OPTIMISATION OF SECONDARY TREATMENT AT BOWRAL STP

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ABSTRACT

An augmentation of the Bowral sewerage treatment plant was carried out in 2006. This was a substantial upgrade that provided council with a facility that was capable of consistently delivering a very high quality effluent to the receiving waters, being the Wingecarribee River.

Augmentations and plant upgrades can be very challenging times for operational teams as training and new procedures must be embraced to ensure that best possible outcomes are achieved during commissioning, and in early stages of operation. The team at Bowral identified some problems in the secondary treatment area at the plant and have since carried out some further upgrades in this area to address these issues. Optimisation of the plant was carried out to minimise the impact of these problems in the secondary treatment area. Another significant capital works project has been identified for next year to further improve this area of the plant.

1.0 INTRODUCTION

Wingecarribee Shire covers the area known as the Southern Highlands, between Sydney and Canberra. We have six sewerage plants located at Bundanoon, Berrima, Moss Vale, Bowral, Robertson and Mittagong and seventy seven pump stations delivering sewage to these plants. A $16 million augmentation was undertaken on the Bowral scheme in 2006. The Bundanoon scheme was upgraded in 2009 increasing the capacity of the plant from 2000 EP to 5400 EP which should service this community well into the future. A new scheme in the township of Robertson is being commissioned early this year. This will be a new challenge for the operations team as it is our first membrane reactor plant fed by a pressurized reticulation system. Further upgrades to the Bowral, Mittagong and Moss Vale systems will be necessary in the near future.

The augmentation of the Bowral STP in 2006 included the installation of a new inlet works which included a lift pump station to deliver the sewage to the inlet works. We were provided with a new intermittently decanted extended aeration tank (10,600 EP) with chemical removal of phosphorus (P), both primary and secondary dosing. A secondary catch pond with associated pipe work utilising the old tertiary dam as a storm bypass was provided, which diverts excessive flows from the UV system which is the bottle neck of the plant. A gravity fed filter feed pump station and cloth media filters feeding the UV system for disinfection of effluent were also constructed along with a pipeline from the effluent pit to the Wingecarribee River to avoid discharge into the Mittagong Rivulet. Four new drying beds and two new sludge lagoons along with a supernatant pump station and associated pipe work were installed with the project to increase sludge management capabilities at the plant. The project also entailed the provision of new chemical dosing equipment, a new amenities building and upgrades of the electrical, telemetry and SCADA equipment at the plant. New roads, fences and landscaping and an 18 ML storm diversion pond at the head of the works to cater for wet weather flows, were also part of the upgrade.

This paper will concentrate on the steps we have taken to optimise the secondary treatment area including creation and implementation of work procedures and maintenance schedules and other associated areas which impact this part of the plant.

It will also outline some improvements we have carried out to existing infrastructure and further improvements we intend to do in the future.

2.0 DISCUSSION

2.1 Original Improvements of Secondary Catch Pond

In the original design it was proposed that a creepy crawly sludge removal system be used to remove sludge from the catch pond. A trial of this system deemed it unsuitable for the application so we had to look at other alternatives to cleaning the catch pond. We programmed a project to install a sump and pump arrangement, including lifting equipment, access walkway and associated pipe work. We also included an extension of the re-use system which allowed us to use recycled effluent for cleaning and washing down the catch pond. This worked well but the size of the catch pond still caused us problems. With the catch pond being so big and opening up on the inlet end, and the fact that it was basically designed with a flat bottom, meant it was very time consuming to empty the catch pond and get the sludge to the sump.

Figure 1: ***The blade attachment on the lawn mower***

2.2 Operational Procedure for Cleaning the Catch Pond

The operators at the plant realised an operational procedure was necessary for this activity as it was going to be very disruptive to plant operations. The procedure involved the setting up of all necessary equipment during normal working hours on the previous day. The size of the catch pond means we cannot use the sump pump in the pond for emptying as the plant would be required to be off line for a week which is not operationally possible. To minimise the time to empty the pond we hire a diesel pump to ensure we can empty the pond in 8-10 hours. At 10.00 pm two staff go to the plant and carry out the plant shutdown which effectively isolates the catch pond ready for emptying. After shutdown and the isolation occurs, one person leaves the site. The other person stays on site all night to monitor the pumping.

This is necessary because we can’t pump everything into the sludge lagoons as this would cause an overflow. While pumping clear effluent we deliver it to the filter feed pump station. When we start to pull sludge we change the delivery line to the sludge lagoon.

The fact that our diesel pump can pump more than our supernatant system can handle means the level in the sludge lagoon must be closely monitored to prevent an overflow. By morning we are left with a layer of sludge in the bottom of the catch pond. We still have the problem that our pumps suction lines can only be utilised in the sump so we have to get the sludge to the sump. This required many hours of squeegeeing by up to five people. The innovative operators at the plant then designed and manufactured a blade with a rubber squeegee to attach to the front of the ride on mower at the plant (shown in Figure 1). This worked very well and lead to a significant reduction in the time and the manual handling involved in carrying out the task.

Although we achieve our goal using this method there are many negatives involved in the above procedure. They include having staff on site all night which would have some impact on their lives for several days and is costly to Council. We also have to hire in equipment and extra internal staff to help out with the activity. The impact on the plant is significant as we have to use the storm balance tank to store raw sewage in, while the plant is shut down. This in turn leads to odour problems and creates another job in itself, having to clean it out after use. The plant also receives no flow during the activity and then higher flows than normal until the storm pond is empty as the sewage in it is returned to the head of the works the following day and night. This can lead to operational difficulties as the plant is receiving a higher load during this period.

2.3 Optimisation of the System

It is for this reason we looked at ways to optimise our operations to reduce the frequency we needed to clean out the catch pond. The first thing we looked at was the chemical dosing at the plant. We thought if we could reduce the alum post dose we could significantly reduce the amount of sludge being captured in the catch pond which would in turn lesson the need to clean it out. Unfortunately reducing the post dose required us to remove more phosphorus with the primary dose which caused us operational problems in the aeration tanks and seemed to have minimal impact on sludge levels in the catch pond.

On investigation we found that the sludge in the catch pond was mainly caused by the carry over with the decanted effluent from the aeration tanks and that the post alum dosing was contributing, but not significantly.

The next step in our optimisation of the system was to find out why sludge was being carried over. First we checked the sludge settleability using the following methods. We carried out suspended solids (cylinder/ stirred cylinder) tests and MLSS tests to determine the zone settling velocity and the sludge volume index. The results of these tests indicated that the sludge had very good settleability. With the plant struggling with biological loading we are running the aeration tanks on cycles with very short settling times to allow for longer aeration periods to achieve nitrification. What we found is even though our sludge was settling as well as can be expected because of the short settle periods, our sludge blanket was still high at the time of decant which led to the drawing up of sludge into the catch pond. We also checked the sludge age and found that this problem was occurring even though we were running with a 19 day sludge age which is under the design recommendation. Therefore reducing the volume of sludge we were holding in the tanks was not a viable option.

We took samples of the sludge and sent them to the laboratory for analysis. The VMLSS come back with readings of 58% and 63% which means around 40% of our biomass was doing nothing.

This did not surprise us as we have an aging reticulation system and no grit removal and we dose alum very heavily to achieve the phosphorus requirements. We calculated that if we could increase the VMLSS to 75% we could reduce the biomass by 20% without affecting the volatile biomass. This would result in a significant lowering of the sludge blanket but would have no effect on the treatment capabilities of the biomass. It should be remembered that if you are doing this you must reduce your wasting proportionally to the reduction in biomass volume, or you will reduce your sludge age and lessen the processes ability to denitrify. With the introduction of a formal and regular maintenance schedule to remove grit from all wet wells within the reticulation system and the inlet pump station, including dead spots in the inlet works, we greatly reduced the grit content of the biomass. Council are lucky enough to have their own Vacuum Truck (Super Sucker) so can do this cost effectively. We also looked at our alum dose with a view of reducing the alum sludge content of the biomass. With closer monitoring of the chemical dosing (not set and forget) we were able to achieve a significant reduction in the alum sludge content. We achieved VMLSS results averaging 73% which resulted in lowering of the sludge blanket and a significant reduction in solids carry over. This only works in dry weather flows and after every wet weather event the catch pond must be cleaned, along with the rest of the system.

2.4 Importance of plant visuals.

The following observation shows the importance of operators to being allowed the time and being motivated to do a visual check very regularly of their plant during all facets of the cycle. Operators can rely on plant trends, alarms and effluent results too much, which the majority of the time will give you a clear picture of plant performance, but not always. On this occasion a visual inspection of the decant cycle during peak flows highlighted a problem that could have only been picked up in this way.

During early stages of operation we were having problems with total nitrogen results at the plant. First the plant had trouble nitrifying; hence we changed the cycles to allow for longer aeration periods and shorter settling times to allow for more air. Then we noticed although our nitrification was sufficient we could not get the plant to denitrify causing high nitrates. Results told us that this was not due to over aeration. We determined that it was due to the sludge settling too quickly and not coming into contact long enough with the nitrate rich effluent to use the oxygen out of the nitrate compound. This left the effluent with high nitrates. With the settling periods being so short it was decided to introduce a flash mix towards the end of the settle period to allow the sludge contact time with the effluent after it had been oxygen starved during the settle period to enhance denitrification.

The trick was to ensure the mix was long enough to pull the sludge up but not long enough to aerate. The only oxygen you want available is the oxygen in the nitrate compound. The sludge then had enough time to settle again while the decant weir was lowering to ensure no carry over. This was very effective and is still used at the plant today. The only problem with it was that during peak flows the amount of time before the decant hit the water was not sufficient to allow for proper settlement after the flash mix and resulted in significant carry over to the catch pond. This was because the level in the tanks is high and the decant weirs are fixed speed. This worked perfectly except for the two diurnal peaks of the day, where it contributed significantly to the solids in the catch pond. The use of the flash mix on these cycles has been stopped and is under review. We have now installed a start and stop time on the SCADA system so that we can fine tune the flash mix times according to flows and levels.

<u>Figure 2</u>: ***Cleaning the catch pond***

3.0 CONCLUSION

On conclusion we determined that the optimisation of the process had been worthwhile and had given us a better understanding of how problems in one area of the plant can have a huge impact on other areas of the process. If operators are struggling with heavily loaded plants, particularly with sludge age the above actions outlined in 2.3 could be worthwhile investigating.

We also determined that our procedure for cleaning the catch pond was inefficient and too disruptive on plant operations and on operational staff themselves. Even with the optimisation we are still required to carry out the cleaning up to 12 times a year and possibly more depending on the weather. This is necessary to provide protection for our down stream systems, including the filters and the UV system and to ensure our effluent is consistently of the high quality required by the EPA licence. It is for this reason that we have identified a project for the capital works program for the next financial year which will include the design and construction of a secondary catch pond bypass and wet weather flow return pump station.

This will include cutting in a T piece and two valves to the existing catch pond inlet pipe and extending the pipe to the existing catch pond overflow pipe. This will allow us to bypass the catch pond for cleaning and maintenance purposes without have to shut down the plant. It can also be used if we need to carry out maintenance on the filter feed pump station. It means that the operators can carry out the emptying and cleaning of the catch pond during normal working hours over a two day period with out having to work all night. The need to disrupt the biological side of the plant is also eliminated, which is very important as starving the plant of food one day and loading it up the next does cause instability in the treatment process. We also eliminate the use of the inlet storm catch pond. This means the time consuming task of cleaning this pond is no longer necessary and possible odour emissions experienced with the use of this pond are eliminated.

The storage dam that collects the bypassed effluent from the catch pond is the storage for EPA licence point 10 and the licence states that we are only to discharge from this point if the plant is receiving high flows. It is for this reason that we have to provide infrastructure to ensure discharges do not occur whilst cleaning the catch pond.

Our solution for this problem is to design and construct a storm return pump station and rising main from the storage dam so that any bypassed effluent can be returned to the head of the works and the level in the storage dam can be controlled. The construction of this pump station will not only allow us to bypass the catch pond but will decrease discharges from EPA point 10 and reduce licence breaches at the plant.

At present if we have a wet weather event and exhaust the storage in the dam we discharge from EPA point 10. We then have to rely on evaporation to regain storage in this dam as there is no way of emptying it. Therefore if we have two wet weather events in close succession, no evaporation would have taken place leading to an immediate discharge. With the pump station provided we will be able to lower the level in the pond quick enough to regain storage for the next event. This is why our plant bypasses from EPA point 10 will decrease.

The project will also provide us with the option of an effluent diversion. At the moment at the plant if we have a drop in effluent quality due to process failure we have no option but to notify the relevant people (EPA, SCA) and discharge the effluent. Keeping this dam at low levels by use of the pump station will give us the option of diverting effluent that does not meet our licence conditions to the dam and returning it to the head of the works for further treatment when the process failures have been rectified. This will reduce licence breaches at the plant.

This will be an expensive project, but as you can see it will be very worthwhile and is justified, which is important when seeking capital works funding. It will have a positive impact on plant operations and make dealing with plant maintenance and process problems a lot easier for the operators.

Another conclusion we came to is the smaller the pond the easier it is to clean it out. At the design stage instead of being supplied with one big catch pond the provision of two small ponds with the same hydraulic capacity could have been considered. With two smaller catch ponds the idea is to use one only during normal flow periods. When the plant goes into wet weather mode and receives higher flows the duty catch pond overflows into the standby pond and when they're both full you bypass. When cleaning is necessary which would not be considered during a wet weather event you divert into the standby pond taking the duty pond off line for cleaning. Plant operations are not disrupted and it only takes half the time to empty the pond and clean it as it is only half the size. We have this set up at the Moss Vale STP and it works very well. It may result in slightly higher capital costs at the construction stage but these costs will be recouped easily over the life of the plant.

The above project will be carried out in the next financial year and the operators at the plant and Council management will be heavily involved to ensure a positive outcome is achieved.

4.0 ACKNOWLEDGEMENTS

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