BEENLEIGH WATER RECLAMATION FACILITY IMPROVING NITROGEN REMOVAL

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ABSTRACT
The Beenleigh WRF was retrofitted as part of a capacity upgrade in 1999 from Extended Aeration Oxidation Ditchs to a Bio-Denipho Process and has had inconsistent nitrogen control over several years since the upgrade of the plant, which has lead to several licence breaches.

The reason for the upgrade was to increase the plants hydraulic capacity and further reduce final effluent nitrogen levels. The plant serves a population of approx 60,000 and approximately 20% of the plant inflow comes from an industrial catchment covering industries such as a brewery, dog food manufacturer and paper recycling plants etc.

The plants upgrade was delivered via a short term “Design, Build, Operate” (DBO) project delivery method, giving the contractor 3 years operational control after construction completion, main reason for choosing this method of delivery for this upgrade was that if you have the design, construction and commissioning all undertaken by one party you would be in a better position to ensure the plant delivers what it was designed to do.

After much analysis by both the initial contracted constructor / operator and when the plant was returned back to GCW for operations a decision was made to simplify the process control philosophy in an attempt to improve the plants performance. Results of process changes initiated by the plant Supervisor and Coordinator of Operations in conjunction with a more targeted focus by GCW on its trade waste generators in the catchment has resulted in improved, more stable nitrogen removal at the plant.

1.0 INTRODUCTION

The Beenleigh WRF was retrofitted in 1999 from an Extended Aeration Oxidation Ditch to a Bio-Denipho Process. The reason for the upgrade was to increase the plants hydraulic capacity as well as improve in the treatment and removal of nutrients. We are located on the northern end of the Gold Coast and serve a population of approx 60,000, with about 20% of the flow being generated by an industrial catchment i.e. brewery, paper recycling etc. We discharge into the nearby Albert River and then into the sensitive Morten Bay catchment and therefore have a fairly tight discharge licence in regards to Nitrogen.

Licence nutrients summary table

Quality Characteristic	**Units**	**Median**	**80th%ile**	**85th %ile**	**Maximum**
NH4 N	mg/l		1.5	1.0	3.0
NH4 + NO3	mg/l		7.5	5.0	10.0
TN	mg/l	7.5			15.0
TP	mg/l		3.0	2.0	4.0

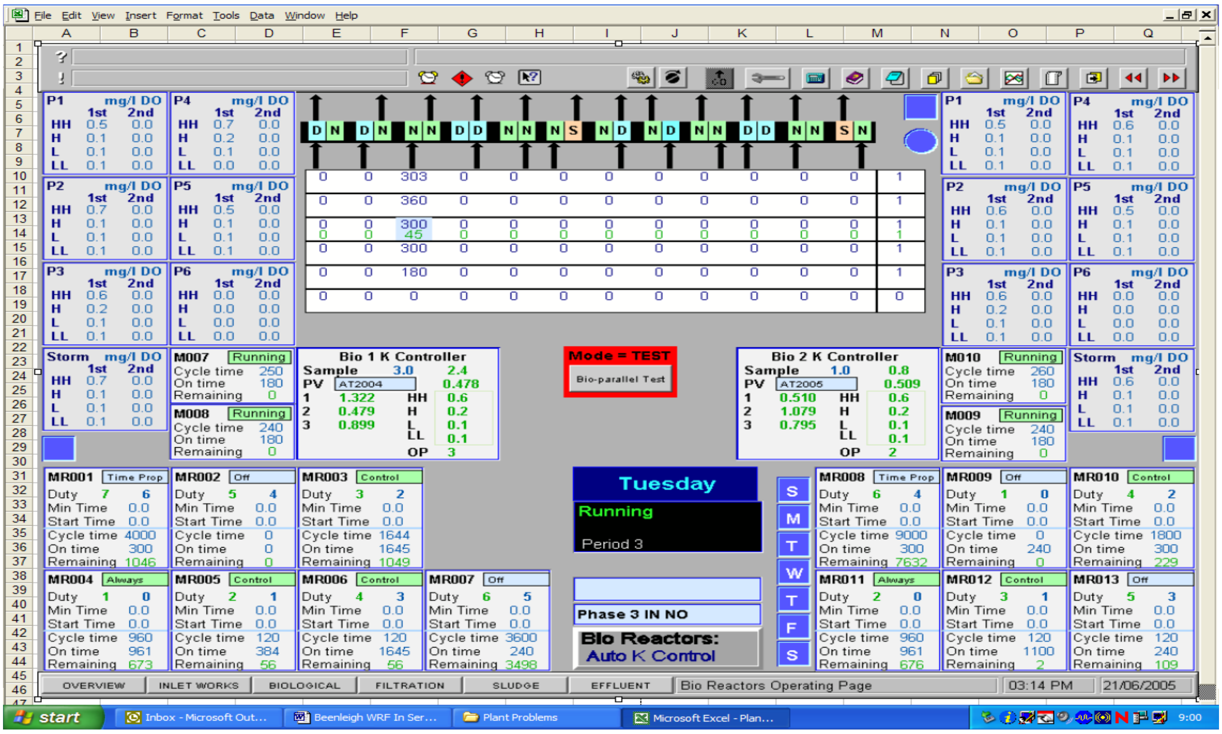
Figure 1: ***Beenleigh WRP Site Layout***

1.1 Process Problems

The Problem – instability of the process led to several breaches of our discharge limits in particular the Ammonia Nitrogen short term limit of 1.5mg/l has been breached on several occasions

The facility operated as a Bio-Denipho process (Danish Technology) that controlled the biological treatment of the incoming sewage. The biggest problem with the system was that it was a very reactive & complex control system that required constant monitoring to make changes based on the results of the inline nutrient analysers.

The plant was designed with a number of different Cycles, Phases and Periods available in the system that could be adjusted by the operations staff. The Bioreactor sequence allows for a combination of the following phases whereby influent travelled through the pair of bioreactors in accordance with the options presented in the following table.

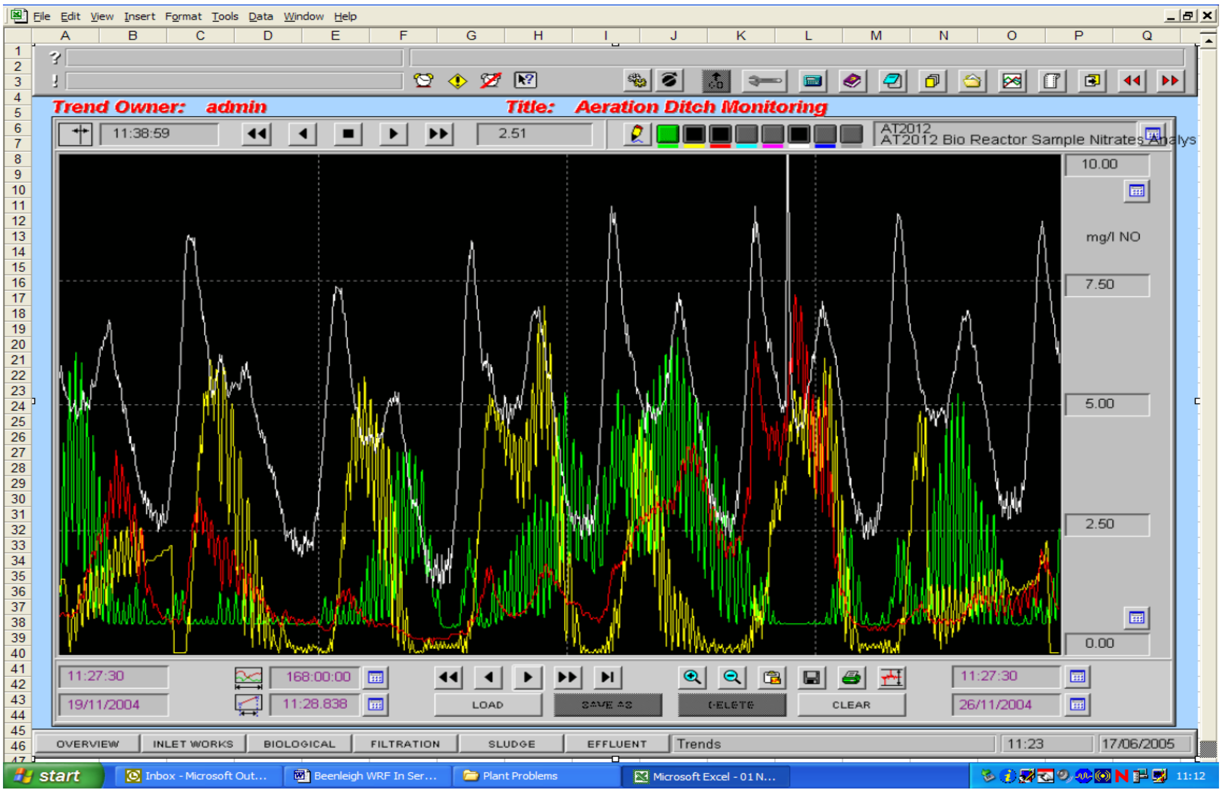


<u>Figure 2:</u> ***The Beenleigh Bio-Denipho Bioreactor Control Screen***

Each phase could be selected to operate for a set time and the phases would operate sequentially. Each day you have the possibility of running 6 blocks of time per bioreactor where different combinations of the above 12 phases could be run. The week is set up of 7 days each of which is able to have its unique set of 6 operational cycles.

As you can see the entire process was quite complicated, it requires the operations staff to be able to see into the future so the combinations of the correct phases and cycles can be programmed. As the flow rates and the compositions of the sewage do tend to vary from day to day and week-to-week, in particular on a plant with 20+ % of its influent coming from a industrial catchment the plant tended to be operated very reactively.

Process control decisions were made, based on the results of the inline nutrient analysers these analyser's drew a sample from the distribution box (after its been through the bioreactors), it was filtered and then tested, with the results being displayed on the Citec control system. It's from these results that we then made changes to the phases / cycle run times. What was always difficult to determine though "*due to lack of representative influent quality monitoring*" was that we could only react to historical data and programme best guess nitrification / denitrification cycles. What was always very difficult to determine was the cause of increased either ammonia / nitrate concentrations !!! was it influent variability, or that the plants phases and cycles were not set up appropriately to manage the diurnal loads entering the plant ???



<u>Figure 3:</u>
Beenleigh WRF Nutrients Screen showing the diurnal variations of NH4 and NO3 leaving the plant.

Trends above cover a timeframe of a typical week when the plant was unstable.
Yellow = Ammonia peaked at 5.9 mg/l

2.0 IMPROVEMENTS

Due to the processes lacked of stability, it was proposed that by reverting back to a conventional activated sludge process, establishing a constant anoxic mass fraction 24/7 and controlling load into the plant without reducing this mass fraction significantly it was thought we would then stabilize the process and in turn improve the nitrogen removal, as well as making the system more operator friendly. The facility is a retrofit of an activated sludge process with the 2 ditches joined by an interconnecting channel, meaning we could continue to use the existing control system and only make a couple of small changes to the current set up to revert back to the Activated Sludge Process.

The only physical change needed was moving the D.O. probes to other locations. The inlet weirs were both left fully open and the outlet weirs were adjusted to control the immersion depth of the rotors and then left in that position. The changes basically meant that one of the rotors were to be run constantly using the existing system, a second rotor to be run from the existing system on D.O. control and a third will be run from the existing system using built in timer controls.

The aim of running the rotors in this manner was to achieve a dedicated anoxic zone of about 30 - 40 percent in each of the two reactors. We thought the continual feed to the two reactors and the plant operating as an activated sludge plant would provide a more stable environment for the reduction of both nitrogen and phosphorus removal.

However after a couple of sludge ages, it did not work that way and it was difficult to maintain the 30% anoxic zone due to the number and location of the aerators. The system was now a lot less reactive, yet still required a lot of monitoring and fine tunning. It was decided between the plant supervisor and section coordinator that we would continue with the Activated Sludge theme with a variation, " *this proposal was put to mgmt and process support staff and endorsed* " we'd call it Activated Sludge In Series, this is where we direct all the flow into bioreactor 1 "to facilitate nitrification" the flow then would travel through the interconnecting channel and into Bioreactor 2, "to facilitate de-nitrification" in essence 80% of bioreactor 2 was anoxic, and then the flow would be distributed to each Clarifier via a balance tank.

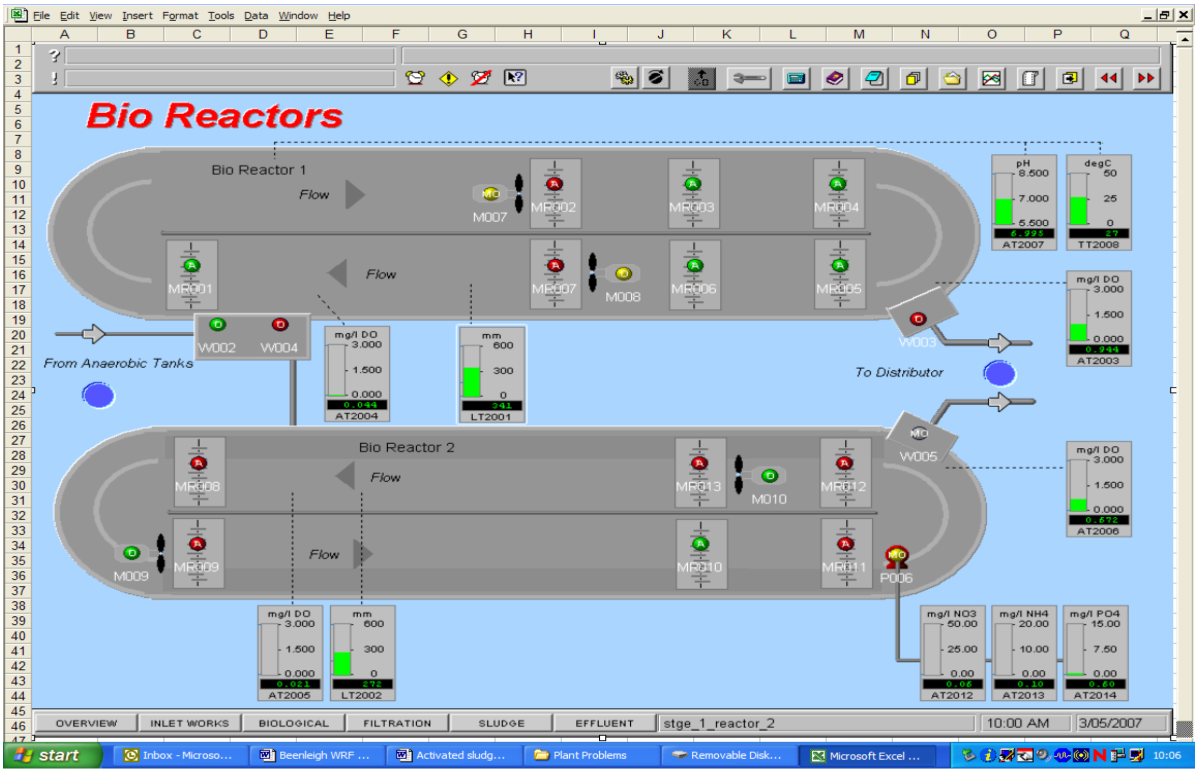


Figure 4: ***Beenleigh WRF Bioreactors Screen***

We operated in this fashion for a few more sludge ages and we were very happy with the results that we could achieve, in particular with the ammonia nitrogen levels (very low compared to what we were used to and more stable). We now wanted to concentrate on fine tunning the process, we were having some issues with the Nitrate levels, due to the way the bioreactors are set up we found we were using all the available carbon in the nitrification process in Bioreactor 1 and by the time the flow entered bioreactor 2 there was limited carbon to drive the denitrification process.

The easiest way to supplement the carbon source was to dose ethanol into the start of the anoxic zone, since the dosing of the ethanol has began the ammonia and nitrate results have become very stable. The costs of supplementation of carbon to enhance denitrification is marginal at approx $150 day and has been offset by the reduction in aerator starts that were associated with the Bio-denipho process configuration.

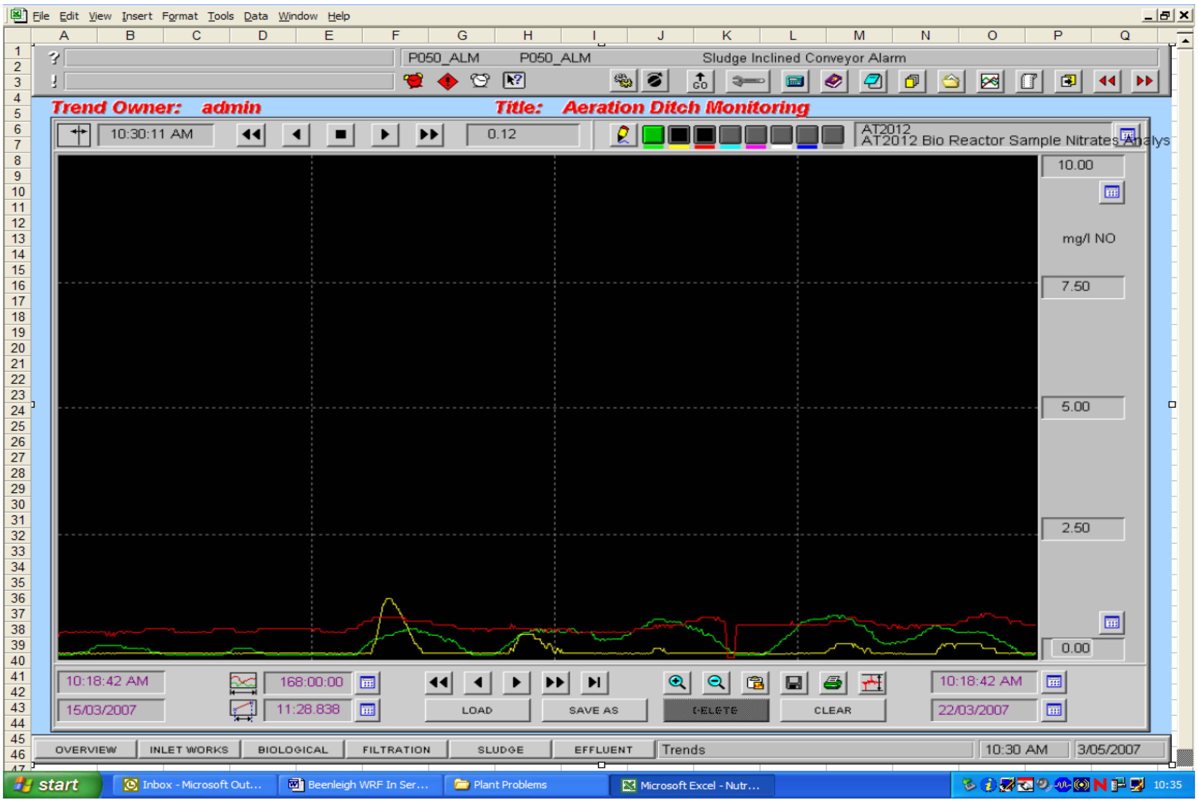
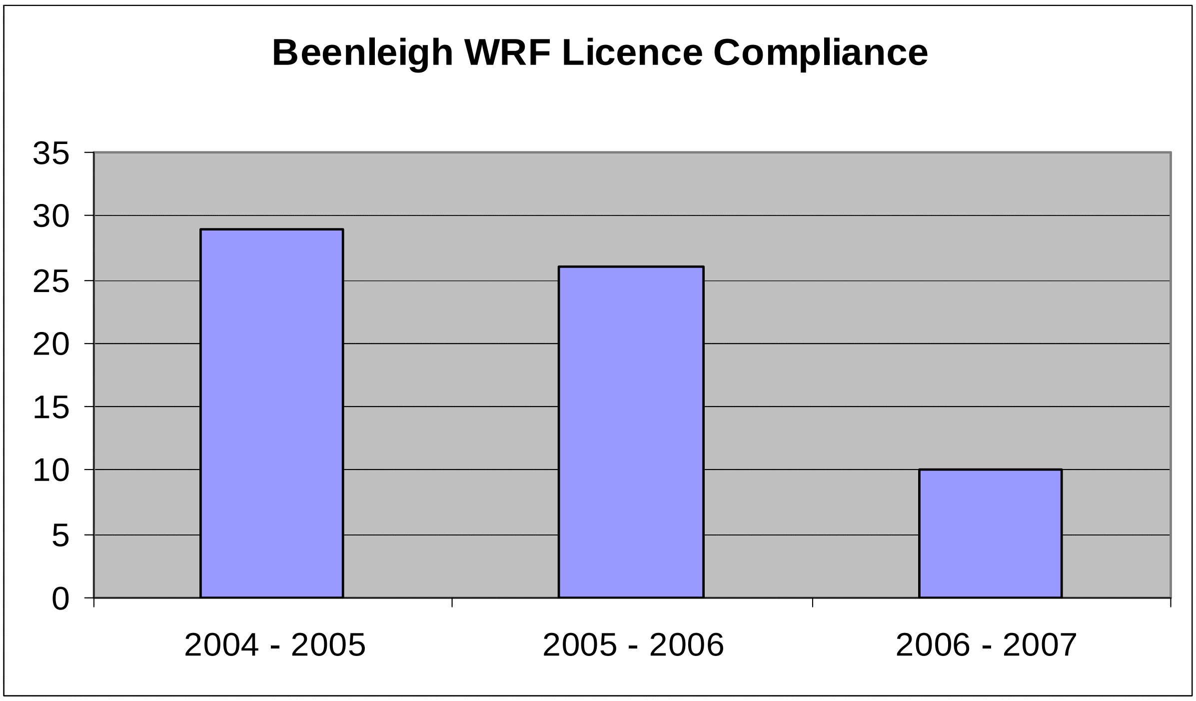


Figure 5:
Beenleigh WRF Nutrient Screen more typical of current performance, trends above cover a period of a week and are for Ammonia, Nitrate & Phosphorous.

Conclusion

The decision to prepare this paper has been twofold , one to reinforce the value of simplicity in design, it is often considered that the more complex something is, the smarter or more sophisticated it must be and the more likely we will be able to improve performance. However it is often the opposite that is true, these process changes initiated by line management at Beenleigh is testimony to the value of operational staff showing initiative in optimising processes under their control.

It would also be remiss to down play the importance of understanding the variability of influent quality that is entering your plant, in particular where you have a significant proportion of your catchment that is industrial. We believe that the increased surveillance of our key customers modified their own diligence to discharge quality leaving their sites, knowing that it may have detrimental consequences downstream, this in conjunction with the simplified in- series process configuration has led to the current stable performance of the Beenleigh WRF and a reduction of licence breaches.



Some of the plants breaches are not related to Nutrient there has been a series of Disinfection problems with the UV system.