Passive systems for effluent solids separation (6-26)

The lowest energy use system for separating liquid from solids is via gravity.

Advantages for separating solids:
- Fewer blockages in irrigation equipment
- Reduced sludge build-up in storage pond
- Provides more liquid effluent which can be pumped over a greater distance
- Allows for strategic use of effluent solids, e.g. for cropping land

Weeping wall systems

Weeping walls are the most common method of passive solid separation. Raw effluent in a bunker is held in beds, effluent is separated by walls which are generally constructed of wooden slats or plastic panels. Liquid will seep through the gaps in the walls, leaving the solid effluent behind in the sludge bed. Effluent solids removed from sludge beds are generally a wet semi-solid effluent product. The top layers will be drier than the lower layers but on average the consistency would be similar to a fresh cow pat. This will be variable depending on the farm feeding and effluent system.

![Diagram of a weeping wall system]

Figure 1: A typical process for effluent separated in a weeping wall

Location of a weeping wall and sludge bed

It is important that the weeping wall meets all food safety, district and regional council rules and guidelines, for example the sludge bed needs to be at least 45m from the any milk contact point. Contact your milk processor, district and regional councils during the design period and prior to beginning any construction to ensure your design is compliant.

A key feature of the system is to make use of gravity where possible. Ideally the system will have a gravity inflow of raw effluent and the liquid fraction of effluent will gravity flow out to storage.
Principles of good design

- Should be designed by a specialist engineer
- Must take into account the weight and pressure of the effluent and any machinery used to empty the sludge bunker
- Effluent must not be able to flow around the outside wall and erode the wall supports
- The sludge bed floor should ideally be flat, with no slope
- Ensure sludge bed is sealed to prevent leaching. Reinforced concrete is best practice, however compacted clay or GCL (geo-synthetic clay) may also meet regional council requirements
- Have plenty of room for excavation machinery to enter/exit/turn. Tractor access ramps need a 1:4 gradient or lower, with grooves and a rough finish for traction
- Smooth 50mm wide wall slats with even 6-10mm spacing. Timber slats swell when wet so soak them before installing
- Ensure the weeping wall panels go right down to the sludge bed floor (for maximum drainage)
- Ensure the outflow for the liquid moving into the storage pond, is lower than the sludge bed floor, the open side of the weeping wall should never have liquid backed up against it (to allow the solids to dry out)

Figure 2 (left): A weeping wall with smooth evenly spaced slats
Figure 3 (right): A functioning weeping wall often squirts as well as weeps liquid

Management of weeping walls

- Check the weeping wall face regularly (every couple days) to make sure it is flowing/draining and there are no signs of blockages or damage
- Never let liquid back up from the storage pond against the open side of the weeping wall (or solids won't be able to dry out and weeping wall will be ineffective)
- Ensure solids never overflow the weeping wall
- Ensure foreign debris (autumn leaves) are removed from contact with the weeping wall to prevent blockages
- Plan to empty sludge beds when soil conditions allow spreading and nutrients can be best utilised
- Covering the sludge bed and use of effective storm water diversion systems may enhance the drying of the sludge bed.
Design criteria for Farm Dairy Effluent and flood wash systems (High liquid content)

- The sludge is the filter, maximise the distance from effluent inflow to weeping wall, ensure no blind ends are present (areas not directly between inflow and weeping wall)
- Ensure the sludge bed is long and narrow (minimum of 4 times longer from inflow to weeping wall, than the width)
- Slats generally 50 mm wide with gaps of 6-10 mm between each slat
- Volume rough rule of thumb: 1.5-2.0 L effluent solids/cow/day for farm dairy effluent only (more with feed-pad)

Design criteria for scraped feed-pad systems (Low liquid content)

- Have some weeping wall area adjacent to entry points for scrapings to drain off excess liquid; preferably horizontal slats to prevent blocking as shown in Figure five below.
- Square deep sludge beds tend to work best
- Smooth 50mm wide slats with even spacing, generally 6-10 mm gap size
- Volume rough rule of thumb: 15-20 L effluent solids/cow/24 hours, calculate with feed-pad use
Figure 5: A basic diagram for scraped feed-pad effluent passive solid separation system

**Safety**

The sludge often looks solid on the surface however most of the time it cannot support human weight. This could be very dangerous. Use signage and fencing to prevent unwanted entry to the sludge bed. It is a good rule to never work alone around the sludge bed.

**Drying Time**

The drying of effluent sludge is variable depending on the farm system, effluent types, and climate conditions. In New Zealand conditions there would seldom be extended periods without rain. Due to this, it is difficult to dry effluent sludge completely so it will likely remain a semi-solid.

**Nutrient Values**

Solids which have been separated by gravity will have high nutrient concentrations. Test the nutrient value of the effluent at a laboratory (most labs which do soil and pasture analysis will be able to do this). Use your nutrient budget and the DairyNZ FDE Spreading Calculator (found on dairynz.co.nz under Effluent) to determine land application rates.

**Storage of solids**

The separated solids can be stored and applied to land as a fertiliser. The storage area must sealed (pad or bunker), so there is no leaching of excess nutrients into ground water. Liquid draining from the effluent solids bunker must drain back into the effluent system. Ideally removed effluent solids will be stored in a covered area to ensure that it does not rehydrate and turn into an effluent slurry when it rains.

*Effluent solids should not be applied to land unless there is a soil moisture deficit.*
Alternative passive methods of solids separation

1. **Covered housing with basement bunkers** – some slatted floor feed and standing areas collect effluent in basements. These often have some liquid drainage from the base of the bunkers and use evaporation to help dry the bunker manure to a semi solid product. The success of these bunkers to drain the material is variable depending on the system and frequency of use. The air temperature will affect the drying of the effluent.

2. **Sludge bed with T pipe** - similar to a sludge bed with weeping wall. The effluent solids remain as liquid drains out via the T pipe. The solids will always remain sloppy and will be difficult to handle, however this system can prevent solids entering the storage pond and irrigation system.

3. **De-watering** – effluent is pumped into a large bladder made from a high strength, woven geotextile material called Geotube®, developed by the University of Georgia. Liquid drains out and solids remain. Incoming slurries of 4% DM can be de-watered to 25% solids.