UPGRADES TO THE PULGUL WASTEWATER TREATMENT PLANT - WERE THEY WORTH IT ?

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ABSTRACT

The Pulgul wastewater treatment plant is located in Hervey Bay. The plant was commissioned in 1985 with a design capacity of 8000 persons and consisted of an oxidation ditch with two clarifiers and chlorine disinfection. The capacity was doubled in 1991 when a fill and decant intermittent aeration lagoon (I.D.E.A.L.) was constructed. In addition, a "Bathurst Box" batch activated sludge treatment tank was installed to accept septic and grease trap waste. Waste activated sludge was pumped to a sludge lagoon. Since that time, a number of plant upgrades have taken place which are discussed from an operator's perspective.

1.0 INTRODUCTION

The Pulgul wastewater treatment plant is one of six wastewater treatment plants operated by Wide Bay Water in Hervey Bay. Originally, the plant was designed with a capacity of 8000 persons. Treatment consisted of a coarse mechanically raked bar screen, an oxidation ditch, clarifiers and chlorine disinfection. Waste activated sludge together with partially treated septic and grease trap waste were pumped to a sludge lagoon which was emptied every two years or so by contractor using a mobile centrifuge. Plant capacity was increased by a further 8000 equivalent persons in 1991 when an Intermittent Decant Extended Aeration Lagoon (I.D.E.A.L.) plant was commissioned.

In the past five years, a number of plant upgrades have taken place to resolve various operational challenges and to improve plant efficiency. These upgrades are described in the paper together with comments regarding post-commissioning performance and whether the upgrades have met the operator's expectations.

The following plant upgrades are described and discussed: -

- Aerobic sludge digestion
- Mechanical sludge thickening and dewatering
- New inlet works – step screens, vortex grit removal, odour scrubbing
- Modified septic tank and grease trap waste receival system
- Capacity upgrade to the oxidation ditch (blowers, scum removal and RAS)
- New chlorine contact tanks

In each case, the reason for the upgrade is described and the outcomes assessed in terms of the operator's expectations, what works, what doesn't and the projects are then rated from the operator's point of view ie. the person who has to work with the new plant upgrades.

2.0 DETAILS

The aerobic waste sludge digester and de-watering upgrades were completed in 2002 at a cost of $950,000. The purpose of this project was to resolve the sludge handling capacity and environmental issues since disposal to lagoons was no-longer sustainable.

The new inlet works (including a new sewage lift pump station) were completed in 2004 at a cost of $1.2 million. There were two reasons for this upgrade – firstly, to cope with population growth, a new sewer was constructed which required an on-site pump station. Secondly, there were issues of odour and maintenance problems caused by rag blockages.

The septic tank and grease trap waste handling system and plant capacity upgrades were completed in 2005. The old facilities were environmentally unacceptable.

The latest plant capacity upgrades were required to treat additional flow increases of 50% since year 2000. The project was completed this year at a cost of $3.4 million.

The current plant now has the capacity to treat wastewater from an equivalent population of 25,000. But would the decisions for the various upgrades have been the same if there had been a higher level of operator involvement?

3.0 DISCUSSION

3.1 Aerobic Sludge Digester

The aerobic digester receives activated sludge which has been thickened via a gravity drainage deck. By pre-thickening the sludge, the consultants advised that the digester tank volume could be reduced. The digester has a volume of 720 kL with three separate cells which are aerated by fine bubble diffusers fed by positive displacement blowers. The aeration to the cells is alternated to create anoxic conditions so that de-nitrification can restore alkalinity and the pH to around 7.0.

3.2 Why upgraded?

The key function is to stabilize sludge and reduce the mass of solids and reduce odours.

3.3 Challenges.

- Extra work associated with plant, inconsistent wasting due to time/operational problems
- The blowers were not big enough to run 24 hours a day, 7 days a week.
- To achieve a dissolved oxygen concentration of 1 mg/L, it is necessary to operate at 1.0% to 1.5% solids instead of the designed for 2.0 to 2.5% solids. At higher solids concentrations there is no dissolved oxygen.
- The lower sludge concentration means that the detention time is reduced to only 10 days which together with the low dissolved oxygen has resulted in a sludge which is not fully stabilized. Odours occur when the stockpiled dewatered sludge is removed off site.

4.0 SOLUTIONS.

4.1 Waste sludge from the I.D.E.A.L. plant

Needs a balance tank to provide a uniform feed to the thickening and stabilization processes. Blower and digester capacity need to be increased.

Rating: Could do better

4.2 Mechanical Sludge Thickening and Dewatering

Waste activated sludge is thickened using a Tema gravity drainage deck (G.D.D.) prior to the aerobic digester. This G.D.D. thickener system consists of polyelectrolyte conditioning and drainage through a 3 metre open weave fabric belt. The unit works quite well with the waste activated sludge from the Oxidation Ditch, however it experiences problems with inconsistent sludge solids concentration and flows from the I.D.E.A.L. plant due to decant and settle times. The installation of a sludge feed balance tank would have overcome this variability.

Thickened sludge from the aerobic digester is pumped to a Tema belt filter press. Dewatered sludge has a solids content of 12% to 14% and is conveyed to a truck and stockpiled on site in a bunded storage area prior to bi-annual application to farms.

In general, the units have been reliable in terms of mechanical and electrical performance and the sludge handling and disposal system is satisfactory in meeting EPA requirements for 100% beneficial reuse. However, the wash water and filtrate causes issues when returned to the plant inlet. The amount of returned filtrate at high flow periods has created difficulties with the I.D.E.A.L. plant performance due to the aerators being on timer and the hydraulics associated with this type of plant.

Rating: Pass

4.3 New Inlet Works – screens, grit removal and odour scrubbing

The new inlet works consists of a new pump station, two step screens designed to remove particles of 6mm or greater, a single vortex grit separation tank and a conveyor system to remove screenings and grit to a 2.5 metre storage bin.

The inlet works is also now sealed and gasses are extracted and passed through an activated carbon odour scrubber. As with most plants, a lot of maintenance can be reduced with a good screenings and grit removal and this has been the outcome here. The setting up of operating cycle times for the step screens is crucial, remembering that as rags accumulate they will catch more screenings material.

The design could have been improved because one issue (caught just in time) is that if the lift pumps fail, sewage can overflow and flooding can occur because there is no raw sewage by-pass system. A generator has been installed to resolve this situation. The generator has been a great addition to the plant, however, it should be one of the first things in place on any plant or pump station which does not have a gravity sewage overflow.

Why upgraded?

The new pump station and pre-treatment units have been successful in managing increased flows, reducing odour and in eliminating rag blockages. The only issue was that the contractor removing the storage bins complained about water in the bin. This was resolved by drain holes and adding dry sawdust each night as an adsorbent.

Compared to the old mechanical bar screen, the new inlet works are a major benefit.

Rating: Very good

4.4 Modified Septic/Grease Trap Waste Handling System

Who wants this type of waste ? – Nobody!!!

Changes to the septic/grease trap handling system had to be made due to increasing odour complaints caused by tankers discharging on to an open concrete apron, to improve the aesthetic appearance and also to reduce the maintenance caused by solids and fats.

The new system consists of a flow metered step screen ("The Silver Dinosaur") which receives waste via a 100mm diameter hose connected to the tanker. Material collected on the screen is collected and binned. The liquid is discharged to a "Bathhurst Box" activated sludge tank and batches of waste sludge are pumped to the old sludge lagoon. Supernatant water from the lagoons is periodically returned to the plant for treatment.

Challenges.
The size of the tank is still not big enough to handle the waste which is delivered spasmodically. Problems occur with the flow meters as follows:-

- Choking;
- Electronic issues – due to the general thickness and inconsistency of the waste.

Rating: Pass

4.5 Capacity Upgrade to Oxidation Ditch (blowers, scum removal & R.A.S. pumps)

When the various options were being discussed to increase treatment plant capacity, a new 10,000 e.p. plant (oxidation ditch) would have cost $6 million plus. However, funds were limited due to other capital projects. It was therefore decided to go ahead with an augmentation to the existing wastewater treatment facilities instead of adding a separate plant module.

This project involved optimising the existing oxidation ditch by removal of the horizontal shaft mechanical aerators and replacing by four fine bubble diffused air aeration zones with DO controlled air blowers and installation of two propeller mixers for recirculation. In addition, a foam harvester was provided, larger capacity return activated sludge pumps and the old RAS pumps used to pump scum from the clarifier skimmers directly to the sludge lagoon.

The design concept assumed that by being able to accurately monitor and control the dissolved oxygen, aerobic and anoxic zones could be precisely established. In conjunction with the positive foam and floating scum removal system it was expected that improved sludge settleability could be maintained and that there would be no sludge bulking. This would then enable the mixed liquor solids to be increased to about 4500 mg/L and by operating at a sludge age of approximately 12 days rather than 20 days, more sewage could be treated. The plant is not yet up to full capacity and flows to the oxidation ditch are being temporarily increased to see how much additional sewage can be treated. Therefore, at this stage no rating has been given.

Another alternative was considered. This involved converting the IDEAL plant into a conventional aeration tank and providing new clarifiers. This option was discounted because if the IDEAL plant was off-line, the oxidation ditch could not cope with double the flow. As it happened, the IDEAL plant did manage to struggle through having to treat extra sewage.

Fortunately, the construction program had specified that the time to undertake these specific modifications to the oxidation ditch had to be minimized to three weeks. EPA approval was given in case the effluent did not meet the licence standards, which it did not meet with respect to suspended solids and E-coli on only one occasion. In addition, during this work, all the treated effluent was pumped to a 650 ML storage dam for "polishing" and was not discharged. The storage dam forms part of the effluent irrigation scheme.

Possible Challenges.

- The clarifiers have a shallow side wall and their hydraulic capacity at peak flow may not be big enough.
- Increased loading means more waste activated sludge and extra work for the aerobic digester and G.D.D. The lower sludge age will have a snowball effect on the already undersized digester.

Two benefits appear to have occurred. Firstly, the floating Nocardia type foam or scum has disappeared. Secondly, it appears that mixing in the aeration tanks has been improved. It is still possible to operate using the old mechanical aerators which have not yet been removed or to use the new system. If the mixed liquor is sampled on the same day and operation of the two different aeration systems compared, it has been found that the MLSS is about 200 to 300 mg/L higher with the new diffused air and propeller mixers. It should be noted that when the ditch was emptied to allow installation of the new diffused air system, approximately 250 m^3 of silt and non-pumpable sludge had to be removed.

4.6 New Chlorine Contact Tank.

A new chlorine contact tank has been constructed, this will be solely used for chlorination of effluent from the I.D.E.A.L. plant. The old chlorine contact tank did not have the required retention time for flows from both activated sludge plants particularly as the I.D.E.A.L. plant has a high instantaneous flow rate because it decants intermittently and not at a continuous flow rate.

Why upgraded?

A new chlorine tank was required to ensure 30 minutes contact for the increased flow volumes and also to handle the "batch" nature of the decant from the I.D.E.A.L. plant.

At this stage, no problems are envisaged here - obviously the K.I.S.S theory was applied.

4.7 Learning Experiences (How to help the fellow Operator through upgrades).

Points to Follow –

- Always add 20% to 30% on time limits (finish date).
- Help contractors but do not hinder yourself or the contract.
- Prioritise your own work for better planning.
- You will be stuck in between contractors and engineers. Ask for people you can work co-operatively with if possible.
- Try to establish ground rules for a good working relationship between contractors and your staff from the start.
- Look for options to help later maintenance/operations,
- Existing plant performance and effluent quality are **No.**1 priority. The project

plan needs to permit contractors to work around this priority.
- Plan any major disruptions of the plant operation to be timed for low flow periods.
- Contractors will always look for an easier way out!
- Minimise loaning of equipment.
- Stipulate contractor's work hours.
- Do not guarantee locations of pipes and services (won't make any difference).
- Insist that damaged pipes and services are repaired immediately (a second No.1 priority).

Design reports are always questionable. What and where some of the information and assumptions comes from, who knows? Pre-conceived mind sets on what really happens at the plant and unreliable information used by an out of town office bound consulting engineer are a formula for unsatisfactory designs with respect to user friendly operation and maintenance. As a minimum, the on-site operator is available and should be contacted to check doubtful information and assumptions and invited to comment on design concepts and plans.

5.0 CONCLUSIONS

- The operator has had two other plants which also had upgrades – a rather difficult and stressful situation.
- From 2001 the operator only had a 12 month rest from disruptions due to plant upgrades.
- Priorities of the operator may well differ from the engineer's ideas.
- The feeling of ownership of the plant can be reduced while construction is taking place - the operator can experience a loss of control.
- The reduction in effluent quality during the upgrades and plant disruptions was not significant. Effluent quality before, during and after the upgrade is outlined below:

Table 1: ***Effluent Quality***

	BOD (mg/L)	Susp. Solids	Total Nitrogen	E-coli / 00ml
Before	3	3	5.5	<10
During	4	8	12.5	65
After	2	3	9.5	<10

Each upgrade has been rated but at this stage it is not yet possible to score the last project. Overall the upgrades have been a necessary evil because of the very high rate of population growth in Hervey Bay and the resulting increase in sewage flows. However, the potential environmental impact could have been very unsatisfactory if it had not been for the availability of the large irrigation storage dam for effluent reuse on farms.

Possible BNR upgrades may be required in future but the EPA supports the same preferred option of Wide Bay Water which is to target 90% effluent reuse. Nevertheless, this operator would like a couple of years with no upgrades to be able to operate a stable plant and complete all investigations to optimize effluent quality and efficient sludge processing.

No doubt there are a large number of operators throughout Queensland in the same position.