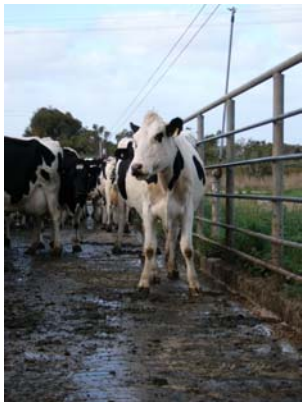
South East Dairy Effluent Guidelines

# Effluent management for large herds

*Guideline No 17.*



*Effluent systems that are designed for small herds cannot simply be made bigger to cater for larger herds. Issues associated with larger cow numbers, length of time the cows are at the dairy and greater volumes of water required to wash down yards and shed cleaning, all contribute to an overall increase in the amount of effluent that is produced at the dairy.*

*Management of dairy effluent from large herds can be improved by focusing on two main issues:-*

1. *Reducing the amount of effluent by reducing water use*
2. *Reducing the amount of odour produced through solids management*

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Compared to smaller herds, large herds deposit more wastes and nutrients at the dairy, yard and shed cleaning use more water, and create a larger waste volume. Setting up to manage the wastes produced is not simply a matter of making things bigger!

The most confronting issue with effluent management of large herds is managing the huge amount of effluent produced. Dairy shed effluent will produce some odour and the more effluent there is, the more odour that is produced. Odours are generated mainly from decomposing solids in the effluent – the so-called volatile solids.

Managing dairy effluent from large herds can be approached by focusing on two main issues:-

**1. Reducing the amount of effluent by reducing water use.**

Limiting the water use at the dairy and using recycled effluent for yard wash down will reduce the total amount of effluent which has to be handled and reduce the size of the wet weather storage which will be required over the winter period. This can save many thousands of dollars in pond construction costs and reduce the costs of pumping and annual costs associated with spreading the effluent.

**2. Reducing the amount of odour produced by:-**

- Separating solids from the effluent early in the waste management system, or
- Treatment of solids in a deep properly designed anaerobic pond, or
- Trapping solids in a “solids pond or trench” which operates as an anaerobic sludge pond with a surface crust.

## 1. Reducing the amount of effluent by reducing water use

The first step in reducing the amount of effluent is to try to limit the amount of fresh water that is used at the dairy. It is also important to limit or eliminate the amount of stormwater that enters the effluent stream.

Limiting the use of fresh water and diverting stormwater are both important in minimising the size of the effluent storage ponds that are required for winter storage when it is too wet to irrigate effluent onto pastures.

DairySA · National Foods · Dairy Farmers · Landcare South Australia · Warrnambool Cheese & Butter Est. 1888 · SENRCC South East Natural Resource Consultative Committee
Government of South Australia, Primary Industries and Resources SA · Rural Solutions SA · Australian Government, Department of Agriculture, Fisheries and Forestry · EPA South Australia · South East Catchment Water Management Board

Most large herds are milked on rotary platforms, with fresh water being used at the dairy for the following:

- Cup sprays
- Platform sprays
- Plate coolers
- Shed wash-down
- Machine wash-down
- Yard wash-down

Reducing the amount of fresh water used in many of these areas in the dairy will have a large impact on the amount of effluent produced.

***Reducing fresh water use – cup sprays***
Although the flow rates for cup sprays are not usually high they are often running for the whole milking. At a flow rate of 30 litres per minute they will keep the cups clean but use 10,800 litres per day, for six hours of milking.

**Reducing the flow rate to 10 – 15 litres per minute using a fine spray will prevent manure sticking to the cups and reduce fresh water use to 3,500 – 5,250 litres.**

On the last rotation the flow rate can be turned on full to 70–80 litres per minute, which will wash the cups. This rotation is usually about 10 minutes and uses 700–800 litres of water. The net effect is a reduction from 10,800 litres per day to between 4,200 and 6,050 litres. This strategy will reduce water use over six months by at least 855,000 litres.

***Reducing fresh water use –platform sprays***
Platform sprays keep the rotary platform clean during milking. They are often run for the whole milking using about 60 litres per minute, which amounts to 21,600 litres per day for six hours milking. However, unless there is manure that must be removed, the platform sprays can be left off until the last rotation, when they can be turned on full.

**They will use about 80 litres per minute for the 10 minutes of the last rotation, or 800 litres per day, which is a reduction of 20,800 litres per day.**

When this saving is combined with the saving from operation of the cup sprays, the reduction in water use over six months is **4.6 megalitres**, which is equivalent to an effluent pond 50x45x3 metres deep.

***Reducing fresh water use –plate coolers***
Plate coolers operate most efficiently at a water to milk ratio of 2.5–3.0:1. A herd producing 20,000 litres per day will use 50,000 litres of water at a ratio of 2.5:1.

The plate cooler water can be used for a number of things after passing through the plate cooler.

- It can be recycled through a water cooling system for re-use in the plate cooler e.g. a cooling tower system.
- It can be stored for wash-down.
- Water in excess of wash-down requirements can be used for a stock water supply.
- It can run direct to the effluent management system.
- Combinations of all of these suggestions can be used.

Plate cooler water must be good quality fresh water and is often sourced from a bore. It is a good idea to keep the amount going into the effluent stream as low as possible. Recycling of pond effluent to a flood wash tank will dramatically reduce the amount of fresh water used for wash-down at the dairy and allow the plate cooler water to be used in other areas.

***Reducing fresh water use – shed wash-down***
Shed wash down is typically done with hand held hoses with high flow rates – about 300 litres per minute. The volume of water applied tends to move the manure by its depth and momentum.

**Restricting the hose outlet using twist type nozzles can increase the velocity of the water, which enhances its ability to transport manure. At the same time, it reduces the water flow rate from the hose by one third to one half.**

Flow rates of this nature are unlikely to cause excessive spatter during wash down. Provided that the wash-down of the shed takes no longer, there is a potential saving of 3,000 to 4,500 litres per day for a 30-minute per day wash-down.

***Reducing fresh water use – yard wash-down***
Using twist type nozzles on yard hoses can reduce water use in yard wash-down as described in the section on shed wash-down.

A reduction in the amount of water used in yard wash-down can also be achieved through recycling of effluent from the second pond, of a two-pond effluent storage system.

This will reduce the amount of fresh water used at the dairy by as much as 50%. The continual recycling of effluent for wash-down will result in a more concentrated effluent. As the effluent becomes more concentrated a chemical called Struvite may form in pipes and fittings.

**For notes on managing Struvite see Victorian Agnote AG1038; Dairy Effluent; Struvite Management in Dairy Effluent Systems.**

***Reducing water use and the effect on effluent spreading***
Limiting the water use at the dairy and using recycled effluent for yard wash-down will reduce the amount of effluent which has to be handled and also reduce the size of the wet weather storage required over the winter period.

**This can save many thousands of dollars in pond construction costs and reduce the annual costs of pumping and spreading the effluent.**

The amount of effluent that can be spread per hectare is determined by developing a nitrogen budget **(Refer to *South East Dairy Effluent Guideline No. 16 – Nitrogen Budget* and *Nitrogen Budget Calculator computer program*).**

Implementing water saving techniques, such as effluent recycling, will result in a reduction in the volume of effluent but will not reduce the area required for effluent spreading. This is due to the effluent becoming more concentrated. If insufficient area is available, removing nutrients from the effluent can reduce the area required for effluent spreading.

***How can nutrients be removed from the effluent?***
Nutrients can be removed from the effluent by separating solids from the effluent stream.

Removal of solids from the effluent can be done by:

a) **The use of mechanical solids separators, gravity settling systems, and slurry trenches.** The separated solids can be used as fertiliser on other areas of the farm. **(Refer to *South East Dairy Effluent Guidelines No. 8 : Solids Separation Systems*).**
b) **Anaerobic digestion of effluent before passing to an aerobic storage pond.**
   Anaerobic digestion will reduce the amount of solids, and reduce the amount of nutrients, particularly nitrogen, in the effluent. The sludge and crust will need to be removed from the anaerobic pond after several years, and can be used as fertiliser on other areas of the farm. If necessary it can be moved off-farm.

c) **Extending storage times to allow breakdown of organic nitrogen and its release as gases.** This process also reduces the number of pathogens in the effluent, but requires a larger storage volume.

Reduction of nitrogen can also be achieved during spreading by using a spreading system that results in higher volatilisation of nitrogen.

***(Refer to section "The Amount of Nitrogen Lost as a Gas" in South East Dairy Effluent Guideline No. 16 : Nitrogen Budget).***

## 2. Reducing the amount of odour through the removal of solids from large Herd effluent

Compared to smaller herds, large herds generally require different management systems to remove solids. Systems that are designed and operate successfully for smaller herds cannot simply be scaled up and used for large herds. This is due to difficulties in handling the increased volumes of effluent and of wet solids.

Removal of solids from large herd effluent can be achieved through mechanical or gravity separation.

### *a) Mechanical separation*

There are many different types of solids separation machines designed to remove solids from effluent streams ***(Refer to South East Dairy Effluent Guideline No. 8 – Solids Separation Systems).*** The main types which have been used for dairy shed effluent are the **stationary run-down screen** and the **screw press**.

The **stationary screen** is capable of removing up to 65% of solids but has the drawback of becoming clogged with biological slime, which reduces its effectiveness. It requires regular cleaning to maintain its efficiency.

The **screw press** can remove up to 45% of the solids in dairy effluent and requires very little power to operate it.

The disadvantage of both systems is they have a relatively slow operating speed. For example, a screw press with a capacity of 115 litres per minute would take about 6 hours to process the daily effluent from an average 600 cow dairy.

Throughput of the separator can be adjusted by altering the amount of moisture retained in the separated solids. The dry matter can be adjusted to as high as 80–90% but the throughput will be reduced. Some down time needs to be built into the system to allow for repairs and maintenance.

Press Screw with Solids Extruding

Sufficient pre-separator effluent storage is required for at least two days in case of breakdowns. An agitation system is required in the pre- separator storage when the effluent is being pumped to the separator. To avoid "dead" sectors during agitation the pre-separator storage should be circular.

### *b) Gravity separation*

Gravity sedimentation systems rely on gravity to settle the heavier particles. Gravity settling has the potential to remove more solids than most alternatives but requires more management.

In closed ponds or slurry trenches the surface will crust over and the solids settle to the bottom. The effluent beneath the crust is drained into a storage lagoon.

During the cleaning process the crust is removed carefully with an excavator, then the settled solids are vigorously agitated so that they can be handled as slurry and removed with a vacuum tanker or manure pump. Cleaning should be done before the settled solids reach more than 50% of the depth of the trench or a solids content of greater than 8% in the agitated slurry. Slurries with solids content greater than 8% may be difficult to remove with a slurry tanker and vacuum pump. Thick slurries will require the addition of water to dilute them. This system can also be used with synthetic liners.

Sedimentation systems are usually a basin or terrace system. For basins and terraces settling occurs when the flow of the effluent is slowed as it spreads across the structure and the denser particles settle to the bottom by gravity. Settling basins should be shallow, typically 0.6–1.0 metres deep, long, wide and free draining with the effluent moving on to a storage lagoon. The design flow rate through the basin should be less than 0.3 m/sec with a hydraulic retention time of at least 20–30 minutes.

A front-end loader can be used to remove the solids every 1–2 months. Regular removal is necessary to prevent the development of septic conditions or sludge re-suspension. Two basins or terraces side by side can be used alternately, with one being filled while the other dries out for cleaning.

**Anaerobic digestion**

Anaerobic digestion is the breakdown of organic matter by micro-organisms in the absence of oxygen. The end products of anaerobic digestion of effluent include biogas that is comprised of methane, carbon dioxide, some trace gases and stabilized organic matter.

An anaerobic treatment pond is sized to accommodate the volatile solids loading. The pond size depends on herd numbers, cow size and the time cows spend in areas which contribute to the effluent flow into the pond. The design-loading rate is dependent on climate, which affects the biological activity within the pond. This governs the amount of solids that can be loaded into the pond per cubic metre of pond volume.

**The engineering details of anaerobic pond design are beyond the scope of these guidelines. For assistance in designing an anaerobic pond you should contact the SE Dairy Effluent Technical Field Service, 9 Old North Rd, CLARE SA 5453, Ph 08 8842 6272 or a waste management engineer.**

When properly designed, managed and not overloaded, the anaerobic pond can function for many years. A low-level musty odour is normal. A foul odour indicates a malfunction.

***Handling solids***

Separated solids can be spread on the dairy farm as a soil conditioner and fertiliser or they can be sold off-farm, particularly if they are low enough in moisture content to handle easily with loaders and trucks.

The method of handling the separated solids will depend on the moisture content of the solids. Vacuum tanks are suitable for slurries up to 20% total solids. Vacuum tankers provide flexibility of distribution, which maximises the nutrient utilisation and value of the waste. However, vacuum tankers have a high labour requirement. When the soils are wet, issues such as soil compaction with machinery wheels and traction problems can occur. Vacuum tankers are limited to small waste volumes.

Solid manure spreaders are suitable for materials with solids content greater than 20% total solids. They are the only method of getting an even distribution of solid material. The disadvantages are the high labour requirement, soil compaction caused by the machinery wheels and traction problems are common in wet soils.

***For more details on general handling of solids refer to South East Dairy Effluent Guideline No. 15 - Management of Solids.***

***Spreading the effluent***

Spreading the effluent from large herds will generally require a large irrigation system. This could be a centre pivot into which the effluent is injected, big gun travelling irrigators or a permanent sprinkler system.

Injection of dairy effluent into centre pivots and permanent sprinkler systems requires the sprinklers to be set up to handle the type of effluent injected.

Effluent, which is free of solids, either by settling or filtration can be spread through all types of conventional sprinklers. Effluent, which contains solids, will need to be spread through sprinklers that have been set up to handle solids.


***Centre Pivot Irrigator***

Conventional sprinklers will need to be fitted with flow control nozzles to minimise blockages that will occur when solids are present.

Impact sprinklers are able to handle solids that are smaller than the smallest nozzle diameter. These will generally have lower efficiency and uniformity than conventional sprinklers.

Big gun sprinklers are capable of handling larger solids but require higher operating pressures to operate. Both the efficiency and uniformity of irrigation are low. Big gun supply lines can be underslung from conventional centre pivot systems which will allow two separate methods of irrigation – fresh and effluent.