20:30 FROM A LAGOON STP

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ABSTRACT

Typical limits to indicate an acceptable level of sewage treatment for release to a non-sensitive environment or for municipal irrigation reuse are 20mg/L biochemical oxygen demand (BOD) and 30mg/L suspended solids (SS). This paper describes the overhaul carried out to the Biggenden sewage treatment plant in North Burnett to achieve this standard.

The plant comprised bar screen, grit channels, Imhoff tank, trickling filter, three facultative lagoons in series and chlorine disinfection. Prior to the overhaul the average effluent BOD was 30mg/L and SS was highly variable but averaging 100mg/L courtesy of algae.

The overhaul included repairs to the Imhoff tank settling chamber and desludging of the ponds. Upgrade items included a mechanical screen, new sludge drying beds, improved hydraulics and partitioning in the first two ponds and conversion of the third pond to a rock filter.

The upgraded plant was commissioned in June 2013. In the six months to March 2014 the average BOD has been 4mg/L and SS 2mg/L. Perhaps just as significantly, the thermotolerant coliform level has been below 1,000 cfu/100mL (Class C) without chlorination – suitable for irrigation of the adjacent golf course.

1.0 INTRODUCTION

Biggenden is a town of 660 residents in the eastern corner of North Burnett Region, situated about 80 km west of Maryborough. The town is sewered and sewage is treated in a plant adjacent to the golf course on the east of town. Effluent is reused for irrigation of tees and greens on the golf course, with wet weather discharges to Delgilbo Creek.

The treatment plant was constructed in the 1970s and comprised bar screen, grit channels, Imhoff tank, trickling filter, and three facultative/maturation ponds, with sludge drying beds for the solids.

The licence specification for discharge to either water or land are:

Table 1: ***Effluent Licence standards***

Parameter	Minimum	80%ile	Maximum	Sampling Frequency
BOD		20	40	mthly
SS		30	60	mthly
pH	6.5		8.5	daily
DO	2			daily
Faecal		1000		mthly
TDS			1000	mthly

As might be expected with a ponds plant these standards were rarely met, in particular the suspended solids and pH criteria which are elevated by the presence of algae. In the 4 years to the end of 2012 average BOD was 30mg/L and average SS was 99mg/L. 20% of the BOD results and 60% of SS results exceeded the licence maximum. Sample pH was almost invariably above the 8.5 licence limit. Half the samples exceeded the 1,000 limit for thermotolerant coliforms.

2.0 PLANT ASSESSMENT

Council commissioned John Ashworth through Wide Bay Water Corporation (WBWC) to undertake an assessment of the plant and determine the best option to meet licence conditions.

The plant needed overdue maintenance – repairs to the Imhoff tank, desludging of the ponds, structural repairs. In addition, the plant needed workplace health and safety upgrades to meet current standards, in particular balustrading around virtually all the access ways.

2.1 Options

The three primary options were:

1. do nothing
2. construct a new activated sludge treatment plant
3. overhaul the existing plant

The first was not really an option. Essential maintenance and safety upgrades had to be addressed and Council was keen to meet licenced effluent quality.

Option 2 would cost of the order of $1.3million and could be guaranteed to fix the effluent quality issue.

Option 3 was estimated to cost $540,000, substantially less than the cost of a new plant. The main issue with this option was achieving consistent effluent quality. Ponds rely on algae as an oxygen generator but algae will always show as high suspended solids. John identified 6 relatively low-cost options that had been used for removing algae from the final effluent.

Table 2: ***Options for reducing algae concentration in effluent***

	BOD:SS:TN; *E.coli* mg/L; /100ml	Comment
AquaMats[2]	10:20:15; 1,000	Curtains placed in a pond acting as fixed film process with bottom aeration preventing algae growth. Crystal clear effluent
Aerated Rock Filter[3]	5:10:15; 1,000	Fixed film plastic balls and rock media with bottom aeration. Plastic media over aeration is for ease of removal. Need high alkalinity to achieve de-nitrification (nitrates to nitrous oxides)
Intermittent Sand Filter[4]	5: 5:20; 1,000	A filtration bed, but needs large area for resting to prevent clogging. Good for BOD & SS removal
Duckweed[5]	15:30:10; 5,000	Dense duck weed in a small pond cuts light and algae decreased. If algae harvested then significant nutrient removal
Farm Fodder Crop[6]		BOD, SS and nutrients kept to improve crop yield
Subsurface wetland[7]	5: 5:20; 1,000	Compact but will need relaying every ten years. Little nitrogen removal. Effluent of low turbidity ready for UV disinfection

Notes: 2. Te Kauwhata, NZ (Meridian Aquatic Technologies; 3. Power & Water, Darwin Pilot; 4. France, USA & Thames Coromandel NZ; 5. Batchelor STP, NT; 6. Lucerne often grown; 7. Ngunguru STP, NZ

Council decided on primary Option 3, upgrading the existing plant, and a sub-surface flow wetland to reduce the algae in the final effluent. One of the drivers for this decision was that Council has several other ponds plants in other towns. If a low cost option could be proven to work in this environment the potential saving was four-fold.

3.0 OVERHAUL SCOPE

The 6 components of the overhaul with actual costs are summarised below.

Repairs to Imhoff tank, $84,000 – replacement of the Imhoff settling chamber, replacement of the concrete trickling filter syphon chamber

Workplace health and safety improvements, $53,000 - installation of screw press inlet screen (obtained second-hand at minimal cost), balustrading

New sludge drying beds, $69,000 – new beds with increased area and concrete ramps for machine access (to replace manual sludge removal)

Pond desludging, $64,000 – some pumping was necessary because of time constraints

Pond hydraulics upgrade, $41,000 – included installation of baffles, relocation of inlets and lowering to mid-depth, new oulet drawing from mid-depth – all generally in accordance with the NT Power and Water Design Manual.

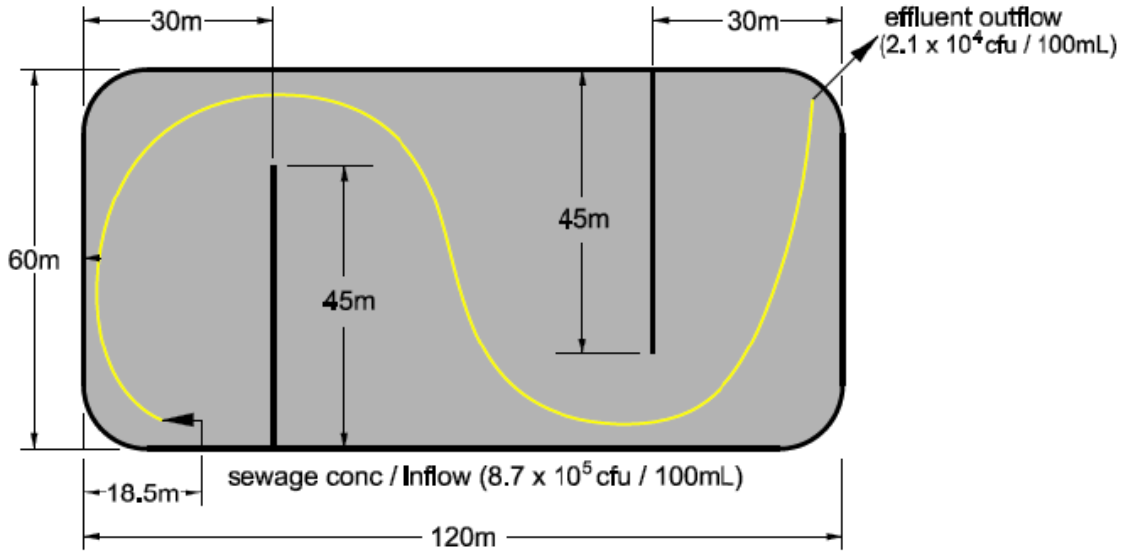

Figure 1: ***Typical Baffle Arrangement to Minimise Short-Circuiting***

Rock filter, $106,000 – nominally an unplanted sub-surface flow wetland with a rock filter up front to minimise accumulation of solids in the wetland – perhaps best described as a dual media rock filter. The overall flow rate is 0.25m^3 effluent per m^3 rock per day and the aspect ratio is 1.

Total cost of the works was $417,000 – and the break-up of the costs was quite different from the budget as a consequence of issues that emerged as the work progressed..

4.0 UPGRADED PLANT PERFORMANCE

The plant overhaul was completed in mid-2013. Perhaps the most notable improvement was the reduction in SS, as indicated in the following graph.

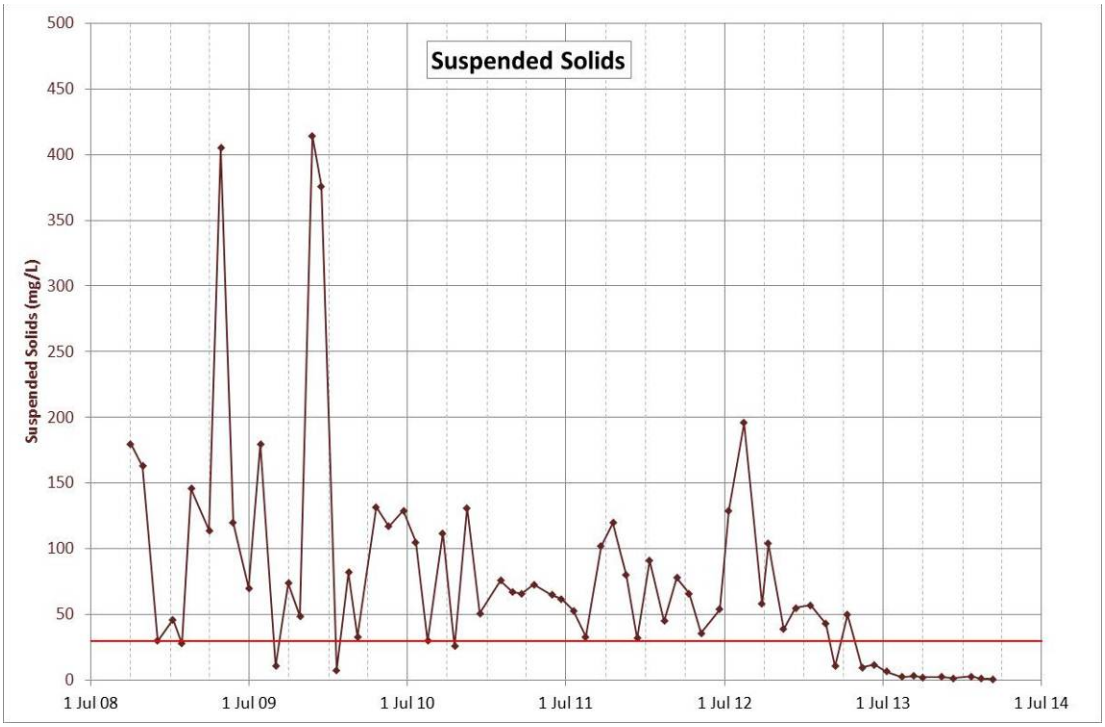

Figure 2: ***Effluent Suspended Solids showing improvement since July 2013***

In the 8 months to March 2014 the average SS has been 2mg/L.

BOD has also shown a substantial improvement.

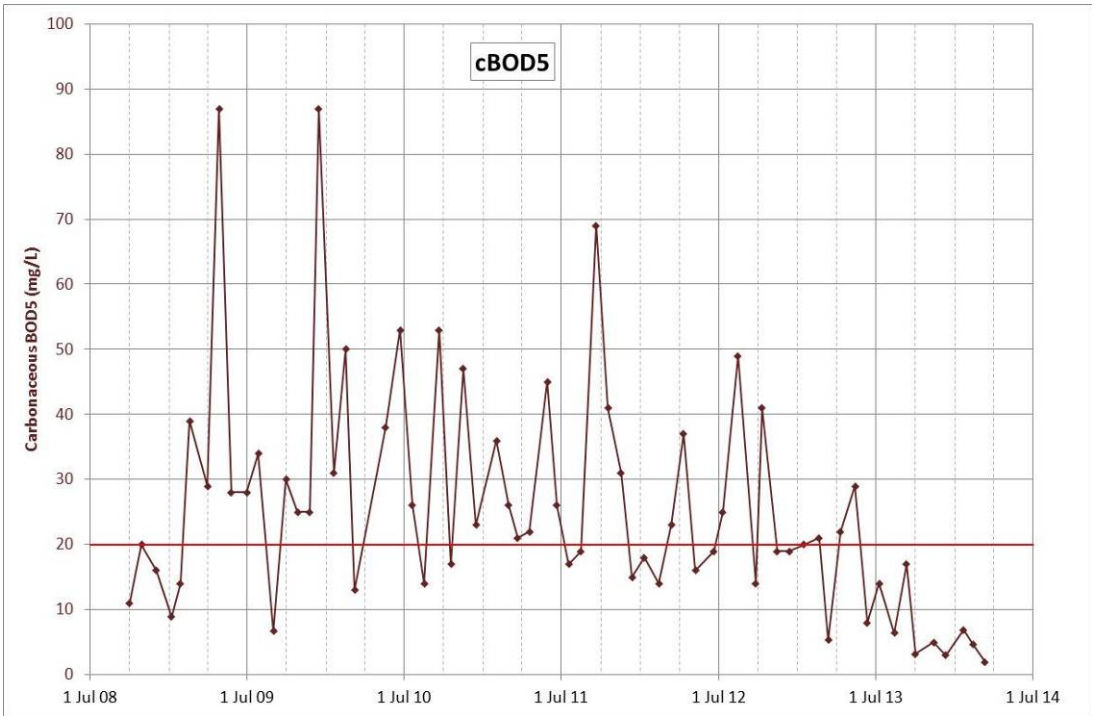

Figure 3: ***Effluent Carbonaceous BOD***

Since the upgrade BOD has remained below the 20mg/L 80%ile mark. In the 6 months to March 2014 the average was 4mg/L.

Thermotolerant coliforms have also shown an improvement since the upgrade.

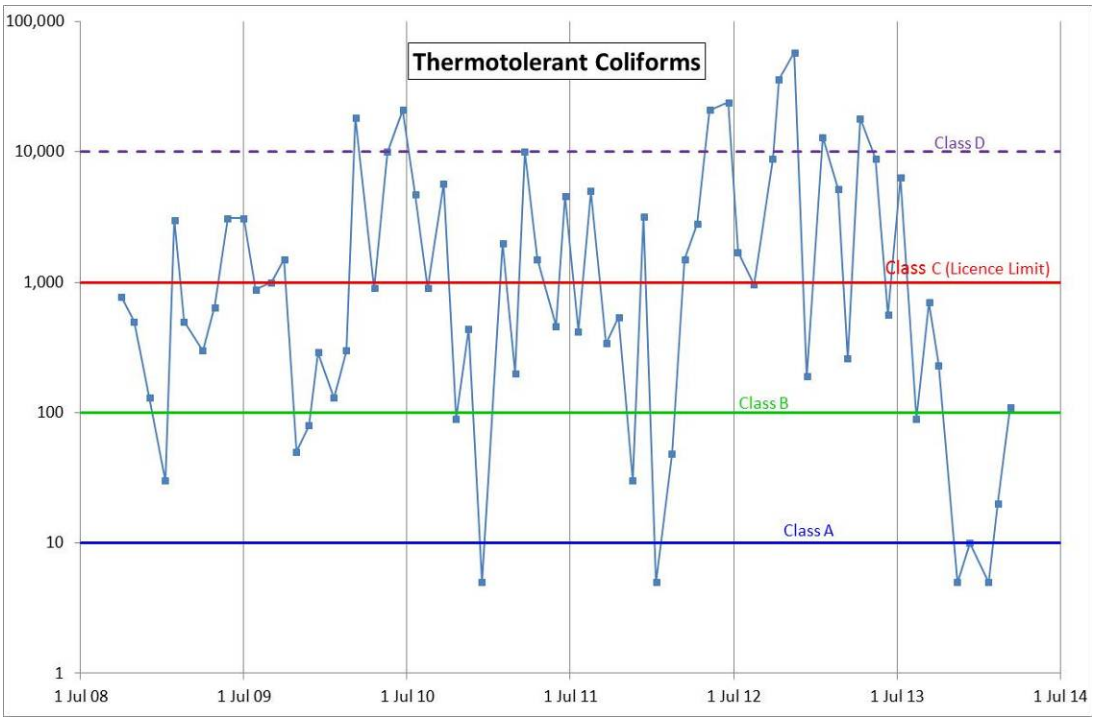

Figure 4: ***Effluent Thermotolerant Coliforms (log scale)***

Since the plant settled down after the upgrade, the thermotolerant coliforms have been less than 1,000 cfu/100mL without chlorine or UV disinfection. Internal sampling indicates that the coliform reduction is obtained by the end of pond 2 with no improvement (or minor deterioration) in the rock filter.

4.0 ROCK FILTER LIMITATIONS

The rock filter is an anaerobic process. Dissolved oxygen (DO) in the effluent is low, typically less than 1. If this is significant in the receiving environment then re-aeration would be necessary. The rock filter tends to increase the ammonia nitrogen. However if the preceding ponds are able to nitrify then the rock filter will thoroughly denitrify and so total nitrogen may be low.

With the removal of algae the rock filter reduces the pH from around 10 at the inlet to the mid-8s. There have been a few results of 8.6 - 8.7 so it would be difficult to achieve a firm 8.5 limit.

3.0 CONCLUSION

The overhaul of the Biggenden STP has achieved the aim of producing effluent that meets the key licence criteria, at the same time completing long term maintenance and improving operator safety and operability – all at a cost well under the cost of a new treatment plant.

4.0 ACKNOWLEDGEMENTS

As with any such project many people contributed, in particular:
John Ashworth who provided the knowledge and experience
Operators Laurie Hebblewhite and Brad Thode who make it work
Council's engineers and project managers Trevor Harvey, Graham Cole and Phil Green.

5.0 REFERENCES

Power and Water Corporation *Waste Stabilisation Design Manual* (2011)