

SLUDGY SOLUTIONS: DEALING WITH EXCESSIVE SLUDGE AT BAROSSA WTP

Liam Tohill, *Water Production Engineer, SA Water*

Andrew Sawilski, *Wastewater & Reuse Treatment Manager South, SUEZ*

ABSTRACT

The Production & Treatment Alliance is an alliance between SA Water and SUEZ to operate and maintain water and wastewater assets in Metropolitan Adelaide. Barossa Water Treatment Plant (WTP) is a large WTP site located 40 km north-east of Adelaide.

From 2022 to 2024, Barossa WTP experienced an unusually high water demand at the same time as experiencing poor raw water quality. This resulted in an excessively high level of sludge production. Barossa WTP utilises climate-dependent sludge drying beds and lagoons for sludge dewatering. This period of high sludge production aligned with two summers of lower temperatures and higher rainfall. This resulted in a situation whereby the sludge became too wet to desludge one of the lagoons, severely restricting sludge capacity for the following year.

The team innovated and adapted rapidly. They maximised the capacity of the remaining sludge drying assets. They rapidly commissioned a sludge thickening process using a temporary poly batching system. They also commissioned tankering connections for excess sludge to be diverted to another site which had spare sludge handling capacity. This rapid response ensured that water production was able to continue uninterrupted. Any potential environmental incidents due to sludge overflow were avoided.

1.0 INTRODUCTION

Barossa WTP is a large water treatment plant serving metropolitan and regional areas to the north of Adelaide, with a design capacity of 160 ML/d. It was fully commissioned in 1982 and supplies an approximate population of 85,000. The cost of sludge management at Barossa WTP represents a significant operational cost for the site. Working to optimise the sludge management costs is one of the most important ways that the Production & Treatment Alliance is able deliver outcomes for our customers.

The treatment process at Barossa WTP is conventional. The raw water from Barossa Reservoir is coagulated with aluminium sulphate or aluminium chlorohydrate, before passing through the flocculation stage into the sedimentation tanks. The clarified water is then filtered via dual-media filters before being disinfected with chlorine.

Sludge is generated in the sedimentation process. This sludge consists of the suspended solids and organic material that is removed from the raw water, along with the residual material that is generated by the upstream chemical dosing. This sludge is removed from the sedimentation tanks and directed to two sludge thickeners. The sludge thickening process removes some of the water component from the liquid sludge stream. The thickened sludge is then directed to a series of drying beds and lagoons, where the sludge is dried via evaporation.

In a typical year, the sludge drying beds are used for six months, and one of the sludge lagoons is used for the other six months. This schedule allows for sufficient time to dry out the sludge in the lagoons and drying beds. The final dried sludge product is then disposed

to a nearby abandoned quarry, located within the SA Water reserve. The sludge material is used to rehabilitate the site. During 2022/23 and 2023/24, compounding factors were experienced that impacted on the ability of one of the sludge lagoons to dry the sludge sufficiently for disposal to the quarry.

Firstly, the total amount of sludge material generated at Barossa WTP was significantly above average. This was due to:

- **High water demand being placed on Barossa WTP.** Whilst these years did not see excessively high demand for SA Water as a whole, there was improved availability of water in the Barossa Reservoir catchment during these years. SA Water has a highly flexible distribution network, which allowed for higher water production to be prioritised at Barossa WTP during this period of improved water availability, offsetting water demand in areas with lower water availability. This prioritisation meant that higher volumes of water were produced at Barossa WTP.
- **Poor raw water quality at Barossa WTP.** With significant volumes of fresh inflows into the catchment of Barossa Reservoir, there was a deterioration in the quality of the raw water being supplied to the water treatment plant. With higher loading of organic material and higher chemical dosing requirements, this meant that a higher amount of sludge was being generated per volume of water produced.
- **Increased algal activity in Barossa Reservoir.** With higher inflows in the catchment of Barossa Reservoir, the fresh nutrients in the raw water encouraged higher levels of algal activity in the reservoir. This resulted in more frequent occasions when Powdered Activated Carbon (PAC) was required to be dosed at Barossa WTP. PAC is used within the treatment process to improve the taste and odour of the treated water during periods of high algal activity. During the periods when PAC is being used, higher volumes of sludge are produced by the process.

With higher water production and more sludge being generated by the treatment process, this resulted in the sludge production being significantly above average for 2 years in a row (Figure 1).

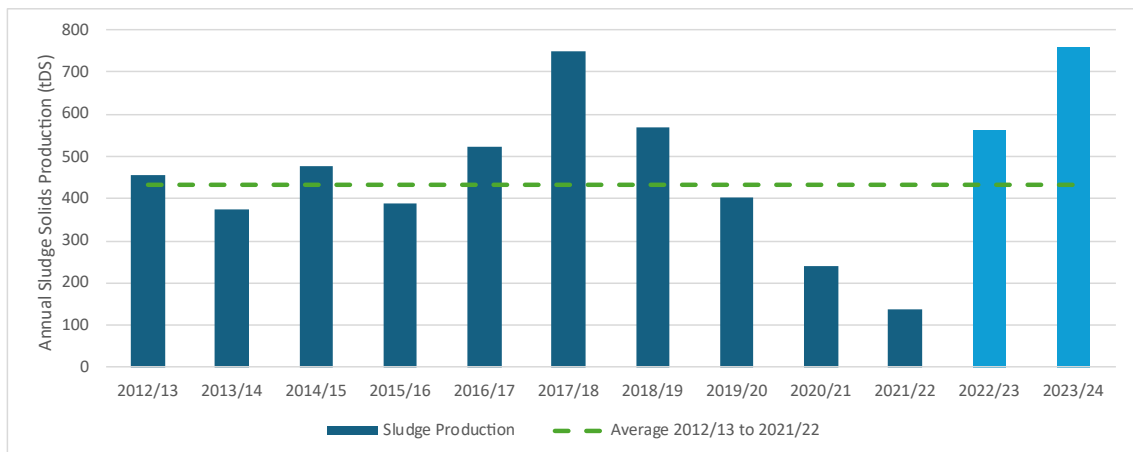


Figure 1: Modelled Annual Sludge Solids Production at Barossa WTP

Secondly, the weather conditions during the drying season (November-February) were cooler than normal during these two years. The average daily maximum temperature during these months was lower than the average over the previous decade (Figure 2).

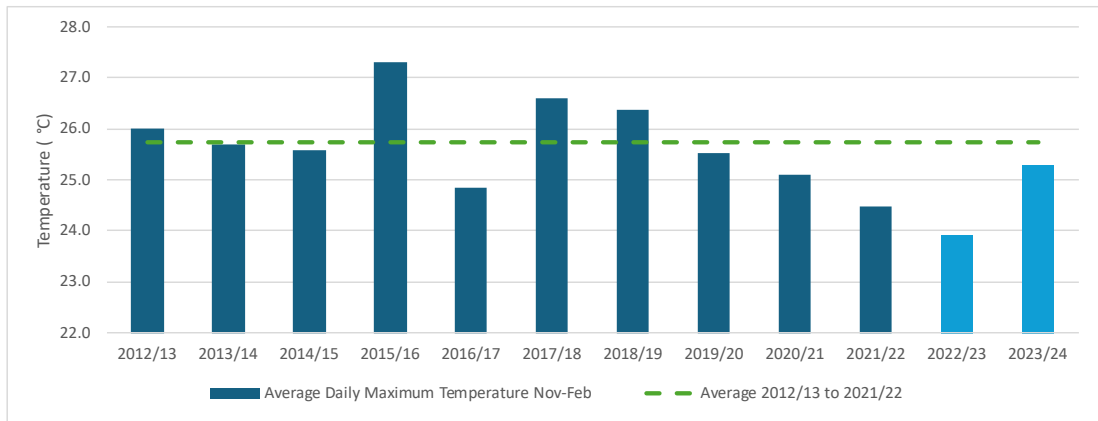


Figure 2: Average daily maximum temperature data nearby Barossa WTP during drying period (Nov-Feb)

The final factor was that the drying season was also wetter than typical during these two years. The total rainfall between November and February was higher than the average over the previous decade (Figure 3).

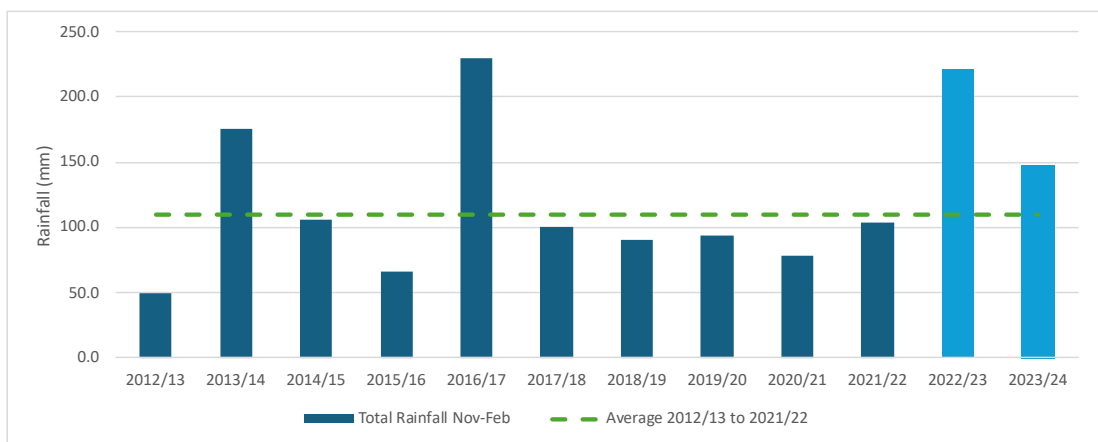


Figure 3: Total rainfall data nearby Barossa WTP during drying period (Nov-Feb)

The combination of these three factors meant that it was significantly more challenging than normal to effectively dry the sludge. This culminated in the sludge in Lagoon 1 still being too wet to be able to remove effectively at the end of the drying season in 2024 (Figure 4).



Figure 4: Attempted desludging of Lagoon 1 with wet sludge at Barossa WTP

This wet sludge was unable to be safely disposed at the abandoned quarry (Figure 5). When the sludge was attempted to be disposed, it began to flow as a liquid slurry. If this was left un-checked, it may have resulted in a loss of sludge containment. Because of this, all further sludge movement was stopped, ensuring that no environmental incident would occur.



Figure 5: Inability of sludge to be disposed to abandoned quarry at Barossa WTP

Because the sludge in Lagoon 1 was unable to be removed, it was apparent that there would be insufficient capacity in the remaining sludge drying beds and lagoons for the following year. There was a need for the team to innovate to adapt to this challenging situation.

2.0 DISCUSSION

There were a number of actions that were implemented by the team to reduce the sludge production and to increase the sludge handling capacity of the site.

2.1 Sludge Lagoon embankments

Sludge Lagoon 1, which had been attempted to be desludged at the end of the 2024 drying season, was only able to be partially emptied. Approximately one third of the total area of the lagoon was able to be cleared before the job had to be stopped due to the excessively wet nature of the sludge (Figure 6). The remaining sludge would require more time to dry sufficiently for removal.



Figure 6: Partially cleared Lagoon 1

In order to allow the cleared area of the lagoon to be used for sludge drying without impacting on the partially dried sludge already in the lagoon, two earthen embankments were installed into the lagoon (Figure 7). Clean fill with a high clay content was sourced from a local quarry for this purpose.



Figure 7: Earthen embankments installed to Lagoon 1

These embankments ensured that Lagoon 1 would be partially available for the upcoming months of sludge production. In a typical year, this lagoon would be expected to be utilised for 6 months of sludge production. However, because only one third of the sludge lagoon capacity would be available, further actions were required to be taken to maximise the usage of the limited sludge handling capacity that was remaining.

2.2 Sludge Thickening

Barossa WTP was originally designed with two sludge thickeners. However, for at least the previous 15 years, the thickening process had not been in-use. Work was undertaken to restore the sludge thickening process. The restoration of the sludge thickening process would reduce the total volume of sludge being pumped to the sludge drying beds and lagoons.

The critical part of the sludge thickening process that needed to be restored to service was the polyacrylamide dosing system. Barossa WTP already had an existing polyacrylamide batching and dosing system, with Magnafloc DW22S (cationic) being used as a flocculation aid. However, lab testing showed that this particular grade of polyacrylamide was ineffective as a sludge thickening aid. A full-scale trial also validated this finding. It was therefore determined that an alternative grade of polyacrylamide would be required as a sludge thickening aid.

Lab testing showed that Magnafloc DW20 (non-ionic) was an effective sludge thickening aid. A temporary poly batching system was fabricated by the Maintenance team using a disused 1000 L container and an electric mixer (Figure 8). This was then plumbed into an existing dosing pump.



Figure 8: Temporary poly batching system

Once the sludge thickening process has been restored to service, a significant improvement in sludge thickness was observed (Figure 9). This resulted in a significant reduction in volume being pumped to the sludge drying beds and lagoons and ensured that the limited remaining capacity in the sludge drying beds and lagoons was able to be utilised optimally.

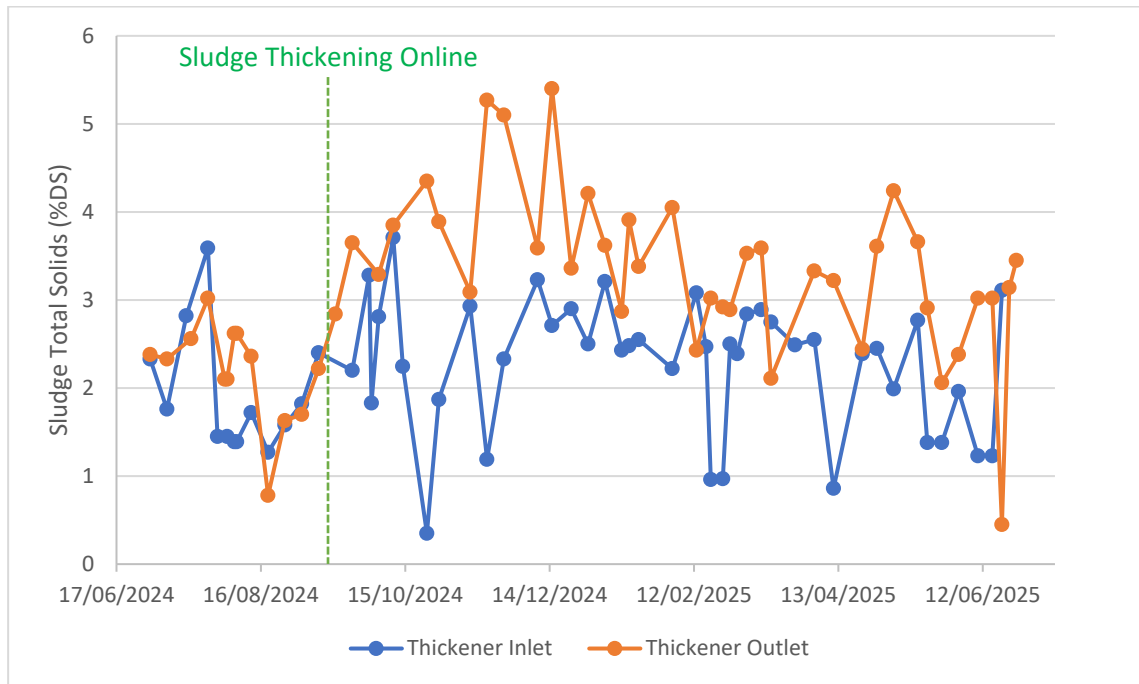


Figure 9: Sludge thickness improvement after sludge thickening process recommissioned

2.3 Sludge Drying Bed & Lagoon Management

The operational schedule of the sludge drying beds and lagoons was reviewed to determine if additional capacity could be obtained from the assets. The drying beds are a different design compared to the sludge lagoons. The drying beds are configured with a sand base and underdrains to allow for any free water to drain out of the sludge. The sludge lagoons have no drainage. This means that the drying beds have a higher capacity to dewater the sludge.

In previous years, the sludge drying beds would be filled from empty to full, and then taken offline and allowed to dry. With the sludge capacity constraints in Lagoon 1, it was decided to transfer additional sludge into the drying beds, after they had partially dried. This was achieved by applying a second and third fill to each drying bed, after each bed had a few weeks to partially dry. These successive top-ups were done throughout winter and early spring. From November, no further sludge was transferred into the drying beds, to allow them to dry out. Even with the additional refills of the sludge drying beds, there were no issues with drying them out over summer. This confirmed that the additional top-up fills were able to maximise the utilisation of the drying beds with no impact to their drying ability.

Because the sludge lagoons were not originally designed with underdrains, they take significantly longer to dry out. Without any free drainage, deeper sludge has a tendency to remain wet, even when the upper layer of sludge is relatively dry. In order to encourage the deeper sludge to dry out, a mid-season turnover of the sludge in the lagoon was implemented (Figure 10). Once the top layer of sludge has dried out, and the total depth of sludge reduced low enough to allow an excavator to enter the lagoon, the team engaged an earthmoving contractor to turnover the sludge in the lagoon. This ensured that the wet sludge was brought up to the surface and accelerated the drying process. This reduces the risk of the sludge still being too wet to remove at the end of the drying season.



Figure 10: Lagoon 2 being turned over

Given the lack of underdrains in the sludge lagoons, the local Operations team determined that it would be possible to install a basic underdrain into the lagoons. These lagoons do not have any liner, with the local geology being relatively impermeable. This allowed for an underdrain pipe to be installed directly into the base of the lagoon, with a cover of sand and gravel (Figure 11). Going forward, as each lagoon is dried and emptied, an underdrain pipe is being installed through the centre of the lagoon. This will assist further at improving the capacity of these lagoons to dewater the sludge.



Figure 11: Underdrain pipe installed to base of Lagoon 2

2.4 Liquid Sludge Carting

Whilst there were multiple corrective actions put in place to minimise sludge production and maximise the sludge holding capacity of the drying beds and lagoons, the drying beds and Lagoon 1 were approaching full level in November 2024. It became apparent that the capacity of this lagoon would be exceeded prior to the sludge drying beds being emptied and becoming available for fresh sludge.

Alternative methods of dewatering the sludge or disposing the sludge were explored. These included:

- rental equipment (eg. centrifuge)
- relocation & recommissioning of redundant sludge dewatering equipment from other sites
- vacuum trucks to transport the sludge offsite

The preferred option was determined to be the use of vacuum trucks. This option had the flexibility to increase/decrease in capacity as required. It was also significantly lower cost and easier to implement, as compared to the other options (which involved mechanical dewatering equipment).

The preferred location to receive the excess sludge was Little Para WTP, which is the next-closest water treatment plant to Barossa WTP. Little Para WTP is located approximately 20 km south-west from Barossa WTP. The water treatment sludge from Little Para WTP is disposed directly to the wastewater network. The disposal system at Little Para WTP and the receiving wastewater network was reviewed for spare capacity. It was determined that there was sufficient capacity to receive the excess sludge from Barossa WTP.

The Maintenance Team worked to install a 100mm camlock connection to the thickened sludge pipe at Barossa WTP for the vacuum trucks to load. A 100mm camlock connection was also installed at Little Para WTP to the sludge tank to for the vacuum trucks to unload (Figure 12). The unloading connection point at Little Para WTP was located within the chemical delivery bund, to ensure that any sludge spills would be captured and avoid a potential environmental incident.



Figure 12: Vacuum truck unloading sludge at Little Para WTP

From November 2024 to January 2025, the level of sludge in Lagoon 1 was assessed each week, and a schedule was put in-place for vacuum trucks. This ensured that the capacity of the onsite sludge treatment was maximised, and only the excess sludge was carted to Little Para WTP. This helped to ensure that the cost of this process was managed to be as low as possible. Over the course of this period, a total of 2.5 ML of sludge was carted from Barossa WTP to Little Para WTP, ensuring that the sludge level in Lagoon 1 remained below the maximum capacity.

3.0 CONCLUSION

The combination of all the innovations and adaptations that was undertaken by the team at Barossa WTP were able to successfully manage the challenging situation. Despite the limited sludge handling capacity that was available in Lagoon 1 following the inability to fully empty this lagoon in 2024, the team was able to adapt. The team was able to deliver a series of corrective actions to ensure that all sludge produced by Barossa WTP was able to be managed without any adverse environmental or safety impacts. This work also ensured that the water production capacity of Barossa WTP was not restricted, ensuring that our customers continued to receive a reliable drinking water supply.

In January-March 2025, the drying beds and Lagoon 2 were able to be completely dried and emptied. With the full availability of these assets restored, the sludge handling capacity constraints were back to normal, and no further liquid sludge carting to Little Para WTP was required.

The learnings from this period have been documented and will be applied as part of standard operation of the sludge assets. This will ensure that Barossa WTP is best-placed to adapt to increasing water demands in the future, along with a changing climate which will affect the ability to dry the sludge.

4.0 ACKNOWLEDGEMENTS

Thank you to the Water Production Operations & Maintenance team at Barossa WTP, who rose to meet the challenging circumstances and delivered a great outcome for our customers.