



## FACT SHEET

### REMOVAL OF SLUDGE FROM PONDS

Choices of pond desludging techniques depend on pond operation and structure, physical sludge characteristics and frequency of desludging. The design of a pond influences its ability to be desludged. To improve desludging capability follow these recommendations:

- Use deep ponds to increase sludge flow to draw-off pipeline
- Use long narrow steep sided ponds to permit draw-off from side of pond
- Provide two inlets to the pond, discharging towards the sides of the pond to deposit heavy sludge components closer to draw-off point
- Provide sludge discharge channels alongside the pond to receive removed sludge and discharge to the sludge processing area.

Desludging can be broadly categorised into three groups:

- Desludging dewatered ponds (after liquid effluent removal)
- Desludging an uncovered pond containing effluent
- Desludging a HDPE covered or lined pond.

#### Desludging Dewatered Ponds

Due to the high cost of desludging ponds containing settled sludge with a high total solids (TS >15%) content, it is often cheaper to remove the liquid layer first and then mechanically remove the sludge with conventional earthmoving equipment such as an excavator and dump trucks.

Figure 1 shows a pump being used to dewater a pond. This illustrates two problems with this approach. Firstly, there must be a suitable place for the effluent to be stored or used immediately. Secondly, there must be an alternate pond available to receive incoming wastewater. If not, farm management must cease operation during the desludging operation. Finally a bunded area is required to store the wet sludge allowing it to dry to improve handling.



Figure 1 – Dewatering an anaerobic piggery pond

This issue generally does not exist for feedlot sedimentation ponds and holding ponds. As these structures only fill with water following rainfall, there are dry periods when the basins and ponds become dry and the accumulated sludge can be removed mechanically (Figure 2).



Figure 2 – Mechanical sludge removal from a dewatered pond



After dewatering, the sludge may still have a high moisture content making removal difficult with conventional equipment. If the pond is above natural ground level the pond embankment can be breached to let the sludge flow out into a designated drying bay. The runoff must be captured to prevent land contamination. The embankment is then reconstructed and normal pond operations recommence.

#### Advantages:

- Relatively simple and does not require expensive equipment, only suited to infrequent pond desludging for ponds with large sludge accumulation volume.

#### Disadvantages:

- Pond must go off-line during process
- Site to store/dewater large volume of sludge required
- Capture of effluent runoff to prevent land contamination
- Transport of liquid to storage site if required
- Biological seal on base of pond may be removed leading to groundwater contamination
- Completely unsuitable for plastic-lined or covered ponds.

## Desludging Uncovered Ponds Containing Effluent

It is usually more desirable to remove sludge from a pond without dewatering as this maintains the function of the pond. There are three basic methods of sludge removal from an operating, uncovered pond - pumping, dredging and mechanical removal.

### Pumping

A solids concentration of below 6 per cent is the most suitable for pumping, when solids reach 12 per cent, flows are significantly reduced. Typical flow rates range from 80-130 m<sup>3</sup>/hr.

When desludging by pumping, a pump designed for slurries (5-15 per cent TS) is located on the pond embankment. The slurry is pumped either into a tanker (Figure 3) for immediate disposal or to a dewatering location. There are various suitable pump types including; vacuum pumps, centrifugal pump with a chopper, or a positive displacement pump. Problems arise when the sludge has settled into a solid mass (>15 per cent TS) which does not flow. Mechanical agitators can be used to un-settle the sludge into slurry which is then possible to pump (Figure 4).



**Figure 3 – Sludge removal using a suction tanker with recirculating pump for agitation**

High-volume pumps (15 000 to 25 000 litres/minute), specifically designed for agitation and loading, will provide the best suspension of solids. Agitation equipment is only effective at suspending solids within a limited area (within 15 m of agitator) and for a short period of time. Therefore, more than one agitator may be needed for a large pond or one agitator needs to move around the pond so as to suspend most of the sludge.

Two common methods for agitating ponds include; a recirculating pump and nozzle on the pond base, and a traditional agitator involving a hinged shaft to place a propeller into the manure, usually three-point hitch mounted or trailer mounted.



**Figure 4 – Tractor PTO driven pond agitator**



The effluent with suspended solids should be pumped out of the pond during the agitation to prevent the solids from re-settling. The agitator head and pump inlet need to be kept a reasonable distance above the bottom of pond (e.g. 0.5 m) so that the pond lining is not damaged by turbulence. This is critical for HDPE plastic lined ponds. Agitators can also erode earthen liners and should always be used cautiously.

Pump-out of pond sludge should be designed for easy setup, regular sludge removal, and protection of liner integrity. Infrequent sludge removal will result in high TS (>12 per cent) concentrations, significant nutrient accumulation, substantial land disposal area requirements, and significant transportation cost.

## Dredging

For large ponds, sludge may be dredged and pumped at the same time using a floating dredge (Figure 5). A suction auger is used to suck the sludge out and transport it through a pipe supported by pontoons. The dredge needs to be operated from around the pond perimeter to access all sludge.

Alternatively, a manual survey or ultrasonic detection (ref to Characteristics and Accumulation of Sludge Fact Sheet) may be used to find the main area of sludge before dredging.

Depending on the access depth of the dredge, the water level of the pond may need to be reduced so that the lower layer of sludge can be reached. To prevent damage of pond linings, the cutter head of dredge may be modified by adding a wheel system to keep the cutter head about 100 mm above the surface of the sludge. A similar system could also be designed for an agitator.

Some companies that provide dredging services in Australia include, UAT SludgeRat, Epsom Environmental, Apex Envirocare, Dredging Solutions and Dredging Systems.



Figure 5 – Floating dredger in operation

## Mechanical Removal

It is possible to desludge uncovered ponds containing effluent using mechanical methods. Two options include the use of draglines that drag a scoop bucket across the base of the pond drawing wet slurry up onto the side bank, or using a long-reach excavator (Figure 6) which can access most areas of the pond from the side banks.



Figure 6 – Excavator removing sludge from a clay lined pond

## Desludging Covered Anaerobic Ponds (CAPS)

Sludge removal from CAPs present specific difficulties as the cover cannot be removed during the operational phase. There are essentially three methods of sludge removal from CAPs, including; In-situ desludging, suspension removal and life-time accumulation.



## In-situ Desludging

In-situ desludging involves allowing the solids to settle at the pond base where they are removed by pumping via a pre-installed pipeline. Continuous or semi-continuous sludge draw-off is desirable for covered ponds. This is done by laying a network of pipes at the base of the pond and sucking the sludge out through inlets on the pipes (Figures 7, 8, and 9).



**Figure 7 – Installation of sludge removal pipeline system**



**Figure 8 – Sludge extraction pipelines (deflated pond cover)**



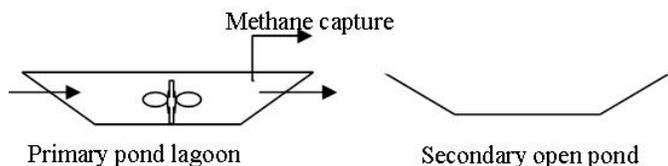
**Figure 9 – Pump suction pipe into a pre-installed desludging pipeline**

Usually, conventional positive-displacement or vacuum pumps are used to remove sludge. Air-lift pump systems have been suggested for sludge removal due to minimal blockages, ability to pump concentrated solids and to mix sludge. However, limitations of using air-lift pump include that the specific gravity of sludge needs to be close to 1.0 and the flow rate can be limited.

The main problem with submerged pipes is they are only effective for removing sludge near the inlet holes. After a period of time, a sludge void may develop near the inlet holes, reducing sludge removal efficiency.

## Suspension Removal

Covered pond digesters have been developed to generate methane from flushed manure while reducing the sludge accumulation. This is achieved by connecting two ponds in series. The primary pond is for biological treatment of manure and biogas generation and the secondary pond acts as a solids drying bay and effluent storage (Figure 10). By agitating the solids in the primary pond, less sludge settles and more flows or is pumped to the secondary pond to settle. Desludging the primary pond is still generally necessary every eight to 15 years, by which time the pond cover may need replacement.



**Figure 10 – Schematic of covered pond digester**

## Life-time Accumulation

An extension of the suspension removal method is providing a larger sludge accumulation volume in the primary pond without including internal pond agitators. The effluent exiting from the CAP would not have a large solid content and, hence, would not require sludge settling before disposal. In this case, the larger pond excavation cost would need to be offset by reduced costs of sludge agitation and the construction of a secondary pond. As far as is known, no CAP has been designed with this concept in Australia.

## Advantages and Disadvantages

The choice of covered pond desludging method requires an economic and practical trade-off between: cost of larger pond construction, completeness of methane generation, functionality of sludge removal pipeline, and frequency of sludge removal.

The issue with sludge removal frequency is to maintain a balance between TS concentration and biogas production. If sludge removal is frequent (every few months), the sludge is likely to be relatively low TS and be fluid so that it can easily be pumped. However, the sludge would not be completely digested thus losing biogas potential.

## Key Points

- **Desludging a dewatered pond is a simple pumping procedure suited to infrequent desludging of large ponds.**
- **Desludging uncovered ponds containing effluent can be achieved by pumping, dredging or mechanical removal.**
- **Care needs to be taken when using pumps, agitators and dredgers in HDPE line ponds to ensure damage to the liner is not sustained.**
- **Desludging covered ponds can be achieved through in-situ sludge removal, installing a suspension removal pond system or building a large pond for life-time accumulation.**
- **Piggeries and feedlots should analyse the practicality and cost benefit of the desludging method before applying it to a specific pond system.**

## References and Further Reading

GHD 2008, In-situ desludging of anaerobic lagoons and sludge drying, APL Project Final Report, Australian Pork Ltd, Canberra, ACT.

Skerman, A et al. 2013, Queensland sedimentation and evaporation pond system (SEPS) trial, Final Report prepared for Australian Pork Ltd, APL Project No. 2009/2248.

Watson, M 1999, Continuous anaerobic pond desludging, PRENV.003, Meat & Livestock Australia Ltd.

## Other Fact Sheets in this Series

- Characteristics and Accumulation of Sludge
- Dewatering Sludge.

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