oct | Tuesday | | | | | | | | | | | | | | |
| 226 | 07-Oct | Wednesday | | | | | | | | | | | | | | |
| 227 | 08-Oct | Thursday | 0.27 | 1.95 | 0.27 | 5.38 | 3.99 | 0.24 | 0.44 | 0.53 | 0.11 | 0.03 | 0.55 | 0.35 | 0.15 | 0.35 |
| 228 | 09-Oct | Friday | 0.14 | 0.90 | 0.64 | 8.11 | 5.64 | 0.41 | 5.25 | 0.17 | 0.03 | 0.06 | 0.79 | 0.48 | 0.02 | 0.48 |
| 229 | 10-Oct | Saturday | | 0.70 | 0.55 | 6.81 | 5.59 | 0.22 | 6.24 | 0.40 | 0.02 | 0.04 | 0.70 | 0.53 | 0.20 | 0.48 |
| 230 | 11-Oct | Sunday | 0.55 | 0.89 | 0.55 | 6.82 | 7.01 | 0.23 | 10.73 | 0.03 | 0.04 | 0.04 | 0.69 | 0.59 | 0.19 | 0.54 |
| 231 | 12-Oct | Monday | 0.30 | 0.60 | 0.69 | 6.72 | 6.32 | 0.37 | 14.95 | 0.00 | 0.02 | 0.06 | 0.69 | 0.50 | 0.03 | 0.47 |
| 232 | 13-Oct | Tuesday | 0.79 | 2.97 | 0.23 | 0.47 | 4.06 | 0.28 | 17.92 | 0.00 | 0.12 | 0.02 | 0.03 | 0.29 | 0.17 | 0.26 |
| 233 | 14-Oct | Wednesday | | | | | | | | | | | | | | |
| 234 | 15-Oct | Thursday | | | | | | | | | | | | | | |
| End of Batch 27 | | | 0.39 | 2.07 | 0.75 | 6.52 | 5.49 | 0.25 | 16.30 | 0.41 | 0.25 | 0.09 | 0.57 | 0.46 | 0.26 | 1.00 |
| 235 | 16-Oct | Friday | 0.16 | 3.09 | 0.72 | 11.13 | 8.56 | 0.31 | 11.30 | 0.03 | 0.08 | 0.04 | 0.82 | 0.58 | 0.26 | 0.42 |
| 236 | 17-Oct | Saturday | | | | | | | | | | | | | | |
| 237 | 18-Oct | Sunday | | | | | | | | | | | | | | |
| 238 | 19-Oct | Monday | | | | | | | | | | | | | | |
| 239 | 20-Oct | Tuesday | | | | | | | | | | | | | | |
| 240 | 21-Oct | Wednesday | | | | | | | | | | | | | | |
| 241 | 22-Oct | Thursday | | | | | | | | | | | | | | |
| 242 | 23-Oct | Friday | | | | | | | | | | | | | | |
| 243 | 24-Oct | Saturday | | | | | | | | | | | | | | |
| 244 | 25-Oct | Sunday | | | | | | | | | | | | | | |
| 245 | 26-Oct | Monday | 0.96 | 2.52 | 1.83 | 5.18 | 2.91 | 0.22 | 32.54 | 1.03 | 0.06 | 0.10 | 0.33 | 0.13 | 0.13 | 1.20 |
| 246 | 27-Oct | Tuesday | | | | | | | | | | | | | | |
| 247 | 28-Oct | Wednesday | | | | | | | | | | | | | | |
| 248 | 29-Oct | Thursday | 0.21 | 3.10 | 0.68 | 10.98 | 7.12 | 0.22 | 14.66 | 0.09 | 0.06 | 0.07 | 0.73 | 0.38 | 0.18 | 0.57 |
| 249 | 30-Oct | Friday | | | | | | | | | | | | | | |
| 250 | 31-Oct | Saturday | | | | | | | | | | | | | | |
| 251 | 01-Nov | Sunday | 0.25 | 10.74 | 0.73 | 8.20 | 6.53 | 0.32 | 28.45 | 0.10 | 0.74 | 0.03 | 0.47 | 0.26 | 0.24 | 1.07 |
| 252 | 02-Nov | Monday | 0.26 | 2.59 | 0.66 | 7.71 | 7.44 | 0.65 | 28.47 | 0.12 | 0.10 | 0.04 | 0.37 | 0.30 | 0.88 | 1.05 |
| 253 | 03-Nov | Tuesday | 0.48 | 4.38 | 1.85 | 8.55 | 7.31 | 0.14 | 32.58 | 0.66 | 0.31 | 0.20 | 0.47 | 0.31 | 0.14 | 1.16 |
| 254 | 04-Nov | Wednesday | | | | | | | | | | | | | | |
| End of Batch 28 | | | 0.37 | 4.41 | 0.92 | 8.64 | 6.51 | 0.34 | 23.08 | 0.27 | 0.31 | 0.05 | 0.54 | 0.33 | 0.34 | 0.86 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Measured Nitrate Values mgNO3-N/l | | | | | | | Measured Nitrite Values mgNO2-N/l | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Anaerobic | Main_Ano | Pre_Ano | Aerobic | Final Filtered Eff | IntSet Filtered Ef | ExtNit Filtered Ef | Anaerobic | Main_Ano | Pre_Ano | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff |
| 255 | 05-Nov | Thursday | 0.49 | 0.42 | 0.34 | 7.94 | 10.13 | 0.47 | 6.55 | 0.24 | 0.02 | 0.10 | 0.45 | 0.45 | 0.29 | 0.27 |
| 256 | 06-Nov | Friday | 0.20 | 6.93 | 0.07 | 9.64 | 10.23 | 0.44 | 17.32 | 0.08 | 0.59 | 0.08 | 0.59 | 0.44 | 0.36 | 0.70 |
| 257 | 07-Nov | Saturday | 0.08 | 5.64 | | 13.96 | 12.75 | 0.45 | 16.77 | 0.07 | 0.48 | 1.07 | 0.82 | 0.55 | 0.43 | 0.72 |
| 258 | 08-Nov | Sunday | 0.16 | 6.13 | 1.01 | 16.69 | 13.52 | 0.30 | 12.16 | 0.09 | 0.51 | 1.07 | 0.98 | 0.65 | 0.31 | 0.43 |
| 259 | 09-Nov | Monday | | | | | | | | | | | | | | |
| 260 | 10-Nov | Tuesday | 0.15 | 4.13 | 0.39 | 14.09 | 15.11 | 0.65 | 19.46 | 0.10 | 0.34 | 0.23 | 0.79 | 0.72 | 0.74 | 0.66 |
| 261 | 11-Nov | Wednesday | 0.08 | 1.94 | | 13.02 | 16.48 | 0.54 | 18.46 | 0.07 | 0.16 | 1.07 | 0.62 | 0.66 | 0.55 | 0.79 |
| 262 | 12-Nov | Thursday | 0.25 | 5.09 | 0.61 | 12.05 | 12.73 | 0.82 | 20.07 | 0.10 | 0.42 | 0.33 | 0.55 | 0.21 | 0.90 | 0.57 |
| 263 | 13-Nov | Friday | 0.51 | 5.05 | 0.03 | 11.63 | 16.93 | 0.56 | 12.90 | 1.01 | 0.46 | 0.61 | 0.86 | 1.00 | 0.80 | 0.57 |
| End of Batch 29 | | | 0.24 | 4.42 | 0.41 | 12.38 | 13.49 | 0.53 | 15.46 | 0.22 | 0.37 | 0.57 | 0.71 | 0.59 | 0.55 | 0.59 |
| 264 | 14-Nov | Saturday | | | | | | | | | | | | | | |
| 265 | 15-Nov | Sunday | | | | | | | | | | | | | | |
| 266 | 16-Nov | Monday | 0.79 | 0.18 | 0.04 | 1.99 | 2.84 | 0.33 | 24.23 | 0.71 | 0.02 | 0.09 | 0.10 | 0.05 | 0.18 | 0.46 |
| 267 | 17-Nov | Tuesday | 1.13 | 0.08 | 0.10 | 3.11 | 2.25 | 0.26 | 21.45 | 0.99 | 0.02 | 0.10 | 0.18 | 0.04 | 0.14 | 0.45 |
| 268 | 18-Nov | Wednesday | 0.70 | 0.19 | 0.07 | 2.57 | 3.38 | 0.29 | 31.00 | 0.62 | 0.01 | 0.05 | 0.12 | 0.10 | 0.16 | 0.46 |
| 269 | 19-Nov | Thursday | 0.44 | 0.09 | 0.06 | 7.11 | 4.59 | 0.32 | 28.69 | 0.08 | 0.01 | 0.04 | 0.56 | 0.19 | 0.19 | 0.38 |
| 270 | 20-Nov | Friday | 0.57 | 0.47 | 0.06 | 8.84 | 7.96 | 0.41 | 15.68 | 0.19 | 0.03 | 0.04 | 0.71 | 0.41 | 0.37 | 0.25 |
| 271 | 21-Nov | Saturday | 1.25 | 0.38 | 0.18 | 3.11 | 6.47 | 0.37 | 20.35 | 0.47 | 0.02 | 0.06 | 0.17 | 0.20 | 0.20 | 0.36 |
| 272 | 22-Nov | Sunday | | | | | | | | | | | | | | |
| 273 | 23-Nov | Monday | | | | | | | | | | | | | | |
| 274 | 24-Nov | Tuesday | | | | | | | | | | | | | | |
| 275 | 25-Nov | Wednesday | 0.05 | 0.19 | 0.08 | 2.96 | 1.58 | 0.10 | 26.37 | 0.07 | 0.01 | 0.05 | 0.09 | 0.05 | 0.03 | 0.46 |
| 276 | 26-Nov | Thursday | 0.22 | 2.33 | 0.09 | 3.52 | 1.87 | 0.14 | 24.33 | 0.17 | 0.21 | 0.03 | 0.24 | 0.06 | 0.10 | 0.47 |
| End of Batch 30 | | | 0.64 | 0.49 | 0.08 | 4.15 | 3.87 | 0.28 | 24.01 | 0.41 | 0.04 | 0.06 | 0.27 | 0.14 | 0.17 | 0.41 |
| 277 | 27-Nov | Friday | | | | | | | | | | | | | | |
| 278 | 28-Nov | Saturday | | | | | | | | | | | | | | |
| 279 | 29-Nov | Sunday | | | | | | | | | | | | | | |
| 280 | 30-Nov | Monday | 0.08 | 0.29 | 0.11 | 7.50 | 7.26 | 0.16 | 33.41 | 0.12 | 0.01 | 0.12 | 0.01 | 0.05 | 0.27 | 0.74 |
| 281 | 01-Dec | Tuesday | | | | | | | | | | | | | | |
| 282 | 02-Dec | Wednesday | 0.05 | 1.39 | 0.10 | 6.90 | 6.43 | 0.24 | 35.92 | 0.04 | 0.13 | 0.03 | 0.42 | 0.28 | 0.12 | 0.66 |
| 283 | 03-Dec | Thursday | 0.10 | 0.64 | 0.05 | 9.82 | 5.98 | 0.13 | 31.81 | 0.01 | 0.07 | 0.01 | 0.35 | 0.22 | 0.15 | 0.71 |
| 284 | 04-Dec | Friday | | | | | | | | | | | | | | |
| 285 | 05-Dec | Saturday | | | | | | | | | | | | | | |
| 286 | 06-Dec | Sunday | | | | | | | | | | | | | | |
| End of Batch 31 | | | 0.08 | 0.78 | 0.09 | 8.07 | 6.56 | 0.18 | 33.71 | 0.06 | 0.07 | 0.05 | 0.26 | 0.18 | 0.18 | 0.70 |
| 287 | 07-Dec | Monday | | | | | | | | | | | | | | |
| 288 | 08-Dec | Tuesday | | | | | | | | | | | | | | |
| 289 | 09-Dec | Wednesday | | | | | | | | | | | | | | |
| 290 | 10-Dec | Thursday | | | | | | | | | | | | | | |
| 291 | 11-Dec | Friday | | | | | | | | | | | | | | |
| 292 | 12-Dec | Saturday | | | | | | | | | | | | | | |
| 293 | 13-Dec | Sunday | | | | | | | | | | | | | | |
| 294 | 14-Dec | Monday | | | | | | | | | | | | | | |
| 295 | 15-Dec | Tuesday | 0.14 | 2.21 | 0.80 | 1.52 | 0.97 | 0.05 | 23.29 | 0.03 | 0.01 | 0.03 | 0.05 | 0.04 | | 0.40 |
| 296 | 16-Dec | Wednesday | 0.12 | 0.63 | 0.06 | 0.36 | 0.34 | 0.06 | 22.53 | | 0.02 | | 0.01 | 0.03 | | 0.42 |
| 297 | 17-Dec | Thursday | 0.14 | 0.64 | 0.06 | 1.06 | 0.82 | 0.08 | 20.36 | 0.01 | 0.01 | | 0.05 | 0.02 | | 0.37 |
| 298 | 18-Dec | Friday | 0.09 | 0.36 | 0.07 | 0.80 | 0.45 | 0.01 | 16.36 | 0.01 | 0.01 | 0.01 | 0.03 | 0.01 | 0.02 | 0.30 |
| 299 | 19-Dec | Saturday | | | | | | | | | | | | | | |
| 300 | 20-Dec | Sunday | | | | | | | | | | | | | | |
| 301 | 21-Dec | Monday | | | | | | | | | | | | | | |
| 302 | 22-Dec | Tuesday | | | | | | | | | | | | | | |
| End of Batch 32 | | | 0.12 | 0.96 | 0.24 | 0.94 | 0.64 | 0.05 | 20.64 | 0.02 | 0.01 | 0.02 | 0.04 | 0.03 | 0.02 | 0.37 |
| 303 | 23-Dec | Wednesday | | | | | | | | | | | | | | |
| 304 | 24-Dec | Thursday | 0.12 | 1.23 | 0.08 | 7.17 | 5.52 | 0.23 | 8.33 | 0.03 | 0.07 | 0.03 | 0.51 | 0.31 | 0.37 | 0.18 |
| 305 | 25-Dec | Friday | 0.57 | 1.51 | 0.08 | 5.53 | 7.91 | 1.04 | 26.89 | 1.00 | 0.06 | 0.09 | 0.39 | 0.42 | | 0.51 |
| 306 | 26-Dec | Saturday | 0.20 | 1.75 | 0.07 | 7.22 | 9.06 | 0.53 | 30.54 | 0.20 | 0.10 | 0.04 | 0.46 | 0.47 | | 0.56 |
| 307 | 27-Dec | Sunday | | | | | | | | | | | | | | |
| 308 | 28-Dec | Monday | 0.56 | 1.47 | 0.13 | 6.28 | 7.90 | 0.49 | 31.25 | 1.01 | 0.11 | 0.18 | 0.39 | 0.42 | | 0.59 |
| 309 | 29-Dec | Tuesday | 0.46 | 1.30 | 0.10 | 4.03 | 4.61 | 0.36 | 30.52 | 0.83 | 0.09 | 0.12 | 0.23 | 0.20 | | 0.58 |
| 310 | 30-Dec | Wednesday | 0.46 | 2.57 | 0.08 | 6.79 | 4.91 | 0.35 | 31.59 | 0.91 | 0.21 | 0.09 | 0.34 | 0.18 | | 0.62 |
| 311 | 31-Dec | Thursday | | | | | | | | | | | | | | |
| 312 | 01-Jan | Friday | | | | | | | | | | | | | | |
| 313 | 02-Jan | Saturday | | | | | | | | | | | | | | |
| 314 | 03-Jan | Sunday | | | | | | | | | | | | | | |
| 315 | 04-Jan | Monday | 1.43 | 0.56 | 0.20 | 7.50 | 11.08 | 0.48 | 23.95 | | | | | | | |
| End of Batch 33 | | | 0.55 | 1.48 | 0.11 | 6.36 | 7.29 | 0.50 | 26.15 | 0.66 | 0.11 | 0.09 | 0.38 | 0.34 | 0.37 | 0.51 |
| 316 | 05-Jan | Tuesday | 0.35 | 8.39 | 0.16 | 14.89 | 8.73 | 0.12 | 35.37 | | | | | | | |
| 317 | 06-Jan | Wednesday | | | | | | | | | | | | | | |
| 318 | 07-Jan | Thursday | | | | | | | | | | | | | | |
| 319 | 08-Jan | Friday | | | | | | | | | | | | | | |
| 320 | 09-Jan | Saturday | | | | | | | | | | | | | | |
| 321 | 10-Jan | Sunday | | | | | | | | | | | | | | |
| 322 | 11-Jan | Monday | | | | | | | | | | | | | | |
| 323 | 12-Jan | Tuesday | | | | | | | | | | | | | | |
| 324 | 13-Jan | Wednesday | 0.18 | 12.98 | 1.84 | 21.27 | 20.82 | 1.70 | 28.88 | | | | | | | |
| 325 | 14-Jan | Thursday | 1.67 | 12.98 | 2.44 | 21.49 | 20.26 | 0.20 | 25.30 | | | | | | | |
| 326 | 15-Jan | Friday | | | | | | | | | | | | | | |
| 327 | 16-Jan | Saturday | | | | | | | | | | | | | | |
| 328 | 17-Jan | Sunday | | | | | | | | | | | | | | |
| 329 | 18-Jan | Monday | | | | | | | | | | | | | | |
| 330 | 19-Jan | Tuesday | | | | | | | | | | | | | | |
| 331 | 20-Jan | Wednesday | | | | | | | | | | | | | | |
| 332 | 21-Jan | Thursday | 0.31 | 1.68 | 0.20 | 10.07 | 12.98 | 0.83 | 18.80 | | | | | | | |
| 333 | 22-Jan | Friday | | | | | | | | | | | | | | |
| 334 | 23-Jan | Saturday | | | | | | | | | | | | | | |
| 335 | 24-Jan | Sunday | | | | | | | | | | | | | | |
| 336 | 25-Jan | Monday | | | | | | | | | | | | | | |
| End of Batch 34 | | | 0.72 | 9.22 | 1.49 | 17.61 | 18.02 | 0.91 | 24.35 | | | | | | | |
| 337 | 26-Jan | Tuesday | 0.20 | 3.13 | 0.09 | 13.43 | 12.54 | 0.81 | 21.27 | | | | | | | |
| 338 | 27-Jan | Wednesday | 0.81 | 0.95 | 0.15 | 12.65 | 13.32 | 0.72 | 18.58 | | | | | | | |
| 339 | 28-Jan | Thursday | 0.40 | 1.23 | 0.22 | 13.88 | 8.95 | 0.43 | 12.76 | | | | | | | |
| 340 | 29-Jan | Friday | 0.17 | 1.01 | 0.10 | 14.44 | 10.07 | 0.43 | 8.73 | | | | | | | |
| 341 | 30-Jan | Saturday | | | | | | | | | | | | | | |
| 342 | 31-Jan | Sunday | | | | | | | | | | | | | | |
| 343 | 01-Feb | Monday | | | | | | | | | | | | | | |
| 344 | 02-Feb | Tuesday | | | | | | | | | | | | | | |
| End of Batch 35 | | | 0.39 | 1.58 | 0.14 | 13.60 | 11.22 | 0.59 | 15.33 | | | | | | | |
| 345 | 03-Feb | Wednesday | | | | | | | | | | | | | | |
| 346 | 04-Feb | Thursday | | | | | | | | | | | | | | |
| 347 | 05-Feb | Friday | | | | | | | | | | | | | | |
| 348 | 06-Feb | Saturday | | | | | | | | | | | | | | |
| 349 | 07-Feb | Sunday | 0.25 | 0.17 | 0.13 | 4.01 | 3.46 | 0.26 | 24.91 | 0.11 | 0.09 | 0.03 | 0.12 | 0.05 | 0.03 | 0.28 |
| 350 | 08-Feb | Monday | | | | | | | | | | | | | | |
| 351 | 09-Feb | Tuesday | 0.07 | 0.18 | 0.05 | 3.38 | 2.54 | 0.10 | 24.82 | 0.02 | 0.34 | 0.07 | 0.12 | 0.04 | 0.04 | 0.19 |
| 352 | 10-Feb | Wednesday | 0.03 | 0.26 | 0.06 | 2.89 | 3.09 | 0.10 | 24.66 | 0.11 | 0.41 | 0.04 | 0.14 | 0.04 | 0.03 | 0.17 |
| 353 | 11-Feb | Thursday | 0.16 | 0.81 | 0.19 | 3.86 | 2.54 | 0.13 | 25.62 | 0.02 | 0.57 | 0.08 | 0.10 | 0.04 | 0.03 | 0.12 |
| 354 | 12-Feb | Friday | | | | | | | | | | | | | | |
| 355 | 13-Feb | Saturday | 0.08 | 0.18 | 0.08 | 3.43 | 3.28 | 0.09 | 27.32 | 0.02 | 0.13 | 0.15 | 0.06 | 0.03 | 0.03 | 0.07 |
| 356 | 14-Feb | Sunday | 0.07 | 0.39 | 0.05 | 3.52 | 1.91 | 0.14 | 29.17 | 0.02 | 0.66 | 0.02 | 0.06 | 0.02 | 0.03 | 0.06 |
| 357 | 15-Feb | Monday | 0.10 | 0.43 | 0.06 | 4.54 | 2.27 | 0.11 | 27.71 | 0.02 | 0.43 | 0.02 | 0.05 | 0.03 | 0.03 | 0.06 |
| 358 | 16-Feb | Tuesday | 0.05 | 0.54 | 0.04 | 4.91 | 2.00 | 0.10 | 24.20 | 0.02 | 0.79 | 0.01 | 0.06 | 0.02 | 0.03 | 0.07 |
| End of Batch 36 | | | 0.10 | 0.37 | 0.08 | 3.82 | 2.89 | 0.13 | 26.05 | 0.04 | 0.43 | 0.05 | 0.09 | 0.03 | 0.03 | 0.13 |
| 359 | 17-Feb | Wednesday | | | | | | | | | | | | | | |
| 360 | 18-Feb | Thursday | 0.07 | 0.17 | 0.04 | 2.63 | 0.25 | 0.12 | 26.41 | 0.05 | 0.17 | 0.03 | 0.04 | 0.03 | 0.04 | 0.80 |
| 361 | 19-Feb | Friday | 0.15 | 0.18 | 0.21 | 1.18 | 3.28 | 0.05 | 24.85 | 0.08 | 0.06 | 0.21 | 0.01 | 0.03 | 0.04 | 0.16 |
| 362 | 20-Feb | Saturday | | | | | | | | | | | | | | |
| 363 | 21-Feb | Sunday | | | | | | | | | | | | | | |
| 364 | 22-Feb | Monday | 0.23 | 1.00 | 0.10 | 13.02 | 11.70 | 0.33 | 24.21 | | | | | | | |
| 365 | 23-Feb | Tuesday | 0.56 | 0.18 | 0.31 | 8.73 | 9.47 | 0.85 | 17.28 | | | | | | | |
| 366 | 24-Feb | Wednesday | 0.35 | 0.14 | 0.11 | 9.93 | 9.29 | 0.22 | 9.75 | | | | | | | |
| 367 | 25-Feb | Thursday | | | | | | | | | | | | | | |
| 368 | 26-Feb | Friday | 0.06 | 0.25 | 0.09 | 8.09 | 7.35 | 0.28 | 17.28 | | | | | | | |
| 369 | 27-Feb | Saturday | 0.59 | 0.74 | 0.16 | 10.85 | 10.94 | 0.54 | 15.08 | | | | | | | |
| 370 | 28-Feb | Sunday | | | | | | | | | | | | | | |
| 371 | 01-Mar | Monday | | | | | | | | | | | | | | |
| 372 | 02-Mar | Tuesday | 0.22 | 1.28 | 1.31 | 13.61 | 11.49 | 0.35 | 14.53 | | | | | | | |
| 373 | 03-Mar | Wednesday | 0.08 | 1.19 | 0.17 | 14.25 | 12.87 | 0.43 | 14.71 | | | | | | | |
| End of Batch 37 | | | 0.26 | 0.57 | 0.28 | 9.14 | 8.52 | 0.35 | 18.23 | 0.07 | 0.11 | 0.12 | 0.02 | 0.03 | 0.04 | 0.48 |

# A.10

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Influent l/d | Recycle l/d | Nitrate Dosage mgNO3/d | Anaerobic Outflow | Flow into Ae & Anox | Flow to Ext Nitrifier (l/d) | Bypass to Main Anox | itrate recy Ae to Anox (mgN/d) | NO3 denit Main Anox (mgN/d) | NO3 denit Pre-Anox (mgN/d) | NO3 denit Anaerobic (mgN/d) | NO3 denit Settler (mgN/d) | Tot Denit (mgN/d) | N in W (mgN/d) | N in Eff (mgN/d) | TKN S/c (mgN/d) | Total TKN Leaving (mgN/d) | Inf TKN mgN/d | MB % (mgN/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24-Feb | Tuesday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 829.11 | 213.86 | 9.50 | | 1052.47 | 271.86 | 377.62 | | 1701.95 | 2045.60 | 83.20 |
| 2 | 25-Feb | Wednesday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 897.19 | 106.93 | 10.93 | | 1015.05 | 264.59 | 229.54 | 89.52 | 1598.70 | 1729.20 | 92.45 |
| 3 | 26-Feb | Thursday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 786.57 | 137.82 | 6.65 | 85.54 | 1016.59 | 299.72 | 179.65 | 138.92 | 1634.89 | 1760.00 | 92.89 |
| End of Batch 1 | | | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 837.62 | 152.87 | 9.03 | | 999.52 | 278.91 | 262.27 | | 1540.70 | 1844.93 | 83.51 |
| 4 | 27-Feb | Friday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 727.29 | 239.76 | 1.19 | 114.06 | 1082.29 | 258.85 | 341.90 | 171.61 | 1854.66 | 1841.20 | 100.73 |
| 5 | 28-Feb | Saturday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 667.88 | 387.56 | 12.59 | | 1068.04 | 297.52 | 495.51 | 94.35 | 1955.42 | 1816.00 | 107.68 |
| 6 | 01-Mar | Sunday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 837.42 | 473.58 | 15.92 | | 1326.93 | 324.06 | 559.76 | | 2210.75 | 1788.00 | 123.64 |
| 7 | 02-Mar | Monday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 821.15 | 490.22 | 27.80 | 4.75 | 1343.92 | 325.30 | 585.05 | | 2254.27 | 1760.00 | 128.08 |
| 8 | 03-Mar | Tuesday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 682.89 | 300.34 | 11.33 | | 994.56 | 237.56 | 390.19 | 108.48 | 1730.79 | 1832.80 | 94.43 |
| 9 | 04-Mar | Wednesday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 657.13 | 273.55 | 9.27 | | 939.95 | 269.65 | 370.70 | 165.85 | 1746.16 | 1754.40 | 99.53 |
| 10 | 05-Mar | Thursday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 626.35 | 293.65 | 23.70 | | 943.69 | 389.31 | 376.86 | 115.00 | 1824.86 | 1874.80 | 97.34 |
| 11 | 06-Mar | Friday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 806.91 | 287.46 | 29.36 | | 1123.74 | 380.14 | 327.13 | 263.20 | 2094.21 | 1872.00 | 111.87 |
| 12 | 07-Mar | Saturday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 752.43 | 273.04 | 33.49 | 87.58 | 1146.54 | 397.52 | 353.01 | 155.61 | 2052.67 | 1883.20 | 109.00 |
| 13 | 08-Mar | Sunday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 824.04 | 257.07 | 13.91 | 25.76 | 1120.78 | 396.94 | 310.89 | 236.05 | 2064.66 | 1905.60 | 108.35 |
| 14 | 09-Mar | Monday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 663.95 | 270.98 | 13.91 | | 948.84 | 377.53 | 343.37 | 434.30 | 2104.04 | 1911.20 | 110.09 |
| 15 | 10-Mar | Tuesday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 723.20 | 287.21 | 23.96 | | 1034.36 | 365.48 | 369.13 | 234.38 | 2003.35 | 1894.40 | 105.75 |
| 16 | 11-Mar | Wednesday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 809.23 | 290.36 | 19.58 | 30.91 | 1150.27 | 377.77 | 367.28 | 104.84 | 2000.17 | 1880.40 | 106.37 |
| 17 | 12-Mar | Thursday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 562.72 | 301.37 | 33.49 | | 897.58 | 355.71 | 373.89 | 291.70 | 1918.88 | 1866.40 | 102.81 |
| End of Batch 2 | | | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 725.90 | 316.17 | 19.25 | | 1061.32 | 360.92 | 397.48 | 161.97 | 1981.68 | 1848.60 | 107.20 |
| 18 | 13-Mar | Friday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 672.20 | 204.52 | 17.52 | 72.12 | 966.36 | 27.56 | 282.95 | 274.65 | 1551.32 | 1908.40 | 81.30 |
| 19 | 14-Mar | Saturday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 811.07 | 255.20 | 24.06 | 134.91 | 1225.23 | 475.80 | 342.14 | 138.18 | 2181.35 | 1961.60 | 111.20 |
| 20 | 15-Mar | Sunday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 1046.59 | 191.34 | 25.41 | 53.96 | 1317.30 | 330.83 | 302.14 | | 1950.27 | 1799.20 | 108.40 |
| 21 | 16-Mar | Monday | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 945.19 | 197.86 | 15.74 | | 1158.79 | 368.78 | 320.89 | 69.83 | 1918.29 | 1844.00 | 104.03 |
| 22 | 17-Mar | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 3 | | | 20.00 | 20.00 | 500.00 | 40.00 | | 30.00 | 10.00 | | 868.76 | 212.23 | 20.68 | 59.63 | 1161.30 | 407.63 | 312.03 | 111.20 | 1992.16 | 1878.30 | 106.06 |
| 23 | 18-Mar | Wednesday | | | | | | | | | | | | | | | | | | | |
| 24 | 19-Mar | Thursday | | | | | | | | | | | | | | | | | | | |
| 25 | 20-Mar | Friday | | | | | | | | | | | | | | | | | | | |
| 26 | 21-Mar | Saturday | | | | | | | | | | | | | | | | | | | |
| 27 | 22-Mar | Sunday | | | | | | | | | | | | | | | | | | | |
| 28 | 23-Mar | Monday | 40.00 | 20.00 | 650.00 | 60.00 | | 50.00 | 10.00 | | 1428.07 | 45.87 | | 6.75 | 1480.68 | 608.18 | 954.03 | 168.37 | 3211.27 | 3192.40 | 100.59 |
| 29 | 24-Mar | Tuesday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1396.56 | 44.07 | | 13.49 | 1454.12 | 522.43 | 817.94 | 314.44 | 3108.93 | 3277.60 | 94.85 |
| 30 | 25-Mar | Wednesday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1447.93 | 23.83 | | 6.75 | 1478.51 | 636.87 | 721.47 | 82.92 | 2919.77 | 3143.20 | 92.89 |
| End of Batch 4 | | | 40.00 | 20.00 | 550.00 | 60.00 | | 50.00 | 10.00 | | 1400.80 | 38.67 | | 10.12 | 1449.59 | 340.91 | 833.02 | 213.59 | 2937.11 | 3204.40 | 88.54 |
| 31 | 26-Mar | Thursday | | | | | | | | | | | | | | | | | | | |
| 32 | 27-Mar | Friday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1090.74 | 31.45 | | | 1122.19 | 483.02 | 444.61 | 261.50 | 2311.33 | 2930.40 | 78.87 |
| 33 | 28-Mar | Saturday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 973.07 | 26.46 | | | 999.53 | 446.40 | 396.73 | 543.20 | 2387.87 | 2975.20 | 80.26 |
| 34 | 29-Mar | Sunday | | | | | | | | | | | | | | | | | | | |
| 35 | 30-Mar | Monday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1166.44 | 39.26 | | | 1205.70 | 339.38 | 412.82 | 357.04 | 2314.94 | 2700.80 | 85.71 |
| 36 | 31-Mar | Tuesday | | | | | | | | | | | | | | | | | | | |
| 37 | 01-Apr | Wednesday | | | | | | | | | | | | | | | | | | | |
| 38 | 02-Apr | Thursday | | | | | | | | | | | | | | | | | | | |
| End of Batch 5 | | | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1123.52 | 36.93 | | | 1160.45 | 477.57 | 424.97 | 385.27 | 2448.27 | 2856.20 | 85.72 |
| 39 | 03-Apr | Friday | | | | | | | | | | | | | | | | | | | |
| 40 | 04-Apr | Saturday | | | | | | | | | | | | | | | | | | | |
| 41 | 05-Apr | Sunday | | | | | | | | | | | | | | | | | | | |
| 42 | 06-Apr | Monday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1140.41 | 31.45 | | 97.61 | 1269.47 | 739.91 | 836.61 | 294.04 | 3140.02 | 3658.40 | 85.83 |
| 43 | 07-Apr | Tuesday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1031.96 | 38.18 | | | 1070.14 | 775.67 | 862.09 | 274.03 | 2981.92 | 3759.20 | 79.32 |
| 44 | 08-Apr | Wednesday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1211.12 | 32.10 | | | 1243.23 | 820.63 | 831.01 | 572.16 | 3467.03 | 3781.60 | 91.68 |
| 45 | 09-Apr | Thursday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 500.00 | | | | 500.00 | 778.75 | 750.40 | 1302.00 | 3331.15 | 3748.00 | 88.88 |
| End of Batch 6 | | | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1127.83 | 33.91 | | | 1161.74 | 820.64 | 838.10 | 447.74 | 3268.23 | 3716.80 | 87.46 |
| 46 | 10-Apr | Friday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 978.54 | 37.46 | | | 1016.00 | 729.81 | 1714.57 | 1051.42 | 4511.80 | 3944.00 | 114.40 |
| 47 | 11-Apr | Saturday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1268.50 | 31.09 | | | 1299.59 | 758.60 | 1687.92 | 945.82 | 4691.93 | 4442.40 | 105.62 |
| 48 | 12-Apr | Sunday | | | | | | | | | | | | | | | | | | | |
| 49 | 13-Apr | Monday | | | | | | | | | | | | | | | | | | | |
| 50 | 14-Apr | Tuesday | | | | | | | | | | | | | | | | | | | |
| 51 | 15-Apr | Wednesday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1740.38 | 13.13 | | 34.76 | 1788.27 | 746.35 | 2011.95 | 109.41 | 4655.97 | 4162.40 | 111.86 |
| 52 | 16-Apr | Thursday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1865.08 | 23.17 | | 11.59 | 1899.84 | 690.10 | 2306.33 | 1233.30 | 6129.58 | 4033.60 | 151.96 |
| End of Batch 7 | | | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1463.13 | 26.22 | | 11.59 | 1500.93 | 733.74 | 1865.50 | 334.99 | 4935.15 | 4145.60 | 119.05 |
| 53 | 17-Apr | Friday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1329.36 | 110.01 | | 11.87 | 1451.24 | 973.84 | 2228.71 | 1037.76 | 5691.55 | 4240.80 | 134.21 |
| 54 | 18-Apr | Saturday | | | | | | | | | | | | | | | | | | | |
| 55 | 19-Apr | Sunday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1320.76 | 107.63 | | 35.61 | 1464.00 | 705.33 | 1259.91 | 86.26 | 3515.50 | 3221.60 | 109.12 |
| 56 | 20-Apr | Monday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1140.02 | 107.24 | | 29.68 | 1276.93 | 663.08 | 1181.51 | 84.70 | 3206.23 | 3120.80 | 102.74 |
| 57 | 21-Apr | Tuesday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1181.56 | 117.13 | | | 1298.70 | 690.34 | 1086.50 | 190.29 | 3265.82 | 3176.80 | 102.80 |
| 58 | 22-Apr | Wednesday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1161.24 | 111.00 | | 23.74 | 1295.98 | 586.33 | 1010.23 | 281.34 | 3173.87 | 3255.20 | 97.50 |
| 59 | 23-Apr | Thursday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1062.70 | 120.30 | | 11.87 | 1194.87 | 548.32 | 1009.26 | 402.15 | 3154.60 | 3098.40 | 101.81 |
| 60 | 24-Apr | Friday | | | | | | | | | | | | | | | | | | | |
| 61 | 25-Apr | Saturday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1300.87 | 113.17 | | 41.55 | 1455.60 | 1038.57 | 948.63 | 207.53 | 3650.33 | 2997.60 | 121.77 |
| 62 | 26-Apr | Sunday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1494.52 | 43.92 | | | 1538.45 | 1013.46 | 749.69 | 69.49 | 3371.08 | 2958.40 | 113.95 |
| 63 | 27-Apr | Monday | | | | | | | | | | | | | | | | | | | |
| 64 | 28-Apr | Tuesday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1336.34 | 45.90 | | | 1382.24 | 1019.95 | 814.09 | 264.88 | 3481.15 | 3042.40 | 114.42 |
| 65 | 29-Apr | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 8 | | | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1258.60 | 97.37 | | 3.96 | 1359.92 | 641.61 | 1049.65 | 182.15 | 3233.33 | 2961.20 | 109.19 |
| 66 | 30-Apr | Thursday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1670.38 | 66.95 | | | 1737.33 | 546.04 | 715.13 | | 2998.50 | 3300.00 | 90.86 |
| 67 | 01-May | Friday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1514.35 | 47.98 | | | 1562.33 | 571.09 | 741.83 | | 2875.25 | 3255.20 | 88.33 |
| 68 | 02-May | Saturday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1658.93 | 35.33 | | | 1694.26 | 600.18 | 686.43 | | 2980.86 | 3288.80 | 90.64 |
| End of Batch 9 | | | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1614.55 | 50.08 | | | 1664.64 | 572.37 | 714.46 | | 2951.47 | 3281.33 | 89.95 |
| 69 | 03-May | Sunday | | | | | | | | | | | | | | | | | | | |
| 70 | 04-May | Monday | | | | | | | | | | | | | | | | | | | |
| 71 | 05-May | Tuesday | | | | | | | | | | | | | | | | | | | |
| 72 | 06-May | Wednesday | | | | | | | | | | | | | | | | | | | |
| 73 | 07-May | Thursday | | | | | | | | | | | | | | | | | | | |
| 74 | 08-May | Friday | | | | | | | | | | | | | | | | | | | |
| End of Batch10 | | | | | | | | | | | | | | | | | | | | | |
| 75 | 09-May | Saturday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1777.27 | 73.06 | | | 1850.33 | 546.37 | 728.27 | | 3124.97 | 3300.00 | 94.70 |
| 76 | 10-May | Sunday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1606.99 | 52.36 | | | 1659.35 | 571.46 | 751.79 | | 2982.60 | 3255.20 | 91.63 |
| 77 | 11-May | Monday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1764.77 | 38.55 | | | 1803.33 | 600.65 | 694.39 | | 3098.38 | 3288.80 | 94.21 |
| 78 | 12-May | Tuesday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 991.20 | 117.80 | | 356.98 | 1465.98 | 348.84 | 1496.31 | | 3311.13 | 3255.20 | 101.72 |
| 79 | 13-May | Wednesday | 40.00 | 20.00 | 500.00 | 60.00 | | 45.00 | 15.00 | | 1622.88 | 29.51 | | | 1652.39 | 500.27 | 1289.40 | | 3442.05 | 5316.00 | 64.75 |
| 80 | 14-May | Thursday | | | | | | | | | | | | | | | | | | | |
| 81 | 15-May | Friday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 1517.51 | 16.18 | | 42.84 | 1576.53 | 4.46 | 1134.84 | | 2715.83 | 2852.00 | 95.23 |
| 82 | 16-May | Saturday | | | | | | | | | | | | | | | | | | | |
| 83 | 17-May | Sunday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 2628.43 | 15.23 | | 35.70 | 2679.35 | 522.16 | 1132.04 | | 4333.56 | 3272.00 | 132.44 |
| 84 | 18-May | Monday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 2939.71 | 24.99 | | | 2964.70 | 290.27 | 1355.48 | | 4610.45 | 3188.00 | 144.62 |
| 85 | 19-May | Tuesday | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 3309.90 | 20.23 | | 21.42 | 3351.54 | 581.66 | 1390.76 | | 5323.97 | 4296.80 | 123.91 |
| End of Batch 11 | | | 40.00 | 20.00 | 500.00 | 60.00 | | 50.00 | 10.00 | | 2088.78 | 43.10 | | 21.42 | 2153.30 | 458.37 | 1108.14 | | 3719.81 | 3558.22 | 104.54 |
| 86 | 20-May | Wednesday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1500.24 | 4.72 | | 18.89 | 1523.85 | 539.22 | 1127.69 | | 3190.76 | 3094.80 | 103.10 |
| 87 | 21-May | Thursday | | | | | | | | | | | | | | | | | | | |
| 88 | 22-May | Friday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1397.44 | 9.76 | | 18.89 | 1426.10 | 492.75 | 1837.48 | 215.05 | 3971.39 | 3766.80 | 105.43 |
| 89 | 23-May | Saturday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1265.05 | 3.15 | | 28.34 | 1296.54 | 580.25 | 1881.59 | | 3758.38 | 3867.60 | 97.18 |
| 90 | 24-May | Sunday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1390.20 | 7.24 | | | 1397.44 | 586.47 | 1717.08 | 155.19 | 3856.18 | 3733.20 | 103.29 |
| 91 | 25-May | Monday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1480.41 | | | 18.89 | 1499.30 | 296.97 | 1826.99 | | 3623.26 | 3923.60 | 92.35 |
| 92 | 26-May | Tuesday | | | | | | | | | | | | | | | | | | | |
| 93 | 27-May | Wednesday | | | | | | | | | | | | | | | | | | | |
| 94 | 28-May | Thursday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1433.65 | 4.72 | | | 1438.37 | 567.79 | 1696.09 | | 3702.25 | 3778.00 | 98.00 |
| 95 | 29-May | Friday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1295.59 | | | | 1295.59 | 553.79 | 1553.29 | | 3402.67 | 3430.80 | 99.18 |
| 96 | 30-May | Saturday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1368.48 | 6.30 | | 9.45 | 1384.22 | 523.47 | 1100.39 | | 3008.08 | 3195.60 | 94.13 |
| 97 | 31-May | Sunday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1183.51 | 10.70 | | | 1194.21 | 595.79 | 1045.08 | | 2835.08 | 2960.40 | 95.77 |
| 98 | 01-Jun | Monday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1195.32 | 37.47 | | 0.00 | 1232.78 | 565.12 | 1157.06 | | 2954.96 | 3055.60 | 96.71 |
| 99 | 02-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 100 | 03-Jun | Wednesday | | | | | | | | | | | | | | | | | | | |
| 101 | 04-Jun | Thursday | | | | | | | | | | | | | | | | | | | |
| 102 | 05-Jun | Friday | | | | | | | | | | | | | | | | | | | |
| End of Batch 12 | | | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 1350.99 | 8.25 | | 4.72 | 1363.96 | 533.23 | 1464.68 | | 3361.87 | 3480.64 | 96.59 |
| 103 | 06-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 104 | 07-Jun | Sunday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 461.29 | 37.63 | | | 498.92 | 718.85 | 1438.34 | 734.08 | 3390.20 | 4293.20 | 78.97 |
| 105 | 08-Jun | Monday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 417.68 | 33.30 | | | 450.97 | 718.28 | 1429.22 | 745.44 | 3343.92 | 4293.20 | 77.89 |
| 106 | 09-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 107 | 10-Jun | Wednesday | | | | | | | | | | | | | | | | | | | |
| 108 | 11-Jun | Thursday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 370.07 | 38.77 | | | 408.83 | 572.13 | 1694.91 | 781.49 | 3457.37 | 3509.20 | 98.52 |
| 109 | 12-Jun | Friday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 632.22 | 47.89 | | | 680.12 | 555.77 | 1589.95 | | 2825.84 | 3240.40 | 87.21 |
| End of Batch13 | | | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 470.32 | 39.40 | | | 509.72 | 643.73 | 1538.11 | 536.19 | 3227.74 | 3834.00 | 84.19 |
| 110 | 13-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 111 | 14-Jun | Sunday | | | | | | | | | | | | | | | | | | | |
| 112 | 15-Jun | Monday | | | | | | | | | | | | | | | | | | | |
| 113 | 16-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 114 | 17-Jun | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch14 | | | | | | | | | | | | | | | | | | | | | |
| 115 | 18-Jun | Thursday | | | | | | | | | | | | | | | | | | | |
| 116 | 19-Jun | Friday | | | | | | | | | | | | | | | | | | | |
| 117 | 20-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 118 | 21-Jun | Sunday | | | | | | | | | | | | | | | | | | | |
| 119 | 22-Jun | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch15 | | | | | | | | | | | | | | | | | | | | | |

# A.11

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Influent l/d | Recycle l/d | Nitrate Dosage mgNO3/d | Anaerobic Outflow | Flow into Ae & Anox | Flow to Ext Nitrifier (l/d) | Bypass to Main Anox | Nitrate recycl Ae to Anox (mgN/d) | NO3 denit Main Anox (mgN/d) | NO3 denit Pre-Anox (mgN/d) | NO3 denit Anaerobic (mgN/d) | NO3 denit Settler (mgN/d) | Tot Denit (mgN/d) | N in W (mgN/d) | N in Eff (mgN/d) | TKN S/c (mgN/d) | Total TKN Leaving (mgN/d) | Inf TKN mgN/d | MB % (mgN/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | 23-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 121 | 24-Jun | Wednesday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 496.97 | 22.36 | | 47.34 | 566.67 | 649.59 | 3028.66 | 589.67 | 4834.59 | 4472.40 | 108.10 |
| 122 | 25-Jun | Thursday | | | | | | | | | | | | | | | | | | | |
| 123 | 26-Jun | Friday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 581.66 | 26.04 | | | 607.70 | 846.79 | 2443.12 | 514.25 | 4411.86 | 4119.60 | 107.09 |
| 124 | 27-Jun | Saturday | | | | | | | | | | | | | | | | | | | |
| 125 | 28-Jun | Sunday | | | | | | | | | | | | | | | | | | | |
| End of Batch16 | | | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 539.32 | 24.20 | | 15.78 | 579.29 | 746.37 | 1844.09 | 364.96 | 3434.71 | 2947.33 | 116.54 |
| 126 | 29-Jun | Monday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 668.19 | 24.99 | | 7.89 | 701.07 | 711.60 | 2005.98 | 1344.03 | 4762.68 | 3761.20 | 126.63 |
| 127 | 30-Jun | Tuesday | | | | | | | | | | | | | | | | | | | |
| 128 | 01-Jul | Wednesday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 533.27 | 37.61 | | 7.89 | 578.77 | 884.42 | 1836.62 | 302.16 | 3601.97 | 4282.00 | 84.12 |
| 129 | 02-Jul | Thursday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 594.29 | 31.04 | | | 625.32 | 879.60 | 1809.64 | 225.46 | 3540.03 | 4506.00 | 78.56 |
| 130 | 03-Jul | Friday | | | | | | | | | | | | | | | | | | | |
| 131 | 04-Jul | Saturday | | | | | | | | | | | | | | | | | | | |
| 132 | 05-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 133 | 06-Jul | Monday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 948.86 | 28.67 | | 15.78 | 993.31 | 372.43 | 1065.18 | | 2430.93 | 2243.60 | 108.35 |
| 134 | 07-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch17 | | | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 686.21 | 30.98 | | 7.89 | 724.68 | 713.73 | 1398.48 | 233.61 | 3030.50 | 3008.56 | 100.73 |
| 135 | 08-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| 136 | 09-Jul | Thursday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 556.81 | 23.67 | | | 580.48 | 326.93 | 1596.50 | | 2503.91 | 3038.80 | 82.40 |
| 137 | 10-Jul | Friday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 491.84 | 43.40 | | | 535.24 | 653.09 | 1467.02 | 256.03 | 2911.38 | 3386.00 | 85.98 |
| 138 | 11-Jul | Saturday | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 431.22 | 38.40 | | | 469.62 | 4.93 | 1434.10 | 275.52 | 2194.17 | 3453.20 | 63.23 |
| 139 | 12-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 140 | 13-Jul | Monday | | | | | | | | | | | | | | | | | | | |
| 141 | 14-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| 142 | 15-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| 143 | 16-Jul | Thursday | | | | | | | | | | | | | | | | | | | |
| 144 | 17-Jul | Friday | | | | | | | | | | | | | | | | | | | |
| 145 | 18-Jul | Saturday | | | | | | | | | | | | | | | | | | | |
| 146 | 19-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 147 | 20-Jul | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 18 | | | 40.00 | 20.00 | 250.00 | 60.00 | | 50.00 | 10.00 | | 493.29 | 35.16 | | 0.00 | 528.44 | 518.29 | 1499.21 | 157.62 | 2703.57 | 3292.67 | 82.11 |
| 148 | 21-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| 149 | 22-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 19 | | | | | | | | | | | | | | | | | | | | | |
| 150 | 23-Jul | Thursday | | | | | | | | | | | | | | | | | | | |
| 151 | 24-Jul | Friday | 30.00 | 15.00 | 500.00 | 45.00 | | 32.00 | 13.00 | | 940.21 | 69.83 | | | 1010.04 | 665.02 | 1313.57 | 34.49 | 3023.12 | 2600.00 | 116.27 |
| 152 | 25-Jul | Saturday | 30.00 | 15.00 | 500.00 | 45.00 | | 32.00 | 13.00 | | 1043.15 | 64.31 | | 76.93 | 1184.39 | 841.45 | 1310.14 | | 3335.99 | 3137.60 | 106.32 |
| 153 | 26-Jul | Sunday | | | | | | | | | | | | | | | | | | | |
| 154 | 27-Jul | Monday | 30.00 | 15.00 | 500.00 | 45.00 | | 32.00 | 13.00 | | 1171.96 | 50.10 | | 47.34 | 1269.41 | 638.01 | 1198.52 | | 3105.94 | 2969.60 | 104.59 |
| End of Batch 20 | | | 30.00 | 15.00 | 500.00 | 45.00 | | 32.00 | 13.00 | | 1075.75 | 64.50 | | 36.99 | 1177.24 | 557.33 | 1280.32 | | 3014.90 | 2902.40 | 103.88 |
| 155 | 28-Jul | Tuesday | | | | | | | | | | | | | | | | | | | |
| 156 | 29-Jul | Wednesday | | | | | | | | | | | | | | | | | | | |
| 157 | 30-Jul | Thursday | | | | | | | | | | | | | | | | | | | |
| 158 | 31-Jul | Friday | | | | | | | | | | | | | | | | | | | |
| 159 | 01-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 160 | 02-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 161 | 03-Aug | Monday | | | | | | | | | | | | | | | | | | | |
| 162 | 04-Aug | Tuesday | | | | | | | | | | | | | | | | | | | |
| 163 | 05-Aug | Wednesday | | | | | | | | | | | | | | | | | | | |
| 164 | 06-Aug | Thursday | | | | | | | | | | | | | | | | | | | |
| 165 | 07-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 166 | 08-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 167 | 09-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 168 | 10-Aug | Monday | | | | | | | | | | | | | | | | | | | |
| 169 | 11-Aug | Tuesday | 30.00 | 15.00 | 500.00 | 45.00 | | 32.00 | 13.00 | | 750.85 | 105.64 | 4.70 | | 861.18 | 310.06 | 1288.61 | | 2459.85 | 2936.00 | 87.78 |
| 170 | 12-Aug | Wednesday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 1014.61 | 122.90 | 0.83 | 4.14 | 1142.48 | 302.68 | 1232.11 | 178.65 | 2855.93 | 3120.80 | 91.51 |
| 171 | 13-Aug | Thursday | | | | | | | | | | | | | | | | | | | |
| 172 | 14-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 173 | 15-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 174 | 16-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 175 | 17-Aug | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 22 | | | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 899.67 | 114.27 | 2.76 | | 1016.70 | 275.22 | 1260.36 | 75.40 | 2627.69 | 3028.40 | 96.77 |
| 176 | 18-Aug | Tuesday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 1103.17 | 207.13 | | | 1310.30 | 444.71 | 773.22 | | 2528.24 | 2280.80 | 110.85 |
| 177 | 19-Aug | Wednesday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 868.42 | 223.01 | 4.42 | | 1095.85 | 472.96 | 703.03 | | 2271.85 | 2406.80 | 94.39 |
| 178 | 20-Aug | Thursday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 765.13 | 220.25 | | | 985.38 | 515.22 | 970.51 | | 2471.12 | 2222.00 | 111.21 |
| 179 | 21-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 180 | 22-Aug | Saturday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 508.98 | 49.16 | 3.04 | 29.00 | 590.17 | 498.47 | 594.91 | 245.07 | 1928.62 | 2222.00 | 86.80 |
| 181 | 23-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| 182 | 24-Aug | Monday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 512.24 | 23.06 | | | 535.30 | 509.93 | 410.25 | 215.16 | 1670.64 | 2440.40 | 68.46 |
| 183 | 25-Aug | Tuesday | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 533.19 | 16.02 | | 4.14 | 553.35 | 534.39 | 574.94 | 47.21 | 1709.90 | 2432.00 | 70.31 |
| 184 | 26-Aug | Wednesday | | | | | | | | | | | | | | | | | | | |
| 185 | 27-Aug | Thursday | | | | | | | | | | | | | | | | | | | |
| 186 | 28-Aug | Friday | | | | | | | | | | | | | | | | | | | |
| 187 | 29-Aug | Saturday | | | | | | | | | | | | | | | | | | | |
| 188 | 30-Aug | Sunday | | | | | | | | | | | | | | | | | | | |
| End of Batch 23 | | | 30.00 | 15.00 | 500.00 | 45.00 | | 35.00 | 10.00 | | 687.46 | 109.60 | | | 797.06 | 501.58 | 640.50 | | 1939.55 | 2334.00 | 83.10 |
| 189 | 31-Aug | Monday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 184.63 | 848.15 | 91.66 | | | 939.81 | 440.71 | 613.31 | 35.51 | 2029.34 | 2381.60 | 85.21 |
| 190 | 01-Sep | Tuesday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 130.32 | 769.41 | 78.74 | | | 848.15 | 341.89 | 614.41 | | 1904.44 | 2062.40 | 87.49 |
| 191 | 02-Sep | Wednesday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 158.56 | 751.78 | 9.34 | | 205.26 | 966.38 | 324.17 | 439.62 | 70.73 | 1800.90 | 2423.60 | 74.31 |
| 192 | 03-Sep | Thursday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 154.22 | 750.98 | 67.88 | | 22.81 | 841.67 | 287.48 | 609.41 | 103.50 | 1842.07 | 2381.60 | 77.35 |
| 193 | 04-Sep | Friday | | | | | | | | | | | | | | | | | | | |
| 194 | 05-Sep | Saturday | | | | | | | | | | | | | | | | | | | |
| 195 | 06-Sep | Sunday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 156.39 | 747.69 | 86.01 | | | 833.70 | 480.83 | 700.94 | 281.43 | 2296.89 | 2742.80 | 83.74 |
| 196 | 07-Sep | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 24 | | | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 158.92 | 772.62 | 71.12 | | 17.92 | 861.66 | 324.97 | 603.94 | 97.30 | 1887.86 | 2398.40 | 78.71 |
| 197 | 08-Sep | Tuesday | | | | | | | | | | | | | | | | | | | |
| 198 | 09-Sep | Wednesday | | | | | | | | | | | | | | | | | | | |
| 199 | 10-Sep | Thursday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 269.34 | 752.43 | 157.58 | | | 910.02 | 339.96 | 737.20 | 194.32 | 2181.49 | 3024.20 | 72.13 |
| 200 | 11-Sep | Friday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 347.53 | 931.01 | 167.47 | | 13.03 | 1111.51 | 476.77 | 788.24 | | 2376.52 | 2726.00 | 87.18 |
| 201 | 12-Sep | Saturday | | | | | | | | | | | | | | | | | | | |
| 202 | 13-Sep | Sunday | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 395.32 | 1106.01 | 172.35 | | 65.16 | 1343.53 | 446.35 | 805.48 | 83.91 | 2679.27 | 2852.00 | 93.94 |
| 203 | 14-Sep | Monday | | | | | | | | | | | | | | | | | | | |
| 204 | 15-Sep | Tuesday | | | | | | | | | | | | | | | | | | | |
| 205 | 16-Sep | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 25 | | | 30.00 | 15.00 | 500.00 | 45.00 | 75 | 35.00 | 10.00 | 342.64 | 939.98 | 166.35 | | 8.15 | 1114.48 | 324.53 | 777.51 | 70.01 | 2286.54 | 2867.40 | 79.74 |
| 206 | 17-Sep | Thursday | | | | | | | | | | | | | | | | | | | |
| 207 | 18-Sep | Friday | | | | | | | | | | | | | | | | | | | |
| 208 | 19-Sep | Saturday | | | | | | | | | | | | | | | | | | | |
| 209 | 20-Sep | Sunday | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 228 | 1047 | 111 | | | 1158 | 399 | 567 | | 2124 | 2558 | 83 |
| 210 | 21-Sep | Monday | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 287 | 779 | 118 | | 70 | 967 | 255 | 514 | | 1736 | 2785 | 62 |
| 211 | 22-Sep | Tuesday | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 255 | 381 | 134 | | | 514 | 211 | 561 | | 1286 | 2684 | 48 |
| 212 | 23-Sep | Wednesday | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 330 | 1433 | 166 | | | 1600 | 348 | 553 | | 2501 | 2541 | 98 |
| 213 | 24-Sep | Thursday | | | | | | | | | | | | | | | | | | | |
| 214 | 25-Sep | Friday | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 250 | 948 | 95 | | 100 | 1143 | 338 | 783 | | 2265 | 2760 | 82 |
| 215 | 26-Sep | Saturday | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 242 | 708 | 66 | | 148 | 921 | 290 | 399 | 426 | 2035 | 3175 | 64 |
| 216 | 27-Sep | Sunday | | | | | | | | | | | | | | | | | | | |
| 217 | 28-Sep | Monday | | | | | | | | | | | | | | | | | | | |
| 218 | 29-Sep | Tuesday | | | | | | | | | | | | | | | | | | | |
| 219 | 30-Sep | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 26 | | | 30 | 15 | 500 | 45 | 75 | 32 | 13 | 265 | 883 | 115 | | 44 | 1042 | 266 | 518 | | 1825 | 2429 | 75 |
| 220 | 01-Oct | Thursday | | | | | | | | | | | | | | | | | | | |
| 221 | 02-Oct | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 371 | 822 | 135 | | 46 | 1004 | 257 | 525 | | 1786 | 1932 | 92 |
| 222 | 03-Oct | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 130 | 759 | 40 | | 51 | 850 | 252 | 323 | | 1425 | 1819 | 78 |
| 223 | 04-Oct | Sunday | 30 | 15 | | 45 | 75 | 32 | 13 | 195 | 912 | 49 | | 93 | 1053 | 552 | 754 | | 2360 | 2932 | 80 |
| 224 | 05-Oct | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 232 | 1000 | 63 | 4 | 107 | 1173 | 273 | 337 | | 1783 | 2045 | 87 |
| 225 | 06-Oct | Tuesday | | | | | | | | | | | | | | | | | | | |
| 226 | 07-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 227 | 08-Oct | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 161 | 37 | 61 | | 71 | 169 | 310 | 324 | 543 | 1346 | 1932 | 70 |
| 228 | 09-Oct | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 243 | 363 | 82 | | 125 | 569 | 317 | 331 | 23 | 1240 | 2033 | 61 |
| 229 | 10-Oct | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 204 | 371 | 83 | | 62 | 516 | 348 | 381 | 72 | 1317 | 1869 | 70 |
| 230 | 11-Oct | Sunday | 30 | 15 | | 45 | 75 | 32 | 13 | 205 | 501 | 105 | | | 606 | 348 | 409 | | 1363 | 2272 | 60 |
| 231 | 12-Oct | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 202 | 654 | 91 | | 27 | 772 | 359 | 391 | | 1522 | 2033 | 75 |
| 232 | 13-Oct | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 14 | 370 | 62 | | | 431 | 323 | 273 | | 1028 | 2045 | 50 |
| 233 | 14-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 234 | 15-Oct | Thursday | | | | | | | | | | | | | | | | | | | |
| End of Batch 27 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 196 | 579 | 80 | | 42 | 701 | 335 | 410 | | 1446 | 2091 | 69 |
| 235 | 16-Oct | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 334 | 479 | 126 | 3 | 127 | 734 | 273 | 526 | | 1533 | 2331 | 66 |
| 236 | 17-Oct | Saturday | | | | | | | | | | | | | | | | | | | |
| 237 | 18-Oct | Sunday | | | | | | | | | | | | | | | | | | | |
| 238 | 19-Oct | Monday | | | | | | | | | | | | | | | | | | | |
| 239 | 20-Oct | Tuesday | | | | | | | | | | | | | | | | | | | |
| 240 | 21-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 241 | 22-Oct | Thursday | | | | | | | | | | | | | | | | | | | |
| 242 | 23-Oct | Friday | | | | | | | | | | | | | | | | | | | |
| 243 | 24-Oct | Saturday | | | | | | | | | | | | | | | | | | | |
| 244 | 25-Oct | Sunday | | | | | | | | | | | | | | | | | | | |
| 245 | 26-Oct | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 155 | 1046 | 17 | | 111 | 1174 | 397 | 310 | | 1881 | 2440 | 77 |
| 246 | 27-Oct | Tuesday | | | | | | | | | | | | | | | | | | | |
| 247 | 28-Oct | Wednesday | | | | | | | | | | | | | | | | | | | |
| 248 | 29-Oct | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 330 | 585 | 102 | | 190 | 877 | 264 | 662 | 5 | 1807 | 1924 | 94 |
| 249 | 30-Oct | Friday | | | | | | | | | | | | | | | | | | | |
| 250 | 31-Oct | Saturday | | | | | | | | | | | | | | | | | | | |
| 251 | 01-Nov | Sunday | 30 | 15 | | 45 | 75 | 32 | 13 | 246 | 337 | 91 | | 84 | 512 | 409 | 548 | | 1469 | 2478 | 59 |
| 252 | 02-Nov | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 231 | 994 | 105 | | 16 | 1115 | 271 | 362 | | 1748 | 1932 | 90 |
| 253 | 03-Nov | Tuesday | | | | | | | | | | | | | | | | | | | |
| 254 | 04-Nov | Wednesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 28 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 259 | 688 | 88 | | 105 | 882 | 323 | 482 | | 1686 | 2221 | 76 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Influent l/d | Recycle l/d | Nitrate Dosage mgNO3/d | Anaerobic Outflow | Flow into Ae & Anox | Flow to Ext Nitrifier (l/d) | Bypass to Main Anox | Nitrate recy Ae to Anox (mgN/d) | NO3 denit Main Anox (mgN/d) | NO3 denit Pre-Anox (mgN/d) | NO3 denit Anaerobic (mgN/d) | NO3 denit Settler (mgN/d) | Tot Denit (mgN/d) | N in W (mgN/d) | N in Eff (mgN/d) | TKN S/c (mgN/d) | Total TKN Leaving (mgN/d) | Inf TKN mgN/d | MB % (mgN/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255 | 05-Nov | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 238 | 434 | 152 | | | 586 | 302 | 729 | 1119 | 2736 | 4200 | 65 |
| 256 | 06-Nov | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 289 | 312 | 158 | | | 470 | 278 | 749 | 744 | 2240 | 2612 | 86 |
| 257 | 07-Nov | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 419 | 531 | 183 | 9 | 67 | 791 | 293 | 680 | 261 | 2025 | 2354 | 79 |
| 258 | 08-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 259 | 09-Nov | Monday | | | | | | | | | | | | | | | | | | | |
| 260 | 10-Nov | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 423 | 750 | 228 | | | 978 | 307 | 660 | 1027 | 2972 | 3175 | 94 |
| 261 | 11-Nov | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 391 | 863 | 241 | 9 | | 1114 | 288 | 708 | 537 | 2646 | 2684 | 99 |
| 262 | 12-Nov | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 362 | 631 | 180 | | | 811 | 360 | 462 | 758 | 2391 | 2432 | 98 |
| 263 | 13-Nov | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 330 | 385 | 259 | | | 644 | 285 | 748 | 739 | 2417 | 2478 | 98 |
| End of Batch 29 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 353 | 521 | 196 | | | 718 | 303 | 677 | 754 | 2452 | 2876 | 85 |
| 264 | 14-Nov | Saturday | | | | | | | | | | | | | | | | | | | |
| 265 | 15-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 266 | 16-Nov | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 60 | 841 | 41 | | | 883 | 354 | 255 | | 1491 | 2251 | 66 |
| 267 | 17-Nov | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 93 | 792 | 31 | | 45 | 868 | 284 | 169 | 74 | 1395 | 1789 | 78 |
| 268 | 18-Nov | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 77 | 1075 | 50 | | | 1125 | 277 | 203 | | 1608 | 1688 | 95 |
| 269 | 19-Nov | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 213 | 1143 | 70 | | 130 | 1343 | 267 | 349 | | 1959 | 1798 | 109 |
| 270 | 20-Nov | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 265 | 748 | 124 | | 54 | 925 | 313 | 415 | 290 | 1943 | 1802 | 108 |
| 271 | 21-Nov | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 93 | 733 | 96 | | | 830 | 284 | 339 | 166 | 1619 | 1688 | 96 |
| 272 | 22-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 273 | 23-Nov | Monday | | | | | | | | | | | | | | | | | | | |
| 274 | 24-Nov | Tuesday | | | | | | | | | | | | | | | | | | | |
| 275 | 25-Nov | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 89 | 934 | 22 | | 64 | 1020 | 289 | 217 | 33 | 1559 | 1848 | 84 |
| 276 | 26-Nov | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 106 | 712 | 27 | | 82 | 821 | 307 | 226 | | 1354 | 1672 | 81 |
| End of Batch 30 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 125 | 872 | 58 | | 19 | 949 | 297 | 272 | | 1518 | 1817 | 84 |
| 277 | 27-Nov | Friday | | | | | | | | | | | | | | | | | | | |
| 278 | 28-Nov | Saturday | | | | | | | | | | | | | | | | | | | |
| 279 | 29-Nov | Sunday | | | | | | | | | | | | | | | | | | | |
| 280 | 30-Nov | Monday | | | | | | | | | | | | | | | | | | | |
| 281 | 01-Dec | Tuesday | | | | | | | | | | | | | | | | | | | |
| 282 | 02-Dec | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 207 | 1268 | 99 | | 27 | 1394 | 365 | 352 | | 2111 | 2003 | 105 |
| 283 | 03-Dec | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 294 | 1285 | 92 | | 178 | 1556 | 362 | 230 | | 2148 | 3276 | 66 |
| 284 | 04-Dec | Friday | | | | | | | | | | | | | | | | | | | |
| 285 | 05-Dec | Saturday | | | | | | | | | | | | | | | | | | | |
| 286 | 06-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| End of Batch 31 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 251 | 1293 | 99 | | 72 | 1464 | 362 | 300 | | 2126 | 2640 | 81 |
| 287 | 07-Dec | Monday | | | | | | | | | | | | | | | | | | | |
| 288 | 08-Dec | Tuesday | | | | | | | | | | | | | | | | | | | |
| 289 | 09-Dec | Wednesday | | | | | | | | | | | | | | | | | | | |
| 290 | 10-Dec | Thursday | | | | | | | | | | | | | | | | | | | |
| 291 | 11-Dec | Friday | | | | | | | | | | | | | | | | | | | |
| 292 | 12-Dec | Saturday | | | | | | | | | | | | | | | | | | | |
| 293 | 13-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| 294 | 14-Dec | Monday | | | | | | | | | | | | | | | | | | | |
| 295 | 15-Dec | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 46 | 638 | 3 | 5 | 25 | 670 | 395 | 186 | | 1251 | 1672 | 73 |
| 296 | 16-Dec | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 11 | 698 | 5 | | | 702 | 561 | 284 | | 1547 | 1680 | 92 |
| 297 | 17-Dec | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 32 | 648 | 12 | | 12 | 672 | 394 | 199 | 61 | 1326 | 1764 | 75 |
| 298 | 18-Dec | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 24 | 530 | 6 | | 17 | 552 | 562 | 287 | | 1401 | 1680 | 83 |
| 299 | 19-Dec | Saturday | | | | | | | | | | | | | | | | | | | |
| 300 | 20-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| 301 | 21-Dec | Monday | | | | | | | | | | | | | | | | | | | |
| 302 | 22-Dec | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 32 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 28 | 628 | 6 | | 14 | 648 | 478 | 239 | | 1365 | 1699 | 80 |
| 303 | 23-Dec | Wednesday | | | | | | | | | | | | | | | | | | | |
| 304 | 24-Dec | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 215 | 398 | 86 | | 83 | 567 | 1116 | 561 | 230 | 2475 | 2604 | 95 |
| 305 | 25-Dec | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 166 | 938 | 122 | | | 1060 | 303 | 703 | | 2067 | 1831 | 113 |
| 306 | 26-Dec | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 217 | 1080 | 141 | | | 1221 | 603 | 635 | | 2459 | 1823 | 135 |
| 307 | 27-Dec | Sunday | | | | | | | | | | | | | | | | | | | |
| 308 | 28-Dec | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 188 | 1096 | 120 | | | 1216 | 674 | 632 | | 2522 | 2083 | 121 |
| 309 | 29-Dec | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 121 | 1017 | 69 | | | 1085 | 706 | 489 | | 2280 | 2402 | 95 |
| 310 | 30-Dec | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 204 | 1031 | 74 | | 92 | 1196 | 644 | 384 | | 2224 | 2369 | 94 |
| 311 | 31-Dec | Thursday | | | | | | | | | | | | | | | | | | | |
| 312 | 01-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 313 | 02-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 314 | 03-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 315 | 04-Jan | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 223 | 956 | 163 | | | 1119 | 606 | 513 | 351 | 2589 | 3956 | 65 |
| End of Batch 33 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 191 | 936 | 111 | | | 1047 | 665 | 561 | | 2273 | 2438 | 93 |
| 316 | 05-Jan | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 447 | 950 | 129 | | 277 | 1336 | 430 | 443 | 118 | 2346 | 2503 | 94 |
| 317 | 06-Jan | Wednesday | | | | | | | | | | | | | | | | | | | |
| 318 | 07-Jan | Thursday | | | | | | | | | | | | | | | | | | | |
| 319 | 08-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 320 | 09-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 321 | 10-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 322 | 11-Jan | Monday | | | | | | | | | | | | | | | | | | | |
| 323 | 12-Jan | Tuesday | | | | | | | | | | | | | | | | | | | |
| 324 | 13-Jan | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 638 | 610 | 285 | 19 | 20 | 935 | 463 | 912 | 257 | 2567 | 2730 | 94 |
| 325 | 14-Jan | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 645 | 483 | 267 | | 55 | 806 | 491 | 696 | 398 | 2390 | 2852 | 84 |
| 326 | 15-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 327 | 16-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 328 | 17-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 329 | 18-Jan | Monday | | | | | | | | | | | | | | | | | | | |
| 330 | 19-Jan | Tuesday | | | | | | | | | | | | | | | | | | | |
| 331 | 20-Jan | Wednesday | | | | | | | | | | | | | | | | | | | |
| 332 | 21-Jan | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 302 | 789 | 192 | | | 981 | 1336 | 906 | | 3223 | 2881 | 112 |
| 333 | 22-Jan | Friday | | | | | | | | | | | | | | | | | | | |
| 334 | 23-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 335 | 24-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 336 | 25-Jan | Monday | | | | | | | | | | | | | | | | | | | |
| End of Batch 34 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 528 | 627 | 248 | | | 875 | 763 | 838 | 180 | 2657 | 2821 | 94 |
| 337 | 26-Jan | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 403 | 859 | 187 | | 40 | 1086 | 576 | 561 | | 2222 | 2654 | 84 |
| 338 | 27-Jan | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 379 | 912 | 198 | | | 1110 | 417 | 547 | | 2073 | 2352 | 88 |
| 339 | 28-Jan | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 416 | 738 | 131 | | 222 | 1090 | 507 | 470 | | 2067 | 2436 | 85 |
| 340 | 29-Jan | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 433 | 643 | 150 | | 196 | 989 | 368 | 479 | | 1835 | 2407 | 76 |
| 341 | 30-Jan | Saturday | | | | | | | | | | | | | | | | | | | |
| 342 | 31-Jan | Sunday | | | | | | | | | | | | | | | | | | | |
| 343 | 01-Feb | Monday | | | | | | | | | | | | | | | | | | | |
| 344 | 02-Feb | Tuesday | | | | | | | | | | | | | | | | | | | |
| End of Batch 35 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 408 | 788 | 166 | | 107 | 1061 | 467 | 514 | | 2042 | 2462 | 83 |
| 345 | 03-Feb | Wednesday | | | | | | | | | | | | | | | | | | | |
| 346 | 04-Feb | Thursday | | | | | | | | | | | | | | | | | | | |
| 347 | 05-Feb | Friday | | | | | | | | | | | | | | | | | | | |
| 348 | 06-Feb | Saturday | | | | | | | | | | | | | | | | | | | |
| 349 | 07-Feb | Sunday | 30 | 15 | | 45 | 75 | 32 | 13 | 120 | 911 | 80 | | | 991 | 381 | 384 | | 1756 | 1848 | 95 |
| 350 | 08-Feb | Monday | | | | | | | | | | | | | | | | | | | |
| 351 | 09-Feb | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 101 | 865 | 37 | | 41 | 943 | 405 | 342 | | 1689 | 1814 | 93 |
| 352 | 10-Feb | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 87 | 832 | 45 | | | 878 | 432 | 291 | 110 | 1711 | 1852 | 92 |
| 353 | 11-Feb | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 116 | 838 | 33 | | 62 | 935 | 428 | 350 | | 1713 | 1806 | 95 |
| 354 | 12-Feb | Friday | | | | | | | | | | | | | | | | | | | |
| 355 | 13-Feb | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 103 | 958 | 46 | | 8 | 1012 | 435 | 393 | | 1861 | 1730 | 108 |
| 356 | 14-Feb | Sunday | | | | | | | | | | | | | | | | | | | |
| 357 | 15-Feb | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 136 | 962 | 33 | | 103 | 1099 | 401 | 224 | | 1725 | 1672 | 103 |
| 358 | 16-Feb | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 147 | 826 | 30 | | 132 | 988 | 570 | 334 | | 1891 | 1680 | 113 |
| End of Batch 36 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 116 | 896 | 42 | | 44 | 982 | 439 | 327 | | 1748 | 1772 | 99 |
| 359 | 17-Feb | Wednesday | | | | | | | | | | | | | | | | | | | |
| 360 | 18-Feb | Thursday | 30 | 15 | | 45 | 75 | 32 | 13 | 79 | 926 | 3 | | 108 | 1037 | 406 | 267 | | 1709 | 1571 | 109 |
| 361 | 19-Feb | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 36 | 819 | 43 | | | 862 | 392 | 271 | | 1525 | 1593 | 96 |
| 362 | 20-Feb | Saturday | | | | | | | | | | | | | | | | | | | |
| 363 | 21-Feb | Sunday | | | | | | | | | | | | | | | | | | | |
| 364 | 22-Feb | Monday | 30 | 15 | | 45 | 75 | 32 | 13 | 391 | 1095 | 174 | | 60 | 1328 | 426 | 532 | | 2286 | 1823 | 125 |
| 365 | 23-Feb | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 262 | 812 | 137 | | | 950 | 591 | 427 | | 1968 | 1554 | 127 |
| 366 | 24-Feb | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 298 | 602 | 138 | | 29 | 769 | 420 | 484 | 31 | 1704 | 1743 | 98 |
| 367 | 25-Feb | Thursday | | | | | | | | | | | | | | | | | | | |
| 368 | 26-Feb | Friday | 30 | 15 | | 45 | 75 | 32 | 13 | 243 | 780 | 109 | | 33 | 922 | 459 | 439 | | 1820 | 1630 | 112 |
| 369 | 27-Feb | Saturday | 30 | 15 | | 45 | 75 | 32 | 13 | 325 | 759 | 162 | | | 921 | 428 | 570 | 14 | 1933 | 2092 | 92 |
| 370 | 28-Feb | Sunday | | | | | | | | | | | | | | | | | | | |
| 371 | 01-Mar | Monday | | | | | | | | | | | | | | | | | | | |
| 372 | 02-Mar | Tuesday | 30 | 15 | | 45 | 75 | 32 | 13 | 408 | 781 | 153 | 10 | 95 | 1039 | 425 | 538 | | 2002 | 1739 | 115 |
| 373 | 03-Mar | Wednesday | 30 | 15 | | 45 | 75 | 32 | 13 | 428 | 815 | 191 | | 62 | 1067 | 429 | 579 | 29 | 2105 | 1525 | 138 |
| End of Batch 37 | | | 30 | 15 | | 45 | 75 | 32 | 13 | 336 | 889 | 122 | | 28 | 1039 | 450 | 453 | | 1942 | 1729 | 112 |

Daily Tests on Modified Dephenox BNRAS External Nitrification System

| Day No | 1998 | | Influent COD mgCOD/d | Effluent COD mgCOD/d | Waste COD mgCOD/d | COD used in ExtNit mgCOD/d | Nitrifying Check ! mgO/d | OUR*24*V Measured mgO/d | MOn 4.57*Nit mgO/d | MOc OUR-MO mgO/d | Denit O2 MO4 mgO/d | MOt MOc+MO4 mgO/d | COD leaving mgCOD/d | MB_COD % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24-Feb | Tuesday | 19089 | 1125 | 3751 | 3376 | 0 | 3240 | | 3240 | 3010 | 6250 | 14503 | 76 |
| 2 | 25-Feb | Wednesday | 16505 | 1250 | 4210 | 3376 | 0 | 1958 | | 1958 | 2903 | 4861 | 13698 | 83 |
| 3 | 26-Feb | Thursday | 13005 | 1260 | 3698 | 853 | 0 | 1872 | | 1872 | 2907 | 4779 | 10591 | 81 |
| End of Batch 1 | | | 16200 | 1212 | 3886 | 2535 | 0 | 2376 | 0 | 2376 | 2859 | 5235 | 12868 | 79 |
| 4 | 27-Feb | Friday | 12192 | 528 | 3170 | 1707 | 162 | 2016 | 738 | 1278 | 3095 | 4373 | 9778 | 80 |
| 5 | 28-Feb | Saturday | 12842 | 975 | 5039 | 2560 | 273 | 1512 | 1249 | 263 | 3055 | 3318 | 11893 | 93 |
| 6 | 01-Mar | Sunday | 12842 | 1707 | 4389 | 1463 | 566 | 2304 | 2585 | | 3795 | 3514 | 11074 | 86 |
| 7 | 02-Mar | Monday | 12924 | 1097 | 4145 | 2073 | 608 | 2232 | 278 | | 3844 | 3296 | 10611 | 82 |
| 8 | 03-Mar | Tuesday | 10892 | 325 | 3251 | 1585 | 129 | 1426 | 589 | 837 | 2844 | 3681 | 8843 | 81 |
| 9 | 04-Mar | Wednesday | 10810 | 732 | 2723 | 1341 | 121 | 1764 | 553 | 1211 | 2688 | 3899 | 8695 | 80 |
| 10 | 05-Mar | Thursday | 11542 | 650 | 8453 | 1707 | 93 | 1224 | 424 | 800 | 2699 | 3499 | 14309 | 124 |
| 11 | 06-Mar | Friday | 11948 | 853 | 5080 | 732 | 180 | 1541 | 824 | 717 | 3214 | 3931 | 10596 | 89 |
| 12 | 07-Mar | Saturday | 11217 | 163 | 4796 | 1219 | 242 | 1800 | 1107 | 693 | 3279 | 3973 | 10150 | 90 |
| 13 | 08-Mar | Sunday | 11867 | 732 | 5364 | 1219 | 214 | 1922 | 977 | 945 | 3205 | 4151 | 11466 | 97 |
| 14 | 09-Mar | Monday | 12355 | 1097 | 5771 | 2682 | 116 | 1807 | 530 | 1277 | 2714 | 3991 | 13542 | 110 |
| 15 | 10-Mar | Tuesday | 12408 | 993 | 5335 | 1241 | 126 | 1670 | 577 | 1094 | 2958 | 4052 | 11621 | 94 |
| 16 | 11-Mar | Wednesday | 12408 | 910 | 4715 | 2109 | 252 | 1548 | 1154 | 394 | 3290 | 3684 | 11418 | 92 |
| 17 | 12-Mar | Thursday | 15055 | 579 | 5460 | 1737 | 52 | 1591 | 235 | 1356 | 2567 | 3923 | 11699 | 78 |
| End of Batch 2 | | | 12236 | 810 | 4835 | 1670 | 224 | 1656 | 1023 | 633 | 3035 | 3668 | 10983 | 90 |
| 18 | 13-Mar | Friday | 14228 | 993 | 7238 | 2730 | 126 | 1512 | 577 | 935 | 2764 | 3699 | 14659 | 103 |
| 19 | 14-Mar | Saturday | 13235 | 165 | 7197 | 1613 | 283 | 1728 | 1295 | 433 | 3504 | 3937 | 12913 | 98 |
| 20 | 15-Mar | Sunday | 15386 | 165 | 7362 | 2482 | 180 | 1879 | 822 | 1057 | 3767 | 4825 | 14834 | 96 |
| 21 | 16-Mar | Monday | 13566 | 331 | 6824 | 3226 | 112 | 2182 | 514 | 1668 | 3314 | 4982 | 15363 | 113 |
| 22 | 17-Mar | Tuesday | | | | | | | | | | | | |
| End of Batch 3 | | | 14104 | 414 | 7155 | 2513 | 175 | 1800 | 802 | 998 | 3321 | 4319 | 14401 | 102 |
| 23 | 18-Mar | Wednesday | | | | | | | | | | | | |
| 24 | 19-Mar | Thursday | | | | | | | | | | | | |
| 25 | 20-Mar | Friday | | | | | | | | | | | | |
| 26 | 21-Mar | Saturday | | | | | | | | | | | | |
| 27 | 22-Mar | Sunday | | | | | | | | | | | | |
| 28 | 23-Mar | Monday | 26327 | 2780 | 9096 | 6132 | 115 | 1879 | 524 | 1355 | 4235 | 5590 | 23598 | 90 |
| 29 | 24-Mar | Tuesday | 26817 | 4252 | 8432 | 2248 | 132 | 3240 | 601 | 2639 | 4159 | 6798 | 21729 | 81 |
| 30 | 25-Mar | Wednesday | 27798 | 5069 | 11395 | 7154 | 61 | 3089 | 277 | 2811 | 4229 | 7040 | 30658 | 110 |
| End of Batch 4 | | | 26981 | 4033 | 9641 | 5178 | 104 | 2736 | 474 | 2262 | 4146 | 6408 | 25260 | 94 |
| 31 | 26-Mar | Thursday | | | | | | | | | | | | |
| 32 | 27-Mar | Friday | 30415 | 2044 | 5774 | 5928 | 23 | 2203 | 104 | 2099 | 3209 | 5309 | 19054 | 63 |
| 33 | 28-Mar | Saturday | 30088 | 3107 | 6541 | 4292 | 7 | 2491 | 30 | 2461 | 2859 | 5320 | 19260 | 64 |
| 34 | 29-Mar | Sunday | | | | | | | | | | | | |
| 35 | 30-Mar | Monday | 27144 | 1799 | 6847 | 1635 | 10 | 2390 | 45 | 2346 | 3448 | 5794 | 16075 | 59 |
| 36 | 31-Mar | Tuesday | | | | | | | | | | | | |
| 37 | 01-Apr | Wednesday | | | | | | | | | | | | |
| 38 | 02-Apr | Thursday | | | | | | | | | | | | |
| End of Batch 5 | | | 28861 | 2105 | 6298 | 4241 | 9 | 2362 | 41 | 2321 | 3319 | 5640 | 18284 | 63 |
| 39 | 03-Apr | Friday | | | | | | | | | | | | |
| 40 | 04-Apr | Saturday | | | | | | | | | | | | |
| 41 | 05-Apr | Sunday | | | | | | | | | | | | |
| 42 | 06-Apr | Monday | 25312 | 2895 | 6928 | 4550 | 146 | 2376 | 669 | 1707 | 3631 | 5338 | 19710 | 78 |
| 43 | 07-Apr | Tuesday | 24485 | 2151 | 10805 | 4136 | 29 | 2837 | 134 | 2703 | 3061 | 5764 | 22836 | 93 |
| 44 | 08-Apr | Wednesday | 24816 | 2647 | 8892 | 3309 | 10 | 2326 | 45 | 2281 | 3556 | 5837 | 20685 | 83 |
| 45 | 09-Apr | Thursday | 29423 | 4389 | 12294 | 6096 | | 2513 | | 2513 | 1430 | 3943 | 26722 | 91 |
| End of Batch 6 | | | 26009 | 3021 | 9730 | 4523 | | 2513 | | 2513 | 3323 | 5835 | 23108 | 89 |
| 46 | 10-Apr | Friday | 26985 | 2113 | 5994 | 4206 | 81 | 2232 | 371 | 1861 | 2906 | 4767 | 17081 | 63 |
| 47 | 11-Apr | Saturday | 27310 | 2601 | 6096 | 4023 | | 2808 | | 2808 | 3717 | 6525 | 19245 | 70 |
| 48 | 12-Apr | Sunday | | | | | | | | | | | | |
| 49 | 13-Apr | Monday | | | | | | | | | | | | |
| 50 | 14-Apr | Tuesday | | | | | | | | | | | | |
| 51 | 15-Apr | Wednesday | 28611 | 3251 | 4674 | 4938 | 29 | 4522 | 132 | 4389 | 5114 | 9504 | 22366 | 78 |
| 52 | 16-Apr | Thursday | 28448 | 4470 | 6350 | 4938 | 52 | 3240 | 238 | 3002 | 5434 | 8435 | 24193 | 85 |
| End of Batch 7 | | | 27838 | 3109 | 5779 | 4526 | 54 | 3200 | 245 | | 4293 | 7248 | 20662 | 74 |
| 53 | 17-Apr | Friday | 30724 | 4877 | 11684 | 4938 | 291 | 2376 | 1329 | 1047 | 4151 | 5197 | 26696 | 87 |
| 54 | 18-Apr | Saturday | | | | | | | | | | | | |
| 55 | 19-Apr | Sunday | 28731 | 2147 | 10939 | 2043 | 323 | 2052 | 1478 | 574 | 4187 | 4761 | 19890 | 69 |
| 56 | 20-Apr | Monday | 28236 | 3963 | 10372 | 5016 | 279 | 2563 | 1275 | 1288 | 3652 | 4940 | 24290 | 86 |
| 57 | 21-Apr | Tuesday | 26419 | 2559 | 9701 | 1486 | 276 | 1721 | 1261 | 459 | 3714 | 4174 | 17920 | 68 |
| 58 | 22-Apr | Wednesday | 26089 | 2724 | 8927 | 3344 | 306 | 2045 | 1397 | 648 | 3706 | 4354 | 19349 | 74 |
| 59 | 23-Apr | Thursday | 25263 | 2477 | 8978 | 2415 | 326 | 2041 | 1492 | 549 | 3417 | 3967 | 17837 | 71 |
| 60 | 24-Apr | Friday | | | | | | | | | | | | |
| 61 | 25-Apr | Saturday | 25759 | 3468 | 11249 | 2786 | 338 | 2700 | 1546 | 1154 | 4163 | 5317 | 22820 | 89 |
| 62 | 26-Apr | Sunday | 27080 | 3055 | 13158 | 3344 | 45 | 2714 | 203 | 2511 | 4400 | 6911 | 26467 | 98 |
| 63 | 27-Apr | Monday | | | | | | | | | | | | |
| 64 | 28-Apr | Tuesday | 23117 | 2312 | 11868 | 743 | 77 | 1994 | 353 | 1642 | 3953 | 5595 | 20518 | 89 |
| 65 | 29-Apr | Wednesday | | | | | | | | | | | | |
| End of Batch 8 | | | 26824 | 3065 | 10764 | 2902 | 251 | 2275 | 1148 | 1127 | 3889 | 5016 | 21746 | 81 |
| 66 | 30-Apr | Thursday | 29376 | 1632 | 10608 | 4223 | 80 | 4500 | 366 | 4134 | 4969 | 9103 | 25565 | 87 |
| 67 | 01-May | Friday | 28397 | 3917 | 11118 | 3305 | 49 | 4500 | 224 | 4276 | 4468 | 8744 | 27084 | 95 |
| 68 | 02-May | Saturday | 27091 | 2122 | 10098 | 2020 | 62 | 3197 | 284 | 2913 | 4846 | 7758 | 21998 | 81 |
| End of Batch 9 | | | 28288 | 2557 | 10608 | 3182 | 64 | 4066 | 291 | 3774 | 4761 | 8535 | 24882 | 88 |
| 69 | 03-May | Sunday | | | | | | | | | | | | |
| 70 | 04-May | Monday | | | | | | | | | | | | |
| 71 | 05-May | Tuesday | | | | | | | | | | | | |
| 72 | 06-May | Wednesday | | | | | | | | | | | | |
| 73 | 07-May | Thursday | | | | | | | | | | | | |
| 74 | 08-May | Friday | | | | | | | | | | | | |
| End of Batch10 | | | | | | | | | | | | | | |
| 75 | 09-May | Saturday | 29376 | 1632 | 10608 | 4223 | 87 | 4500 | 400 | 4100 | 5292 | 9392 | 25855 | 88 |
| 76 | 10-May | Sunday | 28397 | 3917 | 11118 | 3305 | 54 | 4500 | 245 | 4255 | 4746 | 9001 | 27341 | 96 |
| 77 | 11-May | Monday | 27091 | 2122 | 10098 | 2020 | 68 | 3197 | 310 | 2887 | 5158 | 8044 | 22284 | 82 |
| 78 | 12-May | Tuesday | 28071 | 2955 | 4463 | 4617 | 282 | 1454 | 1289 | 166 | 4193 | 4358 | 16393 | 58 |
| 79 | 13-May | Wednesday | 28564 | 3201 | 7952 | 739 | 39 | 1951 | 179 | 1772 | 4726 | 6498 | 18389 | 64 |
| 80 | 14-May | Thursday | | | | | | | | | | | | |
| 81 | 15-May | Friday | 22326 | 2791 | 7233 | 3899 | 50 | 1980 | 228 | 1752 | 4509 | 6260 | 20183 | 90 |
| 82 | 16-May | Saturday | | | | | | | | | | | | |
| 83 | 17-May | Sunday | 26594 | 3201 | 7131 | 6566 | 71 | 2268 | 326 | 1942 | 7663 | 9605 | 26503 | 100 |
| 84 | 18-May | Monday | 26758 | 2544 | 8413 | 3899 | 50 | 2376 | 228 | 2148 | 8479 | 10627 | 25483 | 95 |
| 85 | 19-May | Tuesday | 24952 | 3201 | 8362 | 410 | 75 | 2952 | 343 | 2609 | 9585 | 12195 | 24168 | 97 |
| End of Batch 11 | | | 26993 | 2840 | 8375 | 3481 | 86 | 2712 | 394 | 2318 | 6158 | 8477 | 23174 | 86 |
| 86 | 20-May | Wednesday | 23990 | 2122 | 7956 | 3468 | 19 | 2326 | 86 | 2239 | 4358 | 6597 | 20143 | 84 |
| 87 | 21-May | Thursday | | | | | | | | | | | | |
| 88 | 22-May | Friday | 28723 | 2448 | 8160 | 2040 | 14 | 2520 | 65 | 2455 | 4079 | 6534 | 19182 | 67 |
| 89 | 23-May | Saturday | 28234 | 1632 | 7242 | 3570 | 38 | 2390 | 173 | 2218 | 3708 | 5926 | 18370 | 65 |
| 90 | 24-May | Sunday | 23827 | 3509 | 7089 | 2856 | 19 | 2232 | 86 | 2146 | 3997 | 6142 | 19596 | 82 |
| 91 | 25-May | Monday | 27907 | 3734 | 4641 | 4896 | 5 | 2254 | 22 | 2232 | 4288 | 6520 | 19811 | 71 |
| 92 | 26-May | Tuesday | | | | | | | | | | | | |
| 93 | 27-May | Wednesday | | | | | | | | | | | | |
| 94 | 28-May | Thursday | 24480 | 2611 | 7140 | 5406 | | 1699 | | 1699 | 4114 | 5813 | 20970 | 86 |
| 95 | 29-May | Friday | 25949 | 3182 | 6426 | 5100 | | 2678 | | 2678 | 3705 | 6384 | 21092 | 81 |
| 96 | 30-May | Saturday | 26928 | 3427 | 8568 | 7936 | 28 | 2254 | 129 | 2124 | 3959 | 6083 | 26034 | 97 |
| 97 | 31-May | Sunday | 23802 | 4210 | 7236 | 4048 | | 2369 | | 2369 | 3415 | 5784 | 21278 | 89 |
| 98 | 01-Jun | Monday | 24774 | 2510 | 7438 | 4048 | 43 | 2520 | 194 | 2326 | 3526 | 5852 | 19847 | 80 |
| 99 | 02-Jun | Tuesday | | | | | | | | | | | | |
| 100 | 03-Jun | Wednesday | | | | | | | | | | | | |
| 101 | 04-Jun | Thursday | | | | | | | | | | | | |
| 102 | 05-Jun | Friday | | | | | | | | | | | | |
| End of Batch 12 | | | 25861 | 2940 | 7190 | 4339 | 12 | 2324 | 54 | 2270 | 3901 | 6171 | 20640 | 80 |
| 103 | 06-Jun | Saturday | | | | | | | | | | | | |
| 104 | 07-Jun | Sunday | 28336 | 3319 | 10626 | 2024 | 55 | 2311 | 250 | 2062 | 1427 | 3488 | 19458 | 69 |
| 105 | 08-Jun | Monday | 28336 | 3319 | 10626 | 2024 | 10 | 2311 | 46 | 2265 | 1290 | 3555 | 19525 | 69 |
| 106 | 09-Jun | Tuesday | | | | | | | | | | | | |
| 107 | 10-Jun | Wednesday | | | | | | | | | | | | |
| 108 | 11-Jun | Thursday | 31251 | 5757 | 8892 | 4318 | 52 | 2693 | 239 | 2454 | 1169 | 3624 | 22590 | 72 |
| 109 | 12-Jun | Friday | 21218 | 3372 | 8018 | 2673 | 20 | 2736 | 91 | 2645 | 1945 | 4590 | 18653 | 88 |
| End of Batch13 | | | 27285 | 3942 | 9541 | 2760 | 34 | 2513 | 156 | 2356 | 1458 | 3814 | 20056 | 74 |
| 110 | 13-Jun | Saturday | | | | | | | | | | | | |
| 111 | 14-Jun | Sunday | | | | | | | | | | | | |
| 112 | 15-Jun | Monday | | | | | | | | | | | | |
| 113 | 16-Jun | Tuesday | | | | | | | | | | | | |
| 114 | 17-Jun | Wednesday | | | | | | | | | | | | |
| End of Batch14 | | | | | | | | | | | | | | |
| 115 | 18-Jun | Thursday | | | | | | | | | | | | |
| 116 | 19-Jun | Friday | | | | | | | | | | | | |
| 117 | 20-Jun | Saturday | | | | | | | | | | | | |
| 118 | 21-Jun | Sunday | | | | | | | | | | | | |
| 119 | 22-Jun | Monday | | | | | | | | | | | | |
| End of Batch15 | | | | | | | | | | | | | | |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Influent COD mgCOD/d | Effluent COD mgCOD/d | Waste COD mgCOD/d | COD used in ExtNit mgCOD/d | Nitrifying Check ! mgO/d | OUR*24*V Measured mgO/d | MOn 4.57*N_lost mgO/d | MOc OUR-MOn mgO/d | Denit O2 MOd mgO/d | MOt MOc+MOd mgO/d | COD leaving mgCOD/d | MB_COD % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | 23-Jun | Tuesday | | | | | | | | | | | | |
| 121 | 24-Jun | Wednesday | 30400 | 3120 | 8750 | 5200 | 103 | 2815 | 469 | 2346 | 1621 | 3967 | 21037 | 69 |
| 122 | 25-Jun | Thursday | | | | | | | | | | | | |
| 123 | 26-Jun | Friday | 29440 | 3120 | 11500 | 5000 | 39 | 2794 | 180 | 2613 | 1738 | 4351 | 23971 | 81 |
| 124 | 27-Jun | Saturday | | | | | | | | | | | | |
| 125 | 28-Jun | Sunday | | | | | | | | | | | | |
| End of Batch16 | | | 29920 | 3120 | 10125 | 5100 | 71 | 2804 | 325 | 2480 | 1657 | 4137 | 22482 | 75 |
| 126 | 29-Jun | Monday | 28320 | 2560 | 9850 | 2800 | 79 | 2434 | 361 | 2073 | 2005 | 4078 | 19288 | 68 |
| 127 | 30-Jun | Tuesday | | | | | | | | | | | | |
| 128 | 01-Jul | Wednesday | 23360 | 3040 | 8300 | 4000 | 107 | 2326 | 487 | 1839 | 1655 | 3494 | 18834 | 81 |
| 129 | 02-Jul | Thursday | 26080 | 3440 | 7550 | 4200 | 71 | 2275 | 325 | 1951 | 1788 | 3739 | 18929 | 73 |
| 130 | 03-Jul | Friday | | | | | | | | | | | | |
| 131 | 04-Jul | Saturday | | | | | | | | | | | | |
| 132 | 05-Jul | Sunday | | | | | | | | | | | | |
| 133 | 06-Jul | Monday | 28000 | 3760 | 9100 | 5400 | 91 | 2095 | 413 | 1681 | 2841 | 4521 | 22781 | 81 |
| 134 | 07-Jul | Tuesday | | | | | | | | | | | | |
| End of Batch17 | | | 26440 | 3200 | 8700 | 4100 | 87 | 2282 | 397 | 1886 | 2073 | 3958 | 19958 | 75 |
| 135 | 08-Jul | Wednesday | | | | | | | | | | | | |
| 136 | 09-Jul | Thursday | 24320 | 3840 | 9600 | 1200 | 55 | 2304 | 252 | 2052 | 1660 | 3712 | 18352 | 75 |
| 137 | 10-Jul | Friday | | | | | | | | | | | | |
| 138 | 11-Jul | Saturday | 25280 | 3120 | 7900 | 2400 | 8 | 2232 | 36 | 2196 | 1343 | 3539 | 16959 | 67 |
| 139 | 12-Jul | Sunday | | | | | | | | | | | | |
| 140 | 13-Jul | Monday | | | | | | | | | | | | |
| 141 | 14-Jul | Tuesday | | | | | | | | | | | | |
| 142 | 15-Jul | Wednesday | | | | | | | | | | | | |
| 143 | 16-Jul | Thursday | | | | | | | | | | | | |
| 144 | 17-Jul | Friday | | | | | | | | | | | | |
| 145 | 18-Jul | Saturday | | | | | | | | | | | | |
| 146 | 19-Jul | Sunday | | | | | | | | | | | | |
| 147 | 20-Jul | Monday | | | | | | | | | | | | |
| End of Batch 18 | | | 24800 | 3480 | 8750 | 1800 | 45 | 2232 | 204 | 2028 | 1511 | 3539 | 17569 | 71 |
| 148 | 21-Jul | Tuesday | | | | | | | | | | | | |
| 149 | 22-Jul | Wednesday | | | | | | | | | | | | |
| End of Batch 19 | | | | | | | | | | | | | | |
| 150 | 23-Jul | Thursday | | | | | | | | | | | | |
| 151 | 24-Jul | Friday | 22032 | 2203 | 9078 | 2220 | 95 | 2246 | 433 | 1814 | 2889 | 4702 | 18203 | 83 |
| 152 | 25-Jul | Saturday | 18482 | 1714 | 7344 | 1567 | 114 | 1958 | 523 | 1436 | 3387 | 4823 | 15447 | 84 |
| 153 | 26-Jul | Sunday | | | | | | | | | | | | |
| 154 | 27-Jul | Monday | 18238 | 1775 | 8568 | 2089 | 158 | 2016 | 721 | 1295 | 3631 | 4925 | 17357 | 95 |
| End of Batch 20 | | | 19584 | 1897 | 8330 | 1958 | 160 | 2074 | 730 | 1343 | 3367 | 4710 | 16896 | 86 |
| 155 | 28-Jul | Tuesday | | | | | | | | | | | | |
| 156 | 29-Jul | Wednesday | | | | | | | | | | | | |
| 157 | 30-Jul | Thursday | | | | | | | | | | | | |
| 158 | 31-Jul | Friday | | | | | | | | | | | | |
| 159 | 01-Aug | Saturday | | | | | | | | | | | | |
| 160 | 02-Aug | Sunday | | | | | | | | | | | | |
| 161 | 03-Aug | Monday | | | | | | | | | | | | |
| 162 | 04-Aug | Tuesday | | | | | | | | | | | | |
| 163 | 05-Aug | Wednesday | | | | | | | | | | | | |
| 164 | 06-Aug | Thursday | | | | | | | | | | | | |
| 165 | 07-Aug | Friday | | | | | | | | | | | | |
| 166 | 08-Aug | Saturday | | | | | | | | | | | | |
| 167 | 09-Aug | Sunday | | | | | | | | | | | | |
| 168 | 10-Aug | Monday | | | | | | | | | | | | |
| 169 | 11-Aug | Tuesday | 16920 | 2100 | 8120 | 3328 | 203 | 4118 | 928 | 3191 | 2463 | 5654 | 19202 | 113 |
| 170 | 12-Aug | Wednesday | 18360 | 1080 | 8320 | 700 | 273 | 4406 | 1250 | 3157 | 3267 | 6424 | 16524 | 90 |
| 171 | 13-Aug | Thursday | | | | | | | | | | | | |
| 172 | 14-Aug | Friday | | | | | | | | | | | | |
| 173 | 15-Aug | Saturday | | | | | | | | | | | | |
| 174 | 16-Aug | Sunday | | | | | | | | | | | | |
| 175 | 17-Aug | Monday | | | | | | | | | | | | |
| End of Batch 22 | | | 17640 | 1590 | 8220 | 2170 | 238 | 4248 | 1089 | 3159 | 2908 | 6067 | 18047 | 102 |
| 176 | 18-Aug | Tuesday | 18240 | 2040 | 7000 | 560 | 476 | 4810 | 2177 | 2632 | 3747 | 6380 | 15980 | 88 |
| 177 | 19-Aug | Wednesday | 20400 | 1800 | 6360 | 1260 | 547 | 5472 | 2499 | 2973 | 3134 | 6107 | 15527 | 76 |
| 178 | 20-Aug | Thursday | 18720 | 1200 | 4920 | 1400 | 452 | 6336 | 2064 | 4272 | 2818 | 7091 | 14611 | 78 |
| 179 | 21-Aug | Friday | | | | | | | | | | | | |
| 180 | 22-Aug | Saturday | 20604 | 1768 | 7396 | 1280 | 184 | 6363 | 842 | 5522 | 1688 | 7210 | 17655 | 86 |
| 181 | 23-Aug | Sunday | | | | | | | | | | | | |
| 182 | 24-Aug | Monday | 19263 | 914 | 7071 | 853 | 62 | 6336 | 284 | 6052 | 1531 | 7583 | 16422 | 85 |
| 183 | 25-Aug | Tuesday | 20117 | 1707 | 7437 | 711 | 48 | 7488 | 218 | 7270 | 1583 | 8853 | 18708 | 93 |
| 184 | 26-Aug | Wednesday | | | | | | | | | | | | |
| 185 | 27-Aug | Thursday | | | | | | | | | | | | |
| 186 | 28-Aug | Friday | | | | | | | | | | | | |
| 187 | 29-Aug | Saturday | | | | | | | | | | | | |
| 188 | 30-Aug | Sunday | | | | | | | | | | | | |
| End of Batch 23 | | | 19557 | 1572 | 6697 | 1011 | 266 | 6192 | 1214 | 4978 | 2280 | 7257 | 16537 | 85 |
| 189 | 31-Aug | Monday | 20726 | 1544 | 7356 | 1565 | 269 | 6322 | 1228 | 5093 | 2688 | 7781 | 18246 | 88 |
| 190 | 01-Sep | Tuesday | 21092 | 1422 | 5974 | 1991 | 179 | 4608 | 819 | 3789 | 2426 | 6215 | 15603 | 74 |
| 191 | 02-Sep | Wednesday | 21336 | 1382 | 5446 | 2134 | 217 | 4608 | 990 | 3618 | 2764 | 6382 | 15343 | 72 |
| 192 | 03-Sep | Thursday | 20117 | 1748 | 5568 | 4125 | 210 | 6797 | 960 | 5836 | 2407 | 8244 | 19684 | 98 |
| 193 | 04-Sep | Friday | | | | | | | | | | | | |
| 194 | 05-Sep | Saturday | | | | | | | | | | | | |
| 195 | 06-Sep | Sunday | | | | | | | | | | | | |
| 196 | 07-Sep | Monday | | | | | | | | | | | | |
| End of Batch 24 | | | 23079 | 2145 | 6475 | 2502 | 222 | 5616 | 1012 | 4604 | 2464 | 7068 | 18190 | 79 |
| 197 | 08-Sep | Tuesday | | | | | | | | | | | | |
| 198 | 09-Sep | Wednesday | | | | | | | | | | | | |
| 199 | 10-Sep | Thursday | 16183 | 2069 | 5841 | 2981 | 337 | 5098 | 1541 | 3557 | 2603 | 6159 | 17050 | 105 |
| 200 | 11-Sep | Friday | 18860 | 1886 | 6733 | 3265 | 456 | 5904 | 2085 | 3819 | 3179 | 6998 | 18882 | 100 |
| 201 | 12-Sep | Saturday | | | | | | | | | | | | |
| 202 | 13-Sep | Sunday | 16670 | 1156 | 5435 | 2413 | 593 | 5648 | 2710 | 2938 | 3842 | 6780 | 15785 | 95 |
| 203 | 14-Sep | Monday | | | | | | | | | | | | |
| 204 | 15-Sep | Tuesday | | | | | | | | | | | | |
| 205 | 16-Sep | Wednesday | | | | | | | | | | | | |
| End of Batch 25 | | | 17238 | 1704 | 6003 | 2887 | 466 | 5616 | 2127 | 3489 | 3187 | 6676 | 17269 | 100 |
| 206 | 17-Sep | Thursday | | | | | | | | | | | | |
| 207 | 18-Sep | Friday | | | | | | | | | | | | |
| 208 | 19-Sep | Saturday | | | | | | | | | | | | |
| 209 | 20-Sep | Sunday | 19462 | 490 | 4488 | 3133 | | 4008 | | 4008 | 3312 | 7320 | 15431 | 79 |
| 210 | 21-Sep | Monday | 23011 | 2142 | 3794 | 1306 | 43 | 6062 | 198 | 5865 | 2765 | 8630 | 15872 | 69 |
| 211 | 22-Sep | Tuesday | 23378 | 2020 | 4039 | 3003 | | 7776 | | 7776 | 1470 | 9246 | 18308 | 78 |
| 212 | 23-Sep | Wednesday | 25337 | 2448 | 6610 | 3264 | 731 | 8064 | 3340 | 4724 | 4575 | 9299 | 21621 | 85 |
| 213 | 24-Sep | Thursday | | | | | | | | | | | | |
| 214 | 25-Sep | Friday | 20040 | 2220 | 3680 | 1792 | 361 | 6638 | 1649 | 4989 | 3269 | 8259 | 15951 | 80 |
| 215 | 26-Sep | Saturday | 19920 | 2160 | 3960 | 1664 | 131 | 6264 | 597 | 5667 | 2635 | 8302 | 16086 | 81 |
| 216 | 27-Sep | Sunday | | | | | | | | | | | | |
| 217 | 28-Sep | Monday | | | | | | | | | | | | |
| 218 | 29-Sep | Tuesday | | | | | | | | | | | | |
| 219 | 30-Sep | Wednesday | | | | | | | | | | | | |
| End of Batch 26 | | | 21858 | 1913 | 4429 | 2360 | 112 | 6469 | 511 | 5958 | 2980 | 8938 | 17640 | 81 |
| 220 | 01-Oct | Thursday | | | | | | | | | | | | |
| 221 | 02-Oct | Friday | 20563 | 2570 | 3346 | 2611 | 554 | 5328 | 2531 | 2797 | 2872 | 5669 | 14196 | 69 |
| 222 | 03-Oct | Saturday | 20441 | 3060 | 4774 | 633 | 123 | 7200 | 563 | 6637 | 2432 | 9069 | 17535 | 86 |
| 223 | 04-Oct | Sunday | 21910 | 2020 | 4325 | 1306 | 349 | 5715 | 1596 | 4119 | 3012 | 7132 | 14782 | 67 |
| 224 | 05-Oct | Monday | 21298 | 2509 | 4978 | 0 | 340 | 8942 | 1553 | 7389 | 3354 | 10743 | 18230 | 86 |
| 225 | 06-Oct | Tuesday | | | | | | | | | | | | |
| 226 | 07-Oct | Wednesday | | | | | | | | | | | | |
| 227 | 08-Oct | Thursday | 15178 | 1836 | 5018 | 2089 | 257 | 5011 | 1174 | 3837 | 484 | 4321 | 13264 | 87 |
| 228 | 09-Oct | Friday | 25459 | 2509 | 5304 | 3393 | 541 | 5616 | 2471 | 3145 | 1626 | 4772 | 15979 | 63 |
| 229 | 10-Oct | Saturday | 17626 | 2020 | 5222 | 3133 | 458 | 5285 | 2094 | 3191 | 1476 | 4667 | 15042 | 85 |
| 230 | 11-Oct | Sunday | 32358 | 1765 | 5794 | 2220 | 445 | 5630 | 2033 | 3597 | 1734 | 5331 | 15109 | 46 |
| 231 | 12-Oct | Monday | 29498 | 2020 | 6569 | 3133 | 459 | 6048 | 2098 | 3950 | 2207 | 6157 | 17879 | 61 |
| 232 | 13-Oct | Tuesday | 29498 | 1958 | 5549 | 3264 | | 5501 | | 5501 | 1234 | 6734 | 17506 | 59 |
| 233 | 14-Oct | Wednesday | | | | | | | | | | | | |
| 234 | 15-Oct | Thursday | | | | | | | | | | | | |
| End of Batch 27 | | | 23405 | 2227 | 5088 | 2180 | 334 | 6028 | 1526 | 4502 | 2005 | 6507 | 16002 | 68 |
| 235 | 16-Oct | Friday | 18482 | 1224 | 4202 | 3133 | 603 | 5960 | 2756 | 3205 | 2100 | 5304 | 13864 | 75 |
| 236 | 17-Oct | Saturday | | | | | | | | | | | | |
| 237 | 18-Oct | Sunday | | | | | | | | | | | | |
| 238 | 19-Oct | Monday | | | | | | | | | | | | |
| 239 | 20-Oct | Tuesday | | | | | | | | | | | | |
| 240 | 21-Oct | Wednesday | | | | | | | | | | | | |
| 241 | 22-Oct | Thursday | | | | | | | | | | | | |
| 242 | 23-Oct | Friday | | | | | | | | | | | | |
| 243 | 24-Oct | Saturday | | | | | | | | | | | | |
| 244 | 25-Oct | Sunday | | | | | | | | | | | | |
| 245 | 26-Oct | Monday | 20074 | 2632 | 5875 | 261 | 200 | 4877 | 912 | 3966 | 3357 | 7322 | 16090 | 80 |
| 246 | 27-Oct | Tuesday | | | | | | | | | | | | |
| 247 | 28-Oct | Wednesday | | | | | | | | | | | | |
| 248 | 29-Oct | Thursday | 16769 | 1224 | 5834 | 653 | 591 | 4008 | 2701 | 1307 | 2507 | 3813 | 11523 | 69 |
| 249 | 30-Oct | Friday | | | | | | | | | | | | |
| 250 | 31-Oct | Saturday | | | | | | | | | | | | |
| 251 | 01-Nov | Sunday | 21053 | 3182 | 5100 | -522 | | 5645 | | 5645 | 1464 | 7109 | 14869 | 71 |
| 252 | 02-Nov | Monday | 15422 | 1591 | 4855 | 1175 | 384 | 4320 | 1755 | 2565 | 3190 | 5755 | 13376 | 87 |
| 253 | 03-Nov | Tuesday | | | | | | | | | | | | |
| 254 | 04-Nov | Wednesday | | | | | | | | | | | | |
| End of Batch 28 | | | 18360 | 1971 | 5175 | 940 | 317 | 4962 | 1450 | 3512 | 2522 | 6033 | 14117 | 77 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Influent COD mgCOD/d | Effluent COD mgCOD/d | Waste COD mgCOD/d | COD used in ExtNit mgCOD/d | Nitrifying Check ! mgO/d | OUR*24*V Measured mgO/d | MOn 4.57*Nitr mgO/d | MOc OUR- MOn mgO/d | Denit O2 MOd mgO/d | MOt MOc+MOd mgO/d | COD leaving mgCOD/d | MB_COD % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255 | 05-Nov | Thursday | 21787 | 1938 | 5304 | 2481 | 565 | 5458 | 2580 | 2877 | 1676 | 4553 | 14296 | 66 |
| 256 | 06-Nov | Friday | 21542 | 2020 | 5222 | 3656 | 203 | 4824 | 928 | 3896 | 1344 | 5240 | 16137 | 75 |
| 257 | 07-Nov | Saturday | 22032 | 1958 | 4937 | 1697 | 624 | 5098 | 2852 | 2246 | 2261 | 4507 | 13099 | 59 |
| 258 | 08-Nov | Sunday | | | | | | | | | | | | |
| 259 | 09-Nov | Monday | | | | | | | | | | | | |
| 260 | 10-Nov | Tuesday | 15667 | 2203 | 4284 | 2611 | 747 | 5443 | 3414 | 2029 | 2797 | 4827 | 13925 | 89 |
| 261 | 11-Nov | Wednesday | 15912 | 1346 | 4325 | 522 | 831 | 5285 | 3798 | 1487 | 3185 | 4672 | 10866 | 68 |
| 262 | 12-Nov | Thursday | 24235 | 1714 | 4570 | 1958 | 522 | 5717 | 2385 | 3332 | 2320 | 5652 | 13893 | 57 |
| 263 | 13-Nov | Friday | 16157 | 1530 | 4366 | 1044 | 495 | 5990 | 2263 | 3728 | 1843 | 5571 | 12511 | 77 |
| End of Batch 29 | | | 19619 | 1819 | 4715 | 1996 | 597 | 5402 | 2730 | 2672 | 2053 | 4725 | 13255 | 68 |
| 264 | 14-Nov | Saturday | | | | | | | | | | | | |
| 265 | 15-Nov | Sunday | | | | | | | | | | | | |
| 266 | 16-Nov | Monday | 21542 | 1958 | 5304 | 1828 | 135 | 5832 | 618 | 5214 | 2525 | 7738 | 16829 | 78 |
| 267 | 17-Nov | Tuesday | 24235 | 1591 | 5304 | 2350 | 227 | 5702 | 1036 | 4667 | 2483 | 7149 | 16395 | 68 |
| 268 | 18-Nov | Wednesday | 19217 | 1163 | 4610 | 2742 | 179 | 5530 | 816 | 4714 | 3218 | 7932 | 16447 | 86 |
| 269 | 19-Nov | Thursday | 15667 | 1652 | 5304 | 3264 | 526 | 5242 | 2406 | 2836 | 3841 | 6676 | 16897 | 108 |
| 270 | 20-Nov | Friday | 25214 | 1530 | 4488 | 3133 | 628 | 7819 | 2869 | 4950 | 2647 | 7597 | 16748 | 66 |
| 271 | 21-Nov | Saturday | 22277 | 1469 | 4774 | 3003 | 205 | 8179 | 935 | 7244 | 2374 | 9618 | 18863 | 85 |
| 272 | 22-Nov | Sunday | | | | | | | | | | | | |
| 273 | 23-Nov | Monday | | | | | | | | | | | | |
| 274 | 24-Nov | Tuesday | | | | | | | | | | | | |
| 275 | 25-Nov | Wednesday | 20038 | 1457 | 5384 | 1684 | 207 | 6005 | 947 | 5058 | 2917 | 7975 | 16500 | 82 |
| 276 | 26-Nov | Thursday | 19916 | 1761 | 5303 | 259 | 89 | 5645 | 408 | 5237 | 2348 | 7583 | 14908 | 75 |
| End of Batch 30 | | | 21813 | 1573 | 5059 | 2283 | 274 | 6244 | 1254 | 4990 | 2714 | 7704 | 16618 | .79 |
| 277 | 27-Nov | Friday | | | | | | | | | | | | |
| 278 | 28-Nov | Saturday | | | | | | | | | | | | |
| 279 | 29-Nov | Sunday | | | | | | | | | | | | |
| 280 | 30-Nov | Monday | | | | | | | | | | | | |
| 281 | 01-Dec | Tuesday | | | | | | | | | | | | |
| 282 | 02-Dec | Wednesday | 24652 | 1397 | 3586 | 777 | 413 | 6062 | 1887 | 4176 | 3986 | 8162 | 15922 | 65 |
| 283 | 03-Dec | Thursday | 24774 | 1943 | 6801 | 777 | 688 | 6725 | 3144 | 3581 | 4449 | 8030 | 17551 | 71 |
| 284 | 04-Dec | Friday | | | | | | | | | | | | |
| 285 | 05-Dec | Saturday | | | | | | | | | | | | |
| 286 | 06-Dec | Sunday | | | | | | | | | | | | |
| End of Batch 31 | | | 24713 | 1670 | 6193 | 777 | 547 | 6394 | 2501 | 3893 | 4186 | 8079 | 16719 | 68 |
| 287 | 07-Dec | Monday | | | | | | | | | | | | |
| 288 | 08-Dec | Tuesday | | | | | | | | | | | | |
| 289 | 09-Dec | Wednesday | | | | | | | | | | | | |
| 290 | 10-Dec | Thursday | | | | | | | | | | | | |
| 291 | 11-Dec | Friday | | | | | | | | | | | | |
| 292 | 12-Dec | Saturday | | | | | | | | | | | | |
| 293 | 13-Dec | Sunday | | | | | | | | | | | | |
| 294 | 14-Dec | Monday | | | | | | | | | | | | |
| 295 | 15-Dec | Tuesday | 17280 | 1440 | 6640 | 2560 | | 3182 | | 3182 | 1917 | 5099 | 15739 | 91 |
| 296 | 16-Dec | Wednesday | 17520 | 1020 | 6640 | 2304 | | 4003 | | 4003 | 2008 | 6012 | 15976 | 91 |
| 297 | 17-Dec | Thursday | 23760 | 1260 | 7000 | 3712 | 31 | 4234 | 144 | 4090 | 1921 | 6011 | 17983 | 76 |
| 298 | 18-Dec | Friday | 23760 | 1320 | 7640 | 2176 | 33 | 5242 | 152 | 5090 | 1579 | 6669 | 17805 | 75 |
| 299 | 19-Dec | Saturday | | | | | | | | | | | | |
| 300 | 20-Dec | Sunday | | | | | | | | | | | | |
| 301 | 21-Dec | Monday | | | | | | | | | | | | |
| 302 | 22-Dec | Tuesday | | | | | | | | | | | | |
| End of Batch 32 | | | 20580 | 1260 | 6980 | 2688 | | 4165 | | 4165 | 1853 | 6018 | 16946 | 82 |
| 303 | 23-Dec | Wednesday | | | | | | | | | | | | |
| 304 | 24-Dec | Thursday | 22920 | 1620 | 7320 | 1920 | 446 | 4738 | 2038 | 2699 | 1622 | 4322 | 15182 | 66 |
| 305 | 25-Dec | Friday | 23040 | 1440 | 9120 | 2560 | 301 | 4334 | 1377 | 2937 | 3033 | 5990 | 19110 | 83 |
| 306 | 26-Dec | Saturday | 22360 | 1200 | 9280 | 2432 | 411 | 4910 | 1876 | 3034 | 3492 | 6527 | 19439 | 86 |
| 307 | 27-Dec | Sunday | | | | | | | | | | | | |
| 308 | 28-Dec | Monday | 24000 | 1920 | 9040 | 2304 | 361 | 4666 | 1649 | 3016 | 3477 | 6494 | 19758 | 82 |
| 309 | 29-Dec | Tuesday | 21120 | 2520 | 5680 | 1280 | 205 | 4550 | 935 | 3616 | 3104 | 6720 | 16200 | 77 |
| 310 | 30-Dec | Wednesday | 20640 | 1800 | 5920 | 1280 | 317 | 5386 | 1447 | 3938 | 3421 | 7359 | 16359 | 79 |
| 311 | 31-Dec | Thursday | | | | | | | | | | | | |
| 312 | 01-Jan | Friday | | | | | | | | | | | | |
| 313 | 02-Jan | Saturday | | | | | | | | | | | | |
| 314 | 03-Jan | Sunday | | | | | | | | | | | | |
| 315 | 04-Jan | Monday | 19920 | 720 | 6120 | 1152 | 520 | 5645 | 2379 | 3266 | 3200 | 6466 | 14458 | 73 |
| End of Batch 33 | | | 22029 | 1603 | 7497 | 1847 | 366 | 4890 | 1672 | 3218 | 2995 | 6213 | 17168 | 78 |
| 316 | 05-Jan | Tuesday | 27720 | 1560 | 6480 | 384 | 487 | 5141 | 2225 | 2916 | 3878 | 6794 | 13218 | 35 |
| 317 | 06-Jan | Wednesday | | | | | | | | | | | | |
| 318 | 07-Jan | Thursday | | | | | | | | | | | | |
| 319 | 08-Jan | Friday | | | | | | | | | | | | |
| 320 | 09-Jan | Saturday | | | | | | | | | | | | |
| 321 | 10-Jan | Sunday | | | | | | | | | | | | |
| 322 | 11-Jan | Monday | | | | | | | | | | | | |
| 323 | 12-Jan | Tuesday | | | | | | | | | | | | |
| 324 | 13-Jan | Wednesday | 22680 | 2160 | 5440 | 2688 | 621 | 4522 | 2839 | 1683 | 2674 | 4356 | 14644 | 65 |
| 325 | 14-Jan | Thursday | 24600 | 1800 | 5640 | 2048 | 638 | 5875 | 2916 | 2959 | 2304 | 5264 | 14752 | 60 |
| 326 | 15-Jan | Friday | | | | | | | | | | | | |
| 327 | 16-Jan | Saturday | | | | | | | | | | | | |
| 328 | 17-Jan | Sunday | | | | | | | | | | | | |
| 329 | 18-Jan | Monday | | | | | | | | | | | | |
| 330 | 19-Jan | Tuesday | | | | | | | | | | | | |
| 331 | 20-Jan | Wednesday | | | | | | | | | | | | |
| 332 | 21-Jan | Thursday | 28903 | 1943 | 6193 | 259 | 630 | 4781 | 2877 | 1903 | 2804 | 4708 | 13103 | 45 |
| 333 | 22-Jan | Friday | | | | | | | | | | | | |
| 334 | 23-Jan | Saturday | | | | | | | | | | | | |
| 335 | 24-Jan | Sunday | | | | | | | | | | | | |
| 336 | 25-Jan | Monday | | | | | | | | | | | | |
| End of Batch 34 | | | 25394 | 1968 | 5758 | 1665 | 630 | 5080 | 2877 | 2202 | 2504 | 4706 | 14096 | 56 |
| 337 | 26-Jan | Tuesday | 23990 | 1588 | 6350 | 1756 | 772 | 4910 | 3530 | 1381 | 3106 | 4487 | 14181 | 59 |
| 338 | 27-Jan | Wednesday | 20815 | 1235 | 6350 | 1505 | 877 | 4810 | 4009 | 801 | 3173 | 3974 | 13064 | 63 |
| 339 | 28-Jan | Thursday | 18816 | 1823 | 7213 | 2007 | 949 | 9518 | 4335 | 5183 | 3119 | 8302 | 19345 | 103 |
| 340 | 29-Jan | Friday | 18110 | 1529 | 5174 | 251 | 1007 | 7790 | 4604 | 3187 | 2827 | 6014 | 12968 | 72 |
| 341 | 30-Jan | Saturday | | | | | | | | | | | | |
| 342 | 31-Jan | Sunday | | | | | | | | | | | | |
| 343 | 01-Feb | Monday | | | | | | | | | | | | |
| 344 | 02-Feb | Tuesday | | | | | | | | | | | | |
| End of Batch 35 | | | 20433 | 1544 | 6272 | 1380 | 901 | 6757 | 4119 | 2638 | 3035 | 5673 | 14868 | 73 |
| 345 | 03-Feb | Wednesday | | | | | | | | | | | | |
| 346 | 04-Feb | Thursday | | | | | | | | | | | | |
| 347 | 05-Feb | Friday | | | | | | | | | | | | |
| 348 | 06-Feb | Saturday | | | | | | | | | | | | |
| 349 | 07-Feb | Sunday | 22344 | 1411 | 4861 | 2885 | 288 | 6048 | 1317 | 4731 | 2836 | 7567 | 16724 | 75 |
| 350 | 08-Feb | Monday | | | | | | | | | | | | |
| 351 | 09-Feb | Tuesday | 21050 | 1705 | 6350 | 2634 | 240 | 4622 | 1096 | 3526 | 2697 | 6223 | 16913 | 80 |
| 352 | 10-Feb | Wednesday | 20933 | 1176 | 5723 | 1631 | 197 | 5126 | 901 | 4225 | 2510 | 6736 | 15265 | 73 |
| 353 | 11-Feb | Thursday | 21521 | 1352 | 6507 | 2383 | 228 | 6062 | 1043 | 5019 | 2673 | 7693 | 17936 | 83 |
| 354 | 12-Feb | Friday | | | | | | | | | | | | |
| 355 | 13-Feb | Saturday | 23640 | 2400 | 6600 | 3712 | 244 | 5098 | 1114 | 3984 | 2895 | 6879 | 19591 | 83 |
| 356 | 14-Feb | Sunday | | | | | | | | | | | | |
| 357 | 15-Feb | Monday | 17280 | 1440 | 6640 | 2560 | 309 | 5213 | 1410 | 3802 | 3144 | 6946 | 17586 | 102 |
| 358 | 16-Feb | Tuesday | 18240 | 1380 | 6880 | 2304 | 328 | 4003 | 1497 | 2506 | 2825 | 5331 | 15895 | 87 |
| End of Batch 36 | | | 21128 | 1581 | 6114 | 2634 | 259 | 5168 | 1182 | 3986 | 2809 | 6795 | 17124 | 81 |
| 359 | 17-Feb | Wednesday | | | | | | | | | | | | |
| 360 | 18-Feb | Thursday | 18240 | 1740 | 6760 | 1792 | 184 | 3758 | 841 | 2917 | 2966 | 5883 | 16175 | 89 |
| 361 | 19-Feb | Friday | 18360 | 1200 | 7520 | 1408 | 76 | 3715 | 346 | 3369 | 2466 | 5835 | 15963 | 87 |
| 362 | 20-Feb | Saturday | | | | | | | | | | | | |
| 363 | 21-Feb | Sunday | | | | | | | | | | | | |
| 364 | 22-Feb | Monday | 20280 | 2820 | 6080 | 2432 | 902 | 4608 | 4121 | 487 | 3799 | 4286 | 15618 | 77 |
| 365 | 23-Feb | Tuesday | 17520 | 1560 | 6160 | 1280 | 641 | 5990 | 2931 | 3060 | 2716 | 5776 | 14776 | 84 |
| 366 | 24-Feb | Wednesday | 18480 | 1380 | 6480 | 2048 | 734 | 5731 | 3354 | 2377 | 2198 | 4575 | 14483 | 78 |
| 367 | 25-Feb | Thursday | | | | | | | | | | | | |
| 368 | 26-Feb | Friday | 23400 | 3120 | 7720 | 2048 | 588 | 5141 | 2686 | 2455 | 2638 | 5093 | 17981 | 77 |
| 369 | 27-Feb | Saturday | 21960 | 1320 | 6760 | 2176 | 758 | 5443 | 3464 | 1979 | 2634 | 4614 | 14870 | 68 |
| 370 | 28-Feb | Sunday | | | | | | | | | | | | |
| 371 | 01-Mar | Monday | | | | | | | | | | | | |
| 372 | 02-Mar | Tuesday | 19080 | 1380 | 6120 | 1920 | 924 | 5501 | 4224 | 1276 | 2972 | 4248 | 15668 | 72 |
| 373 | 03-Mar | Wednesday | 17400 | 1940 | 6960 | 128 | 980 | 5357 | 4476 | 880 | 3052 | 3933 | 13961 | 80 |
| End of Batch 37 | | | 19665 | 1815 | 6700 | 1888 | 643 | 5027 | 2938 | 2089 | 2972 | 5061 | 15464 | 79 |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Total Phosphates mg PO4-P/l | | | | | | | | Phosphorous Mass Balance mgP/l inf | | | | | | | P Removal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | AN | Main_Anox | Pre_Anox | AE | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | Influent | Anaerobic | Main Anox | Pre-Anox | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | In-AE | In-FinFEff |
| 1 | 24-Feb | Tuesday | 25.0 | 13.6 | 10.8 | 10.8 | 12.1 | 25.3 | 26.7 | 19.8 | -19.4 | 20.1 | 1.4 | 9.7 | -2.8 | -0.7 | -2.1 | 9.0 | 7.6 |
| 2 | 25-Feb | Wednesday | 19.1 | 12.1 | 8.3 | 8.0 | 10.4 | 21.9 | 22.6 | 19.4 | -10.4 | 19.8 | 2.1 | 8.3 | -4.9 | -5.6 | -1.0 | 11.5 | 9.0 |
| 3 | 26-Feb | Thursday | 17.0 | 11.1 | 4.9 | 6.6 | 7.3 | 20.1 | 22.9 | 15.3 | -13.9 | 19.4 | 2.4 | 9.0 | -1.4 | -6.2 | -4.2 | 8.7 | 8.0 |
| End of Batch 1 | | | 20.4 | 12.0 | 8.0 | 8.4 | 9.9 | 22.4 | 24.1 | 18.2 | -14.6 | 19.8 | 2.0 | 9.0 | -3.0 | -4.2 | -2.4 | 9.7 | 8.2 |
| 4 | 27-Feb | Friday | 18.1 | 11.0 | 4.6 | 7.1 | 6.4 | 19.9 | 24.2 | 20.3 | -11.4 | 19.9 | 1.8 | 7.8 | 1.4 | -3.6 | -6.4 | 13.1 | 13.9 |
| 5 | 28-Feb | Saturday | 15.3 | 12.1 | 6.4 | 8.9 | 7.5 | 18.8 | 23.5 | 16.3 | -7.8 | 15.8 | 1.1 | 6.4 | 2.8 | -7.1 | -6.9 | 7.3 | 8.9 |
| 6 | 01-Mar | Sunday | 16.7 | 14.6 | 8.5 | 11.4 | 8.5 | 22.7 | 23.8 | 17.4 | -7.5 | 16.9 | 0.0 | 6.4 | 5.7 | -12.1 | -1.6 | 6.0 | 8.9 |
| 7 | 02-Mar | Monday | 14.9 | 13.3 | 8.2 | 10.7 | 9.6 | 19.5 | 21.3 | 22.4 | 0.7 | 13.0 | 1.4 | 5.7 | 2.1 | -9.2 | -2.7 | 11.7 | 12.8 |
| 8 | 03-Mar | Tuesday | 15.3 | 12.8 | 8.9 | 10.3 | 9.6 | 16.7 | 18.5 | 17.4 | -4.3 | 8.7 | 0.7 | 5.0 | 1.4 | -2.8 | -2.7 | 7.1 | 7.8 |
| 9 | 04-Mar | Wednesday | 12.8 | 12.4 | 8.2 | 10.3 | 10.3 | 14.2 | 16.3 | 18.5 | 1.1 | 4.6 | 2.1 | 4.3 | 0.0 | -2.8 | -3.2 | 8.2 | 8.2 |
| 10 | 05-Mar | Thursday | 13.1 | 12.1 | 9.2 | 11.7 | 10.7 | 15.6 | 15.6 | 17.8 | 0.7 | 7.1 | 1.4 | 0.7 | 2.1 | -5.0 | 0.0 | 6.0 | 7.1 |
| 11 | 06-Mar | Friday | 12.8 | 10.0 | 8.2 | 10.3 | 9.2 | 17.1 | 15.6 | 18.1 | 0.7 | 13.5 | 1.1 | -0.7 | 2.1 | -8.5 | 2.1 | 7.8 | 8.9 |
| 12 | 07-Mar | Saturday | 12.1 | 10.7 | 9.2 | 10.3 | 9.2 | 16.7 | 17.1 | 18.5 | 3.6 | 12.3 | 0.0 | 0.7 | 2.1 | -9.2 | -0.5 | 8.2 | 9.2 |
| 13 | 08-Mar | Sunday | 14.6 | 12.1 | 8.9 | 10.3 | 9.6 | 16.7 | 18.5 | 18.1 | -2.1 | 10.1 | 0.7 | 3.6 | 1.4 | -4.3 | -2.7 | 7.8 | 8.5 |
| 14 | 09-Mar | Monday | 13.9 | 10.7 | 8.2 | 10.0 | 10.0 | 14.6 | 14.9 | 19.2 | -0.4 | 8.0 | 1.8 | 1.4 | 0.0 | -1.4 | -0.5 | 9.2 | 9.2 |
| 15 | 10-Mar | Tuesday | 14.2 | 10.3 | 9.2 | 10.7 | 11.4 | 14.9 | 17.4 | 18.5 | -0.7 | 10.5 | 2.1 | -0.7 | -1.4 | -1.4 | -3.7 | 7.8 | 7.1 |
| 16 | 11-Mar | Wednesday | 13.1 | 11.7 | 10.0 | 11.0 | 10.7 | 13.9 | 14.9 | 19.5 | 3.2 | 4.8 | 0.7 | 1.4 | 0.7 | -1.4 | -1.6 | 8.5 | 8.9 |
| 17 | 12-Mar | Thursday | 11.7 | 11.4 | 10.0 | 11.0 | 10.3 | 13.1 | 13.9 | 18.5 | 5.0 | 3.9 | 0.4 | 0.7 | 1.4 | -2.8 | -1.1 | 7.5 | 8.2 |
| End of Batch 2 | | | 14.2 | 11.8 | 8.4 | 10.3 | 9.5 | 16.8 | 18.3 | 18.6 | -1.4 | 10.6 | 1.1 | 3.0 | 1.6 | -5.1 | -2.2 | 8.3 | 9.1 |
| 18 | 13-Mar | Friday | 18.9 | 13.4 | 10.3 | 11.7 | 11.4 | 19.3 | 20.0 | 15.8 | -11.7 | 12.1 | 1.0 | 3.4 | 0.7 | -0.7 | -1.0 | 4.1 | 4.5 |
| 19 | 14-Mar | Saturday | 35.8 | 20.7 | 17.6 | 18.6 | 15.2 | 35.5 | 34.1 | 32.4 | -21.7 | 28.9 | -2.4 | 4.1 | 6.9 | 0.7 | 2.1 | 13.8 | 17.2 |
| 20 | 15-Mar | Sunday | 28.2 | 19.6 | 15.8 | 17.6 | 18.6 | 33.4 | 35.1 | 27.9 | -12.7 | 28.4 | 2.8 | 4.1 | -2.1 | -10.3 | -2.6 | 10.3 | 9.3 |
| 21 | 16-Mar | Monday | 35.5 | 20.3 | 14.1 | 16.9 | 16.5 | 35.8 | 34.8 | 28.2 | -28.6 | 30.5 | 2.4 | 6.9 | 0.7 | -0.7 | 1.5 | 11.4 | 11.7 |
| 22 | 17-Mar | Tuesday | | | | | | | | | | | | | | | | | |
| End of Batch 3 | | | 29.6 | 18.5 | 14.5 | 16.2 | 15.4 | 31.0 | 31.0 | 26.1 | -18.7 | 25.0 | 0.9 | 4.6 | 1.5 | -2.8 | 0.0 | 9.9 | 10.7 |
| 23 | 18-Mar | Wednesday | | | | | | | | | | | | | | | | | |
| 24 | 19-Mar | Thursday | | | | | | | | | | | | | | | | | |
| 25 | 20-Mar | Friday | | | | | | | | | | | | | | | | | |
| 26 | 21-Mar | Saturday | | | | | | | | | | | | | | | | | |
| 27 | 22-Mar | Sunday | 40.8 | 22.8 | 25.6 | 16.0 | 18.0 | 51.7 | 45.2 | 30.8 | -17.6 | 41.6 | -3.8 | 10.2 | -3.0 | -16.2 | 8.0 | 14.8 | 12.8 |
| 28 | 23-Mar | Monday | 42.4 | 23.6 | 29.2 | 17.6 | 17.2 | 44.0 | 46.0 | 37.2 | -11.8 | 31.1 | -6.0 | 9.0 | 0.6 | -2.4 | -2.5 | 19.6 | 20.0 |
| 29 | 24-Mar | Tuesday | 31.7 | 24.0 | 38.0 | 19.2 | 18.0 | 46.9 | 48.5 | 31.2 | -27.2 | 34.6 | -10.0 | 7.2 | 1.8 | 7.2 | -2.0 | 12.0 | 13.2 |
| 30 | 25-Mar | Wednesday | 46.4 | 24.8 | 33.6 | 19.2 | 20.0 | 48.5 | 46.0 | 31.2 | -21.6 | 34.8 | -6.8 | 8.4 | -1.2 | -3.0 | 3.0 | 12.0 | 11.2 |
| End of Batch 4 | | | 45.3 | 23.8 | 31.6 | 18.0 | 18.3 | 47.8 | 46.4 | 32.6 | -19.6 | 35.6 | -6.7 | 8.7 | -0.5 | -3.6 | 1.6 | 14.6 | 14.3 |
| 31 | 26-Mar | Thursday | | | | | | | | | | | | | | | | | |
| 32 | 27-Mar | Friday | 20.0 | 7.2 | 11.7 | 4.8 | 7.2 | 20.3 | 18.9 | 15.8 | -8.3 | 19.3 | -2.2 | 3.6 | -3.6 | -0.5 | 1.7 | 11.0 | 8.6 |
| 33 | 28-Mar | Saturday | 20.7 | 9.6 | 17.2 | 5.5 | 5.5 | 23.4 | 23.8 | 15.8 | -6.5 | 20.8 | -5.9 | 6.2 | 0.0 | -4.1 | -0.4 | 10.3 | 10.3 |
| 34 | 29-Mar | Sunday | 22.7 | 11.0 | 21.0 | 4.8 | 7.6 | 22.4 | 23.1 | 15.5 | -8.1 | 17.2 | -6.7 | 9.3 | -4.1 | 0.5 | -0.9 | 10.7 | 7.9 |
| 35 | 30-Mar | Monday | 22.7 | 14.1 | 17.6 | 5.5 | 8.3 | 23.1 | 23.8 | 15.5 | -9.8 | 13.6 | -4.6 | 12.9 | -4.1 | -0.5 | -0.9 | 10.0 | 7.2 |
| 36 | 31-Mar | Tuesday | 22.4 | 13.8 | 18.9 | 5.9 | 7.9 | 23.4 | 23.8 | 15.8 | -8.3 | 14.6 | -5.5 | 11.9 | -3.1 | -1.5 | -0.4 | 10.0 | 7.9 |
| 37 | 01-Apr | Wednesday | | | | | | | | | | | | | | | | | |
| 38 | 02-Apr | Thursday | | | | | | | | | | | | | | | | | |
| End of Batch 5 | | | 21.5 | 10.5 | 16.9 | 5.2 | 7.1 | 22.3 | 22.4 | 15.7 | -8.2 | 17.7 | -4.9 | 8.8 | -3.0 | -1.2 | -0.1 | 10.5 | 8.5 |
| 39 | 03-Apr | Friday | | | | | | | | | | | | | | | | | |
| 40 | 04-Apr | Saturday | | | | | | | | | | | | | | | | | |
| 41 | 05-Apr | Sunday | | | | | | | | | | | | | | | | | |
| 42 | 06-Apr | Monday | 21.7 | 14.8 | 16.2 | 7.9 | 7.9 | 18.3 | 22.0 | 14.5 | -10.0 | 6.1 | -4.1 | 10.3 | 0.0 | 5.2 | -4.7 | 6.5 | 6.5 |
| 43 | 07-Apr | Tuesday | 20.0 | 14.5 | 16.2 | 9.0 | 10.0 | 20.7 | 21.4 | 15.5 | -6.4 | 9.3 | -3.1 | 8.3 | -1.5 | -1.0 | -0.9 | 6.5 | 5.5 |
| 44 | 08-Apr | Wednesday | 23.4 | 13.8 | 13.5 | 5.9 | 10.0 | 21.4 | 25.8 | 15.2 | -12.2 | 12.5 | -2.8 | 11.9 | -6.2 | 3.1 | -5.6 | 9.3 | 5.2 |
| 45 | 09-Apr | Thursday | 24.8 | 15.8 | 17.6 | 10.0 | 11.4 | 23.4 | 23.8 | 18.6 | -9.8 | 11.5 | -3.1 | 8.8 | -2.1 | 2.1 | -0.4 | 8.6 | 7.2 |
| End of Batch 6 | | | 22.5 | 14.7 | 16.4 | 8.2 | 9.8 | 20.9 | 23.2 | 15.9 | -9.6 | 9.9 | -3.3 | 9.8 | -2.5 | 2.3 | -2.9 | 7.7 | 6.1 |
| 46 | 10-Apr | Friday | 23.4 | 16.2 | 20.3 | 11.4 | 12.1 | 24.5 | 25.5 | 18.9 | -6.0 | 12.7 | -4.1 | 7.2 | -1.0 | -1.5 | -1.3 | 7.6 | 6.9 |
| 47 | 11-Apr | Saturday | 23.8 | 16.9 | 18.3 | 11.7 | 12.1 | 24.1 | 26.9 | 18.6 | -7.9 | 11.5 | -3.1 | 7.7 | -0.5 | -0.5 | -3.4 | 6.9 | 6.5 |
| 48 | 12-Apr | Sunday | | | | | | | | | | | | | | | | | |
| 49 | 13-Apr | Monday | | | | | | | | | | | | | | | | | |
| 50 | 14-Apr | Tuesday | | | | | | | | | | | | | | | | | |
| 51 | 15-Apr | Wednesday | 19.6 | 16.2 | 14.1 | 6.5 | 17.2 | 20.0 | 24.1 | 18.9 | -3.4 | 6.7 | 1.5 | 14.5 | -16.0 | -0.5 | -5.2 | 12.4 | 1.7 |
| 52 | 16-Apr | Thursday | 23.8 | 22.4 | 23.4 | 10.0 | 11.4 | 22.4 | 26.5 | 22.4 | -1.5 | 1.0 | -6.0 | 18.6 | -2.1 | 2.1 | -5.2 | 12.4 | 11.0 |
| End of Batch 7 | | | 22.6 | 17.9 | 19.0 | 9.9 | 13.2 | 22.7 | 25.7 | 19.7 | -4.7 | 8.0 | -2.9 | 12.0 | -4.9 | -0.1 | -3.8 | 9.8 | 6.5 |
| 53 | 17-Apr | Friday | 21.4 | 14.8 | 22.0 | 10.0 | 11.7 | 25.1 | 26.5 | 15.5 | -5.5 | 15.8 | -5.2 | 7.2 | -2.6 | -5.7 | -1.7 | 5.5 | 3.8 |
| 54 | 18-Apr | Saturday | | | | | | | | | | | | | | | | | |
| 55 | 19-Apr | Sunday | 25.1 | 16.5 | 17.6 | 5.5 | 10.7 | 24.8 | 23.4 | 16.9 | -12.1 | 12.1 | -3.4 | 16.5 | -7.7 | 0.5 | 1.7 | 11.4 | 6.2 |
| 56 | 20-Apr | Monday | 26.5 | 14.5 | 21.7 | 8.3 | 10.3 | 28.2 | 30.0 | 16.9 | -12.1 | 21.1 | -5.7 | 9.3 | -3.1 | -2.6 | -2.2 | 8.6 | 6.5 |
| 57 | 21-Apr | Tuesday | 30.3 | 16.9 | 24.5 | 8.3 | 9.6 | 30.3 | 31.3 | 16.9 | -16.4 | 20.4 | -7.4 | 12.9 | -2.1 | 0.0 | -1.3 | 8.6 | 7.2 |
| 58 | 22-Apr | Wednesday | 30.3 | 18.6 | 18.6 | 11.7 | 11.7 | 31.3 | 33.8 | 17.6 | -18.6 | 19.7 | -3.4 | 10.3 | 0.0 | -1.5 | -3.0 | 5.9 | 5.9 |
| 59 | 23-Apr | Thursday | 30.0 | 18.3 | 20.7 | 9.6 | 11.0 | 30.3 | 30.7 | 16.9 | -17.7 | 18.2 | -4.8 | 12.9 | -2.1 | -0.5 | -0.4 | 7.2 | 5.9 |
| 60 | 24-Apr | Friday | | | | | | | | | | | | | | | | | |
| 61 | 25-Apr | Saturday | 29.6 | 20.3 | 19.6 | 12.4 | 13.8 | 30.3 | 32.4 | 18.9 | -15.7 | 15.5 | -2.9 | 11.9 | -2.1 | -1.0 | -2.6 | 6.5 | 5.2 |
| 62 | 26-Apr | Sunday | | | | | | | | | | | | | | | | | |
| 63 | 27-Apr | Monday | 22.0 | 27.2 | 10.3 | 8.3 | 12.1 | 18.6 | 19.6 | 23.4 | -4.5 | -12.7 | 0.9 | 28.4 | -5.7 | 5.2 | -1.3 | 15.2 | 11.4 |
| 64 | 28-Apr | Tuesday | | | | | | | | | | | | | | | | | |
| 65 | 29-Apr | Wednesday | 34.8 | 21.4 | 21.0 | 9.3 | 10.3 | 36.2 | 34.1 | 22.0 | -19.6 | 21.7 | -5.3 | 18.1 | -1.5 | -2.1 | 2.6 | 12.7 | 11.7 |
| End of Batch 8 | | | 26.9 | 18.4 | 19.4 | 9.3 | 11.4 | 27.4 | 28.5 | 17.9 | -12.8 | 13.8 | -4.0 | 13.7 | -3.2 | -0.7 | -1.3 | 8.6 | 6.5 |
| 66 | 30-Apr | Thursday | 43.7 | 28.6 | 29.6 | 16.2 | 12.4 | 42.7 | 45.8 | 29.3 | -21.5 | 22.0 | -8.6 | 18.6 | 5.7 | 1.5 | -3.9 | 13.1 | 16.9 |
| 67 | 01-May | Friday | 42.7 | 21.4 | 31.0 | 14.5 | 13.8 | 43.4 | 41.7 | 23.1 | -25.5 | 32.6 | -8.6 | 10.3 | 1.0 | -1.0 | 2.2 | 8.6 | 9.3 |
| 68 | 02-May | Saturday | 42.0 | 25.8 | 23.8 | 9.3 | 13.8 | 37.5 | 42.0 | 23.1 | -28.1 | 18.7 | -5.0 | 24.8 | -6.7 | 6.7 | -5.6 | 13.8 | 9.3 |
| End of Batch 9 | | | 42.8 | 25.3 | 28.1 | 13.3 | 13.3 | 41.2 | 43.2 | 25.1 | -25.0 | 24.4 | -7.4 | 17.9 | 0.0 | 2.4 | -2.4 | 11.8 | 11.8 |
| 69 | 03-May | Sunday | | | | | | | | | | | | | | | | | |
| 70 | 04-May | Monday | | | | | | | | | | | | | | | | | |
| 71 | 05-May | Tuesday | | | | | | | | | | | | | | | | | |
| 72 | 06-May | Wednesday | | | | | | | | | | | | | | | | | |
| 73 | 07-May | Thursday | | | | | | | | | | | | | | | | | |
| 74 | 08-May | Friday | 23.1 | 8.3 | 10.0 | 4.1 | 5.9 | 21.7 | 21.7 | 0.0 | -29.6 | 20.1 | -2.1 | 6.2 | -2.6 | 2.1 | 0.0 | -4.1 | -5.9 |
| End of Batch 10 | | | | | | | | | | | | | | | | | | | |
| 75 | 09-May | Saturday | | | | | | | | | | | | | | | | | |
| 76 | 10-May | Sunday | | | | | | | | | | | | | | | | | |
| 77 | 11-May | Monday | | | | | | | | | | | | | | | | | |
| 78 | 12-May | Tuesday | 21.4 | 30.8 | 12.4 | 15.5 | 13.8 | 21.7 | 20.7 | 20.7 | -3.2 | -18.3 | 0.7 | 27.4 | 2.6 | -0.5 | 1.3 | 5.2 | 6.9 |
| 79 | 13-May | Wednesday | 25.5 | 22.0 | 17.6 | 12.4 | 11.7 | 28.6 | 28.9 | 20.0 | -9.5 | 9.9 | -2.9 | 14.5 | 1.0 | -4.6 | -0.4 | 7.6 | 8.3 |
| 80 | 14-May | Thursday | | | | | | | | | | | | | | | | | |
| 81 | 15-May | Friday | 29.3 | 14.5 | 15.5 | 11.0 | 8.3 | 26.5 | 25.5 | 18.9 | -17.2 | 17.8 | -3.6 | 5.2 | 4.1 | 4.1 | 1.3 | 7.9 | 10.7 |
| 82 | 16-May | Saturday | | | | | | | | | | | | | | | | | |
| 83 | 17-May | Sunday | 31.3 | 20.0 | 22.4 | 13.4 | 12.1 | 27.6 | 30.7 | 20.0 | -15.8 | 12.1 | -5.2 | 9.8 | 2.1 | 5.7 | -3.9 | 6.5 | 7.9 |
| 84 | 18-May | Monday | 30.7 | 21.7 | 22.4 | 14.1 | 13.1 | 29.3 | 32.0 | 20.7 | -14.1 | 12.1 | -4.6 | 11.4 | 1.5 | 2.1 | -3.4 | 6.5 | 7.6 |
| 85 | 19-May | Tuesday | 30.0 | 21.4 | 20.3 | 14.1 | 14.8 | 27.9 | 30.0 | 18.6 | -16.2 | 10.3 | -2.8 | 10.8 | -1.0 | 3.1 | -2.6 | 4.5 | 3.8 |
| End of Batch 11 | | | 28.0 | 22.2 | 18.4 | 13.4 | 12.3 | 26.9 | 28.0 | 19.3 | -13.0 | 7.3 | -3.1 | 13.2 | 1.7 | 1.6 | -1.3 | 6.4 | 7.5 |
| 86 | 20-May | Wednesday | 23.1 | 11.0 | 13.1 | 6.9 | 9.6 | 21.7 | 22.0 | 12.4 | -15.7 | 16.1 | -1.7 | 6.2 | -4.1 | 2.1 | -0.4 | 5.5 | 2.8 |
| 87 | 21-May | Thursday | | | | | | | | | | | | | | | | | |
| 88 | 22-May | Friday | 28.6 | 15.5 | 17.2 | 11.4 | 10.0 | 26.2 | 26.9 | 22.4 | -11.9 | 16.2 | -3.6 | 6.2 | 2.1 | 3.6 | -0.9 | 11.0 | 12.4 |
| 89 | 23-May | Saturday | 27.9 | 18.9 | 20.0 | 13.1 | 13.8 | 27.2 | 27.6 | 21.7 | -10.2 | 12.5 | -3.1 | 8.8 | -1.0 | 1.0 | -0.4 | 8.6 | 7.9 |
| 90 | 24-May | Sunday | 25.8 | 18.6 | 17.6 | 13.4 | 16.9 | 26.5 | 27.2 | 18.6 | -11.4 | 12.1 | -0.3 | 7.7 | -5.2 | -1.0 | -0.9 | 5.2 | 1.7 |
| 91 | 25-May | Monday | 30.3 | 19.3 | 23.1 | 16.2 | 14.8 | 27.2 | 26.9 | 21.0 | -12.9 | 11.8 | -4.1 | 4.6 | 2.1 | 4.6 | 0.4 | 4.8 | 6.2 |
| 92 | 26-May | Tuesday | | | | | | | | | | | | | | | | | |
| 93 | 27-May | Wednesday | | | | | | | | | | | | | | | | | |
| 94 | 28-May | Thursday | 21.7 | 14.5 | 14.1 | 11.7 | 10.3 | 21.0 | 21.0 | 16.2 | -9.3 | 9.8 | -1.9 | 4.1 | 2.1 | 1.0 | 0.0 | 4.5 | 5.9 |
| 95 | 29-May | Friday | 24.1 | 17.6 | 19.3 | 14.1 | 13.8 | 22.0 | 23.8 | 20.7 | -5.9 | 7.1 | -2.8 | 3.2 | 0.5 | 3.1 | -2.2 | 6.5 | 6.9 |
| 96 | 30-May | Saturday | 14.1 | 16.2 | 17.2 | 22.0 | 14.5 | 19.6 | 21.4 | 17.9 | 3.3 | 5.6 | -1.4 | -8.8 | 11.4 | -8.3 | -2.2 | -4.1 | 3.4 |
| 97 | 31-May | Sunday | 22.7 | 17.6 | 17.9 | 13.4 | 14.5 | 21.7 | 23.1 | 18.9 | -6.2 | 6.5 | -1.7 | 6.2 | -1.5 | 1.5 | -1.7 | 5.5 | 4.5 |
| 98 | 01-Jun | Monday | 23.8 | 19.6 | 21.4 | 13.8 | 13.8 | 23.4 | 23.8 | 19.3 | -5.7 | 5.8 | -3.8 | 8.8 | 0.0 | 0.5 | -0.4 | 5.5 | 5.5 |
| 99 | 02-Jun | Tuesday | | | | | | | | | | | | | | | | | |
| 100 | 03-Jun | Wednesday | | | | | | | | | | | | | | | | | |
| 101 | 04-Jun | Thursday | | | | | | | | | | | | | | | | | |
| 102 | 05-Jun | Friday | | | | | | | | | | | | | | | | | |
| End of Batch 12 | | | 24.2 | 16.9 | 18.1 | 13.6 | 13.2 | 23.7 | 24.3 | 18.9 | -8.4 | 10.3 | -2.4 | 4.9 | 0.6 | 0.8 | -0.9 | 5.3 | 5.7 |
| 103 | 06-Jun | Saturday | 23.1 | 19.6 | 14.5 | 8.6 | 12.1 | 24.1 | 24.1 | 18.3 | -9.1 | 6.7 | -1.2 | 16.5 | -5.2 | -1.5 | 0.0 | 9.6 | 6.2 |
| 104 | 07-Jun | Sunday | 27.6 | 18.3 | 14.5 | 7.6 | 11.7 | 26.5 | 25.8 | 17.9 | -16.2 | 12.2 | -1.4 | 16.0 | -6.2 | 1.5 | 0.9 | 10.3 | 6.2 |
| 105 | 08-Jun | Monday | 23.4 | 17.6 | 15.5 | 11.0 | 14.1 | 22.7 | 24.8 | 14.3 | -9.1 | 8.3 | -0.7 | 9.8 | -4.6 | 1.0 | -2.6 | 7.2 | 4.1 |
| 106 | 09-Jun | Tuesday | 23.1 | 17.9 | 14.5 | 11.4 | 13.8 | 23.1 | 25.1 | 17.9 | -9.3 | 8.3 | -0.3 | 9.8 | -3.6 | 0.0 | -2.6 | 6.5 | 4.1 |
| 107 | 10-Jun | Wednesday | 23.4 | 19.6 | 15.2 | 11.7 | 14.1 | 23.4 | 25.5 | 18.9 | -8.6 | 6.2 | -0.5 | 11.9 | -3.6 | 0.0 | -2.6 | 7.2 | 4.8 |
| 108 | 11-Jun | Thursday | 23.8 | 19.3 | 18.3 | 11.4 | 11.7 | 22.7 | 23.4 | 18.6 | -7.9 | 5.3 | -3.3 | 11.9 | -0.5 | 1.5 | -0.9 | 7.2 | 6.9 |
| 109 | 12-Jun | Friday | 27.6 | 23.8 | 31.7 | 20.3 | 12.1 | 23.4 | 25.1 | 18.4 | -7.1 | -0.1 | -9.8 | 5.2 | 12.4 | 6.2 | -2.2 | -1.9 | 6.4 |
| End of Batch13 | | | 24.8 | 19.4 | 18.3 | 12.2 | 12.9 | 23.6 | 25.0 | 18.3 | -9.7 | 6.7 | -2.7 | 10.8 | -1.0 | 1.7 | -1.7 | 6.1 | 5.4 |
| 110 | 13-Jun | Saturday | | | | | | | | | | | | | | | | | |
| 111 | 14-Jun | Sunday | | | | | | | | | | | | | | | | | |
| 112 | 15-Jun | Monday | | | | | | | | | | | | | | | | | |
| 113 | 16-Jun | Tuesday | | | | | | | | | | | | | | | | | |
| 114 | 17-Jun | Wednesday | | | | | | | | | | | | | | | | | |
| End of Batch14 | | | | | | | | | | | | | | | | | | | |
| 115 | 18-Jun | Thursday | | | | | | | | | | | | | | | | | |
| 116 | 19-Jun | Friday | | | | | | | | | | | | | | | | | |
| 117 | 20-Jun | Saturday | | | | | | | | | | | | | | | | | |
| 118 | 21-Jun | Sunday | | | | | | | | | | | | | | | | | |
| 119 | 22-Jun | Monday | | | | | | | | | | | | | | | | | |
| End of Batch15 | | | | | | | | | | | | | | | | | | | |

Daily Tests on Modified Dephanox BNRAS External Nitrification System

| Day No | 1998 | | Total Phosphates mg PO4-P/l | | | | | | | | Phosphorous Mass Balance mgP/l inf | | | | | | | P Removal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | AN | Main_Anox | Pre_Anox | AE | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | Influent | Anaerobic | Main Anox | Pre-Anox | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | In-AE | In-FinFEff |
| 120 | 23-Jun | Tuesday | | | | | | | | | | | | | | | | | |
| 121 | 24-Jun | Wednesday | 28.6 | 25.5 | 23.8 | 11.0 | 13.1 | 28.9 | 29.3 | 23.1 | -7.9 | 5.3 | -5.3 | 21.7 | -3.1 | -0.5 | -0.4 | 12.1 | 10.0 |
| 122 | 25-Jun | Thursday | | | | | | | | | | | | | | | | | |
| 123 | 26-Jun | Friday | 28.2 | 26.5 | 25.5 | 14.5 | 14.8 | 27.6 | 27.2 | 22.7 | -6.9 | 1.5 | -5.3 | 18.1 | -0.5 | 1.0 | 0.4 | 8.3 | 7.9 |
| 124 | 27-Jun | Saturday | | | | | | | | | | | | | | | | | |
| 125 | 28-Jun | Sunday | | | | | | | | | | | | | | | | | |
| End of Batch16 | | | 28.4 | 26.0 | 24.6 | 12.7 | 13.9 | 28.2 | 28.2 | 22.9 | -7.4 | 3.4 | -5.3 | 19.9 | -1.8 | 0.3 | 0.0 | 10.2 | 9.0 |
| 126 | 29-Jun | Monday | 27.6 | 22.4 | 17.9 | 10.0 | 13.4 | 26.5 | 26.9 | 23.4 | -9.0 | 6.3 | -2.2 | 18.6 | -5.2 | 1.5 | -0.4 | 13.4 | 10.0 |
| 127 | 30-Jun | Tuesday | | | | | | | | | | | | | | | | | |
| 128 | 01-Jul | Wednesday | 25.8 | 23.1 | 21.0 | 13.1 | 14.8 | 25.5 | 26.2 | 22.0 | -6.2 | 3.8 | -3.1 | 15.0 | -2.6 | 0.5 | -0.9 | 9.0 | 7.2 |
| 129 | 02-Jul | Thursday | 24.1 | 19.6 | 19.6 | 16.9 | 14.5 | 25.8 | 25.1 | 21.4 | -5.0 | 9.1 | -2.6 | 4.1 | 3.6 | -2.6 | 0.9 | 4.5 | 6.9 |
| 130 | 03-Jul | Friday | 24.8 | 21.7 | 20.0 | 14.1 | 15.2 | 25.1 | 25.5 | 22.4 | -4.8 | 5.3 | -2.4 | 11.4 | -1.5 | -0.5 | -0.4 | 8.3 | 7.2 |
| 131 | 04-Jul | Saturday | | | | | | | | | | | | | | | | | |
| 132 | 05-Jul | Sunday | | | | | | | | | | | | | | | | | |
| 133 | 06-Jul | Monday | 24.5 | 26.9 | 24.5 | 17.2 | 17.2 | 24.8 | 28.6 | 22.4 | -2.1 | -2.2 | -3.6 | 14.5 | 0.0 | -0.5 | -4.7 | 5.2 | 5.2 |
| 134 | 07-Jul | Tuesday | | | | | | | | | | | | | | | | | |
| End of Batch17 | | | 25.3 | 22.7 | 20.6 | 14.3 | 15.0 | 25.6 | 26.5 | 22.3 | -5.4 | 4.5 | -2.8 | 12.7 | -1.1 | -0.3 | -1.1 | 8.1 | 7.3 |
| 135 | 08-Jul | Wednesday | | | | | | | | | | | | | | | | | |
| 136 | 09-Jul | Thursday | 23.8 | 20.7 | 18.6 | 13.4 | 13.4 | 23.1 | 24.5 | 23.1 | -3.3 | 4.0 | -2.6 | 10.8 | 0.0 | 1.0 | -1.7 | 9.6 | 9.6 |
| 137 | 10-Jul | Friday | 25.1 | 21.0 | 18.9 | 15.2 | 14.1 | 24.5 | 25.8 | 24.1 | -4.1 | 5.5 | -2.4 | 8.8 | 1.5 | 1.0 | -1.7 | 9.0 | 10.0 |
| 138 | 11-Jul | Saturday | 25.8 | 21.0 | 19.3 | 16.5 | 15.8 | 24.8 | 23.8 | 27.2 | -1.9 | 5.4 | -1.7 | 6.7 | 1.0 | 1.5 | 1.3 | 10.7 | 11.4 |
| 139 | 12-Jul | Sunday | | | | | | | | | | | | | | | | | |
| 140 | 13-Jul | Monday | | | | | | | | | | | | | | | | | |
| 141 | 14-Jul | Tuesday | | | | | | | | | | | | | | | | | |
| 142 | 15-Jul | Wednesday | | | | | | | | | | | | | | | | | |
| 143 | 16-Jul | Thursday | | | | | | | | | | | | | | | | | |
| 144 | 17-Jul | Friday | | | | | | | | | | | | | | | | | |
| 145 | 18-Jul | Saturday | 30.0 | 22.7 | 20.3 | 16.5 | 15.5 | 29.6 | 34.1 | 26.5 | -8.3 | 11.5 | -2.4 | 9.3 | 1.5 | 0.5 | -5.6 | 10.0 | 11.0 |
| 146 | 19-Jul | Sunday | 28.9 | 23.4 | 21.4 | 13.1 | 16.9 | 26.9 | 32.0 | 28.6 | -4.1 | 6.5 | -2.2 | 15.5 | -5.7 | 3.1 | -6.5 | 15.5 | 11.7 |
| 147 | 20-Jul | Monday | | | | | | | | | | | | | | | | | |
| End of Batch 18 | | | 24.9 | 20.9 | 18.9 | 15.0 | 14.5 | 24.1 | 24.7 | 24.8 | -3.1 | 5.0 | -2.2 | 8.8 | 0.9 | 1.2 | -0.7 | 9.8 | 10.3 |
| 148 | 21-Jul | Tuesday | 18.9 | 14.1 | 12.1 | 9.0 | 10.7 | 17.9 | 23.8 | 19.6 | -2.8 | 7.1 | -0.7 | 7.7 | -2.6 | 1.5 | -7.3 | 10.7 | 9.0 |
| 149 | 22-Jul | Wednesday | | | | | | | | | | | | | | | | | |
| End of Batch 19 | | | | | | | | | | | | | | | | | | | |
| 150 | 23-Jul | Thursday | 30.7 | 25.1 | 19.9 | 17.2 | 14.5 | 32.4 | 29.6 | 27.9 | -8.1 | 9.9 | -2.7 | 11.9 | 4.1 | -2.9 | 3.2 | 10.7 | 13.4 |
| 151 | 24-Jul | Friday | 31.7 | 27.2 | 18.3 | 17.9 | 18.9 | 37.5 | 33.4 | 24.5 | -13.9 | 14.1 | 0.3 | 13.9 | -1.5 | -9.8 | 4.8 | 6.5 | 5.5 |
| 152 | 25-Jul | Saturday | 31.7 | 25.1 | 20.0 | 15.2 | 16.9 | 35.1 | 31.7 | 26.5 | -11.0 | 13.8 | -1.5 | 15.0 | -2.6 | -5.7 | 4.0 | 11.4 | 9.6 |
| 153 | 26-Jul | Sunday | | | | | | | | | | | | | | | | | |
| 154 | 27-Jul | Monday | 32.0 | 25.8 | 18.9 | 15.5 | 17.6 | 34.8 | 35.5 | 23.1 | -15.5 | 13.7 | -0.7 | 15.5 | -3.1 | -4.6 | -0.8 | 7.6 | 5.5 |
| End of Batch 20 | | | 31.5 | 25.8 | 19.3 | 16.4 | 17.0 | 35.0 | 32.5 | 25.5 | -12.2 | 12.9 | -1.1 | 14.1 | -0.8 | -5.7 | 2.8 | 9.0 | 8.5 |
| 155 | 28-Jul | Tuesday | | | | | | | | | | | | | | | | | |
| 156 | 29-Jul | Wednesday | | | | | | | | | | | | | | | | | |
| 157 | 30-Jul | Thursday | | | | | | | | | | | | | | | | | |
| 158 | 31-Jul | Friday | | | | | | | | | | | | | | | | | |
| 159 | 01-Aug | Saturday | | | | | | | | | | | | | | | | | |
| 160 | 02-Aug | Sunday | | | | | | | | | | | | | | | | | |
| 161 | 03-Aug | Monday | | | | | | | | | | | | | | | | | |
| 162 | 04-Aug | Tuesday | | | | | | | | | | | | | | | | | |
| 163 | 05-Aug | Wednesday | | | | | | | | | | | | | | | | | |
| 164 | 06-Aug | Thursday | | | | | | | | | | | | | | | | | |
| 165 | 07-Aug | Friday | | | | | | | | | | | | | | | | | |
| 166 | 08-Aug | Saturday | | | | | | | | | | | | | | | | | |
| 167 | 09-Aug | Sunday | | | | | | | | | | | | | | | | | |
| 168 | 10-Aug | Monday | | | | | | | | | | | | | | | | | |
| 169 | 11-Aug | Tuesday | 34.4 | 25.8 | 12.4 | 10.3 | 10.3 | 39.6 | 39.6 | 23.8 | -21.7 | 20.7 | -1.0 | 23.2 | 0.0 | -8.6 | 0.0 | 13.4 | 13.4 |
| 170 | 12-Aug | Wednesday | 31.3 | 33.1 | 11.4 | 12.1 | 13.8 | 39.3 | 39.6 | 21.0 | -20.3 | 9.4 | 1.2 | 31.5 | -2.6 | -13.2 | -0.4 | 9.0 | 7.2 |
| 171 | 13-Aug | Thursday | | | | | | | | | | | | | | | | | |
| 172 | 14-Aug | Friday | | | | | | | | | | | | | | | | | |
| 173 | 15-Aug | Saturday | | | | | | | | | | | | | | | | | |
| 174 | 16-Aug | Sunday | | | | | | | | | | | | | | | | | |
| 175 | 17-Aug | Monday | | | | | | | | | | | | | | | | | |
| End of Batch 22 | | | 31.9 | 29.4 | 11.9 | 11.2 | 12.1 | 39.4 | 39.6 | 22.4 | -21.0 | 15.0 | 0.1 | 27.4 | -1.3 | -10.9 | -0.2 | 11.2 | 10.3 |
| 176 | 18-Aug | Tuesday | 28.0 | 19.4 | 4.3 | 10.3 | 11.0 | 30.7 | 31.7 | 17.4 | -22.5 | 17.4 | 3.3 | 13.5 | -1.0 | -4.4 | -1.2 | 7.0 | 6.3 |
| 177 | 19-Aug | Wednesday | 31.7 | 23.7 | 3.7 | 9.3 | 10.3 | 33.4 | 34.4 | 16.0 | -29.7 | 14.8 | 3.3 | 21.5 | -1.5 | -2.8 | -1.2 | 6.7 | 5.7 |
| 178 | 20-Aug | Thursday | 30.0 | 28.0 | 11.3 | 14.7 | 13.7 | 33.7 | 34.4 | 16.0 | -23.4 | 8.7 | 1.2 | 20.0 | 1.5 | -6.1 | -0.8 | 1.3 | 2.3 |
| 179 | 21-Aug | Friday | | | | | | | | | | | | | | | | | |
| 180 | 22-Aug | Saturday | 31.0 | 29.0 | 7.7 | 4.7 | 3.7 | 29.0 | 30.0 | 22.0 | -20.7 | 0.3 | -2.0 | 36.5 | 1.5 | 3.3 | -1.2 | 17.4 | 18.4 |
| 181 | 23-Aug | Sunday | | | | | | | | | | | | | | | | | |
| 182 | 24-Aug | Monday | 32.4 | 32.4 | 9.7 | 11.3 | 7.7 | 32.0 | 35.4 | 23.7 | -20.0 | 0.6 | -1.0 | 31.5 | 5.5 | 0.6 | -3.9 | 12.3 | 16.0 |
| 183 | 25-Aug | Tuesday | 35.7 | 38.0 | 18.7 | 11.7 | 9.7 | 35.4 | 48.4 | 21.7 | -22.5 | 0.3 | -4.5 | 39.5 | 3.0 | 0.6 | -15.2 | 10.0 | 12.0 |
| 184 | 26-Aug | Wednesday | | | | | | | | | | | | | | | | | |
| 185 | 27-Aug | Thursday | | | | | | | | | | | | | | | | | |
| 186 | 28-Aug | Friday | | | | | | | | | | | | | | | | | |
| 187 | 29-Aug | Saturday | | | | | | | | | | | | | | | | | |
| 188 | 30-Aug | Sunday | | | | | | | | | | | | | | | | | |
| End of Batch 23 | | | 31.5 | 28.4 | 9.2 | 10.3 | 9.3 | 32.4 | 35.7 | 19.5 | -23.1 | 7.0 | 0.1 | 27.1 | 1.5 | -1.5 | -3.9 | 9.1 | 10.1 |
| 189 | 31-Aug | Monday | 43.9 | 25.7 | 11.1 | 14.3 | 13.6 | 43.6 | 45.7 | 27.9 | -32.5 | 27.5 | 1.2 | 17.1 | 1.1 | 0.6 | -2.5 | 13.6 | 14.3 |
| 190 | 01-Sep | Tuesday | 46.4 | 27.5 | 11.1 | 14.6 | 12.9 | 45.7 | 48.9 | 22.9 | -41.3 | 28.4 | 0.9 | 19.3 | 2.7 | 1.2 | -3.8 | 8.2 | 10.0 |
| 191 | 02-Sep | Wednesday | 48.9 | 25.0 | 11.8 | 13.6 | 13.6 | 50.7 | 50.4 | 24.6 | -42.9 | 38.5 | 0.9 | 17.1 | 0.0 | -3.0 | 0.4 | 11.1 | 11.1 |
| 192 | 03-Sep | Thursday | 47.5 | 30.0 | 15.4 | 17.1 | 14.6 | 45.4 | 50.7 | 25.0 | -38.6 | 24.8 | -0.4 | 19.3 | 3.8 | 3.6 | -6.2 | 7.9 | 10.4 |
| 193 | 04-Sep | Friday | | | | | | | | | | | | | | | | | |
| 194 | 05-Sep | Saturday | 43.6 | 23.9 | 9.3 | 8.9 | 11.1 | 44.6 | 43.9 | 26.8 | -33.9 | 30.8 | 0.9 | 22.5 | -3.2 | -1.8 | 0.8 | 17.9 | 15.7 |
| 195 | 06-Sep | Sunday | 40.7 | 25.7 | 9.6 | 11.8 | 10.7 | 43.2 | 45.4 | 32.5 | -23.8 | 27.0 | 0.5 | 20.9 | 1.6 | -4.2 | -2.5 | 20.7 | 21.8 |
| 196 | 07-Sep | Monday | | | | | | | | | | | | | | | | | |
| End of Batch 24 | | | 45.2 | 26.3 | 11.4 | 13.4 | 12.7 | 45.5 | 47.5 | 26.6 | -35.5 | 29.5 | 0.7 | 19.4 | 1.0 | -0.6 | -2.3 | 13.2 | 13.9 |
| 197 | 08-Sep | Tuesday | | | | | | | | | | | | | | | | | |
| 198 | 09-Sep | Wednesday | | | | | | | | | | | | | | | | | |
| 199 | 10-Sep | Thursday | 32.5 | 15.4 | 2.5 | 7.5 | 6.8 | 32.1 | 30.4 | 27.5 | -20.0 | 24.6 | 2.1 | 11.8 | 1.1 | 0.6 | 2.1 | 20.0 | 20.7 |
| 200 | 11-Sep | Friday | | | | | | | | | | | | | | | | | |
| 201 | 12-Sep | Saturday | 34.3 | 20.7 | 7.5 | 12.1 | 11.1 | 39.3 | 33.6 | 28.2 | -19.5 | 26.0 | 1.8 | 12.9 | 1.6 | -8.3 | 6.7 | 16.1 | 17.1 |
| 202 | 13-Sep | Sunday | 33.2 | 16.4 | 6.1 | 11.1 | 12.5 | 37.1 | 32.9 | 31.1 | -15.7 | 29.6 | 3.2 | 8.0 | -2.1 | -6.5 | 5.0 | 20.0 | 18.6 |
| 203 | 14-Sep | Monday | | | | | | | | | | | | | | | | | |
| 204 | 15-Sep | Tuesday | | | | | | | | | | | | | | | | | |
| 205 | 16-Sep | Wednesday | | | | | | | | | | | | | | | | | |
| End of Batch 25 | | | 33.3 | 17.5 | 5.4 | 10.2 | 10.1 | 36.2 | 32.3 | 28.9 | -18.4 | 26.7 | 2.4 | 10.9 | 0.2 | -4.8 | 4.6 | 18.7 | 18.8 |
| 206 | 17-Sep | Thursday | | | | | | | | | | | | | | | | | |
| 207 | 18-Sep | Friday | | | | | | | | | | | | | | | | | |
| 208 | 19-Sep | Saturday | | | | | | | | | | | | | | | | | |
| 209 | 20-Sep | Sunday | 39.306 | 12.283 | 3.509 | 5.615 | 3.509 | 37.201 | 43.869 | 24.566 | -31.585 | 37.821 | | 16.670 | 3.159 | 3.159 | -7.113 | 18.951 | 21.06 |
| 210 | 21-Sep | Monday | 47.378 | 17.898 | 18.951 | 14.740 | 14.740 | 46.676 | 32.638 | 26.672 | -37.025 | 25.034 | -2.106 | 7.896 | | 1.053 | 14.974 | 11.932 | 11.93 |
| 211 | 22-Sep | Tuesday | 33.691 | 25.268 | 19.302 | 18.951 | 11.581 | 41.763 | 30.884 | 25.970 | -15.091 | 6.820 | -3.860 | 15.793 | 11.055 | -12.108 | 11.605 | 7.019 | 14.39 |
| 212 | 23-Sep | Wednesday | | | | | | | | | | | | | | | | | |
| 213 | 24-Sep | Thursday | 14.038 | 13.336 | 12.985 | 13.336 | 12.283 | 12.634 | 15.442 | 29.831 | 15.442 | 1.942 | -0.351 | | 1.579 | 2.106 | -2.995 | 16.495 | 17.55 |
| 214 | 25-Sep | Friday | 31.936 | 10.528 | 4.562 | 3.860 | 2.808 | 29.480 | 29.831 | 29.129 | -16.846 | 22.133 | -0.877 | 16.670 | 1.579 | 3.685 | -0.374 | 25.268 | 26.32 |
| 215 | 26-Sep | Saturday | | | | | | | | | | | | | | | | | |
| 216 | 27-Sep | Sunday | | | | | | | | | | | | | | | | | |
| 217 | 28-Sep | Monday | | | | | | | | | | | | | | | | | |
| 218 | 29-Sep | Tuesday | | | | | | | | | | | | | | | | | |
| 219 | 30-Sep | Wednesday | | | | | | | | | | | | | | | | | |
| AVG BATCH No 26 | | | 33.270 | 15.863 | 11.862 | 11.301 | 8.984 | 33.551 | 30.533 | 27.234 | -17.021 | 18.750 | -1.799 | 14.257 | 4.343 | -0.421 | 3.219 | 15.933 | 18.24936 |
| 220 | 01-Oct | Thursday | | | | | | | | | | | | | | | | | |
| 221 | 02-Oct | Friday | 21.268 | 20.559 | 19.496 | 20.914 | 18.433 | 24.104 | 24.459 | 22.686 | 1.241 | 6.050 | -0.532 | | 3.722 | -4.254 | -0.378 | 1.772 | 4.25 |
| 222 | 03-Oct | Saturday | 26.231 | 18.433 | 28.003 | 15.951 | 16.660 | 23.750 | 25.876 | 23.395 | -7.976 | 7.763 | -5.672 | 6.203 | -1.063 | 3.722 | -2.269 | 7.444 | 6.73 |
| 223 | 04-Oct | Sunday | 25.876 | 20.559 | 22.686 | 17.369 | 15.951 | 26.940 | 28.003 | 24.104 | -6.026 | 7.515 | -3.367 | 7.976 | 2.127 | -1.595 | -1.134 | 6.735 | 8.15 |
| 224 | 05-Oct | Monday | | | | | | | | | | | | | | | | | |
| 225 | 06-Oct | Tuesday | | | | | | | | | | | | | | | | | |
| 226 | 07-Oct | Wednesday | | | | | | | | | | | | | | | | | |
| 227 | 08-Oct | Thursday | | | | | | | | | | | | | | | | | |
| 228 | 09-Oct | Friday | | | | | | | | | | | | | | | | | |
| 229 | 10-Oct | Saturday | 28.827 | 18.245 | 12.407 | 10.947 | 8.393 | 32.841 | 30.287 | 28.097 | -9.670 | 11.871 | -2.007 | 18.245 | 3.831 | -6.021 | 2.725 | 17.150 | 19.70 |
| 230 | 11-Oct | Sunday | 31.016 | 27.003 | 19.340 | 20.069 | 13.866 | 31.381 | 31.746 | 24.083 | -12.407 | 0.024 | -2.737 | 17.333 | 9.305 | -0.547 | -0.389 | 4.014 | 10.22 |
| 231 | 12-Oct | Monday | 28.097 | 22.989 | 18.975 | 14.231 | 11.866 | 28.827 | 31.746 | 22.624 | -12.407 | 3.114 | -2.554 | 21.894 | 0.547 | -1.095 | -3.114 | 8.393 | 8.76 |
| 232 | 13-Oct | Tuesday | 32.841 | 21.164 | 15.691 | 13.136 | 13.866 | 32.841 | 29.922 | 25.178 | -17.515 | 6.374 | -0.912 | 20.069 | -1.095 | 0.000 | 3.114 | 12.042 | 11.31 |
| 233 | 14-Oct | Wednesday | 33.206 | 20.434 | 18.975 | 14.231 | 11.312 | 32.476 | 31.016 | 25.543 | -17.150 | 10.302 | -3.831 | 15.508 | 4.379 | 1.095 | 1.557 | 11.312 | 14.23 |
| 234 | 15-Oct | Thursday | | | | | | | | | | | | | | | | | |
| AVG BATCH No 27 | | | 27.737 | 21.279 | 19.514 | 16.088 | 14.434 | 28.669 | 28.863 | 24.310 | -9.251 | 7.114 | -2.540 | 15.287 | 2.482 | -1.399 | -0.207 | 8.221 | 9.876109 |
| 235 | 16-Oct | Friday | 35.760 | 16.420 | 16.785 | 12.042 | 12.407 | 36.490 | 33.936 | 23.354 | -24.266 | 23.001 | -2.189 | 10.947 | -0.547 | -1.095 | 2.725 | 11.312 | 10.95 |
| 236 | 17-Oct | Saturday | | | | | | | | | | | | | | | | | |
| 237 | 18-Oct | Sunday | | | | | | | | | | | | | | | | | |
| 238 | 19-Oct | Monday | | | | | | | | | | | | | | | | | |
| 239 | 20-Oct | Tuesday | | | | | | | | | | | | | | | | | |
| 240 | 21-Oct | Wednesday | | | | | | | | | | | | | | | | | |
| 241 | 22-Oct | Thursday | | | | | | | | | | | | | | | | | |
| 242 | 23-Oct | Friday | | | | | | | | | | | | | | | | | |
| 243 | 24-Oct | Saturday | | | | | | | | | | | | | | | | | |
| 244 | 25-Oct | Sunday | | | | | | | | | | | | | | | | | |
| 245 | 26-Oct | Monday | 29.192 | 24.448 | 16.420 | 14.961 | 16.420 | 33.571 | 34.665 | 23.718 | -12.589 | 5.364 | 0.000 | 23.718 | -2.189 | -6.568 | -1.168 | 8.758 | 7.30 |
| 246 | 27-Oct | Tuesday | | | | | | | | | | | | | | | | | |
| 247 | 28-Oct | Wednesday | | | | | | | | | | | | | | | | | |
| 248 | 29-Oct | Thursday | 29.192 | 19.705 | 27.732 | 13.136 | 14.231 | 31.016 | 30.287 | 24.813 | -12.407 | 9.621 | -6.751 | 16.420 | -1.642 | -2.737 | 0.778 | 11.677 | 10.58 |
| 249 | 30-Oct | Friday | | | | | | | | | | | | | | | | | |
| 250 | 31-Oct | Saturday | | | | | | | | | | | | | | | | | |
| 251 | 01-Nov | Sunday | 27.367 | 20.799 | 13.866 | 14.961 | 13.866 | 33.206 | 31.381 | 25.178 | -8.393 | 10.825 | 0.000 | 14.596 | 1.642 | -8.758 | 1.946 | 10.217 | 11.31 |
| 252 | 02-Nov | Monday | 28.462 | 22.989 | 23.354 | 16.056 | 16.785 | 36.490 | 32.111 | 25.908 | -8.758 | 8.648 | -3.284 | 17.333 | -1.095 | -12.042 | 4.671 | 9.852 | 9.12 |
| 253 | 03-Nov | Tuesday | 31.746 | 23.718 | 17.150 | 16.785 | 17.150 | 36.490 | 32.111 | 24.448 | -14.778 | 7.553 | 0.000 | 17.333 | -0.547 | -7.116 | 4.671 | 7.663 | 7.30 |
| 254 | 04-Nov | Wednesday | 28.462 | 21.164 | 11.677 | 13.501 | 15.691 | 31.746 | 34.301 | 24.813 | -11.129 | 10.935 | 2.007 | 19.157 | -3.284 | -4.926 | -2.725 | 11.312 | 9.12 |
| AVG BATCH No 28 | | | 30.026 | 21.321 | 18.141 | 14.492 | 15.222 | 34.144 | 32.685 | 24.605 | -13.189 | 10.850 | -1.460 | 17.072 | -1.095 | -6.177 | 1.557 | 10.113 | 9.383 |

**Daily Tests on Modified Dephanox BNRAS External Nitrification System**

| Day No | 1998 | | Total Phosphates mg PO4-P/l | | | | | | | | Phosphorous Mass Balance mgP/l Inf | | | | | | | P Removal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | AN | Main_Anox | Pre_Anox | AE | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | Influent | Anaerobic | Main Anox | Pre-Anox | Aerobic | Final Filtered Eff | IntSet Filtered Eff | ExtNit Filtered Eff | In-AE | In-FinFEff |
| 255 | 05-Nov | Thursday | 26.207 | 13.103 | 14.828 | 13.793 | 11.724 | 27.241 | 26.552 | 20.000 | -12.414 | 21.161 | -1.552 | | 3.103 | -1.552 | 0.736 | 6.207 | 8.28 |
| 256 | 06-Nov | Friday | 24.483 | 17.931 | 17.931 | 16.207 | 12.414 | 20.690 | 26.552 | 20.345 | -8.276 | 8.667 | -2.759 | 4.310 | 5.690 | 5.690 | -6.253 | 4.138 | 7.93 |
| 257 | 07-Nov | Saturday | 26.207 | 15.862 | 13.448 | 12.759 | 13.103 | 26.207 | 24.828 | 21.034 | -11.897 | 10.943 | -0.172 | 7.759 | -0.517 | | 1.471 | 8.276 | 7.93 |
| 258 | 08-Nov | Sunday | 21.034 | 13.103 | 8.966 | 10.345 | 13.103 | 21.379 | 18.276 | 22.069 | -4.310 | 6.345 | 2.069 | 6.897 | -4.138 | -0.517 | 3.310 | 11.724 | 8.97 |
| 259 | 09-Nov | Monday | | | | | | | | | | | | | | | | | |
| 260 | 10-Nov | Tuesday | 20.690 | 16.897 | 12.759 | 7.586 | 10.690 | 22.759 | 24.828 | 19.655 | -7.586 | 1.690 | -1.034 | 23.276 | -4.655 | -3.103 | -2.207 | 12.069 | 8.97 |
| 261 | 11-Nov | Wednesday | 24.483 | 19.655 | 17.241 | 14.483 | 13.793 | 25.862 | 28.621 | 18.621 | -10.862 | 7.080 | -1.724 | 12.931 | 1.034 | -2.069 | -2.943 | 4.138 | 4.83 |
| 262 | 12-Nov | Thursday | 22.759 | 19.655 | 17.241 | 16.897 | 14.483 | 24.138 | 31.724 | 21.724 | -3.966 | 12.057 | -1.379 | 6.897 | 3.621 | -2.069 | -8.092 | 4.828 | 7.24 |
| 263 | 13-Nov | Friday | 24.483 | 19.310 | 18.966 | 19.310 | 18.966 | 25.172 | 27.241 | 17.931 | -9.138 | 11.000 | | | 0.517 | -1.034 | -2.207 | -1.379 | -1.03 |
| **AVG BATCH No 29** | | | **23.793** | **16.940** | **15.172** | **13.922** | **13.534** | **24.181** | **26.078** | **20.172** | **-8.556** | **11.036** | **-0.936** | **10.345** | **0.582** | **-0.665** | **-2.023** | **6.250** | **6.637931** |
| 264 | 14-Nov | Saturday | | | | | | | | | | | | | | | | | |
| 265 | 15-Nov | Sunday | | | | | | | | | | | | | | | | | |
| 266 | 16-Nov | Monday | 20.756 | 15.221 | 18.680 | 12.453 | 13.145 | 20.410 | 20.756 | 20.410 | -4.497 | 5.385 | -2.767 | 6.919 | -1.038 | 0.519 | -0.369 | 7.956 | 7.26 |
| 267 | 17-Nov | Tuesday | 24.561 | 20.410 | 20.756 | 12.799 | 9.686 | 24.907 | 24.215 | 33.555 | 3.113 | | -5.535 | 19.026 | 4.670 | -0.519 | 0.738 | 20.756 | 23.87 |
| 268 | 18-Nov | Wednesday | 24.215 | 19.026 | 20.064 | 10.724 | 12.107 | 24.561 | 24.561 | 19.026 | -11.934 | | -3.978 | 20.756 | -2.076 | -0.519 | | 8.302 | 6.92 |
| 269 | 19-Nov | Thursday | 22.831 | 21.101 | 15.567 | 12.799 | 11.761 | 23.177 | 24.907 | 22.139 | -5.708 | | -1.903 | 20.756 | 1.557 | -0.519 | -1.845 | 9.340 | 10.38 |
| 270 | 20-Nov | Friday | 22.485 | 25.599 | 15.221 | 14.529 | 12.453 | 21.793 | 23.869 | 19.372 | -7.091 | | -1.384 | 27.674 | 3.113 | 1.038 | -2.214 | 4.843 | 6.92 |
| 271 | 21-Nov | Saturday | 24.215 | 15.221 | 15.913 | 8.648 | 11.761 | 24.561 | 25.253 | 27.328 | -4.670 | 8.175 | -2.076 | 16.431 | -4.670 | -0.519 | -0.738 | 18.680 | 15.57 |
| 272 | 22-Nov | Sunday | | | | | | | | | | | | | | | | | |
| 273 | 23-Nov | Monday | | | | | | | | | | | | | | | | | |
| 274 | 24-Nov | Tuesday | | | | | | | | | | | | | | | | | |
| 275 | 25-Nov | Wednesday | | | | | | | | | | | | | | | | | |
| 276 | 26-Nov | Thursday | 30.856 | 16.831 | 15.428 | 10.870 | 8.415 | 30.155 | 31.558 | 21.740 | -19.110 | 15.522 | -3.506 | 14.902 | 3.682 | 1.052 | -1.496 | 10.870 | 13.32 |
| **AVG BATCH No 30** | | | **24.274** | **19.058** | **17.375** | **11.832** | **11.333** | **24.223** | **25.017** | **23.367** | **-7.129** | **9.694** | **-3.021** | **18.066** | **0.748** | **0.076** | **-0.987** | **11.535** | **12.03** |
| 277 | 27-Nov | Friday | 23.493 | 15.779 | 31.558 | 10.519 | 9.818 | 20.688 | 30.856 | 22.090 | -7.889 | 12.950 | -10.870 | 13.149 | 1.052 | 4.208 | -10.846 | 11.571 | 12.27 |
| 278 | 28-Nov | Saturday | | | | | | | | | | | | | | | | | |
| 279 | 29-Nov | Sunday | | | | | | | | | | | | | | | | | |
| 280 | 30-Nov | Monday | | | | | | | | | | | | | | | | | |
| 281 | 01-Dec | Tuesday | 40.324 | 27.350 | 41.025 | 29.804 | 19.636 | 41.025 | 42.428 | 23.493 | -22.090 | 24.463 | -10.695 | | 15.253 | -1.052 | -1.496 | -6.312 | 3.86 |
| 282 | 02-Dec | Wednesday | | | | | | | | | | | | | | | | | |
| 283 | 03-Dec | Thursday | 39.622 | 18.935 | 14.376 | 12.623 | 9.117 | 39.973 | 42.077 | 28.051 | -25.071 | 27.490 | -2.630 | 15.779 | 5.260 | -0.526 | -2.244 | 15.428 | 18.93 |
| 284 | 04-Dec | Friday | 42.778 | 21.038 | 19.285 | 12.623 | 9.818 | 41.376 | 43.479 | 27.350 | -30.506 | 24.334 | -4.734 | 21.038 | 4.208 | 2.104 | -2.244 | 14.727 | 17.53 |
| 285 | 05-Dec | Saturday | 43.129 | 22.090 | 25.947 | 13.324 | 12.272 | 39.973 | 41.726 | 23.493 | -34.538 | 19.928 | -6.837 | 21.915 | 1.578 | 4.734 | -1.870 | 10.169 | 11.22 |
| 286 | 06-Dec | Sunday | 40.674 | 22.090 | 21.038 | 9.117 | 10.169 | 40.324 | 37.869 | 19.636 | -36.817 | 11.758 | -5.435 | 32.434 | -1.578 | 0.526 | 2.618 | 10.519 | 9.47 |
| **AVG BATCH No 31** | | | **38.337** | **21.214** | **25.538** | **14.668** | **11.805** | **37.226** | **39.739** | **24.019** | **-26.152** | **20.154** | **-6.867** | **20.863** | **4.295** | **1.666** | **-2.680** | **9.350** | **12.214** |
| 287 | 07-Dec | Monday | | | | | | | | | | | | | | | | | |
| 288 | 08-Dec | Tuesday | | | | | | | | | | | | | | | | | |
| 289 | 09-Dec | Wednesday | samples | | | | | | | | | | | | | | | | |
| 290 | 10-Dec | Thursday | | | | | | | | | | | | | | | | | |
| 291 | 11-Dec | Friday | | | | | | | | | | | | | | | | | |
| 292 | 12-Dec | Saturday | discarded | | | | | | | | | | | | | | | | |
| 293 | 13-Dec | Sunday | | | | | | | | | | | | | | | | | |
| 294 | 14-Dec | Monday | | | | | | | | | | | | | | | | | |
| 295 | 15-Dec | Tuesday | | | | | | | | | | | | | | | | | |
| 296 | 16-Dec | Wednesday | | | | | | | | | | | | | | | | | |
| 297 | 17-Dec | Thursday | 43.526 | 26.927 | 28.403 | 4.795 | 5.533 | 45.002 | 49.059 | 26.558 | -36.333 | 9.308 | -11.435 | 55.330 | -1.107 | -2.213 | -4.328 | 21.763 | 21.03 |
| 298 | 18-Dec | Friday | 39.100 | 30.247 | 26.189 | 5.902 | 7.377 | 48.690 | 54.961 | 19.919 | -35.780 | 10.009 | -9.406 | 60.863 | -2.213 | -14.386 | -6.689 | 14.017 | 12.54 |
| 299 | 19-Dec | Saturday | 40.944 | 29.509 | 28.771 | 4.058 | 5.164 | 46.108 | 53.485 | 19.181 | -40.206 | 7.316 | -11.804 | 63.629 | -1.660 | -7.746 | -7.869 | 15.123 | 14.02 |
| 300 | 20-Dec | Sunday | 45.002 | 28.771 | 25.083 | 6.271 | 2.951 | 47.215 | 50.903 | 19.181 | -45.186 | 9.099 | -11.066 | 56.252 | 4.980 | -3.320 | -3.935 | 12.910 | 16.23 |
| 301 | 21-Dec | Monday | | | | | | | | | | | | | | | | | |
| 302 | 22-Dec | Tuesday | | | | | | | | | | | | | | | | | |
| **AVG BATCH No 32** | | | **42.143** | **28.864** | **27.112** | **5.256** | **5.256** | **46.754** | **52.102** | **21.210** | **-39.376** | **8.933** | **-10.928** | **59.018** | **-0.000** | **-6.916** | **-5.705** | **15.953** | **15.953** |
| 303 | 23-Dec | Wednesday | | | | | | | | | | | | | | | | | |
| 304 | 24-Dec | Thursday | | | | | | | | | | | | | | | | | |
| 305 | 25-Dec | Friday | | | | | | | | | | | | | | | | | |
| 306 | 26-Dec | Saturday | | | | | | | | | | | | | | | | | |
| 307 | 27-Dec | Sunday | 35.780 | 15.861 | 10.697 | 2.213 | 2.213 | 35.780 | 26.558 | 18.443 | -34.120 | 6.394 | -4.242 | 34.120 | | | 9.836 | 16.230 | 16.23 |
| 308 | 28-Dec | Monday | 40.944 | 21.763 | 15.492 | 7.377 | 11.435 | 39.100 | 49.428 | 32.460 | -25.267 | 22.636 | -2.029 | 35.964 | -6.086 | 2.766 | -11.017 | 25.083 | 21.03 |
| 309 | 29-Dec | Tuesday | 47.215 | 29.509 | 19.919 | 14.755 | 21.394 | 54.223 | 63.445 | 33.936 | -29.509 | 32.153 | 0.738 | 36.886 | -9.959 | -10.513 | -9.836 | 19.181 | 12.54 |
| 310 | 30-Dec | Wednesday | | | | | | | | | | | | | | | | | |
| 311 | 31-Dec | Thursday | 51.641 | 29.878 | 24.714 | 20.288 | 21.394 | 48.690 | 64.551 | 24.345 | -42.973 | 35.546 | -1.660 | 23.976 | -1.660 | 4.426 | -16.919 | 4.058 | 2.95 |
| 312 | 01-Jan | Friday | 58.650 | 37.255 | 37.255 | 25.083 | 21.394 | 57.174 | 64.182 | 34.673 | -40.760 | 25.181 | -7.931 | 30.431 | 5.533 | 2.213 | -7.476 | 9.590 | 13.28 |
| 313 | 02-Jan | Saturday | 65.658 | 38.731 | 29.140 | 40.575 | 25.821 | 66.765 | 70.453 | 33.198 | -45.002 | 47.829 | -1.660 | | 22.132 | -1.660 | -3.935 | -7.377 | 7.38 |
| 314 | 03-Jan | Sunday | | | | | | | | | | | | | | | | | |
| 315 | 04-Jan | Monday | | | | | | | | | | | | | | | | | |
| **AVG BATCH No 33** | | | **52.821** | **31.427** | **25.304** | **21.615** | **20.288** | **53.190** | **62.412** | **31.722** | **-36.702** | **32.669** | **-2.508** | **31.815** | **1.992** | **-0.553** | **-9.836** | **10.107** | **11.435** |
| 316 | 05-Jan | Tuesday | 29.509 | 25.821 | 20.288 | 20.288 | 16.599 | 28.034 | 40.575 | 24.714 | -9.406 | 11.164 | -1.844 | 13.832 | 5.533 | 1.475 | -13.377 | 4.426 | 8.12 |
| 317 | 06-Jan | Wednesday | | | | | | | | | | | | | | | | | |
| 318 | 07-Jan | Thursday | | | | | | | | | | | | | | | | | |
| 319 | 08-Jan | Friday | | | | | | | | | | | | | | | | | |
| 320 | 09-Jan | Saturday | | | | | | | | | | | | | | | | | |
| 321 | 10-Jan | Sunday | | | | | | | | | | | | | | | | | |
| 322 | 11-Jan | Monday | | | | | | | | | | | | | | | | | |
| 323 | 12-Jan | Tuesday | | | | | | | | | | | | | | | | | |
| 324 | 13-Jan | Wednesday | 25.083 | 17.337 | 16.230 | 16.230 | 15.492 | 25.452 | 25.821 | 22.501 | -7.008 | 11.459 | -0.369 | 2.766 | 1.107 | -0.553 | -0.393 | 6.271 | 7.01 |
| 325 | 14-Jan | Thursday | 20.656 | 18.812 | 16.968 | 16.968 | 17.706 | 25.083 | 24.714 | 22.501 | | 7.168 | 0.369 | 4.611 | -1.107 | -6.640 | 0.393 | 5.533 | 4.80 |
| 326 | 15-Jan | Friday | | | | | | | | | | | | | | | | | |
| 327 | 16-Jan | Saturday | | | | | | | | | | | | | | | | | |
| 328 | 17-Jan | Sunday | | | | | | | | | | | | | | | | | |
| 329 | 18-Jan | Monday | | | | | | | | | | | | | | | | | |
| 330 | 19-Jan | Tuesday | | | | | | | | | | | | | | | | | |
| 331 | 20-Jan | Wednesday | | | | | | | | | | | | | | | | | |
| 332 | 21-Jan | Thursday | 32.460 | 23.238 | 19.550 | 19.550 | 16.599 | 35.780 | 36.886 | 26.927 | -11.988 | 16.304 | -1.475 | 9.222 | 4.426 | -4.980 | -1.180 | 7.377 | 10.33 |
| 333 | 22-Jan | Friday | | | | | | | | | | | | | | | | | |
| 334 | 23-Jan | Saturday | | | | | | | | | | | | | | | | | |
| 335 | 24-Jan | Sunday | | | | | | | | | | | | | | | | | |
| 336 | 25-Jan | Monday | | | | | | | | | | | | | | | | | |
| **AVG BATCH No 34** | | | **26.066** | **19.796** | **17.583** | **17.583** | **16.599** | **28.771** | **29.140** | **23.976** | **-9.498** | **11.644** | **-0.492** | **5.533** | **1.475** | **-4.058** | **-0.393** | **6.394** | **7.377296** |
| 337 | 26-Jan | Tuesday | 30.616 | 20.288 | 16.230 | 16.230 | 13.648 | 34.304 | 40.575 | 23.238 | -14.370 | 23.657 | -1.291 | 10.144 | 3.873 | -5.533 | -6.689 | 7.008 | 9.59 |
| 338 | 27-Jan | Wednesday | 33.567 | 22.132 | 18.443 | 18.443 | 15.492 | 32.460 | 37.624 | 21.394 | -19.734 | 17.312 | -1.475 | 9.222 | 4.426 | 1.660 | -5.508 | 2.951 | 5.90 |
| 339 | 28-Jan | Thursday | 28.403 | 22.132 | 16.599 | 16.599 | 12.910 | 35.411 | 40.206 | 21.394 | -12.910 | 19.501 | -1.844 | 13.832 | 5.533 | -10.513 | -5.115 | 4.795 | 8.48 |
| 340 | 29-Jan | Friday | 37.255 | 21.025 | 18.812 | 18.812 | 13.279 | 35.780 | 36.886 | 22.501 | -23.976 | 21.099 | -2.766 | 5.533 | 8.299 | 2.213 | -1.180 | 3.689 | 9.22 |
| 341 | 30-Jan | Saturday | | | | | | | | | | | | | | | | | |
| 342 | 31-Jan | Sunday | | | | | | | | | | | | | | | | | |
| 343 | 01-Feb | Monday | | | | | | | | | | | | | | | | | |
| 344 | 02-Feb | Tuesday | | | | | | | | | | | | | | | | | |
| **AVG BATCH No 35** | | | **32.460** | **21.394** | **17.521** | **17.521** | **13.832** | **34.489** | **38.823** | **22.132** | **-17.798** | **20.392** | **-1.844** | **9.683** | **5.533** | **-3.043** | **-4.623** | **4.611** | **8.299458** |
| 345 | 03-Feb | Wednesday | | | | | | | | | | | | | | | | | |
| 346 | 04-Feb | Thursday | | | | | | | | | | | | | | | | | |
| 347 | 05-Feb | Friday | | | | | | | | | | | | | | | | | |
| 348 | 06-Feb | Saturday | | | | | | | | | | | | | | | | | |
| 349 | 07-Feb | Sunday | 19.919 | 18.074 | 20.288 | 9.222 | 9.590 | 36.149 | 39.469 | 23.607 | -1.660 | 21.800 | -5.349 | 22.132 | -0.553 | -24.345 | -3.541 | 14.386 | 14.02 |
| 350 | 08-Feb | Monday | | | | | | | | | | | | | | | | | |
| 351 | 09-Feb | Tuesday | 41.682 | 23.607 | 25.452 | 16.230 | 12.541 | 42.419 | 42.419 | 23.607 | -30.800 | 20.841 | -6.455 | 18.443 | 5.533 | -1.107 | | 7.377 | 11.07 |
| 352 | 10-Feb | Wednesday | 44.264 | 26.189 | 31.354 | 16.968 | 14.017 | 43.895 | 45.739 | 26.558 | -31.354 | 19.304 | -8.668 | 23.054 | 4.426 | 0.553 | -1.967 | 9.590 | 12.54 |
| 353 | 11-Feb | Thursday | 42.051 | 26.558 | 26.189 | 16.230 | 14.017 | 42.419 | 42.788 | 23.607 | -31.354 | 13.857 | -6.086 | 25.821 | 3.320 | -0.553 | -0.393 | 7.377 | 9.59 |
| 354 | 12-Feb | Friday | | | | | | | | | | | | | | | | | |
| 355 | 13-Feb | Saturday | 46.477 | 28.771 | 32.091 | 15.861 | 14.755 | 46.477 | 50.534 | 26.189 | -35.595 | 17.976 | -8.668 | 32.276 | 1.660 | | -4.328 | 10.328 | 11.43 |
| 356 | 14-Feb | Sunday | 46.846 | 24.345 | 28.403 | 14.755 | 11.435 | 44.633 | 50.166 | 26.189 | -36.702 | 26.743 | -8.484 | 23.976 | 4.980 | 3.320 | -5.902 | 11.435 | 14.75 |
| 357 | 15-Feb | Monday | 45.739 | 22.501 | 28.034 | 15.861 | 12.910 | 44.264 | 50.534 | 25.452 | -35.227 | 32.694 | -7.562 | 16.599 | 4.426 | 2.213 | -6.689 | 9.590 | 12.54 |
| 358 | 16-Feb | Tuesday | 42.419 | 21.345 | 25.452 | 14.755 | 12.173 | 42.419 | 46.846 | 25.083 | -31.169 | 29.743 | -6.640 | 16.476 | 3.873 | | -4.721 | 10.328 | 12.91 |
| **AVG BATCH No 36** | | | **41.175** | **23.924** | **27.158** | **14.985** | **12.680** | **42.834** | **46.062** | **25.037** | **-29.233** | **22.870** | **-7.239** | **22.347** | **3.458** | **-3.320** | **-3.935** | **10.052** | **12.35697** |
| 359 | 17-Feb | Wednesday | | | | | | | | | | | | | | | | | |
| 360 | 18-Feb | Thursday | 46.477 | 26.189 | 32.460 | 14.755 | 11.435 | 45.370 | 51.272 | 24.345 | -37.993 | 23.632 | -10.513 | 28.587 | 4.980 | 1.660 | -6.295 | 9.590 | 12.91 |
| 361 | 19-Feb | Friday | 55.330 | 35.780 | 44.633 | 19.550 | 14.386 | 49.428 | 58.650 | 29.878 | -43.342 | 14.078 | -15.123 | 40.575 | 7.746 | 8.853 | -9.836 | 10.328 | 15.49 |
| 362 | 20-Feb | Saturday | | | | | | | | | | | | | | | | | |
| 363 | 21-Feb | Sunday | | | | | | | | | | | | | | | | | |
| 364 | 22-Feb | Monday | 55.330 | 30.985 | 29.878 | 22.870 | 20.288 | 44.264 | 57.912 | 25.452 | -46.108 | 26.362 | -4.795 | 20.288 | 3.873 | 16.599 | -14.558 | 2.582 | 5.16 |
| 365 | 23-Feb | Tuesday | 50.534 | 26.189 | 24.345 | 15.492 | 15.492 | 48.321 | 51.272 | 23.607 | -44.448 | 25.648 | -4.426 | 26.743 | 0.000 | 3.320 | -3.148 | 8.115 | 8.12 |
| 366 | 24-Feb | Wednesday | 50.534 | 29.509 | 25.452 | 18.074 | 15.123 | 47.952 | 52.379 | 28.034 | -38.731 | 20.952 | -5.164 | 28.587 | 4.426 | 3.873 | -4.721 | 9.959 | 12.91 |
| 367 | 25-Feb | Thursday | | | | | | | | | | | | | | | | | |
| 368 | 26-Feb | Friday | 41.682 | 22.870 | 18.443 | 12.173 | 9.590 | 41.313 | 50.903 | 26.189 | -30.247 | 27.198 | -4.426 | 26.743 | 3.873 | 0.553 | -10.230 | 14.017 | 16.60 |
| 369 | 27-Feb | Saturday | 47.952 | 24.714 | 17.337 | 15.492 | 12.173 | 41.313 | 47.952 | 25.083 | -39.100 | 22.759 | -2.582 | 23.054 | 4.980 | 9.959 | -7.082 | 9.590 | 12.91 |
| 370 | 28-Feb | Sunday | | | | | | | | | | | | | | | | | |
| 371 | 01-Mar | Monday | | | | | | | | | | | | | | | | | |
| 372 | 02-Mar | Tuesday | 33.198 | 20.656 | 14.755 | 17.337 | 11.435 | 34.673 | 34.304 | 24.345 | -16.783 | 17.312 | -1.660 | 8.299 | 8.853 | -2.213 | 0.393 | 7.008 | 12.91 |
| 373 | 03-Mar | Wednesday | 41.313 | 23.238 | 19.919 | 18.812 | 17.706 | 39.469 | 40.575 | 23.238 | -29.325 | 21.099 | -1.107 | 11.066 | 1.660 | 2.766 | -1.180 | 4.426 | 5.53 |
| **AVG BATCH No 37** | | | **45.792** | **25.452** | **21.447** | **17.179** | **14.544** | **42.472** | **47.900** | **25.136** | **-34.963** | **23.047** | **-3.452** | **20.683** | **3.952** | **4.980** | **-5.789** | **7.957** | **10.59169** |

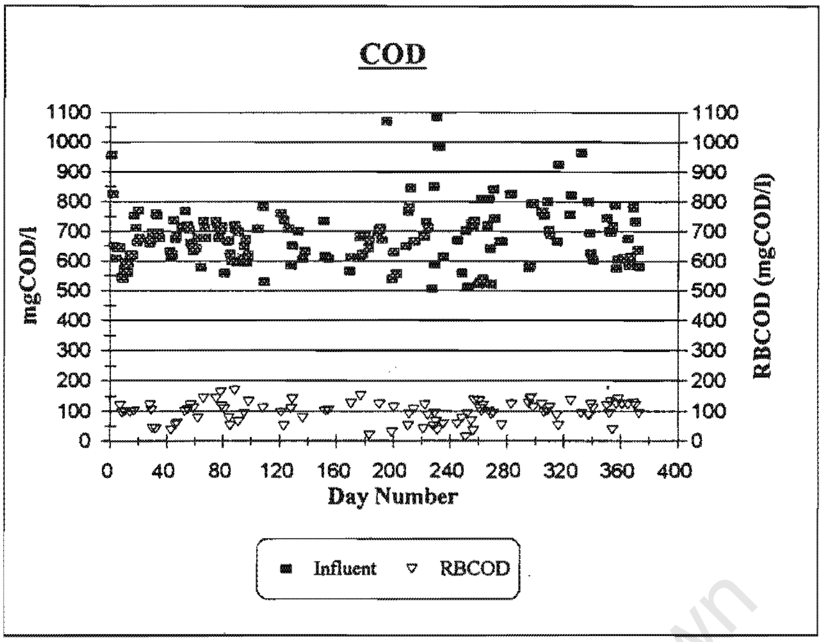


**Figure A1:** Daily unfiltered influent and RBCOD concentrations in BNRAS External Nitrification system.

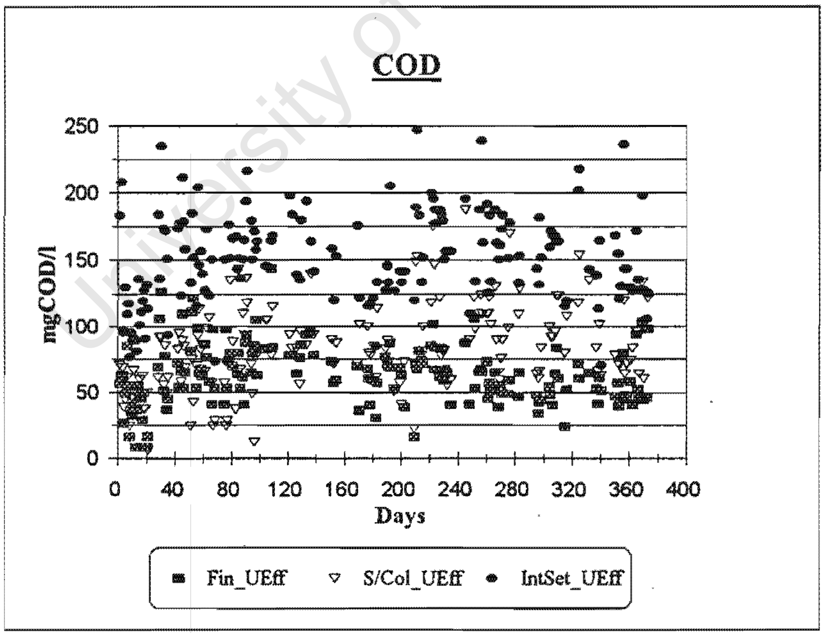


**Figure A2:** Daily unfiltered external nitrifer, internal settler and final effluent COD concentrations in BNRAS External Nitrification system.

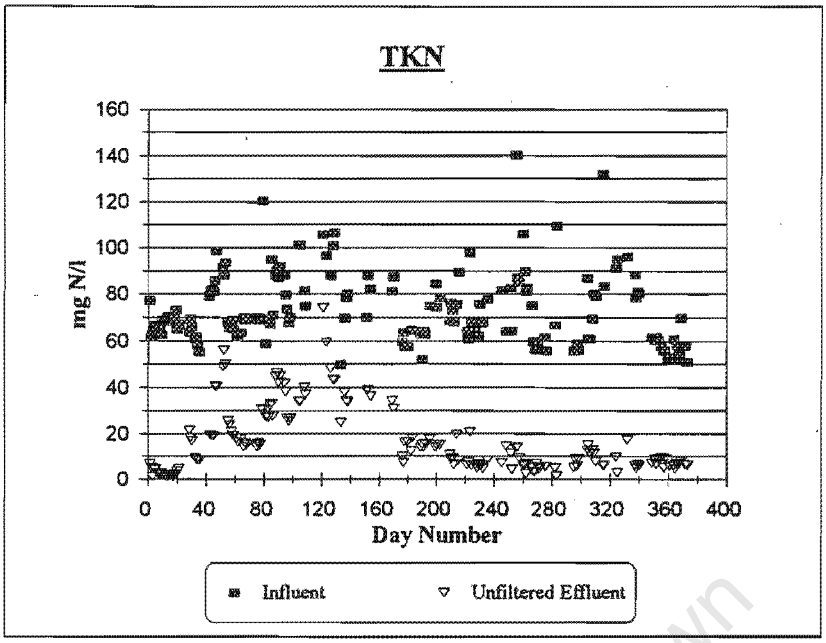


**Figure A3:** Daily unfiltered influent and effluent TKN concentrations in BNRAS External Nitrification system.



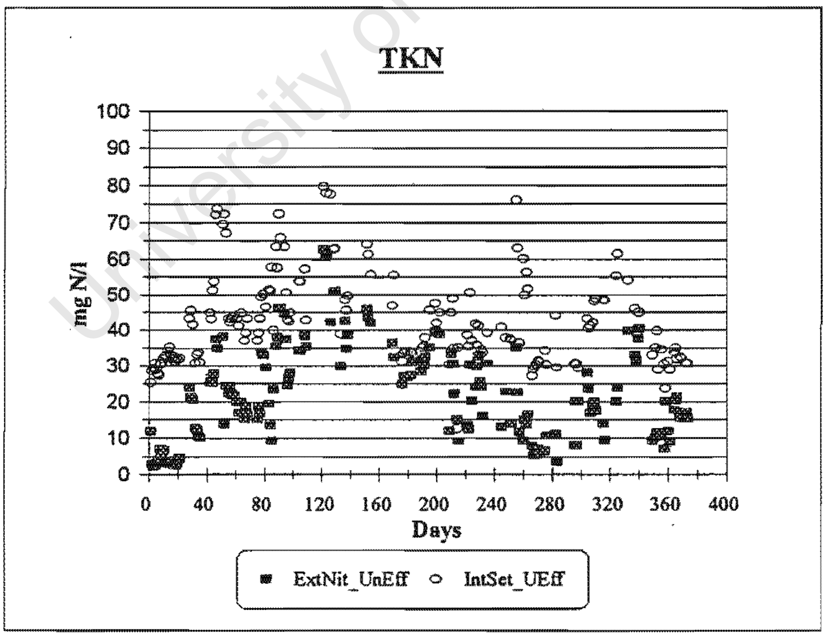


**Figure A4:** Daily unfiltered external nitrifier and internal settler effluent TKN concentrations in BNRAS External Nitrification system.

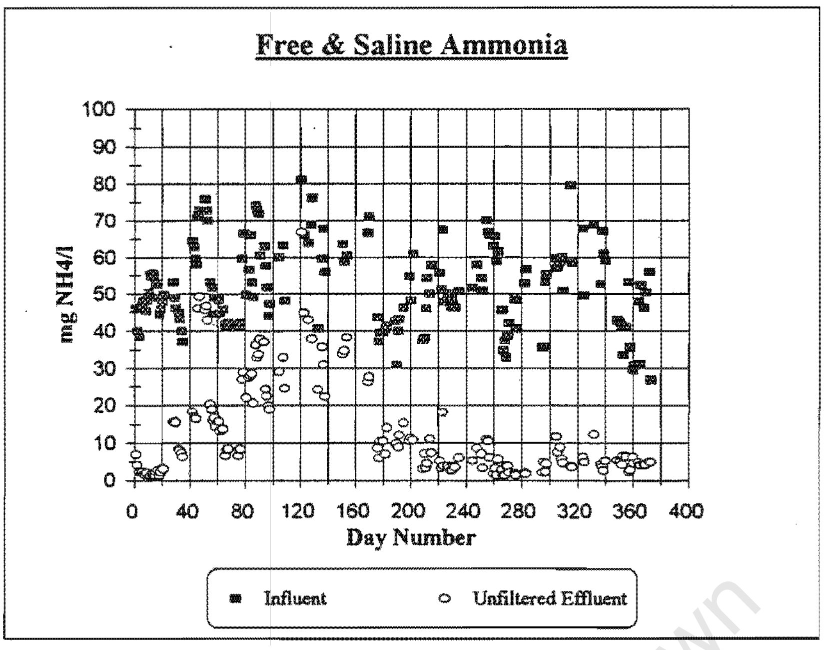


**Figure A5:** Daily unfiltered influent and effluent Ammonia concentrations in BNRAS External Nitrification system.



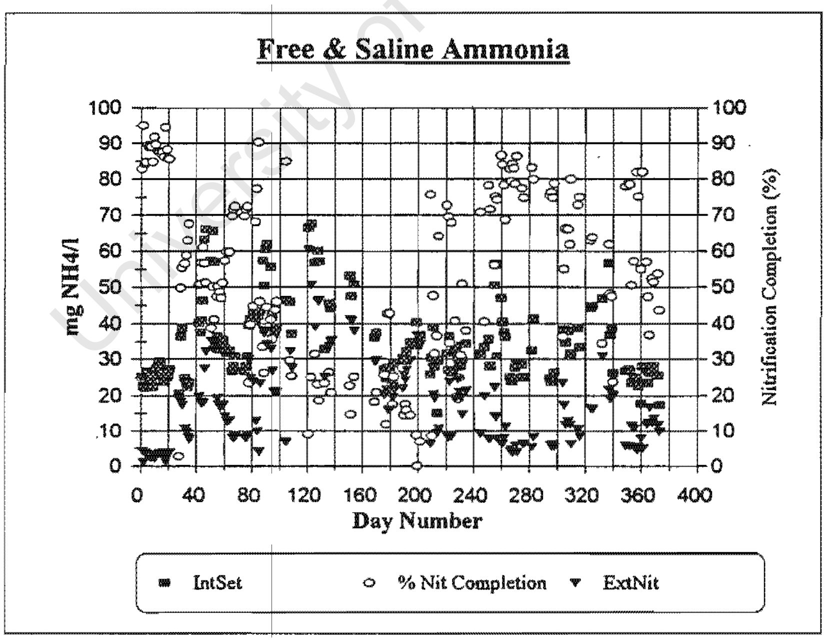


**Figure A6:** Daily unfiltered internal settler and external nitrifier effluent Ammonia concentrations in BNRAS External Nitrification system.

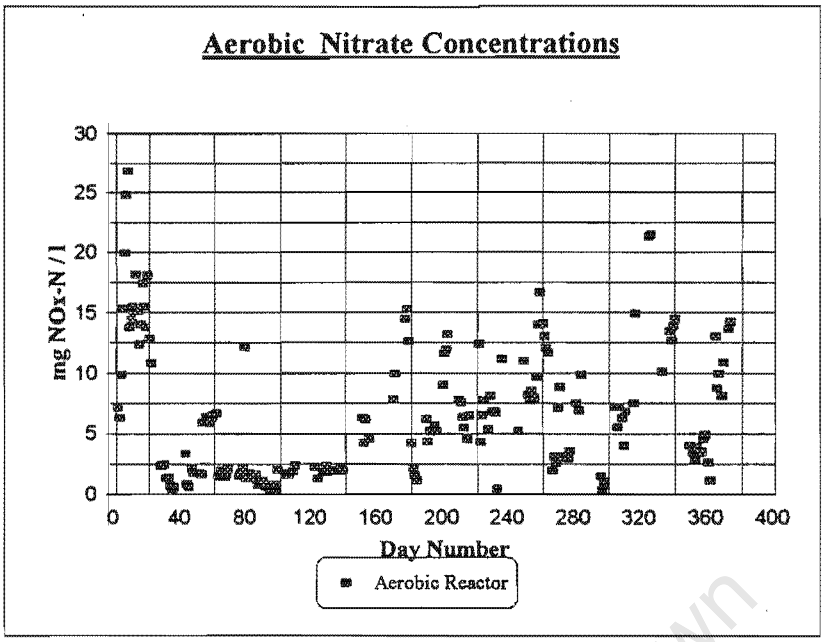


**Figure A7:** Daily filtered aerobic reactor nitrate concentration in BNRAS External Nitrification system.



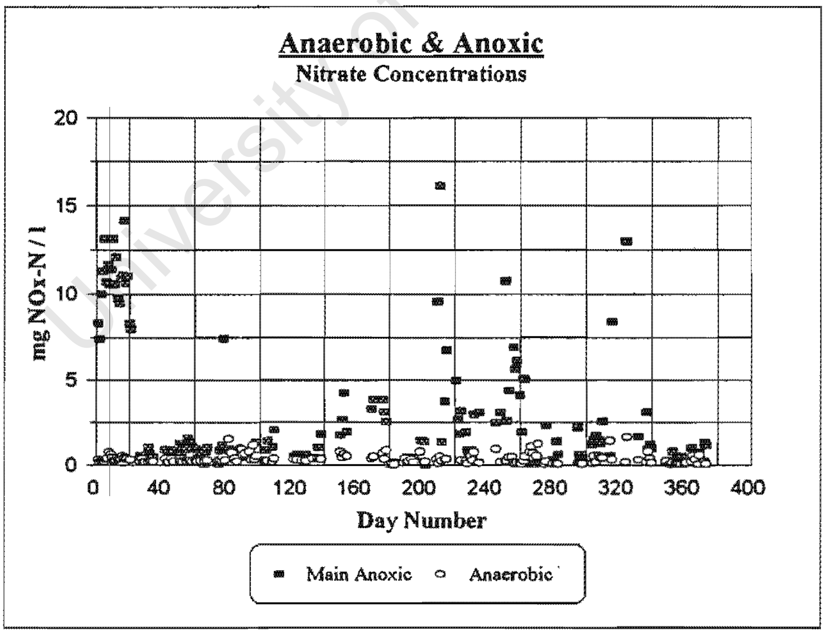


**Figure A8:** Daily filtered anaerobic and main anoxic reactor nitrate plus nitrite concentration in BNRAS External Nitrification system.

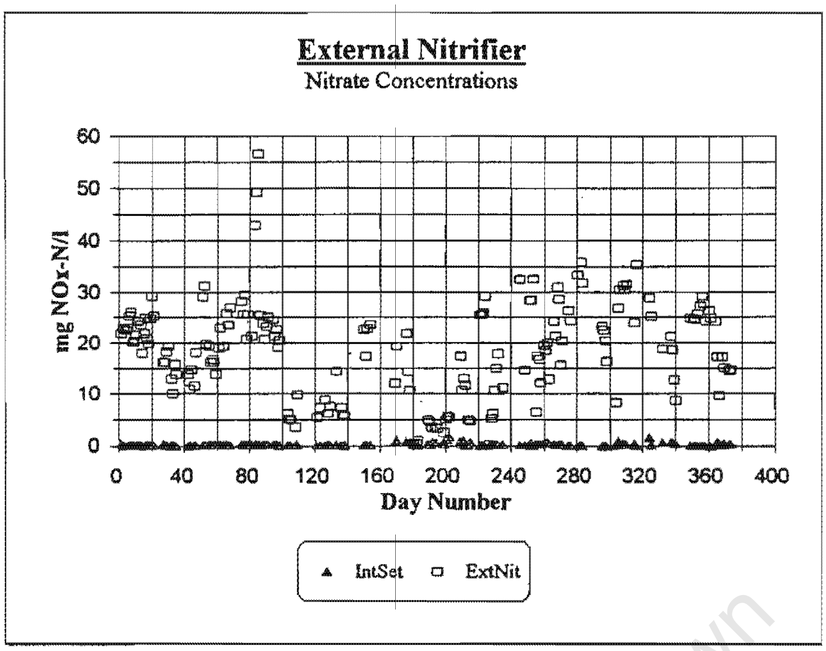


**Figure A9:** Daily filtered external nitrifier and internal settler nitrate concentrations in BNRAS External Nitrification system.



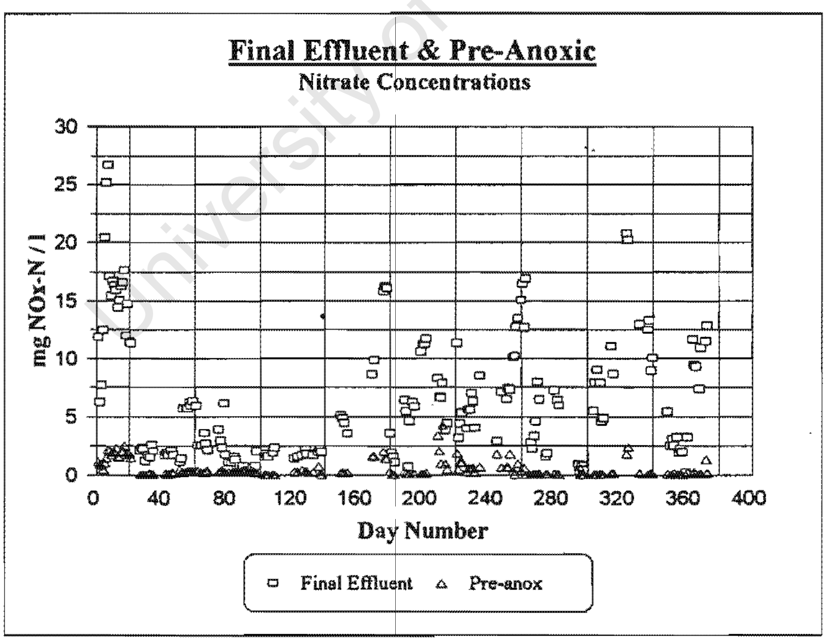


**Figure A10:** Daily filtered pre-anoxic and final effluent nitrate concentrations in BNRAS External Nitrification system.

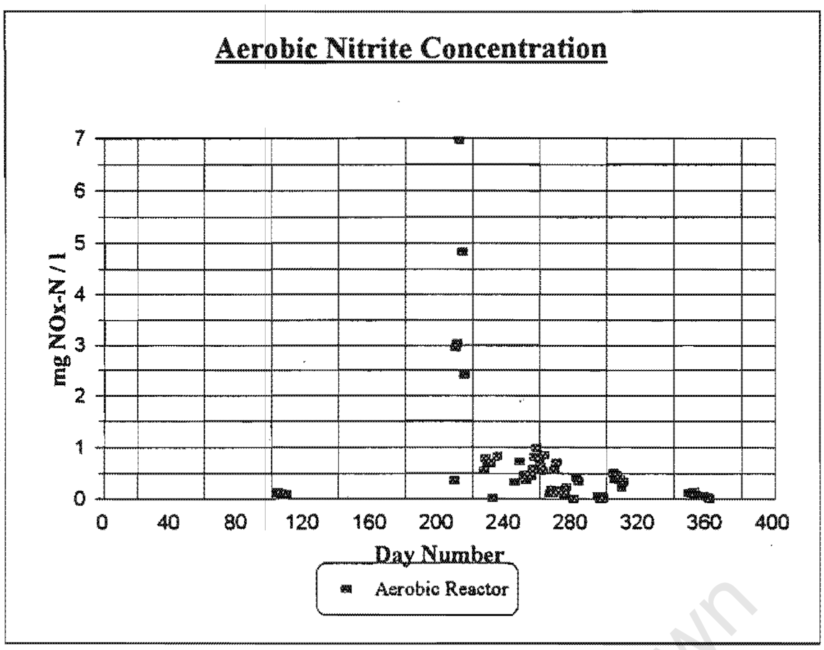


**Figure A11:** Daily filtered aerobic reactor nitrite concentration in BNRAS External Nitrification system.

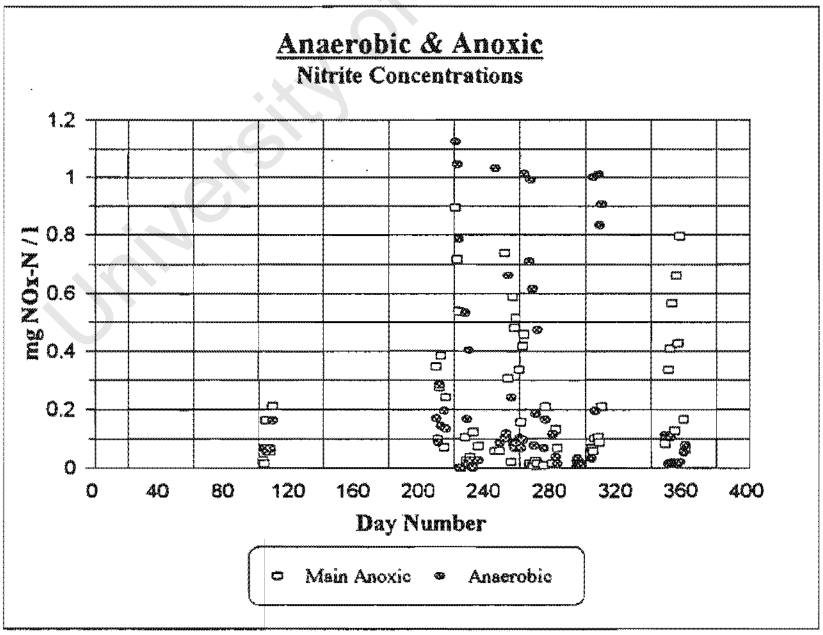


**Figure A12:** Daily filtered anaerobic and main anoxic reactor nitrite concentrations in BNRAS External Nitrification system.

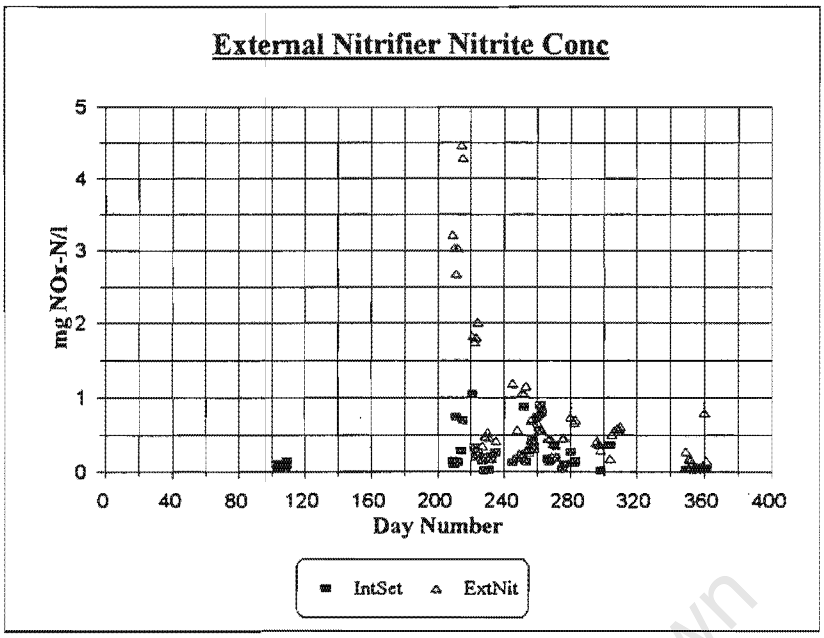


**Figure A13:** Daily filtered external nitrifier and internal settler nitrite concentrations in BNRAS External Nitrification system.

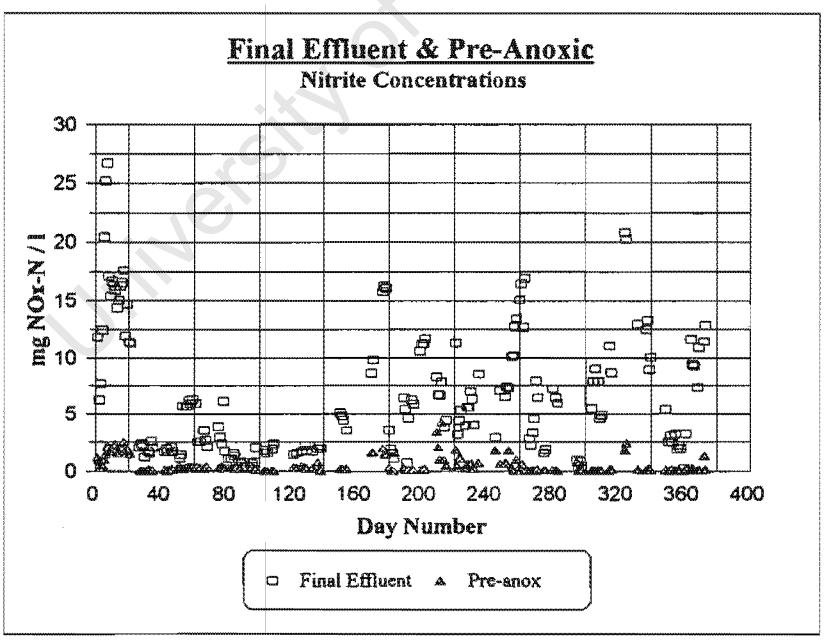


**Figure A14:** Daily filtered pre-anoxic and final effluent nitrite concentrations in BNRAS External Nitrification system.

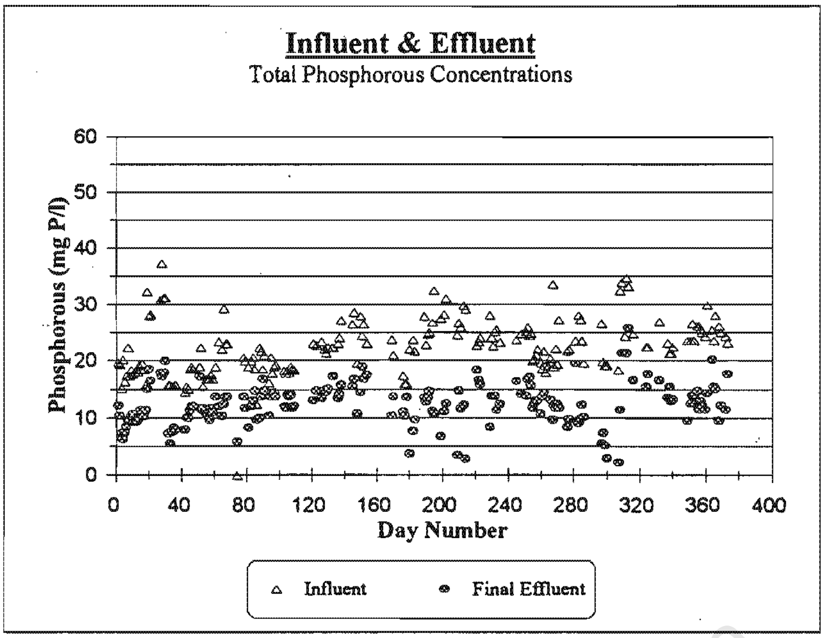


Figure A15: Daily unfiltered influent and final unfiltered effluent Total P concentration in BNRAS External Nitrification system.

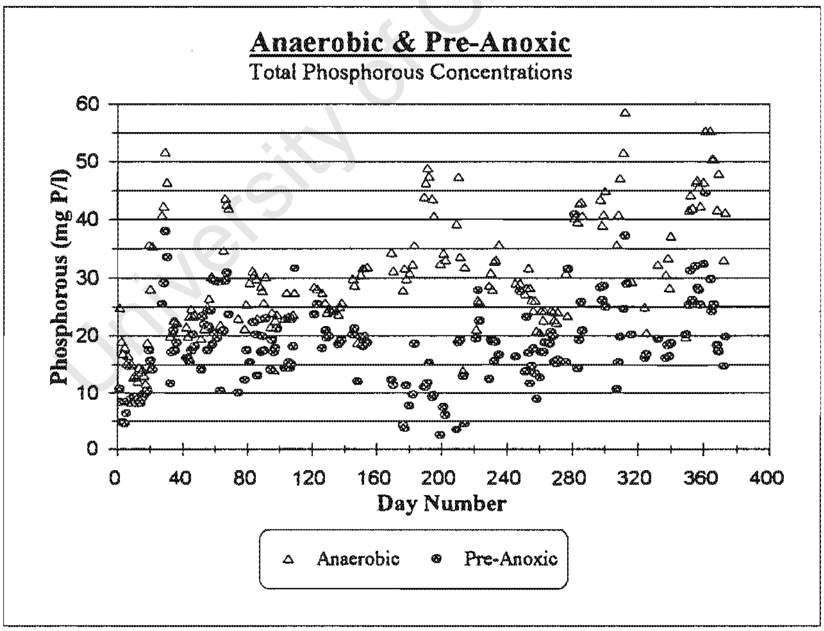


Figure A16: Daily filtered anaerobic and pre-anoxic Total P concentrations in BNRAS External Nitrification system.

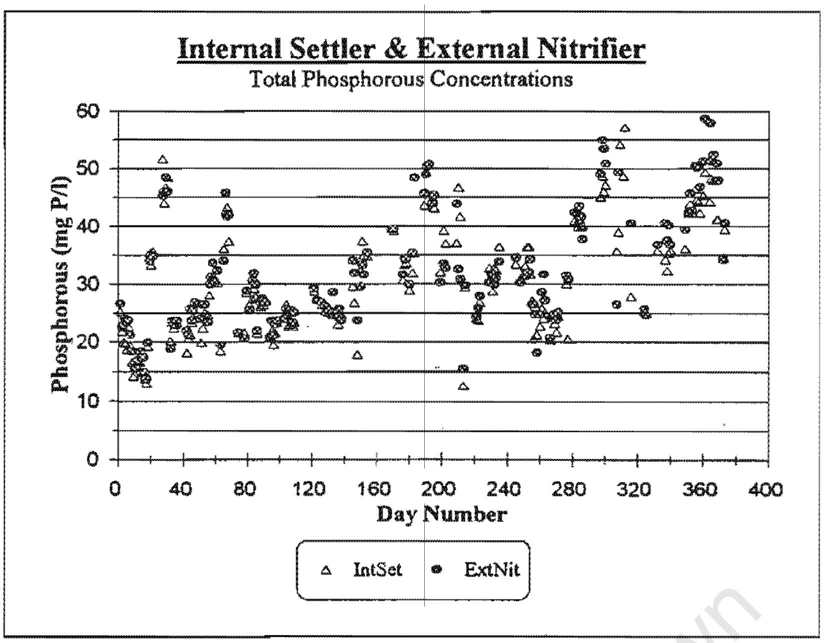


**Figure A17:** Daily filtered internal settler and external nitrifier Total P concentrations in BNRAS External Nitrification system.



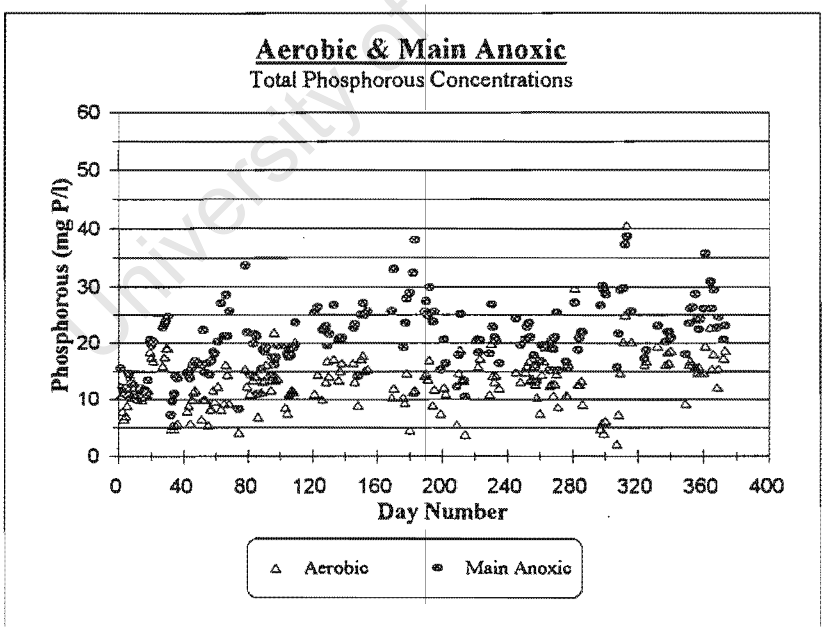


**Figure A18:** Daily filtered aerobic and main anoxic Total P concentrations in BNRAS External Nitrification system.

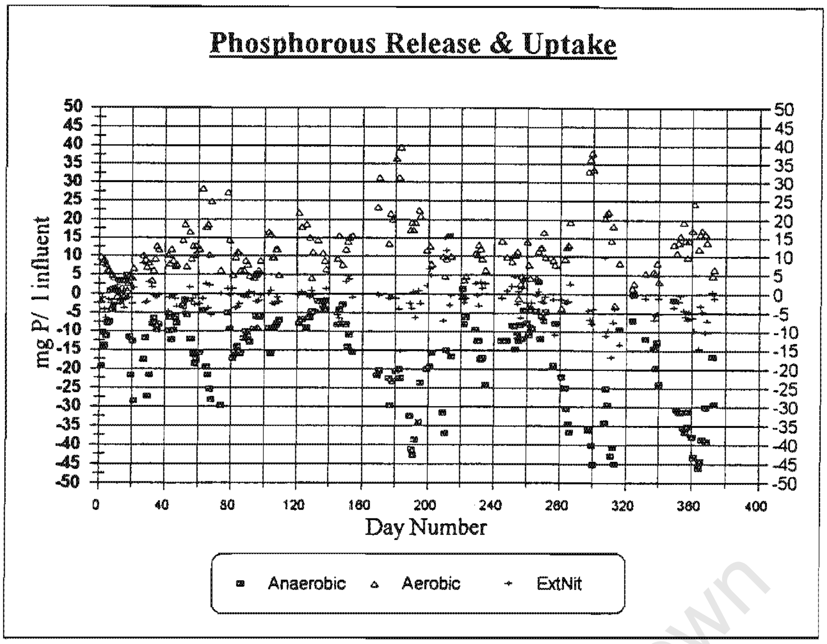


**Figure A19:** Daily filtered anaerobic, aerobic and external nitrifier Total P mass balance in BNRAS External Nitrification system.

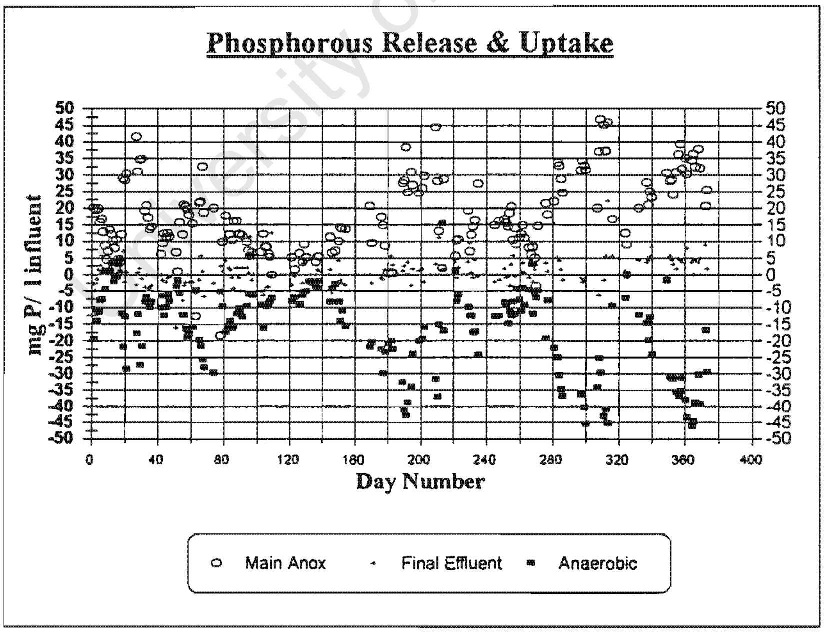


**Figure A20:** Daily filtered anaerobic, main anoxic and final effluent Total P mass balance in BNRAS External Nitrification system.

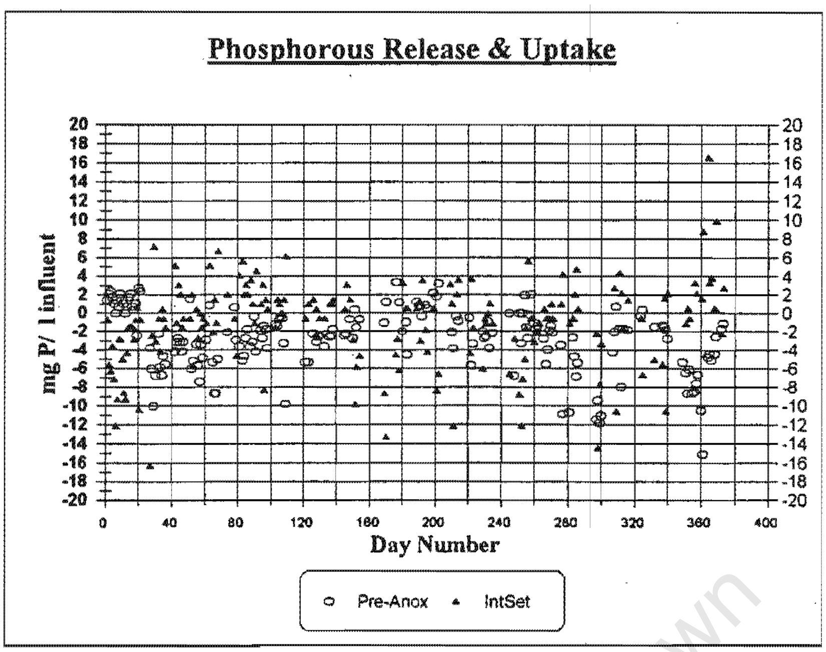


**Figure A21:** Daily filtered anaerobic, main anoxic and final effluent Total P mass balance in BNRAS External Nitrification system.

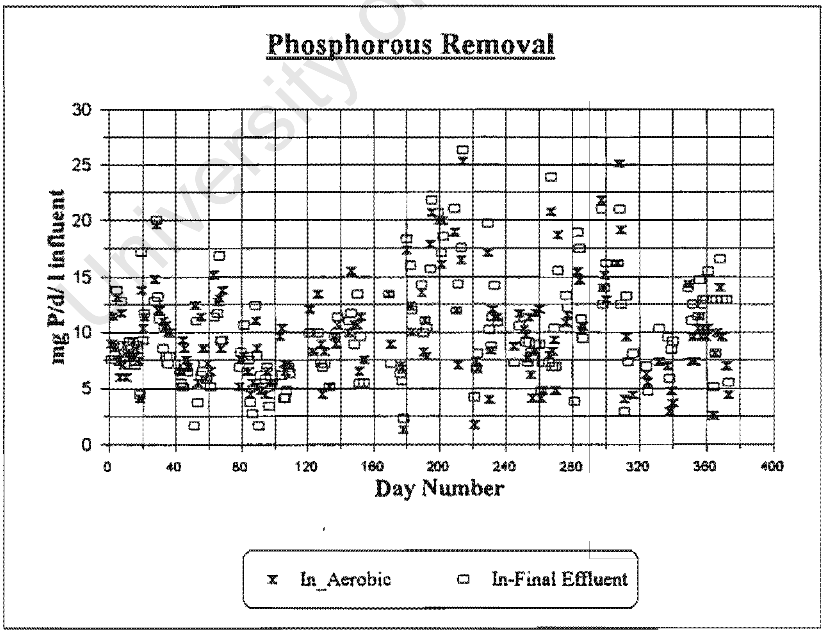


**Figure A22:** Daily Total P removal in BNRAS External Nitrification system.

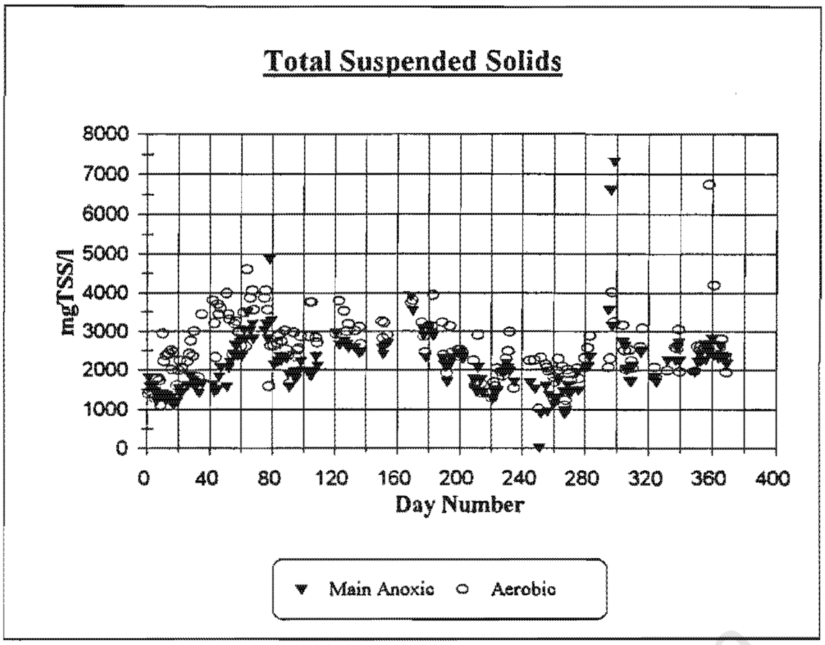


**Figure A23:** Daily aerobic and main anoxic Total Suspended Solids concentrations in BNRAS External Nitrification system.

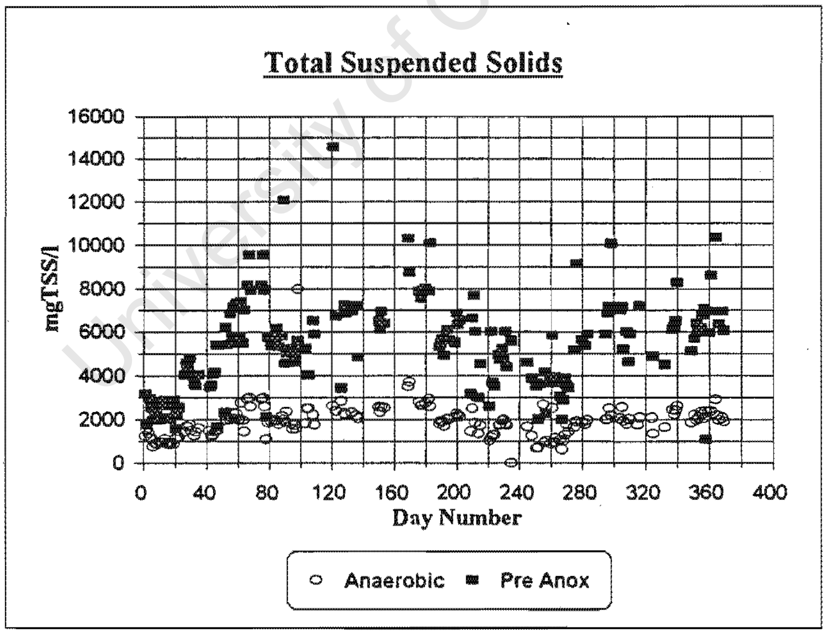


**Figure A24:** Daily anaerobic and pre-anoxic Total Suspended Solids concentrations in BNRAS External Nitrification system.

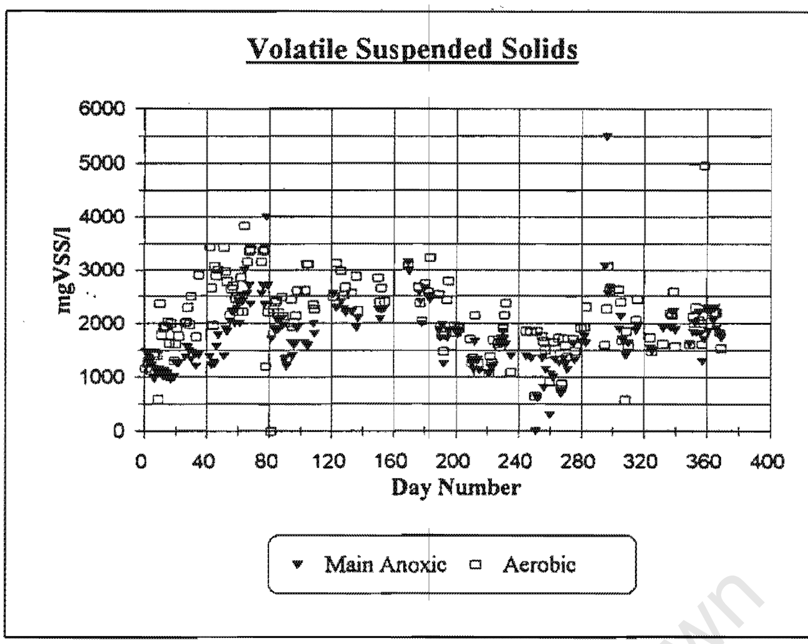


**Figure A25:** Daily aerobic and main anoxic Volatile Suspended Solids concentrations in BNRAS External Nitrification system.

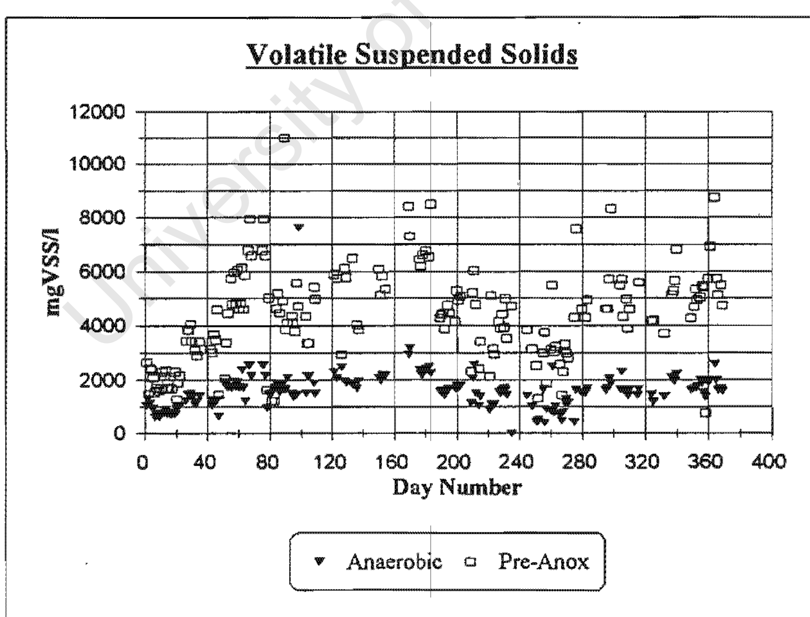


**Figure A26:** Daily anaerobic and pre-anoxic Volatile Suspended Solids concentrations in BNRAS External Nitrification system.

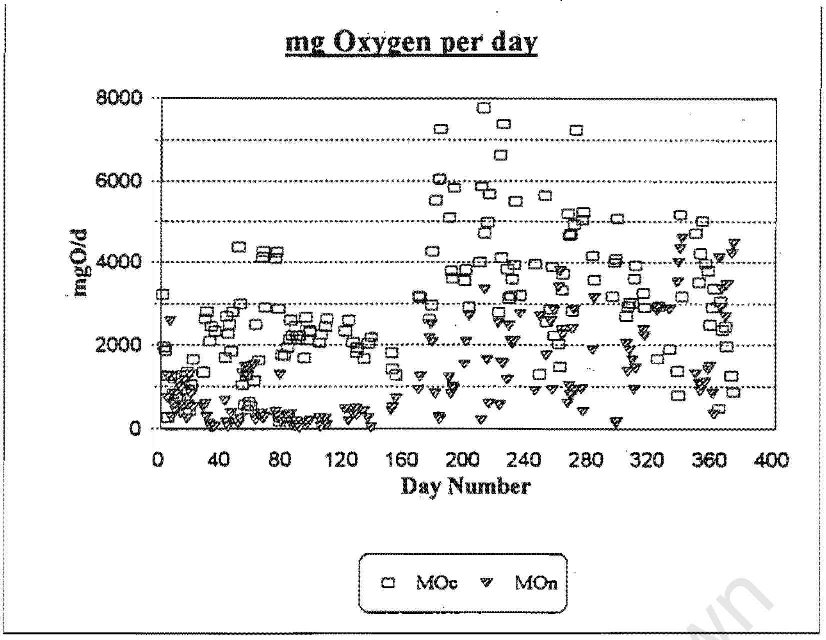


Figure A27: Daily carbonaceous and nitrification oxygen demand in BNRAS External Nitrification system.



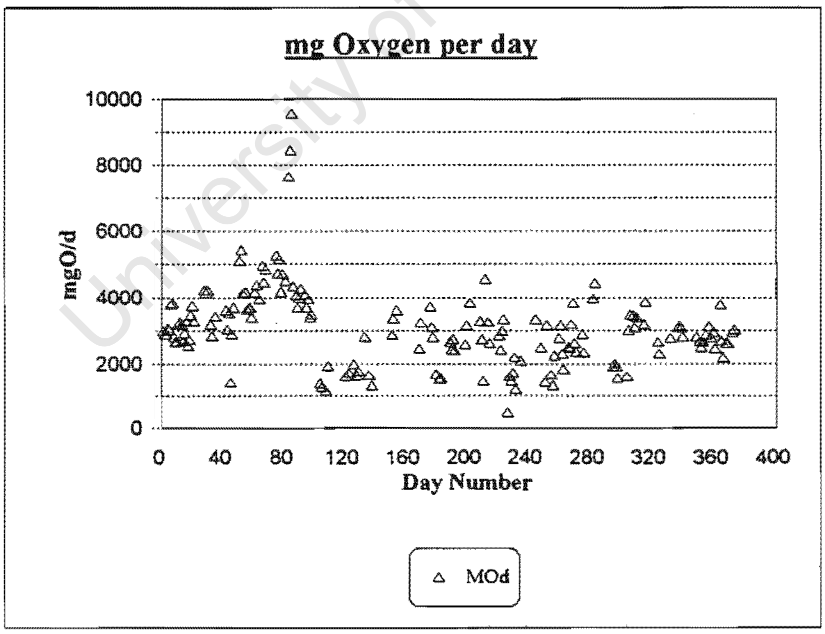


Figure A28: Daily denitrification oxygen recovery in BNRAS External Nitrification system.

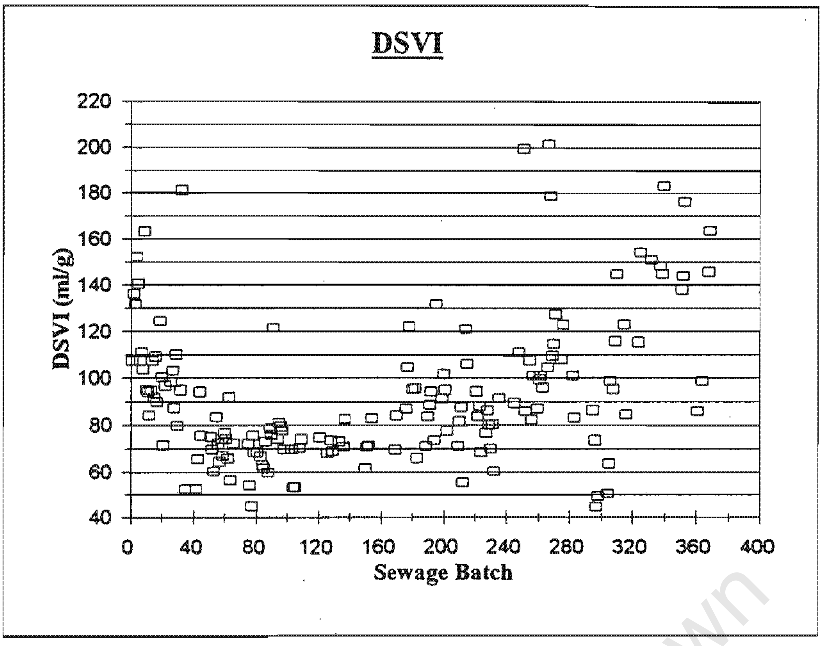


**Figure A29:** Daily aerobic reactor Diluted Sludge Volume Index in BNRAS External Nitrification system.

# APPENDIX B

- Nitrogen Mass Balance.
- COD Mass Balance.

# APPENDIX B

# NITROGEN AND COD MASS BALANCES

In order to test the accuracy of the measured system response data, nitrogen and COD mass balances were performed on the system. These are discussed in detail and illustrated by an example using the data of sewage batch 32 of the external nitrification BNRAS system (see Table B1 and B2 below).

## 1. NITROGEN MASS BALANCE

The daily mass of nitrogen that enters the laboratory system in the form of the influent TKN and nitrate dose should be accounted for as follows:

- i) Nitrogen that is denitrified.
- ii) Nitrogen in the waste sludge.
- iii) Nitrogen utilized in the external nitrification system.
- iv) Nitrogen in the effluent i.e. TKN plus nitrate and nitrite.

### 1.1 Mass of Nitrate Denitrified

In the external nitrification BNRAS system configuration (see figure 3.1) the mass of the nitrogen denitrified is calculated by carrying out a mass balance around the pre-anoxic, anaerobic and main anoxic reactors. If significant amounts of nitrite were generated it would have been necessary to split the nitrate and nitrite in order to produce an accurate calculation particularly for the COD mass balance. Howerver, as there were no large amounts of nitrite produced during this investigation, the nitrate and nitrite can be added together and is indicated by the symbol $NO_x$.

The mass of nitrate and nitrite denitrified in the pre-anoxic, anaerobic, main anoxic reactors and final settler was calculated in the following way:

Mass of $NO_x$ denitrified in the pre-anoxic reactor:

$$MNO_{xd\ pre\text{-}anox} = s.Q.(NO_2 + NO_3)_{eff} - (s).Q.(NO_2 + NO_3)_{pre\text{-}anox} \qquad (mg\ NO_x\text{-}N/d)$$

Mass of $NO_x$ denitrified in the anaerobic reactor:

$MNO_{xd\ anear}$ = $s.Q.(NO_2 + NO_3)_{pre\text{-}anox}$ - $(1+s).Q.(NO_2 + NO_3)_{anaer}$ (mg $NO_x$-N/d)

Mass of $NO_x$ denitrified in the main anoxic reactor:

$MNO_{xd\ anox}$ = $q.Q.(NO_2 + NO_3)_{Ext}$ + $n.Q(NO_3)_{dose}$ + $a.Q.(NO_2 + NO_3)_{aer}$ $(1+s-q).(NO_2 + NO_3)_{IntSet}$ - $(1+s+n+a).Q.(NO_2 + NO_3)_{anox}$ (mg $NO_x$-N/d)

And mass of $NO_x$ denitrified in the final settler

$MNO_{xd\ Set}$ = $(1+s).Q.(NO_2+NO_3)_{aer}$ - $Q.(NO_2+NO_3)_{eff}$ - $s.Q.(NO_2+NO_3)_{eff}$ (mg $NO_x$-N/d)

where: $MNO_{xd}$ = mass of nitrite and nitrate denitrified in the pre-anoxic, anaerobic, or main anoxic reactor respectively per day (mg $NO_x$-N/d)

pre-anox = indicates $NO_x$ concentration in pre-anoxic reactor

anaer = indicates $NO_x$ concentration in pre-anoxic reactor

anox = indicates $NO_x$ concentration in main anoxic reactor

aer = indicates $NO_x$ concentration in aerobic reactor

eff = indicates $NO_x$ concentration in effluent

Ext = indicates $NO_x$ concentration in external nitrifier

IntSet = indicates $NO_x$ concentration in internal settling tank

a,s = recycle ratios equal to 2 and 1 respectively

q,n = flow ratios of external nitrifier and nitrate dose respectively

Substituting the appropriate average values for steady state 36 of the external nitrification BNRAS system you get

$MNO_{xd\ pre\text{-}anox}$ = 0.5*30.(0.03 + 2.89) - 0.5*30.(0.05 + 0.08)

= 42 mgNOx-N/d

$MNO_{xd\ anear}$ = 0.5*30.(0.05 + 0.08) - (1+0.5).30.(0.04 + 0.10)

= -0.3 (here set to zero) mgNOx-N/d

$MNO_{xd\ anox}$ = 1.07*30.(0.13 + 26.05) + 0 + 1*30(0.09 + 3.82) + (1+0.5-1.07).30.(0.03 + 0.13) - (1+0.5+0+1).30.(0.43 + 0.37)

| | | | |
|---|---|---|---|
| | = | 896 | mgNOx-N/d |
| MNOxd Set | = | (1+0.5).30.(0.09 + 3.82) - 30.(0.03 + 2.89) - 0.5*30.(0.03 + 2.89) | |
| | = | 45 | mgNOx-N/d |

Therefore the total mass of nitrate and nitrite ($NO_x$) denitrified

$MNO_{xd}$ = $MNO_{xd\ pre\text{-}anox} + MNO_{xd\ anear} + MNO_{xd\ Set} + MNO_{xd\ anox}$

= 42 + 0 + 45 + 896

= 983 mgNOx-N/d

## 1.2 Nitrogen in Waste Sludge

The mass of N in the waste sludge is given by the product of the TKN/VSS ratio ($f_n$) and the mass of VSS wasted per day.

$MX_n$ = $f_n.MX_v + Qws.(NO_2+NO_3)_{aer}$

where: $f_n$ = (215.4)/(2332.75) = 0.09 and Qws = 20/10 = 2 l/d

Substituting the appropriate values gives

$MX_n$ = 0.09*(2.2332.75) + 2.(0.09 + 3.82)

= 438 (mg N/d)

## 1.3 Mass of Nitrogen Utilized in External Nitrifier

The mass of nitrogen utilized in the external nitrifier is the product of the flow to the external nitrifier and the difference in the nitrate, nitrite and TKN concentrations entering and leaving the external nitrifier:

$MN_{Ext}$ = $q.Q[(NO_2 + NO_3 + TKN)_{IntSet} - (NO_2 + NO_3 + TKN)_{Ext}]$

= 1.07*30[(0.03 +0.13 +32.19) - (0.13 +26.05 +11.57)]

= - 172.8 (here set to zero) (mg N/d)

## 1.4 Mass of Nitrogen in Effluent

The mass of N in the effluent is the product of the daily flow rate and the sum of the effluent TKN, nitrate and nitrite concentrations:

$MN_{eff}$ = $Q.(N_{te} + NO_{2\ eff} + NO_{3\ eff})$

= 30.(7.98 + 0.03 + 2.89)

= 327 (mg N/d)

1.5 Nitrogen Mass Balance

The % N mass balance is then given by:

% N Balance = $100.(MNO_{xd} + MX_n + MN_{Ext} + MN_{eff}) / (_{Mnti})$

where: $MN_{ti}$ is the mass of TKN in the influent given by the product of the influent TKN concentration and the daily flow rate ($MN_{ti} = N_{ti}.Q$)

Substituting the values calculated above:

% N Balance = 100.(983 + 438 + 0 + 327)/ (59.06*30)

= 99 %

## 2. COD MASS BALANCE

The daily mass of COD ($MS_{ti}$) that enters the system should be accounted by:

i) The mass oxygen demand required per day for degradation of carbonaceous material in the aerobic reactor.

ii) The equivalent mass oxygen demand per day by denitrification of nitrate and nitrite.

iii) The COD utilized in the external nitrifier.

iv) The COD mass in the waste sludge.

v) The COD mass in the effluent.

2.1 Carbonaceous Oxygen Demand

The total amount of oxygen utilized in the aerobic reactor is made up of the nitrification oxygen demand and the carbonaceous oxygen demand. Since nitrification, if any, does not consume any of the influent COD, the oxygen demand due to nitrification must be subtracted from the total measured oxygen demand. Stoichiometrically, the oxygen requirements for nitrification of ammonia to nitrite (by *nitrosomonas*) and to nitrate (by both *nitrosomonas* and *nitrobacter*) is different with the former being slightly less (i.e. 3.43 mgO/mgN and 4.57 mgO/mgN generated from ammonia). As already stated however, there was never excessive nitrite build up in the system which meant that the nitrite could be added to the nitrate and called $NO_x$. The calculation for the carbonaceous oxygen demand is as follows:

Provided that the nitrogen mass balance is acceptable, the mass of nitrogen generated in the systems $MS_{no}$ is found by calculating the mass balance of $NO_x$ around the aerobic reactor.

$MS_{no}$ = $MNO_{x\,aer}$

= $(1 + s + n + a).Q.[(NO_2 + NO_3)_{aer} - (NO_2 + NO_3)_{anox}]$

Substituting the appropriate values for sewage batch 29 of the external nitrification BNRAS system:

= $(1 + 0.5 + 0 + 1).30[(0.09 + 3.82) - (0.43 + 0.37)]$

= 259 mgN/d

From the mass of nitrate generated, the nitrification oxygen demand ($MO_n$) is given by:

$MO_n$ = $4.57.(MS_{no})$

= 4.57.(259)

= 1182 mgO/d

where: 4.57 is the mass of oxygen utilized per mg $NH_4$-N nitrified.

From the measured OUR (mgO/l/h) the mass carbonaceous oxygen demand is given by:

$MO_c$ = $(OUR).V_a.(24) - MO_n$

where Va is the volume of the aerobic reactor (l)

= 35.89*24*6 - 1182

= 3986 mgO/d

2.2 <u>Equivalent Oxygen Demand for Denitrification</u>

The equivalent oxygen demand for denitrification Mod is given by:

$MO_d$ = $2.86(MNO_{xd})$

= 2.86.(983)

= 2810 mgO/d

## 2.3 Mass of COD Utilized in the External Nitrifier

The COD utilized in the external nitrifier $MS_{Ext}$ is given by the product of the flow to the external nitrifier and the difference in the COD concentrations entering and leaving the external nitrifier:

| | | | |
|---|---|---|---|
| $MS_{Ext}$ | = | $q.Q(COD_{IntSet} - COD_{Ext})$ | |
| | = | 1.07*30(159.37 - 77.05) | |
| | = | 2634 | mgCOD/d |

## 2.4 Mass of COD in Waste Sludge

The COD of the waste sludge mass is given by the COD/VSS ratio times the mass of VSS wasted per day i.e.

| | | | |
|---|---|---|---|
| $MS_{ws}$ | = | $f_{cv}.(MX_v)$ | |
| where: $f_{cv}$ | = | (3056.8)/(2332.75) = 1.31 | |
| $MS_{ws}$ | = | 1.31* (2.2332.75) | |
| | = | 6113.6 | mgCOD/d |



## 2.5 Mass of COD in Effluent

The mass of COD in the effluent MSte is given by:

| | | | |
|---|---|---|---|
| $MS_{te}$ | = | $Q.S_{te}$ | |
| | = | 30.(52.69) | |
| | = | 1580.8 | mgCOD/d |

## 2.6 COD Mass Balance

The % COD mass balance is then given by:

% COD Balance = $100(MO_c + MO_d + MS_{Ext} + MSws + MS_{te})/MS_{ti}$

where: MSti is the total COD mass fed to the system.

Substituting the values calculated above:

% COD Balance = 100(3986 + 2810 + 2634 + 6114 + 1581)/(704*30)

= 81 %

| Average of Sewage Batch | Nitrogen Mass Balance | | | | | | | | | | | | | Carbonaceous Mass Balance | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NO3 Dosage mgNO3/d | Nitrate recy mgN/l | NO3 denit Aox mgN/d | NO3 denit ax mgN/d | NO3 denit Ae | NO3 denit se mgN/d | Tot Denit (mgN/d) | N in Waste (mgN/d) | N in Eff (mgN/d) | TKN Lost (mgN/d) | Tot TKN Leaving | Inf TKN mgN/d | MB % (mgN/d) | Influent mgCOD | Effluent mgCOD | Waste mgCOD | ExtNit mgCOD us | Oxygen mgO/d | MOd Recov mgO/d | MOc mgO/d | MOn mgO/d | MOt mgO/d | COD leavin mgCOD | MBCOD % | OUR mgO/l/h |
| 1 | 500 | | 838 | 153 | 9 | | 1000 | 279 | 262 | | 1541 | 1845 | 84 | 16200 | 1212 | 3886 | 2535 | 2376 | 2859 | 2376 | 0 | 5235 | 12868 | 79 | 33 |
| 2 | 500 | | 726 | 316 | 19 | | 1061 | 361 | 397 | 162 | 1982 | 1849 | 107 | 12236 | 810 | 4835 | 1670 | 1656 | 3035 | 633 | 1023 | 3668 | 10983 | 90 | 23 |
| 3 | 500 | | 869 | 212 | 21 | 60 | 1161 | 408 | 312 | 111 | 1992 | 1878 | 106 | 14104 | 414 | 7155 | 2513 | 1800 | 3321 | 998 | 802 | 4319 | 14401 | 102 | 25 |
| 4 | 550 | | 1401 | 39 | | 10 | 1450 | 341 | 833 | 214 | 2837 | 3204 | 89 | 26981 | 4033 | 9641 | 3178 | 2736 | 4146 | 2262 | 474 | 6408 | 25260 | 94 | 38 |
| 5 | 500 | | 1124 | 37 | | | 1160 | 478 | 425 | 385 | 2448 | 2856 | 86 | 28861 | 2105 | 6298 | 4241 | 2362 | 3319 | 2321 | 41 | 5640 | 18284 | 63 | 33 |
| 6 | 500 | | 1128 | 34 | | | 1162 | 821 | 838 | 448 | 3268 | 3737 | 87 | 26009 | 3021 | 9730 | 4523 | 2513 | 3323 | 2313 | | 5835 | 23108 | 89 | 35 |
| 7 | 500 | | 1463 | 26 | | 12 | 1501 | 734 | 1865 | 835 | 4935 | 4146 | 119 | 27838 | 3109 | 5779 | 4526 | 3200 | 4293 | | 245 | 7248 | 20662 | 74 | 44 |
| 8 | 500 | | 1239 | 97 | | 4 | 1360 | 642 | 1050 | 182 | 3233 | 2961 | 109 | 26824 | 3065 | 10764 | 2902 | 2275 | 3889 | 1127 | 1148 | 5016 | 21746 | 81 | 32 |
| 9 | 500 | | 1615 | 50 | | | 1665 | 572 | 714 | | 2951 | 3281 | 90 | 28288 | 2557 | 10608 | 3182 | 4066 | 4761 | 3774 | 291 | 8535 | 24882 | 88 | 56 |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 500 | | 2089 | 43 | | 21 | 2153 | 458 | 1108 | | 3720 | 3558 | 105 | 26903 | 2840 | 8375 | 3481 | 2712 | 6158 | 2318 | 394 | 8477 | 23174 | 86 | 38 |
| 12 | 250 | | 1351 | 8 | | 5 | 1364 | 533 | 1465 | | 3362 | 3481 | 97 | 25861 | 2940 | 7190 | 4339 | 2324 | 3901 | 2270 | 54 | 6171 | 20640 | 80 | 32 |
| 13 | 250 | | 470 | 39 | | | 510 | 644 | 1538 | 536 | 3228 | 3834 | 84 | 27285 | 3942 | 9541 | 2760 | 2513 | 1458 | 2356 | 156 | 3814 | 20056 | 74 | 35 |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | 250 | | 539 | 24 | | 16 | 579 | 746 | 1844 | 265 | 3435 | 2947 | 117 | 29920 | 3120 | 10125 | 5100 | 2804 | 1657 | 2480 | 325 | 4137 | 22482 | 75 | 39 |
| 17 | 250 | | 686 | 31 | | 8 | 725 | 714 | 1358 | 234 | 3031 | 3009 | 101 | 26440 | 3200 | 8700 | 4100 | 2282 | 2073 | 1886 | 397 | 3958 | 19958 | 75 | 32 |
| 18 | 250 | | 493 | 35 | | 0 | 528 | 518 | 1499 | 158 | 2704 | 3293 | 82 | 24800 | 3480 | 8750 | 1800 | 2232 | 1511 | 2028 | 204 | 3539 | 17569 | 71 | 31 |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 500 | | 1076 | 65 | | 37 | 1177 | 557 | 1280 | | 3015 | 2902 | 104 | 19584 | 1897 | 8330 | 1958 | 2074 | 3367 | 1343 | 730 | 4710 | 16896 | 86 | 29 |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 500 | | 900 | 114 | 3 | | 1017 | 275 | 1260 | 75 | 2628 | 3028 | 87 | 17640 | 1590 | 8220 | 2170 | 4248 | 2908 | 3159 | 1089 | 6067 | 18047 | 102 | 30 |
| 23 | 500 | | 687 | 110 | | | 797 | 502 | 641 | | 1940 | 2334 | 83 | 19557 | 1572 | 6697 | 1011 | 6192 | 2280 | 4978 | 1214 | 7257 | 16537 | 85 | 43 |
| 24 | 500 | 159 | 773 | 71 | | 18 | 862 | 325 | 604 | 97 | 1888 | 2398 | 79 | 23079 | 2145 | 6475 | 2502 | 5616 | 2464 | 4604 | 1012 | 7068 | 18190 | 79 | 39 |
| 25 | 500 | 343 | 940 | 166 | | 8 | 1114 | 325 | 778 | 70 | 2287 | 2867 | 80 | 17238 | 1704 | 6003 | 2887 | 5616 | 3187 | 3489 | 2127 | 6676 | 17269 | 100 | 39 |
| 26 | 500 | 265 | 883 | 115 | | 44 | 1042 | 266 | 518 | | 1825 | 2429 | 75 | 21858 | 1913 | 4429 | 2360 | 6469 | 2980 | 5938 | 511 | 8938 | 17640 | 81 | 45 |
| 27 | | 196 | 579 | 80 | | 42 | 701 | 335 | 410 | | 1446 | 2091 | 69 | 23403 | 2227 | 5088 | 2180 | 6028 | 2005 | 4502 | 1526 | 6507 | 16002 | 68 | 42 |
| 28 | | 259 | 688 | 88 | | 105 | 882 | 323 | 482 | | 1686 | 2221 | 76 | 18360 | 1971 | 5173 | 940 | 4962 | 2053 | 3512 | 1450 | 6033 | 14117 | 77 | 34 |
| 29 | | 353 | 521 | 196 | | | 718 | 303 | 677 | 754 | 2452 | 2876 | 85 | 19619 | 1819 | 4715 | 1996 | 5402 | 2522 | 2672 | 2730 | 4725 | 13255 | 68 | 38 |
| 30 | | 175 | 872 | 58 | | 19 | 949 | 297 | 272 | | 1518 | 1817 | 84 | 21013 | 1573 | 5059 | 2283 | 6244 | 2714 | 4990 | 1254 | 7704 | 16618 | 79 | 43 |
| 31 | | 251 | 1293 | 99 | | 72 | 1464 | 362 | 300 | | 2126 | 2640 | 81 | 24713 | 1670 | 6193 | 777 | 6394 | 4186 | 3893 | 2501 | 8079 | 16719 | 68 | 44 |
| 32 | | 28 | 628 | 6 | | 14 | 648 | 478 | 239 | | 1365 | 1699 | 80 | 20580 | 1260 | 6980 | 2688 | 4165 | 1853 | 4165 | 0 | 6018 | 16946 | 82 | 29 |
| 33 | | 191 | 936 | 111 | | | 1047 | 665 | 561 | | 2273 | 2438 | 93 | 22029 | 1603 | 7497 | 1847 | 4890 | 2995 | 3218 | 1672 | 6213 | 17160 | 78 | 34 |
| 34 | | 528 | 627 | 248 | | | 875 | 763 | 838 | 180 | 2657 | 2821 | 94 | 25394 | 1968 | 5758 | 1665 | 5080 | 2304 | 2202 | 2877 | 4706 | 14096 | 56 | 35 |
| 35 | | 408 | 788 | 166 | | 107 | 1061 | 467 | 514 | | 2042 | 2462 | 83 | 20433 | 1544 | 6272 | 1380 | 6757 | 3035 | 2638 | 4119 | 5673 | 14868 | 73 | 47 |
| 36 | | 116 | 896 | 42 | | 44 | 982 | 439 | 327 | | 1748 | 1772 | 99 | 21128 | 1581 | 6114 | 2634 | 5168 | 2809 | 3986 | 1182 | 6793 | 17124 | 81 | 36 |
| 37 | | 336 | 889 | 122 | | 28 | 1039 | 450 | 453 | | 1942 | 1729 | 112 | 19665 | 1815 | 6700 | 1888 | 5027 | 2972 | 2089 | 2938 | 5061 | 13464 | 79 | 35 |
| Average 1 | 500 | | 811 | 227 | 16 | 20 | 1074 | 349 | 324 | 91 | 1838 | 1857 | 99 | 14180 | 812 | 5292 | 2239 | 1944 | 3072 | 1336 | 608 | 4408 | 12751 | 90 | 27 |
| Averages above are for sewage batches 1 to 3 i.e. Configuration 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 2 | 400 | | 1135 | 39 | | | 1180 | 600 | 1212 | 271 | 3263 | 3359 | 97 | 27168 | 3118 | 8792 | 3844 | 2668 | 3374 | 2303 | 339 | 5731 | 21485 | 79 | 37 |
| Averages above are for sewage batches 4 to 19 i.e. Configuration 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 3 | 500 | 251 | 825 | 115 | 3 | 9 | 947 | 357 | 821 | 61 | 2185 | 2657 | 82 | 19379 | 1753 | 6849 | 2142 | 5418 | 2710 | 4057 | 1361 | 6767 | 17511 | 91 | 38 |
| Averages above are for sewage batches 22 to 25 i.e. Configuration 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 4 | 500 | 255 | 800 | 111 | | 40 | 951 | 429 | 466 | 78 | 1923 | 2250 | 86 | 21516 | 1745 | 5831 | 1887 | 5549 | 2719 | 3652 | 1897 | 6371 | 15834 | 74 | 39 |
| Averages above are for sewage batches 26 to 37 i.e. Configuration 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 5 | 443 | 254 | 938 | 94 | 3 | 22 | 1055 | 481 | 802 | 147 | 2484 | 2700 | 91 | 22620 | 2178 | 7096 | 2688 | 4006 | 3270 | 2927 | 1112 | 5945 | 17907 | 80 | 36 |
| Averages above are for sewage batches 1 to 37 i.e. average over entire investigation | | | | | | | | | | | | | | | | | | | | | | | | | |

# APPENDIX C

- Average Sewage Batch Results of External Nitrification System.
- fS,up and fXBG,P Calculations for each Sewage Batch

| Average of Sewage Batch | Carbonaceous Oxygen Demand Sys. Inf mgCOD/l | Reactor 3 mgCOD/l | Fin_UEff mgCOD/l | Ext_FEff mgCOD/l | IntSet_FEff mgCOD/l | Fin_FEff mgCOD/l | RBCOD Floc Floc. Inf. mgCOD/l | Floc. Eff. mgCOD/l | RBCOD mgCOD/l | COD Removal % | Free & Saline Ammonia Influent mgN/l | Fin_UEff mgN/l | ExtNit_UE mgN/l | IntSet_UE mgN/l | Total Kjeldahl Nitrogen Influent mgN/l | Reactor 3 mgN/l | Fin_UEff mgN/l | ExtNit_UE mgN/l | IntSet_UE mgN/l | Nitrogen Removal % | Measured Nitrate Values mgNOx-N/l Anaerobic | Main_Ano | Pre_Ano | Aerobic | Fin_FEff | IntSet_FEff | ExtNit_FE | Measured Nitrite Values mgNO2-N/l Anaerobic | Main_Ano | Pre_Ano | Aerobic | Fin_FEff | IntSet_FEff | ExtNit_FE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 810 | 1943 | 61 | 79 | 163 | | | | 92 | 93 | 43 | 5 | 3 | 23 | 67 | 132 | 6 | 6 | 28 | 84 | 0.27 | 8.37 | 0.99 | 7.76 | 8.63 | 0.34 | 22.57 | | | | | | | |
| 2 | 612 | 2418 | 41 | 48 | 100 | | 143 | 40 | 103 | 93 | 51 | 2 | 3 | 26 | 67 | 153 | 2 | 4 | 31 | 78 | 0.42 | 11.42 | 1.81 | 17.01 | 17.61 | 0.24 | 22.67 | | | | | | | |
| 3 | 703 | 3578 | 21 | 33 | 116 | | | | 92 | 97 | 47 | 3 | 3 | 26 | 69 | 188 | 3 | 4 | 32 | 83 | 0.37 | 9.49 | 1.77 | 13.87 | 12.38 | 0.25 | 24.86 | | | | | | | |
| 4 | 675 | 3836 | 101 | 82 | 185 | | 148 | 59 | 89 | 85 | 49 | 16 | 18 | 32 | 66 | 234 | 19 | 23 | 43 | 74 | 0.25 | 0.44 | 0.06 | 2.16 | 2.00 | 0.29 | 17.48 | | | | | | | |
| 5 | 722 | 2519 | 53 | 63 | 148 | 38 | 141 | 100 | 41 | 93 | 41 | 7 | 9 | 24 | 59 | 171 | 9 | 11 | 32 | 85 | 0.23 | 0.66 | 0.13 | 0.81 | 1.98 | 0.18 | 13.23 | | | | | | | |
| 6 | 630 | 3892 | 76 | 81 | 172 | 72 | 64 | 27 | 37 | 88 | 61 | 17 | 18 | 41 | 81 | 310 | 19 | 26 | 48 | 78 | 0.25 | 0.60 | 0.11 | 1.62 | 1.81 | 0.21 | 13.23 | | | | | | | |
| 7 | 696 | 2311 | 78 | 64 | 164 | 33 | 77 | 20 | 57 | 89 | 73 | 47 | 32 | 63 | 91 | 391 | 47 | 31 | 72 | 53 | 0.26 | 0.92 | 0.31 | 1.81 | 1.62 | 0.24 | 22.55 | | | | | | | |
| 8 | 671 | 4306 | 77 | 85 | 149 | 59 | 141 | 39 | 102 | 89 | 50 | 19 | 18 | 36 | 68 | 316 | 23 | 22 | 46 | 63 | 0.25 | 1.08 | 0.33 | 5.27 | 5.20 | 0.34 | 18.18 | | | | | | | |
| 9 | 707 | 4243 | 64 | 37 | 107 | | 167 | 24 | 143 | 91 | 42 | 8 | 8 | 29 | 70 | 227 | 15 | 17 | 40 | 78 | 0.28 | 0.65 | 0.33 | 1.71 | 2.83 | 0.34 | 25.51 | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 673 | 3330 | 71 | 73 | 142 | 33 | 154 | 44 | 110 | 89 | 53 | 21 | 14 | 37 | 76 | 191 | 25 | 21 | 47 | 69 | 0.54 | 1.39 | 0.32 | 2.80 | 2.47 | 0.37 | 33.37 | | | | | | | |
| 12 | 647 | 2876 | 74 | 82 | 169 | 48 | 160 | 45 | 92 | 89 | 59 | 28 | 29 | 48 | 81 | 311 | 37 | 35 | 54 | 57 | 0.68 | 0.62 | 0.33 | 0.82 | 0.74 | 0.33 | 22.70 | | | | | | | |
| 13 | 682 | 3816 | 99 | 101 | 156 | 53 | 162 | 53 | 109 | 86 | 58 | 29 | 18 | 44 | 90 | 254 | 26 | 36 | 52 | 60 | 0.30 | 1.37 | 0.05 | 1.94 | 1.94 | 0.26 | 5.90 | 0.09 | 0.11 | 0.02 | 0.11 | 0.11 | 0.06 | 0.09 |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | 748 | 4030 | 78 | 89 | 191 | | 117 | 44 | 73 | 90 | 74 | 56 | 55 | 67 | 101 | 298 | 67 | 62 | 79 | 36 | 0.31 | 0.59 | 0.30 | 1.78 | 1.51 | 0.26 | 6.44 | | | | | | | |
| 17 | 661 | 3480 | 80 | 80 | 163 | 62 | 163 | 39 | 92 | 88 | 62 | 36 | 39 | 52 | 86 | 283 | 40 | 43 | 61 | 35 | 0.22 | 0.56 | 0.35 | 2.01 | 1.87 | 0.29 | 9.34 | | | | | | | |
| 18 | 620 | 3500 | 87 | 117 | 153 | 64 | 136 | 58 | 78 | 86 | 61 | 30 | 35 | 45 | 76 | 233 | 35 | 29 | 48 | 54 | 0.39 | 1.32 | 0.30 | 2.06 | 2.06 | 0.22 | 6.40 | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 653 | 3333 | 63 | 83 | 144 | 57 | 136 | 34 | 102 | 90 | 61 | 36 | 40 | 50 | 80 | 281 | 38 | 44 | 60 | 56 | 0.64 | 2.66 | 0.20 | 5.33 | 4.50 | 0.26 | 21.63 | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 588 | 4110 | 53 | 87 | 149 | 50 | 154 | 28 | 63 | 91 | 69 | 27 | 30 | 37 | 84 | 129 | 33 | 34 | 51 | 58 | 0.48 | 3.59 | 1.63 | 8.88 | 9.25 | 1.03 | 15.74 | | | | | | | |
| 23 | 652 | 3349 | 52 | 86 | 115 | 42 | 123 | 37 | 86 | 92 | 40 | 9 | 19 | 27 | 61 | 140 | 13 | 27 | 33 | 73 | 0.31 | 1.46 | 0.75 | 7.36 | 8.06 | 0.46 | 7.10 | | | | | | | |
| 24 | 769 | 3237 | 72 | 77 | 148 | 52 | 158 | 35 | 124 | 91 | 41 | 11 | 26 | 31 | 63 | 182 | 15 | 31 | 38 | 75 | 0.35 | 0.37 | 0.16 | 5.30 | 4.90 | 0.58 | 3.89 | | | | | | | |
| 25 | 575 | 3001 | 57 | 57 | 139 | 47 | 108 | 38 | 71 | 90 | 55 | 11 | 35 | 37 | 79 | 199 | 15 | 39 | 45 | 73 | 0.35 | 1.08 | 0.15 | 11.42 | 11.24 | 1.21 | 4.74 | | | | | | | |
| 26 | 729 | 2214 | 64 | 97 | 171 | 61 | 121 | 38 | 82 | 91 | 41 | 5 | 13 | 24 | 64 | 124 | 9 | 18 | 30 | 78 | 0.33 | 7.85 | 2.05 | 6.36 | 6.31 | 0.63 | 10.45 | 0.17 | 0.24 | 0.87 | 3.43 | 2.43 | 0.35 | 3.46 |
| 27 | 780 | 2544 | 74 | 110 | 178 | 54 | 115 | 44 | 70 | 90 | 51 | 5 | 18 | 30 | 70 | 160 | 8 | 23 | 38 | 80 | 0.39 | 2.07 | 0.75 | 6.53 | 5.69 | 0.25 | 16.30 | 0.41 | 0.25 | 0.09 | 0.57 | 0.46 | 0.26 | 1.00 |
| 28 | 612 | 2587 | 66 | 111 | 141 | | 102 | 43 | 58 | 89 | 53 | 6 | 13 | 33 | 74 | 152 | 9 | 19 | 39 | 78 | 0.37 | 4.41 | 0.92 | 8.64 | 6.31 | 0.34 | 23.08 | 0.27 | 0.21 | 0.05 | 0.54 | 0.33 | 0.34 | 0.66 |
| 29 | 654 | 2358 | 61 | 113 | 175 | | 135 | 36 | 100 | 91 | 65 | 6 | 11 | 43 | 96 | 139 | 8 | 18 | 36 | 76 | 0.24 | 4.42 | 0.41 | 13.38 | 13.49 | 0.53 | 15.46 | 0.22 | 0.37 | 0.57 | 0.71 | 0.59 | 0.55 | 0.59 |
| 30 | 700 | 2529 | 52 | 97 | 169 | 39 | 119 | 35 | 84 | 93 | 40 | 2 | 5 | 26 | 61 | 144 | 3 | 7 | 30 | 85 | 0.64 | 0.49 | 0.08 | 4.15 | 3.87 | 0.28 | 24.01 | 0.41 | 0.04 | 0.06 | 0.27 | 0.14 | 0.17 | 0.41 |
| 31 | 824 | 3097 | 56 | 119 | 144 | 26 | 160 | 36 | 123 | 93 | 55 | 2 | 7 | 37 | 88 | 173 | 3 | 7 | 37 | 89 | 0.08 | 0.78 | 0.09 | 8.07 | 6.56 | 0.18 | 33.71 | 0.06 | 0.07 | 0.03 | 0.26 | 0.18 | 0.18 | 0.70 |
| 32 | 686 | 3490 | 42 | 69 | 153 | | 159 | 29 | 131 | 94 | 45 | 3 | 6 | 25 | 57 | 238 | 3 | 14 | 30 | 86 | 0.13 | 0.96 | 0.24 | 0.94 | 0.64 | 0.05 | 20.64 | 0.02 | 0.01 | 0.02 | 0.04 | 0.03 | 0.02 | 0.37 |
| 33 | 734 | 3749 | 53 | 101 | 159 | 56 | 143 | 39 | 104 | 93 | 60 | 8 | 13 | 36 | 81 | 326 | 11 | 20 | 43 | 77 | 0.55 | 1.48 | 0.11 | 6.36 | 7.39 | 0.50 | 26.15 | 0.66 | 0.11 | 0.09 | 0.38 | 0.34 | 0.37 | 0.51 |
| 34 | 846 | 2879 | 66 | 136 | 188 | 59 | 162 | 47 | 115 | 92 | 62 | 8 | 21 | 45 | 94 | 364 | 10 | 28 | 57 | 70 | 0.72 | 9.22 | 1.49 | 17.61 | 18.02 | 0.91 | 24.33 | | | | | | | |
| 35 | 681 | 3136 | 51 | 79 | 122 | | 133 | 31 | 101 | 92 | 60 | 4 | 20 | 40 | 82 | 220 | 6 | 26 | 44 | 79 | 0.39 | 1.58 | 0.14 | 13.60 | 11.22 | 0.59 | 15.33 | | | | | | | |
| 36 | 704 | 3057 | 53 | 77 | 159 | 73 | 133 | 31 | 102 | 93 | 41 | 5 | 7 | 25 | 59 | 215 | 8 | 12 | 32 | 82 | 0.10 | 0.37 | 0.08 | 3.83 | 2.89 | 0.13 | 26.05 | 0.04 | 0.43 | 0.05 | 0.09 | 0.03 | 0.03 | 0.13 |
| 37 | 656 | 3350 | 60 | 82 | 141 | 63 | 171 | 48 | 124 | 91 | 44 | 5 | 13 | 23 | 58 | 216 | 7 | 18 | 32 | 74 | 0.26 | 0.57 | 0.28 | 9.14 | 8.32 | 0.35 | 18.33 | 0.07 | 0.11 | 0.12 | 0.02 | 0.03 | 0.04 | 0.48 |
| Average 1 | 709 | 2646 | 41 | 53 | 128 | | 143 | 40 | 96 | 94 | 46 | 3 | 3 | 25 | 68 | 158 | 4 | 4 | 30 | 82 | 0.35 | 9.83 | 1.52 | 12.88 | 12.88 | 0.27 | 23.37 | | | | | | | |
| Averages above are for sewage batches 1 to 3 i.e. Configuration 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 2 | 679 | 3517 | 78 | 79 | 158 | 52 | 136 | 46 | 85 | 89 | 57 | 26 | 25 | 43 | 79 | 252 | 31 | 30 | 52 | 64 | 0.34 | 0.85 | 0.24 | 1.87 | 2.17 | 0.28 | 16.19 | | | | | | | |
| Averages above are for sewage batches 4 to 19 i.e. Configuration 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 3 | 620 | 3721 | 58 | 85 | 147 | 54 | 145 | 31 | 87 | 91 | 65 | 31 | 35 | 44 | 82 | 205 | 35 | 39 | 56 | 57 | 0.56 | 3.15 | 0.92 | 7.10 | 6.58 | 0.64 | 18.69 | | | | | | | |
| Averages above are for sewage batches 22 to 25 i.e. Configuration 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 4 | 787 | 2972 | 59 | 94 | 153 | 52 | 136 | 38 | 98 | 92 | 50 | 6 | 15 | 32 | 72 | 206 | 9 | 21 | 39 | 78 | 0.34 | 2.47 | 0.51 | 8.15 | 7.68 | 0.47 | 17.96 | 0.25 | 0.18 | 0.20 | 0.63 | 0.45 | 0.23 | 0.85 |
| Averages above are for sewage batches 26 to 37 i.e. Configuration 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 5 | 691 | 3192 | 64 | 84 | 152 | 52 | 137 | 41 | 97 | 91 | 53 | 15 | 19 | 36 | 75 | 219 | 18 | 24 | 44 | 71 | 0.36 | 3.59 | 0.53 | 6.23 | 6.05 | 0.39 | 17.85 | 0.27 | 0.18 | 0.18 | 0.58 | 0.42 | 0.21 | 0.78 |
| Averages above are for sewage batches 1 to 37 i.e. average over entire investigation. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

C.2

| Average of Sewage Batch | Anoxic Solids TSS mgTSS/l | Anoxic Solids VSS mgVSS/l | Anoxic Solids ISS mgISS/l | Main Anoxic Solids TSS mgTSS/l | Main Anoxic Solids VSS mgVSS/l | Main Anoxic Solids ISS mgISS/l | Pre Anoxic Solids TSS mgTSS/l | Pre Anoxic Solids VSS mgVSS/l | Pre Anoxic Solids ISS mgISS/l |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1396.67 | 1186.00 | 210.67 | 1664.00 | 1381.33 | 282.67 | 2645.33 | 2204.00 | 441.33 |
| 2 | 945.06 | 779.73 | 165.29 | 1304.16 | 1080.57 | 223.57 | 2357.29 | 1930.14 | 427.14 |
| 3 | 1072.63 | 924.67 | 148.00 | 1367.87 | 1172.53 | 195.33 | 2232.00 | 1846.00 | 386.00 |
| 4 | 1618.80 | 1414.80 | 204.00 | 1716.00 | 1462.80 | 253.20 | 4369.60 | 3724.40 | 645.20 |
| 5 | 1442.67 | 1244.67 | 198.00 | 1566.00 | 1348.00 | 218.00 | 3731.33 | 3141.33 | 590.00 |
| 6 | 1357.50 | 1174.50 | 183.00 | 1516.50 | 1277.50 | 239.00 | 3816.00 | 3331.00 | 485.00 |
| 7 | 1783.00 | 1401.00 | 382.00 | 1870.50 | 1653.00 | 217.50 | 3897.00 | 2872.50 | 1024.50 |
| 8 | 2072.91 | 1788.55 | 284.36 | 2675.27 | 2262.55 | 412.73 | 6290.00 | 5259.09 | 1030.91 |
| 9 | 2843.33 | 2430.00 | 413.33 | 2993.33 | 2532.00 | 461.33 | 8553.33 | 7108.00 | 1445.33 |
| 10 | | | | | | | | | |
| 11 | 2139.78 | 1845.11 | 294.67 | 2489.11 | 2124.00 | 461.11 | 6226.00 | 4474.44 | 1751.56 |
| 12 | 2485.80 | 2228.60 | 257.20 | 3154.78 | 1665.40 | 1489.38 | 5805.60 | 5089.80 | 715.80 |
| 13 | 2247.00 | 1927.50 | 319.50 | 2038.00 | 1739.00 | 299.00 | 5098.50 | 4280.50 | 818.00 |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |
| 16 | 2508.00 | 2177.00 | 331.00 | 2789.00 | 2415.00 | 374.00 | 10623.00 | 5612.00 | 1608.00 |
| 17 | 2410.00 | 2040.00 | 370.00 | 2626.50 | 2262.50 | 364.00 | 6107.50 | 5330.50 | 777.00 |
| 18 | 2119.00 | 1838.00 | 281.00 | 2440.00 | 2000.00 | 440.00 | 6022.00 | 3938.00 | 2084.00 |
| 19 | | | | | | | | | |
| 20 | 2499.00 | 2114.00 | 385.00 | 2318.00 | 2211.00 | 347.00 | 6484.00 | 5597.50 | 886.50 |
| 21 | | | | | | | | | |
| 22 | 3607.00 | 3052.00 | 555.00 | 3711.00 | 3049.00 | 662.00 | 9512.00 | 7869.00 | 1643.00 |
| 23 | 2719.00 | 2322.33 | 396.67 | 2863.00 | 2422.67 | 440.33 | 8216.67 | 6846.33 | 1370.33 |
| 24 | 1898.00 | 1596.00 | 302.00 | 2102.33 | 1730.67 | 371.67 | 5502.33 | 4370.93 | 1131.40 |
| 25 | 2161.50 | 1747.00 | 414.50 | 2363.50 | 1841.50 | 522.00 | 6298.00 | 4859.50 | 1436.50 |
| 26 | 1989.33 | 1626.00 | 363.33 | 1652.67 | 1301.67 | 351.00 | 5162.00 | 4031.00 | 1131.00 |
| 27 | 1551.80 | 1349.60 | 202.20 | 1762.00 | 1479.60 | 282.40 | 4572.80 | 3820.80 | 752.00 |
| 28 | 862.00 | 674.40 | 187.60 | 1146.80 | 947.20 | 199.60 | 3911.20 | 3116.00 | 795.20 |
| 29 | 1446.29 | 1150.00 | 296.29 | 1314.29 | 994.57 | 223.71 | 3897.43 | 3363.14 | 534.29 |
| 30 | 1347.00 | 953.50 | 393.50 | 1387.75 | 1168.00 | 219.75 | 4127.00 | 3420.75 | 706.25 |
| 31 | 1872.00 | 1603.00 | 269.00 | 2209.00 | 1691.00 | 518.00 | 5606.00 | 4625.00 | 981.00 |
| 32 | 2178.00 | 1814.50 | 363.50 | 3144.55 | 3440.50 | 1704.05 | 7196.30 | 5826.50 | 1670.00 |
| 33 | 2019.63 | 1067.45 | 317.64 | 1395.09 | 1097.27 | 297.82 | 5258.18 | 2640.00 | 418.18 |
| 34 | 1664.67 | 1338.00 | 326.67 | 1910.00 | 1646.00 | 264.00 | 4740.67 | 4029.33 | 711.33 |
| 35 | 2425.50 | 2067.50 | 358.00 | 2437.00 | 2053.00 | 384.00 | 6780.50 | 3721.50 | 1059.00 |
| 36 | 2160.25 | 1703.50 | 456.75 | 2345.75 | 1786.75 | 559.00 | 5524.00 | 4497.25 | 1026.75 |
| 37 | 2202.00 | 1897.60 | 304.40 | 2332.00 | 1934.00 | 398.00 | 5378.80 | 3970.40 | 1358.40 |
| Average 1 | 1138.12 | 963.47 | 174.65 | 1445.34 | 1211.48 | 233.86 | 2411.54 | | 418.16 |
| Average 2 | 2085.65 | 1792.48 | 293.17 | 2356.35 | 1920.15 | 436.18 | 5878.49 | 4530.55 | 1347.94 |
| Average 3 | 3453.00 | 2583.00 | 870.00 | 3134.50 | 2630.00 | 504.50 | 7993.00 | 6733.25 | 1364.75 |
| Average 4 | 1981.38 | 1529.89 | 351.54 | 2359.32 | 1783.63 | 455.43 | 5494.81 | 4475.90 | 1018.91 |
| Average 5 | 1978.90 | 1641.08 | 306.88 | 2227.18 | 1796.58 | 430.60 | 5506.08 | 4404.74 | 1101.34 |

| Average of Sewage Batch | Aerobic Solids TSS mgTSS/l | Aerobic Solids VSS mgVSS/l | Aerobic Solids ISS mgISS/l | Waste/Nitrifier Solids TSS mgTSS/l | Waste/Nitrifier Solids VSS mgVSS/l | Waste/Nitrifier Solids ISS mgISS/l | DSVI ml/g | COD/VSS mgCOD/mgVSS | TKN/VSS mgN/mgVSS | TKN/COD mgN/mgCOD |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1461.33 | 1230.67 | 230.67 | | | | 121.09 | 1.38 | 0.11 | 0.03 |
| 2 | 2030.29 | 1623.71 | 406.57 | | | | 110.36 | 1.49 | 0.09 | 0.06 |
| 3 | 1945.33 | 1616.00 | 329.33 | | | | 98.79 | 2.21 | 0.12 | 0.05 |
| 4 | 2553.20 | 2161.20 | 392.00 | | | | 95.83 | 1.78 | 0.11 | 0.06 |
| 5 | 2314.67 | 2074.67 | 266.00 | 1458.00 | 1351.33 | 106.67 | 109.50 | 1.24 | 0.04 | 0.07 |
| 6 | 3263.00 | 2783.00 | 480.00 | 1907.00 | 1791.50 | 115.50 | 71.96 | 1.40 | 0.11 | 0.08 |
| 7 | 3622.00 | 3071.50 | 550.50 | 2346.00 | 1942.50 | 403.50 | 72.44 | 0.75 | 0.05 | 0.07 |
| 8 | 3128.91 | 2616.55 | 512.36 | 2866.18 | 2366.36 | 499.82 | 71.46 | 1.65 | 0.09 | 0.06 |
| 9 | 3835.33 | 3301.33 | 534.00 | 3709.33 | 3030.00 | 679.33 | 72.39 | 1.29 | 0.07 | 0.05 |
| 10 | | | | | | | | | | |
| 11 | 2982.49 | 2268.00 | 714.49 | 3153.11 | 2646.22 | 506.89 | 43.86 | 1.44 | 0.07 | 0.05 |
| 12 | 2559.20 | 2136.16 | 423.04 | 1467.00 | 1157.00 | 310.00 | 79.06 | 1.35 | 0.08 | 0.06 |
| 13 | 3260.50 | 2709.00 | 551.50 | 2741.00 | 2242.00 | 499.00 | 42.78 | 1.41 | 0.06 | 0.04 |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |
| 16 | 3361.00 | 2813.00 | 548.00 | 3121.00 | 2623.00 | 498.00 | 74.78 | 1.44 | 0.07 | 0.05 |
| 17 | 3181.00 | 2686.00 | 495.00 | 2882.50 | 2354.50 | 528.00 | 70.88 | 1.30 | 0.03 | 0.04 |
| 18 | 2484.00 | 2158.00 | 326.00 | 2592.00 | 2272.00 | 320.00 | 74.74 | 1.37 | 0.09 | 0.07 |
| 19 | | | | | | | | | | |
| 20 | 3046.00 | 2576.50 | 469.50 | 2943.00 | 2378.00 | 565.00 | 71.70 | 1.29 | 0.08 | 0.06 |
| 21 | | | | | | | | | | |
| 22 | 3770.00 | 3103.00 | 667.00 | 3745.00 | 3032.00 | 713.00 | 76.86 | 1.32 | 0.04 | 0.03 |
| 23 | 3127.00 | 2608.67 | 518.33 | 3283.67 | 2709.00 | 574.67 | 95.14 | 1.28 | 0.09 | 0.07 |
| 24 | 2558.33 | 2155.67 | 402.67 | | | | 90.46 | 1.50 | 0.07 | 0.05 |
| 25 | 2463.00 | 1908.50 | 551.50 | | | | 91.42 | 1.57 | 0.08 | 0.05 |
| 26 | 1920.00 | 1471.10 | 448.90 | | | | 87.18 | 1.51 | 0.08 | 0.06 |
| 27 | 2014.80 | 1666.80 | 348.20 | | | | 78.64 | 1.53 | 0.10 | 0.06 |
| 28 | 1870.00 | 1460.00 | 410.00 | | | | 115.47 | 1.77 | 0.10 | 0.06 |
| 29 | 2000.57 | 1510.00 | 490.57 | | | | 96.33 | 1.56 | 0.09 | 0.06 |
| 30 | 1338.75 | 1011.00 | 327.75 | | | | 133.80 | 1.79 | 0.07 | 0.04 |
| 31 | 2730.00 | 2123.00 | 607.00 | | | | 92.09 | 1.46 | 0.08 | 0.06 |
| 32 | 2913.50 | 2389.00 | 524.50 | 2822.00 | 2520.00 | 302.00 | 43.55 | 1.46 | 0.10 | 0.07 |
| 33 | 1559.27 | 1163.45 | 395.82 | 3994.00 | 3342.00 | 652.00 | 86.43 | 3.22 | 0.16 | 0.05 |
| 34 | 1961.33 | 1616.67 | 344.67 | 2473.33 | 2190.93 | 282.40 | 140.18 | 2.47 | 0.10 | 0.04 |
| 35 | 2340.00 | 2124.50 | 415.50 | 1446.00 | 232.00 | 1214.00 | 138.79 | 1.48 | 0.10 | 0.07 |
| 36 | 3020.50 | 2332.73 | 687.73 | 814.00 | 718.00 | 96.00 | 152.73 | 1.36 | 0.06 | 0.05 |
| 37 | 2465.60 | 1995.20 | 470.40 | 266.67 | 233.33 | 33.33 | 134.07 | 1.48 | 0.08 | 0.05 |
| Average 1 | 1813.32 | 1490.13 | 323.19 | | | | 111.41 | 1.76 | 0.11 | 0.06 |
| Average 2 | 3078.81 | 2594.37 | 484.44 | 2567.56 | 2161.49 | 406.06 | 76.81 | 1.37 | 0.08 | 0.06 |
| Average 3 | 3408.00 | 2839.75 | 568.25 | 3318.00 | 2785.00 | 639.00 | 74.28 | 1.31 | 0.06 | 0.05 |
| Average 4 | 2325.51 | 1862.41 | 463.18 | 2157.18 | 1706.47 | 450.63 | 107.87 | 1.71 | 0.09 | 0.06 |
| Average 5 | 2627.54 | 2143.07 | 464.47 | 2501.54 | 2056.58 | 444.96 | 94.45 | 1.56 | 0.09 | 0.06 |

| Average of Sewage Batch | Total Phosphorus Concentration AN mg P/l | Main_ANO mg P/l | Pre_ANO mg P/l | AE mg P/l | Fin_FEff mg P/l | InSet_FEff mg P/l | S/Cd_FEff mg P/l | Influent mg P/l |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.356 | 12.954 | 7.981 | 8.443 | 9.947 | 22.438 | 24.058 | 18.159 |
| 2 | 14.189 | 11.803 | 8.402 | 10.284 | 9.493 | 16.753 | 18.250 | 18.606 |
| 3 | 29.619 | 18.512 | 14.465 | 16.187 | 13.412 | 30.996 | 30.996 | 26.088 |
| 4 | 45.348 | 23.825 | 31.634 | 18.019 | 18.320 | 47.251 | 46.450 | 32.635 |
| 5 | 21.525 | 10.304 | 16.876 | 3.166 | 7.146 | 22.360 | 22.386 | 15.670 |
| 6 | 22.472 | 14.723 | 16.359 | 8.180 | 9.815 | 20.932 | 23.247 | 15.929 |
| 7 | 22.644 | 17.909 | 19.028 | 9.962 | 13.173 | 22.721 | 25.744 | 19.717 |
| 8 | 26.906 | 16.342 | 19.323 | 9.236 | 11.365 | 27.180 | 28.456 | 17.866 |
| 9 | 42.821 | 25.256 | 28.126 | 13.317 | 13.317 | 41.213 | 43.163 | 25.141 |
| 10 | | | | | | | | |
| 11 | 28.013 | 22.214 | 16.425 | 13.432 | 12.284 | 26.921 | 27.954 | 19.803 |
| 12 | 24.213 | 16.876 | 18.081 | 13.604 | 13.191 | 23.660 | 24.329 | 18.908 |
| 13 | 24.793 | 19.601 | 18.253 | 12.726 | 12.915 | 23.649 | 24.969 | 18.339 |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | 28.413 | 26.002 | 24.623 | 12.713 | 13.946 | 28.211 | 26.241 | 22.903 |
| 17 | 25.348 | 22.731 | 20.195 | 14.238 | 13.036 | 23.555 | 26.430 | 22.312 |
| 18 | 24.912 | 26.894 | 18.942 | 15.039 | 14.465 | 24.108 | 24.682 | 24.797 |
| 19 | | | | | | | | |
| 20 | 31.513 | 23.030 | 19.261 | 16.445 | 16.962 | 34.937 | 32.546 | 23.446 |
| 21 | | | | | | | | |
| 22 | 32.890 | 29.446 | 11.882 | 11.193 | 12.054 | 39.434 | 39.606 | 22.346 |
| 23 | 31.479 | 28.420 | 9.232 | 10.345 | 9.344 | 32.369 | 33.706 | 19.466 |
| 24 | 45.179 | 26.310 | 41.369 | 13.393 | 12.734 | 45.534 | 47.500 | 26.607 |
| 25 | 33.353 | 17.360 | 5.357 | 10.238 | 10.119 | 34.194 | 37.262 | 24.929 |
| 26 | 33.270 | 15.863 | 11.862 | 11.301 | 8.984 | 33.331 | 34.533 | 27.234 |
| 27 | 27.737 | 21.379 | 19.314 | 16.088 | 14.434 | 28.649 | 28.863 | 24.310 |
| 28 | 29.995 | 20.872 | 19.632 | 16.231 | 14.742 | 34.155 | 32.436 | 24.594 |
| 29 | 23.793 | 16.940 | 15.172 | 13.922 | 13.534 | 24.181 | 26.078 | 20.172 |
| 30 | 24.274 | 19.058 | 17.375 | 11.832 | 11.333 | 24.223 | 25.017 | 23.367 |
| 31 | 39.622 | 18.935 | 14.376 | 12.623 | 9.117 | 39.973 | 42.077 | 28.051 |
| 32 | 41.313 | 28.362 | 27.296 | 5.319 | 6.455 | 46.844 | 52.010 | 23.738 |
| 33 | 49.981 | 28.362 | 22.370 | 18.182 | 17.275 | 50.289 | 56.436 | 29.509 |
| 34 | 26.066 | 19.796 | 17.583 | 13.583 | 16.599 | 28.771 | 29.140 | 23.976 |
| 35 | 32.660 | 21.394 | 17.521 | 12.521 | 13.832 | 34.489 | 38.823 | 32.132 |
| 36 | 41.175 | 24.299 | 27.138 | 14.985 | 12.680 | 42.634 | 46.063 | 25.037 |
| 37 | 45.792 | 25.452 | 21.447 | 17.179 | 14.544 | 42.472 | 47.900 | 25.136 |
| Average 1 | 31.39 | 16.42 | 20.18 | 11.64 | 11.62 | 33.46 | 24.43 | 20.95 |
| Average 2 | 28.11 | 19.89 | 20.86 | 13.10 | 12.91 | 27.87 | 28.84 | 21.17 |
| Average 3 | 32.19 | 27.64 | 15.57 | 13.82 | 14.81 | 37.28 | 36.08 | 23.94 |
| Average 4 | 35.03 | 22.34 | 17.28 | 13.66 | 13.38 | 36.38 | 36.86 | 24.78 |
| Average 5 | 30.98 | 28.96 | 17.81 | 13.90 | 12.64 | 31.99 | 33.10 | 23.02 |

| Average of Sewage Batch | Total Phosphorus Mass Balance AN mg P/l | ANO1 mg P/l | ANO2 mg P/l | AE mg P/l | Fin_FEff mg P/l | InSet_FEff mg P/l | Source mg P/l | In-AE mg P/l | In-FinFEff mg P/l |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -14.57 | 19.78 | 1.97 | 9.02 | -3.01 | -4.16 | -2.43 | 9.715566 | 8.21 |
| 2 | -1.37 | 10.63 | 1.09 | 3.05 | 1.57 | -5.13 | -2.25 | 8.323530 | 9.11 |
| 3 | -16.69 | 21.97 | 0.93 | 4.65 | 1.55 | -2.76 | 0.00 | 9.901544 | 10.68 |
| 4 | -19.17 | 35.56 | -6.66 | 8.71 | -4.43 | -3.60 | 1.63 | 14.6136 | 14.32 |
| 5 | -4.18 | 17.72 | -4.86 | 8.01 | -2.97 | -1.16 | -8.11 | 10.50425 | 8.52 |
| 6 | -9.60 | 9.88 | -3.27 | 9.82 | -2.45 | 2.32 | -7.91 | 7.749034 | 6.13 |
| 7 | -4.74 | 7.99 | -2.93 | 12.01 | -4.91 | -0.13 | -3.37 | 9.815443 | 6.54 |
| 8 | -12.83 | 13.77 | -4.00 | 13.69 | -3.16 | -0.71 | -1.35 | 8.610038 | 6.50 |
| 9 | -23.03 | 24.62 | -7.41 | 17.91 | 0.00 | 2.11 | -3.14 | 11.82445 | 11.82 |
| 10 | | | | | | | | | |
| 11 | -13.00 | 7.32 | -5.07 | 13.17 | 1.72 | 1.64 | -1.29 | 6.371424 | 7.52 |
| 12 | -6.37 | 10.35 | -2.43 | 4.91 | 0.62 | 0.83 | -0.86 | 5.303783 | 5.72 |
| 13 | -0.73 | 6.76 | -2.67 | 10.76 | -1.03 | 1.72 | -1.65 | 6.113127 | 5.42 |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |
| 16 | -7.30 | 3.36 | -5.34 | 19.89 | -1.81 | 0.26 | 0.00 | 10.13984 | 8.95 |
| 17 | -5.41 | 4.36 | -2.79 | 12.71 | -1.14 | -0.31 | -1.12 | 6.058996 | 7.30 |
| 18 | -3.10 | 4.97 | -2.24 | 8.78 | 0.66 | 1.21 | -4.72 | 9.758043 | 10.33 |
| 19 | | | | | | | | | |
| 20 | -12.15 | 12.83 | -1.13 | 14.46 | 4.77 | -5.74 | 2.81 | 9.60654 | 9.52 |
| 21 | | | | | | | | | |
| 22 | -21.01 | 13.04 | 0.09 | 27.36 | -1.29 | -10.91 | -0.20 | 11.19303 | 10.33 |
| 23 | -23.14 | 7.01 | 0.06 | 27.11 | 1.50 | -1.18 | -3.89 | 9.121216 | 10.12 |
| 24 | -33.48 | 29.49 | 0.68 | 19.38 | 0.98 | -0.60 | -2.29 | 13.21429 | 13.47 |
| 25 | -18.39 | 26.73 | 2.38 | 10.69 | 0.18 | -4.76 | 1.14 | 18.65048 | 18.81 |
| 26 | -17.02 | 18.75 | -1.80 | 14.26 | 1.34 | -0.12 | 3.72 | 15.933 | 18.23 |
| 27 | -9.25 | 6.10 | -2.51 | 15.29 | 2.18 | -1.30 | -0.21 | 8.221 | 9.88 |
| 28 | -13.28 | 11.19 | -2.44 | 16.64 | -0.77 | -4.21 | 1.79 | 10.363 | 9.85 |
| 29 | -6.56 | 9.87 | -4.94 | 10.33 | 0.58 | -0.67 | -2.02 | 4.250 | 6.64 |
| 30 | -2.33 | 9.69 | -3.02 | 16.07 | 0.75 | 0.04 | -0.99 | 11.335 | 12.03 |
| 31 | -25.07 | 22.49 | -2.63 | 15.78 | 5.36 | -0.33 | -2.24 | 15.428 | 18.93 |
| 32 | -34.06 | 9.66 | -10.42 | 38.10 | -1.66 | -1.30 | -5.51 | 17.490 | 16.78 |
| 33 | -36.27 | 28.79 | -2.80 | 32.28 | 1.99 | -0.33 | -6.56 | 11.127 | 12.23 |
| 34 | -9.50 | 11.64 | -0.49 | 5.53 | 1.18 | -4.06 | -0.39 | 6.394 | 7.38 |
| 35 | -17.80 | 20.59 | -1.53 | 9.68 | 5.53 | -3.04 | -4.62 | 1.611 | 8.30 |
| 36 | -29.23 | 21.93 | -7.24 | 23.29 | 3.46 | -3.32 | -3.93 | 10.052 | 12.36 |
| 37 | -34.96 | 23.05 | -3.45 | 20.69 | 3.95 | 1.98 | -3.79 | 7.957 | 10.59 |
| Average 1 | -11.54 | 18.47 | 1.33 | 5.57 | 0.04 | -4.02 | -1.56 | 9.31 | 9.33 |
| Average 2 | -18.70 | 12.16 | -3.74 | 11.88 | -1.19 | -0.10 | -0.91 | 9.07 | 8.16 |
| Average 3 | -24.50 | 19.57 | 0.00 | 21.19 | 0.34 | -4.14 | 8.45 | 10.12 | 9.43 |
| Average 4 | -20.34 | 16.53 | -3.30 | 19.99 | 2.28 | -1.96 | -2.27 | 11.13 | 12.40 |
| Average 5 | -16.12 | 15.34 | -2.54 | 15.49 | 0.41 | -1.70 | -1.47 | 10.12 | 10.37 |

Average 1: Averages above are for sewage batches 1 to 3 i.e. Configuration 1
Average 2: Averages above are for sewage batches 4 to 19 i.e. Configuration 2
Average 3: Averages above are for sewage batches 22 to 25 i.e. Configuration 3
Average 4: Averages above are for sewage batches 26 to 37 i.e. Configuration 4
Average 5: Averages above are for sewage batches 1 to 37 i.e. average over entire investigation

External Nitrification BNRAS system $fS_{up}$ and $f_{XBG,P}$ calculation using the model of Wentzel *et al.* (1990)

| Sewage Batch | Q (l/d) | a ratio | $NO_3$ mgN/l | S'ti mgCOD/l | $f_{XBG,P}$ gP/mgAVS | $f_{S,us}$ fraction | $fS_{,up}$ fraction | $S_{up}$ mgCOD/l | Sti mgCOD/l | Sbsi mgCOD/l | S'ba mgCOD/l | INPUT $S_{seH}$ mgCOD/l | 9th Iteration $MX_{BH}/Q$ mgAVSS/d | 9th Iteration $S_{bsH}$ mgCOD/l | $MS_{seq}$ mgCOD/l | $MS_{a,H}$ mgCOD/l | $MX_{B,O}$ mgVASS/d | $MX_{E,O}$ mgVESS/d | $\Delta P_O$ mgP/l Inf | $MX_{B,H}$ mgVASS/d | $MX_{E,H}$ mgVESS/d | $\Delta P_H$ mgP/l Inf | $MX_I$ mgAVSS/d | $\Delta P_I$ mgP/l Inf | $R_s$ d | $MXv_{(calc)}$ mgVSS | $\Delta P_{(calc)}$ mgP/l Inf | $MXv_{(meas)}$ mgVSS | $\Delta P_{(meas)}$ mgP/l Inf | fav,OHO | fav,PAO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| test | 1 | 1 | 1 | 500 | 0.38 | 0.07 | 0.13 | 65.00 | 400.00 | 96.00 | 87.40 | 0.00 | 525.38 | 12.99 | 61.42 | 338.58 | 307.10 | 61.42 | 5.93 | 525.38 | 504.37 | 1.54 | 878.38 | 1.32 | 20 | 2276.65 | 8.79 | 43261.49 | 10.40 | | |
| 1 | 20 | 1 | 0.99 | 683.232 | 0.233 | 0.07 | -2.134 | | 632.12 | 92.00 | 83.49 | 0.00 | 751.36 | 9.53 | 1288.59 | 11353.84 | 4141.89 | 414.19 | 4.87 | 15027.14 | 7213.03 | 3.34 | ********* | -29.54 | 10 | 24796.25 | 8.20 | 21536.47 | 8.21 | 0.36 | 0.15 |
| 2 | 20 | 1 | 1.81 | 518.50543 | 0.283 | 0.07 | 0.143 | 75.55 | 418.39 | 101.77 | 87.24 | 0.00 | 475.09 | 13.90 | 1188.74 | 7179.13 | 3820.93 | 382.09 | 5.48 | 9501.79 | 4560.86 | 2.11 | 10209.15 | 1.53 | 10 | 28403.44 | 9.12 | 28415.00 | 9.11 | 0.33 | 0.13 |
| 3 | 20 | 1 | 1.77 | 579.337 | 0.385 | 0.03 | 0.079 | 45.79 | 519.55 | 92.00 | 76.78 | 0.00 | 613.06 | 10.21 | 1127.02 | 9264.07 | 3622.58 | 362.26 | 7.05 | 12261.37 | 5885.41 | 2.72 | 6187.16 | 0.93 | 10 | 28240.36 | 16.70 | 28280.06 | 16.68 | 0.43 | 0.13 |
| 4 | 40 | 0.5 | 0.06 | 545.06667 | 0.491 | 0.09 | 0.021 | 11.45 | 493.65 | 89.25 | 88.99 | 0.00 | 525.32 | 14.29 | 2702.22 | 17043.59 | 7369.69 | 589.58 | 11.34 | 21012.64 | 8068.83 | 2.73 | 2474.90 | 0.23 | 8 | 39633.51 | 14.30 | 39622.00 | 14.32 | 0.55 | 0.19 |
| 5 | 40 | 0.5 | 0.13 | 615.4995 | 0.451 | 0.05 | -2.135 | | 382.81 | 40.88 | 40.31 | 0.00 | 678.63 | 5.30 | 1294.44 | 22017.82 | 3530.30 | 283.42 | 4.99 | 27145.25 | 10423.78 | 3.51 | ********* | -26.64 | 8 | 41381.76 | 8.51 | 37192.22 | 8.52 | 0.66 | 0.09 |
| 6 | 40 | 0.5 | 0.11 | 537.165 | 0.173 | 0.11 | 0.183 | 98.30 | 417.19 | 37.22 | 36.74 | 0.00 | 480.71 | 6.31 | 1091.31 | 13596.35 | 2976.31 | 238.11 | 1.64 | 19228.38 | 7383.70 | 2.49 | 21254.31 | 1.99 | 8 | 50964.66 | 6.13 | 51821.47 | 6.11 | 0.38 | 0.06 |
| 7 | 40 | 0.5 | 0.31 | 582.803 | 0.119 | 0.05 | 0.181 | 105.49 | 459.72 | 56.90 | 55.58 | 0.00 | 513.01 | 9.06 | 1679.57 | 16709.10 | 4580.64 | 366.45 | 1.72 | 20600.36 | 7910.50 | 2.67 | 22808.07 | 2.14 | 8 | 54391.94 | 6.53 | 56318.83 | 6.54 | 0.37 | 0.08 |
| 8 | 40 | 0.5 | 0.33 | 598.06267 | 0.107 | 0.09 | 0.063 | 37.68 | 525.33 | 102.47 | 101.05 | 0.00 | 551.98 | 15.62 | 3104.61 | 17908.56 | 8467.13 | 677.37 | 2.87 | 22079.04 | 8478.35 | 2.86 | 8146.58 | 0.76 | 8 | 47977.79 | 6.50 | 47978.88 | 6.50 | 0.46 | 0.18 |
| 9 | 40 | 0.5 | 0.33 | 627.64 | 0.201 | 0.03 | 0.147 | 92.26 | 515.78 | 142.80 | 141.38 | 0.00 | 504.83 | 23.39 | 4251.55 | 16379.67 | 11595.14 | 927.61 | 7.33 | 20194.11 | 7754.54 | 2.62 | 19948.77 | 1.87 | 8 | 60555.88 | 11.82 | 60524.44 | 11.82 | 0.33 | 0.19 |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 40 | 0.5 | 0.32 | 585.54467 | 0.154 | 0.03 | -2.135 | | 556.96 | 109.98 | 108.62 | 0.00 | 582.54 | 16.11 | 3378.25 | 18900.20 | 9213.42 | 737.07 | 4.47 | 23301.61 | 8947.82 | 3.02 | ********* | -25.34 | 8 | 42199.91 | 7.50 | 41580.00 | 7.52 | 0.55 | 0.22 |
| 12 | 40 | 0.5 | 0.33 | 538.066 | 0.118 | 0.07 | 0.02 | 10.76 | 490.57 | 92.00 | 90.59 | 0.00 | 520.22 | 14.65 | 2744.43 | 16878.20 | 7484.80 | 598.78 | 2.79 | 20808.73 | 7990.53 | 2.70 | 2326.77 | 0.22 | 8 | 39883.30 | 5.71 | 39162.93 | 5.72 | 0.53 | 0.19 |
| 13 | 40 | 0.5 | 0.03 | 613.142 | 0.058 | 0.08 | 0.076 | 46.60 | 518.32 | 108.97 | 108.76 | 0.00 | 536.71 | 17.18 | 3319.56 | 17413.31 | 9053.34 | 724.27 | 1.68 | 21468.46 | 8243.89 | 2.79 | 10075.41 | 0.94 | 8 | 49697.94 | 5.41 | 49665.00 | 5.42 | 0.43 | 0.18 |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | 40 | 0.3 | 0.30 | 620.3 | 0.248 | 0.06 | 0.104 | 64.53 | 512.24 | 73.00 | 71.70 | 0.00 | 563.32 | 10.91 | 2213.17 | 18176.60 | 6035.93 | 482.87 | 4.74 | 22532.79 | 8652.59 | 2.92 | 13952.86 | 1.31 | 8 | 51532.89 | 8.97 | 51571.67 | 8.95 | 0.44 | 0.12 |
| 17 | 40 | 0.5 | 0.33 | 558.5 | 0.146 | 0.09 | 0.122 | 68.14 | 457.97 | 92.00 | 90.52 | 0.00 | 481.71 | 13.51 | 2689.94 | 15628.83 | 7336.19 | 586.90 | 3.43 | 19268.42 | 7399.07 | 2.50 | 14732.32 | 1.38 | 8 | 49202.15 | 7.21 | 49143.33 | 7.30 | 0.39 | 0.15 |
| 18 | 40 | 0.5 | 0.30 | 573 | 0.384 | 0.10 | 0.02 | 11.50 | 509.13 | 78.00 | 76.70 | 0.00 | 594.57 | 11.20 | 2396.26 | 17969.12 | 7702.28 | 770.23 | 7.43 | 23782.66 | 11415.68 | 2.64 | 3108.11 | 0.23 | 10 | 46934.36 | 10.31 | 46896.67 | 10.33 | 0.31 | 0.16 |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 30 | 0.5 | 0.20 | 587.52 | 0.184 | 0.09 | 0.128 | 75.20 | 481.44 | 102.00 | 101.12 | 0.00 | 535.14 | 16.01 | 2313.25 | 12129.82 | 7435.46 | 743.55 | 4.61 | 16034.18 | 7706.01 | 2.38 | 15243.76 | 1.52 | 10 | 47362.84 | 8.51 | 47235.83 | 8.52 | 0.34 | 0.16 |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 30 | 0.3 | 1.63 | 515.66667 | 0.408 | 0.05 | 0.354 | 182.55 | 309.08 | 63.00 | 55.97 | 0.00 | 358.31 | 11.84 | 1146.30 | 8126.12 | 3684.54 | 368.45 | 3.06 | 10735.16 | 5162.48 | 1.59 | 37001.57 | 3.70 | 10 | 56868.67 | 18.35 | 56888.33 | 18.33 | 0.19 | 0.06 |
| 23 | 30 | 0.5 | 0.75 | 618.22133 | 0.288 | 0.06 | 0.118 | 72.93 | 509.32 | 86.16 | 82.91 | 0.00 | 388.58 | 12.20 | 1938.50 | 13341.17 | 6230.90 | 623.09 | 6.02 | 17657.44 | 8475.57 | 2.61 | 14787.19 | 1.48 | 10 | 47899.49 | 18.12 | 47825.56 | 18.12 | 0.37 | 0.13 |
| 24 | 30 | 0.3 | 0.16 | 685.8872 | 0.326 | 0.07 | -2.134 | | 653.09 | 123.95 | 123.27 | 0.00 | 734.06 | 15.21 | 3013.88 | 16638.78 | 9687.46 | 968.75 | 10.59 | 22021.92 | 10570.52 | 3.26 | ********* | -29.67 | 10 | 43248.65 | 13.85 | 39526.56 | 13.87 | 0.31 | 0.22 |
| 25 | 30 | 0.3 | 0.15 | 478.38267 | | 0.08 | 0.09 | 43.05 | 403.61 | 70.98 | 70.33 | 0.00 | 465.64 | 12.36 | 1333.85 | 10554.58 | 4994.53 | 499.45 | 15.85 | 13969.29 | 6705.26 | 2.07 | 8727.25 | 0.87 | 10 | 34992.75 | 18.79 | 34988.17 | 18.81 | 0.40 | 0.14 |
| 26 | 30 | 0.5 | 2.05 | 649.92267 | 0.772 | 0.08 | -2.134 | | 622.50 | 82.23 | 75.45 | 0.00 | 744.47 | 8.96 | 1800.42 | 16874.64 | 3787.07 | 378.71 | 14.93 | 22334.09 | 10720.36 | 3.31 | ********* | -28.11 | 10 | 39428.22 | 18.24 | 26970.17 | 18.25 | 0.57 | 0.15 |
| 27 | 30 | 0.5 | 0.75 | 707.4176 | 0.348 | 0.07 | -2.134 | | 667.25 | 70.23 | 67.01 | 0.00 | 809.38 | 7.63 | 1667.06 | 18350.37 | 5358.40 | 535.84 | 6.29 | 24287.23 | 11657.88 | 3.59 | ********* | -30.60 | 10 | 41839.37 | 9.88 | 30554.33 | 9.88 | 0.58 | 0.13 |
| 28 | 30 | 0.5 | 0.92 | 580.6656 | 0.494 | 0.07 | -2.134 | | 540.02 | 38.34 | 34.38 | 0.00 | 657.32 | 7.33 | 1301.31 | 14899.26 | 4182.78 | 418.28 | 6.94 | 19719.61 | 9465.41 | 2.92 | ********* | -25.12 | 10 | 33786.08 | 9.86 | 26766.67 | 9.85 | 0.58 | 0.12 |
| 29 | 30 | 0.3 | 0.41 | 587.44229 | 0.15 | 0.05 | -2.134 | | 558.07 | 99.67 | 97.91 | 0.00 | 635.94 | 13.56 | 2327.47 | 14414.64 | 7481.15 | 748.11 | 3.79 | 19078.20 | 9157.53 | 2.82 | ********* | -23.41 | 10 | 36464.99 | 6.61 | 27683.33 | 6.64 | 0.52 | 0.21 |
| 30 | 30 | 0.3 | 0.08 | 624.348 | 0.412 | 0.06 | -2.134 | | 593.06 | 83.54 | 83.18 | 0.00 | 696.11 | 10.71 | 2013.23 | 15778.45 | 6471.10 | 647.11 | 8.93 | 20883.24 | 10023.95 | 3.09 | ********* | -27.01 | 10 | 38025.40 | 12.02 | 25868.33 | 12.03 | 0.55 | 0.17 |
| 31 | 30 | 0.3 | 0.09 | 797.8608 | 0.448 | 0.03 | -2.134 | | 772.38 | 123.46 | 123.10 | 0.00 | 885.16 | 13.00 | 3107.76 | 20063.53 | 9989.23 | 998.92 | 14.98 | 26554.67 | 12746.24 | 3.93 | ********* | -34.51 | 10 | 50289.07 | 18.91 | 38921.47 | 18.93 | 0.53 | 0.20 |
| 32 | 30 | 0.3 | 0.24 | 596.4 | 0.414 | 0.04 | 0.062 | 36.98 | 534.97 | 130.50 | 129.45 | 0.00 | 573.21 | 19.39 | 3011.01 | 13038.12 | 9678.24 | 967.82 | 13.49 | 17256.33 | 8283.04 | 2.55 | 7495.30 | 0.75 | 10 | 43881.62 | 16.79 | 43798.33 | 16.78 | 0.39 | 0.22 |
| 33 | 30 | 0.3 | 0.11 | 672.73381 | 0.33 | 0.08 | -2.134 | | 636.81 | 103.60 | 103.15 | 0.00 | 731.65 | 12.76 | 2520.30 | 16584.01 | 8100.96 | 810.10 | 8.97 | 21949.43 | 10535.72 | 3.25 | ********* | -29.10 | 10 | 41396.21 | 12.21 | 31338.00 | 12.23 | 0.53 | 0.20 |
| 34 | 30 | 0.3 | 1.49 | 790.97387 | 0.118 | 0.07 | -2.134 | | 746.78 | 114.53 | 108.13 | 0.00 | 868.31 | 11.61 | 2731.63 | 19681.62 | 8748.11 | 874.81 | 3.50 | 26049.20 | 12503.62 | 3.86 | ********* | -34.21 | 10 | 48175.75 | 7.35 | 29638.89 | 7.38 | 0.54 | 0.18 |
| 35 | 30 | 0.3 | 0.14 | 635.10533 | 0.198 | 0.05 | -2.134 | | 603.35 | 101.43 | 100.83 | 0.00 | 691.03 | 13.06 | 2437.07 | 15663.43 | 7833.43 | 783.34 | 5.22 | 20731.02 | 9950.89 | 3.07 | ********* | -27.47 | 10 | 39298.68 | 8.29 | 38949.17 | 8.30 | 0.53 | 0.20 |
| 36 | 30 | 0.3 | 0.08 | 616.45867 | 0.332 | 0.10 | 0.094 | 57.95 | 531.15 | 101.64 | 101.29 | 0.00 | 599.43 | 14.69 | 2377.67 | 13586.98 | 7642.52 | 764.25 | 8.56 | 17982.76 | 8631.73 | 2.66 | 11746.04 | 1.17 | 10 | 46642.34 | 12.46 | 46655.08 | 12.36 | 0.39 | 0.16 |
| 37 | 30 | 0.3 | 0.28 | 592.56667 | 0.248 | 0.10 | 0.044 | 26.07 | 514.23 | 124.00 | 122.80 | 0.00 | 555.57 | 18.89 | 2833.95 | 12592.97 | 9109.12 | 910.91 | 7.39 | 16667.17 | 8000.24 | 2.47 | 5285.03 | 0.53 | 10 | 39852.38 | 10.59 | 39984.00 | 10.59 | 0.42 | 0.23 |
| Average 1 | 20 | 1 | 2 | 597 | 0.300 | 0.06 | 0.11 | 40.44 | 523.36 | 95.59 | 82.50 | 0.00 | 613.17 | 11.21 | 1281.45 | 9245.68 | 3861.81 | 386.18 | 5.80 | 12265.40 | 5886.43 | 2.72 | 8198.15 | 1.23 | 10 | 27813.35 | 9.34 | 26077.22 | 9.33 | 0.44 | 0.14 |
| Averages above are for sewage batches 1 to 3 i.e. Configuration 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 2 | 40 | 1 | 0 | 581 | 0.221 | 0.07 | 0.09 | 45.56 | 503.31 | 85.29 | 84.24 | 0.00 | 544.63 | 13.29 | 2572.11 | 17560.11 | 7112.10 | 581.88 | 4.54 | 21785.20 | 8555.78 | 2.79 | 11882.81 | 1.11 | 8 | 47963.01 | 8.25 | 47563.40 | 8.26 | 0.46 | 0.15 |
| Averages above are for sewage batches 4 to 19 i.e. Configuration 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 3 | 30 | 1 | 1 | 575 | 0.341 | 0.07 | 0.19 | 74.64 | 469.28 | 86.82 | 83.12 | 0.00 | 536.78 | 12.98 | 1913.13 | 12345.16 | 6149.36 | 614.94 | 9.38 | 16198.95 | 7728.46 | 2.38 | 20172.33 | 2.02 | 10 | 45752.39 | 13.28 | 44805.90 | 13.28 | 0.37 | 0.14 |
| Averages above are for sewage batches 22 to 25 i.e. Configuration 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 4 | 30 | 1 | 1 | 642 | 0.348 | 0.07 | 0.07 | 15.80 | 592.64 | 98.29 | 96.08 | 0.00 | 682.54 | 12.76 | 2388.34 | 15470.84 | 7419.67 | 741.97 | 9.84 | 20476.11 | 9828.53 | 3.03 | 8175.46 | 0.82 | 10 | 41675.53 | 12.39 | 34625.01 | 12.40 | 0.49 | 0.18 |
| Averages above are for sewage batches 26 to 37 i.e. Configuration 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 5 | 33 | 1 | 1 | 610 | 0.291 | 0.07 | 0.115 | 36.34 | 548.31 | 92.17 | 89.27 | 0.00 | 609.59 | 12.89 | 2267.32 | 15338.65 | 6854.55 | 636.93 | 6.79 | 19755.11 | 8769.53 | 2.85 | 12107.19 | 1.29 | 9 | 43384.37 | 10.37 | 39765.37 | 10.37 | 0.46 | 0.16 |
| Averages above are for sewage batches 1 to 37 i.e. average over entire investigation. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Known Parameters | |
|---|---|
| K | 0.06 |
| $Y_{h,o}$ | 0.45 |
| $f_{c}$ | 0.15 |
| $f_{e,o}$ | 0.25 |
| $b_o$ | 0.04 |
| $f_{XBG,P}$ | 0.38 |
| $f_{XE,P}$ | 0.03 |
| fcv | 1.48 |
| $f_{XBH,P}$ | 0.03 |
| $f_{XBO,P}$ | 0.03 |
| $f_{XI,P}$ | 0.03 |
| $b_H$ | 0.24 |
| N | 1 |
| a | 1 |
| $f_{e,H}$ | 0.2 |

The measured mass of VSS ie. $MXv_{meas}$ is found from the measured MLVSS concentration and the total process volume Vp, taking due consideration that the anaerobic reactor has a lower concentration than the subsequent reactors.

$MXv = Xva[(Vp-Van) + Van/(1+s)]$

where

$Xva$ = MLVSS concentration in the aerobic reactor (mg/l)

$Vp$ = total volume of reactors

$Van$ = volume of anaerobic reactor

$s$ = recycle to anaerobic reactor

External Nitrification BNRAS system $f_{XBG,P}$ calculation with $f_{S,up}$ fraction using the model of Wentzel *et al.* (1990)

| Sewage Batch | Q (l/d) | a ratio | $NO_{3,s}$ mgN/l | Sti mgCOD/l | $f_{XBG,P}$ gP/mgAVSS | $f_{S,us}$ fraction | $f_{S,up}$ fraction | $S_{ups}$ mgCOD/l | Sbi mgCOD/l | Sbsi mgCOD/l | $S'_{bsi}$ mgCOD/l | INPUT $S_{bsai}$ mgCOD/l | 9th iteration $MX_{BH}/Q$ mgAVSS/d | 9th iteration $S_{bsai}$ mgCOD/l | $MS_{seq}$ mgCOD/l | $MS_{bH}$ mgCOD/l | $MX_{B,G}$ mgVASS/d | $MX_{E,G}$ mgVESS/d | $\Delta P_G$ mgP/l Inf | $MX_{B,H}$ mgVASS/d | $MX_{E,H}$ mgVESS/d | $\Delta P_H$ mgP/l Inf | $MX_I$ mgAVSS/d | $\Delta P_I$ mgP/l Inf | Kd d | $MX_{V(calc)}$ mgVSS | $\Delta P_{(calc)}$ mgP/l Inf | $MX_{V(meas)}$ mgVSS | $\Delta P_{(meas)}$ mgP/l Inf | fav,OHO | fav,PAO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| test | 1 | 1 | 1 | 500.00 | 0.38 | 0.07 | 0.13 | 65.00 | 400.00 | 96.00 | 87.40 | 0.00 | 525.38 | 12.99 | 61.42 | 338.58 | 307.10 | 61.42 | 5.93 | 525.38 | 504.37 | 1.54 | 878.38 | 1.32 | 20 | 2276.65 | 8.79 | 43261.49 | 10.40 | | |
| 1 | 20 | 1 | 0.99 | 683.23 | 0.175 | 0.07 | 0.13 | 88.82 | 546.59 | 92.00 | 83.49 | 0.00 | 641.36 | 10.74 | 1240.05 | 9691.67 | 3985.86 | 398.59 | 3.55 | 12827.21 | 6157.06 | 2.85 | 12002.72 | 1.80 | 10 | 35371.44 | 8.20 | 21536.67 | 8.21 | 0.36 | 0.11 |
| 2 | 20 | 1 | 1.81 | 528.31 | 0.287 | 0.07 | 0.13 | 68.68 | 424.73 | 102.77 | 87.24 | 0.00 | 483.06 | 13.74 | 1195.03 | 7299.64 | 3841.16 | 384.12 | 5.57 | 9661.28 | 4637.42 | 2.14 | 9281.04 | 1.79 | 10 | 27805.01 | 9.11 | 28413.00 | 9.11 | 0.35 | 0.14 |
| 3 | 20 | 1 | 1.77 | 579.56 | 0.569 | 0.03 | 0.13 | 75.34 | 486.83 | 92.00 | 76.78 | 0.00 | 571.18 | 10.75 | 1105.46 | 8631.10 | 3533.25 | 355.33 | 6.61 | 11423.52 | 5483.29 | 2.34 | 10181.41 | 1.53 | 10 | 30996.79 | 10.67 | 28280.00 | 10.68 | 0.37 | 0.11 |
| 4 | 40 | 0.5 | 0.06 | 545.07 | 0.475 | 0.09 | 0.13 | 70.86 | 426.86 | 89.23 | 88.99 | 0.00 | 446.38 | 16.13 | 2591.83 | 14482.52 | 7068.62 | 563.49 | 10.55 | 17855.16 | 6856.36 | 2.32 | 15320.79 | 1.44 | 8 | 47666.45 | 14.30 | 39622.00 | 14.32 | 0.37 | 0.15 |
| 5 | 40 | 0.5 | 0.13 | 615.50 | 0.361 | 0.05 | 0.13 | 80.01 | 502.79 | 40.88 | 40.31 | 0.00 | 581.26 | 5.99 | 1253.06 | 18838.61 | 3417.42 | 273.39 | 3.88 | 23250.34 | 8928.13 | 3.02 | 17300.53 | 1.62 | 8 | 53169.81 | 6.52 | 37192.22 | 8.52 | 0.44 | 0.06 |
| 6 | 40 | 0.5 | 0.11 | 537.17 | 0.245 | 0.11 | 0.13 | 69.83 | 406.71 | 37.22 | 36.74 | 0.00 | 468.02 | 6.43 | 1083.75 | 15184.56 | 2955.68 | 236.45 | 2.27 | 18720.69 | 7188.74 | 2.43 | 15098.69 | 1.42 | 8 | 44200.26 | 6.11 | 51021.67 | 6.11 | 0.42 | 0.07 |
| 7 | 40 | 0.5 | 0.31 | 582.80 | 0.151 | 0.05 | 0.13 | 75.76 | 479.81 | 56.90 | 55.58 | 0.00 | 539.21 | 8.75 | 1696.20 | 17494.31 | 4631.46 | 370.52 | 2.22 | 21568.32 | 8282.24 | 2.80 | 16381.49 | 1.54 | 8 | 51234.03 | 6.55 | 56310.83 | 6.54 | 0.42 | 0.09 |
| 8 | 40 | 0.5 | 0.33 | 598.06 | 0.091 | 0.09 | 0.13 | 77.75 | 467.39 | 102.47 | 101.05 | 0.00 | 483.59 | 17.27 | 3006.02 | 15689.72 | 8198.24 | 655.86 | 2.39 | 19343.48 | 7427.90 | 2.51 | 16810.41 | 1.58 | 8 | 52435.89 | 6.48 | 47970.00 | 6.50 | 0.37 | 0.16 |
| 9 | 40 | 0.5 | 0.33 | 627.64 | 0.205 | 0.03 | 0.13 | 81.59 | 524.32 | 142.80 | 141.38 | 0.00 | 514.75 | 23.05 | 4271.94 | 16700.89 | 11650.76 | 932.06 | 7.48 | 20590.14 | 7906.61 | 2.67 | 17641.77 | 1.65 | 8 | 58721.34 | 11.80 | 60524.44 | 11.82 | 0.35 | 0.20 |
| 10 | | | | | | | 0.13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 40 | 0.5 | 0.32 | 585.54 | 0.121 | 0.05 | 0.13 | 76.12 | 480.84 | 109.98 | 108.62 | 0.00 | 492.75 | 18.30 | 3246.64 | 15986.98 | 8854.48 | 708.36 | 3.41 | 19709.97 | 7568.63 | 2.56 | 16458.55 | 1.54 | 8 | 53300.00 | 7.51 | 41580.00 | 7.52 | 0.37 | 0.17 |
| 12 | 40 | 0.5 | 0.13 | 538.07 | 0.085 | 0.07 | 0.13 | 69.95 | 428.00 | 92.00 | 90.59 | 0.00 | 446.35 | 16.42 | 2638.47 | 14481.42 | 7195.82 | 575.67 | 1.97 | 17853.81 | 6855.86 | 2.32 | 15124.02 | 1.42 | 8 | 47605.18 | 5.70 | 39162.93 | 5.72 | 0.38 | 0.15 |
| 13 | 40 | 0.5 | 0.05 | 613.14 | 0.041 | 0.08 | 0.13 | 79.71 | 485.83 | 108.97 | 108.76 | 0.00 | 498.47 | 18.17 | 3260.30 | 16172.71 | 8891.72 | 711.34 | 1.21 | 19938.95 | 7656.56 | 2.59 | 17234.26 | 1.62 | 8 | 54432.83 | 5.41 | 49665.00 | 5.42 | 0.37 | 0.16 |
| 14 | | | | | | | 0.13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | 0.13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | 40 | 0.5 | 0.30 | 620.50 | 0.235 | 0.06 | 0.13 | 80.67 | 503.34 | 73.00 | 71.70 | 0.00 | 552.64 | 11.08 | 2203.45 | 17929.95 | 6009.40 | 480.75 | 4.46 | 22105.42 | 8488.48 | 2.87 | 17441.08 | 1.64 | 8 | 54525.14 | 8.96 | 51571.67 | 8.95 | 0.41 | 0.11 |
| 17 | 40 | 0.5 | 0.35 | 558.50 | 0.151 | 0.09 | 0.13 | 72.61 | 433.51 | 92.00 | 90.52 | 0.00 | 452.89 | 16.23 | 2646.64 | 14693.73 | 7218.11 | 577.45 | 3.46 | 18115.56 | 6956.37 | 2.35 | 13698.38 | 1.47 | 8 | 48565.87 | 7.28 | 49243.33 | 7.30 | 0.37 | 0.15 |
| 18 | 40 | 0.5 | 0.30 | 575.00 | 0.351 | 0.10 | 0.13 | 74.75 | 440.90 | 78.00 | 76.70 | 0.00 | 507.13 | 12.65 | 2309.10 | 15326.70 | 7422.11 | 742.21 | 6.37 | 20285.34 | 9736.97 | 2.25 | 20202.70 | 1.52 | 10 | 58389.34 | 10.34 | 46896.67 | 10.33 | 0.35 | 0.13 |
| 19 | | | | | | | 0.13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 30 | 0.5 | 0.20 | 587.52 | 0.169 | 0.09 | 0.13 | 76.38 | 459.73 | 102.00 | 101.12 | 0.00 | 507.71 | 16.66 | 2283.95 | 11508.08 | 7341.27 | 734.13 | 4.70 | 15231.29 | 7311.02 | 2.25 | 15481.95 | 1.55 | 10 | 46099.64 | 8.50 | 47235.83 | 8.52 | 0.33 | 0.16 |
| 21 | | | | | | | 0.13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 30 | 0.5 | 1.63 | 515.67 | 0.495 | 0.05 | 0.13 | 67.04 | 424.07 | 63.00 | 55.97 | 0.00 | 505.56 | 9.25 | 1262.88 | 11459.36 | 4059.25 | 405.93 | 6.74 | 15166.79 | 7280.06 | 2.24 | 13588.51 | 1.36 | 10 | 40500.54 | 10.34 | 56888.33 | 10.33 | 0.37 | 0.10 |
| 23 | 30 | 0.5 | 0.75 | 618.22 | 0.285 | 0.06 | 0.13 | 80.37 | 498.19 | 86.16 | 82.91 | 0.00 | 574.32 | 12.43 | 1927.93 | 13017.88 | 6196.93 | 619.69 | 5.95 | 17229.55 | 8270.19 | 2.55 | 16290.97 | 1.63 | 10 | 48607.33 | 10.13 | 47825.56 | 10.12 | 0.35 | 0.13 |
| 24 | 30 | 0.5 | 0.16 | 685.89 | 0.299 | 0.07 | 0.13 | 89.17 | 550.54 | 123.95 | 123.27 | 0.00 | 600.93 | 17.84 | 2895.19 | 13621.04 | 9305.97 | 930.60 | 9.37 | 18027.85 | 8653.37 | 2.67 | 18074.05 | 1.81 | 10 | 54991.83 | 13.84 | 39520.56 | 13.87 | 0.33 | 0.17 |
| 25 | 30 | 0.5 | 0.15 | 478.38 | 0.955 | 0.08 | 0.13 | 62.19 | 377.36 | 70.98 | 70.33 | 0.00 | 432.26 | 13.05 | 1522.85 | 9797.93 | 4894.89 | 489.49 | 15.63 | 12967.85 | 6224.57 | 1.92 | 12606.03 | 1.26 | 10 | 37182.82 | 18.81 | 34989.17 | 18.81 | 0.35 | 0.13 |
| 26 | 30 | 0.5 | 2.05 | 649.92 | 0.748 | 0.08 | 0.13 | 84.49 | 510.59 | 82.25 | 73.45 | 0.00 | 599.71 | 10.65 | 1724.29 | 13593.46 | 5542.35 | 554.24 | 13.87 | 17991.34 | 8635.85 | 2.66 | 17126.34 | 1.71 | 10 | 49850.12 | 18.25 | 26970.17 | 18.25 | 0.36 | 0.11 |
| 27 | 30 | 0.5 | 0.75 | 707.42 | 0.286 | 0.07 | 0.13 | 91.96 | 566.12 | 70.23 | 67.01 | 0.00 | 678.09 | 8.81 | 1613.64 | 15370.01 | 5186.69 | 518.67 | 5.00 | 20342.66 | 9764.48 | 3.01 | 18641.41 | 1.86 | 10 | 54433.91 | 9.87 | 30554.33 | 9.88 | 0.37 | 0.10 |
| 28 | 30 | 0.5 | 0.92 | 580.67 | 0.431 | 0.07 | 0.13 | 75.49 | 464.15 | 58.34 | 54.38 | 0.00 | 558.87 | 8.33 | 1236.34 | 12667.82 | 4038.87 | 403.89 | 5.84 | 16766.24 | 8047.79 | 2.48 | 15301.32 | 1.57 | 10 | 44558.11 | 9.85 | 26766.67 | 9.85 | 0.38 | 0.09 |
| 29 | 30 | 0.5 | 0.41 | 587.44 | 0.111 | 0.05 | 0.13 | 76.37 | 479.14 | 99.67 | 97.91 | 0.00 | 535.33 | 15.50 | 2240.04 | 12134.07 | 7200.14 | 720.01 | 2.74 | 16039.80 | 7708.71 | 2.38 | 15479.90 | 1.55 | 10 | 47168.56 | 6.66 | 27683.33 | 6.64 | 0.34 | 0.15 |
| 30 | 30 | 0.5 | 0.08 | 624.33 | 0.371 | 0.06 | 0.13 | 81.17 | 508.23 | 83.54 | 83.18 | 0.00 | 586.92 | 12.26 | 1943.39 | 13303.58 | 6246.62 | 624.66 | 7.79 | 17607.68 | 8451.69 | 2.61 | 16432.41 | 1.65 | 10 | 49383.06 | 12.04 | 25868.33 | 12.03 | 0.36 | 0.13 |
| 31 | 30 | 0.5 | 0.09 | 797.86 | 0.415 | 0.03 | 0.13 | 103.72 | 668.65 | 123.46 | 123.10 | 0.00 | 751.63 | 14.89 | 3022.68 | 17036.96 | 9715.74 | 971.57 | 13.47 | 22548.91 | 10823.48 | 3.34 | 21024.71 | 2.10 | 10 | 65084.42 | 18.91 | 38921.67 | 18.93 | 0.35 | 0.15 |
| 32 | 30 | 0.5 | 0.24 | 596.40 | 0.405 | 0.04 | 0.13 | 77.53 | 494.09 | 130.50 | 129.45 | 0.00 | 523.96 | 20.83 | 2946.27 | 11876.45 | 9470.14 | 947.01 | 12.88 | 15718.83 | 7545.04 | 2.33 | 15713.95 | 1.57 | 10 | 49396.97 | 16.78 | 43798.33 | 16.78 | 0.32 | 0.19 |
| 33 | 30 | 0.5 | 0.11 | 672.72 | 0.297 | 0.08 | 0.13 | 87.45 | 533.96 | 103.60 | 103.15 | 0.00 | 599.88 | 14.95 | 2421.61 | 13597.33 | 7783.75 | 778.38 | 7.78 | 17996.47 | 8638.30 | 2.66 | 17727.18 | 1.77 | 10 | 52924.08 | 12.22 | 21330.00 | 12.23 | 0.34 | 0.15 |
| 34 | 30 | 0.5 | 1.49 | 790.97 | 0.071 | 0.07 | 0.13 | 102.83 | 632.71 | 114.55 | 108.13 | 0.00 | 721.16 | 13.53 | 2635.05 | 16346.33 | 8469.82 | 846.98 | 2.09 | 21634.85 | 10384.73 | 3.20 | 20843.23 | 2.08 | 10 | 62179.61 | 7.38 | 29638.89 | 7.38 | 0.35 | 0.14 |
| 35 | 30 | 0.5 | 0.14 | 635.11 | 0.155 | 0.05 | 0.13 | 82.56 | 523.30 | 101.42 | 100.83 | 0.00 | 588.60 | 14.83 | 2357.35 | 13341.63 | 7577.20 | 757.72 | 3.99 | 17638.04 | 8475.86 | 2.61 | 16735.88 | 1.67 | 10 | 51204.70 | 8.28 | 38949.17 | 8.30 | 0.34 | 0.15 |
| 36 | 30 | 0.5 | 0.08 | 616.46 | 0.537 | 0.10 | 0.13 | 80.14 | 473.30 | 101.64 | 101.29 | 0.00 | 524.68 | 16.28 | 2306.20 | 11892.68 | 7412.77 | 741.28 | 8.40 | 15740.32 | 7555.31 | 2.33 | 16244.52 | 1.62 | 10 | 47694.24 | 12.36 | 46655.00 | 12.36 | 0.33 | 0.16 |
| 37 | 30 | 0.5 | 0.28 | 592.37 | 0.231 | 0.10 | 0.13 | 77.03 | 459.03 | 124.00 | 122.80 | 0.00 | 486.48 | 20.89 | 2744.02 | 11026.98 | 8820.07 | 882.01 | 6.88 | 14594.54 | 7005.38 | 2.16 | 15614.93 | 1.56 | 10 | 46916.92 | 10.60 | 39904.00 | 10.59 | 0.31 | 0.19 |
| Average 1 | 20 | 1 | 2 | 597.03 | 0.277 | 0.06 | 0.130 | 77.61 | 486.05 | 96 | 82.50 | 0.00 | 565.20 | 11.75 | 1180.18 | 8546.80 | 3793.42 | 379.34 | 5.24 | 11304.80 | 5425.92 | 2.51 | 10488.39 | 1.57 | 10 | 31391.08 | 9.32 | 26077.22 | 9.33 | 0.36 | 0.12 |
| Averages above are for sewage batches 1 to 3 i.e. Configuration 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 2 | 40 | 1 | 0 | 583.08 | 0.209 | 0.07 | 0.130 | 75.80 | 465.02 | 85 | 84.24 | 0.00 | 498.62 | 14.21 | 2517.45 | 16083.51 | 6959.49 | 569.13 | 4.15 | 19944.77 | 7821.07 | 2.56 | 16726.06 | 1.54 | 8 | 52820.51 | 8.25 | 47563.40 | 8.26 | 0.38 | 0.13 |
| Averages above are for sewage batches 4 to 19 i.e. Configuration 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 3 | 30 | 1 | 1 | 574.54 | 0.509 | 0.07 | 0.130 | 74.69 | 462.54 | 86 | 83.12 | 0.00 | 528.27 | 13.14 | 1902.21 | 11974.85 | 6114.26 | 611.43 | 9.42 | 15848.01 | 7607.05 | 2.35 | 15139.89 | 1.51 | 10 | 45320.63 | 13.28 | 44805.90 | 13.28 | 0.35 | 0.13 |
| Averages above are for sewage batches 22 to 25 i.e. Configuration 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 4 | 30 | 1 | 1 | 642.29 | 0.360 | 0.07 | 0.130 | 83.56 | 515.96 | 98 | 96.08 | 0.00 | 584.19 | 14.34 | 2237.14 | 13241.61 | 7198.80 | 719.88 | 8.11 | 17525.66 | 8412.52 | 2.59 | 16925.26 | 1.69 | 10 | 50773.11 | 12.40 | 34625.01 | 12.40 | 0.35 | 0.14 |
| Averages above are for sewage batches 26 to 37 i.e. Configuration 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Average 5 | 33 | 1 | 1 | 610.18 | 0.294 | 0.07 | 0.130 | 79.32 | 489.43 | 92 | 89.27 | 0.00 | 545.47 | 13.96 | 2214.18 | 13756.75 | 6692.39 | 621.68 | 6.21 | 17784.13 | 7640.83 | 2.55 | 16897.72 | 1.61 | 9 | 48956.76 | 10.37 | 39765.37 | 10.37 | 0.36 | 0.14 |
| Averages above are for sewage batches 1 to 37 i.e. average over entire investigation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## APPENDIX D

- Design and Operating Parameters of UCT Control System.
- Daily Results of UCT Control System
- Figures D1 to D18 : Graphs of Daily Results.

Table D1: Design and operating parameters of the laboratory scale UCT system.

| Parameter | Value | Units |
|---|---|---|
| **System:** | | |
| Sludge age | 8 | days |
| Temperature | 20 | $^0C$ |
| pH of anaerobic reactor | 7.2 - 8.2 | |
| ph of aerobic reactor | 7.2 - 8.2 | |
| DO in aerobic eactor | 2.0 - 5.0 | mg/l |
| | | |
| **Influent:** Mitchells Plain (Raw) unsettled wastewater | | |
| Flow | 20 | l/d |
| COD concentration | 755 | mgCOD/l |
| TKN/VSS ratio | 0.10 | mgN/mgVSS |
| Total P removal/l influent COD | 0.020 | mgP/mgCOD |
| | | |
| **Reactor Volumes (l) and Mass Fractions:** | | |
| Anaerobic | 3* | 15% |
| Anoxic | 7 | 35% |
| Aerobic | 10 | 50% |
| Unaerated mass fraction | 10 | 50% |
| | | |
| **Recycles:** | | |
| Anoxic to anaerobic (r-recycle) | 1:1 | |
| Aerobic to anoxic (a-recycle) | 2:1 | |
| Underflow (s-recycle) | 1:1 | |
| | | |
| * actual volume is 6l, but with r = 1:1 the VSS concentration in the anaerobic reactor is half that in the remainder of the system; therefore equivalent volume at system VSS concentration is 3l. | | |

# D .2

**Daily Tests on Control System (System 2)**

| | | | | COD | | | | FSA | | | TKN | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Day No. | 1998 | | OUR | Sys Infl. mgCOD/l | Reactor mgCOD/l | UE mgCOD/l | FE mgCOD/l | Influent mgN/l | UE mgN/l | FE mgN/l | Influent mgN/l | Reactor mgN/l | UE mgN/l | FE mgN/l | OSVI ml/g | TSS mg/l | VSS mg/l | COD/VSS | TKN/VSS |
| 1 | Thursday | 26 February | 49.000 | 654 | | 152 | 102 | 47.2 | 14.8 | 12.2 | 72.7 | | 20.9 | 16.9 | 95 | 2314 | 2022 | 1.48 | 0.10 |
| 2 | Friday | 27 February | 32.500 | 715 | | 110 | 69 | 46.2 | 8.5 | 6.6 | 72.2 | | 12.9 | 10.1 | 84 | 2262 | 1984 | 1.48 | 0.10 |
| 3 | Saturday | 28 February | 29.900 | 867 | | 93 | 85 | 55.0 | 3.1 | 2.1 | 68.2 | | 6.9 | 4.1 | 110 | 2178 | 1888 | 1.48 | 0.10 |
| 4 | Sunday | 01 March | 34.500 | 732 | | 73 | 47 | 54.7 | 3.5 | 2.7 | 88.3 | | 6.9 | 5.9 | 120 | 2154 | 1864 | 1.48 | 0.10 |
| 5 | Monday | 02 March | 35.850 | 959 | | 106 | 91 | 53.3 | 2.1 | 1.7 | 70.3 | | 2.9 | 1.8 | 119 | 2178 | 1834 | 1.48 | 0.10 |
| 6 | Tuesday | 03 March | 44.200 | 650 | | 81 | 71 | 53.1 | 1.7 | 1.5 | 67.5 | | 3.2 | 2.9 | 108 | 2400 | 1992 | 1.48 | 0.10 |
| 7 | Wednesday | 04 March | 42.500 | 662 | | 71 | 35 | 52.8 | 1.8 | 1.0 | 88.9 | | 4.5 | 3.8 | 119 | 2276 | 1878 | 1.48 | 0.10 |
| 8 | Thursday | 05 March | 39.300 | 642 | 2641.80 | 75 | 37 | 54.3 | 3.4 | 2.7 | 72.5 | 141.4 | 3.9 | 2.8 | 104 | 2396 | 1952 | 1.35 | 0.07 |
| 9 | Friday | 06 March | 41.100 | 764 | 2804.16 | 71 | 71 | 59.9 | 2.9 | 2.4 | 79.9 | 190.4 | 5.2 | 4.1 | 117 | 2398 | 1938 | 1.45 | 0.10 |
| 10 | Saturday | 07 March | 40.200 | 744 | 2458.72 | 61 | 39 | 52.9 | 1.7 | 0.0 | 77.8 | 211.4 | 4.9 | 3.6 | 114 | 2372 | 1860 | 1.32 | 0.11 |
| 11 | Sunday | 08 March | 42.600 | 711 | 2418.08 | 45 | 39 | 51.4 | 1.7 | 1.4 | 78.5 | 171.5 | 3.6 | 3.2 | 110 | 2354 | 1870 | 1.29 | 0.09 |
| 12 | Monday | 09 March | 41.200 | 875 | 2397.76 | 45 | 39 | 55.7 | 1.8 | 1.5 | 74.9 | 201.6 | 3.4 | 2.9 | 118 | 2288 | 1830 | 1.31 | 0.11 |
| 13 | Tuesday | 10 March | 41.800 | 740 | 1861.20 | 41 | 35 | 57.7 | 2.2 | 2.2 | 77.3 | 151.2 | 3.6 | 2.9 | 83 | 3024 | 2518 | 0.74 | 0.06 |
| 14 | Wednesday | 11 March | 41.900 | 724 | 2460.92 | 52 | 39 | 56.7 | 2.7 | 2.4 | 76.4 | 183.4 | 4.8 | 3.9 | 126 | 2060 | 1952 | 1.26 | 0.09 |
| 15 | Thursday | 12 March | 41.600 | 749 | 2460.92 | 70 | 41 | 55.7 | 1.7 | 1.4 | 76.3 | 168.7 | 3.4 | 2.7 | 124 | 2206 | 1800 | 1.37 | 0.09 |
| | End of Batch 2 | | 39.863 | 719.191 | 2437.92 | 76.434 | 55.982 | 53.769 | 3.569 | 2.784 | 73.323 | 177.450 | 6.059 | 4.779 | 110 | 2325 | 1945 | 1.36 | 0.10 |
| 16 | Friday | 13 March | 37.900 | 778 | 2647.04 | 56 | 39 | 49.1 | 2.9 | 2.8 | 70.6 | 176.4 | 3.5 | 3.2 | 128 | 2352 | 1852 | 1.43 | 0.10 |
| 17 | Saturday | 14 March | 36.200 | 778 | 2440.24 | 54 | 41 | 49.0 | 2.2 | 2.0 | 73.4 | 161.0 | 4.1 | 3.2 | 123 | 2278 | 1804 | 1.35 | 0.09 |
| 18 | Sunday | 15 March | 34.600 | 877 | 2419.56 | 50 | 25 | 54.0 | 1.7 | 1.4 | 74.8 | 171.5 | 3.1 | 2.4 | 130 | 2156 | 1708 | 1.42 | 0.10 |
| 19 | Monday | 16 March | 35.500 | 860 | 2398.88 | 37 | 29 | 51.2 | 2.1 | 2.0 | 73.5 | 151.2 | 4.1 | 3.1 | 123 | 2114 | 1690 | 1.42 | 0.09 |
| 20 | Tuesday | 17 March | 35.900 | 802 | 2502.28 | 70 | 29 | 50.7 | 4.1 | 2.1 | 76.6 | 184.8 | 5.9 | 2.2 | 133 | 2248 | 1832 | 1.37 | 0.10 |
| | End of Batch 3 | | 36.020 | 818.931 | 2481.60 | 53.354 | 32.674 | 50.820 | 2.604 | 2.044 | 73.752 | 168.980 | 4.116 | 2.828 | 127 | 2230 | 1777 | 1.40 | 0.10 |
| 21 | Wednesday | 18 March | 36.200 | 744 | 2564.32 | 52 | 31 | 51.2 | 1.7 | 1.7 | 71.5 | 176.4 | 4.5 | 3.6 | 123 | 2270 | 1832 | 1.40 | 0.10 |
| 22 | Thursday | 19 March | 33.200 | 720 | 2274.30 | 58 | 37 | 50.0 | 1.7 | 1.7 | 68.7 | 165.9 | 2.8 | 2.0 | 130 | 2156 | 1718 | 1.32 | 0.10 |
| 23 | Friday | 20 March | 33.300 | 756 | 2166.64 | 59 | 43 | 51.1 | 1.5 | 1.5 | 68.0 | 149.8 | 2.9 | 2.2 | 130 | 2008 | 1580 | 1.37 | 0.09 |
| 24 | Saturday | 21 March | 33.800 | 809 | 2248.40 | 49 | 37 | 51.4 | 2.1 | 1.7 | 74.3 | 152.6 | 3.1 | 2.2 | 130 | 2002 | 1850 | 1.22 | 0.08 |
| 25 | Sunday | 22 March | 33.200 | 719 | 2125.76 | 41 | 27 | 53.2 | 1.7 | 1.4 | 71.4 | 141.4 | 2.9 | 2.2 | 135 | 1920 | 1516 | 1.40 | 0.09 |
| 26 | Monday | 23 March | 33.500 | 777 | 2289.28 | 65 | 35 | 48.4 | 1.5 | 1.4 | 73.4 | 144.2 | 3.6 | 2.8 | 137 | 1872 | 1520 | 1.51 | 0.09 |
| 27 | Tuesday | 24 March | 34.300 | 801 | 2371.04 | 78 | 53 | 48.4 | 1.8 | 1.4 | 75.6 | 134.4 | 3.6 | 2.2 | 144 | 1944 | 1496 | 1.58 | 0.09 |
| 28 | Wednesday | 25 March | 34.100 | 711 | 2207.52 | 70 | 53 | 50.1 | 2.0 | 1.1 | 72.5 | 145.6 | 3.2 | 2.8 | 136 | 1984 | 1540 | 1.43 | 0.09 |
| | End of Batch 4 | | 33.850 | 754.826 | 2280.97 | 58.925 | 39.441 | 50.488 | 1.750 | 1.490 | 71.943 | 151.288 | 3.343 | 2.520 | 133 | 2020 | 1632 | 1.40 | 0.09 |
| 29 | Thursday | 26 March | 33.400 | 670 | 2105.32 | 53 | 29 | 63.6 | 4.2 | 2.9 | 73.6 | 161.0 | 4.5 | 3.5 | 144 | 1942 | 1500 | 1.40 | 0.11 |
| 30 | Friday | 27 March | 32.100 | 732 | 2555.00 | 87 | 49 | 35.4 | 2.1 | 2.1 | 49.8 | 144.2 | 3.6 | 2.4 | 140 | 2284 | 1808 | 1.41 | 0.08 |
| 31 | Saturday | 28 March | 28.000 | 852 | 2378.20 | 62 | 37 | 41.4 | 1.3 | 1.0 | 59.6 | 138.6 | 2.1 | 1.8 | 138 | 2102 | 1692 | 1.41 | 0.08 |
| 32 | Sunday | 29 March | 29.000 | 728 | 2130.04 | 41 | 31 | 38.9 | 1.5 | 1.1 | 54.2 | 151.2 | 2.1 | 1.4 | 143 | 2032 | 1692 | 1.26 | 0.09 |
| 33 | Monday | 30 March | 28.200 | 789 | 2440.24 | 60 | 50 | 36.1 | 2.4 | 1.8 | 59.1 | 131.6 | 2.7 | 2.0 | 149 | 1880 | 1600 | 1.53 | 0.06 |
| 34 | Tuesday | 31 March | 29.500 | 753 | 2212.78 | 50 | 35 | 36.8 | 1.7 | 1.3 | 56.0 | 144.9 | 2.4 | 1.5 | 149 | 1878 | 1434 | 1.54 | 0.10 |
| 35 | Wednesday | 01 April | 41.300 | 790 | 2543.64 | 60 | 52 | 39.5 | 1.7 | 1.7 | 57.3 | 154.0 | 2.2 | 2.0 | 155 | 2066 | 1782 | 1.43 | 0.09 |
| 36 | Thursday | 02 April | 42.800 | 728 | 2584.32 | 58 | 37 | 38.5 | 2.0 | 1.7 | 51.7 | 147.0 | 2.9 | 2.4 | 142 | 2118 | 1670 | 1.54 | 0.09 |
| | End of Batch 5 | | 33.013 | 752.764 | 2366.19 | 56.433 | 39.954 | 41.283 | 2.100 | 1.698 | 57.663 | 146.563 | 2.818 | 2.118 | 145 | 2038 | 1647 | 1.44 | 0.09 |
| 37 | Friday | 03 April | 41.900 | 740 | 2522.96 | 52 | 27 | 35.4 | 2.2 | 1.4 | 55.2 | 171.5 | 2.4 | 1.8 | 153 | 2096 | 1612 | 1.57 | 0.11 |
| 38 | Saturday | 04 April | | | | | | | | | | | | | | power | | | |
| 39 | Sunday | 05 April | | 720 | 2522.98 | 58 | 37 | 34.3 | 0.7 | 0.6 | 58.2 | 154.7 | 2.4 | 2.4 | 155 | 2064 | 1596 | 1.58 | 0.10 |
| 40 | Monday | 06 April | 43.400 | 790 | 2398.86 | 46 | 37 | 37.2 | 1.0 | 0.0 | 58.2 | 150.5 | 2.9 | 1.8 | 157 | 2032 | 1614 | 1.49 | 0.09 |
| 41 | Tuesday | 07 April | 39.600 | 877 | 2254.12 | 33 | 25 | 37.0 | 2.2 | 0.7 | 58.5 | 160.3 | 2.5 | 1.0 | 150 | 2000 | 1572 | 1.43 | 0.10 |
| 42 | Wednesday | 08 April | | | | | | | | | | | | | | | | | |
| 43 | Thursday | 09 April | 39.500 | 881 | 2479.04 | 45 | 37 | 67.3 | 1.7 | 1.3 | 99.3 | 187.6 | 6.3 | 2.4 | 140 | 2290 | 1786 | 1.40 | 0.11 |
| | End of Batch 6 | | 41.100 | 801.548 | 2435.59 | 46.166 | 32.540 | 42.252 | 1.568 | 0.784 | 66.080 | 154.920 | 3.304 | 1.876 | 151 | 1747 | 1632 | 1.07 | 0.07 |
| 44 | Friday | 10 April | 54.500 | 740 | 2397.76 | 37 | 28 | 73.3 | 2.0 | 2.2 | 102.7 | 157.5 | 2.3 | 3.1 | 157 | 2292 | 1814 | 1.32 | 0.09 |
| 45 | Saturday | 11 April | 80.570 | 760 | 2580.64 | 41 | 20 | 88.2 | 2.1 | 1.7 | 81.1 | 170.8 | 2.7 | 2.5 | 153 | 2224 | 1732 | 1.49 | 0.10 |
| 46 | Sunday | 12 April | | | | | | | | | | | | | | belt | | | |
| 47 | Monday | 13 April | 52.500 | 902 | 2296.16 | 81 | 20 | 59.2 | 3.4 | 1.8 | 91.4 | 173.6 | 5.3 | 3.6 | 156 | 2052 | 1650 | 1.39 | 0.11 |
| 48 | Tuesday | 14 April | 56.900 | 732 | 2336.80 | 37 | 28 | 83.2 | 2.2 | 0.8 | 101.6 | 165.2 | 3.1 | 1.3 | 151 | 2126 | 1666 | 1.40 | 0.10 |
| 49 | Wednesday | 15 April | 54.600 | 727 | 2275.84 | 35 | 14 | 74.5 | 1.8 | 1.8 | 102.5 | 174.3 | 2.9 | 2.9 | 155 | 2064 | 1674 | 1.36 | 0.10 |
| 50 | Thursday | 16 April | 48.800 | 740 | 2255.52 | 53 | 33 | 73.6 | 3.8 | 2.4 | 100.4 | 165.9 | 4.8 | 3.2 | 174 | 2008 | 1578 | 1.43 | 0.11 |
| | End of Batch 7 | | 54.645 | 766.743 | 2357.12 | 43.688 | 24.045 | 71.983 | 2.520 | 1.797 | 96.610 | 167.883 | 3.502 | 2.777 | 158 | 1823 | 1686 | 1.40 | 0.10 |
| 51 | Friday | 17 April | 44.600 | 744 | 2133.60 | 53 | 33 | 57.3 | 3.8 | 1.8 | 78.5 | 188.3 | 4.1 | 2.2 | 140 | 2142 | 1606 | 1.33 | 0.12 |
| 52 | Saturday | 18 April | | | | | | | | | | | | | | over | | | |
| 53 | Sunday | 19 April | 38.000 | 788 | 1971.04 | 81 | 37 | 48.8 | 2.0 | 1.8 | 77.7 | 141.4 | 3.2 | 2.4 | 191 | 1574 | 1236 | 1.59 | 0.11 |
| 54 | Monday | 20 April | 42.500 | 780 | 2332.32 | 70 | 64 | 53.1 | 3.2 | 2.2 | 79.2 | 166.6 | 3.5 | 3.5 | 161 | 1866 | 1562 | 1.49 | 0.11 |
| 55 | Tuesday | 21 April | 40.700 | 813 | 2518.08 | 54 | 50 | 47.7 | 1.4 | 0.8 | 75.7 | 127.4 | 2.4 | 1.7 | 143 | 1952 | 1560 | 1.81 | 0.08 |
| 56 | Wednesday | 22 April | 32.800 | 751 | 2146.56 | 50 | 41 | 53.9 | 2.7 | 2.2 | 55.0 | 131.6 | 3.1 | 2.9 | 143 | 1954 | 1536 | 1.40 | 0.09 |
| 57 | Thursday | 23 April | 34.100 | 751 | 1857.60 | 50 | 41 | 64.3 | 4.1 | 1.4 | 74.2 | 166.6 | 4.5 | 1.7 | 137 | 1896 | 1502 | 1.24 | 0.11 |
| 58 | Friday | 24 April | 32.100 | 731 | 2497.44 | 43 | 35 | 54.3 | 3.5 | 2.1 | 79.2 | 130.2 | 4.1 | 2.2 | 145 | 1656 | 1328 | 1.88 | 0.10 |
| 59 | Saturday | 25 April | 30.900 | 735 | 2270.40 | 50 | 45 | 51.9 | 3.1 | 3.1 | 64.8 | 147.0 | 4.8 | 4.3 | 150 | 1738 | 1364 | 1.66 | 0.11 |
| 60 | Sunday | 26 April | 40.100 | 817 | 2105.38 | 45 | 30 | 47.3 | 2.4 | 2.1 | 74.2 | 144.2 | 3.9 | 2.2 | 123 | 1864 | 1534 | 1.37 | 0.09 |
| 61 | Monday | 27 April | 42.400 | | | | | | | | | | | | | | | | |
| 62 | Tuesday | 28 April | 42.400 | 718 | 2724.48 | 37 | 0 | 50.0 | 3.1 | 2.4 | 68.2 | 176.4 | 4.9 | 2.5 | 125 | 1920 | 1424 | 1.91 | 0.12 |
| 63 | Wednesday | 29 April | 33.300 | 673 | 2683.20 | 45 | 29 | 47.3 | 2.7 | 2.8 | 67.3 | 133.0 | 2.8 | 2.9 | 118 | 2026 | 1578 | 1.70 | 0.08 |
| | End of Batch 8 | | 37.825 | 754.732 | 2294.55 | 50.687 | 36.770 | 52.335 | 2.890 | 2.075 | 73.105 | 150.245 | 3.742 | 2.609 | 143 | 1716 | 1475 | 1.32 | 0.09 |
| 64 | Thursday | 30 April | 37.100 | 852 | 2640.00 | 60 | 20 | 43.5 | 2.8 | 2.4 | 68.9 | 161.0 | 3.1 | 2.7 | 120 | 2090 | 1660 | 1.59 | 0.10 |
| 65 | Friday | 01 May | 42.900 | 796 | 1960.00 | 36 | 24 | 45.4 | 2.4 | 2.9 | 65.5 | 151.2 | 2.8 | 3.5 | 107 | 2052 | 1846 | 1.06 | 0.08 |
| 66 | Saturday | 02 May | 39.100 | 792 | 2240.00 | 44 | 36 | 44.5 | 3.1 | 0.8 | 63.6 | 127.4 | 3.6 | 1.1 | 143 | 1536 | 1214 | 1.85 | 0.10 |
| | End of Batch 9 | | 39.700 | 813.333 | 2280.00 | 46.667 | 26.667 | 44.473 | 2.753 | 2.053 | 65.987 | 148.533 | 3.173 | 2.427 | 123 | 1893 | 1573 | 1.50 | 0.09 |
| 67 | Sunday | 03 May | 41.200 | 744 | 2640.00 | 44 | 32 | 38.3 | 3.1 | 2.4 | 66.9 | 148.4 | 3.4 | 3.2 | 109 | 2020 | 1618 | 1.63 | 0.09 |
| 68 | Monday | 04 May | 39.000 | 768 | 1960.00 | 46 | 44 | 48.2 | 2.1 | 2.2 | 83.3 | 161.0 | 3.2 | 2.9 | 110 | 2008 | 1578 | 1.24 | 0.10 |
| 69 | Tuesday | 05 May | 39.200 | 776 | 1840.00 | 48 | 36 | 43.8 | 1.0 | 0.6 | 69.3 | 135.8 | 3.6 | 3.8 | 114 | 1936 | 1472 | 1.25 | 0.09 |
| 70 | Wednesday | 06 May | 40.800 | 860 | 1780.00 | 42 | 34 | 46.5 | 1.0 | 1.7 | 83.3 | 119.0 | 0.0 | 3.2 | 102 | 1760 | 1388 | 1.28 | 0.09 |
| 71 | Thursday | 07 May | 38.300 | 728 | 2040.00 | 72 | 36 | 45.1 | 1.5 | 0.0 | 63.7 | | 1.4 | 0.0 | 104 | 1640 | 1276 | 1.60 | |
| 72 | Friday | 08 May | 37.900 | 656 | 1920.00 | 64 | 40 | 37.5 | 2.8 | 1.5 | 67.3 | 163.8 | 4.3 | 2.8 | 95 | 1792 | 1390 | 1.38 | 0.12 |
| | End of Batch10 | | 39.387 | 755.333 | 2030.00 | 56.333 | 37.000 | 42.560 | 1.913 | 1.400 | 65.637 | 145.600 | 2.660 | 2.637 | 105 | 1859 | 1454 | 1.40 | 0.08 |
| 73 | Saturday | 09 May | | | | | | | | | | | | | | | | | |
| 74 | Sunday | 10 May | 31.600 | 739 | 2480.00 | 40 | 36 | 43.1 | 1.6 | 2.2 | 50.7 | 128.8 | 4.9 | 2.5 | 119 | 1683 | 1340 | 1.85 | 0.10 |
| 75 | Monday | 11 May | 32.800 | 788 | 2380.32 | 57 | 45 | 54.0 | 4.1 | 3.4 | 65.8 | 133.0 | 6.2 | 1.5 | 93 | 1942 | 1502 | 1.58 | 0.09 |
| 76 | Tuesday | 12 May | 33.600 | 644 | 1949.92 | 62 | 49 | 58.9 | 2.5 | 2.1 | 75.3 | 98.0 | 2.7 | 2.2 | 95 | 1886 | 1480 | 1.32 | 0.07 |
| 77 | Wednesday | 13 May | 33.800 | 788 | 2175.12 | 62 | 33 | 59.8 | 2.8 | 2.6 | 77.6 | 156.8 | 6.3 | 4.3 | | | | | |
| 78 | Thursday | 14 May | | 743 | 2216.16 | 74 | 53 | 58.2 | 6.9 | 6.4 | 79.9 | 158.2 | 8.5 | 7.4 | 112 | 1964 | 1612 | 1.37 | 0.10 |
| 79 | Friday | 15 May | 37.200 | 734 | 2257.20 | 82 | 66 | 62.4 | 2.2 | 2.2 | 82.7 | 138.6 | 5.0 | 4.6 | 108 | 1950 | 1490 | 1.51 | 0.09 |
| 80 | Saturday | 16 May | 35.400 | 722 | 2175.12 | 74 | 53 | 55.6 | 1.7 | 1.7 | 77.6 | 156.8 | 3.5 | 3.1 | 104 | 1920 | 1418 | 1.53 | 0.11 |
| 81 | Sunday | 17 May | 39.100 | 665 | 2462.40 | 74 | 25 | 60.5 | 2.8 | 5.2 | 88.2 | 176.4 | 3.1 | 5.6 | 133 | 1734 | 1320 | 1.87 | 0.13 |
| 82 | Monday | 18 May | 36.200 | 604 | 2162.40 | 45 | 61 | 64.7 | 2.5 | 1.7 | 80.9 | 126.0 | 3.9 | 2.9 | 118 | 1694 | 1316 | 1.64 | 0.10 |
| 83 | Tuesday | 19 May | 34.600 | 673 | 2570.40 | 82 | 57 | 52.8 | 1.8 | 2.0 | 75.0 | 128.8 | 0.4 | 2.5 | 126 | 1584 | 1250 | 2.06 | 0.10 |
| | End of Batch 11 | | 34.944 | 710.012 | 2282.90 | 65.875 | 47.852 | 57.008 | 2.892 | 2.988 | 75.404 | 140.140 | 4.446 | 3.682 | 112 | 1817 | 1414 | 1.47 | 0.09 |

# D .3

Daily Tests on Control System (System 2)

| | | | | COD | | | | FSA | | | TKN | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Day No. | 1998 | | OUR | Sys Infl. mgCOD/l | Reactor mgCOD/l | UE mgCOD/l | FE mgCOD/l | Influent mgN/l | UE mgN/l | FE mgN/l | Influent mgN/l | Reactor mgN/l | UE mgN/l | FE mgN/l | DSVI ml/g | TSS mg/l | VSS mg/l | COD/VSS | TKN/VSS |
| 84 | Wednesday | 20 May | 34.800 | 812 | 2040.00 | 35 | 8 | 58.0 | 2.2 | 1.8 | 74.5 | 154.0 | 4.8 | 3.5 | 131 | 1608 | 1280 | 1.59 | 0.12 |
| 85 | Thursday | 21 May | 38.000 | 763 | 1530.00 | 2 | 0 | 83.3 | | | 80.4 | 144.2 | 2.9 | 2.8 | 95 | 2214 | 1780 | 0.86 | 0.08 |
| 86 | Friday | 22 May | 37.000 | 840 | 1838.00 | 41 | 33 | 78.1 | 2.2 | 2.1 | 105.4 | 182.4 | 4.1 | 3.8 | 122 | 1644 | 1312 | 1.40 | 0.12 |
| 87 | Saturday | 23 May | 39.000 | 829 | 2570.40 | 49 | 41 | 73.2 | 6.7 | 2.8 | 103.7 | 112.0 | 8.3 | 2.9 | 128 | 1566 | 1208 | 2.13 | 0.09 |
| 88 | Sunday | 24 May | | | | | | | | | | | | | | 1842 | 1440 | | |
| 89 | Monday | 25 May | 30.200 | 783 | 2529.60 | 85 | 37 | 84.0 | 12.7 | 10.1 | 103.0 | 175.0 | 5.3 | 3.4 | 114 | | | | |
| 90 | Tuesday | 26 May | 43.200 | 824 | 2407.20 | 61 | 37 | 69.2 | 2.2 | 2.0 | 73.8 | 193.2 | 2.9 | 2.7 | | | | | |
| 91 | Wednesday | 27 May | | | | | | | | | | | | | | no | | | |
| 92 | Thursday | 28 May | 47.200 | 710 | 2284.80 | 57 | 24 | 66.1 | 1.8 | 2.9 | 70.0 | 194.6 | 3.2 | 3.4 | 113 | 1952 | 1584 | 1.44 | 0.12 |
| 93 | Friday | 29 May | 36.000 | 840 | 2488.80 | 37 | 33 | 57.1 | 1.5 | 2.1 | 85.7 | 177.8 | 3.2 | 3.2 | 97 | 2070 | 1844 | 1.35 | 0.10 |
| 94 | Saturday | 30 May | 42.300 | 690 | 3100.80 | 53 | 37 | 48.9 | 2.0 | 2.2 | 68.0 | 156.2 | 2.9 | 2.8 | 122 | 2124 | 1704 | 1.82 | 0.09 |
| 95 | Sunday | 31 May | 38.500 | 738 | | 69 | 41 | 44.4 | 1.1 | 2.9 | 66.6 | 119.0 | 2.2 | 4.5 | 122 | 1806 | 1376 | | 0.09 |
| 96 | Monday | 01 June | 43.800 | 692 | 1862.08 | 28 | 28 | 47.3 | 3.4 | 2.0 | 70.1 | 130.1 | 4.3 | 4.1 | 115 | 1748 | 1330 | 1.40 | 0.10 |
| 97 | Tuesday | 02 June | 54.800 | 700 | 2550.24 | 45 | 28 | 57.0 | 4.3 | 4.1 | 74.9 | 177.8 | 5.8 | 5.0 | 124 | 1862 | 1544 | 1.65 | 0.12 |
| 98 | Wednesday | 03 June | | | | | | | | | | | | | | | no | | |
| 99 | Thursday | 04 June | | | | | | | | | | | | | | | no | | |
| 100 | Friday | 05 June | 33.500 | 575 | 2671.58 | 53 | 24 | 48.2 | 1.4 | 1.7 | 67.3 | 188.2 | 1.7 | 2.0 | 114 | 2110 | 1668 | 1.60 | 0.11 |
| | End of Batch 12 | | 42.300 | 706.533 | 2493.07 | 48.767 | 30.799 | 52.700 | 2.220 | 2.558 | 71.820 | 163.391 | 3.320 | 3.560 | 115 | 1519 | 1579 | 1.32 | 0.10 |
| 101 | Saturday | 06 June | 32.800 | 745 | 2307.36 | 36 | 32 | 53.5 | 2.4 | 2.1 | 73.2 | 152.6 | 4.3 | 3.5 | 122 | 1964 | 1528 | 1.51 | 0.10 |
| 102 | Sunday | 07 June | 30.700 | 680 | 1902.56 | 49 | 40 | 48.4 | 2.0 | 1.5 | 78.6 | 150.0 | 4.9 | 2.9 | 126 | 1746 | 1378 | 1.38 | 0.11 |
| 103 | Monday | 08 June | 30.900 | 688 | 2024.16 | 53 | 53 | 56.0 | 1.5 | 1.4 | 72.0 | 215.6 | 2.2 | 1.7 | 149 | 1608 | 1236 | 1.64 | 0.17 |
| 104 | Tuesday | 09 June | 37.600 | 692 | 2165.68 | 34 | 34 | 54.9 | 1.8 | 1.4 | 78.8 | 180.8 | 2.4 | 2.2 | 107 | 2236 | 1728 | 1.25 | 0.10 |
| 105 | Wednesday | 10 June | 45.700 | 747 | 2580.00 | 60 | 56 | 60.1 | 6.9 | 3.4 | 79.8 | 156.8 | 6.6 | 5.8 | 133 | 1810 | 1454 | 1.77 | 0.11 |
| 106 | Thursday | 11 June | 43.200 | 747 | 1857.60 | 78 | 29 | 59.4 | 4.3 | 2.8 | 82.9 | 148.4 | 5.6 | 3.4 | 131 | 1674 | 1320 | 1.41 | 0.11 |
| 107 | Friday | 12 June | 45.100 | 654 | 1603.68 | 58 | 37 | 58.8 | 1.4 | 1.2 | 77.6 | 113.4 | 3.5 | 3.4 | 150 | 1400 | 1096 | 1.46 | 0.10 |
| | End of Batch13 | | 38.000 | 707.630 | 2063.01 | 52.514 | 40.219 | 55.860 | 2.900 | 1.974 | 77.260 | 159.629 | 4.220 | 3.240 | 131 | 1777 | 1391 | 1.49 | 0.12 |
| 108 | Saturday | 13 June | 19.900 | 724 | 2384.96 | 58 | 37 | 61.3 | 2.1 | 1.7 | 93.5 | 159.6 | 11.3 | 4.5 | 126 | 1740 | 1400 | 1.70 | 0.11 |
| 109 | Sunday | 14 June | | | | | | | | | | | | | | | | | |
| 110 | Monday | 15 June | | | | | | | | | | | | | | | | | |
| 111 | Tuesday | 16 June | | | | | | | | | | | | | | | | | |
| 112 | Wednesday | 17 June | | | | | | | | | | | | | | | clean | | |
| | End of Batch14 | | 19.900 | 724 | 2384.96 | 58 | 37 | 61.320 | 2.100 | 1.680 | 93.520 | 159.600 | 11.340 | 4.480 | 126 | 1740 | 1400 | 1.70 | 0.11 |
| 113 | Thursday | 18 June | 38.300 | 831 | 1809.28 | 56 | 41 | 104.7 | 28.6 | 27.4 | 133.0 | 137.2 | 32.2 | 29.7 | 82 | 1464 | 1236 | 1.46 | 0.11 |
| 114 | Friday | 19 June | 45.400 | | | | | | | | | | | | | | | | |
| 115 | Saturday | 20 June | | | | | | | | | | | | | | | | | |
| 116 | Sunday | 21 June | 49.600 | 775 | 2407.20 | 126 | 106 | 95.5 | 38.9 | 37.9 | 135.0 | 215.6 | 44.8 | 44.2 | 259 | 1874 | 1562 | 1.54 | 0.14 |
| 117 | Monday | 22 June | 48.300 | 783 | 2325.60 | 88 | 81 | 85.1 | 26.9 | 25.6 | 155.1 | 183.4 | 40.9 | 40.0 | 130 | 1770 | 1524 | 1.53 | 0.12 |
| | End of Batch15 | | 45.400 | 798.393 | 2180.69 | 92.650 | 69.467 | 95.107 | 31.453 | 30.333 | 141.027 | 178.733 | 39.299 | 37.987 | 157 | 1703 | 1441 | 1.51 | 0.12 |
| 118 | Tuesday | 23 June | 48.700 | 665 | 1917.80 | 78 | 65 | 55.0 | 24.6 | 19.2 | 85.1 | 155.4 | 25.9 | 23.1 | 134 | 1790 | 1508 | 1.27 | 0.10 |
| 119 | Wednesday | 24 June | 41.850 | 787 | 2040.00 | 73 | 65 | 67.3 | 4.2 | 4.2 | 93.8 | 135.8 | 7.1 | 6.4 | 172 | 1512 | 1302 | 1.57 | 0.10 |
| 120 | Thursday | 25 June | 38.500 | 808 | 2244.00 | 90 | 57 | 57.4 | 7.0 | 6.3 | 94.1 | 154.0 | 8.1 | 7.6 | 136 | 1468 | 1312 | 1.71 | 0.12 |
| 121 | Friday | 26 June | | | | | | | | | | | | | | | | | |
| 122 | Saturday | 27 June | | | | | | | | | | | | | | | | | |
| 123 | Sunday | 28 June | | | | | | | | | | | | | | | | | |
| | End of Batch16 | | 43.017 | 753.440 | 2067.20 | 80.240 | 62.560 | 59.920 | 11.947 | 9.893 | 91.000 | 148.400 | 13.720 | 12.367 | 147 | 1590 | 1374 | 1.52 | 0.11 |
| 124* | Monday | 29 June | 34.600 | 677 | 1876.80 | 94 | 86 | 63.6 | 3.6 | 2.4 | 86.8 | 120.4 | 4.6 | 3.8 | 173 | 1560 | | | |
| 125 | Tuesday | 30 June | 38.800 | 702 | 2056.32 | 85 | 48 | 75.0 | 1.4 | 1.4 | 98.3 | 147.0 | 4.5 | 3.6 | 156 | 1540 | 1310 | 1.57 | 0.11 |
| 126 | Wednesday | 01 July | 34.800 | 722 | 1854.72 | 59 | 56 | 58.7 | 1.8 | 1.5 | 80.9 | 135.8 | 4.1 | 2.9 | 161 | 1368 | 1166 | 1.59 | 0.12 |
| 127 | Thursday | 02 July | | | | | | | | | | | | | | | | | |
| 128 | Friday | 03 July | | | | | | | | | | | | | | | | | |
| 129 | Saturday | 04 July | | | | | | | | | | | | | | | | | |
| 130 | Sunday | 05 July | | | | | | | | | | | | | | | | | |
| 131 | Monday | 06 July | 30.600 | 778 | 1814.40 | 89 | 52 | 66.9 | 6.6 | 5.3 | 100.1 | 126.0 | 7.7 | 7.3 | 196 | 1324 | 1192 | 1.52 | 0.11 |
| 132 | Tuesday | 07 July | 29.000 | 879 | 2479.68 | 63 | 63 | 74.2 | 4.2 | 6.6 | 95.8 | 173.6 | 6.6 | 7.3 | 164 | 1708 | 1500 | 1.65 | 0.12 |
| | End of Batch17 | | 33.160 | 751.548 | 2016.38 | 79.650 | 61.186 | 67.676 | 3.528 | 3.444 | 91.980 | 140.560 | 5.488 | 4.956 | 170 | 1500 | 1292 | 1.27 | 0.09 |
| 133 | Wednesday | 08 July | 31.000 | 696 | 2362.08 | 50 | 46 | 52.1 | 2.7 | 2.7 | 68.3 | 169.4 | 5.2 | 3.9 | 187 | 1608 | 1430 | 1.65 | 0.12 |
| 134 | Thursday | 09 July | 39.800 | 729 | 2942.24 | 54 | 41 | 44.0 | 0.0 | 0.0 | 68.3 | 145.6 | 0.0 | 0.0 | 167 | 1920 | 1692 | 1.74 | 0.09 |
| 135 | Friday | 10 July | 36.600 | 800 | 2859.40 | 82 | 62 | 53.2 | 1.4 | 1.4 | 74.5 | 155.4 | 2.2 | 1.7 | 182 | 1762 | 1562 | 1.83 | 0.10 |
| 136 | Saturday | 11 July | 32.600 | 804 | 2569.30 | 50 | 25 | 53.8 | 1.8 | 1.7 | 73.4 | 156.8 | 3.9 | 2.8 | 160 | 1748 | 1528 | 1.68 | 0.10 |
| 137 | Sunday | 12 July | 31.300 | 750 | 1699.00 | 37 | 29 | 53.2 | 2.8 | 1.7 | 76.2 | 134.4 | 3.9 | 2.2 | 178 | 1460 | 1282 | 1.35 | 0.11 |
| 138 | Monday | 13 July | 34.300 | 767 | 1678.30 | 52 | 39 | 56.3 | 6.7 | 1.4 | 77.0 | 99.4 | 9.9 | 1.7 | 166 | 1146 | 898 | 1.87 | 0.11 |
| 139 | Tuesday | 14 July | | | | | | | | | | | | | | | | | |
| 140 | Wednesday | 15 July | | | | | | | | | | | | | | | | | |
| 141 | Thursday | 16 July | 41.600 | 895 | 2154.90 | 79 | 66 | 60.1 | 4.8 | 5.7 | 79.0 | 133.0 | 8.1 | 6.3 | 200 | 1190 | 1102 | 1.96 | 0.12 |
| 142 | Friday | 17 July | 36.700 | 751 | 1591.20 | 57 | 45 | 43.7 | 4.2 | 2.0 | 75.2 | 120.4 | 4.8 | 3.9 | | | | | |
| 143 | Saturday | 18 July | 39.200 | | | | | | | | | | | | | | | | |
| 144 | Sunday | 19 July | 38.200 | | | | | | | | | | | | | | | | |
| 145 | Monday | 20 July | 39.200 | | | | | | | | | | | | | | | | |
| | End of Batch 18 | | 35.488 | 773.974 | 2232.05 | 55.048 | 44.203 | 52.033 | 3.045 | 2.065 | 73.975 | 139.300 | 4.760 | 2.817 | 177 | 1548 | 1353 | 1.73 | 0.11 |
| 146 | Tuesday | 21 July | 39.200 | 400 | 1958.40 | 45 | 41 | 34.6 | 1.3 | 0.0 | 51.2 | 138.6 | 1.7 | 1.7 | 130 | 1544 | 1394 | 1.40 | 0.10 |
| 147 | Wednesday | 22 July | | | | | | | | | | | | | | | | | |
| | End of Batch 19 | | 39.200 | 399.800 | 1958.40 | 44.880 | 40.800 | 34.580 | 1.260 | 0.000 | 51.240 | 138.600 | 1.680 | 1.680 | 130 | 1544 | 1394 | 1.40 | 0.10 |
| 148 | Thursday | 23 July | 38.600 | 800 | 2162.40 | 32 | 45 | 54.8 | 2.9 | 2.2 | 84.0 | 148.4 | 6.0 | 4.8 | 141 | 1842 | 1628 | 1.33 | 0.09 |
| 149 | Friday | 24 July | 30.100 | 712 | 2182.80 | 87 | 39 | 54.2 | 5.7 | 2.8 | 101.6 | 142.8 | 8.3 | 5.6 | 163 | 1720 | 1512 | 1.44 | 0.09 |
| 150 | Saturday | 25 July | 33.500 | 722 | 1958.40 | 69 | 49 | 53.2 | 2.2 | 1.7 | 70.0 | 124.6 | 4.2 | 3.6 | 138 | 1888 | 1624 | 1.21 | 0.08 |
| 151 | Sunday | 26 July | 34.950 | 751 | 2652.00 | 65 | 45 | 45.5 | 3.2 | 3.1 | 73.4 | 155.4 | 6.0 | 3.4 | 167 | 1674 | 1438 | 1.85 | 0.11 |
| 152 | Monday | 27 July | | | | | | | | | | | | | | | | | |
| | End of Batch 20 | | 34.538 | 746.100 | 2238.90 | 70.900 | 44.360 | 51.870 | 3.535 | 2.450 | 82.250 | 142.800 | 5.635 | 4.340 | 152 | 1781 | 1550 | 1.46 | 0.09 |
| 153 | Tuesday | 28 July | 35.800 | 743 | 1999.20 | 73 | 45 | 49.8 | 26.6 | 2.2 | 68.7 | 156.8 | 6.7 | 5.2 | 159 | 1632 | 240 | 8.33 | 0.65 |
| 154 | Wednesday | 29 July | 24.200 | 730 | 1550.40 | 86 | 41 | 51.0 | 2.2 | 2.9 | 70.3 | 152.6 | 4.3 | 4.3 | 187 | 1336 | 1134 | 1.37 | 0.13 |
| 155 | Thursday | 30 July | 34.500 | 742 | 2352.50 | 85 | 77 | 51.1 | 1.5 | 2.5 | 89.3 | 112.0 | 3.9 | 2.5 | 158 | 1710 | 1446 | 1.63 | 0.08 |
| 156 | Friday | 31 July | 35.800 | 746 | 2393.00 | 85 | 77 | 48.2 | 3.5 | 1.5 | 72.5 | 172.2 | 6.3 | 4.3 | 151 | 1850 | 1570 | 1.52 | 0.11 |
| 157 | Saturday | 01 August | | | | | | | | | | | | | | | | | |
| 158 | Sunday | 02 August | | | | | | | | | | | | | | | | | |
| 159 | Monday | 03 August | | | | | | | | | | | | | | | | | |
| | End of Batch 21 | | 32.525 | 740.350 | 2073.73 | 82.380 | 59.970 | 49.945 | 8.470 | 2.297 | 70.210 | 148.400 | 5.318 | 4.095 | 164 | 1632 | 1098 | 3.21 | 0.24 |
| 160 | Tuesday | 04 August | 34.500 | 815 | 2514.70 | 73 | 53 | 57.4 | 0.0 | 0.0 | 86.8 | 154.0 | 6.3 | 1.7 | 143 | 1822 | 1506 | 1.67 | 0.10 |
| 161 | Wednesday | 05 August | 32.500 | 827 | 2028.00 | 61 | 49 | 59.4 | 3.8 | 2.5 | 87.9 | 144.2 | 6.4 | 5.9 | 153 | 1566 | 226 | 8.97 | 0.64 |
| 162 | Thursday | 06 August | | | | | | | | | | | | | | | | | |
| 163 | Friday | 07 August | 40.500 | 750 | 266.70 | 73 | 45 | 63.4 | 8.4 | 7.8 | 88.5 | 208.6 | 12.5 | 11.3 | 169 | 1774 | 1538 | 0.17 | 0.14 |
| 164 | Saturday | 08 August | | | | | | | | | | | | | | | | | |
| 165 | Sunday | 09 August | | | | | | | | | | | | | | | | | |
| 166 | Monday | 10 August | | | | | | | | | | | | | | | | | |
| 167 | Tuesday | 11 August | | | | | | | | | | | | | | | | | |
| 168 | Wednesday | 12 August | 28.400 | 766 | 2802.20 | 87 | 50 | 64.7 | 3.9 | 2.7 | 81.5 | 154.0 | 5.3 | 5.6 | 118 | 1860 | 1634 | 1.91 | 0.09 |
| 169 | Thursday | 13 August | 35.400 | 758 | 1814.40 | 73 | 65 | 63.0 | 1.5 | 0.0 | 86.8 | 137.2 | 2.9 | 0.0 | 154 | 1424 | 1212 | 1.50 | 0.11 |
| 170 | Friday | 14 August | | | | | | | | | | | | | | | | | |
| 171 | Saturday | 15 August | 35.640 | 625 | 3124.00 | 71 | 54 | 45.6 | 10.4 | 1.8 | 75.6 | 147.0 | 11.6 | 3.1 | 132 | 1664 | 1448 | 2.16 | 0.10 |
| 172 | Sunday | 16 August | | | | | | | | | | | | | | | | | |
| 173 | Monday | 17 August | | | | | | | | | | | | | | | | | |
| | End of Batch 22 | | 34.480 | 757.033 | 2091.67 | 72.783 | 52.550 | 58.917 | 4.667 | 2.427 | 84.513 | 157.500 | 7.537 | 4.597 | 145 | 1685 | 1261 | 2.73 | 0.20 |
| 174 | Tuesday | 18 August | 25.800 | 734 | 20.96 | 77 | 56 | 44.5 | 1.7 | 0.0 | 98.0 | 154.0 | 4.6 | 4.5 | 145 | 1514 | 1304 | 0.02 | 0.12 |
| 175 | Wednesday | 19 August | 28.600 | 769 | 1781.10 | 89 | 81 | 49.6 | 2.5 | 0.0 | 62.7 | 100.8 | 6.2 | 3.9 | 166 | | 1268 | | |
| 176 | Thursday | 20 August | 29.600 | 870 | 2671.70 | 97 | 85 | 50.7 | 3.6 | 2.0 | 62.2 | 151.2 | 4.8 | 2.8 | | | | | |
| | | | 28.000 | 791.067 | 1491.25 | 87.633 | 74.133 | 48.253 | 2.613 | 0.653 | 74.293 | 135.333 | 5.180 | 3.733 | 155 | 1391 | 1304 | 0.02 | 0.12 |

# D.4

**Nitrate (NO3) and Nitrite (NO2) Concentrations**

| Day No. | 1996 | | Nitrates (mg/l NO3-N) Anaerobic | Anoxic | Aerobic | Filtered Effluent | Phosphorous (mg/l PO4-P) Influent | Anaerobic | Anoxic | Aerobic | Filtered Effluent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Thursday | 26 February | 0.36 | 0.36 | 8.60 | 5.80 | 19.2 | 18.9 | 10.2 | 0.0 | 0.0 |
| 2 | Friday | 27 February | 0.65 | 0.66 | 13.20 | 10.10 | 19.2 | 20.0 | 8.3 | 0.0 | 0.0 |
| 3 | Saturday | 28 February | 0.46 | 0.15 | 10.00 | 11.30 | 19.2 | 23.3 | 23.4 | 11.7 | 1.3 |
| 4 | Sunday | 01 March | 0.58 | 0.31 | 12.70 | 12.50 | 20.8 | 23.8 | 10.6 | 0.0 | 0.0 |
| 5 | Monday | 02 March | 0.77 | 1.01 | 13.60 | 12.00 | 21.9 | 26.0 | 12.1 | 0.8 | 0.8 |
| 6 | Tuesday | 03 March | 0.34 | 0.50 | 13.20 | 13.00 | 20.0 | 27.5 | 11.7 | 0.8 | 0.4 |
| 7 | Wednesday | 04 March | 0.13 | 0.65 | 13.40 | 16.00 | 19.5 | 27.9 | 12.3 | 2.2 | 1.1 |
| 8 | Thursday | 05 March | 0.26 | 0.60 | 15.20 | 15.20 | 22.1 | 31.5 | 14.5 | 4.3 | 3.3 |
| 9 | Friday | 06 March | 0.31 | 0.65 | 16.10 | 16.00 | 22.4 | 34.0 | 16.6 | 5.1 | 4.3 |
| 10 | Saturday | 07 March | 0.47 | 0.74 | 16.20 | 16.20 | 23.5 | 36.2 | 17.4 | 5.1 | 4.7 |
| 11 | Sunday | 08 March | 0.48 | 0.59 | 16.00 | 16.00 | 24.2 | 37.3 | 18.5 | 5.8 | 5.4 |
| 12 | Monday | 09 March | 0.45 | 0.44 | 15.20 | 16.20 | 24.2 | 38.0 | 18.5 | 6.5 | 6.2 |
| 13 | Tuesday | 10 March | 0.21 | 1.86 | 16.20 | 15.20 | 24.6 | 38.3 | 23.5 | 8.3 | 5.8 |
| 14 | Wednesday | 11 March | 0.11 | 1.27 | 16.60 | 21.00 | 24.0 | 35.3 | 16.6 | 5.7 | 5.7 |
| 15 | Thursday | 12 March | 0.22 | 2.29 | 16.20 | 18.40 | 23.0 | 34.3 | 16.6 | 7.8 | 6.4 |
| | **End of Batch 2** | | **0.387** | **0.805** | **14.160** | **14.327** | **21.862** | **30.143** | **15.374** | **4.258** | **3.013** |
| 16 | Friday | 13 March | 0.23 | 0.56 | 15.20 | 16.60 | 23.0 | 37.8 | 20.5 | 8.1 | 7.8 |
| 17 | Saturday | 14 March | 0.23 | 0.86 | 16.00 | 14.40 | 22.6 | 35.7 | 18.4 | 6.7 | 6.4 |
| 18 | Sunday | 15 March | 0.26 | 0.75 | 15.40 | 16.60 | 23.3 | 36.0 | 20.9 | 7.4 | 7.4 |
| 19 | Monday | 16 March | 0.28 | 0.60 | 13.60 | 13.00 | 25.4 | 36.4 | 20.1 | 7.8 | 7.4 |
| 20 | Tuesday | 17 March | 0.20 | 0.45 | 13.00 | 14.20 | 23.0 | 33.0 | 1.9 | 5.5 | 5.5 |
| | **End of Batch 3** | | **0.240** | **0.644** | **14.640** | **14.960** | **23.474** | **35.786** | **16.344** | **7.106** | **6.894** |
| 21 | Wednesday | 18 March | 0.11 | 0.62 | 13.00 | 13.40 | 19.6 | 33.0 | 17.2 | 4.8 | 4.5 |
| 22 | Thursday | 19 March | 0.20 | 0.70 | 14.20 | 12.60 | 21.7 | 31.3 | 14.8 | 4.1 | 3.8 |
| 23 | Friday | 20 March | 0.15 | 1.23 | 15.60 | 15.00 | 20.6 | 31.3 | 14.1 | 3.4 | 3.4 |
| 24 | Saturday | 21 March | 0.28 | 0.72 | 13.80 | 17.80 | 22.7 | 31.6 | 15.5 | 4.1 | 2.8 |
| 25 | Sunday | 22 March | 0.25 | 0.65 | 14.40 | 15.60 | 22.4 | 32.4 | 17.2 | 5.5 | 4.8 |
| 26 | Monday | 23 March | 0.15 | 0.45 | 13.00 | 13.80 | 23.7 | 33.7 | 18.6 | 5.8 | 5.8 |
| 27 | Tuesday | 24 March | 0.19 | 0.69 | 12.70 | 13.60 | 22.2 | 35.1 | 19.0 | 7.2 | 5.7 |
| 28 | Wednesday | 25 March | 0.15 | 0.69 | 13.70 | 11.70 | 22.2 | 35.1 | 17.2 | 5.4 | 4.7 |
| | **End of Batch 4** | | **0.185** | **0.719** | **13.800** | **14.188** | **21.881** | **32.933** | **16.681** | **5.048** | **4.434** |
| 29 | Thursday | 26 March | 0.12 | 0.78 | 13.50 | 13.00 | 23.3 | 35.8 | 16.5 | 4.3 | 3.6 |
| 30 | Friday | 27 March | 0.25 | 0.56 | 9.60 | 10.00 | 24.4 | 34.7 | 15.9 | 5.0 | 5.0 |
| 31 | Saturday | 28 March | 0.14 | 0.46 | 8.60 | 8.50 | 24.7 | 34.4 | 17.2 | 5.7 | 4.7 |
| 32 | Sunday | 29 March | 0.10 | 0.46 | 8.50 | 8.00 | 23.6 | 34.4 | 16.5 | 4.3 | 4.3 |
| 33 | Monday | 30 March | 0.07 | 0.42 | 8.00 | 7.70 | 22.2 | 33.7 | 17.9 | 6.8 | 6.8 |
| 34 | Tuesday | 31 March | 0.20 | 0.41 | 7.90 | 8.10 | 19.4 | 32.8 | 18.0 | 7.8 | 5.3 |
| 35 | Wednesday | 01 April | 0.13 | 0.36 | 8.10 | 8.80 | 18.7 | 32.1 | 13.4 | 2.1 | 2.1 |
| 36 | Thursday | 02 April | 0.21 | 0.50 | 8.10 | 9.00 | 19.0 | 32.8 | 13.7 | 2.5 | 2.1 |
| | **End of Batch 5** | | **0.152** | **0.494** | **9.038** | **9.138** | **21.904** | **33.815** | **16.131** | **4.809** | **4.230** |
| 37 | Friday | 03 April | 0.15 | 0.40 | 8.50 | 8.40 | 20.4 | 33.5 | 13.7 | 2.5 | 2.5 |
| 38 | Saturday | 04 April | | | | | | | | | |
| 39 | Sunday | 05 April | 0.25 | 0.50 | 7.40 | 8.30 | 19.4 | 34.5 | 11.3 | 2.1 | 1.8 |
| 40 | Monday | 06 April | 0.28 | 0.34 | 8.10 | 7.50 | 19.0 | 34.5 | 14.1 | 2.8 | 2.8 |
| 41 | Tuesday | 07 April | 0.21 | 0.45 | 8.10 | 7.00 | 19.7 | 33.8 | 12.7 | 2.1 | 2.1 |
| 42 | Wednesday | 08 April | | | | | | | | | |
| 43 | Thursday | 09 April | 0.25 | 1.16 | 14.70 | 14.80 | 21.8 | 40.9 | 19.7 | 6.7 | 5.3 |
| | **End of Batch 6** | | **0.228** | **0.570** | **9.360** | **9.200** | **20.080** | **35.440** | **14.302** | **3.240** | **2.888** |
| 44 | Friday | 10 April | 0.40 | 4.10 | 17.20 | 17.50 | 22.0 | 39.8 | 18.8 | 4.9 | 4.5 |
| 45 | Saturday | 11 April | 0.52 | 6.80 | 20.70 | 20.70 | 22.0 | 39.8 | 18.5 | 5.9 | 5.6 |
| 46 | Sunday | 12 April | | | | | | | | | |
| 47 | Monday | 13 April | 0.48 | 9.00 | 25.10 | 25.00 | 22.0 | 41.2 | 17.1 | 5.9 | 5.2 |
| 48 | Tuesday | 14 April | 0.41 | 8.00 | 24.60 | 23.50 | 22.3 | 37.7 | 16.8 | 9.1 | 9.1 |
| 49 | Wednesday | 15 April | 0.37 | 7.75 | 24.00 | 24.00 | 21.6 | 37.3 | 18.8 | 8.7 | 7.7 |
| 50 | Thursday | 16 April | 0.33 | 6.50 | 23.50 | 21.60 | 22.7 | 34.5 | 17.8 | 12.6 | 11.2 |
| | **End of Batch 7** | | **0.418** | **7.025** | **22.517** | **22.050** | **22.097** | **38.382** | **17.970** | **7.850** | **7.212** |
| 51 | Friday | 17 April | 0.45 | 0.53 | 15.10 | 19.70 | 23.7 | 36.5 | 21.5 | 10.9 | 11.3 |
| 52 | Saturday | 18 April | | | | | | | | | |
| 53 | Sunday | 19 April | 0.18 | 0.75 | 11.80 | 13.50 | 26.4 | 33.9 | 17.7 | 7.5 | 7.5 |
| 54 | Monday | 20 April | 0.35 | 0.80 | 11.00 | 12.70 | 24.9 | 38.4 | 20.0 | 7.2 | 7.2 |
| 55 | Tuesday | 21 April | 0.23 | 0.85 | 13.10 | 12.50 | 27.8 | 40.3 | 20.3 | 6.4 | 6.4 |
| 56 | Wednesday | 22 April | 0.21 | 0.95 | 12.20 | 13.10 | 25.2 | 42.2 | 21.5 | 7.5 | 7.5 |
| 57 | Thursday | 23 April | 0.22 | 2.04 | 13.20 | 13.50 | 26.0 | 39.6 | 22.7 | 11.4 | 10.3 |
| 58 | Friday | 24 April | 0.29 | 2.46 | 12.30 | 14.80 | 26.0 | 39.6 | 23.1 | 11.0 | 9.9 |
| 59 | Saturday | 25 April | 0.22 | 1.69 | 12.70 | 16.20 | 26.0 | 42.5 | 23.8 | 10.3 | 10.3 |
| 60 | Sunday | 26 April | 0.11 | 0.95 | 11.10 | 14.00 | 36.3 | 46.2 | 26.7 | 13.9 | 12.1 |
| 61 | Monday | 27 April | | | | | | | | | |
| 62 | Tuesday | 28 April | 0.63 | 2.43 | 14.90 | 15.30 | 29.3 | 41.0 | 27.1 | 20.5 | 16.5 |
| 63 | Wednesday | 29 April | 0.11 | 0.45 | 8.70 | 11.00 | 24.9 | 42.1 | 27.1 | 14.3 | 17.6 |
| | **End of Batch 8** | | **0.273** | **1.264** | **12.373** | **14.209** | **26.955** | **40.198** | **22.860** | **10.987** | **10.588** |
| 64 | Thursday | 30 April | 0.10 | 0.00 | 10.90 | 10.50 | 24.7 | 40.6 | 20.9 | 7.1 | 6.7 |
| 65 | Friday | 01 May | 0.24 | 0.34 | 6.20 | 10.90 | 22.3 | 39.2 | 19.8 | 6.7 | 6.0 |
| 66 | Saturday | 02 May | 0.22 | 0.65 | 9.20 | 11.60 | 21.9 | 35.3 | 18.0 | 6.7 | 5.3 |
| | **End of Batch 9** | | **0.187** | **0.330** | **8.767** | **11.000** | **22.967** | **38.393** | **19.553** | **6.830** | **6.007** |
| 67 | Sunday | 03 May | 0.12 | 0.56 | 12.50 | 10.50 | 20.5 | 37.8 | 19.4 | 6.0 | 6.0 |
| 68 | Monday | 04 May | 0.00 | 0.16 | 15.00 | 10.50 | 23.7 | 38.5 | 20.5 | 6.7 | 6.4 |
| 69 | Tuesday | 05 May | 0.35 | 0.82 | 11.50 | 13.10 | 24.0 | 36.8 | 18.7 | 5.3 | 5.3 |
| 70 | Wednesday | 06 May | 0.17 | 0.65 | 12.80 | 12.60 | 23.3 | 40.3 | 21.2 | 8.1 | 7.2 |
| 71 | Thursday | 07 May | 0.39 | 1.29 | 12.60 | 12.40 | 23.3 | 41.0 | 21.2 | 8.8 | 8.5 |
| 72 | Friday | 08 May | 0.88 | 2.55 | 19.70 | 15.50 | 22.1 | 38.0 | 22.5 | 10.0 | 9.2 |
| | **End of Batch10** | | **0.318** | **1.005** | **14.017** | **12.433** | **22.827** | **38.722** | **20.588** | **7.490** | **7.093** |
| 73 | Saturday | 09 May | | | | | | | | | |
| 74 | Sunday | 10 May | 0.28 | 2.11 | 14.30 | 14.10 | 21.4 | 36.2 | 14.4 | 5.9 | 5.5 |
| 75 | Monday | 11 May | 0.65 | 2.55 | 16.10 | 17.50 | 24.0 | 31.0 | 17.7 | 5.2 | 4.4 |
| 76 | Tuesday | 12 May | 0.82 | 2.55 | 15.20 | 16.30 | 19.9 | 35.0 | 18.4 | 6.3 | 5.2 |
| 77 | Wednesday | 13 May | 0.31 | 1.68 | 12.90 | 15.00 | 21.4 | 34.3 | 19.9 | 10.0 | 7.4 |
| 78 | Thursday | 14 May | 0.96 | 1.58 | 19.60 | 18.50 | 21.8 | 32.6 | 18.9 | 7.4 | 7.0 |
| 79 | Friday | 15 May | 0.63 | 1.38 | 20.70 | 18.70 | 22.2 | 32.6 | 18.5 | 6.3 | 5.6 |
| 80 | Saturday | 16 May | 0.46 | 2.75 | 20.20 | 19.60 | 22.6 | 32.2 | 18.1 | 7.4 | 6.7 |
| 81 | Sunday | 17 May | 0.44 | 2.75 | 18.30 | 20.60 | 25.2 | 34.0 | 20.2 | 9.6 | 8.9 |
| 82 | Monday | 18 May | 0.33 | 2.75 | 16.40 | 19.20 | 17.0 | 32.9 | 19.6 | 10.7 | 10.0 |
| 83 | Tuesday | 19 May | 0.55 | 1.13 | 20.10 | 20.00 | 21.5 | 36.6 | 19.6 | 11.8 | 10.7 |
| | **End of Batch 11** | | **0.543** | **2.123** | **17.380** | **17.950** | **21.687** | **33.733** | **18.532** | **8.056** | **7.134** |

# D .5

**Nitrate (NO3) and Nitrite (NO2) Concentrations**

| Day No. | 1996 | | Nitrates (mg/l NO3-N) | | | | Phosphorous (mg/l PO4-P) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Anaerobic | Anoxic | Aerobic | Filtered Effluent | Influent | Anaerobic | Anoxic | Aerobic | Filtered Effluent |
| 84 | Wednesday | 20 May | 0.62 | 1.38 | 22.10 | 24.30 | 19.9 | 33.1 | 21.3 | 12.1 | 11.8 |
| 85 | Thursday | 21 May | 0.64 | 1.26 | 25.00 | 26.30 | 25.3 | 36.3 | 21.7 | 12.1 | 11.8 |
| 86 | Friday | 22 May | 0.40 | 0.52 | 21.60 | 23.90 | 27.1 | 35.6 | 22.1 | 10.7 | 10.7 |
| 87 | Saturday | 23 May | 0.50 | 0.25 | 20.90 | 22.00 | 21.9 | 34.2 | 21.7 | 11.0 | 10.3 |
| 88 | Sunday | 24 May | | | | | | | | | |
| 89 | Monday | 25 May | 0.22 | 0.16 | 18.60 | 17.60 | 23.5 | 37.4 | 19.6 | 9.3 | 9.3 |
| 90 | Tuesday | 26 May | | | | | 24.2 | 36.7 | 21.0 | 7.1 | 5.7 |
| 91 | Wednesday | 27 May | | | | | | | | | |
| 92 | Thursday | 28 May | 0.30 | 0.90 | 19.40 | 12.60 | 25.7 | 40.7 | 20.8 | 7.1 | 7.1 |
| 93 | Friday | 29 May | 0.24 | 2.01 | 12.60 | 12.60 | 24.9 | 42.3 | 19.9 | 5.4 | 5.4 |
| 94 | Saturday | 30 May | 0.28 | 1.09 | 13.80 | 12.60 | 25.3 | 42.3 | 20.3 | 6.6 | 6.6 |
| 95 | Sunday | 31 May | 0.25 | 1.42 | 12.00 | 12.80 | 28.6 | 44.4 | 22.8 | 7.9 | 3.7 |
| 96 | Monday | 01 June | 0.24 | 1.18 | 11.00 | 11.60 | 24.5 | 43.2 | 24.9 | 7.9 | 7.5 |
| 97 | Tuesday | 02 June | 0.20 | 0.14 | 11.00 | 8.80 | 25.7 | 43.6 | 30.3 | 8.3 | 8.7 |
| 98 | Wednesday | 03 June | | | | | | | | | |
| 99 | Thursday | 04 June | | | | | | | | | |
| 100 | Friday | 05 June | 0.44 | 1.41 | 14.40 | 14.40 | 24.9 | 44.0 | 21.2 | 5.4 | 4.2 |
| | End of Batch 12 | | 0.279 | 1.164 | 13.457 | 12.200 | 25.676 | 42.931 | 22.877 | 6.940 | 6.169 |
| 101 | Saturday | 06 June | 0.42 | 0.81 | 18.40 | 19.00 | 25.5 | 37.5 | 20.2 | 3.7 | 3.4 |
| 102 | Sunday | 07 June | 0.32 | 3.85 | 18.20 | 14.60 | 21.3 | 41.9 | 21.0 | 3.7 | 2.3 |
| 103 | Monday | 08 June | 0.50 | 3.44 | 15.00 | 17.00 | 22.8 | 47.8 | 21.3 | 3.7 | 3.0 |
| 104 | Tuesday | 09 June | 0.37 | 2.55 | 18.20 | 18.00 | 22.5 | 38.2 | 21.3 | 3.0 | 2.6 |
| 105 | Wednesday | 10 June | 0.20 | 1.88 | 18.80 | 18.80 | 22.5 | 32.6 | 25.5 | 6.0 | 6.0 |
| 106 | Thursday | 11 June | 0.81 | 0.91 | 19.20 | 29.80 | 22.5 | 34.1 | 25.8 | 9.7 | 6.7 |
| 107 | Friday | 12 June | 0.89 | 0.92 | 22.40 | 31.00 | 19.5 | 31.4 | 25.3 | 12.3 | 9.4 |
| | End of Batch13 | | 0.501 | 2.051 | 18.600 | 21.171 | 22.363 | 37.639 | 22.920 | 6.031 | 4.764 |
| 108 | Saturday | 13 June | 0.31 | 0.59 | 27.40 | 30.00 | 23.8 | 31.8 | 21.7 | 4.3 | 3.3 |
| 109 | Sunday | 14 June | | | | | | | | | |
| 110 | Monday | 15 June | | | | | | | | | |
| 111 | Tuesday | 16 June | | | | | | | | | |
| 112 | Wednesday | 17 June | | | | | | | | | |
| | End of Batch14 | | 0.310 | 0.590 | 27.400 | 30.000 | 23.820 | 31.760 | 21.660 | 4.330 | 3.250 |
| 113 | Thursday | 18 June | 0.30 | 1.07 | 32.40 | 33.00 | 24.5 | 30.0 | 20.9 | 10.8 | 11.2 |
| 114 | Friday | 19 June | 0.47 | 0.64 | 40.00 | 33.60 | | | | | |
| 115 | Saturday | 20 June | | | | | | | | | |
| 116 | Sunday | 21 June | | | | | 21.7 | 30.0 | 21.7 | 12.6 | 11.9 |
| 117 | Monday | 22 June | 0.24 | 0.80 | 44.40 | 36.80 | 23.5 | 29.2 | 22.0 | 11.9 | 11.9 |
| | End of Batch15 | | 0.337 | 0.837 | 38.933 | 34.467 | 23.220 | 29.720 | 21.540 | 11.790 | 11.670 |
| 118 | Tuesday | 23 June | 0.18 | 1.46 | 43.40 | 44.00 | 21.7 | 28.6 | 22.0 | 14.4 | 12.6 |
| 119 | Wednesday | 24 June | 0.18 | 0.90 | 40.00 | 31.60 | 23.5 | 28.2 | 24.5 | 17.3 | 16.2 |
| 120 | Thursday | 25 June | 0.55 | 0.85 | 20.60 | 19.00 | 23.8 | 29.5 | 25.9 | 19.4 | 18.0 |
| 121 | Friday | 26 June | | | | | | | | | |
| 122 | Saturday | 27 June | | | | | | | | | |
| 123 | Sunday | 28 June | | | | | | | | | |
| | End of Batch16 | | 0.303 | 1.070 | 34.667 | 31.533 | 22.962 | 28.750 | 24.154 | 17.070 | 15.623 |
| 124 | Monday | 29 June | 0.42 | 0.89 | 21.50 | 19.00 | 24.5 | 22.3 | 16.2 | 7.6 | 7.2 |
| 125 | Tuesday | 30 June | 0.15 | 0.31 | 20.30 | 20.00 | 22.0 | 25.2 | 18.0 | 9.0 | 7.6 |
| 126 | Wednesday | 01 July | 0.13 | 0.37 | 20.30 | 20.90 | 23.4 | 26.3 | 22.0 | 15.1 | 11.5 |
| 127 | Thursday | 02 July | | | | | | | | | |
| 128 | Friday | 03 July | | | | | | | | | |
| 129 | Saturday | 04 July | | | | | | | | | |
| 130 | Sunday | 05 July | | | | | | | | | |
| 131 | Monday | 06 July | 0.38 | 0.34 | 19.00 | 18.60 | 24.5 | 23.0 | 21.6 | 18.0 | 17.6 |
| 132 | Tuesday | 07 July | 0.12 | 0.17 | 17.20 | 20.20 | 28.8 | 30.6 | 19.8 | 14.8 | 16.6 |
| | End of Batch17 | | 0.240 | 0.416 | 19.660 | 19.740 | 24.624 | 25.488 | 19.512 | 12.888 | 12.096 |
| 133 | Wednesday | 08 July | 0.12 | 0.10 | 14.80 | 15.00 | 24.1 | 23.0 | 22.0 | 16.9 | 15.8 |
| 134 | Thursday | 09 July | 0.15 | 0.53 | 13.40 | 12.80 | 26.0 | 21.4 | 20.4 | 15.8 | 16.4 |
| 135 | Friday | 10 July | 0.12 | 0.12 | 15.60 | 13.10 | 23.7 | 24.7 | 22.7 | 18.0 | 16.7 |
| 136 | Saturday | 11 July | 0.13 | 0.53 | 16.50 | 15.00 | 26.4 | 224.4 | 22.4 | 19.4 | 18.7 |
| 137 | Sunday | 12 July | 0.21 | 0.85 | 18.10 | 15.70 | 24.7 | 22.7 | 21.7 | 18.7 | 18.7 |
| 138 | Monday | 13 July | 0.15 | 0.32 | 16.10 | 13.00 | 24.7 | 25.4 | 23.7 | 21.4 | 20.0 |
| 139 | Tuesday | 14 July | | | | | | | | | |
| 140 | Wednesday | 15 July | | | | | | | | | |
| 141 | Thursday | 16 July | 0.13 | 0.12 | 15.40 | 14.60 | 26.0 | 19.4 | 18.0 | 15.7 | 16.0 |
| 142 | Friday | 17 July | 0.17 | 0.79 | 17.50 | 15.10 | 24.5 | 19.9 | 18.1 | 14.5 | 12.1 |
| 143 | Saturday | 18 July | | | | | | | | | |
| 144 | Sunday | 19 July | | | | | | | | | |
| 145 | Monday | 20 July | | | | | | | | | |
| | End of Batch 18 | | 0.148 | 0.420 | 15.925 | 14.288 | 25.004 | 47.583 | 21.100 | 17.539 | 16.794 |
| 146 | Tuesday | 21 July | 0.23 | 0.76 | 13.00 | 17.10 | 25.5 | 15.2 | 12.4 | 10.4 | 7.8 |
| 147 | Wednesday | 22 July | | | | | | | | | |
| | End of Batch 19 | | 0.230 | 0.760 | 13.000 | 17.100 | 25.520 | 15.240 | 12.410 | 10.370 | 7.800 |
| 148 | Thursday | 23 July | 0.27 | 0.61 | 15.10 | 14.00 | 20.2 | 21.3 | 22.0 | 17.4 | 16.0 |
| 149 | Friday | 24 July | 0.23 | 1.64 | 14.00 | 12.00 | 18.8 | 21.3 | 21.3 | 16.7 | 16.7 |
| 150 | Saturday | 25 July | 0.22 | 0.72 | 15.00 | 13.20 | 20.2 | 37.6 | 19.9 | 14.5 | 14.2 |
| 151 | Sunday | 26 July | 0.16 | 0.58 | 17.70 | 17.10 | 21.6 | 22.3 | 19.5 | 13.1 | 14.2 |
| 152 | Monday | 27 July | | | | | | | | | |
| | End of Batch 20 | | 0.220 | 0.888 | 15.450 | 14.075 | 20.208 | 25.613 | 20.650 | 15.420 | 15.243 |
| 153 | Tuesday | 28 July | 0.38 | 0.35 | 16.40 | 14.40 | 22.7 | 24.5 | 19.9 | 13.5 | 13.5 |
| 154 | Wednesday | 29 July | | | | | 26.1 | 22.6 | 17.4 | 13.2 | 13.2 |
| 155 | Thursday | 30 July | | | | | 21.6 | 24.0 | 20.5 | 14.9 | 14.6 |
| 156 | Friday | 31 July | | | | | 23.6 | 24.3 | 19.8 | 14.6 | 13.9 |
| 157 | Saturday | 01 August | | | | | | | | | |
| 158 | Sunday | 02 August | | | | | | | | | |
| 159 | Monday | 03 August | | | | | | | | | |
| | End of Batch 21 | | 0.380 | 0.350 | 16.400 | 14.400 | 23.488 | 23.833 | 19.388 | 14.033 | 13.783 |
| 160 | Tuesday | 04 August | | | | | 22.6 | 24.3 | 19.8 | 13.6 | 13.2 |
| 161 | Wednesday | 05 August | | | | | 21.6 | 23.3 | 17.7 | 15.0 | 14.3 |
| 162 | Thursday | 06 August | | | | | | | | | |
| 163 | Friday | 07 August | | | | | 21.2 | 21.6 | 15.6 | 13.6 | 13.6 |
| 164 | Saturday | 08 August | | | | | | | | | |
| 165 | Sunday | 09 August | | | | | | | | | |
| 166 | Monday | 10 August | | | | | | | | | |
| 167 | Tuesday | 11 August | | | | | | | | | |
| 168 | Wednesday | 12 August | | | | | 20.7 | 20.0 | 14.4 | 12.3 | 11.9 |
| 169 | Thursday | 13 August | | | | | 20.4 | 14.0 | 16.8 | 14.4 | 11.9 |
| 170 | Friday | 14 August | | | | | | | | | |
| 171 | Saturday | 15 August | | | | | 19.7 | 21.4 | 17..19 | 14.4 | 14.0 |
| 172 | Sunday | 16 August | | | | | | | | | |
| 173 | Monday | 17 August | | | | | | | | | |
| | End of Batch 22 | | ERR | ERR | ERR | ERR | 21.007 | 20.768 | 14.068 | 13.855 | 13.153 |
| 174 | Tuesday | 18 August | | | | | 19.7 | 23.9 | 17.9 | 11.2 | 10.9 |
| 175 | Wednesday | 19 August | | | | | 20.4 | 22.5 | 21.1 | 14.7 | 9.8 |
| 176 | Thursday | 20 August | | | | | 20.4 | 26.7 | 22.1 | 13.0 | 10.9 |
| | | | ERR | ERR | ERR | ERR | 20.117 | 24.330 | 20.353 | 12.980 | 10.530 |

**Mass Balance for Phosphorous**

| Day No. | 1998 | | Anaerobic | | | Anoxic | | | Aerobic | | | Settler | | | Sum Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | |
| 1 | Thursday | 26 February | 29.4 | 37.7 | 8.3 | 37.7 | 51.0 | 13.2 | 40.8 | | -40.8 | 0.0 | 0.0 | | -19.2 |
| 2 | Friday | 27 February | 27.5 | 40.0 | 12.5 | 40.0 | 41.5 | 1.5 | 33.2 | | -33.2 | 0.0 | 0.0 | | -19.2 |
| 3 | Saturday | 28 February | 42.6 | 46.6 | 3.9 | 70.0 | 117.0 | 47.0 | 93.6 | 46.8 | -46.8 | 23.4 | 2.6 | -20.8 | -16.6 |
| 4 | Sunday | 01 March | 31.3 | 47.5 | 16.2 | 47.5 | 52.8 | 5.3 | 42.2 | | -42.2 | 0.0 | 0.0 | | -20.8 |
| 5 | Monday | 02 March | 34.0 | 52.1 | 18.1 | 53.6 | 60.4 | 6.8 | 48.3 | 3.0 | -45.3 | 1.5 | 1.5 | 0.0 | -20.4 |
| 6 | Tuesday | 03 March | 31.7 | 55.1 | 23.4 | 56.6 | 58.5 | 1.9 | 46.8 | 3.0 | -43.8 | 1.5 | 0.8 | -0.7 | -19.2 |
| 7 | Wednesday | 04 March | 31.8 | 55.7 | 23.9 | 60.0 | 61.5 | 1.5 | 49.2 | 8.7 | -40.5 | 4.3 | 2.2 | -2.2 | -17.4 |
| 8 | Thursday | 05 March | 36.5 | 62.9 | 26.4 | 71.6 | 72.4 | 0.7 | 57.9 | 17.4 | -40.5 | 8.7 | 6.5 | -2.2 | -15.5 |
| 9 | Friday | 06 March | 39.1 | 68.0 | 28.9 | 78.1 | 83.2 | 5.1 | 66.6 | 20.2 | -46.3 | 10.1 | 8.7 | -1.4 | -13.7 |
| 10 | Saturday | 07 March | 40.9 | 72.3 | 31.5 | 82.5 | 86.8 | 4.3 | 69.4 | 20.2 | -49.2 | 10.1 | 9.4 | -0.7 | -14.1 |
| 11 | Sunday | 08 March | 42.7 | 74.5 | 31.8 | 86.1 | 92.3 | 6.2 | 73.8 | 23.2 | -50.6 | 11.6 | 10.9 | -0.7 | -13.4 |
| 12 | Monday | 09 March | 42.7 | 76.0 | 33.3 | 89.0 | 92.3 | 3.3 | 73.8 | 26.0 | -47.8 | 13.0 | 12.3 | -0.7 | -11.9 |
| 13 | Tuesday | 10 March | 48.1 | 76.7 | 28.6 | 93.3 | 117.6 | 24.2 | 94.0 | 33.3 | -60.8 | 16.6 | 11.6 | -5.1 | -13.0 |
| 14 | Wednesday | 11 March | 40.6 | 70.7 | 30.0 | 82.0 | 83.1 | 1.1 | 56.4 | 22.6 | -43.8 | 11.3 | 11.3 | 0.0 | -12.7 |
| 15 | Thursday | 12 March | 39.6 | 68.5 | 29.0 | 84.1 | 83.1 | -1.0 | 66.4 | 31.1 | -35.4 | 15.5 | 12.7 | -2.8 | -10.3 |
| | End of Batch 2 | | 37.236 | 60.285 | 23.049 | 68.801 | 76.870 | 8.069 | 61.496 | 17.032 | -44.464 | 8.516 | 6.026 | -2.490 | -15.836 |
| 16 | Friday | 13 March | 43.5 | 75.6 | 32.2 | 91.9 | 102.5 | 10.6 | 82.0 | 32.5 | -49.4 | 16.3 | 15.5 | -0.7 | -7.4 |
| 17 | Saturday | 14 March | 41.0 | 71.4 | 30.4 | 84.8 | 91.9 | 7.1 | 73.5 | 26.8 | -46.6 | 13.4 | 12.7 | -0.7 | -9.9 |
| 18 | Sunday | 15 March | 44.2 | 72.1 | 27.9 | 86.9 | 104.3 | 17.3 | 83.4 | 29.7 | -53.7 | 14.8 | 14.8 | 0.0 | -8.5 |
| 19 | Monday | 16 March | 45.5 | 72.8 | 27.2 | 88.3 | 100.7 | 12.4 | 80.6 | 31.1 | -49.5 | 15.5 | 14.8 | -0.7 | -10.6 |
| 20 | Tuesday | 17 March | 24.9 | 66.0 | 41.1 | 77.0 | 9.4 | -67.7 | 7.5 | 22.0 | 14.5 | 11.0 | 11.0 | 0.0 | -12.0 |
| | End of Batch 3 | | 39.818 | 71.572 | 31.754 | 85.784 | 81.720 | -4.064 | 65.376 | 28.424 | -36.952 | 14.212 | 13.788 | -0.424 | -9.686 |
| 21 | Wednesday | 18 March | 36.8 | 66.0 | 29.2 | 75.6 | 86.0 | 10.3 | 68.8 | 19.2 | -49.5 | 9.6 | 8.9 | -0.7 | -10.7 |
| 22 | Thursday | 19 March | 36.4 | 62.6 | 26.1 | 70.8 | 73.9 | 3.1 | 59.1 | 16.5 | -42.6 | 8.3 | 7.6 | -0.7 | -14.1 |
| 23 | Friday | 20 March | 34.7 | 62.6 | 27.9 | 69.5 | 70.5 | 1.0 | 56.4 | 13.8 | -42.6 | 6.9 | 6.9 | 0.0 | -13.7 |
| 24 | Saturday | 21 March | 38.2 | 63.3 | 25.1 | 71.5 | 77.4 | 5.8 | 61.9 | 16.5 | -45.4 | 8.3 | 5.5 | -2.8 | -17.2 |
| 25 | Sunday | 22 March | 39.5 | 64.8 | 25.2 | 75.8 | 86.0 | 10.2 | 68.8 | 22.0 | -46.8 | 11.0 | 9.6 | -1.4 | -12.7 |
| 26 | Monday | 23 March | 42.3 | 67.4 | 25.1 | 79.1 | 92.8 | 13.7 | 74.2 | 23.4 | -50.9 | 11.7 | 11.7 | 0.0 | -12.0 |
| 27 | Tuesday | 24 March | 41.2 | 70.2 | 29.0 | 84.5 | 94.9 | 10.4 | 75.9 | 28.6 | -47.3 | 14.3 | 11.5 | -2.9 | -10.7 |
| 28 | Wednesday | 25 March | 39.4 | 70.2 | 30.8 | 80.9 | 85.9 | 5.0 | 68.7 | 21.5 | -47.2 | 10.7 | 9.3 | -1.4 | -12.9 |
| | End of Batch 4 | | 38.562 | 65.865 | 27.303 | 75.960 | 83.404 | 7.444 | 66.724 | 20.190 | -46.534 | 10.095 | 8.868 | -1.228 | -13.014 |
| 29 | Thursday | 26 March | 39.7 | 71.6 | 31.9 | 80.2 | 82.4 | 2.1 | 65.9 | 17.2 | -48.7 | 8.6 | 7.2 | -1.4 | -16.1 |
| 30 | Friday | 27 March | 40.3 | 69.5 | 29.2 | 79.5 | 79.6 | 0.1 | 63.7 | 20.0 | -43.6 | 10.0 | 10.0 | 0.0 | -14.3 |
| 31 | Saturday | 28 March | 41.9 | 68.7 | 26.8 | 80.2 | 86.0 | 5.8 | 68.8 | 22.9 | -45.8 | 11.5 | 9.3 | -2.2 | -15.4 |
| 32 | Sunday | 29 March | 40.1 | 68.7 | 28.6 | 77.3 | 82.4 | 5.0 | 65.9 | 17.2 | -48.7 | 8.6 | 8.6 | 0.0 | -15.0 |
| 33 | Monday | 30 March | 40.1 | 67.3 | 27.2 | 80.9 | 89.5 | 8.6 | 71.6 | 27.2 | -44.4 | 13.6 | 13.6 | 0.0 | -8.6 |
| 34 | Tuesday | 31 March | 37.4 | 65.5 | 28.2 | 81.0 | 89.9 | 8.8 | 71.9 | 31.0 | -40.9 | 15.5 | 10.6 | -4.9 | -8.8 |
| 35 | Wednesday | 01 April | 32.1 | 64.1 | 32.1 | 68.3 | 67.0 | -1.4 | 53.6 | 8.4 | -45.1 | 4.2 | 4.2 | 0.0 | -14.5 |
| 36 | Thursday | 02 April | 32.8 | 65.5 | 32.8 | 70.5 | 68.7 | -1.8 | 55.0 | 9.9 | -45.1 | 4.9 | 4.2 | -0.7 | -14.8 |
| | End of Batch 5 | | 38.035 | 67.630 | 29.595 | 77.248 | 80.656 | 3.409 | 64.525 | 19.235 | -45.290 | 9.618 | 8.460 | -1.158 | -13.444 |
| 37 | Friday | 03 April | 34.2 | 66.9 | 32.8 | 71.9 | 68.7 | -3.2 | 55.0 | 9.9 | -45.1 | 4.9 | 4.9 | 0.0 | -15.5 |
| 38 | Saturday | 04 April | | | | | | | | | | | | | |
| 39 | Sunday | 05 April | 30.7 | 69.0 | 38.4 | 73.3 | 56.4 | -16.9 | 45.1 | 8.4 | -36.6 | 4.2 | 3.5 | -0.7 | -15.9 |
| 40 | Monday | 06 April | 33.1 | 69.0 | 35.9 | 74.7 | 70.5 | -4.2 | 56.4 | 11.3 | -45.1 | 5.6 | 5.6 | 0.0 | -13.4 |
| 41 | Tuesday | 07 April | 32.4 | 67.6 | 35.2 | 71.9 | 63.4 | -8.5 | 50.7 | 8.4 | -42.3 | 4.2 | 4.2 | 0.0 | -15.5 |
| 42 | Wednesday | 08 April | | | | | | | | | | | | | |
| 43 | Thursday | 09 April | 41.6 | 81.7 | 40.2 | 95.1 | 98.7 | 3.5 | 78.9 | 26.8 | -52.2 | 13.4 | 10.6 | -2.8 | -11.3 |
| | End of Batch 6 | | 34.382 | 70.880 | 36.498 | 77.360 | 71.510 | -5.850 | 57.208 | 12.960 | -44.248 | 6.480 | 5.776 | -0.704 | -14.304 |
| 44 | Friday | 10 April | 40.8 | 79.6 | 38.7 | 89.3 | 94.2 | 4.9 | 75.4 | 19.6 | -55.8 | 9.8 | 9.1 | -0.7 | -12.9 |
| 45 | Saturday | 11 April | 40.5 | 79.6 | 39.1 | 91.4 | 92.5 | 1.0 | 74.0 | 23.7 | -50.2 | 11.9 | 11.2 | -0.7 | -10.8 |
| 46 | Sunday | 12 April | | | | | | | | | | | | | |
| 47 | Monday | 13 April | 39.1 | 82.3 | 43.3 | 94.2 | 85.5 | -8.7 | 68.4 | 23.7 | -44.7 | 11.9 | 10.5 | -1.4 | -11.5 |
| 48 | Tuesday | 14 April | 39.1 | 75.4 | 36.3 | 93.5 | 83.8 | -9.8 | 67.0 | 36.3 | -30.7 | 18.1 | 18.1 | 0.0 | -4.2 |
| 49 | Wednesday | 15 April | 40.5 | 74.7 | 34.2 | 92.1 | 94.2 | 2.1 | 75.4 | 34.9 | -40.5 | 17.4 | 15.4 | -2.1 | -6.3 |
| 50 | Thursday | 16 April | 40.5 | 69.1 | 28.6 | 94.2 | 89.0 | -5.2 | 71.2 | 50.2 | -21.0 | 25.1 | 22.3 | -2.8 | -0.3 |
| | End of Batch 7 | | 40.067 | 76.763 | 36.697 | 92.463 | 89.850 | -2.613 | 71.880 | 31.400 | -40.480 | 15.700 | 14.423 | -1.277 | -7.673 |
| 51 | Friday | 17 April | 45.2 | 73.0 | 27.9 | 94.9 | 107.3 | 12.4 | 35.8 | 43.7 | -42.2 | 21.8 | 22.6 | 0.8 | -1.1 |
| 52 | Saturday | 18 April | | | | | | | | | | | | | |
| 53 | Sunday | 19 April | 44.1 | 67.8 | 23.7 | 82.8 | 88.5 | 5.7 | 70.8 | 30.1 | -40.7 | 15.1 | 15.1 | 0.0 | -11.3 |
| 54 | Monday | 20 April | 44.8 | 76.8 | 32.0 | 91.1 | 99.8 | 8.7 | 79.8 | 28.6 | -51.2 | 14.3 | 14.3 | 0.0 | -10.5 |
| 55 | Tuesday | 21 April | 48.2 | 80.6 | 32.4 | 93.4 | 101.7 | 8.3 | 81.3 | 25.6 | -55.7 | 12.8 | 12.8 | 0.0 | -15.0 |
| 56 | Wednesday | 22 April | 46.7 | 84.3 | 37.7 | 99.4 | 107.3 | 7.9 | 85.8 | 30.1 | -55.7 | 15.1 | 15.1 | 0.0 | -10.2 |
| 57 | Thursday | 23 April | 48.7 | 79.1 | 30.4 | 101.8 | 113.6 | 11.7 | 90.8 | 45.4 | -45.4 | 22.7 | 20.5 | -2.2 | -5.5 |
| 58 | Friday | 24 April | 49.1 | 79.1 | 30.0 | 101.1 | 115.4 | 14.3 | 92.3 | 44.0 | -48.4 | 22.0 | 19.8 | -2.2 | -6.2 |
| 59 | Saturday | 25 April | 49.8 | 85.0 | 35.2 | 105.5 | 119.1 | 13.5 | 95.2 | 41.0 | -54.2 | 20.5 | 20.5 | 0.0 | -5.5 |
| 60 | Sunday | 26 April | 63.0 | 92.3 | 29.3 | 120.1 | 133.7 | 13.6 | 107.0 | 55.7 | -51.3 | 27.8 | 24.2 | -3.7 | -12.1 |
| 61 | Monday | 27 April | | | | | | | | | | | | | |
| 62 | Tuesday | 28 April | 56.4 | 82.1 | 25.7 | 123.1 | 135.6 | 12.5 | 108.4 | 82.0 | -26.4 | 41.0 | 33.0 | -8.1 | 3.7 |
| 63 | Wednesday | 29 April | 52.0 | 84.2 | 32.2 | 112.8 | 135.6 | 22.7 | 108.4 | 57.2 | -51.3 | 28.6 | 35.2 | 6.6 | 10.3 |
| | End of Batch 8 | | 49.815 | 80.396 | 30.582 | 102.371 | 114.300 | 11.929 | 91.440 | 43.949 | -47.491 | 21.975 | 21.177 | -0.798 | -5.778 |
| 64 | Thursday | 30 April | 45.6 | 81.3 | 35.7 | 95.4 | 104.3 | 8.8 | 83.4 | 28.3 | -55.1 | 14.1 | 13.4 | -0.7 | -11.3 |
| 65 | Friday | 01 May | 42.1 | 78.4 | 36.4 | 91.9 | 99.0 | 7.1 | 79.2 | 26.8 | -52.3 | 13.4 | 12.0 | -1.4 | -10.2 |
| 66 | Saturday | 02 May | 39.9 | 70.7 | 30.7 | 84.1 | 90.1 | 6.0 | 72.1 | 26.8 | -45.2 | 13.4 | 10.6 | -2.8 | -11.3 |
| | End of Batch 9 | | 42.520 | 76.787 | 34.267 | 90.447 | 97.767 | 7.320 | 78.213 | 27.320 | -50.893 | 13.660 | 12.013 | -1.647 | -10.953 |
| 67 | Sunday | 03 May | 39.9 | 75.6 | 35.7 | 87.6 | 97.2 | 9.5 | 77.7 | 24.0 | -53.7 | 12.0 | 12.0 | 0.0 | -8.5 |
| 68 | Monday | 04 May | 44.2 | 77.0 | 32.9 | 90.4 | 102.5 | 12.0 | 82.0 | 26.8 | -55.1 | 13.4 | 12.7 | -0.7 | -11.0 |
| 69 | Tuesday | 05 May | 42.8 | 73.5 | 30.7 | 84.1 | 93.7 | 9.6 | 74.9 | 21.2 | -53.7 | 10.6 | 10.6 | 0.0 | -13.4 |
| 70 | Wednesday | 06 May | 44.5 | 80.6 | 36.1 | 96.8 | 106.0 | 9.1 | 84.8 | 32.5 | -52.2 | 16.3 | 14.4 | -1.9 | -8.9 |
| 71 | Thursday | 07 May | 44.5 | 82.0 | 37.5 | 99.6 | 106.0 | 6.3 | 84.8 | 35.3 | -49.4 | 17.7 | 17.0 | -0.7 | -6.4 |
| 72 | Friday | 08 May | 44.6 | 76.0 | 31.4 | 95.9 | 112.5 | 16.6 | 90.0 | 39.8 | -50.2 | 19.9 | 18.4 | -1.5 | -3.7 |
| | End of Batch10 | | 43.415 | 77.443 | 34.028 | 92.423 | 102.942 | 10.518 | 82.353 | 29.960 | -52.393 | 14.980 | 14.187 | -0.793 | -8.640 |
| 73 | Saturday | 09 May | | | | | | | | | | | | | |
| 74 | Sunday | 10 May | 35.8 | 72.3 | 36.5 | 84.1 | 72.0 | -12.1 | 57.6 | 23.6 | -34.0 | 11.8 | 11.1 | -0.7 | -10.3 |
| 75 | Monday | 11 May | 41.7 | 62.0 | 20.3 | 72.3 | 88.6 | 16.3 | 70.8 | 20.6 | -50.2 | 10.3 | 8.9 | -1.5 | -15.1 |
| 76 | Tuesday | 12 May | 38.4 | 70.1 | 31.7 | 82.6 | 92.2 | 9.6 | 73.8 | 25.1 | -48.7 | 12.5 | 10.3 | -2.2 | -9.6 |
| 77 | Wednesday | 13 May | 41.3 | 68.6 | 27.3 | 88.5 | 99.6 | 11.1 | 79.7 | 39.8 | -39.9 | 19.9 | 14.8 | -5.1 | -6.6 |
| 78 | Thursday | 14 May | 40.7 | 65.1 | 24.4 | 79.9 | 94.3 | 14.4 | 75.4 | 29.6 | -45.8 | 14.8 | 14.1 | -0.7 | -7.8 |
| 79 | Friday | 15 May | 40.7 | 65.1 | 24.4 | 77.7 | 92.5 | 14.8 | 74.0 | 25.2 | -48.8 | 12.6 | 11.1 | -1.5 | -11.1 |
| 80 | Saturday | 16 May | 40.7 | 64.4 | 23.7 | 79.2 | 90.7 | 11.5 | 72.5 | 29.6 | -42.9 | 14.8 | 13.3 | -1.5 | -9.2 |
| 81 | Sunday | 17 May | 45.3 | 68.1 | 22.7 | 87.3 | 100.9 | 13.6 | 80.7 | 38.5 | -42.2 | 19.2 | 17.8 | -1.5 | -7.4 |
| 82 | Monday | 18 May | 36.6 | 65.8 | 29.2 | 87.3 | 98.0 | 10.7 | 78.4 | 42.9 | -35.5 | 21.5 | 20.0 | -1.5 | 3.0 |
| 83 | Tuesday | 19 May | 41.1 | 73.2 | 32.2 | 96.9 | 98.0 | 1.1 | 78.4 | 47.4 | -31.0 | 23.7 | 21.5 | -2.2 | 0.0 |
| | End of Batch 11 | | 40.219 | 67.466 | 27.247 | 83.578 | 92.660 | 9.082 | 74.128 | 32.224 | -41.904 | 16.112 | 14.268 | -1.844 | -7.419 |

**Mass Balance for Phosphorous**

| Day No. | 1998 | | Anaerobic | | | Anoxic | | | Aerobic | | | Settler | | | Sum Diff. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | Mass In mgP/l infl | Mass Out mgP/l infl | Diff | |
| 84 | Wednesday | 20 May | 41.2 | 66.2 | 25.0 | 90.4 | 106.4 | 15.9 | 85.1 | 48.4 | -36.6 | 24.2 | 23.5 | -0.7 | 3.6 |
| 85 | Thursday | 21 May | 47.0 | 72.6 | 25.6 | 96.9 | 108.6 | 11.7 | 86.9 | 48.4 | -38.4 | 24.2 | 23.5 | -0.7 | -1.8 |
| 86 | Friday | 22 May | 49.1 | 71.2 | 22.1 | 92.6 | 110.4 | 17.8 | 88.3 | 42.7 | -45.6 | 21.4 | 21.4 | 0.0 | -5.7 |
| 87 | Saturday | 23 May | 43.6 | 68.4 | 24.7 | 90.4 | 108.6 | 18.2 | 86.9 | 44.2 | -42.7 | 22.1 | 20.7 | -1.4 | -1.3 |
| 88 | Sunday | 24 May | | | | | | | | | | | | | |
| 89 | Monday | 25 May | 43.1 | 74.8 | 31.7 | 93.3 | 97.9 | 4.6 | 78.3 | 37.0 | -41.3 | 18.5 | 18.5 | 0.0 | -5.0 |
| 90 | Tuesday | 26 May | 45.2 | 73.3 | 28.1 | 87.6 | 105.1 | 17.5 | 84.0 | 28.5 | -55.6 | 14.2 | 11.4 | -2.8 | -12.8 |
| 91 | Wednesday | 27 May | | | | | | | | | | | | | |
| 92 | Thursday | 28 May | 46.5 | 81.4 | 34.9 | 95.5 | 103.8 | 8.3 | 83.0 | 28.2 | -54.8 | 14.1 | 14.1 | 0.0 | -11.6 |
| 93 | Friday | 29 May | 44.8 | 84.7 | 39.9 | 95.5 | 99.3 | 3.8 | 79.4 | 21.6 | -57.8 | 10.8 | 10.8 | 0.0 | -14.1 |
| 94 | Saturday | 30 May | 45.7 | 84.7 | 39.0 | 98.0 | 101.7 | 3.7 | 81.4 | 26.6 | -54.8 | 13.3 | 13.3 | 0.0 | -12.0 |
| 95 | Sunday | 31 May | 51.5 | 88.8 | 37.4 | 104.6 | 114.2 | 9.5 | 91.3 | 31.6 | -59.8 | 15.8 | 7.5 | -8.3 | -21.2 |
| 96 | Monday | 01 June | 49.4 | 86.3 | 37.0 | 102.1 | 124.5 | 22.4 | 99.6 | 31.6 | -68.0 | 15.8 | 14.9 | -0.8 | -9.5 |
| 97 | Tuesday | 02 June | 56.0 | 87.2 | 31.1 | 103.8 | 151.5 | 47.7 | 121.2 | 33.2 | -88.0 | 16.6 | 17.4 | 0.8 | -8.3 |
| 98 | Wednesday | 03 June | | | | | | | | | | | | | |
| 99 | Thursday | 04 June | | | | | | | | | | | | | |
| 100 | Friday | 05 June | 46.1 | 88.0 | 41.9 | 98.8 | 105.9 | 7.1 | 84.7 | 21.6 | -63.1 | 10.8 | 8.3 | -2.5 | -16.6 |
| | End of Batch 12 | | 48.553 | 85.863 | 37.310 | 99.743 | 114.386 | 14.643 | 91.509 | 27.760 | -63.749 | 13.880 | 12.337 | -1.543 | -13.339 |
| 101 | Saturday | 06 June | 45.7 | 74.9 | 29.2 | 82.4 | 101.1 | 18.7 | 80.9 | 15.0 | -65.9 | 7.5 | 6.7 | -0.7 | -18.7 |
| 102 | Sunday | 07 June | 42.3 | 83.9 | 41.6 | 91.4 | 104.9 | 13.5 | 83.9 | 15.0 | -68.9 | 7.5 | 4.5 | -3.0 | -16.8 |
| 103 | Monday | 08 June | 44.2 | 95.6 | 51.5 | 103.1 | 106.7 | 3.6 | 85.4 | 15.0 | -70.4 | 7.5 | 6.0 | -1.5 | -16.8 |
| 104 | Tuesday | 09 June | 43.8 | 76.4 | 32.6 | 82.4 | 106.7 | 24.3 | 85.4 | 12.0 | -73.4 | 6.0 | 5.2 | -0.8 | -17.2 |
| 105 | Wednesday | 10 June | 47.9 | 65.2 | 17.2 | 77.1 | 127.3 | 50.2 | 101.8 | 24.0 | -77.9 | 12.0 | 12.0 | 0.0 | -10.5 |
| 106 | Thursday | 11 June | 48.3 | 68.2 | 19.8 | 87.6 | 129.2 | 41.6 | 103.4 | 39.0 | -64.4 | 19.5 | 13.5 | -6.0 | -9.0 |
| 107 | Friday | 12 June | 44.8 | 62.8 | 18.0 | 87.3 | 126.4 | 39.0 | 101.1 | 49.1 | -52.0 | 24.5 | 18.8 | -5.8 | -0.7 |
| | End of Batch13 | | 45.283 | 75.277 | 29.994 | 87.340 | 114.600 | 27.260 | 91.680 | 24.126 | -67.554 | 12.063 | 9.529 | -2.534 | -12.834 |
| 108 | Saturday | 13 June | 45.5 | 63.5 | 18.0 | 72.2 | 108.3 | 36.1 | 86.6 | 17.3 | -69.3 | 8.7 | 6.5 | -2.2 | -17.3 |
| 109 | Sunday | 14 June | | | | | | | | | | | | | |
| 110 | Monday | 15 June | | | | | | | | | | | | | |
| 111 | Tuesday | 16 June | | | | | | | | | | | | | |
| 112 | Wednesday | 17 June | | | | | | | | | | | | | |
| | End of Batch14 | | 45.480 | 63.520 | 18.040 | 72.180 | 108.300 | 36.120 | 86.640 | 17.320 | -69.320 | 8.660 | 6.500 | -2.160 | -17.320 |
| 113 | Thursday | 18 June | 45.5 | 59.9 | 14.4 | 81.6 | 104.7 | 23.1 | 83.8 | 43.3 | -40.4 | 21.7 | 22.4 | 0.7 | -2.2 |
| 114 | Friday | 19 June | | | | | | | | | | | | | |
| 115 | Saturday | 20 June | | | | | | | | | | | | | |
| 116 | Sunday | 21 June | 43.3 | 59.9 | 16.6 | 85.2 | 108.3 | 23.1 | 86.6 | 50.5 | -36.1 | 25.3 | 23.8 | -1.4 | 2.2 |
| 117 | Monday | 22 June | 45.5 | 58.5 | 13.0 | 82.3 | 110.1 | 27.8 | 88.1 | 47.6 | -40.4 | 23.8 | 23.8 | 0.0 | 0.4 |
| | End of Batch15 | | 44.760 | 59.440 | 14.680 | 83.020 | 107.700 | 24.680 | 86.160 | 47.160 | -39.000 | 23.580 | 23.340 | -0.240 | 0.120 |
| 118 | Tuesday | 23 June | 43.7 | 57.2 | 13.5 | 86.0 | 110.0 | 24.0 | 88.0 | 57.8 | -30.2 | 28.9 | 25.3 | -3.6 | 3.6 |
| 119 | Wednesday | 24 June | 48.0 | 56.3 | 8.3 | 91.0 | 122.7 | 31.7 | 98.2 | 69.3 | -28.8 | 34.7 | 32.5 | -2.2 | 9.0 |
| 120 | Thursday | 25 June | 49.7 | 59.0 | 9.4 | 97.9 | 129.6 | 31.7 | 103.7 | 77.8 | -25.9 | 38.9 | 36.0 | -2.9 | 12.2 |
| 121 | Friday | 26 June | | | | | | | | | | | | | |
| 122 | Saturday | 27 June | | | | | | | | | | | | | |
| 123 | Sunday | 28 June | | | | | | | | | | | | | |
| | End of Batch16 | | 47.116 | 57.500 | 10.384 | 91.640 | 120.770 | 29.130 | 96.616 | 68.280 | -28.336 | 34.140 | 31.247 | -2.893 | 8.285 |
| 124 | Monday | 29 June | 40.7 | 44.6 | 4.0 | 59.8 | 81.0 | 21.2 | 64.8 | 30.2 | -34.6 | 15.1 | 14.4 | -0.7 | -10.1 |
| 125 | Tuesday | 30 June | 40.0 | 50.4 | 10.4 | 68.4 | 90.0 | 21.6 | 72.0 | 36.0 | -36.0 | 18.0 | 15.1 | -2.9 | -6.8 |
| 126 | Wednesday | 01 July | 45.4 | 52.6 | 7.2 | 82.8 | 109.8 | 27.0 | 87.8 | 60.5 | -27.4 | 30.2 | 23.0 | -7.2 | -0.4 |
| 127 | Thursday | 02 July | | | | | | | | | | | | | |
| 128 | Friday | 03 July | | | | | | | | | | | | | |
| 129 | Saturday | 04 July | | | | | | | | | | | | | |
| 130 | Sunday | 05 July | | | | | | | | | | | | | |
| 131 | Monday | 06 July | 46.1 | 46.1 | 0.0 | 82.1 | 108.0 | 25.9 | 86.4 | 72.0 | -14.4 | 36.0 | 35.3 | -0.7 | |
| 132 | Tuesday | 07 July | 48.6 | 61.2 | 12.6 | 90.7 | 99.0 | 8.3 | 79.2 | 59.0 | -20.2 | 29.5 | 33.1 | 3.6 | 4.3 |
| | End of Batch17 | | 44.136 | 50.976 | 6.840 | 76.752 | 97.560 | 20.808 | 78.048 | 51.552 | -26.496 | 25.776 | 24.192 | -1.584 | -2.592 |
| 133 | Wednesday | 08 July | 46.1 | 46.1 | 0.0 | 79.9 | 109.8 | 29.9 | 87.8 | 67.7 | -20.2 | 33.8 | 31.7 | -2.2 | |
| 134 | Thursday | 09 July | 46.4 | 42.7 | -3.7 | 74.3 | 101.8 | 27.5 | 81.4 | 63.2 | -18.2 | 31.6 | 32.7 | 1.1 | 6.7 |
| 135 | Friday | 10 July | 46.4 | 49.4 | 3.0 | 85.4 | 113.4 | 28.0 | 90.7 | 72.0 | -18.7 | 36.0 | 33.4 | -2.7 | 9.7 |
| 136 | Saturday | 11 July | 48.7 | 448.7 | 400.0 | 487.4 | 111.8 | -375.7 | 89.4 | 77.4 | -12.0 | 38.7 | 37.4 | -1.3 | 11.0 |
| 137 | Sunday | 12 July | 46.4 | 45.4 | -1.0 | 82.7 | 108.4 | 25.7 | 86.7 | 74.7 | -12.0 | 37.4 | 37.4 | 0.0 | 12.7 |
| 138 | Monday | 13 July | 48.4 | 50.7 | 2.3 | 93.4 | 118.5 | 25.1 | 94.8 | 85.4 | -9.4 | 42.7 | 40.0 | -2.7 | 15.4 |
| 139 | Tuesday | 14 July | | | | | | | | | | | | | |
| 140 | Wednesday | 15 July | | | | | | | | | | | | | |
| 141 | Thursday | 16 July | 44.0 | 38.7 | -5.3 | 70.1 | 90.1 | 20.0 | 72.0 | 62.7 | -9.3 | 31.4 | 32.0 | 0.7 | 6.0 |
| 142 | Friday | 17 July | 42.5 | 39.7 | -2.8 | 68.8 | 90.4 | 21.6 | 72.3 | 58.1 | -14.2 | 29.1 | 24.2 | -4.9 | -0.3 |
| 143 | Saturday | 18 July | | | | | | | | | | | | | |
| 144 | Sunday | 19 July | | | | | | | | | | | | | |
| 145 | Monday | 20 July | | | | | | | | | | | | | |
| | End of Batch 18 | | 46.104 | 95.165 | 49.061 | 130.243 | 105.500 | -24.742 | 84.400 | 70.155 | -14.245 | 35.078 | 33.588 | -1.490 | 7.639 |
| 146 | Tuesday | 21 July | 37.9 | 30.5 | -7.5 | 51.2 | 62.1 | 10.8 | 49.6 | 41.5 | -8.2 | 20.7 | 15.6 | -5.1 | -9.9 |
| 147 | Wednesday | 22 July | | | | | | | | | | | | | |
| | End of Batch 19 | | 37.930 | 30.480 | -7.450 | 51.220 | 62.050 | 10.830 | 49.640 | 41.480 | -8.160 | 20.740 | 15.600 | -5.140 | -9.920 |
| 148 | Thursday | 23 July | 42.2 | 42.5 | 0.4 | 77.3 | 109.9 | 32.6 | 87.9 | 69.5 | -18.4 | 34.7 | 31.9 | -2.8 | 11.7 |
| 149 | Friday | 24 July | 40.1 | 42.5 | 2.5 | 75.9 | 106.4 | 30.5 | 85.1 | 66.6 | -18.4 | 33.3 | 33.3 | 0.0 | 14.5 |
| 150 | Saturday | 25 July | 40.1 | 75.2 | 35.1 | 104.2 | 99.3 | -5.0 | 79.4 | 58.1 | -21.3 | 29.1 | 28.4 | -0.7 | 8.1 |
| 151 | Sunday | 26 July | 41.1 | 44.7 | 3.5 | 70.9 | 97.5 | 26.6 | 78.0 | 52.5 | -25.5 | 26.2 | 28.4 | 2.1 | 6.7 |
| 152 | Monday | 27 July | | | | | | | | | | | | | |
| | End of Batch 20 | | 40.858 | 51.225 | 10.367 | 82.065 | 103.250 | 21.185 | 82.600 | 61.680 | -20.920 | 30.840 | 30.485 | -0.355 | 10.277 |
| 153 | Tuesday | 28 July | 42.5 | 48.9 | 6.4 | 75.9 | 99.3 | 23.4 | 79.4 | 53.9 | -25.5 | 26.9 | 26.9 | 0.0 | 4.2 |
| 154 | Wednesday | 29 July | 43.5 | 45.2 | 1.7 | 71.6 | 86.9 | 15.3 | 69.5 | 52.8 | -16.7 | 26.4 | 26.4 | 0.0 | 0.4 |
| 155 | Thursday | 30 July | 42.1 | 47.9 | 5.8 | 77.6 | 102.6 | 25.0 | 82.0 | 59.4 | -22.6 | 29.7 | 29.1 | -0.6 | 7.6 |
| 156 | Friday | 31 July | 43.5 | 48.7 | 5.2 | 77.9 | 99.1 | 21.2 | 79.2 | 58.4 | -20.8 | 29.2 | 27.8 | -1.4 | 4.2 |
| 157 | Saturday | 01 August | | | | | | | | | | | | | |
| 158 | Sunday | 02 August | | | | | | | | | | | | | |
| 159 | Monday | 03 August | | | | | | | | | | | | | |
| | End of Batch 21 | | 42.875 | 47.665 | 4.790 | 75.730 | 96.938 | 21.208 | 77.550 | 56.130 | -21.420 | 28.065 | 27.565 | -0.500 | 4.078 |
| 160 | Tuesday | 04 August | 42.4 | 48.7 | 6.3 | 75.8 | 99.1 | 23.3 | 79.2 | 54.2 | -25.0 | 27.1 | 26.4 | -0.7 | 3.8 |
| 161 | Wednesday | 05 August | 39.3 | 46.6 | 7.3 | 76.5 | 88.7 | 12.2 | 70.9 | 59.8 | -11.1 | 29.9 | 28.5 | -1.4 | 7.0 |
| 162 | Thursday | 06 August | | | | | | | | | | | | | |
| 163 | Friday | 07 August | 36.8 | 43.1 | 6.3 | 70.2 | 78.2 | 8.0 | 62.6 | 54.2 | -8.3 | 27.1 | 27.1 | 0.0 | 5.9 |
| 164 | Saturday | 08 August | | | | | | | | | | | | | |
| 165 | Sunday | 09 August | | | | | | | | | | | | | |
| 166 | Monday | 10 August | | | | | | | | | | | | | |
| 167 | Tuesday | 11 August | | | | | | | | | | | | | |
| 168 | Wednesday | 12 August | 35.1 | 40.0 | 4.9 | 64.6 | 72.0 | 7.4 | 57.6 | 49.1 | -8.4 | 24.6 | 23.9 | -0.7 | 3.2 |
| 169 | Thursday | 13 August | 37.2 | 28.1 | -9.1 | 56.9 | 84.2 | 27.3 | 67.4 | 57.6 | -9.8 | 28.8 | 23.9 | -4.9 | 3.5 |
| 170 | Friday | 14 August | | | | | | | | | | | | | |
| 171 | Saturday | 15 August | 19.7 | 42.8 | 23.2 | 71.6 | 0.0 | | 0.0 | 57.6 | | 28.8 | 28.1 | -0.7 | |
| 172 | Sunday | 16 August | | | | | | | | | | | | | |
| 173 | Monday | 17 August | 35.1 | 41.5 | 6.5 | ERR | 70.3 | ERR | 56.3 | 55.4 | -0.9 | 27.7 | 26.3 | -1.4 | ERR |
| | End of Batch 22 | | 35.075 | 41.537 | 6.462 | 69.247 | 70.342 | 13.025 | 56.273 | 55.420 | -10.447 | 27.710 | 26.307 | -1.403 | 3.895 |
| 174 | Tuesday | 18 August | 37.6 | 47.7 | 10.2 | 70.2 | 89.5 | 19.3 | 71.6 | 44.9 | -26.7 | 22.4 | 21.8 | -0.7 | 2.1 |
| 175 | Wednesday | 19 August | 41.4 | 44.9 | 3.5 | 74.4 | 105.3 | 30.8 | 84.2 | 59.0 | -25.2 | 29.5 | 19.7 | -9.8 | -0.7 |
| 176 | Thursday | 20 August | 42.5 | 53.3 | 10.9 | 79.3 | 110.6 | 31.2 | 88.4 | 51.9 | -36.5 | 26.0 | 21.8 | -4.2 | 1.4 |
| | | | 40.470 | 48.860 | 8.190 | 74.620 | 101.767 | 27.147 | 81.413 | 51.920 | -29.493 | 25.960 | 21.060 | -4.900 | 0.943 |

**Mass Balance for Nitrogen**

| Day No. | 1998 | | NO3 denit mgN/d | Den in AN | Sum | N in Wast mgN/d | TKN in Eff mgN/d | NO3 in Eff mgN/d | MB mgN/d |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Thursday | 26 February | 438.4 | 0.0 | 438.4 | 404.4 | 417.2 | 116.0 | 94.7 |
| 2 | Friday | 27 February | 690.0 | 0.0 | 690.0 | 396.8 | 258.0 | 202.0 | 107.1 |
| 3 | Saturday | 28 February | 629.4 | 0.0 | 629.4 | 377.6 | 137.2 | 226.0 | 100.5 |
| 4 | Sunday | 01 March | 750.2 | 0.0 | 750.2 | 372.8 | 137.2 | 250.0 | 110.5 |
| 5 | Monday | 02 March | 713.8 | 0.0 | 713.8 | 366.8 | 58.8 | 240.0 | 98.1 |
| 6 | Tuesday | 03 March | 751.6 | 0.0 | 751.6 | 398.4 | 64.4 | 260.0 | 109.2 |
| 7 | Wednesday | 04 March | 796.2 | 7.8 | 804.0 | 375.2 | 89.6 | 320.0 | 118.7 |
| 8 | Thursday | 05 March | 862.4 | 1.6 | 864.0 | 282.8 | 78.4 | 304.0 | 105.4 |
| 9 | Friday | 06 March | 911.4 | 0.6 | 912.0 | 380.8 | 103.6 | 320.0 | 107.4 |
| 10 | Saturday | 07 March | 916.8 | 0.0 | 916.8 | 422.8 | 98.0 | 324.0 | 113.2 |
| 11 | Sunday | 08 March | 920.2 | 0.0 | 920.2 | 343.0 | 72.8 | 320.0 | 105.4 |
| 12 | Monday | 09 March | 906.0 | 0.0 | 906.0 | 403.2 | 67.2 | 324.0 | 113.5 |
| 13 | Tuesday | 10 March | 774.4 | 28.8 | 803.2 | 302.4 | 72.8 | 304.0 | 95.9 |
| 14 | Wednesday | 11 March | 961.4 | 21.0 | 982.4 | 366.8 | 95.2 | 420.0 | 122.0 |
| 15 | Thursday | 12 March | 795.8 | 37.0 | 832.8 | 337.4 | 67.2 | 368.0 | 105.2 |
| | **End of Batch 2** | | **787.9** | **6.5** | **794.3** | **368.7** | **121.2** | **286.5** | **107.1** |
| 16 | Friday | 13 March | 893.2 | 2.0 | 895.2 | 352.8 | 70.0 | 332.0 | 116.9 |
| 17 | Saturday | 14 March | 851.2 | 8.0 | 859.2 | 322.0 | 81.2 | 288.0 | 105.7 |
| 18 | Sunday | 15 March | 883.2 | 4.6 | 887.8 | 343.0 | 61.6 | 332.0 | 108.6 |
| 19 | Monday | 16 March | 755.2 | 0.8 | 756.0 | 302.4 | 81.2 | 260.0 | 95.2 |
| 20 | Tuesday | 17 March | 767.0 | 1.0 | 768.0 | 369.6 | 117.6 | 284.0 | 100.5 |
| | **End of Batch 3** | | **830.0** | **3.3** | **833.2** | **338.0** | **82.3** | **299.2** | **105.4** |
| 21 | Wednesday | 18 March | 730.4 | 8.0 | 738.4 | 352.8 | 89.6 | 268.0 | 101.3 |
| 22 | Thursday | 19 March | 758.0 | 6.0 | 764.0 | 331.8 | 56.0 | 252.0 | 102.1 |
| 23 | Friday | 20 March | 807.0 | 18.6 | 825.6 | 299.6 | 58.8 | 300.0 | 109.1 |
| 24 | Saturday | 21 March | 847.2 | 3.2 | 850.4 | 305.2 | 61.6 | 356.0 | 105.8 |
| 25 | Sunday | 22 March | 833.0 | 3.0 | 836.0 | 282.8 | 58.8 | 312.0 | 104.3 |
| 26 | Monday | 23 March | 757.0 | 3.0 | 760.0 | 288.4 | 72.8 | 276.0 | 95.2 |
| 27 | Tuesday | 24 March | 718.6 | 6.2 | 724.8 | 268.8 | 72.8 | 272.0 | 88.5 |
| 28 | Wednesday | 25 March | 719.0 | 7.8 | 726.8 | 291.2 | 64.4 | 234.0 | 90.8 |
| | **End of Batch 4** | | **771.3** | **7.0** | **778.3** | **302.6** | **66.9** | **283.8** | **99.6** |
| 29 | Thursday | 26 March | 726.8 | 10.8 | 737.6 | 322.0 | 89.6 | 260.0 | 95.7 |
| 30 | Friday | 27 March | 538.0 | 1.2 | 539.2 | 288.4 | 72.8 | 200.0 | 110.4 |
| 31 | Saturday | 28 March | 473.6 | 3.6 | 477.2 | 277.2 | 42.0 | 170.0 | 81.0 |
| 32 | Sunday | 29 March | 458.0 | 5.2 | 463.2 | 302.4 | 42.0 | 160.0 | 89.3 |
| 33 | Monday | 30 March | 434.8 | 5.6 | 440.4 | 263.2 | 53.2 | 154.0 | 77.1 |
| 34 | Tuesday | 31 March | 445.0 | 0.2 | 445.2 | 289.8 | 47.6 | 162.0 | 84.3 |
| 35 | Wednesday | 01 April | 469.2 | 2.0 | 471.2 | 308.0 | 44.8 | 176.0 | 87.3 |
| 36 | Thursday | 02 April | 462.4 | 1.6 | 464.0 | 294.0 | 58.8 | 180.0 | 96.5 |
| | **End of Batch 5** | | **501.0** | **3.8** | **504.8** | **293.1** | **56.4** | **182.8** | **90.2** |
| 37 | Friday | 03 April | 474.0 | 2.0 | 476.0 | 343.0 | 47.6 | 168.0 | 93.8 |
| 38 | Saturday | 04 April | | | | | | | |
| 39 | Sunday | 05 April | 422.0 | 0.0 | 422.0 | 309.4 | 47.6 | 166.0 | 81.1 |
| 40 | Monday | 06 April | 451.2 | 0.0 | 451.2 | 301.0 | 58.8 | 150.0 | 81.1 |
| 41 | Tuesday | 07 April | 427.4 | 0.6 | 428.0 | 320.6 | 50.4 | 140.0 | 80.2 |
| 42 | Wednesday | 08 April | | | | | | | |
| 43 | Thursday | 09 April | 778.0 | 13.2 | 791.2 | 375.2 | 126.0 | 296.0 | 80.0 |
| | **End of Batch 6** | | **510.5** | **3.2** | **513.7** | **329.8** | **66.1** | **184.0** | **83.3** |
| 44 | Friday | 10 April | 644.0 | 66.0 | 710.0 | 315.0 | 45.0 | 350.0 | 69.2 |
| 45 | Saturday | 11 April | 582.8 | 115.2 | 698.0 | 341.6 | 53.2 | 414.0 | 92.9 |
| 46 | Sunday | 12 April | | | | | | | |
| 47 | Monday | 13 April | 623.2 | 160.8 | 784.0 | 347.2 | 106.4 | 500.0 | 95.0 |
| 48 | Tuesday | 14 April | 670.4 | 143.6 | 814.0 | 330.4 | 61.6 | 470.0 | 82.4 |
| 49 | Wednesday | 15 April | 679.8 | 140.2 | 820.0 | 348.6 | 58.8 | 480.0 | 83.3 |
| 50 | Thursday | 16 April | 735.2 | 116.8 | 852.0 | 331.8 | 95.2 | 432.0 | 85.2 |
| | **End of Batch 7** | | **655.9** | **123.8** | **779.7** | **335.8** | **70.0** | **441.0** | **84.7** |
| 51 | Friday | 17 April | 963.0 | 0.0 | 963.0 | 376.6 | 81.2 | 394.0 | 115.5 |
| 52 | Saturday | 18 April | | | | | | | |
| 53 | Sunday | 19 April | 674.2 | 7.8 | 682.0 | 282.8 | 64.4 | 270.0 | 83.6 |
| 54 | Monday | 20 April | 628.0 | 2.0 | 630.0 | 333.2 | 70.0 | 254.0 | 81.2 |
| 55 | Tuesday | 21 April | 698.2 | 7.8 | 706.0 | 254.8 | 47.6 | 250.0 | 83.1 |
| 56 | Wednesday | 22 April | 663.4 | 10.6 | 674.0 | 263.2 | 61.6 | 262.0 | 97.0 |
| 57 | Thursday | 23 April | 602.8 | 32.0 | 634.8 | 333.2 | 89.7 | 270.0 | 89.5 |
| 58 | Friday | 24 April | 553.6 | 37.6 | 591.2 | 260.4 | 81.2 | 296.0 | 77.5 |
| 59 | Saturday | 25 April | 671.8 | 25.0 | 696.8 | 294.0 | 95.2 | 324.0 | 108.8 |
| 60 | Sunday | 26 April | 633.4 | 14.6 | 648.0 | 288.4 | 78.4 | 280.0 | 87.3 |
| 61 | Monday | 27 April | | | | | | | |
| 62 | Tuesday | 28 April | 684.2 | 23.4 | 707.6 | 352.8 | 98.0 | 306.0 | 107.4 |
| 63 | Wednesday | 29 April | 527.4 | 4.6 | 532.0 | 266.0 | 56.0 | 220.0 | 79.7 |
| | **End of Batch 8** | | **663.6** | **15.0** | **678.7** | **300.5** | **74.8** | **284.2** | **91.9** |
| 64 | Thursday | 30 April | 650.0 | 0.0 | 650.0 | 322.0 | 61.6 | 210.0 | 90.3 |
| 65 | Friday | 01 May | 441.6 | 0.0 | 441.6 | 302.4 | 56.0 | 218.0 | 77.7 |
| 66 | Saturday | 02 May | 543.8 | 4.2 | 548.0 | 254.8 | 72.8 | 232.0 | 87.1 |
| | **End of Batch 9** | | **545.1** | **1.4** | **546.5** | **293.1** | **63.5** | **220.0** | **85.0** |
| 67 | Sunday | 03 May | 658.8 | 6.4 | 665.2 | 296.8 | 67.2 | 210.0 | 92.6 |
| 68 | Monday | 04 May | 794.0 | 3.2 | 797.2 | 322.0 | 64.4 | 210.0 | 110.1 |
| 69 | Tuesday | 05 May | 654.0 | 2.4 | 656.4 | 271.6 | 72.8 | 262.0 | 91.1 |
| 70 | Wednesday | 06 May | 705.8 | 6.2 | 712.0 | 238.0 | 0.0 | 252.0 | 95.0 |
| 71 | Thursday | 07 May | 638.6 | 10.2 | 648.8 | 0.0 | 28.0 | 248.0 | 72.6 |
| 72 | Friday | 08 May | 878.2 | 15.8 | 894.0 | 327.6 | 86.8 | 310.0 | 120.2 |
| | **End of Batch10** | | **721.6** | **7.4** | **728.9** | **242.7** | **53.2** | **248.7** | **96.9** |
| 73 | Saturday | 09 May | | | | | | | |
| 74 | Sunday | 10 May | 654.2 | 31.0 | 685.2 | 257.6 | 98.0 | 282.0 | 130.5 |
| 75 | Monday | 11 May | 765.0 | 25.0 | 790.0 | 266.0 | 123.2 | 350.0 | 116.2 |
| 76 | Tuesday | 12 May | 711.8 | 18.2 | 730.0 | 196.0 | 53.2 | 326.0 | 86.6 |
| 77 | Wednesday | 13 May | 660.4 | 21.2 | 681.6 | 0.0 | 126.0 | 300.0 | 71.4 |
| 78 | Thursday | 14 May | 1034.4 | 0.0 | 1034.4 | 316.4 | 170.8 | 370.0 | 118.3 |
| 79 | Friday | 15 May | 1089.2 | 2.4 | 1091.6 | 277.2 | 100.8 | 374.0 | 111.4 |
| 80 | Saturday | 16 May | 943.4 | 36.6 | 980.0 | 313.6 | 70.0 | 392.0 | 112.8 |
| 81 | Sunday | 17 May | 886.6 | 37.4 | 924.0 | 352.8 | 61.6 | 412.0 | 99.2 |
| 82 | Monday | 18 May | 778.2 | 41.8 | 820.0 | 252.0 | 78.4 | 384.0 | 94.8 |
| 83 | Tuesday | 19 May | 1113.0 | 0.6 | 1113.6 | 257.6 | 7.3 | 400.0 | 118.5 |
| | **End of Batch 11** | | **863.6** | **21.4** | **885.0** | **248.9** | **88.9** | **359.0** | **106.0** |

**Mass Balance for Nitrogen**

| Day No. | 1998 | NO3 denit mgN/d | Den in A | Sum | N in Wast mgN/d | TKN in Ef mgN/d | NO3 in Ef mgN/d | MB mgN/d |
|---|---|---|---|---|---|---|---|---|
| 84 | Wednesday 20 May | 1256.8 | 2.8 | 1259.6 | 308.0 | 95.2 | 486.0 | 144.3 |
| 85 | Thursday 21 May | 1425.6 | 0.0 | 1425.6 | 288.4 | 58.8 | 526.0 | 143.0 |
| 86 | Friday 22 May | 1306.0 | 0.0 | 1306.0 | 324.8 | 81.2 | 478.0 | 103.9 |
| 87 | Saturday 23 May | 1271.0 | 0.0 | 1271.0 | 224.0 | 165.2 | 440.0 | 101.2 |
| 88 | Sunday 24 May | | | | | | | |
| 89 | Monday 25 May | 1088.8 | 0.0 | 1088.8 | 0.0 | 106.4 | 352.0 | 75.1 |
| 90 | Tuesday 26 May | | | | | | | |
| 91 | Wednesday 27 May | | | | | | | |
| 92 | Thursday 28 May | 950.0 | 6.0 | 956.0 | 389.2 | 64.4 | 252.0 | 118.7 |
| 93 | Friday 29 May | 564.6 | 30.6 | 595.2 | 355.6 | 64.4 | 252.0 | 73.9 |
| 94 | Saturday 30 May | 706.2 | 10.6 | 716.8 | 316.4 | 58.8 | 252.0 | 98.8 |
| 95 | Sunday 31 May | 604.0 | 18.4 | 622.4 | 238.0 | 44.8 | 256.0 | 87.1 |
| 96 | Monday 01 June | 563.6 | 14.0 | 577.6 | 260.3 | 86.8 | 232.0 | 82.5 |
| 97 | Tuesday 02 June | 610.0 | 0.0 | 610.0 | 355.6 | 112.0 | 176.0 | 83.7 |
| 98 | Wednesday 03 June | | | | | | | |
| 99 | Thursday 04 June | | | | | | | |
| 100 | Friday 05 June | 740.6 | 10.6 | 751.2 | 372.4 | 33.6 | 288.0 | 107.3 |
| | End of Batch 12 | 677.0 | 12.9 | 689.9 | 326.8 | 66.4 | 244.0 | 93.1 |
| 101 | Saturday 06 June | 1051.8 | 0.0 | 1051.8 | 305.2 | 86.8 | 380.0 | 124.5 |
| 102 | Sunday 07 June | 647.8 | 64.2 | 712.0 | 300.0 | 98.0 | 292.0 | 91.5 |
| 103 | Monday 08 June | 616.0 | 48.8 | 664.8 | 431.2 | 44.8 | 340.0 | 102.9 |
| 104 | Tuesday 09 June | 847.8 | 36.2 | 884.0 | 361.2 | 47.6 | 360.0 | 104.8 |
| 105 | Wednesday 10 June | 948.0 | 29.6 | 977.6 | 313.6 | 131.6 | 376.0 | 112.7 |
| 106 | Thursday 11 June | 1305.4 | 0.0 | 1305.4 | 296.8 | 112.0 | 596.0 | 139.4 |
| 107 | Friday 12 June | 1459.6 | 0.0 | 1459.6 | 226.8 | 70.0 | 620.0 | 153.2 |
| | End of Batch13 | 982.3 | 25.5 | 1007.9 | 319.3 | 84.4 | 423.4 | 118.4 |
| 108 | Saturday 13 June | 1649.4 | 0.0 | 1649.4 | 319.2 | 226.8 | 600.0 | 149.5 |
| 109 | Sunday 14 June | | | | | | | |
| 110 | Monday 15 June | | | | | | | |
| 111 | Tuesday 16 June | | | | | | | |
| 112 | Wednesday 17 June | | | | | | | |
| | End of Batch14 | 1649.4 | 0.0 | 1649.4 | 319.2 | 226.8 | 600.0 | 149.5 |
| 113 | Thursday 18 June | 1861.0 | 9.4 | 1870.4 | 274.4 | 644.0 | 660.0 | 129.7 |
| 114 | Friday 19 June | | | | | | | |
| 115 | Saturday 20 June | | | | | | | |
| 116 | Sunday 21 June | | | | | | | |
| 117 | Monday 22 June | 2441.6 | 6.4 | 2448.0 | 366.8 | 818.0 | 736.0 | 140.8 |
| | End of Batch15 | 2151.3 | 7.9 | 2159.2 | 320.6 | 731.0 | 698.0 | 135.2 |
| 118 | Tuesday 23 June | 2477.2 | 22.0 | 2499.2 | 310.8 | 518.0 | 880.0 | 247.2 |
| 119 | Wednesday 24 June | 2149.2 | 10.8 | 2160.0 | 271.6 | 142.8 | 632.0 | 170.9 |
| 120 | Thursday 25 June | 1141.0 | 0.0 | 1141.0 | 308.0 | 162.4 | 380.0 | 105.8 |
| 121 | Friday 26 June | | | | | | | |
| 122 | Saturday 27 June | | | | | | | |
| 123 | Sunday 28 June | | | | | | | |
| | End of Batch16 | 1922.5 | 10.9 | 1933.4 | 296.8 | 274.4 | 630.7 | 174.6 |
| 124 | Monday 29 June | 1167.8 | 1.0 | 1168.8 | 0.0 | 92.4 | 380.0 | 94.5 |
| 125 | Tuesday 30 June | 1187.0 | 0.2 | 1187.2 | 294.0 | 89.6 | 400.0 | 102.3 |
| 126 | Wednesday 01 July | 1198.2 | 2.2 | 1200.4 | 271.6 | 81.2 | 418.0 | 121.8 |
| 127 | Thursday 02 July | | | | | | | |
| 128 | Friday 03 July | | | | | | | |
| 129 | Saturday 04 July | | | | | | | |
| 130 | Sunday 05 July | | | | | | | |
| 131 | Monday 06 July | 1113.2 | 0.0 | 1113.2 | 252.0 | 154.0 | 372.0 | 94.5 |
| 132 | Tuesday 07 July | 1079.8 | 0.0 | 1079.8 | 347.2 | 131.6 | 404.0 | 102.5 |
| | End of Batch17 | 1149.2 | 0.7 | 1149.9 | 233.0 | 109.8 | 394.8 | 103.1 |
| 133 | Wednesday 08 July | 886.8 | 0.0 | 886.8 | 338.8 | 103.6 | 300.0 | 119.2 |
| 134 | Thursday 09 July | 745.0 | 4.6 | 749.6 | 291.2 | 0.0 | 256.0 | 94.9 |
| 135 | Friday 10 July | 878.8 | 0.0 | 878.8 | 310.8 | 44.8 | 262.0 | 100.4 |
| 136 | Saturday 11 July | 912.2 | 5.4 | 917.6 | 313.6 | 78.4 | 300.0 | 109.7 |
| 137 | Sunday 12 July | 961.4 | 8.6 | 970.0 | 268.8 | 78.4 | 314.0 | 107.1 |
| 138 | Monday 13 July | 878.0 | 0.4 | 878.4 | 198.8 | 198.8 | 260.0 | 99.7 |
| 139 | Tuesday 14 July | | | | | | | |
| 140 | Wednesday 15 July | | | | | | | |
| 141 | Thursday 16 July | 901.2 | 0.0 | 901.2 | 266.0 | 182.4 | 292.0 | 102.7 |
| 142 | Friday 17 July | 929.8 | 9.0 | 938.8 | 0.0 | 95.2 | 302.0 | 88.9 |
| 143 | Saturday 18 July | | | | | | | |
| 144 | Sunday 19 July | | | | | | | |
| 145 | Monday 20 July | | | | | | | |
| | End of Batch 18 | 886.7 | 3.5 | 890.2 | 248.5 | 95.2 | 285.8 | 102.8 |
| 146 | Tuesday 21 July | 795.2 | 6.0 | 801.2 | 277.2 | 33.6 | 342.0 | 141.9 |
| 147 | Wednesday 22 July | | | | | | | |
| | End of Batch 19 | 795.2 | 6.0 | 801.2 | 277.2 | 33.6 | 342.0 | 141.9 |
| 148 | Thursday 23 July | 833.8 | 1.4 | 835.2 | 296.8 | 120.4 | 280.0 | 91.2 |
| 149 | Friday 24 July | 645.2 | 23.6 | 668.8 | 285.6 | 126.0 | 240.0 | 85.0 |
| 150 | Saturday 25 July | 800.8 | 5.6 | 806.4 | 249.2 | 84.0 | 264.0 | 100.3 |
| 151 | Sunday 26 July | 998.4 | 5.2 | 1003.6 | 310.8 | 120.4 | 342.0 | 121.1 |
| 152 | Monday 27 July | | | | | | | |
| | End of Batch 20 | 819.6 | 8.9 | 828.5 | 285.6 | 112.7 | 281.5 | 94.4 |
| 153 | Tuesday 28 July | 924.2 | 0.0 | 924.2 | 313.6 | 134.4 | 288.0 | 120.8 |
| 154 | Wednesday 29 July | | | | | | | |
| 155 | Thursday 30 July | | | | | | | |
| 156 | Friday 31 July | | | | | | | |
| 157 | Saturday 01 August | | | | | | | |
| 158 | Sunday 02 August | | | | | | | |
| 159 | Monday 03 August | | | | | | | |
| | End of Batch 21 | 924.2 | 0.0 | 924.2 | 313.6 | 134.4 | 288.0 | 120.8 |
| 160 | Tuesday 04 August | | | | | | | |
| 161 | Wednesday 05 August | | | | | | | |
| 162 | Thursday 06 August | | | | | | | |
| 163 | Friday 07 August | | | | | | | |
| 164 | Saturday 08 August | | | | | | | |
| 165 | Sunday 09 August | | | | | | | |
| 166 | Monday 10 August | | | | | | | |
| 167 | Tuesday 11 August | | | | | | | |
| 168 | Wednesday 12 August | | | | | | | |
| 169 | Thursday 13 August | | | | | | | |
| 170 | Friday 14 August | | | | | | | |
| 171 | Saturday 15 August | | | | | | | |
| 172 | Sunday 16 August | | | | | | | |
| 173 | Monday 17 August | | | | | | | |
| | End of Batch 22 | ERR | ERR | ERR | ERR | ERR | ERR | ERR |

**COD Mass Balance**

| Day No. | 1998 | | Sum den MSnod | MSnoe | MSno | MOn mgO/d | MOc mgO/d | MOd mgO/d | COD in W mgO/d | COD in E MSte | MB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Thursday | 26 February | 438.4 | 116.0 | 554.4 | 2533.6 | 9226.4 | 1253.8 | 5985.1 | 3042.6 | 149.1 |
| 2 | Friday | 27 February | 690.0 | 202.0 | 892.0 | 4076.4 | 3723.6 | 1973.4 | 5872.6 | 2194.6 | 96.2 |
| 3 | Saturday | 28 February | 629.4 | 226.0 | 855.4 | 3909.2 | 3266.8 | 1800.1 | 5588.5 | 1869.4 | 94.0 |
| 4 | Sunday | 01 March | 750.2 | 250.0 | 1000.2 | 4570.9 | 3709.1 | 2145.6 | 5517.4 | 1463.0 | 87.7 |
| 5 | Monday | 02 March | 713.8 | 240.0 | 953.8 | 4358.9 | 4197.1 | 2041.5 | 5428.6 | 2112.0 | 71.8 |
| 6 | Tuesday | 03 March | 751.6 | 260.0 | 1011.6 | 4623.0 | 5985.0 | 2149.6 | 5896.3 | 1625.6 | 120.4 |
| 7 | Wednesday | 04 March | 804.0 | 320.0 | 1124.0 | 5136.7 | 5063.3 | 2299.4 | 5553.0 | 1422.4 | 108.2 |
| 8 | Thursday | 05 March | 864.0 | 304.0 | 1168.0 | 5337.8 | 4094.2 | 2471.0 | 5283.2 | 1503.6 | 104.0 |
| 9 | Friday | 06 March | 912.0 | 320.0 | 1232.0 | 5630.2 | 4233.8 | 2608.3 | 5608.3 | 1422.4 | 90.8 |
| 10 | Saturday | 07 March | 916.8 | 324.0 | 1240.8 | 5670.5 | 3977.5 | 2622.0 | 4917.4 | 1219.2 | 85.6 |
| 11 | Sunday | 08 March | 920.2 | 320.0 | 1240.2 | 5667.7 | 4556.3 | 2631.8 | 4836.2 | 894.0 | 90.8 |
| 12 | Monday | 09 March | 906.0 | 324.0 | 1230.0 | 5621.1 | 4266.9 | 2591.2 | 4795.5 | 894.0 | 93.0 |
| 13 | Tuesday | 10 March | 803.2 | 304.0 | 1107.2 | 5059.9 | 4972.1 | 2297.2 | 3722.4 | 827.2 | 79.8 |
| 14 | Wednesday | 11 March | 982.4 | 420.0 | 1402.4 | 6409.0 | 3647.0 | 2809.7 | 4921.8 | 1034.0 | 85.7 |
| 15 | Thursday | 12 March | 832.8 | 368.0 | 1200.8 | 5487.7 | 4496.3 | 2381.8 | 4921.8 | 1406.2 | 88.2 |
| | **End of Batch 2** | | **794.3** | **286.5** | **1080.9** | **4939.5** | **4627.7** | **2271.8** | **5256.6** | **1528.7** | **96.4** |
| 16 | Friday | 13 March | 895.2 | 332.0 | 1227.2 | 5608.3 | 3487.7 | 2560.3 | 5294.1 | 1116.8 | 80.1 |
| 17 | Saturday | 14 March | 859.2 | 288.0 | 1147.2 | 5242.7 | 3445.3 | 2457.3 | 4880.5 | 1075.4 | 76.3 |
| 18 | Sunday | 15 March | 887.8 | 332.0 | 1219.8 | 5574.7 | 2729.3 | 2539.2 | 4839.1 | 992.6 | 63.3 |
| 19 | Monday | 16 March | 756.0 | 260.0 | 1016.0 | 4643.1 | 3876.9 | 2162.2 | 4797.8 | 744.4 | 67.3 |
| 20 | Tuesday | 17 March | 768.0 | 284.0 | 1052.0 | 4807.6 | 3808.4 | 2196.5 | 5004.6 | 1406.2 | 77.4 |
| | **End of Batch 3** | | **833.2** | **299.2** | **1132.4** | **5175.3** | **3469.5** | **2383.1** | **4963.2** | **1067.1** | **72.9** |
| 21 | Wednesday | 18 March | 738.4 | 268.0 | 1006.4 | 4599.2 | 4088.8 | 2111.8 | 5128.6 | 1034.0 | 83.0 |
| 22 | Thursday | 19 March | 764.0 | 252.0 | 1016.0 | 4643.1 | 3324.9 | 2185.0 | 4549.6 | 1158.0 | 77.9 |
| 23 | Friday | 20 March | 825.6 | 300.0 | 1125.6 | 5144.0 | 2848.0 | 2361.2 | 4333.3 | 1185.6 | 70.9 |
| 24 | Saturday | 21 March | 850.4 | 356.0 | 1206.4 | 5513.2 | 2598.8 | 2432.1 | 4496.8 | 981.2 | 64.9 |
| 25 | Sunday | 22 March | 836.0 | 312.0 | 1148.0 | 5246.4 | 2721.6 | 2391.0 | 4251.5 | 817.6 | 70.8 |
| 26 | Monday | 23 March | 760.0 | 276.0 | 1036.0 | 4734.5 | 3305.5 | 2173.6 | 4578.6 | 1308.2 | 73.2 |
| 27 | Tuesday | 24 March | 724.8 | 272.0 | 996.8 | 4555.4 | 3676.6 | 2072.9 | 4742.1 | 1553.4 | 75.2 |
| 28 | Wednesday | 25 March | 726.8 | 234.0 | 960.8 | 4390.9 | 3793.1 | 2078.6 | 4415.0 | 1390.0 | 82.1 |
| | **End of Batch 4** | | **778.3** | **283.8** | **1062.0** | **4853.3** | **3294.7** | **2225.8** | **4561.9** | **1178.5** | **74.7** |
| 29 | Thursday | 26 March | 737.6 | 260.0 | 997.6 | 4559.0 | 3457.0 | 2109.5 | 4210.6 | 1062.8 | 80.8 |
| 30 | Friday | 27 March | 539.2 | 200.0 | 739.2 | 3378.1 | 4325.9 | 1542.1 | 5110.0 | 1349.0 | 84.2 |
| 31 | Saturday | 28 March | 477.2 | 170.0 | 647.2 | 2957.7 | 3762.3 | 1364.8 | 4756.4 | 1240.8 | 65.3 |
| 32 | Sunday | 29 March | 463.2 | 160.0 | 623.2 | 2848.0 | 4112.0 | 1324.8 | 4260.1 | 827.2 | 72.3 |
| 33 | Monday | 30 March | 440.4 | 154.0 | 594.4 | 2716.4 | 4051.6 | 1259.5 | 4880.5 | 1199.4 | 74.0 |
| 34 | Tuesday | 31 March | 445.2 | 162.0 | 607.2 | 2774.9 | 4305.1 | 1273.3 | 4425.5 | 992.6 | 73.0 |
| 35 | Wednesday | 01 April | 471.2 | 176.0 | 647.2 | 2957.7 | 6954.3 | 1347.6 | 5087.3 | 1199.4 | 92.3 |
| 36 | Thursday | 02 April | 464.0 | 180.0 | 644.0 | 2943.1 | 7280.9 | 1327.0 | 5128.6 | 1158.0 | 102.3 |
| | **End of Batch 5** | | **504.8** | **182.8** | **687.5** | **3141.9** | **4781.1** | **1443.6** | **4732.4** | **1128.7** | **80.5** |
| 37 | Friday | 03 April | 476.0 | 168.0 | 644.0 | 2943.1 | 7112.9 | 1361.4 | 5128.6 | 1034.0 | 98.9 |
| 38 | Saturday | 04 April | | | | | | | | | |
| 39 | Sunday | 05 April | 422.0 | 166.0 | 588.0 | 2687.2 | | 1206.9 | 5045.9 | 1116.8 | |
| 40 | Monday | 06 April | 451.2 | 150.0 | 601.2 | 2747.5 | 7668.5 | 1290.4 | 4797.8 | 910.0 | 92.8 |
| 41 | Tuesday | 07 April | 428.0 | 140.0 | 568.0 | 2595.8 | 6908.2 | 1224.1 | 4508.2 | 661.8 | 75.9 |
| 42 | Wednesday | 08 April | | | | | | | | | |
| 43 | Thursday | 09 April | 791.2 | 296.0 | 1087.2 | 4968.5 | 4511.5 | 2262.8 | 4958.1 | 894.0 | 71.7 |
| | **End of Batch 6** | | **513.7** | **184.0** | **697.7** | **3188.4** | **5240.2** | **1469.1** | **4887.7** | **923.3** | **67.8** |
| 44 | Friday | 10 April | 710.0 | 350.0 | 1060.0 | 4844.2 | 8235.8 | 2030.6 | 4795.5 | 731.6 | 106.8 |
| 45 | Saturday | 11 April | 698.0 | 414.0 | 1112.0 | 5081.8 | 9455.0 | 1996.3 | 5161.3 | 812.8 | 114.6 |
| 46 | Sunday | 12 April | | | | | | | | | |
| 47 | Monday | 13 April | 784.0 | 500.0 | 1284.0 | 5867.9 | 6732.1 | 2242.2 | 4592.3 | 1219.2 | 81.9 |
| 48 | Tuesday | 14 April | 814.0 | 470.0 | 1284.0 | 5867.9 | 7788.1 | 2328.0 | 4673.6 | 731.6 | 106.1 |
| 49 | Wednesday | 15 April | 820.0 | 480.0 | 1300.0 | 5941.0 | 7163.0 | 2345.2 | 4551.7 | 690.8 | 101.4 |
| 50 | Thursday | 16 April | 852.0 | 432.0 | 1284.0 | 5867.9 | 5844.1 | 2436.7 | 4511.0 | 1056.6 | 93.6 |
| | **End of Batch 7** | | **779.7** | **441.0** | **1220.7** | **5578.4** | **7536.4** | **2229.8** | **4714.2** | **873.8** | **100.7** |
| 51 | Friday | 17 April | 963.0 | 394.0 | 1357.0 | 6201.5 | 4502.5 | 2754.2 | 4267.2 | 1056.6 | 84.6 |
| 52 | Saturday | 18 April | | | | | | | | | |
| 53 | Sunday | 19 April | 682.0 | 270.0 | 952.0 | 4350.6 | 4769.4 | 1950.5 | 3942.1 | 1219.2 | 75.3 |
| 54 | Monday | 20 April | 630.0 | 254.0 | 884.0 | 4039.9 | 6160.1 | 1801.8 | 4664.6 | 1403.6 | 89.9 |
| 55 | Tuesday | 21 April | 706.0 | 250.0 | 956.0 | 4368.9 | 5399.1 | 2019.2 | 5036.2 | 1073.2 | 83.2 |
| 56 | Wednesday | 22 April | 674.0 | 262.0 | 936.0 | 4277.5 | 3594.5 | 1927.6 | 4293.1 | 990.8 | 71.9 |
| 57 | Thursday | 23 April | 634.8 | 270.0 | 904.8 | 4134.9 | 4049.1 | 1815.5 | 3715.2 | 990.8 | 70.3 |
| 58 | Friday | 24 April | 591.2 | 296.0 | 887.2 | 4054.5 | 3649.5 | 1690.8 | 4994.9 | 866.8 | 76.7 |
| 59 | Saturday | 25 April | 696.8 | 324.0 | 1020.8 | 4665.1 | 2750.9 | 1992.8 | 4540.8 | 990.8 | 69.9 |
| 60 | Sunday | 26 April | 648.0 | 280.0 | 928.0 | 4241.0 | 5383.0 | 1853.3 | 4210.8 | 908.2 | 75.6 |
| 61 | Monday | 27 April | | | | | | | | | |
| 62 | Tuesday | 28 April | 707.6 | 306.0 | 1013.6 | 4632.2 | 5543.8 | 2023.7 | 5449.0 | 743.0 | 95.8 |
| 63 | Wednesday | 29 April | 532.0 | 220.0 | 752.0 | 3436.6 | 4555.4 | 1521.5 | 5366.4 | 908.2 | 91.8 |
| | **End of Batch 8** | | **678.7** | **284.2** | **962.9** | **4400.2** | **4577.9** | **1941.0** | **4589.1** | **1013.7** | **80.5** |
| 64 | Thursday | 30 April | 650.0 | 210.0 | 860.0 | 3930.2 | 4973.8 | 1859.0 | 5280.0 | 1200.0 | 78.1 |
| 65 | Friday | 01 May | 441.6 | 218.0 | 659.6 | 3014.4 | 7281.6 | 1263.0 | 3920.0 | 720.0 | 82.8 |
| 66 | Saturday | 02 May | 548.0 | 232.0 | 780.0 | 3564.6 | 5819.4 | 1567.3 | 4480.0 | 880.0 | 80.5 |
| | **End of Batch 9** | | **546.5** | **220.0** | **766.5** | **3503.1** | **6024.9** | **1563.1** | **4560.0** | **933.3** | **80.5** |
| 67 | Sunday | 03 May | 665.2 | 210.0 | 875.2 | 3999.7 | 5888.3 | 1902.5 | 5280.0 | 880.0 | 93.8 |
| 68 | Monday | 04 May | 797.2 | 210.0 | 1007.2 | 4602.9 | 4757.1 | 2280.0 | 3920.0 | 960.0 | 77.6 |
| 69 | Tuesday | 05 May | 656.4 | 262.0 | 918.4 | 4197.1 | 5210.9 | 1877.3 | 3680.0 | 960.0 | 75.6 |
| 70 | Wednesday | 06 May | 712.0 | 252.0 | 964.0 | 4405.5 | 5338.5 | 2036.3 | 3560.0 | 840.0 | 68.5 |
| 71 | Thursday | 07 May | 648.8 | 248.0 | 896.8 | 4098.4 | 5093.6 | 1855.6 | 4080.0 | 1440.0 | 85.6 |
| 72 | Friday | 08 May | 894.0 | 310.0 | 1204.0 | 5502.3 | 3593.7 | 2556.8 | 3840.0 | 1680.0 | 89.0 |
| | **End of Batch10** | | **728.9** | **248.7** | **977.6** | **4467.6** | **4980.4** | **2084.7** | **4060.0** | **1126.7** | **81.7** |
| 73 | Saturday | 09 May | | | | | | | | | |
| 74 | Sunday | 10 May | 685.2 | 282.0 | 967.2 | 4420.1 | 3211.9 | 1959.7 | 4960.0 | 800.0 | 74.0 |
| 75 | Monday | 11 May | 790.0 | 350.0 | 1140.0 | 5209.8 | 2662.2 | 2259.4 | 4760.6 | 1149.2 | 68.7 |
| 76 | Tuesday | 12 May | 730.0 | 326.0 | 1056.0 | 4825.9 | 3238.1 | 2087.8 | 3899.8 | 1231.2 | 81.1 |
| 77 | Wednesday | 13 May | 681.6 | 300.0 | 981.6 | 4485.9 | 3626.1 | 1949.4 | 4589.8 | 1231.2 | 72.3 |
| 78 | Thursday | 14 May | 1034.4 | 370.0 | 1404.4 | 6418.1 | | 2958.4 | 4432.3 | 1477.4 | |
| 79 | Friday | 15 May | 1091.6 | 374.0 | 1465.6 | 6697.8 | 2230.2 | 3122.0 | 4514.4 | 1641.6 | 78.4 |
| 80 | Saturday | 16 May | 980.0 | 392.0 | 1372.0 | 6270.0 | 2226.0 | 2802.8 | 4350.2 | 1477.4 | 75.2 |
| 81 | Sunday | 17 May | 924.0 | 412.0 | 1336.0 | 6105.5 | 3278.5 | 2642.6 | 4924.8 | 1477.4 | 92.7 |
| 82 | Monday | 18 May | 820.0 | 384.0 | 1204.0 | 5502.3 | 3185.7 | 2345.2 | 4324.8 | 897.6 | 89.0 |
| 83 | Tuesday | 19 May | 1113.6 | 400.0 | 1513.6 | 6917.2 | 1386.8 | 3184.9 | 5140.8 | 1632.0 | 84.3 |
| | **End of Batch 11** | | **885.0** | **359.0** | **1244.0** | **5685.3** | **2504.5** | **2531.2** | **4589.8** | **1301.5** | **79.5** |

**COD Mass Balance**

| Day No. | 1998 | | Sum den MSnod | MSnoe | MSno | MOn mgO/d | MOc mgO/d | MOd mgO/d | COD in W mgO/d | COD in Ef MSte | MB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 84 | Wednesday | 20 May | 1259.6 | 486.0 | 1745.6 | 7977.4 | 374.6 | 3602.5 | 4080.0 | 692.8 | 71.5 |
| 85 | Thursday | 21 May | 1425.6 | 526.0 | 1951.6 | 8918.8 | 201.2 | 4077.2 | 3060.0 | 40.0 | 48.4 |
| 86 | Friday | 22 May | 1306.0 | 478.0 | 1784.0 | 8152.9 | 727.1 | 3735.2 | 3672.0 | 817.8 | 53.3 |
| 87 | Saturday | 23 May | 1271.0 | 440.0 | 1711.0 | 7819.3 | 1540.7 | 3635.1 | 5140.8 | 979.2 | 68.1 |
| 88 | Sunday | 24 May | | | | | | | | | |
| 89 | Monday | 25 May | 1088.8 | 352.0 | 1440.8 | 6584.5 | 663.5 | 3114.0 | 4587.0 | 1305.6 | 61.7 |
| 90 | Tuesday | 26 May | | | | | | | | | |
| 91 | Wednesday | 27 May | | | | | | | | | |
| 92 | Thursday | 28 May | 956.0 | 252.0 | 1208.0 | 5520.6 | 5807.4 | 2734.2 | 4569.6 | 1142.4 | 100.4 |
| 93 | Friday | 29 May | 595.2 | 252.0 | 847.2 | 3871.7 | 4768.3 | 1702.3 | 4977.6 | 734.4 | 72.5 |
| 94 | Saturday | 30 May | 716.8 | 252.0 | 968.8 | 4427.4 | 5724.6 | 2050.0 | 6201.6 | 1060.8 | 109.0 |
| 95 | Sunday | 31 May | 622.4 | 256.0 | 878.4 | 4014.3 | 5225.7 | 1780.1 | 4587.0 | 1380.0 | 87.8 |
| 96 | Monday | 01 June | 577.6 | 232.0 | 809.6 | 3699.9 | 6812.1 | 1651.9 | 3724.2 | 566.8 | 92.1 |
| 97 | Tuesday | 02 June | 610.0 | 176.0 | 786.0 | 3592.0 | 9560.0 | 1744.6 | 5100.5 | 890.6 | 123.5 |
| 98 | Wednesday | 03 June | | | | | | | | | |
| 99 | Thursday | 04 June | | | | | | | | | |
| 100 | Friday | 05 June | 751.2 | 288.0 | 1039.2 | 4749.1 | 3290.9 | 2148.4 | 5343.4 | 1052.4 | 102.9 |
| | End of Batch 12 | | 689.9 | 244.0 | 933.9 | 4267.9 | 5884.1 | 1973.1 | 4929.1 | 975.3 | 98.3 |
| 101 | Saturday | 06 June | 1051.8 | 380.0 | 1431.8 | 6543.3 | 1328.7 | 3008.1 | 4614.7 | 728.6 | 65.0 |
| 102 | Sunday | 07 June | 712.0 | 292.0 | 1004.0 | 4588.3 | 2779.7 | 2036.3 | 3805.1 | 971.6 | 70.5 |
| 103 | Monday | 08 June | 664.8 | 340.0 | 1004.8 | 4591.9 | 2824.1 | 1901.3 | 4048.3 | 1052.4 | 71.4 |
| 104 | Tuesday | 09 June | 884.0 | 360.0 | 1244.0 | 5685.1 | 3338.9 | 2528.2 | 4331.4 | 688.2 | 78.6 |
| 105 | Wednesday | 10 June | 977.6 | 376.0 | 1353.6 | 6186.0 | 4782.0 | 2795.9 | 5160.0 | 1197.2 | 93.3 |
| 106 | Thursday | 11 June | 1305.4 | 596.0 | 1901.4 | 8689.4 | 1678.6 | 3733.4 | 3715.2 | 1562.6 | 71.5 |
| 107 | Friday | 12 June | 1459.6 | 620.0 | 2079.6 | 9503.8 | 1320.2 | 4174.5 | 3207.4 | 1151.4 | 75.4 |
| | End of Batch13 | | 1007.9 | 423.4 | 1431.3 | 6541.1 | 2578.9 | 2882.6 | 4145.1 | 1050.3 | 75.1 |
| 108 | Saturday | 13 June | 1649.4 | 600.0 | 2249.4 | 10279.8 | -5503.8 | 4717.3 | 4769.9 | 1151.4 | 35.5 |
| 109 | Sunday | 14 June | | | | | | | | | |
| 110 | Monday | 15 June | | | | | | | | | |
| 111 | Tuesday | 16 June | | | | | | | | | |
| 112 | Wednesday | 17 June | | | | | | | | | |
| | End of Batch14 | | 1649.4 | 600.0 | 2249.4 | 10279.8 | -5503.8 | 4717.3 | 4769.9 | 1151.4 | 35.5 |
| 113 | Thursday | 18 June | 1870.4 | 660.0 | 2530.4 | 11563.9 | -2371.9 | 5349.3 | 3618.6 | 1315.8 | 47.6 |
| 114 | Friday | 19 June | 2226.8 | 672.0 | 2898.8 | 13247.5 | -2351.5 | 6368.6 | 4134.9 | 1514.7 | |
| 115 | Saturday | 20 June | | | | | | | | | |
| 116 | Sunday | 21 June | | | | | | | | | |
| 117 | Monday | 22 June | 2448.0 | 736.0 | 3184.0 | 14550.9 | -2958.9 | 7001.3 | 4651.2 | 1713.6 | 66.4 |
| | End of Batch15 | | 2181.7 | 689.3 | 2871.1 | 13120.8 | -2560.8 | 6239.8 | 4134.9 | 1514.7 | 57.0 |
| 118 | Tuesday | 23 June | 2499.2 | 880.0 | 3379.2 | 15442.9 | -3754.9 | 7147.7 | 3835.2 | 1550.4 | 66.0 |
| 119 | Wednesday | 24 June | 2160.0 | 632.0 | 2792.0 | 12759.4 | -2715.4 | 6177.6 | 4080.0 | 1468.8 | 57.2 |
| 120 | Thursday | 25 June | 1141.0 | 380.0 | 1521.0 | 6951.0 | 2289.0 | 3263.3 | 4488.0 | 1795.2 | 73.3 |
| 121 | Friday | 26 June | | | | | | | | | |
| 122 | Saturday | 27 June | | | | | | | | | |
| 123 | Sunday | 28 June | | | | | | | | | |
| | End of Batch16 | | 1933.4 | 630.7 | 2564.1 | 11717.8 | -1393.8 | 5529.5 | 4134.4 | 1604.8 | 65.5 |
| 124 | Monday | 29 June | 1168.8 | 380.0 | 1548.8 | 7078.0 | 1226.0 | 3342.8 | 4102.6 | 1876.8 | 77.9 |
| 125 | Tuesday | 30 June | 1187.2 | 400.0 | 1587.2 | 7253.5 | 1578.5 | 3395.4 | 4112.6 | 1693.4 | 76.8 |
| 126 | Wednesday | 01 July | 1200.4 | 418.0 | 1618.4 | 7396.1 | 955.9 | 3433.1 | 3709.4 | 1370.8 | 65.6 |
| 127 | Thursday | 02 July | | | | | | | | | |
| 128 | Friday | 03 July | | | | | | | | | |
| 129 | Saturday | 04 July | | | | | | | | | |
| 130 | Sunday | 05 July | | | | | | | | | |
| 131 | Monday | 06 July | 1113.2 | 372.0 | 1485.2 | 6787.4 | 556.6 | 3183.8 | 3628.8 | 1774.0 | 58.7 |
| 132 | Tuesday | 07 July | 1079.8 | 404.0 | 1483.8 | 6781.0 | 179.0 | 3088.2 | 4959.4 | 1250.0 | 53.9 |
| | End of Batch17 | | 1149.9 | 394.8 | 1544.7 | 7059.2 | 899.2 | 3288.7 | 4102.6 | 1593.0 | 66.6 |
| 133 | Wednesday | 08 July | 886.8 | 300.0 | 1186.8 | 5423.7 | 2016.3 | 2536.2 | 4724.2 | 994.6 | 73.8 |
| 134 | Thursday | 09 July | 749.6 | 256.0 | 1005.6 | 4595.6 | 4956.4 | 2143.9 | 5884.5 | 1077.4 | 96.4 |
| 135 | Friday | 10 July | 878.8 | 262.0 | 1140.8 | 5213.5 | 3570.5 | 2513.4 | 5718.8 | 1243.2 | 81.6 |
| 136 | Saturday | 11 July | 917.6 | 300.0 | 1217.6 | 5564.4 | 2259.6 | 2624.3 | 5138.6 | 994.0 | 68.5 |
| 137 | Sunday | 12 July | 970.0 | 314.0 | 1284.0 | 5867.9 | 1644.1 | 2774.2 | 3398.0 | 746.0 | 57.1 |
| 138 | Monday | 13 July | 878.4 | 260.0 | 1138.4 | 5202.5 | 3029.5 | 2512.2 | 3356.6 | 1036.0 | 64.8 |
| 139 | Tuesday | 14 July | | | | | | | | | |
| 140 | Wednesday | 15 July | | | | | | | | | |
| 141 | Thursday | 16 July | 901.2 | 292.0 | 1193.2 | 5452.9 | 4531.1 | 2577.4 | 4309.8 | 1574.0 | 72.6 |
| 142 | Friday | 17 July | 938.8 | 302.0 | 1240.8 | 5670.5 | 3137.5 | 2685.0 | 4647.2 | 1142.4 | 77.3 |
| 143 | Saturday | 18 July | | | | | | | | | |
| 144 | Sunday | 19 July | | | | | | | | | |
| 145 | Monday | 20 July | | | | | | | | | |
| | End of Batch 18 | | 890.2 | 285.8 | 1175.9 | 5373.9 | 3143.1 | 2545.8 | 4647.2 | 1101.0 | 74.0 |
| 146 | Tuesday | 21 July | 801.2 | 342.0 | 1143.2 | 5224.4 | 4183.6 | 2291.4 | 3916.8 | 897.6 | 141.2 |
| 147 | Wednesday | 22 July | | | | | | | | | |
| | End of Batch 19 | | 801.2 | 342.0 | 1143.2 | 5224.4 | 4183.6 | 2291.4 | 3916.8 | 897.6 | 141.2 |
| 148 | Thursday | 23 July | 835.2 | 280.0 | 1115.2 | 5096.5 | 4407.5 | 2388.7 | 4324.8 | 1632.0 | 79.7 |
| 149 | Friday | 24 July | 668.8 | 240.0 | 908.8 | 4153.2 | 3070.8 | 1912.8 | 4365.6 | 1346.4 | 75.1 |
| 150 | Saturday | 25 July | 806.4 | 264.0 | 1070.4 | 4891.7 | 3148.3 | 2306.3 | 3916.8 | 1388.0 | 74.5 |
| 151 | Sunday | 26 July | 1003.6 | 342.0 | 1345.6 | 6149.4 | 2238.6 | 2870.3 | 5304.0 | 1305.6 | 78.1 |
| 152 | Monday | 27 July | | | | | | | | | |
| | End of Batch 20 | | 828.5 | 281.5 | 1110.0 | 5072.7 | 3216.3 | 2369.5 | 4477.8 | 1418.0 | 76.9 |
| 153 | Tuesday | 28 July | 924.2 | 288.0 | 1212.2 | 5539.8 | 3004.2 | 2643.2 | 3998.4 | 1468.8 | 74.8 |
| 154 | Wednesday | 29 July | | | | | | | | | |
| 155 | Thursday | 30 July | | | | | | | | | |
| 156 | Friday | 31 July | | | | | | | | | |
| 157 | Saturday | 01 August | | | | | | | | | |
| 158 | Sunday | 02 August | | | | | | | | | |
| 159 | Monday | 03 August | | | | | | | | | |
| | End of Batch 21 | | 924.2 | 288.0 | 1212.2 | 5539.8 | 3004.2 | 2643.2 | 3998.4 | 1468.8 | 74.8 |
| 160 | Tuesday | 04 August | | | | | | | | | |
| 161 | Wednesday | 05 August | | | | | | | | | |
| 162 | Thursday | 06 August | | | | | | | | | |
| 163 | Friday | 07 August | | | | | | | | | |
| 164 | Saturday | 08 August | | | | | | | | | |
| 165 | Sunday | 09 August | | | | | | | | | |
| 166 | Monday | 10 August | | | | | | | | | |
| 167 | Tuesday | 11 August | | | | | | | | | |
| 168 | Wednesday | 12 August | | | | | | | | | |
| 169 | Thursday | 13 August | | | | | | | | | |
| 170 | Friday | 14 August | | | | | | | | | |
| 171 | Saturday | 15 August | | | | | | | | | |
| 172 | Sunday | 16 August | | | | | | | | | |
| 173 | Monday | 17 August | | | | | | | | | |
| | End of Batch 22 | | ERR | ERR | ERR | ERR | ERR | ERR | ERR | ERR | ERR |
| | | | | | | | | | | | |
| | | | ERR | ERR | ERR | ERR | ERR | ERR | ERR | ERR | ERR |

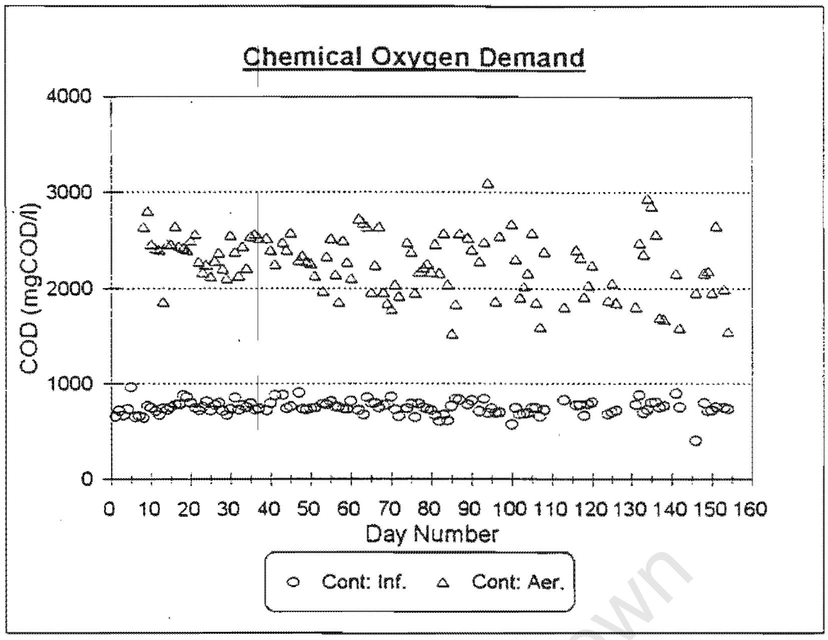


**Figure D1:** Daily influent and aerobic reactor COD concentrations in UCT system.



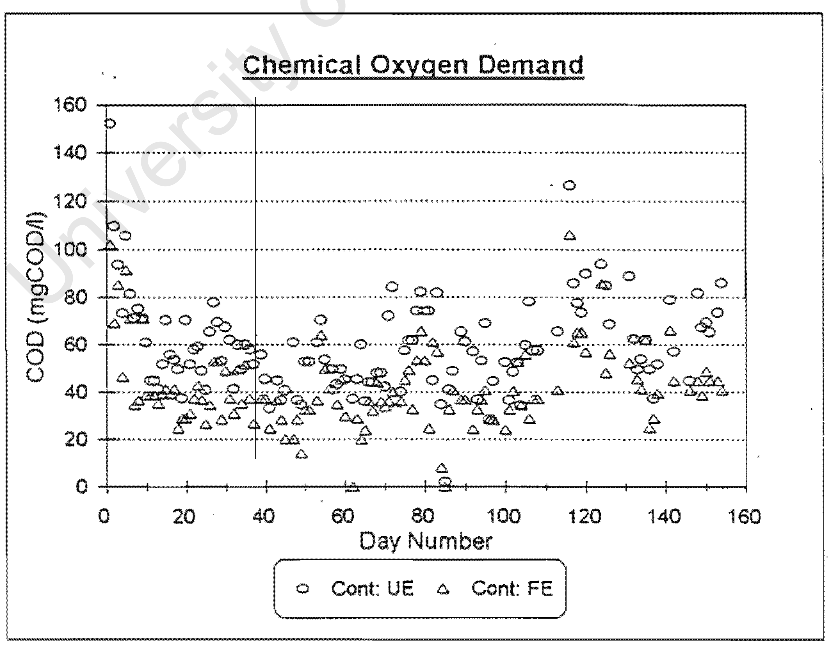


**Figure D2:** Daily Unfiltered and filtered COD concentrations in UCT system.

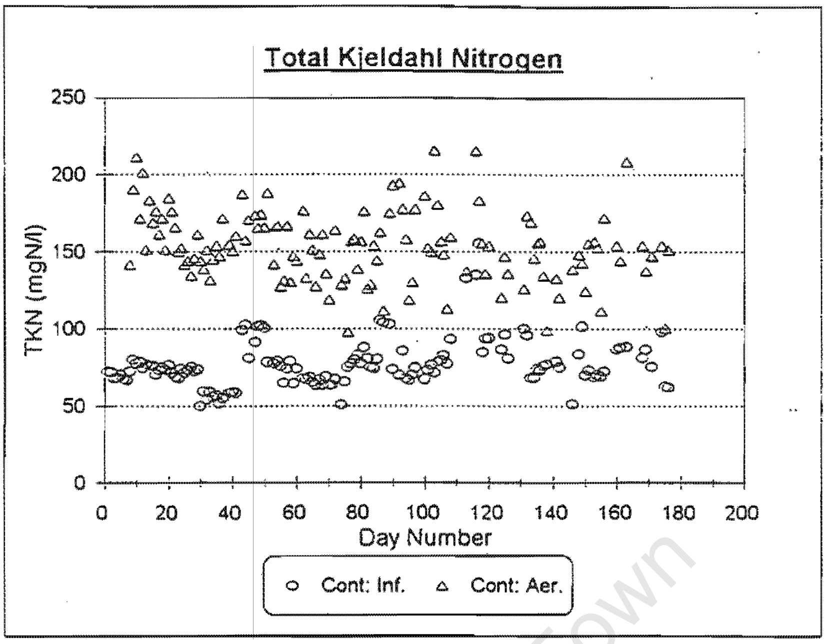


**Figure D3:** Daily influent and aerobic reactor TKN concentrations in UCT system.



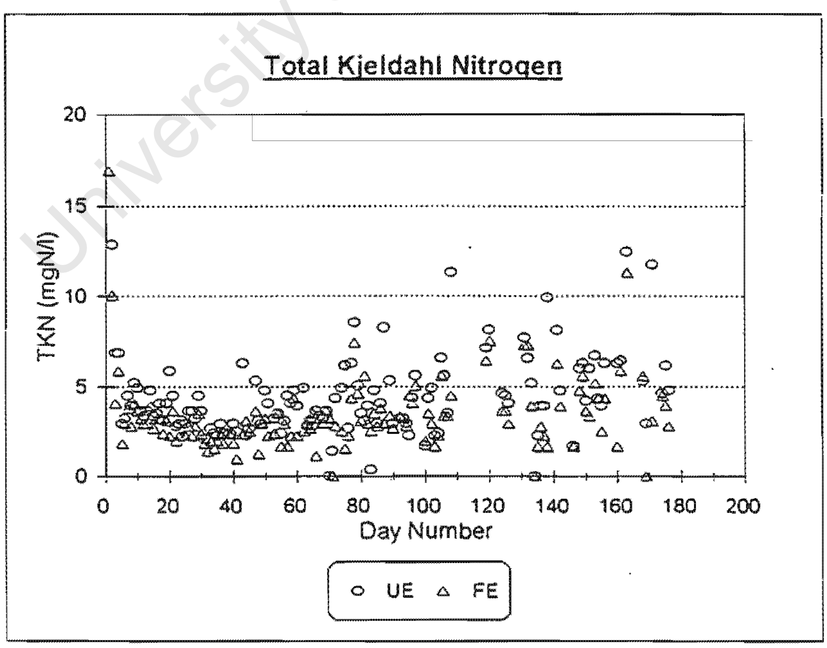


**Figure D4:** Daily Unfiltered and filtered effluent TKN concentrations in UCT system.

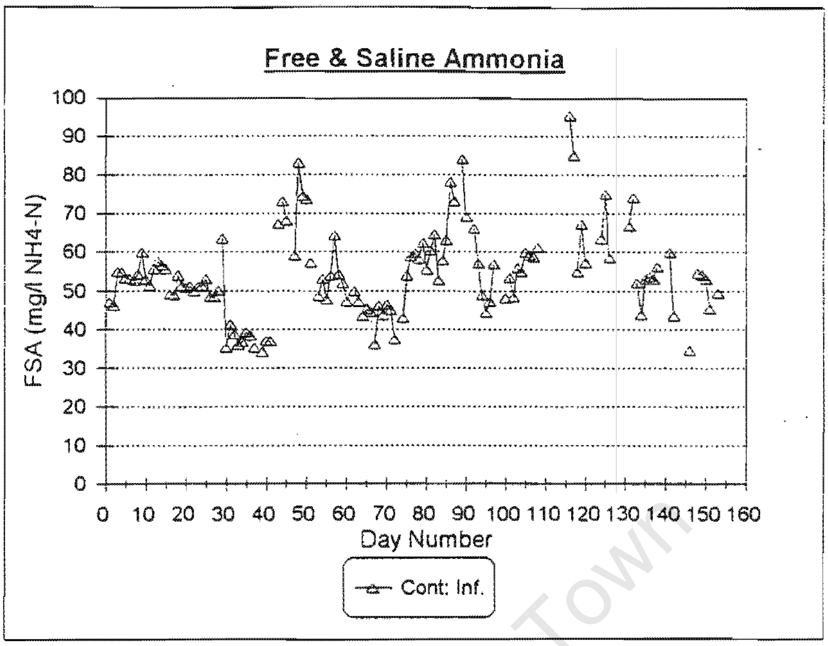


**Figure D5:** Daily influent Ammonia concentration in UCT system.



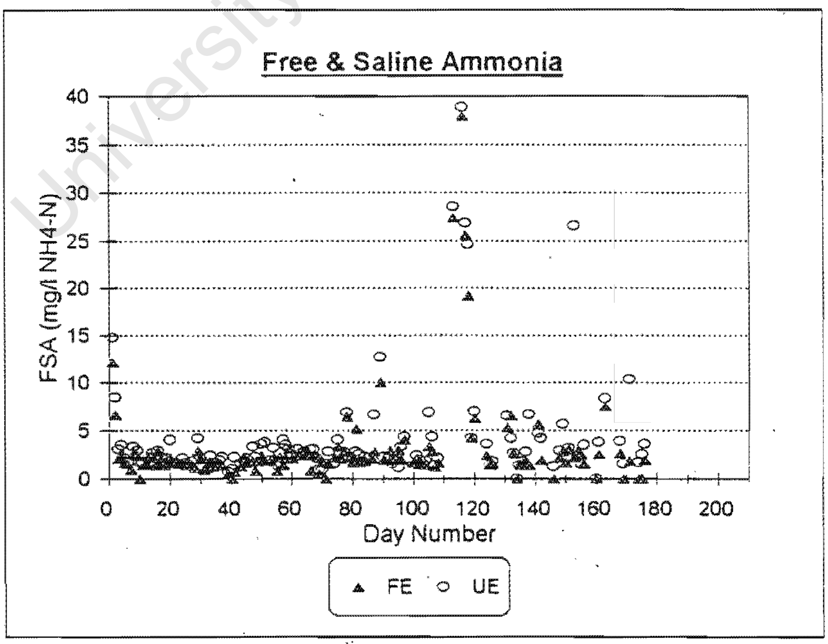


**Figure D6:** Daily Unfiltered and filtered Ammonia concentrations in UCT system.

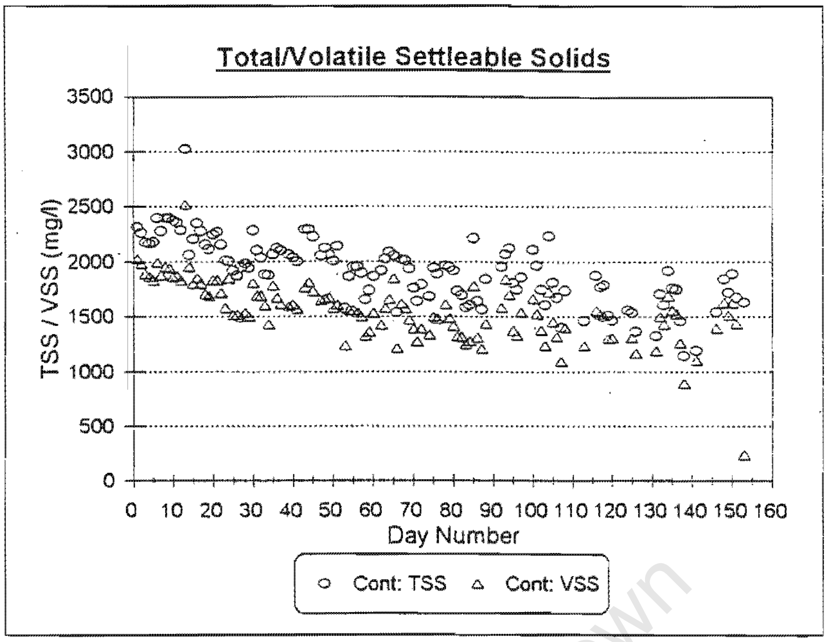


**Figure D7:** Daily aerobic reactor mixed liqour Total and Volatile Suspended Solids concentrations



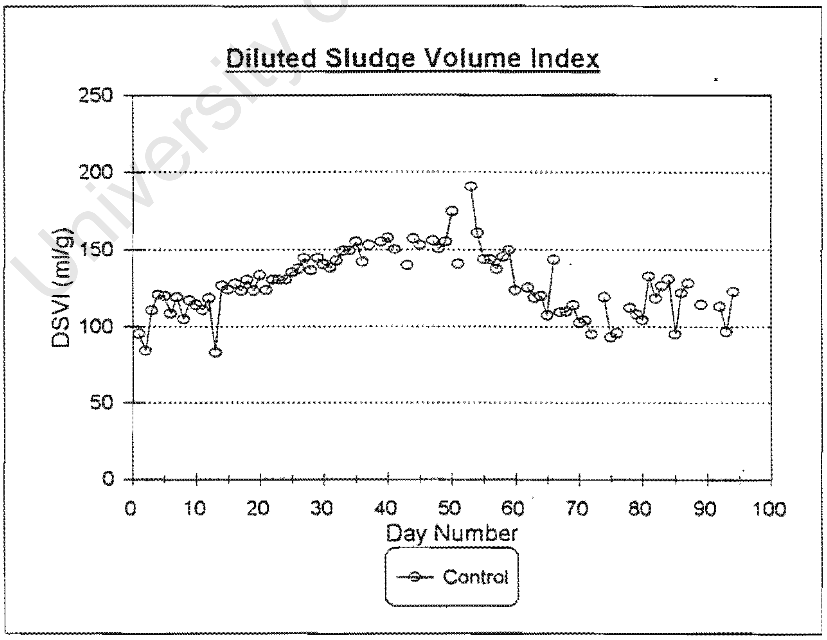


**Figure D8:** Daily aerobic reactor Diluted Sludge Volume Index in UCT system

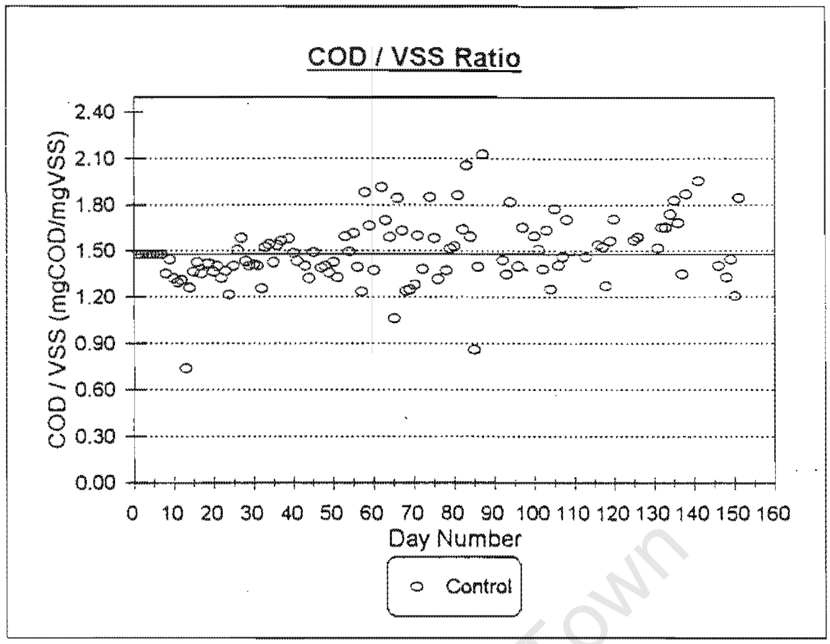


**Figure D9:** Daily COD/VSS ratio in UCT system



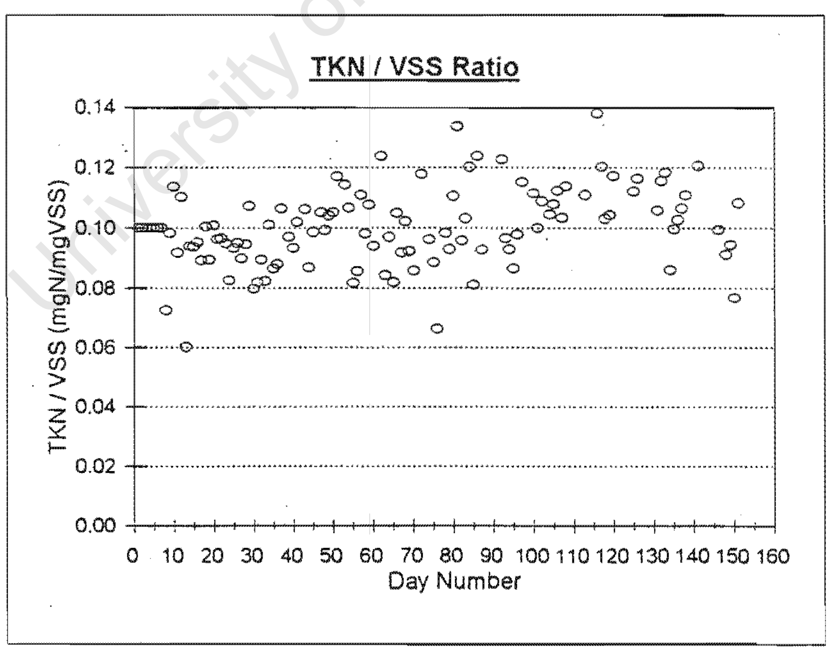


**Figure D10:** Daily TKN/VSS ratio in UCT system

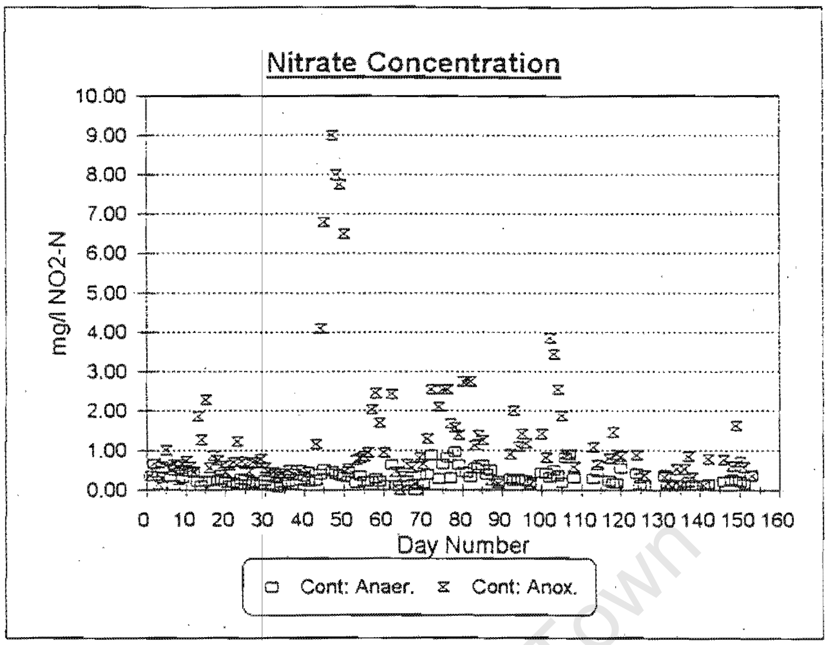


**Figure D11:** Daily anaerobic and anoxic reactor nitrate concentrations in UCT system.



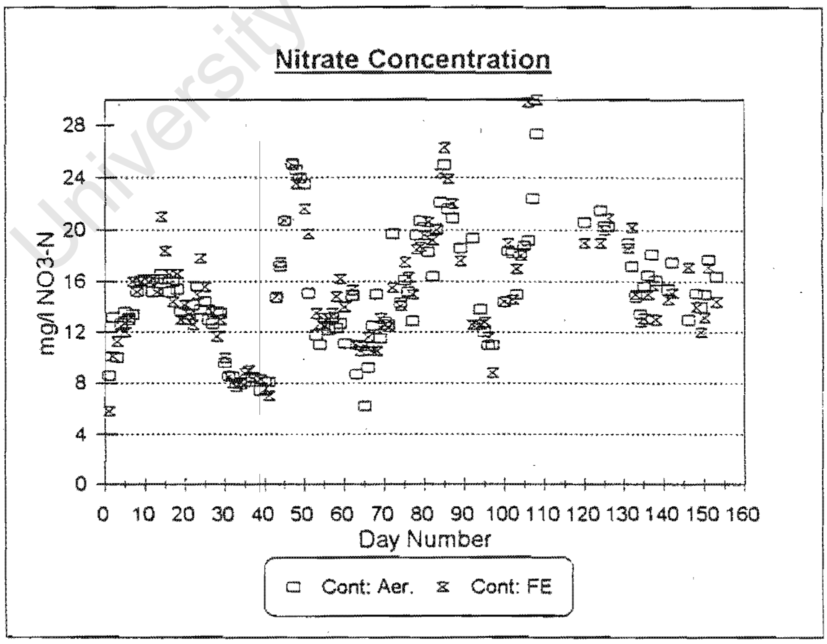


**Figure D12:** Daily aerobic and effluent reactor nitrate concentrations in UCT system.

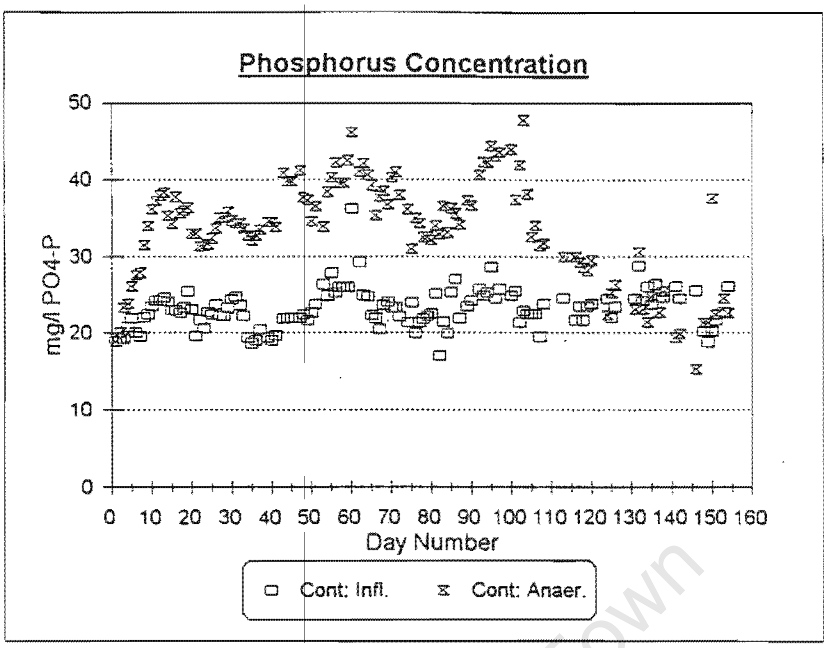


**Figure D13:** Daily influent and filtered anaerobic Total P concentrations in UCT system.

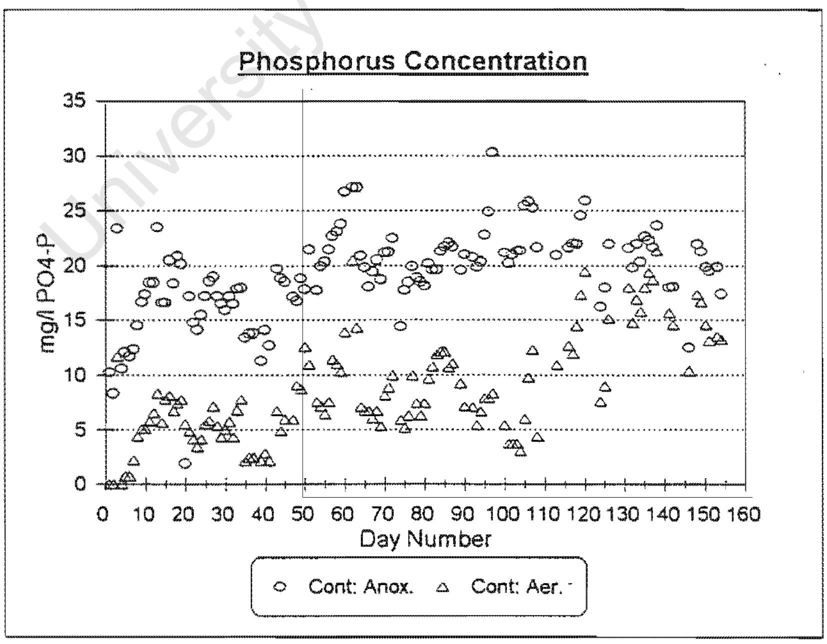


**Figure D14:** Daily filtered anoxic and aerobic Total P concentrations in UCT system.

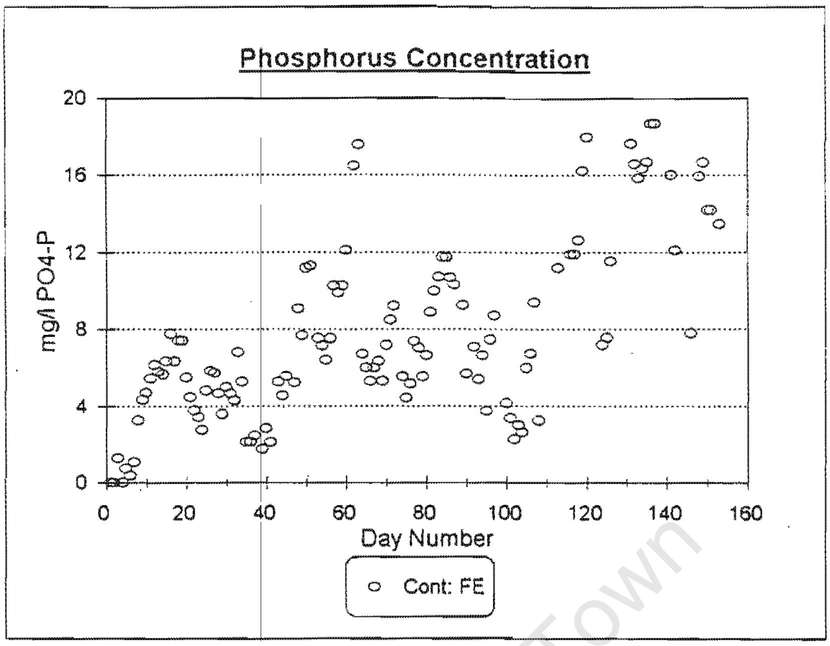


Figure D15: Daily filtered effluent Total P concentrations in UCT system.



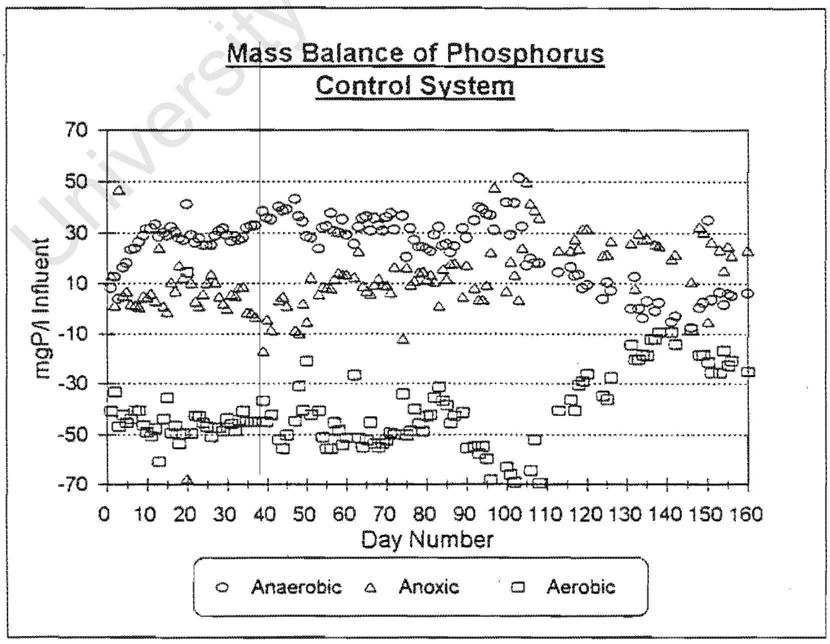


Figure D16: Daily Mass Balance of Total P UCT system.

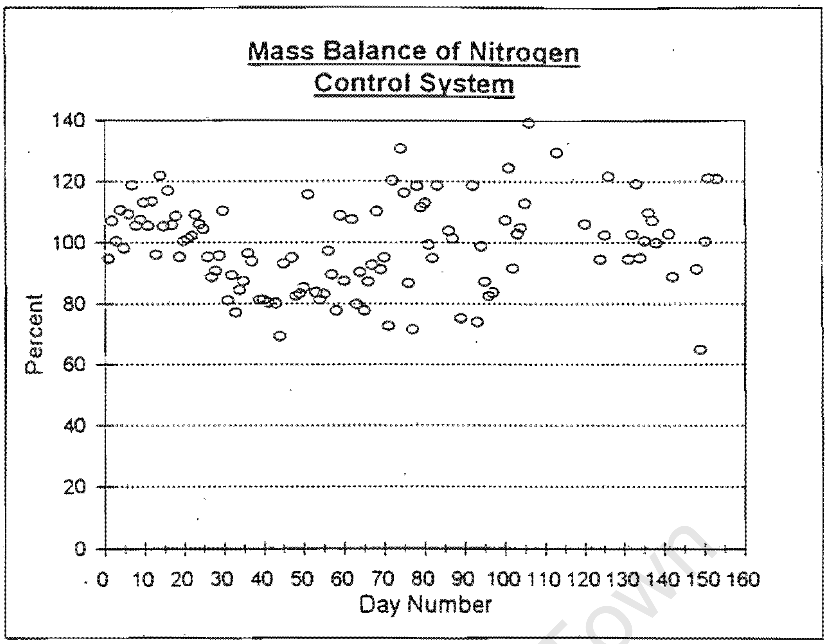


**Figure D17:** Daily Nitrogen Mass Balance of UCT system

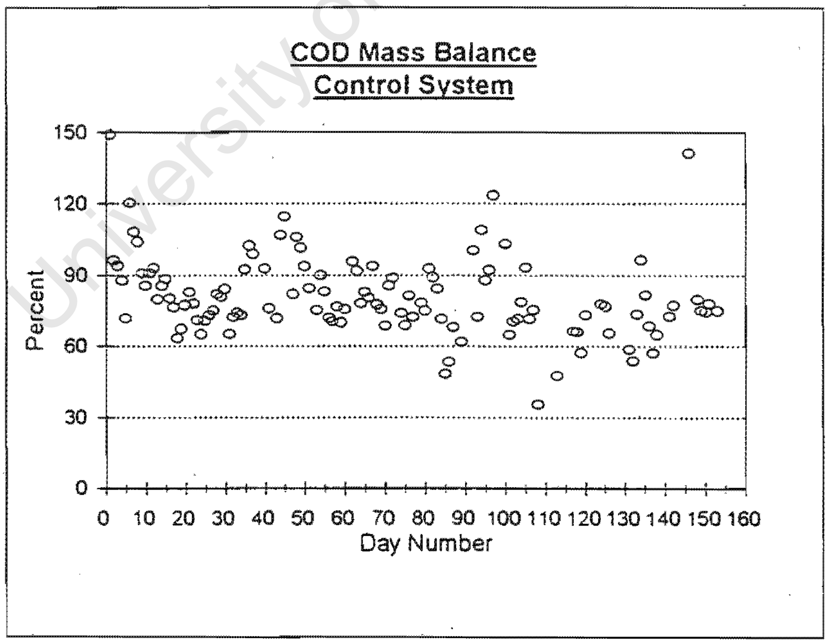


**Figure D18:** Daily COD Mass Balance of UCT system

# APPENDIX E

- Average Sewage Batch Results of UCT Control System.
- Figures E1 to E14 : Graphs of Average Sewage Batch Results.

Average sewage batch results for UCT control system.

| Sewage Batch | DSVI ml/g | TSS mg/l | VSS mg/l | COD/VSS | TKN/VSS | FSA Influent mgN/l | FSA UE mgN/l | FSA FE mgN/l |
|---|---|---|---|---|---|---|---|---|
| 2 | 110 | 2325 | 1945 | 1.36 | 0.10 | 53.769 | 3.569 | 2.784 |
| 3 | 127 | 2230 | 1777 | 1.40 | 0.10 | 50.820 | 2.604 | 2.044 |
| 4 | 133 | 2020 | 1632 | 1.40 | 0.09 | 50.488 | 1.750 | 1.490 |
| 5 | 145 | 2038 | 1647 | 1.44 | 0.09 | 41.283 | 2.100 | 1.698 |
| 6 | 151 | 1747 | 1632 | 1.07 | 0.07 | 42.252 | 1.568 | 0.784 |
| 7 | 158 | 1823 | 1686 | 1.40 | 0.10 | 71.983 | 2.520 | 1.797 |
| 8 | 143 | 1716 | 1475 | 1.32 | 0.09 | 52.335 | 2.890 | 2.075 |
| 9 | 123 | 1893 | 1573 | 1.50 | 0.09 | 44.473 | 2.753 | 2.053 |
| 10 | 105 | 1859 | 1454 | 1.40 | 0.08 | 42.560 | 1.913 | 1.400 |
| 11 | 112 | 1817 | 1414 | 1.47 | 0.09 | 57.008 | 2.892 | 2.968 |
| 12 | 115 | 1519 | 1579 | 1.32 | 0.10 | 52.700 | 2.220 | 2.558 |
| 13 | 131 | 1777 | 1391 | 1.49 | 0.12 | 55.860 | 2.900 | 1.974 |
| 14 | 126 | 1740 | 1400 | 1.70 | 0.11 | 61.320 | 2.100 | 1.680 |
| 15 | 157 | 1703 | 1441 | 1.51 | 0.12 | 95.107 | 31.453 | 30.333 |
| 16 | 147 | 1590 | 1374 | 1.52 | 0.11 | 59.920 | 11.947 | 9.893 |
| 17 | 170 | 1500 | 1292 | 1.27 | 0.09 | 67.676 | 3.528 | 3.444 |
| 18 | 177 | 1548 | 1353 | 1.73 | 0.11 | 52.033 | 3.045 | 2.065 |
| 19 | 130 | 1544 | 1394 | 1.40 | 0.10 | 34.580 | 1.260 | 0.000 |
| 20 | 152 | 1781 | 1550 | 1.46 | 0.09 | 51.870 | 3.535 | 2.450 |
| 21 | 164 | 1632 | 1098 | 3.21 | 0.24 | 49.945 | 8.470 | 2.297 |
| 22 | 145 | 1685 | 1261 | 2.73 | 0.20 | 58.917 | 4.667 | 2.427 |
| 23 | 155 | 1391 | 1304 | 0.02 | 0.12 | 48.253 | 2.613 | 0.653 |
| Average | 139 | 1826 | 1531 | 1.51 | 0.10 | 52 | 3.02 | 2.12 |

| Sewage Batch | TKN Influent mgN/l | TKN Reactor mgN/l | TKN UE mgN/l | TKN FE mgN/l | COD Influent mgCOD/l | COD Reactor mgCOD/l | COD UE mgCOD/l | COD FE mgCOD/l |
|---|---|---|---|---|---|---|---|---|
| 2 | 73.323 | 177.450 | 6.059 | 4.779 | 719.191 | 1950.336 | 76.434 | 55.982 |
| 3 | 73.752 | 168.980 | 4.116 | 2.828 | 818.931 | 2481.600 | 53.354 | 32.674 |
| 4 | 71.943 | 151.288 | 3.343 | 2.520 | 734.826 | 2280.970 | 58.925 | 39.441 |
| 5 | 57.663 | 146.563 | 2.818 | 2.118 | 752.764 | 2366.190 | 56.433 | 39.954 |
| 6 | 66.080 | 164.920 | 3.304 | 1.876 | 801.548 | 2435.592 | 46.166 | 32.540 |
| 7 | 96.610 | 167.883 | 3.502 | 2.777 | 766.743 | 2357.120 | 43.688 | 24.045 |
| 8 | 73.105 | 150.245 | 3.742 | 2.609 | 734.732 | 2294.555 | 50.687 | 36.770 |
| 9 | 65.987 | 146.533 | 3.173 | 2.427 | 813.333 | 2280.000 | 46.667 | 26.667 |
| 10 | 65.637 | 145.600 | 2.660 | 2.637 | 755.333 | 2030.000 | 56.333 | 37.000 |
| 11 | 75.404 | 140.140 | 4.446 | 3.682 | 710.012 | 2282.904 | 65.075 | 47.852 |
| 12 | 71.820 | 163.391 | 3.320 | 3.560 | 706.533 | 2493.067 | 48.767 | 30.799 |
| 13 | 77.260 | 159.629 | 4.220 | 3.240 | 707.630 | 2063.006 | 52.514 | 40.219 |
| 14 | 93.520 | 159.600 | 11.340 | 4.480 | 723.71 | 2384.96 | 57.57 | 37.08 |
| 15 | 141.027 | 178.733 | 39.299 | 37.987 | 796.393 | 2180.693 | 92.650 | 69.467 |
| 16 | 91.000 | 148.400 | 13.720 | 12.367 | 753.440 | 2067.200 | 80.240 | 62.560 |
| 17 | 91.980 | 140.560 | 5.488 | 4.936 | 751.548 | 2016.384 | 79.650 | 61.186 |
| 18 | 73.975 | 139.300 | 4.760 | 2.817 | 773.974 | 2232.053 | 55.048 | 44.203 |
| 19 | 51.240 | 138.600 | 1.680 | 1.680 | 399.800 | 1958.400 | 44.880 | 40.800 |
| 20 | 66.500 | 142.800 | 5.635 | 4.340 | 746.100 | 2238.900 | 70.900 | 44.360 |
| 21 | 70.210 | 148.400 | 5.318 | 4.095 | 740.330 | 2073.775 | 82.380 | 59.970 |
| 22 | 84.513 | 157.500 | 7.537 | 4.597 | 757.033 | 2091.667 | 72.783 | 52.550 |
| 23 | 74.293 | 135.333 | 5.180 | 3.733 | 791.067 | 1491.253 | 87.633 | 74.133 |
| Average | 73.20 | 153.36 | 4.12 | 3.20 | 754.60 | 2242.28 | 58.94 | 40.85 |

| Sewage Batch | Nitrates (mg $NO_3$-N/l) Anaerobic | Nitrates Anoxic | Nitrates Aerobic | Nitrates Filtered Effluent | Phosphorous (mg$PO_4$-P/l) Influent | Phosphorous Anaerobic | Phosphorous Anoxic | Phosphorous Aerobic | Phosphorous Filtered Effluent |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.387 | 0.805 | 14.160 | 14.327 | 21.862 | 30.143 | 15.374 | 4.258 | 3.013 |
| 3 | 0.240 | 0.644 | 14.640 | 14.960 | 23.474 | 35.786 | 16.344 | 7.106 | 6.894 |
| 4 | 0.185 | 0.719 | 13.800 | 14.188 | 21.881 | 32.933 | 16.681 | 5.048 | 4.434 |
| 5 | 0.152 | 0.494 | 9.038 | 9.138 | 21.904 | 33.815 | 16.131 | 4.809 | 4.230 |
| 6 | 0.228 | 0.570 | 9.360 | 9.200 | 20.080 | 35.440 | 14.302 | 3.240 | 2.888 |
| 7 | 0.418 | 7.025 | 22.517 | 22.050 | 22.097 | 38.382 | 17.970 | 7.850 | 7.212 |
| 8 | 0.273 | 1.264 | 12.373 | 14.209 | 26.955 | 40.198 | 22.860 | 10.987 | 10.588 |
| 9 | 0.187 | 0.330 | 8.767 | 11.000 | 22.967 | 38.393 | 19.553 | 6.830 | 6.007 |
| 10 | 0.318 | 1.005 | 14.017 | 12.433 | 22.827 | 38.722 | 20.588 | 7.490 | 7.093 |
| 11 | 0.543 | 2.123 | 17.380 | 17.950 | 21.687 | 33.733 | 18.532 | 8.056 | 7.134 |
| 12 | 0.279 | 1.164 | 13.457 | 12.200 | 23.676 | 42.931 | 22.877 | 6.940 | 6.169 |
| 13 | 0.501 | 2.051 | 18.600 | 21.171 | 22.363 | 37.639 | 22.920 | 6.031 | 4.764 |
| 14 | 0.310 | 0.590 | 27.400 | 30.000 | 23.820 | 31.760 | 21.660 | 4.330 | 3.250 |
| 15 | 0.337 | 0.837 | 38.933 | 34.467 | 23.220 | 29.720 | 21.540 | 11.790 | 11.670 |
| 16 | 0.303 | 1.070 | 34.667 | 31.667 | 22.962 | 28.730 | 24.154 | 17.070 | 15.623 |
| 17 | 0.240 | 0.416 | 19.660 | 19.740 | 24.624 | 25.488 | 19.512 | 12.888 | 12.096 |
| 18 | 0.148 | 0.420 | 15.925 | 14.288 | 25.004 | 47.583 | 21.100 | 17.539 | 16.794 |
| 19 | 0.230 | 0.760 | 13.000 | 17.100 | 25.520 | 15.240 | 12.410 | 10.370 | 7.800 |
| 20 | 0.220 | 0.888 | 15.450 | 14.075 | 20.208 | 25.613 | 20.650 | 15.420 | 15.243 |
| 21 | 0.380 | 0.350 | 16.400 | 14.400 | 23.488 | 23.833 | 19.388 | 14.033 | 13.783 |
| 22 | ERR | ERR | ERR | ERR | 21.007 | 20.768 | 14.068 | 13.855 | 13.153 |
| 23 | ERR | ERR | ERR | ERR | 20.117 | 24.330 | 20.353 | 12.980 | 10.530 |
| Average | 0.29 | 1.27 | 14.72 | 14.71 | 22.94 | 35.04 | 19.05 | 8.66 | 8.02 |

| Sewage Batch | Phosphorous Mass Balance Anaerobic mgP/l infl | Anoxic mgP/l infl | Aerobic mgP/l infl | Settler mgP/l infl | Removal mgP/l infl | N MB % | COD MB % |
|---|---|---|---|---|---|---|---|
| 2 | 23.049 | 8.069 | -44.464 | -2.490 | 18.8 | 107.1 | 96.4 |
| 3 | 31.754 | -4.064 | -36.952 | -0.424 | 16.6 | 105.4 | 72.9 |
| 4 | 27.303 | 7.444 | -46.534 | -1.228 | 17.4 | 99.6 | 74.7 |
| 5 | 29.595 | 3.409 | -45.290 | -1.158 | 17.7 | 90.2 | 80.5 |
| 6 | 36.498 | -5.850 | -44.248 | -0.704 | 17.2 | 83.3 | 67.8 |
| 7 | 36.697 | -2.613 | -40.480 | -1.277 | 14.9 | 84.7 | 100.7 |
| 8 | 30.582 | 11.929 | -47.491 | -0.798 | 16.4 | 91.9 | 80.5 |
| 9 | 34.267 | 7.320 | -50.893 | -1.647 | 17.0 | 85.0 | 80.5 |
| 10 | 34.028 | 10.518 | -52.393 | -0.793 | 15.7 | 96.9 | 81.7 |
| 11 | 27.247 | 9.082 | -41.904 | -1.844 | 14.6 | 106.0 | 79.5 |
| 12 | 37.310 | 14.643 | -63.749 | -1.543 | 19.5 | 93.1 | 98.3 |
| 13 | 29.994 | 27.260 | -67.554 | -2.534 | 17.6 | 118.4 | 75.1 |
| 14 | 18.040 | 36.120 | -69.320 | -2.160 | 20.6 | 149.5 | 35.5 |
| 15 | 14.680 | 24.680 | -39.000 | -0.240 | 11.5 | 135.2 | 57.0 |
| 16 | 10.384 | 29.130 | -28.336 | -2.893 | 7.3 | 174.6 | 65.5 |
| 17 | 6.840 | 20.808 | -26.496 | -1.584 | 12.5 | 103.1 | 66.6 |
| 18 | 49.061 | -24.742 | -14.245 | -1.490 | 8.2 | 102.8 | 74.0 |
| 19 | -7.450 | 10.830 | -8.160 | -5.140 | 17.7 | 141.9 | 141.2 |
| 20 | 10.367 | 21.185 | -20.920 | -0.355 | 5.0 | 94.4 | 76.9 |
| 21 | 4.790 | 21.208 | -21.420 | -0.500 | 9.7 | 120.8 | 74.8 |
| 22 | 6.462 | 13.025 | -10.447 | -1.403 | 7.9 | | |
| 23 | 8.190 | 27.147 | -29.493 | -4.900 | 9.6 | | |
| Average | 28.09 | 7.85 | -41.56 | -1.27 | 14.92 | 99.00 | 80.30 |

Averages above are from start to end of study excluding sewage batches 14,
15,16 and 19 as these were periods when the influent wastewater was septic and many operational problems were encountered.

fS,up and fXBG,P calculation for the UCT system using Wentzel *et al.* (1990) model

| Sewage Batch | Rs | INPUT $f_{S,up}$ | INPUT $f_{XBG,P}$ | $f_{E,w}$ | $NO_{3}$ | Sti mgCOD/l | $S_{ai}$ mgCOD/l | Sbi mgCOD/l | Sbsi mgCOD/l | S'bsi mgCOD/l | INPUT $S_{bs,H}$ mgCOD/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 10 | 0.068 | 0.612 | 0.08 | 0.81 | 719.19 | 49.62 | 614.30 | 102.80 | 97.27 | 0.00 |
| 3 | 10 | -7.865 | 0.563 | 0.04 | 0.64 | 818.93 | | 786.26 | 92.00 | 83.82 | 0.00 |
| 4 | 8 | 0.03 | 0.563 | 0.05 | 0.72 | 754.83 | 21.89 | 692.74 | 89.25 | 86.76 | 0.00 |
| 5 | 8 | 0.053 | 1.297 | 0.05 | 0.49 | 752.76 | 40.65 | 672.91 | 40.31 | 36.78 | 0.00 |
| 6 | 8 | 0.031 | 7.075 | 0.05 | 0.57 | 801.55 | 25.65 | 734.16 | 37.22 | | 0.00 |
| 7 | 8 | 0.043 | 0.775 | 0.03 | 7.03 | 766.74 | 32.20 | 709.73 | 56.90 | 47.48 | 0.00 |
| 8 | 8 | -7.851 | 0.455 | 0.05 | 1.26 | 754.73 | | 717.96 | 102.47 | 100.95 | 0.00 |
| 9 | 8 | -7.875 | 0.34 | 0.03 | 0.33 | 813.33 | | 786.67 | 142.80 | 137.24 | 0.00 |
| 10 | 8 | -7.847 | 0.595 | 0.05 | 1.01 | 755.33 | | 718.33 | 92.00 | 71.74 | |
| 11 | 8 | -7.837 | 0.405 | 0.07 | 2.12 | 710.01 | | 662.16 | 109.98 | 101.83 | 0.00 |
| 12 | 8 | 0.044 | 0.755 | 0.04 | 1.16 | 706.53 | 31.79 | 644.65 | 92.00 | 76.55 | 0.00 |
| 13 | 8 | -7.844 | 0.502 | 0.06 | 2.05 | 707.63 | | 667.41 | 108.97 | 105.38 | 0.00 |
| 14 | 8 | -7.847 | 0.756 | 0.05 | 0.59 | 723.71 | | 686.63 | 92.00 | 82.80 | 0.00 |
| 15 | 8 | -7.858 | 0.334 | 0.09 | 0.84 | 796.39 | | 726.93 | 92.00 | 80.80 | 0.00 |
| 16 | 8 | -7.843 | 0.235 | 0.08 | 1.07 | 753.44 | | 690.88 | 73.00 | 49.88 | 0.00 |
| 17 | 8 | -7.904 | 0.214 | 0.08 | 0.42 | 751.55 | | 690.36 | 92.00 | 158.89 | 0.00 |
| 18 | 10 | -7.922 | 0.22 | 0.06 | 0.42 | 773.97 | | 729.77 | 78.00 | 74.74 | 0.00 |
| 19 | 10 | 0.212 | 0.96 | 0.10 | 0.76 | 399.80 | 85.16 | 274.24 | 92.00 | 82.37 | 0.00 |
| 20 | 10 | -7.873 | 0.048 | 0.06 | 0.89 | 746.10 | | 701.74 | 102.00 | 101.19 | 0.00 |
| 21 | 10 | -7.961 | 0.301 | 0.08 | 0.35 | 740.35 | | 680.38 | 92.00 | 79.11 | 0.00 |
| Average | | -4.466 | 0.495 | 0.08 | 1.27 | 754.60 | | 693.47 | 92.00 | 90.00 | 0.00 |

| Sewage Batch | $MX_{B,H}/Q$ (9th iteration) | $S_{bs,H}$ (9th iteration) | $MS_{seq}$ mgCOD/d | $MS_{B,H}$ mgCOD/d | $MX_{B,G}$ mgAVSS | $MX_{E,G}$ mgAESS | $\Delta P_G$ mgP/l infl | $MX_{B,H}$ mgAVSS | $MX_{E,H}$ mgAESS | $\Delta P_H$ mgP/l infl | $MX_I$ mgAISS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 714.84 | 11.53 | 1483.58 | 10788.11 | 4768.65 | 476.87 | 14.66 | 14278.38 | 6853.62 | 3.17 | 6608.78 |
| 3 | 950.72 | 7.94 | 1358.77 | 14366.38 | 4367.48 | 436.75 | 12.36 | 19014.32 | 9126.87 | 4.22 | |
| 4 | 771.03 | 9.70 | 1347.26 | 12522.64 | 3674.35 | 293.95 | 12.98 | 15438.87 | 5928.53 | 4.01 | 2448.09 |
| 5 | 794.19 | 4.02 | 574.60 | 12868.62 | 1567.08 | 125.37 | 12.73 | 15865.42 | 6092.32 | 4.12 | 4313.13 |
| 6 | 905.13 | 0.00 | 0.00 | 14667.11 | 0.00 | 0.00 | 0.00 | 18082.74 | 6943.77 | 4.69 | 2686.27 |
| 7 | 828.84 | 5.02 | 749.08 | 13460.82 | 2042.95 | 163.44 | 9.93 | 16595.53 | 6372.68 | 4.31 | 3564.32 |
| 8 | 788.08 | 11.10 | 1574.83 | 12784.40 | 4295.00 | 343.60 | 12.28 | 15761.59 | 6052.45 | 4.09 | |
| 9 | 836.19 | 14.41 | 2168.46 | 13564.87 | 5913.98 | 473.12 | 12.66 | 16723.82 | 6421.95 | 4.34 | |
| 10 | 816.10 | 7.68 | 1127.76 | 13238.91 | 3075.70 | 246.06 | 11.48 | 16321.94 | 6267.63 | 4.24 | |
| 11 | 720.42 | 12.00 | 1556.46 | 11686.74 | 4244.89 | 339.59 | 10.81 | 14408.31 | 5532.79 | 3.74 | |
| 12 | 722.59 | 9.00 | 1170.65 | 11708.16 | 3192.68 | 255.41 | 15.11 | 14434.72 | 5542.93 | 3.75 | 3360.80 |
| 13 | 723.45 | 12.38 | 1612.31 | 11735.92 | 4397.20 | 351.78 | 13.86 | 14468.95 | 5556.08 | 3.75 | |
| 14 | 767.37 | 9.30 | 1284.20 | 12448.40 | 3502.37 | 280.19 | 16.60 | 15347.34 | 5893.38 | 3.98 | |
| 15 | 817.88 | 8.63 | 1270.70 | 13267.83 | 3465.55 | 277.24 | 7.29 | 16357.60 | 6281.32 | 4.24 | |
| 16 | 803.60 | 5.40 | 781.47 | 13036.13 | 2131.27 | 170.50 | 3.16 | 16071.95 | 6171.63 | 4.17 | |
| 17 | 702.33 | 19.09 | 2413.96 | 11393.28 | 6583.53 | 526.68 | 8.90 | 14046.51 | 5393.86 | 3.65 | |
| 18 | 886.77 | 7.49 | 1195.27 | 13400.15 | 3841.94 | 384.19 | 4.28 | 17735.50 | 8513.04 | 3.94 | |
| 19 | 300.31 | 17.51 | 946.12 | 4530.73 | 3041.10 | 301.11 | 14.64 | 5996.56 | 2878.35 | 1.33 | 11453.73 |
| 20 | 823.31 | 10.75 | 1593.65 | 12441.15 | 5122.46 | 512.25 | 1.31 | 16466.22 | 7903.79 | 3.66 | |
| 21 | 818.17 | 8.45 | 1244.19 | 12363.41 | 3999.17 | 399.92 | 6.08 | 16363.34 | 7854.40 | 3.63 | |
| Average | 824.01 | 9.56 | 1417.68 | 12451.78 | 4556.82 | 455.68 | 11.35 | 16480.29 | 7910.54 | 3.66 | |

| Sewage Batch | $\Delta P_I$ mgP/l infl | $\Delta P_{(meas)}$ mgP/l infl | $\Delta P_{(calc)}$ mgP/l infl | $MX_{t(meas)}$ mgVSS | $MX_{t(calc)}$ mgVSS | $f_{av,OHO}$ | $f_{av,PAO}$ |
|---|---|---|---|---|---|---|---|
| 2 | 0.99 | 18.85 | 18.82 | 33070.67 | 33083.49 | 0.43 | 0.14 |
| 3 | 0.00 | 16.58 | 16.58 | 30232.40 | 32945.43 | 0.58 | 0.13 |
| 4 | 0.46 | 17.45 | 17.45 | 27735.50 | 27702.18 | 0.56 | 0.13 |
| 5 | 0.81 | 17.67 | 17.65 | 28003.25 | 28044.70 | 0.57 | 0.06 |
| 6 | 0.50 | 17.19 | 5.20 | 27744.00 | 27799.43 | 0.65 | |
| 7 | 0.67 | 14.88 | 14.90 | 28656.33 | 28656.03 | 0.58 | 0.07 |
| 8 | 0.00 | 16.37 | 16.37 | 25082.73 | 26452.64 | 0.60 | 0.16 |
| 9 | 0.00 | 16.96 | 17.00 | 26746.67 | 29532.86 | 0.57 | 0.20 |
| 10 | 0.00 | 15.73 | 15.72 | 24712.33 | 25931.33 | 0.63 | 0.12 |
| 11 | 0.00 | 14.55 | 14.55 | 24041.78 | 24525.58 | 0.59 | 0.17 |
| 12 | 0.63 | 19.51 | 19.49 | 26835.71 | 26862.92 | 0.54 | 0.12 |
| 13 | 0.00 | 17.60 | 17.62 | 23654.29 | 24773.99 | 0.58 | 0.18 |
| 14 | 0.00 | 20.57 | 20.58 | 23800.00 | 25023.28 | 0.61 | 0.14 |
| 15 | 0.00 | 11.55 | 11.53 | 24491.33 | 26381.72 | 0.62 | 0.13 |
| 16 | 0.00 | 7.34 | 7.33 | 23358.00 | 24545.35 | 0.65 | 0.09 |
| 17 | 0.00 | 12.53 | 12.55 | 21964.00 | 26550.58 | 0.53 | 0.25 |
| 18 | 0.00 | 8.21 | 8.22 | 23003.43 | 30474.67 | 0.58 | 0.13 |
| 19 | 1.72 | 17.72 | 17.69 | 23698.00 | 23727.87 | 0.25 | 0.13 |
| 20 | 0.00 | 4.97 | 4.96 | 26350.00 | 30004.71 | 0.55 | 0.17 |
| 21 | 0.00 | 9.71 | 9.71 | 18657.50 | 28616.83 | 0.57 | 0.14 |
| Average | 0.00 | 15.00 | 15.01 | 26027.00 | 29403.34 | 0.56 | 0.14 |

| Known Parameters | |
|---|---|
| K | 0.06 |
| Q | 20l/d |
| r | 1 |
| $Y_{A,G}$ | 0.45 |
| $f_{aa}$ | 0.15 |
| $f_{E,G}$ | 0.25 |
| $b_G$ | 0.04 |
| $f_{E,H}$ | 0.2 |
| $f_{XEG,P}$ | 0.03 |
| $f_{cv}$ | 1.48 |
| $f_{XBH,P}$ | 0.03 |
| $f_{XEH,P}$ | 0.03 |
| $f_{XI,P}$ | 0.03 |
| $b_H$ | 0.24 |
| N | 1 |
| n | 1 |

Average sewage batch results for UCT control system.

| Sewage Batch | DSVI ml/g | TSS mg/l | VSS mg/l | COD/VSS | TKN/VSS | FSA Influent mgN/l | FSA UE mgN/l | FSA FE mgN/l | TKN Influent mgN/l | TKN Reactor mgN/l | TKN UE mgN/l | TKN FE mgN/l | COD Influent mgCOD/l | COD Reactor mgCOD/l | COD UE mgCOD/l | COD FE mgCOD/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 110 | 2325 | 1945 | 1.36 | 0.10 | 53.769 | 3.569 | 2.784 | 73.323 | 177.450 | 6.059 | 4.779 | 719.191 | 1950.336 | 76.434 | 55.982 |
| 3 | 127 | 2230 | 1777 | 1.40 | 0.10 | 50.820 | 2.604 | 2.044 | 73.752 | 168.980 | 4.116 | 2.828 | 818.931 | 2481.600 | 53.354 | 32.674 |
| 4 | 133 | 2020 | 1632 | 1.40 | 0.09 | 50.488 | 1.750 | 1.490 | 71.943 | 151.288 | 3.343 | 2.520 | 754.826 | 2260.970 | 58.925 | 39.441 |
| 5 | 145 | 2038 | 1647 | 1.44 | 0.09 | 41.283 | 2.100 | 1.698 | 57.663 | 146.563 | 2.818 | 2.118 | 752.764 | 2366.190 | 56.433 | 39.934 |
| 6 | 151 | 1747 | 1632 | 1.07 | 0.07 | 42.252 | 1.568 | 0.784 | 66.080 | 164.920 | 3.304 | 1.876 | 801.548 | 2435.592 | 46.166 | 32.540 |
| 7 | 158 | 1823 | 1686 | 1.40 | 0.10 | 71.983 | 2.520 | 1.797 | 96.610 | 167.883 | 3.502 | 2.777 | 766.743 | 2357.120 | 43.688 | 24.045 |
| 8 | 143 | 1716 | 1475 | 1.32 | 0.09 | 52.335 | 2.890 | 2.075 | 73.105 | 150.245 | 3.742 | 2.609 | 754.732 | 2294.555 | 50.687 | 36.770 |
| 9 | 123 | 1893 | 1573 | 1.50 | 0.09 | 44.473 | 2.753 | 2.053 | 65.987 | 146.533 | 3.173 | 2.427 | 813.333 | 2280.000 | 46.667 | 26.667 |
| 10 | 105 | 1859 | 1454 | 1.40 | 0.08 | 42.560 | 1.913 | 1.400 | 65.637 | 145.600 | 2.660 | 2.637 | 755.333 | 2030.000 | 56.333 | 37.000 |
| 11 | 112 | 1817 | 1414 | 1.47 | 0.09 | 57.008 | 2.892 | 2.968 | 75.404 | 140.140 | 4.446 | 3.682 | 710.012 | 2282.904 | 65.075 | 47.852 |
| 12 | 115 | 1519 | 1579 | 1.32 | 0.10 | 52.700 | 2.220 | 2.558 | 71.820 | 163.391 | 3.320 | 3.560 | 706.533 | 2493.067 | 48.767 | 30.799 |
| 13 | 131 | 1777 | 1391 | 1.49 | 0.12 | 55.860 | 2.900 | 1.974 | 77.260 | 159.629 | 4.220 | 3.240 | 707.630 | 2063.006 | 52.514 | 40.219 |
| 14 | 126 | 1740 | 1400 | 1.70 | 0.11 | 61.320 | 2.100 | 1.680 | 93.520 | 159.600 | 11.340 | 4.480 | 724 | 2385 | 58 | 37 |
| 15 | 157 | 1703 | 1441 | 1.51 | 0.12 | 95.107 | 31.453 | 30.333 | 141.027 | 178.733 | 39.299 | 37.987 | 796.393 | 2180.693 | 92.650 | 69.467 |
| 16 | 147 | 1590 | 1374 | 1.52 | 0.11 | 59.920 | 11.947 | 9.893 | 91.000 | 148.400 | 13.720 | 12.367 | 753.440 | 2067.200 | 80.240 | 62.560 |
| 17 | 170 | 1500 | 1292 | 1.27 | 0.09 | 67.676 | 3.528 | 3.444 | 91.980 | 140.560 | 5.488 | 4.956 | 751.548 | 2016.384 | 79.650 | 61.186 |
| 18 | 177 | 1548 | 1353 | 1.73 | 0.11 | 52.033 | 3.045 | 2.065 | 73.975 | 139.300 | 4.760 | 2.817 | 773.974 | 2232.053 | 53.048 | 44.203 |
| 19 | 130 | 1544 | 1394 | 1.40 | 0.10 | 34.580 | 1.260 | 0.000 | 51.240 | 138.600 | 1.680 | 1.680 | 399.800 | 1958.400 | 44.880 | 40.800 |
| 20 | 152 | 1781 | 1550 | 1.46 | 0.09 | 51.870 | 3.535 | 2.450 | 66.500 | 142.800 | 5.635 | 4.340 | 746.100 | 2238.900 | 70.900 | 44.360 |
| 21 | 164 | 1632 | 1098 | 3.21 | 0.24 | 49.945 | 8.470 | 2.297 | 70.210 | 148.400 | 5.318 | 4.095 | 740.350 | 2073.775 | 82.360 | 59.970 |
| 22 | 145 | 1685 | 1261 | 2.73 | 0.20 | 58.917 | 4.667 | 2.427 | 84.313 | 157.500 | 7.537 | 4.597 | 757.033 | 2091.667 | 72.783 | 52.550 |
| 23 | 155 | 1391 | 1304 | 0.02 | 0.12 | 48.253 | 2.613 | 0.653 | 74.293 | 135.333 | 5.180 | 3.733 | 791.067 | 1491.253 | 87.633 | 74.133 |
| Average | 139 | 1826 | 1531 | 1.51 | 0.10 | 52 | 3.02 | 2.12 | 73.20 | 153.36 | 4.12 | 3.20 | 754.60 | 2242.28 | 58.94 | 40.85 |

| Sewage Batch | Nitrates (mg $NO_3$-N/l) Anaerobic | Anoxic | Aerobic | Filtered Effluent | Phosphorous (mg$PO_4$-P/l) Influent | Anaerobic | Anoxic | Aerobic | Filtered Effluent | Phosphorous Mass Balance Anaerobic mgP/l infl | Anoxic mgP/l infl | Aerobic mgP/l infl | Settler mgP/l infl | Removal mgP/l infl | N MB % | COD MB % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.387 | 0.805 | 14.160 | 14.327 | 21.862 | 30.143 | 15.374 | 4.238 | 3.013 | 23.049 | 8.069 | -44.464 | -2.490 | 18.8 | 107.1 | 96.4 |
| 3 | 0.240 | 0.644 | 14.640 | 14.960 | 23.474 | 35.786 | 16.344 | 7.106 | 6.894 | 31.754 | -4.064 | -36.952 | -0.424 | 16.6 | 105.4 | 72.9 |
| 4 | 0.185 | 0.719 | 13.800 | 14.188 | 21.881 | 32.933 | 16.681 | 5.048 | 4.434 | 27.303 | 7.444 | -46.534 | -1.228 | 17.4 | 99.6 | 74.7 |
| 5 | 0.152 | 0.494 | 9.038 | 9.138 | 21.904 | 33.815 | 16.131 | 4.809 | 4.230 | 29.595 | 3.409 | -45.290 | -1.158 | 17.7 | 90.2 | 80.5 |
| 6 | 0.228 | 0.570 | 9.360 | 9.200 | 20.080 | 35.440 | 14.302 | 3.240 | 2.888 | 36.498 | -5.850 | -44.248 | -0.704 | 17.2 | 83.3 | 67.8 |
| 7 | 0.418 | 7.025 | 22.517 | 22.050 | 22.097 | 38.382 | 17.970 | 7.850 | 7.212 | 36.697 | -2.613 | -40.480 | -1.277 | 14.9 | 84.7 | 100.7 |
| 8 | 0.273 | 1.264 | 12.373 | 14.209 | 26.955 | 40.198 | 22.860 | 10.987 | 10.588 | 30.582 | 11.929 | -47.491 | -0.798 | 16.4 | 91.9 | 80.5 |
| 9 | 0.187 | 0.330 | 8.767 | 11.000 | 22.967 | 38.393 | 19.553 | 6.830 | 6.007 | 34.267 | 7.320 | -50.893 | -1.647 | 17.0 | 85.0 | 80.5 |
| 10 | 0.318 | 1.005 | 14.017 | 12.433 | 22.827 | 38.722 | 20.588 | 7.490 | 7.093 | 34.028 | 10.518 | -52.393 | -0.793 | 15.7 | 96.9 | 81.7 |
| 11 | 0.543 | 2.123 | 17.380 | 17.950 | 21.687 | 33.733 | 18.532 | 8.056 | 7.134 | 27.247 | 9.082 | -41.904 | -1.844 | 14.6 | 106.0 | 79.5 |
| 12 | 0.279 | 1.164 | 13.457 | 12.200 | 25.676 | 42.931 | 22.877 | 6.940 | 6.169 | 37.310 | 14.643 | -63.749 | -1.543 | 19.5 | 93.1 | 98.3 |
| 13 | 0.501 | 2.031 | 18.600 | 21.171 | 22.363 | 37.639 | 22.920 | 6.031 | 4.764 | 29.994 | 27.260 | -67.554 | -2.534 | 17.6 | 118.4 | 75.1 |
| 14 | 0.310 | 0.590 | 27.400 | 30.000 | 23.820 | 31.760 | 21.660 | 4.330 | 3.250 | 18.040 | 36.120 | -69.320 | -2.160 | 20.6 | 149.5 | 35.5 |
| 15 | 0.337 | 0.837 | 38.933 | 34.467 | 23.220 | 29.720 | 21.540 | 11.790 | 11.670 | 14.680 | 24.680 | -39.000 | -0.240 | 11.5 | 135.2 | 57.0 |
| 16 | 0.303 | 1.070 | 34.667 | 31.667 | 22.962 | 28.750 | 24.154 | 17.070 | 15.623 | 10.384 | 29.130 | -28.336 | -2.893 | 7.3 | 174.6 | 65.5 |
| 17 | 0.240 | 0.416 | 19.660 | 19.740 | 24.624 | 25.488 | 19.512 | 12.888 | 12.096 | 6.840 | 20.808 | -26.496 | -1.584 | 12.5 | 103.1 | 66.6 |
| 18 | 0.148 | 0.420 | 15.925 | 14.288 | 25.004 | 47.583 | 21.100 | 17.539 | 16.794 | 49.061 | -24.742 | -14.243 | -1.490 | 8.2 | 102.8 | 74.0 |
| 19 | 0.230 | 0.760 | 13.000 | 17.100 | 25.520 | 15.240 | 12.410 | 10.370 | 7.800 | -7.450 | 10.830 | -8.160 | -5.140 | 17.7 | 141.9 | 141.2 |
| 20 | 0.220 | 0.888 | 15.450 | 14.075 | 20.208 | 25.613 | 20.650 | 15.420 | 15.243 | 10.367 | 21.185 | -20.920 | -0.355 | 5.0 | 94.4 | 76.9 |
| 21 | 0.380 | 0.350 | 16.400 | 14.400 | 23.488 | 23.833 | 19.388 | 14.033 | 13.783 | 4.790 | 21.208 | -21.420 | -0.500 | 9.7 | 120.8 | 74.8 |
| 22 | ERR | ERR | ERR | ERR | 21.007 | 20.768 | 14.068 | 13.855 | 13.153 | 6.462 | 13.025 | -10.447 | -1.403 | 7.9 | | |
| 23 | ERR | ERR | ERR | ERR | 20.117 | 24.330 | 20.353 | 12.980 | 10.530 | 8.190 | 27.147 | -29.493 | -4.900 | 9.6 | | |
| Average | 0.29 | 1.27 | 14.72 | 14.71 | 22.94 | 35.04 | 19.05 | 8.66 | 8.07 | 28.09 | 7.85 | -41.56 | -1.27 | 14.92 | 99.00 | 80.10 |

Averages above are from start to end of study excluding sewage batches 14, 15,16 and 19 as these were periods when the influent wastewater was septic and many operational problems were encountered.

fS,up and fXBG,P calculation for the UCT system using Wentzel *et al.* (1990) model

| Sewage Batch | Rs | INPUT $f_{S,up}$ | INPUT $f_{XBG,P}$ | $f_{s,us}$ | $NO_{3,e}$ | S'ti mgCOD/l | $S_{spi}$ mgCOD/l | Sbi mgCOD/l | Sbsi mgCOD/l | S'bsi mgCOD/l | INPUT $S_{bsri}$ mgCOD/l | $MX_{B,H}/Q$ (9th Iteration) | $S_{bsH}$ (9th Iteration) | $MS_{req}$ mgCOD/d |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 10 | 0.068 | 0.612 | 0.08 | 0.81 | 719.19 | 49.62 | 614.30 | 102.80 | 97.27 | 0.00 | 714.84 | 11.53 | 1483.58 |
| 3 | 10 | -7.865 | 0.563 | 0.04 | 0.64 | 818.93 | | 786.26 | 92.00 | 83.82 | 0.00 | 950.72 | 7.94 | 1358.77 |
| 4 | 8 | 0.03 | 0.563 | 0.05 | 0.72 | 754.83 | 21.89 | 692.74 | 89.25 | 86.76 | 0.00 | 771.03 | 9.70 | 1347.26 |
| 5 | 8 | 0.053 | 1.297 | 0.05 | 0.49 | 752.76 | 40.65 | 672.91 | 40.31 | 36.78 | 0.00 | 794.19 | 4.02 | 574.60 |
| 6 | 8 | 0.031 | 7.075 | 0.05 | 0.57 | 801.55 | 25.65 | 734.16 | 37.22 | | 0.00 | 905.13 | 0.00 | 0.00 |
| 7 | 8 | 0.643 | 0.775 | 0.03 | 7.03 | 766.74 | 32.20 | 709.73 | 56.90 | 47.48 | 0.00 | 828.84 | 5.02 | 749.08 |
| 8 | 8 | -7.851 | 0.455 | 0.05 | 1.26 | 754.73 | | 717.96 | 102.47 | 100.95 | 0.00 | 788.08 | 11.10 | 1574.83 |
| 9 | 8 | -7.875 | 0.34 | 0.03 | 0.33 | 813.33 | | 786.67 | 142.80 | 137.24 | 0.00 | 836.19 | 14.41 | 2168.46 |
| 10 | 8 | -7.847 | 0.595 | 0.05 | 1.01 | 755.33 | | 718.33 | 92.00 | 71.74 | | 816.10 | 7.68 | 1127.76 |
| 11 | 8 | -7.837 | 0.405 | 0.07 | 2.12 | 710.01 | | 662.16 | 109.98 | 101.83 | 0.00 | 720.42 | 12.00 | 1556.46 |
| 12 | 8 | 0.844 | 0.755 | 0.04 | 1.16 | 706.53 | 31.79 | 644.65 | 92.00 | 76.55 | 0.00 | 722.59 | 9.00 | 1170.65 |
| 13 | 8 | -7.844 | 0.502 | 0.06 | 2.05 | 707.63 | | 667.41 | 108.97 | 105.38 | 0.00 | 723.45 | 12.38 | 1612.31 |
| 14 | 8 | -7.847 | 0.756 | 0.05 | 0.59 | 723.71 | | 686.63 | 92.00 | 82.80 | 0.00 | 767.37 | 9.30 | 1284.20 |
| 15 | 8 | -7.858 | 0.334 | 0.09 | 0.84 | 796.39 | | 726.93 | 92.00 | 80.80 | 0.00 | 817.88 | 8.63 | 1270.70 |
| 16 | 8 | -7.843 | 0.235 | 0.08 | 1.07 | 753.44 | | 690.88 | 73.00 | 49.88 | 0.00 | 803.60 | 5.40 | 781.47 |
| 17 | 8 | -7.904 | 0.214 | 0.08 | 0.42 | 751.55 | | 690.36 | 92.00 | 158.89 | 0.00 | 702.33 | 19.09 | 2413.96 |
| 18 | 10 | -7.922 | 0.22 | 0.06 | 0.42 | 773.97 | | 729.77 | 78.00 | 74.74 | 0.00 | 886.77 | 7.49 | 1193.27 |
| 19 | 10 | 0.212 | 0.96 | 0.10 | 0.76 | 399.80 | 85.16 | 274.24 | 92.00 | 82.37 | 0.00 | 300.31 | 17.51 | 946.12 |
| 20 | 10 | -7.873 | 0.048 | 0.06 | 0.89 | 746.10 | | 701.74 | 102.00 | 101.19 | 0.00 | 823.31 | 10.75 | 1593.63 |
| 21 | 10 | -7.961 | 0.301 | 0.08 | 0.35 | 740.35 | | 680.38 | 92.00 | 79.11 | 0.00 | 818.17 | 8.43 | 1244.19 |
| Average | | -4.466 | 0.495 | 0.08 | 1.27 | 754.60 | | 693.47 | 92.00 | 90.80 | 0.00 | 824.01 | 9.56 | 1417.68 |

| Sewage Batch | $MS_{B,H}$ mgCOD/d | $MX_{B,G}$ mgAVSS | $MX_{E,G}$ mgAESS | $\delta P_G$ mgP/l infl | $MX_{B,H}$ mgAVSS | $MX_{E,H}$ mgAESS | $\delta P_H$ mgP/l infl | $MX_I$ mgAISS | $\delta P_I$ mgP/l infl | $\delta P_{(meas)}$ mgP/l infl | $\delta P_{(calc)}$ mgP/l infl | $MX_{t(meas)}$ mgVSS | $MX_{t(calc)}$ mgVSS | $f_{av,OHO}$ | $f_{av,PAO}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 10788.11 | 4768.65 | 476.87 | 14.66 | 14278.38 | 6853.62 | 3.17 | 6608.78 | 0.99 | 18.85 | 18.82 | 33070.67 | 33083.49 | 0.43 | 0.14 |
| 3 | 14366.38 | 4367.48 | 436.75 | 12.36 | 19014.32 | 9126.87 | 4.22 | | 0.00 | 16.58 | 16.58 | 30212.40 | 32945.43 | 0.58 | 0.13 |
| 4 | 12522.64 | 3674.35 | 293.95 | 12.98 | 15438.87 | 5928.53 | 4.01 | 2448.09 | 0.46 | 17.45 | 17.45 | 27735.50 | 27702.18 | 0.56 | 0.13 |
| 5 | 12868.62 | 1567.08 | 125.37 | 12.73 | 15865.42 | 6092.32 | 4.12 | 4313.13 | 0.81 | 17.67 | 17.65 | 28003.25 | 28044.70 | 0.57 | 0.06 |
| 6 | 14667.11 | 0.00 | 0.00 | 0.00 | 18082.74 | 6943.77 | 4.69 | 2686.27 | 0.50 | 17.19 | 5.20 | 27744.00 | 27799.43 | 0.65 | |
| 7 | 13460.82 | 2042.95 | 163.44 | 9.93 | 16595.53 | 6372.68 | 4.31 | 3564.32 | 0.67 | 14.88 | 14.90 | 28656.33 | 28656.03 | 0.58 | 0.07 |
| 8 | 12784.40 | 4295.00 | 343.60 | 12.28 | 15761.59 | 6052.45 | 4.09 | | 0.00 | 16.37 | 16.37 | 25082.73 | 26452.64 | 0.60 | 0.16 |
| 9 | 13564.87 | 5913.98 | 473.12 | 12.66 | 16723.82 | 6421.95 | 4.34 | | 0.00 | 16.96 | 17.00 | 26746.67 | 29532.86 | 0.57 | 0.20 |
| 10 | 13238.91 | 3075.70 | 246.06 | 11.48 | 16321.94 | 6267.63 | 4.24 | | 0.00 | 15.73 | 15.72 | 24712.33 | 25911.33 | 0.63 | 0.12 |
| 11 | 11686.74 | 4244.89 | 339.59 | 10.81 | 14408.31 | 5532.79 | 3.74 | | 0.00 | 14.55 | 14.55 | 24041.78 | 24525.58 | 0.59 | 0.17 |
| 12 | 11708.16 | 3192.68 | 255.41 | 15.11 | 14434.72 | 5542.93 | 3.75 | 3360.80 | 0.63 | 19.51 | 19.49 | 26835.71 | 26862.92 | 0.54 | 0.12 |
| 13 | 11735.92 | 4397.20 | 351.78 | 13.86 | 14468.95 | 5556.08 | 3.75 | | 0.00 | 17.60 | 17.62 | 23654.29 | 24773.99 | 0.58 | 0.18 |
| 14 | 12448.40 | 3502.37 | 280.19 | 16.60 | 15347.34 | 5893.38 | 3.98 | | 0.00 | 20.57 | 20.58 | 23800.00 | 25023.28 | 0.61 | 0.14 |
| 15 | 13267.83 | 3465.55 | 277.24 | 7.29 | 16357.60 | 6281.32 | 4.24 | | 0.00 | 11.55 | 11.53 | 24491.33 | 26381.72 | 0.62 | 0.13 |
| 16 | 13036.13 | 2131.27 | 170.50 | 3.16 | 16071.95 | 6171.63 | 4.17 | | 0.00 | 7.34 | 7.33 | 23358.00 | 24545.35 | 0.65 | 0.09 |
| 17 | 11393.28 | 6583.33 | 526.68 | 8.90 | 14046.51 | 5393.86 | 3.63 | | 0.00 | 12.53 | 12.55 | 21964.00 | 26550.58 | 0.53 | 0.25 |
| 18 | 13400.15 | 3841.94 | 384.19 | 4.28 | 17735.50 | 8513.04 | 3.94 | | 0.00 | 8.21 | 8.22 | 23003.43 | 30474.67 | 0.58 | 0.13 |
| 19 | 4530.73 | 3041.10 | 304.11 | 14.64 | 5996.56 | 2878.35 | 1.33 | 11453.73 | 1.72 | 17.72 | 17.69 | 23698.00 | 23727.87 | 0.25 | 0.13 |
| 20 | 12441.13 | 5122.46 | 512.25 | 1.31 | 16466.22 | 7903.79 | 3.66 | | 0.00 | 4.97 | 4.96 | 26350.00 | 30004.73 | 0.55 | 0.17 |
| 21 | 12363.41 | 3999.17 | 399.92 | 6.08 | 16363.34 | 7854.40 | 3.63 | | 0.00 | 9.71 | 9.71 | 18657.50 | 28616.83 | 0.57 | 0.14 |
| Average | 12451.78 | 4556.82 | 455.68 | 11.35 | 16480.29 | 7910.54 | 3.66 | | 0.00 | 15.00 | 15.01 | 26027.00 | 29403.34 | 0.56 | 0.14 |

| Known Parameters | |
|---|---|
| K | 0.06 |
| Q | 20l/d |
| r | 1 |
| $Y_{H,G}$ | 0.45 |
| $f_{n}$ | 0.15 |
| $f_{E,G}$ | 0.25 |
| $b_G$ | 0.04 |
| $f_{E,H}$ | 0.2 |
| $f_{XEG,P}$ | 0.03 |
| $f_{cv}$ | 1.48 |
| $f_{XBH,P}$ | 0.03 |
| $f_{XEH,P}$ | 0.03 |
| $f_{XI,P}$ | 0.03 |
| $b_H$ | 0.24 |
| N | 1 |
| n | 1 |

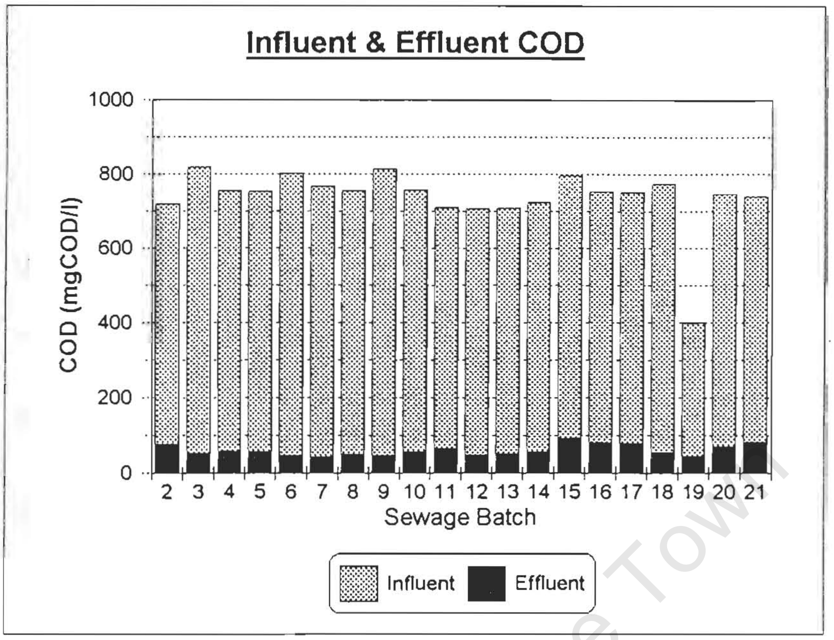


**Figure E1:** Average sewage batch influent and effluent COD concentrations in UCT system.

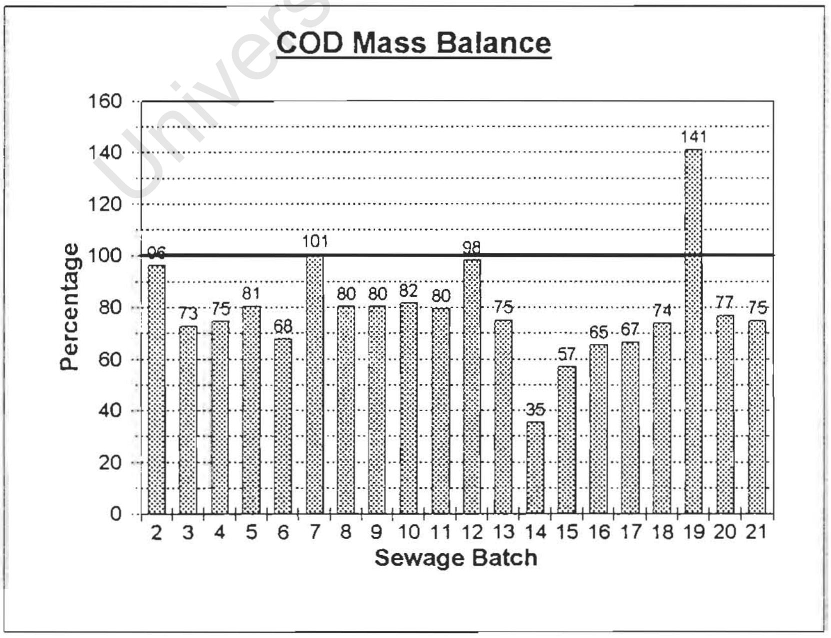


**Figure E2:** Average sewage batch COD Mass Balance in UCT system.

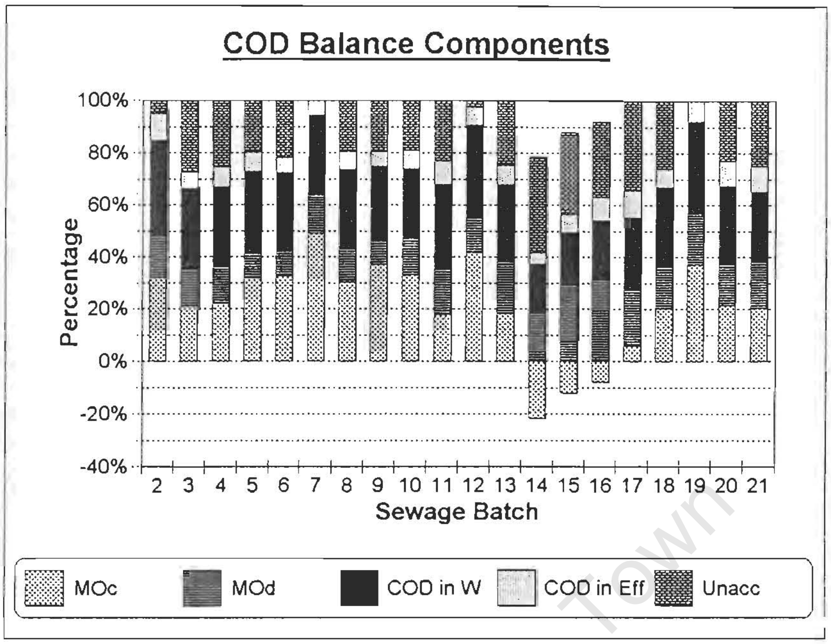


**Figure E3:** Average sewage batch COD Mass Balance Components in UCT system.

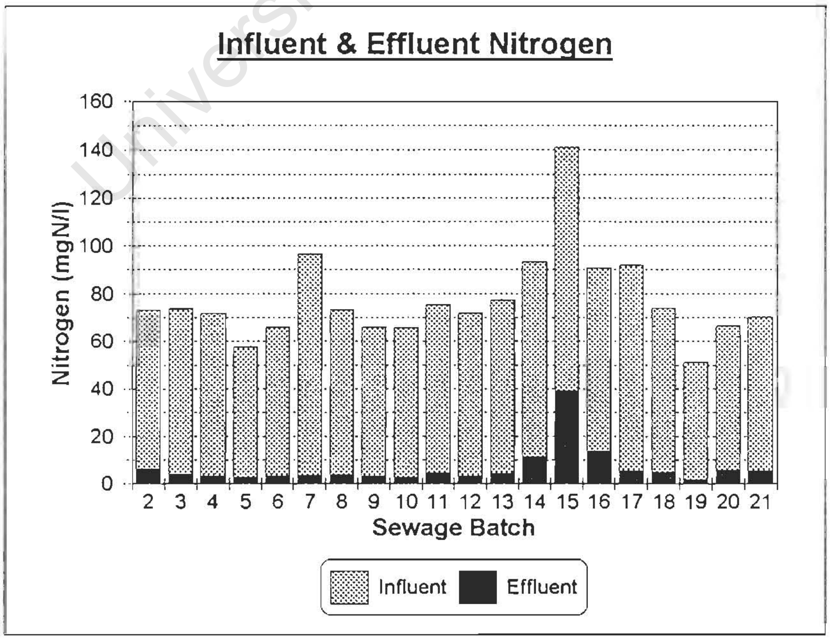


**Figure E4:** Average sewage batch influent and effluent Nitrogen concentrations in UCT system.

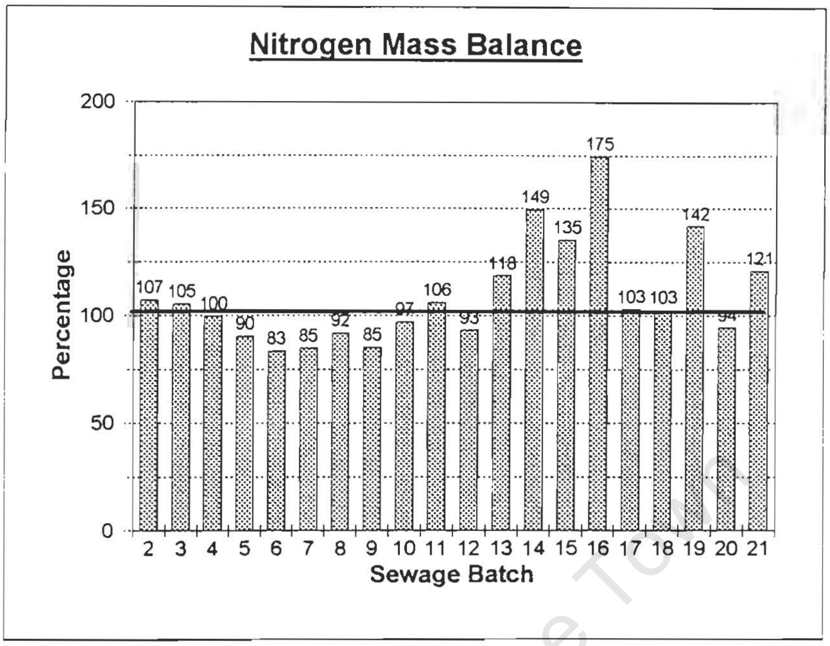


**Figure E5:** Average sewage batch Nitrogen Mass Balance in UCT system.

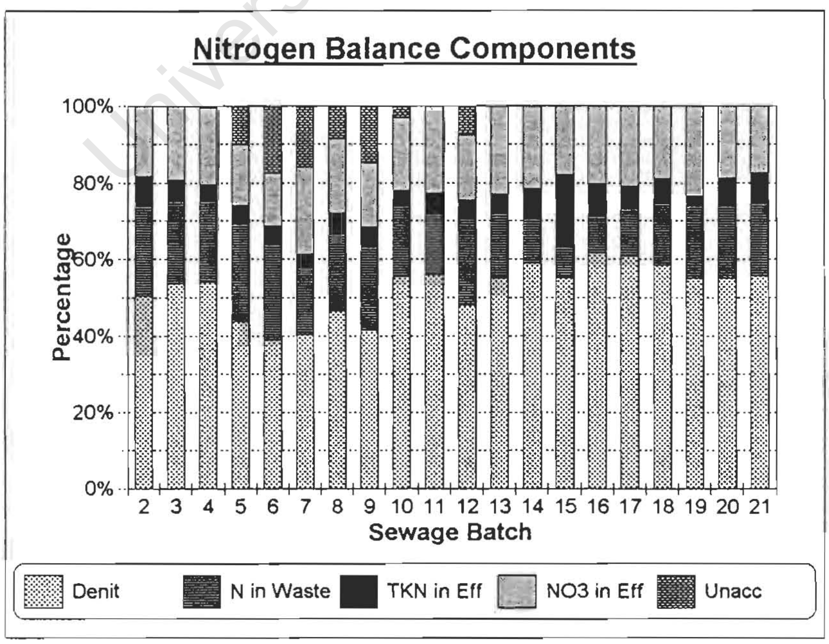


**Figure E6:** Average sewage batch Nitrogen Mass Balance Components in UCT system.

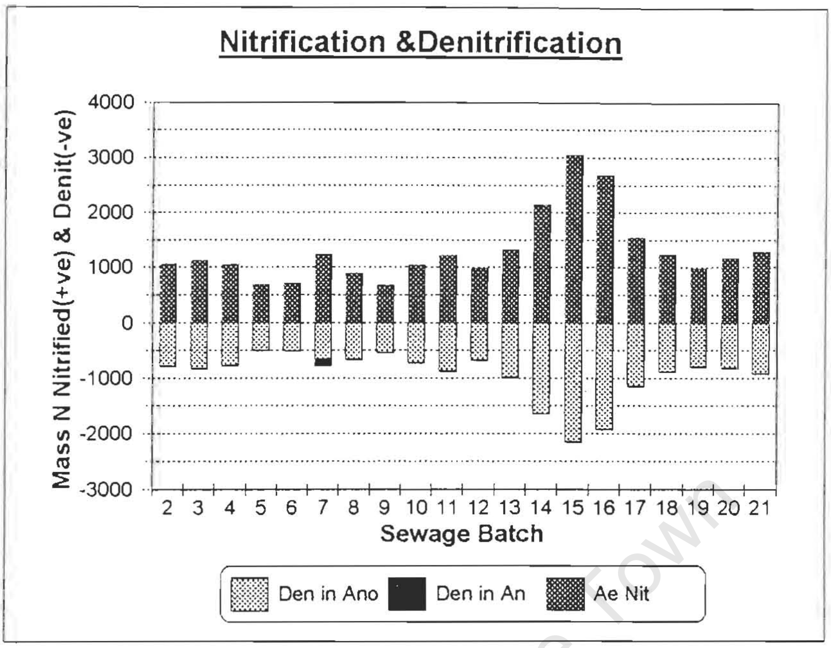


**Figure E7:** Average sewage batch Nitrification and Denitrification in UCT system.

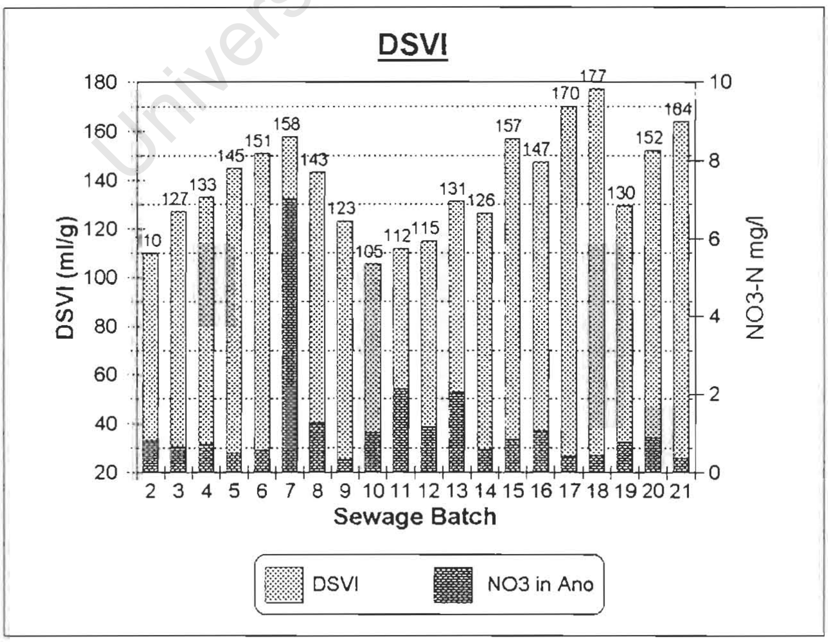


**Figure E8:** Average sewage batch Diluted Stirred Volume Index and Anoxic Nitrate concentration in UCT system

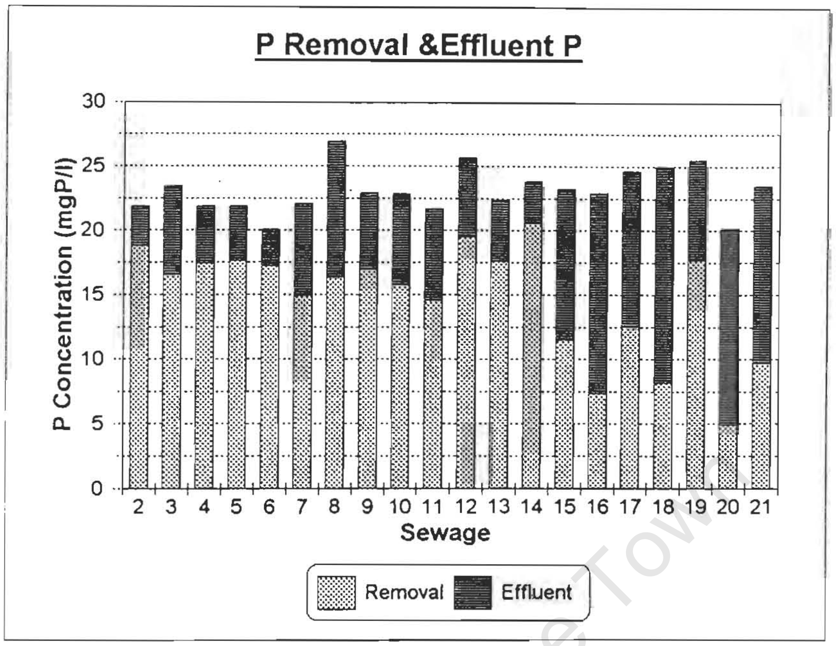


**Figure E9:** Average sewage batch P Removal and Effluent P in UCT system.

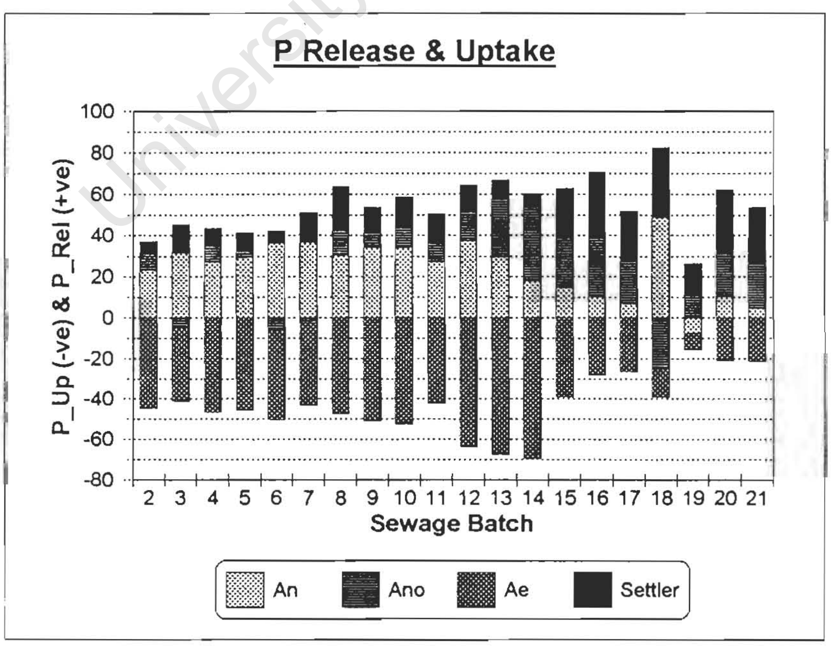


**Figure E10:** Average sewage batch P Relese and Uptake in UCT system.

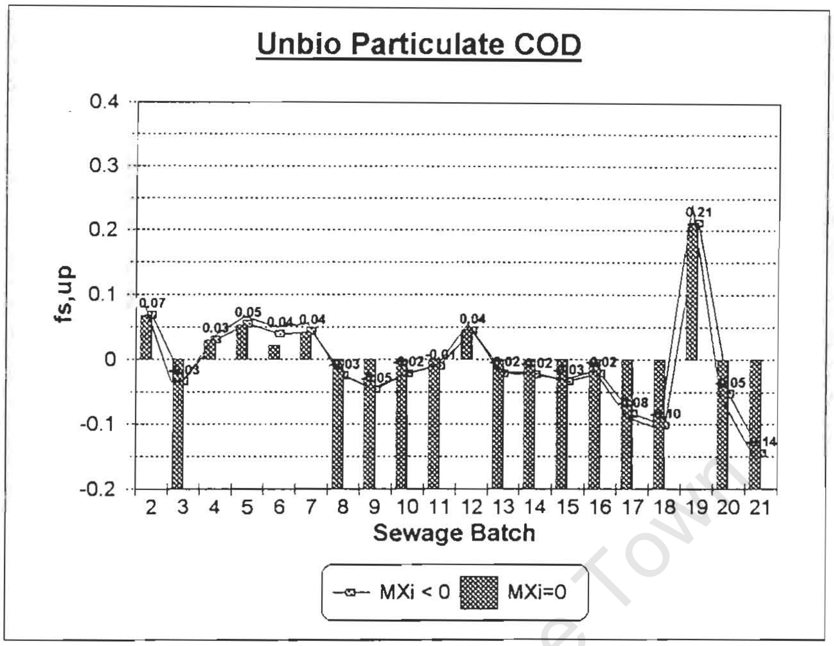


Figure E11: Average sewage batch unbiodegradable particulate fraction in UCT sytem.

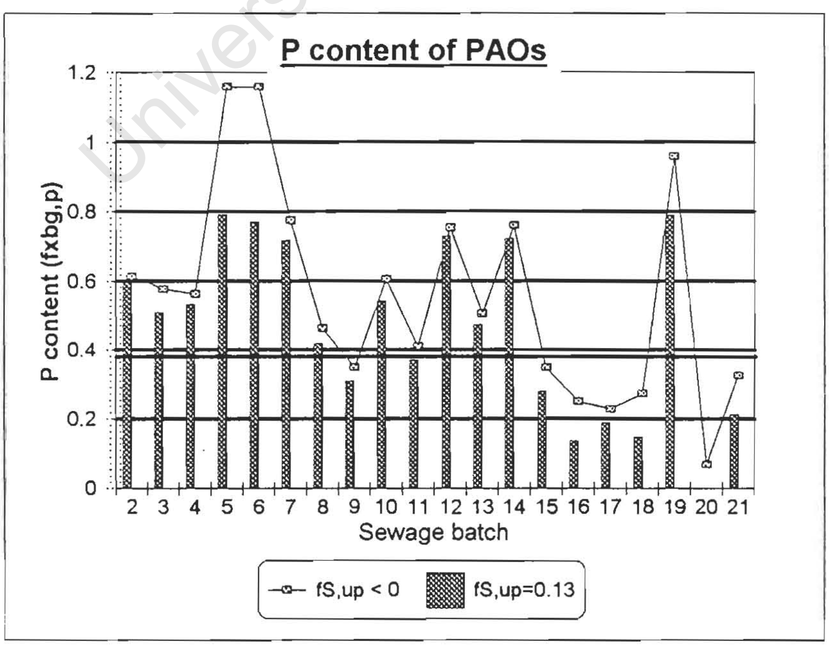


Figure E12: Average sewage batch P content of PAOs in UCT system.

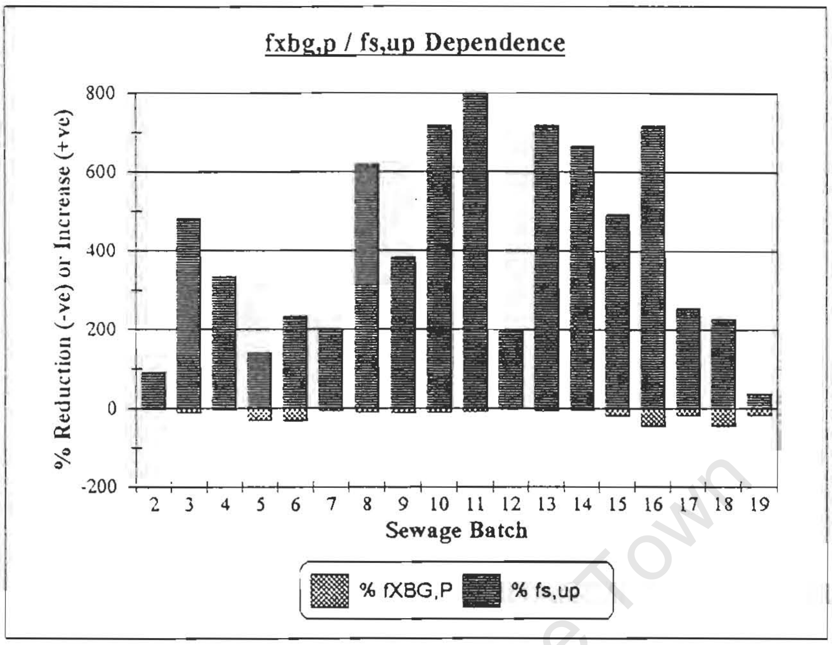


Figure E13: Average sewage batch fXBG,P and fS,up dependence on fS,up fraction equal to 0.13 in UCT system

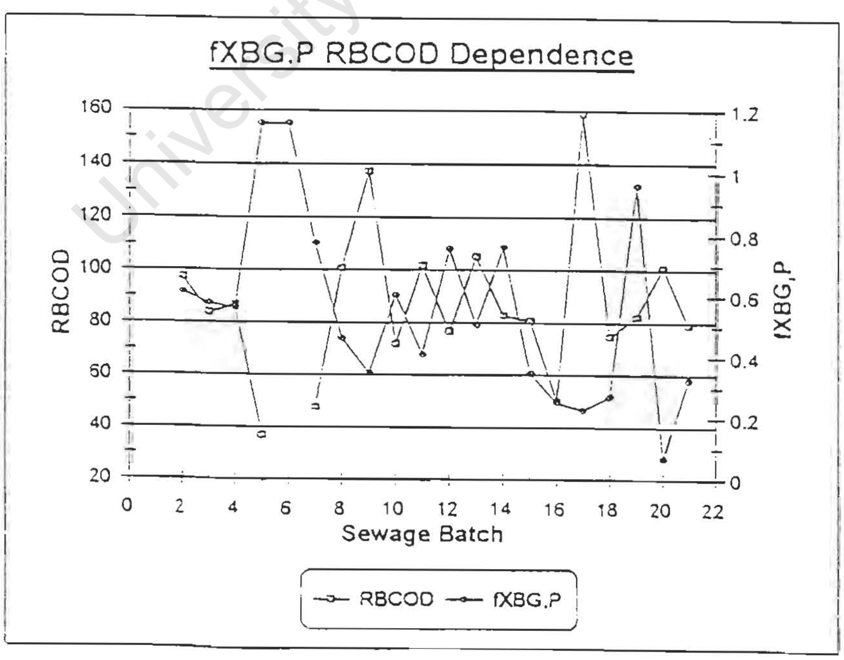


Figure E14: Average sewage batch fXBG,P dependence on influent RBCOD concentration.

# APPENDIX F

- Filament Identification in the External Nitrification and UCT Control Systems.

Table F 1: Filaments identified[1] in the external nitrification (EXT) and UCT Control (CTL) systems

| Date & (Day) | Sewage Batch | DSVI | | System | EXT System | CTL System |
|---|---|---|---|---|---|---|
| | | EXT | CTL | | | |
| 24/2/98 (1) | 1 | 107 | - | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | type 1701 | type1701; type 0092 |
| | | | | Abundance | common; common | common; some; few |
| | | | | Morphology | weak, irregular and | weak, irregular and |
| | | | | Floc | 100 - 150 µm | < 150 µm |
| 23/03/98 (28) | 3 | 87 | 137 | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | type 0092 | type0092; Norcadia sp; H.hydrossis |
| | | | | Abundance | some; few | common; some; few; few |
| | | | | Morphology | weak, irregular and diffuse | weak, irregular and diffuse |
| | | | | Floc Diameter | < 150 µm | < 150 µm |
| 22/04/98 (58) | 8 | 74 | 143 | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | type 021N; type 0092 | type 021N |
| | | | | Abundance | common; some; few | common; some |
| | | | | Morphology | weak, irregular and diffuse | weak, irregular and diffuse |
| | | | | Floc Diameter | < 150 µm | 150 - 500 µm |
| 20/05/98 (86) | 12 | 73 | 131 | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | type 1851; H.hydrossis | type 1851; type 0092; H.hydrossis |
| | | | | Abundance | some; few; few | common; some; few; few |
| | | | | Morphology | weak, irregular and diffuse | firm |
| | | | | Floc Diameter | < 150 µm | 150 - 500 µm |

[1]Filament identification according to Eikelboom and van Buissen (1981) and Jenkins *et al*. (1984).

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/06/98 (108) | 13 | 7 | 131 | Dominant | *M.parvicella* | *M.parvicella; H.hydossis* |
| | | | | Secondary | type 1851 | type 1851 |
| | | | | Abundance | common; common | common; few; some |
| | | | | Morphology | weak, irregular and diffuse | firm, round and compact |
| | | | | Floc Diameter | < 150 µm | 150 - 500 µm |
| 27/07/98 (154) | 20 | 83 | 152' | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | | |
| | | | | Abundance | some | few |
| | | | | Morphology | weak, irregular and diffuse | firm, round and compact |
| | | | | Floc Diameter | 150 - 500 µm | > 500 µm |
| 19/08/98 (177) | 23 | 105 | 166 | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | | |
| | | | | Abundance | some | few |
| | | | | Morphology | weak, irregular and diffuse | firm, round and compact |
| | | | | Floc Diameter | < 150 µm | 150 - 500 µm |
| Monitoring of UCT system, which was operated for a different project was stopped on day 188 after completing sewage batch 23. This system was kept operating for later use and filament identification was continued. | | | | | | |
| 15/09/98 (204) | 25 | 91' | - | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | | |
| | | | | Abundance | few | common |
| | | | | Morphology | weak, irregular and diffuse | firm, round and compact |
| | | | | Floc Diameter | < 150 µm | 150 - 500 µm |
| 20/10/98 (239) | 28 | 115' | - | Dominant | *S.Natans* | type 1701 |
| | | | | Secondary | *M.parvicella*; type 1701 | *M.parvicella* |
| | | | | Abundance | some; few; few | some; some |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Morphology | weak, irregular and diffuse | firm, round and compact |
| | | | | Floc Diameter | < 150 µm | 150 - 500 µm |
| 24/11/98 (275) | 29 | 108 | - | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | type 1851 | type 1851 |
| | | | | Abundance | some; some | some; some |
| | | | | Morphology | weak, irregular and diffuse | weak,irregular and diffuse |
| | | | | Floc Diameter | 150 - 500 µm | 150 - 500 µm |
| 20/12/98 (300) | 31 | 64' | - | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | | |
| | | | | Abundance | few | some |
| | | | | Morphology | weak, round and compact | weak, round and compact |
| | | | | Floc Diameter | 150 - 500 µm | 150 - 500 µm |
| 18/01/99 (329) | 34 | 140' | - | Dominant | *M.parvicella* | *M.parvicella* |
| | | | | Secondary | | Thiothrix sp |
| | | | | Abundance | some | common; few |
| | | | | Morphology | weak, irregular and diffuse | weak, round and compact |
| | | | | Floc Diameter | 150 - 500 µm | 150 - 500 µm |
| 22/02/99 (364) | 37 | 99 | - | Dominant | type 1851 | *M.parvicella* |
| | | | | Secondary | *M.parvicella* | type 1851 |
| | | | | Abundance | common; some | very common; common |
| | | | | Morphology | weak and rounded | |
| | | | | Floc Diameter | 150 - 500 µm | 150 - 500 µm |
| Monitoring of External nitrification system stopped on day 373 after completing sewage batch 37. The system was kept operating for later use and filament identifications were continued. | | | | | | |

| EXT System | | | | | Aerobic Reactor | Nitrification Reactor |
|---|---|---|---|---|---|---|
| 24/03/99 | | | | Dominant | type 1851 | Thiothrix |
| | | | | Secondary | | |
| | | | | Abundance | some | excessive |
| | | | | Morphology | weak, irregular and diffuse | irregular: not true floc but clumps sheered of sides of unit |
| | | | | Floc Diameter | > 150 µm | > 500 µm |
| EXT System | | | | | Aerobic Reactor | Nitrification Reactor |
| 28/04/99 | | | | Dominant | type 1851 | type 1851 |
| | | | | Secondary | *M.parvicella* | *M.parvicella*; type 021N |
| | | | | Abundance | common; common | some; few; few |
| | | | | Morphology | weak; irregular and diffuse | firm, round and compact |
| | | | | Floc Diameter | 150 - 500 µm | 150 - 500 µm |
| EXT System | | | | | Aerobic Reactor | Nitrification Reactor |
| 27/05/99 | | | | Dominant | type 1851 | *N. limcola* |
| | | | | Secondary | *M.parvicella* | |
| | | | | Abundance | some; few | some |
| | | | | Morphology | firm, round and compact | firm, round and compact |
| | | | | Floc Diameter | 150 - 500 µm | 150 - 500 µm |