KAWANA STP UPGRADE ISSUES……..UNPLUGGED!!

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ABSTRACT

Kawana STP is located on the Sunshine Coast. This plant was originally commissioned in 1981 with two previous upgrades before the most recent one in June 2005. Included in this recent upgrade were: new inlet facilities; retrofitting one of two IDAL tanks into a continuous flow bioreactor with the provisions of four secondary clarifiers; the addition of two gravity drainage decks; and the modification of the existing secondary sedimentation tanks for the purpose of new contact tanks and chlorine disinfection.

This paper focuses on selected upgrade experiences associated with the commissioning in 2005 as well as the plant's performance in the first two years of operation after this upgrade.

KEY WORDS

Augmentation, Kawana Sewage Treatment Plant, return activated sludge (RAS), variable speed drive (VSD), dissolved oxygen (DO).

1.0 INTRODUCTION

The Kawana STP is situated at the southern region of the recently amalgamated Sunshine Coast Regional Council in South East Queensland. The plant treats about 20 ML/day in dry weather conditions, with the highest wet weather flow of 59,975 kL/day recorded in September 2007.

The main objective for the augmentation was to increase the plant's hydraulic capacity from 58000 EP to 76000 EP. The augmentation works involved the decommissioning of the existing two processes on site, one of which was a conventional activated sludge system and the other a set of sequencing batch reactors (IDAL) system.

In 2007, two years after the upgrade, the original Caloundra STP was also decommissioned. This flow was redirected to Kawana STP. With the rapid population growth and increased tourism over recent years in the Caloundra region, this has had a clear impact upon the Kawana STP. In less than three years of the 2005 commissioning, the upgrade of the plant is now fast approaching its design load, even though the forecast for this upgrade was projected to last until 2015.

The following are 3 'Unplugged' issues which will be covered:

- DO trends in aeration zones, with a special note on aeration set point in zone # 5.
- Clogging up of RAS N-pumps.
- Alternative solutions to excessive detention time in contact tanks.

In each case, this paper will discuss the contributing factors which led to the particular issue occurring, the action taken and the outcome to date.

2.0 DISCUSSION

2.1 Dissolved Oxygen Trends in Aeration zones

The retro-fitted bioreactor consists of 8 zones (3 anoxic and 5 aeration), all with varying hydraulic capacity. The first of the anoxic zones caters for the MLVSS from A'Recycle pumps, as well as RAS flows from the clarifiers and all incoming influent. Air was originally going to be distributed to the aeration zones by mushroom fine air diffusers used in the previous IDAL system, but this could not be achieved due to the extra structural restraints needed in the bioreactor. Subsequently, the ABS 1090C OKI Submersible Aerators were introduced, ten in total with two per aeration zone. These OKIs were connected to the existing air distribution pipework and supplied by three turbine blowers. The type of valves that govern the air to the OKIs are butterfly valves. These valves, in association with the VSDs (which control the speed for the OKIs), were to be reviewed. Control system logic trends confirmed that there needed to be a more effective way to control the type of aeration to the different aeration zones.

The main areas that needed to be looked at were: the aeration zones in regards to oxygen transfer and water turbulence; and the equipment governing the air distribution in relation to load demands. There were two issues to overcome:

Issue 1: System logic control of butterfly valves

The DO trends for the aeration zones on the system logic fluctuated greatly. These trends demonstrated the opening/closing positions of the butterfly valves in relation to different oxygen demands in the aeration zones. Originally valve movement was in increments (wait time) of approximately eight minutes, but this was causing considerable lagging of valves position, as opposed to where they should have been due to load demand. This was demonstrated in the trends as valve positioning did not align with oxygen demand. Also confirmed was that the air bubbles were shown to be ineffective at transferring oxygen to MLVSS.

Resolved By - Replacing aeration logic control with PID Loop Control system. This was devised by a contract control systems engineer and the senior operator, to attain a more representative trend between the valve control and oxygen load demand. The operator would relay the field position of butterfly valves to the engineer who configured relevant PID loop for each of the aeration zones.

Outcome - DO trends towards load demands and butterfly valve's operation were more trend compatible. Although not perfect with lagging still occurring, it is a vast improvement towards aeration control and the simulated valve movement to oxygen load demands and desired set points.

Issue 2: From VSDs to Direct on Line (DOL) power supply for OKIs

DO was also effected by the type of diffused air bubble and water turbulence being created from the OKIs. Originally the OKIs speed was governed by the VSDs in relation to load demands. Five out of ten VSDs from the aeration zone failed due to excess heat, with three of these failures being caused by a single power outage. Another contributing factor to the VSDs excess heat was that the VSDs were only covered by a roof and had a northerly exposure to weather elements.

Resolved By - Council personnel made a unanimous decision that all OKI aerators that were originally on VSDs, but had failed due to excessive heat, were to be put onto DOL. The remaining VSDs and the OKIs on DOL, would all now run at 100%. Air pressure/flow would be controlled through the air turbine blowers, which in turn would govern the valve positioning of individual aeration zone air demands.

This decision also took into account the observations of the diffused air bubbles when the OKIs were running slow in low demand. The air bubbles were too large and not effective with the transfer of oxygen. This observation was confirmed through system logic trends. Effectively this decision took one control point out of the process to concentrate on the remaining three areas which were the turbine blowers, butterfly valves and the type of diffused air bubbles being produced along with any noticeable turbulence under different load demands.

In relation to excess heat due to weather conditions, the VSDs were enclosed in air conditioned weather proof building.

Outcome - OKIs operating at 100% on DOL have been working effectively to date. It also must be noted that as long as the turbine blower's set points are no higher than 46kPa, then the diffused air bubbles are comparatively smaller with good oxygen uptake and less power consumption. Investigations are still ongoing with adjusting the turbine's set point to achieve optimum value.

The new building over the VSDs have prevented any further unnecessary over-heating and failure, with the control panels and digital readouts on equipment no longer exposed to north facing weather elements.

2.2 Special Note: Set Point In Zone # 5 Of The Aeration Reactor

A glimpse of the typical DO trend in the aeration zones performance under load during the hours from 7am until 3pm is shown in Figure 1 below shows. Notice that the DO drops in zone # 5. This could be because of the aerators not keeping up with the hydraulic capacity, but this is yet to be confirmed. DO is only achieving set point of 1.5 in zone # 5 during off peak flow periods.

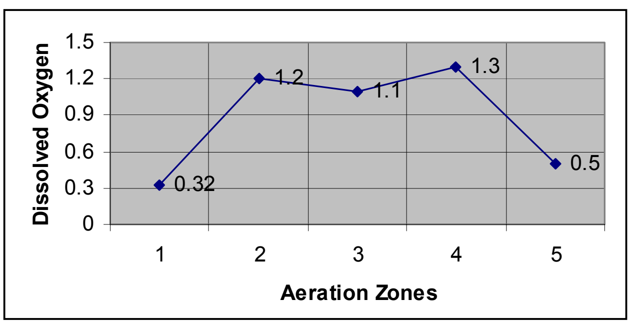

Figure 1: ***Aeration zones dissolved oxygen levels***

Table 1: ***Hydraulic capacity of the different aeration tanks***

Zone 1	978 kL
Zone 2	812 kL
Zone 3	1053 kL
Zone 4	1269 kL
Zone 5	1666 kL

2.3 Clogging Up Of RAS N-pumps

Eight RAS N-pumps were put in place, with two per clarifier to service the four 2.76 ML clarifiers in extracting the sludge back to the bioreactor into anoxic zone # 1.

These N-pumps provided from Flygt were originally to be installed in a horizontal, dry pit position. This would give optimal advantage to the pumps with at least 1 meter of head from the clarifiers. What was put into place and not documented was the vertical, dry-pit installation leaving the pumps with minimal head, less than 500mm from the clarifiers. There were three issues to overcome:

Issue 1: Parallel running of pumps per clarifier creating consistent faulting
Resolved By - Running only one pump to achieve daily duty (30Hz) instead of two pumps running in parallel (27Hz). This also allowed the pumps greater velocity and decreased the chance of pump chokes in achieving normal daily flow requirements.

Outcome - The running of one pump to meet the plant's parameters has been successful. Special Note: The running of parallel pumps now only occurs when the clarifiers need emptying. This can only take place if the clarifiers are full and the pumps run non-stop during the emptying process.

Issue 2: Hydraulic noise indicating cavitation is evident
Resolved By - Replacing the 239mm diameter impeller with the smaller 217mm diameter impeller. Tests by Flygt confirmed the likelihood of cavitation to be minimal during single pumps operating with the 217mm impeller at around 50Hz. This change offered optimum pump performance.

Outcome - Cavitation is now minimal, thanks to constant testing by Flygt. Considering that the N-pumps have to work with only 500mm of head from the clarifiers and their work also has to be within the plant's parameters, the increased speed of the 217mm impeller has overcome excessive cavitation along with increasing the pumps component's life.

Issue 3: Clogging of pumps via ragging
These blockages occurred because of the low suction velocity, which allows hair, fibres etc to mat underneath the impeller.

Resolved By - Trialling the "relief groove" plate with the addition of the adjustable guide pin "shark tooth", which acts as a straightening vane for flow/rag through the pump housing of the N-pumps. The guide pins also break up this rag matting and forces it to the centre of the impeller and is then pumped away.

Outcome - Clogging through entrained solids, such as rags being caught in the impeller, is minimal to the operator's relief. These pumps have performed well to date.

2.4 Alternative Solutions To Excessive Detention Time In Contact Tanks

Long detention time facilitated various bacteria growth, not only on the final effluent surface but also on the bottom of the contact tanks, along with algae growth on the walls. Lessening detention time was crucial along with scheduled cleaning to maintain compliance of the plant's EPA License.

The two new contact tanks were originally the old secondary sedimentation tanks. These tanks hold 610 kL and 1895 kL each respectively, and they were modified to suit the augmentation's requirements.

The Kawana STP has two discharge points, one being an ocean outfall and the other being the Mooloolah River. The effluent from the four clarifiers gets dosed with chlorine by flow pacing and travels through one meter pipework for approximately 250 meters to the first contact tank. At about 20 ML/day dry weather conditions, the flow of chlorinated effluent has around 3 hours contact time. How could this happen?

It was decided that it was not hydraulically possible to convert two 610 kL secondary sedimentation tanks from the old activated sludge system, but was possible through one 610 kL and another one at 1895 kL.

Table 1 is a snap shot of the effluent quality of Kawana STP before, during and after commissioning. It was not part of the upgrade to change the plant's effluent discharge EPA requirements. However the plant's effluent quality did change because of prolonged detention time caused be the upgrade. Throughout the whole upgrade and thereafter, the plant has maintained maximum daily flow with the operators ensuring compliance of the EPA License.

<u>Table 2:</u> ***Release quality characteristic limits***

S1 = Old activated sludge system and S2 = IDAL System Post UV treatment

Effluent Quality License Release Requirement (DWF)		**Before upgrade April 2004**		**During upgrade April 2005**		**After Upgrade April 2006**
		S1	**S2**	**S1**	**S2**	
BOD (mg/L)	<10mg/L – (50%)	6	2	16	1	4
Susp. Solids	<15 mg/L – (80%)	2	1	6	2	2.4
Ammonia Nitrogen	<10mg/L – (50%)	3.50	0.74	6.35	1.28	0.47
E coli	<150/100mls (Median of 5 samples)	1	41	15	0	13

Taking into consideration the plant's effluent quality and EPA License, the following issues were needed to be looked at. Issues to overcome:

Issue 1: Lessening of detention time

Resolved By - Inserting an extra 300mm diameter knife gate valve at 1.5 meter below and adjacent to the final contact tank weir.

Outcome - This knife gate valve now allows detention time to be approximately 1.8 hours instead of the original 3 hours, with the flow then going over the final contact tank weir.

Issue 2: Build up of algae and Pseudomonas type bacteria

Resolved By - a) Erecting a 30m^2 shade cloth structure that covered the 1895 kL contact tank. This cost approximately $45000. b) Building a diversion pipework back to the inlet of the plant for the Schedule Cleaning Program.

Outcome - a) Again a positive outcome with a very noticeable difference during the summer months. More OH&S procedures implemented due to the confined space whilst cleaning the contact tanks. Cleaning is scheduled for every six months. b) Diverted pipework allows cleaning of contact tanks to take place within regular working hours with the assistance of a Sykes pump.

3.0 CONCLUSION

The above upgrade issues faced by the plant have successfully been overcome. The plant is currently waiting for more 217mm diameter impellers and volutes from Flygt, which will then enable the completion of converting the remaining RAS N-pumps.

Since augmentation took place, Kawana STP has achieved all of its design capabilities. Three year down the track and operators are comfortable with the plant's operation to date, although they are continuing to look for ways to improve the plant. As a thought for the next upgrade, a couple of pointers that may be considered are:

- More consulting with relevant experienced operation people,
- Increased scrutinizing of upgrade details and process parameters, and
- Consideration of ongoing OH&S maintenance issues.

This paper has been written from an operator's point of view. Operators gain a wealth of information and take pride in the knowledge attained during upgrades. This is not to also say that upgrades take up a lot of precious time, patience, and a certain amount (if not a lot) of perseverance. The relationships forged during the upgrade with contractors and internal personnel have developed a firm foundation for future works. As another upgrade looms over the horizon it will be good for operators to catch up with old mates!!

Special Note: It was quoted in 2007 by the Department of Local Government, Planning, Sport and Recreation that "There are 150 Sewage Treatment Plants in Queensland that require upgrading or replacing in the next five years, to meet Environmental Protection Agency Standards". The article goes on to say that the capital work program will cost an estimated 1.2 billion dollars. This averages out to 8 million dollars per sewage treatment plant, however the Kawana STP upgrade cost approximately double this amount.

This identifies the opportunity for regional collaboration and procurement which has the potential not only to save money (and operator's sanity), but to rectify ongoing costs and build a more sustainable platform for upgrades.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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