STRATEGIES FOR MANAGING SLUDGE HANDLING CAPACITY LIMITATIONS AT PORT LINCOLN WWTP

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ABSTRACT

Efficient and effective sludge management at the 4 ML/d Port Lincoln Wastewater Treatment Plant on South Australia's west coast has encountered a number of challenges over the last six years. The original design involved treating waste activated sludge in four shallow sludge lagoons, filled sequentially and allowed to dry during summer. This was successful until increased plant loadings led to the lagoons becoming overloaded. A number of operating strategies have been employed to manage the lack of capacity with varied degrees of success including modifying wasting and sludge lagoon filling regimes; increasing aerobic sludge age; increasing operating height of lagoons; utilising biological additives; and providing lagoon mixing/aeration. A significant odour event in 2013 was managed with lime, magnesium hydroxide and caustic dosing; deodorisers; and mechanical desludging and dewatering. Most recently, Geobags have been employed as an alternative sludge destination. This paper will present the learnings from some of the various strategies employed and discuss future directions.

1.0 INTRODUCTION

At Port Lincoln Wastewater Treatment Plant, waste activated sludge (WAS) generated by its two Intermittent Decant Extended Aeration (IDEA) basins is processed through four 1m deep sludge lagoons, each with a nominal area of 0.3ha. The original operational intention was to feed two lagoons during the eight cooler months of the year, and allow them to dry out over the four remaining hotter months. During these four months, the third lagoon would come online, to be dried and emptied when possible. The remaining fourth lagoon was to be used as a backup for wet summers or extended winters. A lagoon was deemed full when the sludge layer was at least 600mm thick (90-108 dry tonne at 5-6% solids).

<u>Figure 1:</u> ***Port Lincoln WWTP: Overview***

This operational strategy proved challenging as it was difficult to dry a 600mm sludge layer in the required timeframes and continuous feeding of the lagoons led to organic overloading indicated by scum and odour generation. Odour issues may have been further compounded by the addition of a denitrification step to the process in 2004, which reduced stabilisation of the sludge during the activated sludge process and perhaps increased loading on the lagoons by the order of 10%.

From 2009-2013, an alternative mode of lagoon operation was adopted where two lagoons were online at a time for twelve months (March-March), fed in alternating weeks, and dried the following summer. By March 2013 at the end of the twelve month feeding period, the lagoons were virtually full of sludge and emitting odours locally and occasionally off site.

Numerous operational disruptions in 2013 including an offline sludge lagoon due to leakage, decanter works resulting in periods of single IDEA basin operation at low sludge age for an extended period of time to keep the sludge blanket down for decanter work which had numerous failures, WAS valve failure and a failed trial of wasting settled activated sludge. This all culminated in a significant odour event at the lagoons in late 2013. While this event was primarily a result of the aforementioned operational disruptions, in particular, the WAS valve failure causing sludge lagoon overload, it did demonstrate the limited robustness of the sludge management system.

This paper will discuss the various actions taken by Operations staff to manage the odour risk and the subsequent odour event.

2.0 DISCUSSION OF STRATEGIES ADOPTED

2.1 Optimising Lagoon Operating Height / Level

The four sludge lagoons achieve drying by gravity with supernatant return to the IDEA basins and evaporation. A system of perforated pipes acts as a cut-off drain to collect any seepage from the lagoons, which is then returned to polishing lagoons. The design levels for the sludge lagoons were for a total depth of 1.0 metre which would eventually allow a sludge depth of 600mm and a water cap of 400mm.

Over the past few years, lagoon operating heights have been varied in an attempt to manage the odour and capacity issues. These included the instigation of a water cap on the on-line or resting lagoons. Previously WAS was fed to lagoons with the stop logs lowered below the full height to help quicken the drying process. This mode returned for a short period while using Lagoon 4 (L4) in early 2013 but the lagoon became odorous and the water cap reinstated.

To improve odour management, and increase lagoon capacity, the lagoon operating height was increased by 300mm to increase the water cap. In early April 2013, the two off-line lagoons were fed with treated effluent to create a water cap, prior to receiving wasted sludge discharged from the aeration basins.

2.2 Instigation of Water Caps and Resulting Issues

By mid-April, seepage onto the neighbouring beach area adjacent to SL3 was detected by the plant operator and an incident was raised.

The section of beach involved was identified and isolated, and sampling commenced immediately for indicators of wastewater contamination, i.e. BOD, nutrient and microbiological parameters.

The SAEPA, Natural Resource Management Board, Port Lincoln City Council and Department of Health were notified, which in turn, triggered a thorough EPA investigation. Water quality sampling results demonstrated that there was no risk to beach users, and the environmental impact was rated as very low.

Limitations in the drainage system, and potential deterioration in condition due to age, were a part of the problem but, whilst some issues have been addressed, there are still possible deficiencies and seepage is still apparent. As a consequence the operation of lagoons at a higher water level was abandoned.

2.3 Adjustments to Aerobic Sludge Age

The Port Lincoln WWTP was designed to operate at total sludge ages between 20 to 40 days (10 to 20 days aerobic), with the intention of running longer sludge ages in order to produce a more stabilised sludge (lower WAS volatile solids) to waste to the sludge lagoons.

In late 2004 an anoxic phase was added to enhance denitrification and also reduce aerator power consumption. This was implemented as intermittent aerator 'off' cycles which totalled 48 minutes of the 120 minute aeration cycle; however, this decreased the effective aerobic sludge age by around 40% and resulted in higher amounts of volatile suspended solids in the wasted sludge.

Unfortunately volatile solids in WAS were not measured until recently and the impact of the anoxic phase was not quantified.; however, modelling suggests that a decrease in aerobic sludge age from 20 to 10 days would lead to the order of a 10% increase in volatile solids loadings to the sludge lagoons.

With the onset of the odour issues and the realisation of capacity limitations in the lagoons this practice was discontinued to minimise loadings.

2.4 Biological Additive Dosing

Prior to the odour event, a biological additive was trialled at the WWTP to enhance the operation of the sludge lagoons.

At the time of the odour event, leftover stock of the product was used in remedial activities:

- Odorous lagoons were initially sprayed with a 100 litre dose of additive with the aim of reducing odours and stimulating biological action, with a subsequent 2 litre dose applied to the WAS daily.
- This was increased to 4.3 Litres/day into each lagoon via the inflow, instead of spraying, due to the thickness of the scum on the top of the lagoons
- When switching between lagoons, before taking them offline, it was recommended to pour 5 litres of the additive into the lagoon that is going offline so as to give the product a chance to remain in the lagoon while it is offline
- An odour killing deodorising product was dosed using a sprinkler trolley, with no definitive or quantifiable effect.

We attempted to monitor the impact of the product by quantifying sludge levels and qualitatively monitoring odour levels within the lagoons, however no apparent benefits of the dosing were observed.

2.5 Lagoon Mixing / Aeration

In an attempt to reduce odour emissions from the sludge lagoons, two mechanical aerators were installed in SL3. These 5.5 kW aspirating units were readily available from another site, but were not specifically designed for the Port Lincoln application.

It is unlikely that sufficient aeration capacity was available to operate the lagoon as a full-scale aerobic digester. The aerators were able to mix the lagoon, thus assisting the application of chemicals and prevent the accumulation of odorous floating scum/sludge, although aerators were not seen as a long-term solution.

2.6 Chemical Additives- Magnesium Hydroxide Liquid (MHL), Caustic (NaOH) and Deodorisers

In conjunction with the above actions, the use of chemicals was also trialled, and the following chemicals used in order to adjust/correct lagoon pH and alkalinity levels:

Magnesium Hydroxide Liquid Slurry (MHLS): MHLS dosing was problematic due to slurry settling and blockage of the gravity feed hose, and general poor mixing throughout the entire lagoon, resulting in slow release.
Sodium Hydroxide (Caustic soda, NaOH): Several thousand litres of 50% NaOH were dosed into the lagoons, and, being liquid in nature, it was a much easier exercise to get the chemical to mix and react. Despite this, dosing of NaOH was deemed unideal due to the inherent WHS risks, and the potential to easily overdose.

During the odour events sludge lagoon pH fell below 7 and the subsequent generation of hydrogen sulphide was likely the main contributor to the odour. Raising the lagoon pH above 7 was effective in reducing odours, presumably by reducing the activity of odour producing anaerobic microorganisms.

2.7 Mechanical Desludging and Dewatering

When it was apparent that the risk of catalysing another odour event was too great, contractors were urgently engaged to mechanically desludge the sludge lagoons. This costly exercise was undertaken in two phases:

- Spring 2013: 402 tonnes of wet sludge (18% solids) were removed. All biosolids were received by a local composter (1000 tonnes) and a farmer (425 tonnes).
- Summer 2014/15: 961 wet tonnes (16.2%) solids were removed. All went to a local composter.

Unfortunately mechanical removal and dewatering was not without its own issues:

- The first dewatering event involved mixing the lagoon contents to pump to the centrifuge. The centrifuge stopped working at approximately 0.5% solids, meaning that approximately 15 dry tonnes of solids were left in the lagoon, which is approximately 15% of the solids capacity, which is not insignificant.
- During the second dewatering event, the sludge was so light and fluffy that the action of the dredge suspended the solids in the lagoon, which in turn fed a low solids percentage feed to the centrifuge, which meant slow operation.

- Significant odour was associated with the mixing of an entire lagoon in comparison with the dredge, which caused little to no odour.

2.8 Geobags

The experiences discussed above prompted an investigation into long-term options including wet sludge transport for off-site processing, additional lagoons, on-site sludge thickening followed by mechanical dewatering and stockpiling, and on-site anaerobic digestion. The selection of the long-term solution has not been finalised at the time of writing, but the availability of funds means that the strategy is unlikely to be implemented before 2018.

In order to control the odour risk now, an interim sludge management strategy has been implemented, involving the use of Geobags for the storage and stabilisation of waste activated sludge. SL1 was converted to a ten Geobag holding facility, with an overall strategy of feeding as much sludge as possible to three sludge lagoons and utilising the Geobags in the fourth lagoon when the other lagoons are unable to take sludge.

This involves the use of two sludge lagoons during eight months of the year and air drying them in the hotter months. The capacity of the Geobags has been determined at around 10 dry tonnes solids each. This means there is capacity to hold 100 dry tonnes in sludge lagoon 1, or approximately 6 months of WAS.

The lagoons will receive lower VSS loading per ha per month as previous, which should shorten the drying time required. Whilst the two lagoons are drying, sludge can be fed to the third lagoon and five Geobags. These Geobags will then have at least 19 months to dry and be removed. For the next two years three Geobags would be filled and five would be filled in each of the subsequent two years.

Figure 2: ***Geobags in Operation***

The longer term dewaterability of the bags and odour potential of the final sludge has not been determined and would be part of ongoing optimisation. So far, optimisation has involved testing various methods of operation, including:

- Filling bags individually, or 3x in parallel
- Filling through one, or both inlet ports
- Filling with and without polymer addition
- Geobag use with, and without, bag surface wetting (use of sprinklers)

The initial trials were somewhat unsuccessful whereby dewatering seemed to stop a very short time after filling, and as a result, two Geobags were emptied during the summer 14/15 dewatering event.

3.0 CONCLUSION

Sludge handling at Port Lincoln WWTP has proven extremely challenging, with the lagoons undersized based on current loadings to the plant, and prone to odour generation. Numerous strategies have been employed including instigation of a water cap by increasing lagoon operating height, addition of an anoxic phase, application of a probiotic, installation of mechanical aerators and pH management via MHLS and NaOH dosing- all with varying degrees of success. Desludging has been employed as an emergency measure; however this is not a long term strategy. An interim strategy of using Geobags in conjunction with sludge lagoons is currently in use, however should this be unsuccessful large capital expenditure may be required to produce a long term solution.

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