DESLUDGING THE WEST KEMPSEY STP EFFLUENT PONDS

Paper Presented by:

Lalji Rathod

Author:

Lalji Rathod, *Project Engineer –Water,*

Kempsey Shire Council

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Lalji Rathod, *Project Engineer –Water*, Kempsey Shire Council

ABSTRACT

The tertiary treatment ponds at West Kempsey STP (Sewage Treatment Plant) were due to be desludged to meet the PRP conditions from EPA as a part of flood recovery and ongoing use of the ponds. The sludge volume was high and with a limited budget conventional options for dewatering were eliminated. De-sludging was achieved by constructing purpose made drying beds using simple fencing material such as plain wire, chook wire, timber posts, star pickets and shade cloth. This paper focuses on the trial, full scale construction of the drying beds, evaluates the consolidation and dewatering behaviour of the drying beds, evaluates the water quality of effluent flowing through the shade cloth and the cost. It also discusses the opportunities for utilising similar dewatering options where land is available within the treatment plant site or within the nearby boundary of the treatment plant.

KEYWORDS: Sewage sludge, drying beds, shade cloth, desludging, dewater, biosolid application

1.0 INTRODUCTION

Desludging of pond 1 and 2 at West Kempsey STP was required in order to meet the flood recovery process as a part of the PRP (Pollution Reduction Plan) conditions imposed by EPA and to improve the treatment performance of the ponds. The ponds to be dredged were the first two of four ponds in series to provide polishing treatment to effluent before its discharge to the Macleay River.

Conventional dewatering options for the huge quantity of sludge from both ponds (approximately 12000 m^3) such as Geobags, centrifuge and belt press were explored and turned out to be far in excess of the limited budget allocated for the project. Thus, the options of geobags and belt press were eliminated. This has created the need of finding some purpose-made dewatering means to complete the desludging. Following the investigation for alternatives, Council decided to construct purpose made drying beds using simple fencing material such as chook wire, timber posts, shade cloth and agricultural pipe. A trial was conducted on a small scale to confirm the performance efficiency expected. A trial with 2m by 1m bed using shade cloth was conducted. Both sides of the bed were sloped in to the middle in a trench where an agricultural pipe was laid and covered by 20 mm gravel and shade cloth graded toward one end of the bed to allow the filtrate to flow through.

Sewage sludge from the tertiary pond 1 was used for the purpose of evaluating the dewatering and consolidation capabilities for design and filling large drying beds with the same sludge. Approximately 150 kg of sludge was drawn from the pond and was mixed with 850 litre of water to obtain the closest probable solid content proposed to be pumped by the dredger. It was then mixed thoroughly to get the consistency of material being fed to the bed. As the material flowed in to the bed, initially some sludge escaped through the fence, however, as the feeding continued, it started to clog the shade cloth and clear supernatant started to filtrate through the fence. After a week of drying, this sludge was dry enough to be spread for land application.

Following this trial, a 1 meter perimeter drain was planned to be constructed around the fence when pumping the sludge, to collect the initial sludge leaving the bed during the starting phase of the pumping, and to drain the filtrate into a common sump. Also the edges of the shade cloth at bottom were pinned down to avoid any sludge flowing from underneath the shade cloth. Beds were planned to be constructed aiming to accommodate the sludge from pond-1 (approximately 9000 m^3). This operation was challenging as there was not enough area available on the STP site. Therefore to overcome this Council negotiated with the racecourse authority who manages the site next to the STP, to use this site for dewatering the sludge in return for compensation. The offer was accepted and cemented better relationship with the racecourse.

2.0 DISCUSSION

2.1 Site Preparation and Construction of Drying Beds

The site was selected in accordance with the Environmental Guidelines: Use and Disposal of Biosolid Products EPA NSW. The highest available spot on the racecourse was selected for the drying beds to reduce any flooding risk. Stormwater during rain events from the drying beds was planned to be collected in the existing sump along with the filtrate from the bunded area and from there to be pumped back to the existing irrigation dam on the racecourse. This area is also the farthest part of the racecourse from the residences and public activity reducing any odour impact risk. The sludge was analysed and classified as “Restricted Use-2” according to the Environmental Guideline. Nine beds of different sizes were planned to be built to follow the contours of the site and to accommodate the sludge from pond-1.

Topsoil was stripped from the entire surface of the proposed drying bed area and the area was levelled with cut and fills and compacted with a small road roller to minimise any groundwater infiltration. V shape drain was created with each side being 5m, sloped toward the 300 mm wide trench in the middle where agricultural pipe was installed. This pipe was covered by 20 mm gravel and shade cloth on top to filter the sludge and minimise the groundwater infiltration. These trenches were sloped at 1% along the length of the beds to draw the supernatant out of the drying bed as shown in Figure 1.

Figure 1: ***Ground compaction, agricultural pipe installation and ready to use bed***

Once the ground work was finished, the fencing work was executed with hydraulic hammer used to push the timber posts into the ground. The timber posts were placed at an interval of 5m. Two star pickets of 8 feet lengths were installed between the two timber posts for additional strength to the fence, chook wire of 20mm×5mm×1.6m size was used to support the shade cloth in addition to 3 circumferences of 10 gauge plain wire.

General purpose 70% shade cloth of 1.8 meter width was used as the main filtrate material. Only 1m of the cloth width was used in the fence, the rest was laid and pinned on the ground to avoid any material flowing from underneath the shade cloth. 1m perimeter drain was created around the drying beds to receive the filtrate from the fence and from the under bed drainage. An example of a ready to use bed is shown in figure-1.

All the drains were designed to eventually drain into the common drain which flowed into the existing sump on the site. The filtrate was pumped from this sump to the existing irrigation dam used for track irrigation; this dam has a balanced pipe receiving the treated effluent from the tertiary treatment pond 2 for track irrigation purposes. As the pipe is balanced, any rise of filtrate into the irrigation dam would push the water back to the tertiary ponds for further treatment prior to its discharge in to the environment.

2.2 Pumping the Sludge into the Beds

The sludge was pumped into the drying beds by the dredger and a booster pump to cover the farthest distance of up to 700 m. As the sludge started to build up evenly into the bed it started to clog up the shade cloth fence. Clear supernatant had started to flow through the fence and through the under bed drainage in a similar pattern to the trial. The drying beds were filled up to approximately 700 mm to maximise the holding capacity. As filling started the first three beds had a smooth run, however, a couple of beds had incidents of fences leaning outwards, especially where the original ground was unstable. However, extra strengthening with a strong wire (6G) on top and additional supports to each timber posts on the corners and to susceptible looking posts were provided. This strengthened the holding capacity of the bed and the beds were filled up to 800mm leaving only the freeboard height of 200mm. This has helped immensely to accommodate the huge volume of wet sludge.

3.0 PERFORMANCE OF THE DRYING BEDS

The performance of the beds was monitored by sampling the sludge at different points. Point 1 was at the inlet, point 2 was the supernatant flowing through the fence, point 3 being halfway through the common drain and point 4 at the end of the drain, just before it flows to the sump.

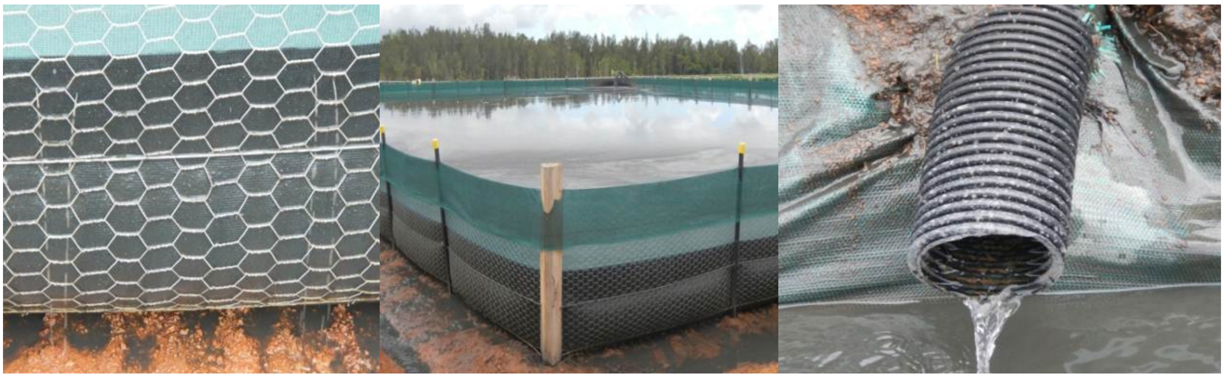

Figure 2: ***A close ups-the filtrate through fencing, a full bed and supernatant via under bed drainage***

3.1 Total Suspended Solids.

The sludge was analysed for TSS, VSS, organic and inorganic content at various points.

The sampling points were selected to assess the effectiveness of the shade cloth to retain and filter the sludge. The results of TSS, VSS and inorganic content are shown in Table-1. The material pumped into bed 1 approximately at 8 to 10 percent solids had Total Suspended Solids content ranging from 33,100 to 120,000 mg/l. The volatile solid content varied from 4600 to 20200 mg/l. The inlet sludge had an inorganic content of 81.45% and the organic content was 18.55%.

Table 1: ***Analytical results of the supernatant***

TSS mg/l		**Point 1**	**Point 2**	**Point 3**	**Point 4**
Bed-1	Day-1	33100	492	2930	3150
	Day-2	115000	61	34700	34000
Bed-2	Day-1	81400	376	6130	648
	Day-2	120000	59	51	184
VSS mg/l		Point 1	Point 2	Point 3	Point 4
Bed-1	Day-1	4600	120	480	620
	Day-2	22500	28	5820	5160
Bed-2	Day-1	14800	1180	176	244
	Day-2	20200	45	40	68
IOC mg/l		Point 1	Point 2	Point 3	Point 4
Bed-1	Day-1	86.1	75.6	83.6	80.3
	Day-2	80.4	54.1	83.2	84.8
Bed-2	Day-1	81.8	80.7	53.2	62.3
	Day-2	83.2	76.3	78.4	37

During the first day of pumping the fence seemed to allow more turbid filtrate through it, with TSS ranging up to 492 mg/l. However, as it can be seen in table 1, on the second day of pumping the filtrate through the fence tends to be lot clearer than the first day. Additionally, the higher the solid content of inlet material the clearer was the filtrate through the fence. This can be supported by the fact that the inflow with TSS of 33,100 mg/l has a filtrate TSS content of 492 mg/l, and the inflow with a TSS content of 81,400 mg/l has a filtrate content of 376 mg/l of TSS on the first day of pumping. Table 2 shows the % removal from the beds, the average removal rate by the beds is 98%. The remaining solid flow into the common sump is pumped back to the treatment work for further treatment. Thus, with proper arrangement to catch and return the supernatant with high TSS back to the pond these beds provided an environmentally safe option for dewatering the sludge, but only if the required land is available on or within a practically logistical distance of the STP.

Once the sludge was dry it had a few rain events on top of it, however this did not affect the consolidation of the sludge and the rain water was filtered quickly through the fence and the rest was evaporated. Thus the dewatering was quite quicker and was fairly resilient to the wet weather. Once finished with the dredging of pond 1 which continued for five weeks, the first three beds were completely dry. They were emptied by using an excavator and a tipper and dredging of pond 2 began with the refilling of these beds.

Table 2: ***% removal rate of the beds***

TSS mg/l	Point 1	Point 2	% via fence	% Removal
Bed-1	33100	492	1.49	98.51
	115000	61	0.05	99.95
Bed-2	81400	376	0.46	99.54
	120000	59	0.05	99.95
VSS mg/l				
Bed-1	4600	120	2.61	97.39
	22500	28	0.12	99.88
Bed-2	14800	1180	7.97	92.03
	20200	45	0.22	99.78

This concept of containing sewage sludge has proven to be construction-practical, technically and economically feasible and environmentally acceptable. There was not much control over the percentage of solids for filling the beds on any given day from the pond. However, there did not appear to be much difference in the time of dewatering or consolidation of the lower or higher percentage solid content materials in the beds. A week of dry weather and the sludge was dry and consistent enough to be spread. Within four weeks the sludge was dry-cracked as shown in figure 3.

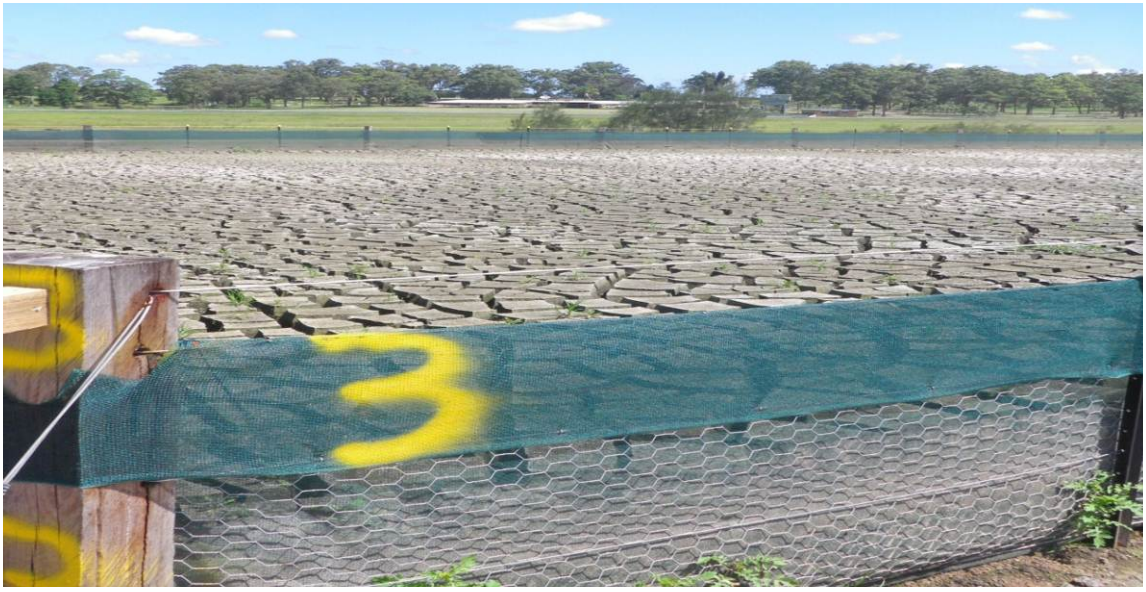

Figure 3: ***Dried material, cracked and ready for spreading***

4.0 COST COMPARISON

Table 3 below shows the cost comparison between the conventional options of dewatering and the purpose made drying beds. The criteria was the same for each option i.e. the cost is for the first pond which has approximately 9000 m^3 of sludge with 16% solid content in situ. The costs are based on the quotations received. The difference can be seen from the table 3. The prices for Centrifuge and belt press as well as geotubes are the estimated price and it could have been substantially more than is represented. The prices for the beds are firm and based on the actual spending by Kempsey Shire Council.

Table 3: ***Cost comparison of conventional dewatering options and purpose made drying beds***

Centrifuge and belt press	Geotubes Including the Ground work	Purpose made drying beds
$591,300.00	$467,967.50	$80,000.00

5.0 COMMUNITY BENEFITS OF THE PROJECT

This option has lead to a solution which was not only the least expensive for Council but has created considerable amount of work for local contractors and suppliers. All the materials and contractors used were local. An access road was created as part of the compensation offered to the racecourse; the training sand track will also be restored by Council. The biosolid will be spread on the racecourse site by Council and the site will be seeded with proper grass species. This will assist the racecourse authority in their current planning to develop the site for animal grazing following the application and restoration of the site. This will be a revenue raising opportunity aiming to develop the racecourse site further. Thus, this option works out to be the least expensive option for Council while ending up with substantial community benefit and a substantial monetary saving to the Council, enabling Council to fund other projects.

6.0 CONCLUSION

It was concluded that the purpose made beds are capable of retaining the fine grained sewage sludge retaining 98% of the inlet solid content. It was shown that the shade cloth is capable of filtering the sludge so that the effluent water passing through the shade cloth on first day has a TSS content of below 500 mg/l; however, this filtrate was collected and returned back to the pond for further treatment before its disposal to the Macleay River. Although during the pumping on day-2 the supernatant had TSS content as low as 60 mg/l, close to the discharge limit of 30 mg/l. However, it is still recommended that this supernatant should be returned to the ponds as it was during this project for further treatment prior to its discharge to the environment.

It was also concluded that this new and innovative option is capable of economically beating the other alternate dewatering techniques for sludge. This technique is passive, and does not require extensive or constant labour and maintenance of equipment. It has created overall community benefits and work for local contractors and suppliers. It is also recommended that small to medium size water and wastewater treatment plants consider the use of this new option for dewatering sludge. It is also recommended that additional trial testing be conducted to substantiate the use of this option for dewatering the sludge or when dealing with sludge of a unique nature.

7.0 ACKNOWLEDGEMENT:

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8.0 REFERENCES:

Environment Protection Authority NSW, (1997), Environmental Guidelines: Use and Disposal of Biosolids Products. Department of Environment and Climate Change NSW, Sydney NSW.