



A Partnership for Sustainable and Profitable Dairy Farming in Western Australia

ENVIRONMENTAL BEST PRACTICE GUIDELINES

6.0 EFFLUENT MANAGEMENT





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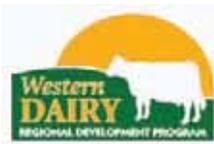
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Effluent Management



6.0 EFFLUENT MANAGEMENT

The information presented in this section is intended to help create useful tools to more effectively recover nutrients from dairy effluent and wash down waters.

Controlled application to pastures and trees is the preferred way to recover nutrients from dairy effluent. This is often called “effluent irrigation”, but the amount of water available from washing down dairies is usually not enough to be considered as irrigation because when you irrigate, you are normally providing enough water to satisfy plant needs. Applying this “by-product from milking operations” back on to pastures is more accurately called “fertigation”. It includes collecting the manure slurry, separating abrasive and clogging material from the flow stream and spreading them on pasture so the farming operation can benefit. A properly designed fertigation system is a tool that collects nutrients and spreads them evenly, using the terrain and vegetation for maximum benefit, as cost effectively as possible. All farm soils require nutrient application to replenish what is removed by grazing, harvesting, leaching and erosion.



A tranquil sight across the southwest and great southern regions of WA

Dairy effluent and manure are an excellent nutrient source; however, they don’t store as easily as synthetic fertilisers, nor are they as easily handled due to their bulk and the presence of abrasive and clogging objects. The equipment used to collect and spread this slurry of diluted organic material is generally designed specifically to meet these challenges. Since many of the nutrients are bound organically, they are released more slowly than synthetic fertilisers, and if managed properly, pose less risk to the environment by run-off or leaching to ground and surface waters. On areas close to surface water, it is actually better to apply effluent nutrients rather than synthetic fertilisers, if adequate care is taken.

The organic material contained in effluent also improves soil structure and water retention capacity.

Generally speaking, it is better to handle effluent with the least amount of storage time possible because nutrient losses can be significant before it reaches the pasture. Some of the phosphorus (P) and potassium (K) can settle in the still conditions of a storage pond where they are difficult and costly to recover. Much of the valuable nitrogen (N) is lost through ammonia escape or biological denitrification and evaporation can raise the salinity level of the water. Nevertheless, storage can be useful for other reasons, such as separating particles that can clog irrigation equipment and making it possible to integrate fertigation into farming routines. In some situations, cost-effective storage is impossible due to soil type and ground water conditions. Building a storage pond that leaks or fills with groundwater can cause more harm than good and locating it incorrectly can make ongoing management more expensive.

Risks Associated with Nutrient Recovery from Effluent

Applying manure to pasture as soon as it is collected is better than storing it because this is when its nutrient value is at its highest and the environmental risk is lowest. It is important to distinguish between actual risks and perceived risks. When wash-down water is applied to pasture daily or weekly, the nutrients are more likely to be spread gradually to actively growing vegetation. Even if it is raining on some application days, it is still a minimal overall risk. During the autumn and spring, dryland pastures are in peak production but growth can be very slow over winter if the soil becomes waterlogged. Neither effluent nor chemical fertilisers should be applied to waterlogged soils where there is a risk of surface runoff carrying nutrients into drains. In addition to the information contained here, the Department of Water has developed Water Quality Protection Notes that recommend precautionary measures you need to have in place if you intend to apply nutrients with your irrigation water. These are referenced under [*Further Information*](#) and can be downloaded online.

These guidelines relate only to the application of dairy effluent to pasture and cereal crops. They do not apply to the application of effluent to fruit or vegetable production enterprises where application guidelines are different due to the higher risk of direct impacts to public health.

Some perennial pasture species are winter dormant, others are winter active. If manure is applied to annual pasture during the summer, some of the nutrients may be leached through the soil profile with the opening rains of autumn. It is no different from top dressing annual pasture with fertiliser before the break.

Top dressing pasture with manure reduces pasture palatability for a while. Therefore it is best to graze the area before applying the slurry and **withhold stock for at least seven days.**

Some of the effluent processing facilities described in these guidelines provide breeding sites for mosquitoes and other insects that potentially could result in adverse impacts to humans. Nuisance insects include (but are not limited to) mosquitoes, biting midge (ceratopogonids), and non-biting midge (chironomids).





The risk of exposure to mosquito-borne diseases such as Ross River Virus, Barmah Forest Virus and Murray Valley Encephalitis varies throughout the state. Generally speaking, several important vector mosquito species in WA will disperse over three kilometres from their breeding sites which include natural wetlands, floodplains and other water bodies.

Although the breeding of mosquitoes is less likely in open ponds, this likelihood increases with the presence of fringing vegetation. Similarly, the high nutrient levels in ponds may be favourable for some species. Using insect repellents and wearing loose fitting clothing during periods of high insect activity is recommended.

Information on recommended annual rates of N & P in kg per hectare based on plant needs, soil reserves and environmental risk are provided in KW Angell 1999 publication entitled *Fertilisers for pastures on sandy soils of the Swan Coastal Plains* (DAWA Bulletin 4357) and in BK Kingdon's 2000 publication entitled *Fertiliser use guidelines for the Swan Coastal Plain of WA* (Vasse-Wonnerup LCDC). The environmental impact of nitrogen and phosphorus application in high rainfall areas is discussed by R Summers in DAWA Farmnote 68/2002.

All dollar figures listed in these guidelines are based on April 2005 values. Most of the **Further Information** listed can be traced using www.scholar.google.com or by contacting your local Department of Agriculture office.

Further Information

Department of Health Western Australia. 2004. Mosquito Management Manual. 350pp.

Department of Water. 2006. Vegetation buffers to sensitive water resources. WQPN 6. Available online at www.water.wa.gov.au

Department of Water. 2006. Nutrient and irrigation management plans. WQPN 33. Available online at www.water.wa.gov.au

Mosquito Control Association of Australia. 2002. Australian Mosquito Control Manual.



6.1.1 COLLECTION OF DAIRY EFFLUENT

Where possible, wash-down water from cleaning the milking machine, shed and yard should be consolidated at a single location as close as possible to the source to remove abrasive and clogging material so it can be pumped to an application area for nutrient recovery. For proper hygiene and maximum product integrity, the milking shed and cool room should be adequately shielded and distanced from all effluent collection and processing areas to ensure minimal impact from flies or other pests.

To comply with hygiene and environmental requirements, dairy sheds and holding yards must be cleaned after each milking. The cleaning method and yard design features influence the volume of water used. Anything that can be done to reduce wash-water consumption will save power to pump water to the dairy and reduce the volume of effluent that needs to be transferred out to application areas, again saving power.

The amount of effluent is reduced by limiting the time cows spend at the dairy shed and surrounding areas. The less manure deposited, the less water will be needed to clean the yard. Handling cows quietly also reduces the amount dropped in the yard. Mechanical removal of manure prior to hose-down can reduce overall water use, pond sludge holding capacity and subsequent effort in sludge handling.

Implementing good practice

Cleaning and the collection of runoff can be made easier by:

- pre-wetting the yard
- using a high volume, low pressure washing system
- building a yard with a good slope: it is safe to use a slope of up to 1:30 as long as a grit mix is used for the surface

Low pressure, high volume wash-down systems are most efficient. As well as saving time, they cause less splashing on walls and fences. The higher water volume required by low pressure systems is offset by reduced washing time; actual water usage is similar to high pressure systems.

Wash-down systems should be designed to deliver around 250 litres of water a minute at 100-140 kPa of pressure. The wash down hose should have a diameter between 38 and 51 millimetres, should be no longer than 9 metres and the number of right angle bends in the delivery system should be kept to a minimum.

Shovelling off the solids plus pre-wetting before wash-down uses least water but is probably only a practical option for smaller herds. Sprinkler systems installed to cool cows in summer also keep the yard wet, making cleaning quicker and easier without using much extra water.

Some farmers are using a flood washing system where a large quantity of water is flushed from a pipe at the highest point of the yard. This technique reduces the time taken to clean the yard but it uses a lot of water.

Flood washing recommendations include:

- using 500 litres of water per metre width of the yard and achieving an approximate water velocity of 1 metre per second over the yard
- having a minimum grade for rapid flush of 1:50 with a cross yard slope of only 25 mm at the top of the yard, increasing to a greater slope at the bottom to direct the large volume of water to the outlet
- the sump receiving flood-wash liquid should be at least big enough to hold the volume of water discharged in the operation of the tank. The trafficable sump constructed to receive these higher hydraulic surges has to be larger than those for hose-down systems



The first and most important step in managing effluent is to remove abrasive and clogging material. Sand and gravel will reduce the reliability and life of pumps and once they enter the discharge pipe they tend to settle. This can reduce the performance of pumping equipment or the ability of gravity pipes to carry water. Clogging material such as plastics, hoofs, horns, silage wrap and rope can also cause maintenance problems and should be trapped by a straining device before pumping. To function properly, solid traps must be cleaned regularly.

When transferring liquid from one point to another before settable or clogging material is removed, it is better to use spoon drains or channels instead of pipe because they are more easily cleaned.

When designing a dairy, the attention spent making sure you have the right sized equipment, properly located hoses, effluent receiving chambers, sumps and pumping equipment can reduce operator time, extend equipment longevity and reduce the frustration of milking staff who must maintain it. Cleaning the dairy and recovering the nutrient value of the manure that is dropped while cows are being milked or handled is part of the operation. Attention to this aspect can make dairying more enjoyable.





Benefits

- comply with regulatory authorities
- dairy effluent can be used as a fertiliser and soil conditioner
- keeps dairy and cows clean
- reduces cleaning time if designed properly
- improves neighbourly relations
- less fly breeding
- improved herd health

Liabilities

- capital invested in infrastructure
- higher power consumption if not designed properly
- equipment depreciation if not designed properly
- management time and effort

Costing

No two dairy farms are alike and each will have unique characteristics. The cost of collecting effluent depends on number of different factors such as:

- size of operation
- geography (slope and soil type)
- availability of power, trade labour and capital inputs
- existing infrastructure

With respect to returns on investment, the cost of labour needed to operate an effluent management system will normally be more than the savings from reduced fertiliser purchases, in the short term. However, not managing your effluent properly will cause environmental health problems, make it impossible to keep staff and reduce the overall value of your milk cheque.

Further Information

Dairy Industry Nutrient Strategy Working Group. 1998. Environmental management for animal based industries-dairy farm effluent. Department of Agriculture, Western Australia.

Wrigley, R. 1994. Managing dairy shed wastes. Vol 2. Dairy Research and Development Corporation, Victoria.



6.1.2 SOLIDS SEPARATION

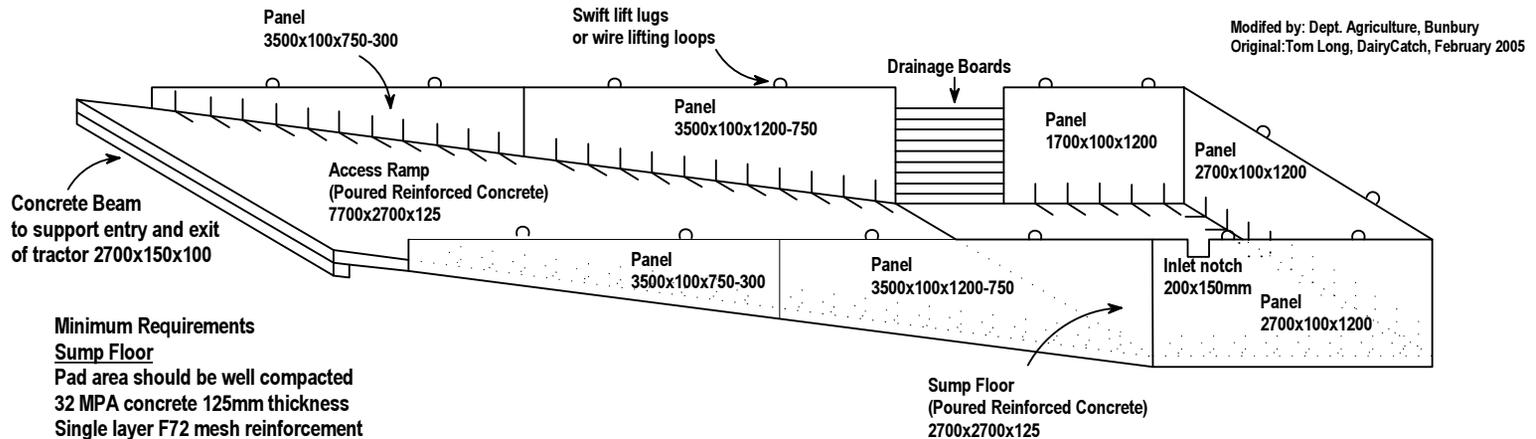
Removing solids from dairy effluent makes management easier and allows for the application of solids to pastures. Sand, sticks, gravel and other material must be removed before effluent enters a recovery system. Removing these solids reduces the wear and tear on pumps, sand-clogging of pipes and prevents storage ponds from silting up as quickly.

A common type of solid separation system used in dairies is the trafficable sump. The general layout is shown in Figure 6.1. The size of the dairy herd will determine the type and size of solid separation system needed. However, for most WA dairies, the trafficable sump is the appropriate system.

A solids removal pit/trench can also be constructed at far less cost than a concrete trafficable sump. A solids removal pit/trench is built by laying a floating barrier across the width of the pit that is long enough to drop down to the floor of the pit when it is empty and rise to the top as it filled up. This barrier holds floating solids away from the drainage end of the pit and can be as simple as a length of 75-100 mm polyethylene pipe fastened at each end to the pit (Figure 6.2).

A drainage wall can also be placed at the discharge end of the pit for access by pump suction or gravity-flow pipe-work. Figures 6.3 and 6.4 present two alternative types of drainage wall designs.

Prefabricated Trafficable Sump with Drainage Wall (Standard Length 10.5m - 13 cubic metre capacity)



Minimum Requirements

Sump Floor

Pad area should be well compacted
32 MPA concrete 125mm thickness
Single layer F72 mesh reinforcement

Panels

32 MPA concrete 100mm thickness
Single layer F72 mesh reinforcement
Re-entry bars 200mmx200 reinforcement steel "L's"
at 300mm spacings along base of panel, 65mm from bottom edge
2 swift lift lugs at top of each panel for lifting, or
expose two loops of wire in top panel, cut from F72 mesh,
tie securely into mesh.

Sealing

If clay is not present in the soil profile down to 2m,
seal the area near joints with clay
from an external source before backfilling.

Drainage Wall Boards

1000x100x40mm
held in place by 2 lengths of 75x40mm channel steel
Channel steel fastened to concrete using dyna bolts

DETAIL OF WEeping WALL DRAINAGE BOARDS

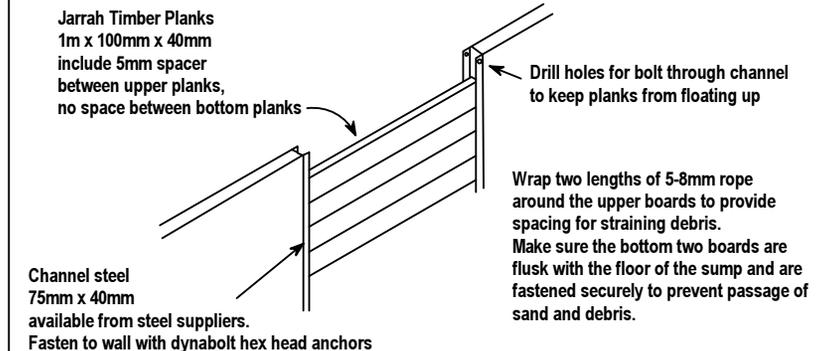


FIGURE 6.1 Diagram of prefabricated trafficable sump with drainage wall

Discharge from the solids removal structures can be by pump with strainer or foot valve floated just under the surface. Deep and narrow pits can be cleaned out using a backhoe or by excavator for base width not exceeding five metres for single- side access and ten metres for two-side access.

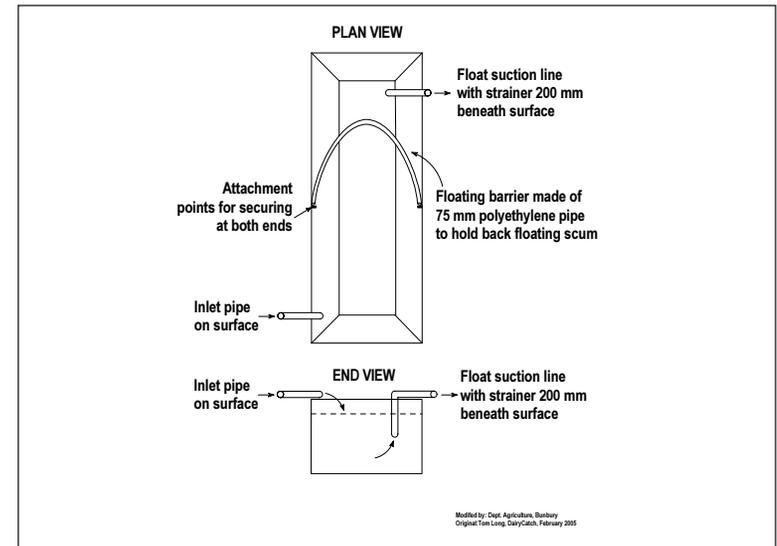


FIGURE 6.2. Diagram of a solids removal trench with a floating scum barrier made of polyethylene pipe



FIGURE 6.3. Drainage wall constructed of reconstituted limestone blocks



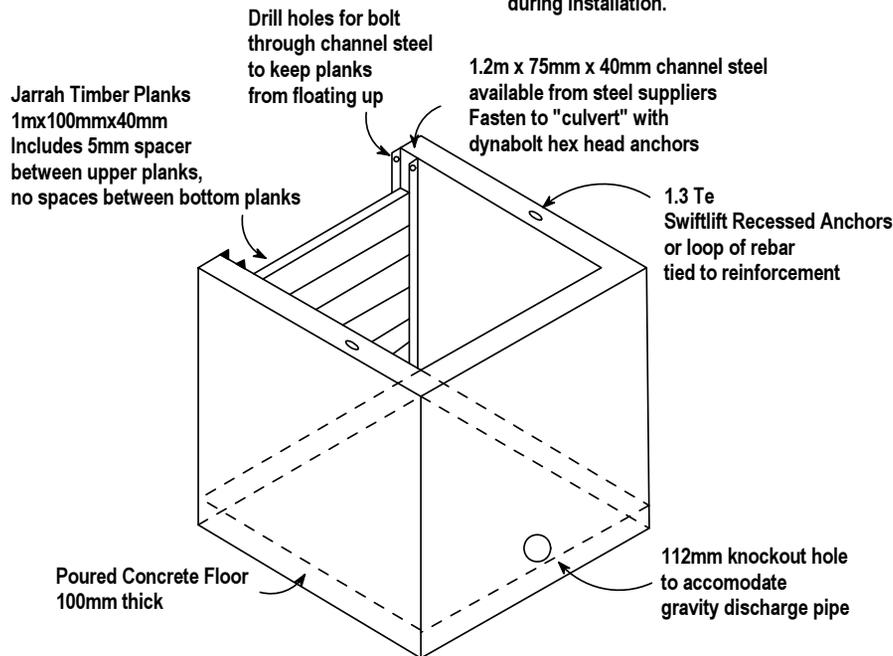
Implementing good practice

Although no two dairies are exactly the same, below are some generic considerations that you need to take on board:

- Solids must be removed from effluent to increase the capacity of effluent management systems, avoid plumbing blockages and decrease sludge build-up in ponds
- Your chosen design should allow for solids removal using a tractor fitted with a front-end loader to do the heavy lifting. The slope of the ramp should take into account the drive system of the tractor you intend to use. 4WD tractors require less of an angle than 2WD tractors
- You need to empty the sump when the level of solids reach half way up the inlet side of the sump
- If the solids are to be stored prior to use or sale, drainage should be directed back into the effluent management system. If this is not possible, try to direct the drainage into vegetation that will capture the nutrients. What you need to do will depend heavily on the characteristics of your individual site
- Sumps should have sufficient capacity to hold twice the volume of effluent produced from washing down the dairy and associated areas after a single milking. Sumps should be protected from paddock run-off
- To enable rapid drainage, the sump inlet should be positioned to drop the effluent into the deep section of the access ramp, away from the drainage wall as this is easily clogged by sand (Figures 6.3 and 6.4)

Box Culvert with Drainage Wall / Pump Chamber

900 "High Culvert"
Available from most prefabricated concrete suppliers, modified by installing two extra swiftlift anchors on one end to facilitate lifting during installation.



Bill of materials

Quantity	Item
1	900 High Box Culvert (delivered)
2	Bag Concrete
8	Timber Planks Jarrah 100mmx40mmx1m
2	Channel Steel Galvanised 75mmx40mm
8	Dynabolts Galvanised
2	0.5mmx10mm bolts with nuts

Assume 3 hours labour and
1 hour tractor time

Tools required

Hammer drill
Tractor capable of lifting 940kg
Spanner & 12mm socket

Modified by: Dept. Agriculture, Bunbury
Original: Tom Long, DairyCatch, February 2005

FIGURE 6.4. Diagram of box culvert drainage wall

- To enable the sumps to drain properly, a spacing of 8 to 10 mm is required between the timber baffles forming the drainage wall. Some sumps work very well by closing off all the drainage wall and allowing flow to pass over it. To make this function better, a baffle can be floated upstream to help start the formation of a mat that traps floating material. Some effluent pumps can handle up to 12 mm solids. Typical sumps with 13 cubic metre capacities require one square metre of drain wall area. Some sumps are designed with overflow walls that work better with no gaps. The bottom boards should be fastened to the floor or else plenty of weight must be placed on the top board to prevent it from floating up. Any gap will allow sand to penetrate the wall
- Where a solid screen or centrifuge system is used, it should be located on a hard stand area which is bunded and drained to ensure any run-off is directed back into the effluent treatment system.

Costs

Building a trafficable sump with form work can be twice as expensive as one built using bunker walls or pre-cast concrete. Installing a solid separation system during the building a new dairy is often cheaper than putting one in after the dairy is built. Annual costs associated with routine solids removal are higher than those for the trafficable sump, but pits/trenches are able to handle large amounts of solids through an entire wet season.

Further Information

ARMCANC, ANZECC. 1999. National water quality management strategy. *Effluent management guidelines for dairy sheds*.

Dairy Industry Nutrient Strategy Working Group. 1998. Environmental Management for Animal Based Industries- Dairy Farm Effluent. Western Australia.

Department of Agriculture. 1998. Farmnote No. 41/98. Trafficable Sumps. Department of Agriculture Western Australia.

Latto, A, Noonan, J and Taylor, R. 2000. Environmental Guidelines for New and Existing Piggeries. Bulletin 4416. Department of Agriculture Western Australia.

Newman.L. 2004. Estimates for Components of Busselton Ell Dairy Effluent Management Projects. Water Corporation, Western Australia. (unpublished)



6.1.3 DAIRY PONDS

Ponds are the conventional method used to store effluent on dairy farms in Australia. In conjunction with a means of solid separation, a single pond system is normally designed to hold the maximum quantity of waste produced over a designated period. Ponds can be designed to be both the solids separation system and storage mechanism. This can be done by trapping floating material behind a barrier and having the inlet-end of the pond designed shallow enough for solids removal using a backhoe or excavator at routine intervals.

The organic component of effluent may break down in a pond. The amount of this break down is related to holding time and ambient temperature.

Ponds should be constructed on clay and situated well away from watercourses and shallow underground winter springs. Ponds make it necessary to double-handle the effluent, but they also make it easier to coordinate nutrient recovery with routine farming operations.

Storage ponds are an option when you have sufficient land and permeability soils but are not and necessarily an essential component of every effluent management system.



Plastic-lined effluent ponds are an expensive option for permeable soils

Dairy ponds are a means of storing effluent, not treating it. Some loss of nutrients occurs during storage due to the breakdown of carbon and loss of nitrogen to the atmosphere. The degree of change that takes place within a pond system is not enough to make the liquid suitable for direct discharge into any surface or groundwater body. The nutrients available in effluent are too valuable to neglect.

The anaerobic processes that occur in a pond partially breakdown organic solids components and reduce bacterial counts. However, they don't have a huge effect on nitrogen and phosphorus levels. Storage ponds allow you to apply nutrients to pasture at specific times to reduce the need for commercial fertilisers. Correct recovery procedures are important to prevent water pollution and are discussed further in sections 6.1.5 and 6.1.6.

Ponds should be long and narrow rather than large squares because wide ponds are more difficult to clean with an excavator. The base width should not exceed the reach of an excavator from both sides (normally 18 metres). Wider bases can cost twice as much to clean. The floor of a pond should be designed with a gentle slope, the shallow end being the inlet and the deeper end the outlet. Effluent should enter the pond at the shallow end where most solids settle. Not only will this make cleaning the pond easier, it also allows for more solid-free effluent storage and better fertigation.

Two pond systems are a more expensive alternative that consist of a primary shallow pond for solid settling followed by a long, deep secondary pond for effluent storage. The advantage of this design over the one-pond system is that the first pond also holds back floating material making irrigator clogging less of an issue and eliminating the need for a trafficable sump that is generally necessary for a single storage pond system. Some older two pond systems consisted of a deep primary pond, to promote anaerobic breakdown of solids, followed by a shallow secondary pond to aerate the effluent. This was regarded as a way of treating effluent, rather than storing it and is not recommended.

Another way to convert a single pond so it more effectively holds back floating scum from the suction pipe-work is to float a barrier across the width of the pond to hold the mat of floating material away from the discharge end of the pond. A large diameter polyethylene pipe fastened at each end can make an effective baffle (see Figure 6.2, Section 6.1.2).

If continuous controlled application to growing pasture is not possible, for instance if soils are waterlogged over winter, extra storage may be required. This can be achieved by either extending the existing deep pond or constructing an additional one.

When constructing either type of pond, remember that water is eventually going to have to be removed from it, most likely using a pump, so install a suction pipe through the berm wall at ground level before piling up soil to build it. Float the suction end of the pipe about 200 mm below the surface with a strainer and/or foot valve and strainer. If you don't heed this simple advice, be prepared to spend far more money on a pontoon pump and visit snakes in deep grass every time you need to work on the system.





Implementation

If the application site is down-hill from the pond surface, install an anti-siphon device on the pump discharge. This will keep the applicator from dribbling forever after the pump shuts off. You are not saving money without such a device because dribbling effluent doesn't spread well and you are certain to get covered with effluent every time you have to do something to the applicator.

Where a pump does not have a flooded suction, it can be difficult to prime the pump. In these cases it is a good idea to put a foot valve on the end of the suction pipe.

Attaching several non-degradable ropes to the suction lines can make it easier to control the location of the pipe end and make it easier to pull over to the side of the pond to clear blockages.

Ponding systems should be designed on the basis of environmental and hydrological factors, not just on the number of cows in a milking herd. Designing the ideal system is a complex task. It is always worthwhile to seek advice from someone with a proven track record in effluent management/nutrient recovery. Table 6.1 provides a simple comparison of some different design options.

Table 6.1. Comparison of different effluent management systems designed for daily or regular land application (adapted from Skerman and Biggs, 2003).

System	Reliability	Wet weather storage	Labour cost	Capital cost
Sump & gravity flow	Low	None	High	Low
Sump, pump & sprinkler	Medium	None	Low	Medium
Sump, pump, temporary storage & sprinkler	Medium	Some	High	Low
Sump & tanker	Low	None	High	High

Regardless of the number of ponds in the effluent management system, two types of storage volumes must be provided:

1. **Sludge storage volume** - to store the solids that settle from the effluent and
2. **Wet weather storage volume** - to store liquid effluent during periods when the land is flooded and too wet for fertigation (fertiliser application could run off), or until the timing of fertigation suits early germination and/or summer cropping

In a single pond system, each of the two treatment/storage volumes described above are provided in one pond (Figures 6.5 and 6.6). In a double pond system, sludge storage volume is provided by the primary pond and the wet weather storage volume in the secondary pond (Figure 6.7).

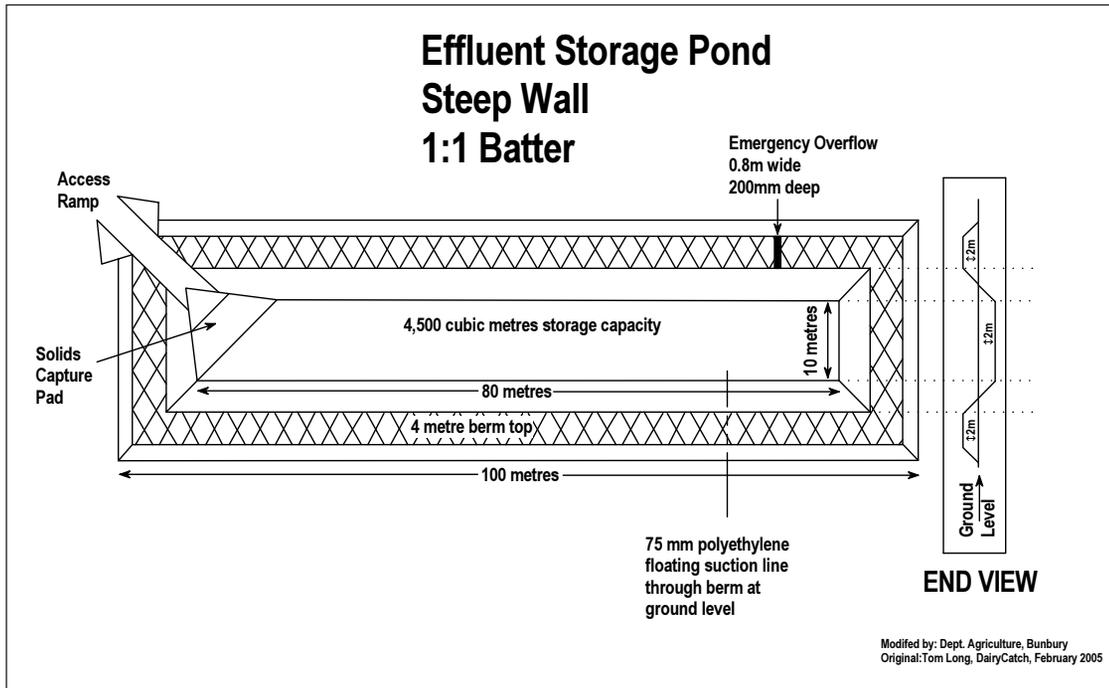


FIGURE 6.5. *Diagram of single pond design*

Building a ramp with access gate into the pond at its shallowest corner makes cleaning sludge easier and cheaper.



FIGURE 6.6. *A single storage pond at the McDonald Monitor Farm in Jindong*

Installing a floating suction hose (75-100 mm diameter) next to the laneway at ground-level through the berm wall at the lowest elevation possible will provide cheap removal and labour savings. This makes it possible for a pump to operate at maximum efficiency with a “flooded” suction and minimise suction lift when liquid level in the pond falls below ground level.

Siting

Ponds should be located away from farm boundaries, dwellings and sources of water.

The more visible and accessible the pond is from the dairy, the more likely it will be managed properly.

When possible, arranging the inlet for a pond without any windbreak at the down-wind end can help hold the floating mat of scum away from the pump suction, especially when a floating physical barrier is used as well to control it.



FIGURE 6.7. Two pond system at Hayes Dairy in Cookernup

Overflows must be contained on the owner's property and must not be allowed to flow into water-courses, drains and ground water systems!

Soils, topography and the availability of suitable storage, treatment and dispersion equipment are the major factors associated with siting and deciding what system best suits your property. You should conduct a site soil investigation before planning a pond to assess the suitability of clay soil and depth of the watertable.

Siting the pond next to main laneways and at laneway junctions makes it easier to access the effluent for pumping. This also makes it possible to use a cheaper pump that can be set in or near the laneway where it is easy to refuel and maintain.

Size, shape and storage capacity

The larger the herd, the greater the volume of waste and therefore the larger the effluent management system. The size of the pond is determined by the daily wash-down water volume, rainfall catchment area of the shed and yard, length of storage period and amount of rainfall capture. Pond size should take account of future increases in cow numbers. It is always better to be a bit larger than your current requirement.

Single or multiple storage ponds can be designed to hold all the effluent produced from a dairy for a specified storage period to prevent the ponds from overflowing and causing environmental damage. You should factor in water from major storm events (10 year average return frequency of 72 hour event; Pilgrim, 1997) plus accumulated water stored during non-irrigation period (90 percentile wet year) **plus** allowance for freeboard to counter wave formation in ponds with a reach exceeding 50 metres. There is no reason stored nutrients can not be pumped from the pond to the application paddock during the wet months if pastures are relatively dry and it isn't raining enough to cause run-off losses to surface waters.

Depth

Ponds are generally two metres deep, with an extra 0.2 metre freeboard required when the banks have settled, to allow for storage of direct rainfall on the ponds.

Soil profiles significantly influence the design depth of a pond. Ponds should not intercept gravel beds. If gravel beds, sand layers and cracking clays cannot be avoided, ponds should be lined or direct application needs to be considered.

To calculate the required pond storage capacity, the anticipated storage period needs to be determined. This is the period between effluent collection and its safe application to pastures. Normally, the storage period is the period when average rainfall exceeds average evaporation in a region. The average storage period for the southwest coastal region of WA is presented in Figure 6.8.

In some situations the storage period is extended when ponds are emptied by shanding effluent with flood irrigation water through the farm irrigation channel system. The effluent has to be collected and held until the irrigation season begins.

Rainfall and evaporation data for different regions is available from the Bureau of Meteorology at www.bom.gov.au



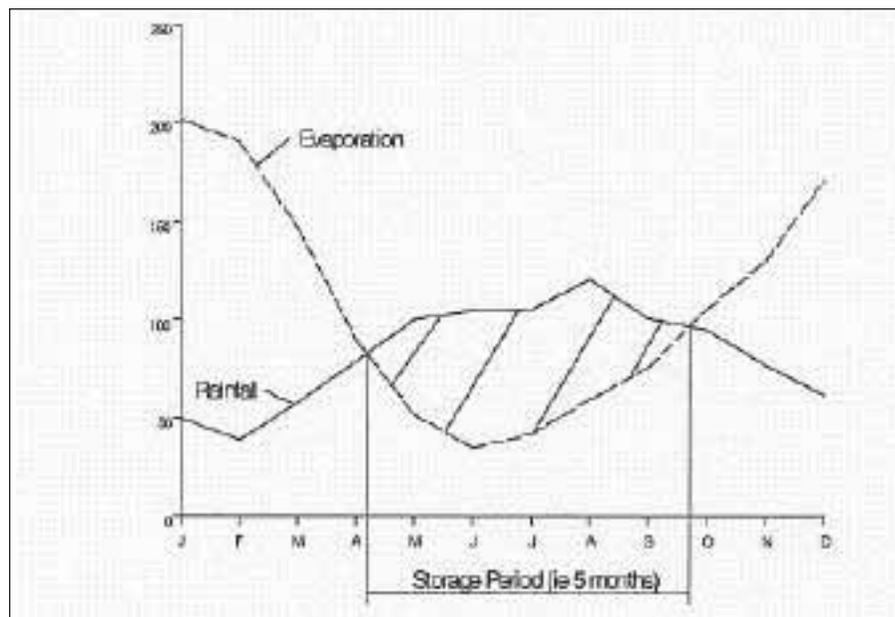


FIGURE 6.8. Average storage period of effluent in the south-west coastal region of WA

If you plan to store nutrient-rich effluent for use on a summer crop or for flood irrigation, the following formula can be used to estimate the pond storage capacity required:

$$V = A + B + C + D$$

where:

- V = pond volume
- A = effluent produced - The amount of wash and cooling water (that is, teat wash, machine wash, yard wash, cooling plate water) delivered to the storage pond during the expected storage period
- B = stormwater off shed and yards - The amount of rainfall runoff from the milking shed roof's, yards and stock races which cannot be diverted away from the effluent system in a year of high rainfall (the highest rainfall expected in the storage period in a 10 year cycle, also called the 90th percentile rainfall figure)
- C = rainfall onto pond surface - The amount of direct rainfall on to the pond in a year of high rainfall
- D = freeboard - The volume taken up with the required 0.2 metre freeboard on the storage pond.

Site preparation

All topsoil should be cleared and stockpiled. The crest of embankments should be a minimum width of 3 metres, 3.5 metres being preferable for ease of construction and to allow for vehicle movement during cleaning and desludging. Width is usually dictated by the width of earthmoving equipment.

Both internal and external banks should have at least a 1:1 batter slope (1 metre in the vertical for every 1 metres in the horizontal direction), to prevent banks slumping and to allow for free machinery movement. Banks will not slump if you use good sealing clay. If you don't have sealing clay, think how you are going to seal the pond before you do anything else.



A dozer being used to build the effluent pond at the Gulberti dairy near Busselton

Using a bulldozer to construct the pond usually produces walls that are less likely to slump.

Think about how you will empty the pond before you start building it. A bottom pipe may enable gravity feeding of the liquid directly into an irrigation system. Alternatively, a bottom pipe with floating suction allows use of a cheaper close engine mounted pump, a significant saving over pontoon-mounted pumps.

Sealing

Ponds constructed on soils containing less than 20 percent clay require sealing. Texture can be estimated using a simple "Ribbon" test. This involves plying a small moist ball of soil between the thumb and forefinger to produce a 50-75 mm long ribbon. Soils with lower clay content will crumble before they reach this length.



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If this happens, clay from another area should be placed 15 centimetres thick and compacted with 15 centimetres of existing soil on the pond floor and walls. Lining a pond with clay will generally cost more than the excavation and more than double construction costs. If you have very sandy soils, you may be better off designing a direct application system. Sites with cracking clays should be avoided.

Operation and maintenance

Ponds should be emptied every year to prevent a build up of salt; the remaining sludge should not be more than half a metre deep. Sludge can usually be removed with an excavator or with a pump and vacuum tanker.



FIGURE 6.9. Cattle should be kept off embankments to avoid damaging the pond and themselves. Readily accessible ponds are a hazard to unsupervised children.

Ponds should be emptied twice a year if practical, after the autumn break and again in spring. Emptying in autumn means that you will have maximum storage capacity over winter, reducing the risk of your pond overflowing. Emptying in spring allows you to apply nutrients to rapidly growing pasture and before evaporation over summer concentrates the salt to potentially dangerous levels. If you do not empty your ponds regularly, you should check the salinity level before you apply the effluent to sensitive pasture. It is better to pump effluent onto pastures between rainfall events than to have ponds overflow.

Cattle should be kept off embankments to minimise bank damage until grass has established (Figure 6.9). Periodic grazing with sheep can be useful in controlling the level of grass around ponds. As soon as construction of ponds has finished, a fence should be erected to keep children and stock away from ponds.

Benefits

- Waste management practice acceptable to regulatory authorities
- Pond systems do not require daily attention
- Pond systems allow the timing of effluent irrigation to be managed to suit pasture or cropping requirements, and other farming practices and constraints
- Pond systems can often be designed to intercept contaminated runoff (by gravity flow) from feed pads, earth yards and regularly used laneways located close to the milking shed
- Well managed fertigation from a suitable pond system reduces the potential for contamination of surface and groundwater by runoff and deep drainage of nutrients, pathogens and other contaminants contained in the effluent
- Pond systems enable effluent fertigation to be integrated with the main farm irrigation system. This may allow shandyng of effluent and the more effective utilisation of the nutrient value of the effluent over a larger, more productive area of the farm
- Pond systems provide opportunities for recycling effluent for yard washing. Recycling is better suited to multiple pond systems because of the lower effluent solids content, the ability to use pumps not designed to handle high levels of solids and the reduced risk of pipe blockages

Liabilities

- Need suitable soil types to construct a low permeability pond
- May not be feasible in areas with rock outcrops or high groundwater levels
- Lower nutrient value in liquid effluent compared to continuous application systems
- Ponds require regular desludging. Sludge generally requires drying and processing (eg composting) before application to land
- Ponds occupy potentially productive land areas
- Ponds may be odorous, primarily if they are not designed and operated correctly, but also during start up and following desludging
- Pond systems may require more pumping equipment, unless they are supplied by gravity flow from the milking shed and associated yards.

Costs

Cost varies with many site factors such as soil type, rainfall and herd size. Nevertheless, pond systems remain attractive because they are relatively low in cost, can be constructed in two to three days and have low maintenance requirements.

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6.1.4 LAND APPLICATION: HOW, WHERE AND WHEN

Application of effluent to vegetation is the preferred means of nutrient recovery from effluent. This is fertigation using a biologically active material meaning the sooner effluent is applied to pastures the more nutrients will be available for immediate use by actively growing plants or stored in the soil for later uptake.

Nutrient retention capacity varies between different soils and nutrients, so where you apply the effluent is a very important aspect of your effluent management plan. If managed properly, fertigation with dairy effluent will enhance productivity and improve soil structure. Effluent is a slurry of slow release organic fertiliser and must be applied evenly and at appropriate rates to achieve maximum economic benefits. The rules that apply to chemical fertiliser use also apply to fertigating with effluent. Inappropriate application diminishes economic benefit to the farming operation and can cause environmental damage.

Applying effluent to land is an attractive means of recovering an abundant supply of nutrients but it can pose a serious environmental risk if not done properly. This is recognised in the *Environmental Protection Act (1984 as amended)*. As a farmer wanting to take advantage of reusing effluent and sludge on your land, you have a moral and legal obligation to ensure that it is carried out in an environmentally sustainable manner. You need to identify and minimise potential risks. In addition to the information contained here, the Department of Water has developed Water Quality Protection Notes that recommend precautionary measures you need to have in place if you intend to apply nutrients with your irrigation water.

These are referenced under [Further Information](#) and can be downloaded online.

The correct procedures for applying effluent to land relate to having

- suitable storage facilities
- adequate receiving areas
- a well planned nutrient and irrigation management plan, and
- buffer distances between the application site and adjoining properties, watercourses and public roads

The two main options for effluent use on pastures are:

- applying effluent directly to land from the dairy yard provided that there is minimal risk of polluting surface or ground water, or
- storing effluent during wet weather or when runoff may occur, and then applying it to land during periods when runoff will not occur.

If you irrigate your pastures and intend to apply the effluent by shandyng it with irrigation water, you will need to extend the effluent storage period to cover the end of one irrigation season and the start of the next.

Despite its relatively low nutrient content compared to commercial fertilisers, effluent should not be underestimated in the context of whole farm nutrient requirements. The value of the organic material in effluent to improve soil structure should also be considered.

Implementing good practice

All systems for applying dairy wash water to land have advantages and disadvantages. It is often easier to deal separately with liquids and solids rather than slurries or sludges. Sprinklers and surface irrigation are commonly used to distribute more diluted effluent while tankers and solid spreaders are used to distribute sludges and dried material.

You should prepare a whole farm plan before you alter or develop your effluent system, to ensure you properly incorporate effluent application into your irrigation, fertiliser and pasture management programs.

Whole farm plans should identify which paddocks and soils are accessible and most suitable for effluent application. Grazing and chemical fertiliser application should be modified to incorporate this source of nutrients. Soil type is also an important consideration when selecting a pond site.

Table 6.2. Assessment of various methods of applying effluent to pastures.

Reuse Method	Advantages and Benefits	Disadvantages & Concerns
Sprinklers suitable where waste contains less than 4% solids	Low labour requirement relative to other methods of application Manure slurries can be applied fresh to achieve greater economic benefit from nutrient recovery Can be used on sloping land Can achieve uniform application	Blockages of sprinklers if orifices are not sized and designed specifically for this task Frequent shifting (unless travelling irrigators are used)
Flood irrigation shandying with fresh water	Low labour inputs Manure can be applied fresh after dilution with irrigation water Can be integrated with existing irrigation practices	Application restricted to irrigated areas Contaminates irrigation water Water quality risk to tail-water and groundwater similar to chemical fertiliser Promotes weed growth in channels and drains when manure is dropped into head ditch without preliminary sedimentation
Vehicle tankers- slurry or vacuum tankers Suitable where effluent contains less than 20% total solids	Flexible distribution. For example, can be carted to neighbour's property If incorporated into the soil during spreading it can maximise nutrient value of waste	High labour requirements Machinery wheels cause soil compaction Limited to small waste volumes Expensive (~\$1200/ML)

How to apply effluent to land

Effluent can be applied to pasture using any one or combination of the following:

- sprinkler systems
- flood irrigation (limited to only during the irrigation season)
- tankers
- solid spreaders.

The advantages and disadvantage of each of these are summarised in Table 6.2.



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Sprinklers

Single, skid mounted sprinklers and travelling irrigators can be used to apply effluent to pastures. Regardless of whether spraying effluent straight from the dairy shed after removing abrasive and clogging material or effluent from a pond where organic solids have been removed, use a sprinkler designed or modified to handle effluent. You also need to move all sprinklers around regularly to ensure controlled application of nutrients and avoid causing boggy conditions.



Effluent being applied using a travelling irrigator

Travelling applicators are better than stationary appliances that require regular shifting and could become a hassle, especially if time and labour are limited.

Travelling applicators winch themselves along using a wire rope fixed to a metal peg at the end of the run. You will be better off setting anchor posts deep into the ground at spacings suited to sprinkler throw or burying a cable bound bunch of old tyres with a loop of cable protruding out of the ground. In paddocks with shallow sands and bedrock profiles where posts don't work, an alternative is to use a boat anchor designed for sand. The aluminium Danforth anchor is light weight and very effective.

Paddocks near main laneways are easier to manage for fertigation. The more convenient it is to reverse direction of an irrigator or shift a stationary one, the more likely this will be done. Areas within sight of the dairy are especially good because staff can visually confirm that the applicator is functioning properly and shift it when necessary.

Select a travelling applicator that has a wide wetted width, variable travel speeds and automatic shut-down at the end of a run. Galvanising is also important as the steel is frequently wetted and this can cause it to rust.

Shandying effluent with flood irrigation water

The best time to discharge effluent into farm irrigation channels is when fresh water is flowing. Applying effluent shandied with irrigation water immediately following grazing will ensure the applied nutrients contribute to plant regrowth. **Keeping animals off the treated pasture for seven days is recommended to give plants time to utilise the nutrients and regain their palatability.** In practice, most grazing rotations are longer than seven days.



Effluent pipe discharging directly into flood irrigation channel

Try not to have effluent sitting in farm channels because it provides an ideal environment for weed growth. Weeds can restrict the flow of irrigation water and reduce irrigation effectiveness. Constant cleaning of weed growth may eventually widen and deepen channels which can interfere with flow rates.

Irrigation drainage reuse

Irrigation drainage reuse systems are not common in Western Australia despite their potential economic and environmental advantages. This is mainly because salinity is a major concern for irrigation runoff in Western Australia.

Care should be taken when flood irrigating to limit the amount of runoff containing nutrients from leaving the farm. Nutrients can be retained on the property using runoff retention ponds.

Drainage reuse systems are usually not designed for effluent storage and therefore effluent should not be conveyed directly from the shed to the reuse storage.



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Occasionally effluent ponds are sited close to reuse systems, so that effluent can be distributed over a broader area of the farm, which can be achieved via the reuse pump. Effluent should therefore only enter the reuse dam, when the reuse water is being pumped back into the irrigation cycle.

As drainage reuse systems are often located close to the regional drainage system, effluent should be pumped out of these and irrigated onto pastures to prevent the likelihood of effluent leaving the property during a heavy rain event.

By law, water containing significant concentrations of nutrients or effluent can not be released from a reuse dam into off-site drainage systems.



Vehicle tankers

A vehicle spreader can be used to empty holding ponds and apply effluent to land several times a year. Effluent is sprayed from the rear of the tank, travelling up and down paddocks in strips, covering the application area. Vehicle spreading gives the most flexibility when it comes to land application of effluent. The application site is not limited to a fixed area and effluent can be spread almost anywhere on the farm.

A tanker was used to spread effluent at the former Anning dairy near Walpole

Effluent is pumped from the storage pond into the vehicle holding tank. Pond sites and fencing should allow vehicle access. The effluent must be stirred to mix the various layers into liquid slurry before removing it from storage. Stirrers usually comprise a tethered float-held spinning arm or heavy propeller.

If the storage facility is sealed with a liner, take care not to damage it with the stirrer or suction end of the pipe. Make contractors aware of the liner.

When using contractors or hiring equipment, make sure the equipment has been cleaned before it comes onto your farm so disease and other pests can not be transferred from one property to another.

Use vehicle spreaders when soils are dry. The vehicle and tank moving across the land can damage the pasture and soil, especially at gate entrances.

Where to apply nutrients

Select large areas accessible to main raceways and laneways where the water table is deep and the soil is free-draining and has a high capacity to retain nutrients. Do not spread effluent within 20 metres of a water source and avoid applying effluent to night or calving paddocks as these areas are generally rich in nutrients. More importantly, young calves are susceptible to many infectious agents that can be transmitted by ingesting potentially infected adult feces via effluent. Therefore, never apply effluent to paddocks containing calves less than one year of age (see 6.3.4 Calf Paddocks). Consider your neighbours when choosing your application sites.

Short pasture will benefit most from the effluent and there is less risk of the sward rotting at ground level. Short pasture allows better entry of the effluent solids into the soil. Perennials have a longer growing season than annuals and should have higher nutrient and water use over time.

Effluent sprayed onto plants is distasteful to stock. Short pasture will recover palatability more easily through clean regrowth. Animals should be kept off treated paddocks until plants have regained their palatability, either by rain washing effluent off leaves, through the production of clean regrowth or by simply waiting seven days.

Make sure your effluent application area is large enough to prevent soil nutrient overloading. If cows spend an average of four hours a day at the dairy shed, effluent should be applied over at least 10% of the milking pasture. On average, each megalitre of effluent from a storage pond can contain 180 kg N, 31 kg P and 420 kg K. However, significant variation in nutrient levels is caused by factors such as animal diet, quality and quantity of wash-down water, age of effluent, seasonal effects and pond sampling procedures. Keep track of where the application equipment has been operated and test the soil nutrient level annually to help make good nutrient management decisions.

Surface application of effluent during the summer can result in high nitrogen losses through ammonia volatilisation. When applying effluent directly to pasture, the application rate needs to be controlled to prevent crusting. If you notice crust forming, increase the irrigator speed, change the angle of the irrigator arms or reduce the nozzle orifice size. Normally crusts are easily broken-up by cows as they move through the area. The potential for crusting increases with increasing solids content of the effluent. Application rates can be adjusted, depending on the consistency of effluent.



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When to apply effluent

Ideally, effluent should be stored when runoff is likely to occur and should be applied to land when the risk leaching off-site is low and pastures are actively growing. However in many cases, farms have deep sandy soils or insufficient space to construct an effluent storage pond and year-round application may be the only option. Effluent drains from the yard to a single collection point (preferably a sump that removes abrasive and clogging material), from where it is pumped to suitable areas where it can be spread daily using a travelling sprinkler system or one that is shifted every other day. Soils should not become waterlogged in winter to minimise risk of runoff that can contaminate surface and ground waters.

Delay grazing until after rain or allow a seven day stock-withholding period to ensure effluent has combined with soil and pasture palatability has been restored. Try to graze an area a few days ahead of application to maximise the amount of time for nutrients to be used by plants. Apply to silage or hay paddocks after the crop is harvested.

Considerations when applying effluent to land

<i>Benefits</i>	<i>Liabilities</i>
Contains many essential nutrients for pasture growth	Variable nutrient content. Nutrient content will vary with material and storage method. Without testing for nutrient content, you really don't know what and how much you are adding
Supplies organic matter to the soil Improves soil structure & assists drainage Increases soil nutrient & water holding capacity	Materials applied at excessive rates or in the wrong place can affect the environment Applying effluent can be time consuming and difficult to apply evenly
Provides slow release of soil nutrients for crops over several years after application	Paddocks closest to the source may receive more nutrients than others
Application on farmland can be practical and affordable. For minimal costs, effluent can be applied with readily available equipment	Offensive odour of effluent

Costs

The capital requirement for effluent application dependants on several factors including method of application (sprinklers versus flood) and its form (slurry, dry or shandied).

The capital outlay for an effluent nutrient recovery system, not including a holding pond, will depend on a number of variables that include distance and elevation differentials between ponds, paddocks and the dairy. Average costs range between \$13,000 and \$17,000 for a 200 cow herd in 2005. This includes a solid separation system priced at approx \$7,500, travelling irrigator at \$4,500, a 7 horsepower (5kW) diesel pump at \$3,500, piping and fittings at \$1000. Ten horsepower (7.5 kW) diesel pumps cost around \$4500 and electrical versions are priced about \$10,000 installed. Electrical power cable runs add \$10/m. Purchasing second hand equipment may reduce costs.

The capital cost for a vehicle spreading system in 2005 ranges between \$17,000 and \$35,000. Most farmers use contractors at \$1,600 for every 1,000 cubic metres of applied effluent, or hire equipment at \$900. A 200 cow herd will produce approximately 2,500 cubic metres of effluent per year.

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6.1.5 REUSING TREATED EFFLUENT AROUND THE DAIRY SHED



Using effluent for yard wash down is not common in WA

This section covers techniques that can be used to recycle treated effluent back to the milking shed for washing down the yards. In addition to saving water, reusing treated effluent reduces the total volume of effluent to be handled.

Most dairy farmers maintain a high level of cleanliness in the yards and prefer to apply effluent to pasture. Using processed effluent for yard wash down is not something WA dairy farmers commonly do for a number of reasons. These include quality assurance concerns and keeping milking staff happy. However, you may wish to think about it if lack of water is limiting the expansion of your operation. Diverting flow by the high powered pump normally used to transfer effluent to the paddocks back to the yard will provide you with a high volume of water under sufficient pressure to speedily clean your yard. This is especially handy at entry areas and feed pads where gravel and sand tend to accumulate. The spray from high pressure hosing may contain bacteria and other hazardous materials that can cause breathing and skin problems. Care should be taken to avoid spray drifts, especially through inhalation.

The water used inside the milking shed must be free from, or contain only very low levels of bacteria, sediment, minerals and salts and hazardous material, so using processed effluent inside the milking shed is not a good idea.

Implementation

The cost of implementing the practice must be offset by the advantages of reduced water consumption and concentrating the nutrients so less power is needed to send them out to the pasture for recovery. Costs are reduced when the same pumping system used to transfer effluent to pastures is redirected back to shed or feeding pad. Single pond storage systems are generally not recommended if the water is to be recycled for yard washing.

Benefits

- reduced pond storage space required
- reduced water consumption
- less power cost to transfer nutrients to pastures and crops

Liabilities

- high set up costs if an appropriate pumping system is not already available on the farm
- concerns over quality assurance and staff health issues using recycled effluent wash-down water

Costs

For a 10 HP (7.5 kW) diesel pump, piping and fittings, a system to reuse treated effluent from a well-designed pond system is likely to cost approximately \$6000 in 2005. Similar strength electric pumps with remote-control switches cost around \$10,000 and large diameter pipe costs about \$4/m.

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6.1.6 RAINWATER MANAGEMENT

Rainwater is another water source that can enter the effluent system and fill storage ponds. The less water that enters the effluent management system, the less that has to be pumped out again. While diverting stormwater can reduce the volume of water that has to be managed, rainfall helps clean the yard and is usually a welcomed relief for those responsible for cleaning the dairy.

Rainwater can be diverted away from the sump, reducing the amount of effluent to be managed. Diverting rainwater away from ponds and solid effluent storages site can reduce the potential for overflow from storage ponds. However, in paddocks where salt scalding and crusting are evident, shandyng the effluent pond with rain water can help alleviate these problems. Rainfall helps offset the salinity that builds up in ponds due to evaporation.

Implementation

Management at the Dairy Shed

A rainfall diversion device can be used at the dairy to divert yard runoff away from the effluent system after the yard has been thoroughly cleaned. With this type of device, wash-down water and dirty runoff from the yards can be collected just after milking. The device can be reset to divert the clean yard runoff from rainfall outside of milking hours away from the effluent system (assuming the yards are cleaned after each milking). This practice can reportedly save 15 to 20% of the pond volume for an average system but care must be taken to make sure yard wash-down water is always diverted to your sump and not into drains. A good safety measure would be to link this to another essential management action so it becomes automatic. However, local anecdotal reports dispute the device's value. Many farmers have complained about high maintenance costs associated with its use.

Whenever possible, ponds should be emptied every year. If not, stormwater that falls on the yard should not be diverted away from your sump. The concentration of salt in storage ponds rises over the summer, reaching levels that could adversely affect pasture plants. Adding storm water to the ponds helps dilute the salt concentrations and make it safer to apply to pastures and crops. Provision should be made to account for the amount of stormwater coming from the yard when calculating pond storage capacity. The extra storage required is not great and there are advantages in collecting this stormwater.



Take into account stormwater coming from yards when calculating pond storage capacity

Diverting run-off from roofs away from your sump is an option. Install guttering on all existing roofs covering the dairy and associated yards, and drain the roof runoff into a storage tank or away from the effluent system. This water could be used for various purposes, including hosing the dairy and yards, recycling into the cooling or hot water systems and/or supplying cattle drinking water.

A roof can be constructed over some or all of the yard area and guttering fitted to reduce yard rainfall runoff entering the effluent management system. The resulting shade will also assist in relieving heat stress at milking times during the hot summer months. Farmers have noticed this increased shade encourages cows into the yard earlier during the summer months. However, the shade may slow cow movement into the shed unless its insides are brightly lit.

Management in the field

Runoff from surrounding paddocks should be diverted away from effluent storage ponds. Diversion banks can be used around ponds, or ponds can be constructed as a turkey nest to prevent surface stormwater entering them. In some cases however, ponds can be constructed as intervention systems that capture washdown and runoff from laneways and feed pads so more nutrients are captured for recovery on the paddocks.





Benefits

- Reduce required pond storage capacity
- Prevent ponds from overflowing
- Less volume means less retention time in storage ponds

Liabilities

- Forgetting to shift the switch on rainfall diversion device (if installed) can result in a messy spill
- Perceived by many farmers as just another device with the potential to cause maintenance problems
- Expensive to purchase and install.

Costs

- Limited expenses are incurred in managing stormwater at the dairy and in the field. Common farming equipment such as a front-end loader can be used to create diversion banks around ponds and around the dairy if necessary
- It can cost \$3,000 to construct guttering around the average dairy shed to divert or collect stormwater. Rather than investing in gutters, increasing the size of existing ponds to accommodate the additional volume of fresh rainwater may prove a more sensible option because it helps control salinity.

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6.1.7 SOLIDS STORAGE AND MANAGEMENT

This covers the stockpiling and/or drying of manure and other sludge material that is removed from solid separation pits or ponds so it can be more easily managed before being spread onto land.

It is not usually practical to immediately spread the sludge removed from ponds and solid separation systems onto paddocks. It has to fit in with dairy routines and the soil must be dry enough to carry the weight of equipment. Further, this material needs time to dry so it can be handled by farm equipment. Short-term stockpiling of manure maintains its high nutrient content and provides flexibility to waste management programs. Effluent nutrients are best utilised when spread during the growing season of the crop or pastures. Proper storage of solids avoids environmental damage and maximises beneficial use.

Implementation

Solids storage structures should be designed to be bunded up-slope wherever possible to prevent contact with clean stormwater, contain seepage, prevent nutrient runoff into surface waters or leaching into groundwater. The base must be able to support the weight of a tractor. Removed solids should be stockpiled on an impervious surface, such as concrete, compacted clay, limestone or a gravel/clay sub-base. One side opposite the entrance ramp should divert runoff back to the sump or pond. Bunker walls made of concrete, reconstituted limestone blocks or wood can provide a “push barrier” for easy loading of solids.



Having a push barrier makes loading solids easier

Depending on herd size, sump or pond cleaning and land application routine, operators may consider installing a roof over dry solid storage facilities to protect against rain. Although effluent stockpiles normally develop an effective water-repellent crust and maintain a core temperature high enough to ensure ongoing drying, the benefits of not having to collect and manage runoff, assurance the stockpile will stay dry and the ease of solids handling during wet weather may offset the additional cost of roofing.

Composting solids

Long term stockpiling of solids is a form of static composting that takes more time than aerobic composting. There may be odour problems when static piles are eventually moved due to products such as ammonia that are generated during the anaerobic process.

Composting is a microbial process that occurs under managed moist and warm conditions. Proper composting stabilises the organic content of the solid effluent. Windrow composting is the most common method used. Large clumps of solids are broken up and mixed with straw from feed sheds or woodchips to increase the carbon to nitrogen ratio and create air pockets. This mixture is then placed on concrete or compacted clay platforms in windrows about 1 to 2 m high and 4 m wide. Front-end loaders (or similar equipment) are used to turn the manure about once a week over a two month period. This accelerates composting by aerating the product. The mature product lacks offensive smell and can be stored without being a nuisance. The process also improves the product's structure, ease of handling and application. Undigested seeds within solids don't survive the heat generated during the process thus reducing the risk of weed spread.

Any runoff from the composting site should be diverted back into sumps or effluent storage ponds. An alternative cost-effective means of managing this run-off is to plant intervention vegetation down gradient from the storage area. Once they become established, pines such as *Pinus radiata* and *P. pinaster* can readily utilise available nutrients for an area of up to ten square metres each. Equally as effective and somewhat preferred for their water use efficiency, biodiversity and shelter value are a number of indigenous species that include *Eucalyptus patens* (WA Blackbutt), *E. diversicolor* (karri), and *Agonis flexuosa* (WA peppermint). With slightly less biodiversity value but added timber value are *E. saligna*, (Sydney bluegum), *E. grandis* (Rose gum) and *E botryoides* (*False mahogany*). It is important to assess the soil type, average rainfall and waterlogging potential of each individual site prior to deciding which tree species to plant.

Benefits

- solids are easier to handle and store
- stockpiled and composted effluent solids retain most of their nutrient content
- small markets can be found for stockpiled solids
- solids can be removed for use on other properties

Liability

- limited choice of management options



EFFLUENT MANAGEMENT



Costs

Establishing a strong and impermeable structure for solid storage close to existing effluent management systems reduces movement costs and makes redirecting compost runoff easier and cheaper to manage. Planting intervention vegetation provides a cost-effective means of further utilising runoff nutrients. Site preparation for the planting of intervention vegetation will cost you about \$1500 per hectare and seedlings of the mentioned species normally cost \$0.35 each. Black beetle mesh is an additional \$0.15 per seedling.

Further Information

Agriculture, Food and Rural Initiatives. 2001. Manure handling and storage. Agriculture, Food and Rural Initiatives. United States of America

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6.2.1 SUMPS

A sump is an in-ground collection point for dairy effluent. It can be used to prepare the effluent for storage and land application. Sumps separate most solids from liquids and can double as a short-term or buffer storage facility.

Sumps are an extremely important component in effluent handling because they:

1. provide a hydraulic gradient at the edge of the yard without which yard-wash would have no where to go
2. remove abrasive materials such as sand, gravel and larger particles from the flow stream to protect pumping and pipe work. A sump can also strain material from the flow so it can flow by gravity without clogging, and
3. provide a chamber for pump suction if a pump will transfer flow to its next destination.

The sump should be located where it can collect the gravity flow of effluent from the dairy yard, pit and milk room. From the sump, effluent may be:

- gravity fed or pumped to a temporary storage pit, pond or intervention ditch prior to land application, or
- immediately pumped through a spray application system onto pasture



Sump conveniently located along side the yard at the Hanks dairy in Harvey

Implementation

Sump capacity and shapes can be designed to match different site situations, pumping arrangements and management schemes. Three different designs include:

1. **Pump chamber without storage.** After settling abrasive material and straining, the effluent is pumped out almost as quickly as it flows into the chamber. The pump must be able to transfer water at the maximum inflow rate flowing into the sump. These sumps require a sand trap upstream of the chamber to minimise maintenance problems. The sump acts as a collection and transfer point only, so there can be problems if the pump fails. These are suitable where effluent only needs to travel very short distances with little elevation difference. Some farmers have used well liners for many years in conjunction with a Rankin pump which doesn't tend to clog easily. A large water trough works better because it is easier to manually clean gravel and sand out of it with a shovel.



Trafficable sump with Rankin pump at the Vasse Research Centre, Busselton



2. **Buffer storage sumps** can store the effluent produced by several milkings. This provides some security if the pump fails. These sumps remove sand and gravel from effluent as these will settle after a few minutes.
3. **Trafficable sumps** are used to settle out solids so the remaining liquid is easier to pump. Trafficable sumps simplify the process of handling solids with farm equipment (see section 6.1.2 for details). Larger trafficable sumps allow time for pump repairs in case of breakdowns, access for cleaning and larger slug storage. A larger sump also allows greater flexibility in pump selection. This can optimise performance and minimise operating costs.

EFFLUENT MANAGEMENT



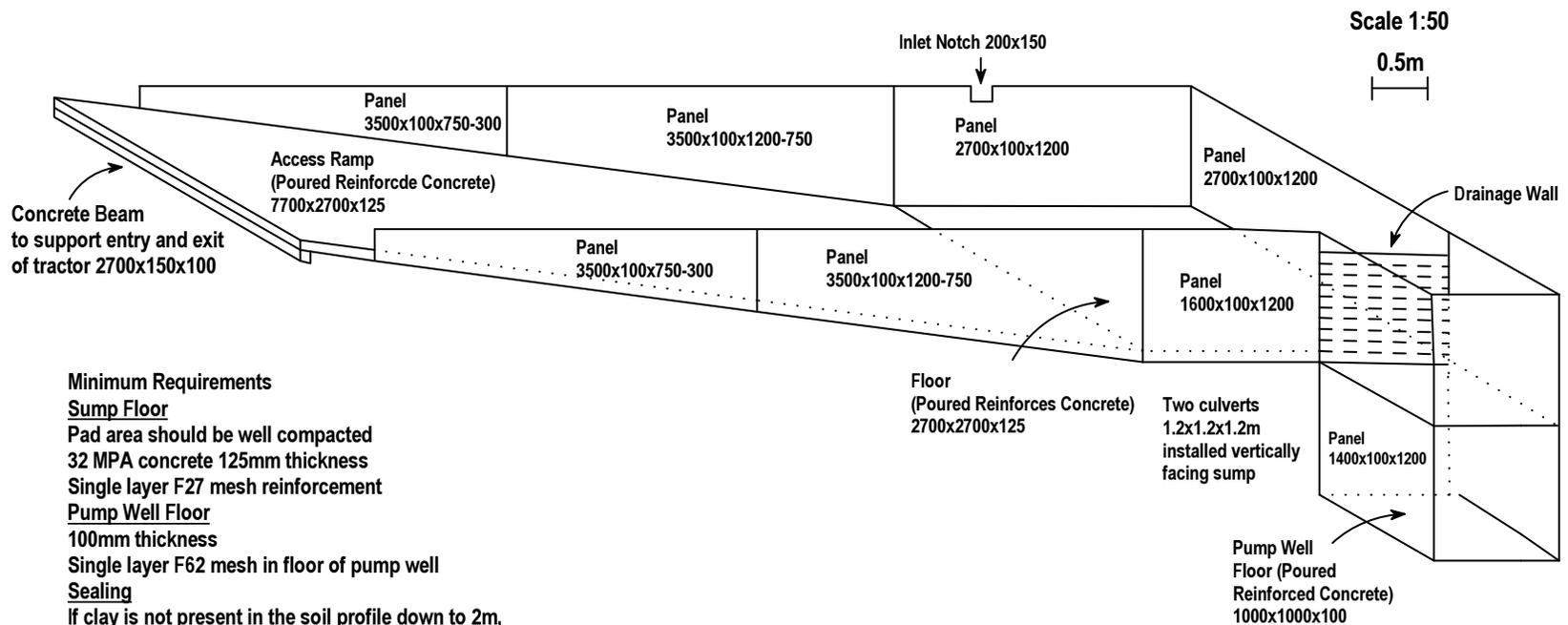
Sumps should be designed for easy cleaning. Ideally, they should be large enough to allow access for a front-end-loader to remove material. It is usually better to position the pump chamber deeper than the sediment portion of the sump. Float switches work better and allow you to use diesel rather than electric pumps. Diesel pumps are especially useful in rural areas where power is usually in short supply and effluent may need to be pumped long distances.

An excellent combination is to join a temporary storage pit with a trafficable sump. Once the heavy grit settles and the floatable material has been removed from the flow stream, the effluent flows to a temporary storage basin. Using a diesel pump to move the amount of effluent accumulated over several days is an excellent option because the pump only has to be operational one day per week. Diesel powered pumps are cheaper to install and operate with fewer problems than electric pumps. Diesel pumps can be readily redeployed around the farm and can normally be easily removed to a covered area for servicing.

Sump design

- The sump floor should be sloped towards the pumping or draining end (Figure 6.10). This helps emptying the sump by providing sufficient depth for pumping and sump cleaning with either a wide mouthed shovel or front-end loader bucket
- The inlet to the sump should be well above and at the opposite end to the outlet. This will stop back flow up the feeder drains and make sure there is time and distance to allow solids to settle
- The wider the sump, the easier it is to remove deposited sand
- Drain boards should be well sealed at the bottom to stop sand movement
- Drainage wall should be positioned away from the back wall
- Deeper pump wells are more suitable for petrol or diesel pumps. They also assure longer pump cycles for electric pumps
- Provide an overflow, especially if the sump is small.

Prefabricated Trafficable Sump and Deep Pump Well (Standard Length 10.5m - 14 cubic metre capacity)



Minimum Requirements

Sump Floor

Pad area should be well compacted
32 MPA concrete 125mm thickness
Single layer F27 mesh reinforcement

Pump Well Floor

100mm thickness
Single layer F62 mesh in floor of pump well

Sealing

If clay is not present in the soil profile down to 2m,
seal the area near joints with clay
from an external source before backfilling

Drainage Wall Boards

1000x100x40mm
held in place by 2 lengths of 75x40mm channel steel
Channel steel fastened to concrete using dyna bolts

Modified by: Dept. Agriculture, Bunbury
Original: Tom Long, DairyCatch, February 2005

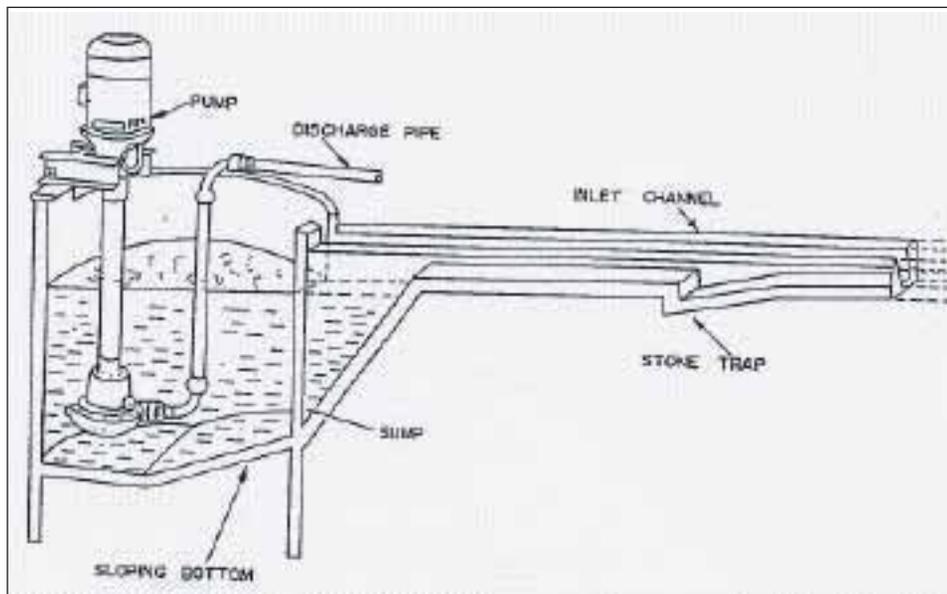
FIGURE 6.10. Diagram of prefabricated trafficable sump and deep pump well

Pumping chambers

Vertical and horizontal effluent pumps are normally mounted on beams above the sump for stability and to provide ideal outlet-inlet flow conditions. The pumping chamber may or may not be connected as an integral part of a sump. There is nothing wrong with putting a submersible pump in a chamber.

Designers should consider pump performance, particularly with regard to the inlet position. Poorly designed pumping chambers will very likely:

- restrict pump performance
- lead to severe damage to the pump, its transmission system, electric motor and switchgear, and
- shorten the useful working life of the pump.



Schematic of pump chamber without storage

Sump Size

- If effluent is to be gravity fed or pumped into a holding pond or pond system, sump capacity should be at least 5 cubic metres per 100 cows. It is important that the pump is easily accessible for repair and maintenance and that all overflows caused by pump breakdown or power failures are directed away from the worksite and open water courses, and onto intervention vegetation
- Avoid small sumps with snug fitting pumps. Match sump depth to the size of the pump. A minimum width of 2 m with 1 m depth is needed to allow free swing of a shovel during sand removal. Allow 300 mm of freeboard from the top of the sump to the highest effluent level
- If effluent is to be pumped directly onto pasture, a plan should be developed for dealing with pump breakdown or situations when flooded conditions make land application undesirable. Having a back-up diesel pump handy in case of primary pump breakdown is a good idea.



Costs

- Price of a prefabricated fibreglass or polyethylene sump is approximately \$2200 in 2005
- Larger concrete trafficable sump prices range from \$7,500 to \$10,000, depending on size.

Further Information

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Wrigley, R. 1994. Managing dairy shed wastes, volume two. Dairy Research and Development Corporation, Victoria.



6.2.2 PUMPS

Pumps are required to move effluent through the various stages of the effluent management system. This includes moving effluent to temporary storage pits and ponds or transferring effluent from storage facilities to application sites for spreading.

It is most important to use a pump that is appropriately designed for the amount and size of solids expected to be in the flow.

Implementation

The physical characteristics of effluent change with each stage of its handling, so the requirements of the pump and pumping station alter accordingly. Generally, the more effective a solid separation system, the fewer problems will be experienced with the pump.

Factors you should consider when selecting a pump include:

- the solids content of the waste stream
- the inlet flow rate
- volume of effluent
- the required discharge pressure of the pump
- the distance and head that effluent has to be pumped to irrigation paddocks
- the type and location of power source available
- the expertise available for operating, maintaining and repairing the pump
- quality of components, and
- available budget.

A wide range of pumps that use a variety of different fuel types are commercially available. Whatever pump you eventually decide on using, remember that it is going to breakdown someday and need maintenance, so make sure you can get to it and service it easily.

The clearance and type of pump impeller, associated pipes and fittings should be designed to handle objects with potential to lodge in pipes and disrupt flow. Blockages are more frequently caused by hay-bale string/netting, sticks and nuts rather than by the solid material found in the effluent stream because the only large objects cows pass are calves.

Pump operating pressures vary considerably according to what they are being used to do. Transferring effluent to a nearby pond with similar elevation may require a low lift pump with a system head of between 3 to 10 metres. Land application sprinklers require much higher working heads of between 20 and 80 metres. Care must be taken to follow the design, installation and operation instructions provided by pump manufacturers. Impaired pump performance is normally caused by restricted suction impellers not designed to deliver high pressure and other physical constraints that affect performance. A 15-20% design contingency should be allowed for pump wear and tear.



The Rankin pump is a favoured choice because of its simple design and robust performance



Vertical shaft pumps should be suspended from beams which span the sump to keep the shaft vertical. Bearing damage will occur if the shaft is not vertical. Conventional horizontal shaft pumps can be housed on the edge of the sump with a vertical suction pipe into the sump or pond. Pumps should be protected from dust and weather but well ventilated at the same time to prevent overheating.

Electrical pontoon pump



Costs

Pump price varies with the size and type of pump needed. Average prices range from \$3000- \$8000 in 2005. Cost of providing an adequate electricity supply for the required pump can be a significant additional cost.

Further Information

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Guy Corbett, G 1995. DPI&F Note AG0442 Dairy effluent: Pumped sumps. Department of Primary Industries and Fisheries, Queensland.

Wrigley, R. 1994. Managing dairy shed wastes, volume two. Dairy Research and Development Corporation, Victoria



6.2.3 PIPES

Piping is often used to transport effluent through the nutrient recovery process. The size and type of pipe you use will depend on the pressures expected, the amount of friction loss that can be tolerated and the economies of scale.

Either UPVC or polyethylene (PVC or poly) pipes can be used for effluent systems. Of the two, poly is the more common. Separating out solids before piping effluent makes it much easier to move effluent through pipes with less chance of blockages.

When deciding on what type of pipes are suited to your situation, you need to consider the distance the effluent will be pumped, head pressure and the presence or size of solids. You also need to consider the effect sunlight might have on the longevity of the pipe. If the pipe is designed to be buried, leaving it on the surface may shorten its effective life.

Implementation

Some general guidelines to follow are presented below.

- For gravity flows, if the fall is between 1 in 60 and 1 in 80, use 200 mm pipe. If the fall is less and the required distance of flow exceeds 50 metres, use a pump.
- If pumping more than 200 m distance or 10 m static head, use 75 mm pipe. Fifty millimetre pipe can be used for shorter distances or lower heads. This all depends on the size and type of pump you plan on using. A positive displacement pump at low flow rates can easily overcome losses of 15 metres head.
- UPVC pipe can normally handle higher pressure than poly pipe but has less flexibility to handle surge pressure.
- If the pipe is expected to move effluent containing solids by gravity, the diameter needs to be at least 150 millimetres. Blockages will be a problem with anything less than this. The steeper the grade, the smaller the pipe you can get away with but this is one place where size will make a big difference.
- The incidence of blockages is also related to material drying out inside the pipe. If sediment within a pipe is allowed to dry, the pipe will clog regardless of its diameter. One way of getting around this is by maintaining a flooded condition by sloping the pipe upwards or putting an inlet T on it, similar to those fitted on septic tank outlets.
- Joiners work well for poly pipes less than 100 mm in diameter. Plastic welding for larger diameters is better but the cost and availability of plastic welders may be limiting factors.

Costs

Pipe costs vary according to type, configuration and supplier. Shop around for the supplier that can best satisfy your needs.

Further Information

Dairy Industry Nutrient Strategy Working Group. 1998. Environmental management for animal based industries- dairy farm effluent. Department of Agriculture, Western Australia.

Wrigley, R. 1994. Managing dairy shed wastes, volume two. Dairy Research and Development Corporation, Victoria



6.2.4 SPRINKLERS

Effluent pumped from a pond or directly from a sump may be applied to land using sprinklers. Sprinklers can be reliable and convenient for spreading effluent when modified specifically for the job and managed properly. If you already use sprinklers to irrigate pasture, you need to decide whether you want to pass effluent through your existing sprinkler system or invest in a separate system.

Implementation

Some general rules to follow when using sprinklers to fertigate with effluent are presented below.

- Always use sprinklers fitted with nozzles designed to handle the expected particle size of the effluent
- Stationary sprinklers need to be moved regularly to prevent ponding and surface crusting
- Effluent spraying should be based on soil and environmental conditions. Your aim should be to target the root zone area. Don't fertigate during and/or immediately after heavy rain to minimise nutrient losses and prevent environmental impact caused by run-off
- Effluent should not be sprayed close proximity to an open water source. The restrictive distance should be based on individual site characteristics including soil type, topography, depth of water table and the integrity of wells and bores close by. If reliable information on all of these is not readily available, effluent should not be sprayed within 100 metres of an open water source. As a general practice, stock troughs within the sprinkler's throw distance should be covered during fertigation
- A vegetative strip should be left unfertigated to buffer adjoining permanent watercourses. The width of the set back should be determined according to slope and soil type. The steeper the slope and higher the clay content, the greater the width
- Effluent-fertigated areas should be managed to minimise human nuisance and prevent environmental impact.

Choosing the right fertigation system

The list of things you need to think about when deciding what system would best suits your needs includes:

- Soil types, topography and standing vegetation (trees)
- Size and shape of paddock
- Proximity to sensitive environments
- Particle size of the effluent
- Proximity of drains and waterways
- Available power supply, location of powerlines and laneways (for ease of operation),
- Age of system (if already installed)
- Availability of labour
- Financial budget.

The range of sprinkler systems that can be used to apply effluent to pastures and crops is currently quite limited. Unless the effluent is very well filtered to avoid costly blockages, many of the available irrigation systems can not be used cost-effectively. However, it is highly likely that, as more farmers become interested in effluent fertigation, irrigation system manufacturers will begin to invest in product development to meet market demands. Slow sand filters may provide an innovative and cost-effective means of achieving high grade filtration in the future.

Brief descriptions of the various systems currently available are presented below.

1. *Self-propelled travelling rotating arm irrigator (Figure 6.11).*

Probably the system most widely used to apply effluent to pasture. These consist of two effluent sprinklers at either end of a rotating arm mounted on a cable pulled platform with either skids or wheels. Effluent is supplied by means of a polyethylene pipe. Poly pipe is a cheaper 50mm (2inch rural pipe). The system is self-propelled by water pressure that pulls a cable. The key to their efficient operation is the use of large diameter poly pipe and flexible tapered rubber hard-wearing nozzles to limit blockages



FIGURE 6.11. *Self-propelled travelling rotating arm irrigator*

2. *Centre-pivot systems (Figure 6.12)*

These are self-propelled and comprise a single pipeline supported by a row of mobile towers suspended 2 to 4 meters above ground. Using these is not viable unless the effluent is very well filtered (particle size less than 2 mm) to avoid repeated blockages. One way to assure minimum blockages is to pass pond effluent through a slow sand filter before injecting it into the centre pivot supply. An alternative is to suspend a separate line of effluent sprinklers under the main water line.



FIGURE 6.12. *Centre-pivot irrigation system*

3. *Linear or lateral-move systems*

These are similar to centre-pivot systems, except that the lateral line and towers move in a straight path across a rectangular field. Although these have proven popular in the eastern States, they have never really taken-off in WA.

4. *Travelling gun sprinkler systems (Figure 6.13)*

These are similar to the travelling rotating arm sprinkler except that a large sprinkler is mounted on a wheel or trailer fed by a very expensive flexible rubber hose. The system is self-propelled by high water pressure (100 psi), pulled by a cable. This kind of pressure requires a high pressure pump (closed impeller pump)



FIGURE 6.13. Travelling gun sprinkler system

5. *Single spray cannons (Figure 6.14)*
These are often used for small or irregular areas and are fed by a stationary pipeline.



FIGURE 6.14. *Single spray cannon*

6. *Other Innovations*

Stationary pot sprayers (Figure 6.15) are simple cast iron or plastic chambers connected to a pipe. They provide a capital-cheap but labour-intensive means of spreading effluent. Similarly, a large diameter rubber irrigator hose with holes drilled into it may be used if readily available.

Important usage and maintenance schedule checks

Daily

- Assess soil moisture to make sure the paddock is not flooded so effluent can be applied without risk of surface runoff. Don't apply effluent if soils are flooded
- Cover stock troughs within reach of the sprinklers' throw
- Assess weather conditions including rainfall and wind speed and direction if wind drift is a concern. Pay particular attention to storm warnings

Regularly

- Apply effluent to recently grazed areas
- Check for and clear blocked nozzles
- Ensure sprinklers are not sending effluent into the water troughs
- Inspect the integrity of established waterway-buffer lanes
- Inspect for evidence of surface water runoff
- Grease applicators

Annually

- Conduct soil nutrient analysis to determine appropriate effluent application rates



FIGURE 6.15. Stationary pot sprayers have to be moved around manually on a daily basis



Check for and clear blocked nozzles regularly

Benefits

- Low labour requirements compared to hauling effluent with a tanker
- Manure can be applied straight to application pastures after sand, gravel and clogging materials have been removed
- Can be used on sloping land
- Can achieve uniform application if moved regularly
- More extensive coverage to dryland paddocks. Not restricted to flood or pivot irrigation area.

Liabilities

- Blockage of pipes and sprinklers
- Frequent physical shifting is required unless travelling irrigators are used
- Costs are more than open discharge into flood irrigation system

Costs

With some of the more expensive travelling irrigators used for fertigation, there is scope to either hire them for the time needed or share them with neighbours

Further Information

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6.3.1 LANEWAYS

Laneways provide vehicle access around the farm and are used to move cows between paddocks and the milking shed. Laneways generally radiate from the dairy. Even when a new dairy is built, it is generally located close to the old one because of the other infrastructure which is found around an existing dairy. On most farms, therefore, there is generally limited scope to change the location of laneways. If a beef farm is being converted to dairy, a whole-farm plan will be developed which will locate the dairy and associated facilities in the most appropriate place.

The first step when renovating or building new laneways is to critically assess their location as part of a whole farm layout. The distances cows have to walk on laneways can be minimised as part of an overall farm plan but the cost of shifting power and access roads can be significant economic factors.

The next consideration is the laneway foundation. If the foundation is not adequate, laneways will break down and need higher maintenance. It is worthwhile spending time and effort in the planning and doing a job that will last, rather than simply adopting a cheaper option.

Laneways that are well planned and constructed, and properly maintained:

- reduce lameness and environmental mastitis
- reduce the amount of teat cleaning required
- improve milk quality
- enable easier and faster stock and vehicle movement
- provide all-weather farm access
- increase milk production through minimising cow travel energy expenditure
- provide access for routine farm maintenance (drain cleaning, fencing)
- reduce stock and farmer stress
- reduce the amount of manure dropped as the cows move to and from the dairy.

Implementation

If you are planning major changes on the farm, these notes should assist you with laneway design and construction but there are several other sources of information such as local earthmoving contractors and agricultural consultants.

Some general pointers include:

- Get a topographical map of the farm (if available)
- Obtain an aerial photograph of the farm, plastic overlay sheets and a pack of non-permanent felt-tip markers to help you plan your new layout
- Determine whether the milking shed is likely to be relocated
- Consider future developments such as the construction of a feed pad or shed
- Take advantage of high ground or topography
- Where laneways are directed down-slope, install diverters to direct run-off on to adjacent paddocks
- Use the soil displaced during the excavation of an effluent storage pond or a water supply dam for laneway construction
- Assess the effects of laneway location on surface water movement. Laneways can serve as diversion banks
- Consider the different soil types on the farm in terms of suitability for use as foundation or surface material
- Determine the nature of traffic that will use the new laneways (cattle only, light vehicles, heavy machinery, tanker access)
- Locating water troughs in laneways slows the movement of stock, leading to more dung and urine dropped in the laneway. If you have to move your cows significant distances and feel they will need a drink along the way, locate drinking troughs on higher ground or on well-drained soil areas to keep from having boggy conditions.

Drainage

Effective drainage is an essential component of good laneway design. Heavily used laneways can accumulate large amounts of manure. As such they need to be designed to shed water quickly. Effective drainage can be achieved by:

- forming a well-crowned and compacted soil base (to form a reliable foundation)
- applying topping material to provide a firm impervious surface
- avoiding shading from trees that encourage cows to loiter in the area
- ensuring good drainage away from laneways. Drainage should not be directed into watercourses and drains that leave the property. Drainage should pass over pasture or vegetated areas where sediment and nutrients can be recovered
- forming a pad above natural surface
- providing drains or bunds to direct run-off from the track surface
- using culverts where necessary to prevent paddock run-off spilling over laneways.

Where possible, the watertable should be kept at least 600 mm below the track surface. On flat country this is difficult to achieve. However, the higher the track can be formed above the watertable the better. Material may need to be imported. Alternatively, effluent storage or small dams can be constructed to serve as quarries on site.

Culverts across gateways should be a least 300 mm in diameter to allow adequate water flow and to avoid blockages. If possible, plan the farm into small catchments and ensure that the laneway does not prevent drainage from one side to the other.





Building laneways

Organic matter such as grass and manure should be scraped from the planned path. Soil graded up from the formation of drains either side of the laneway is suitable as a base. A compacted foundation is essential for a laneway to withstand loads on the surface. Soil condition, in particularly moisture content, at the time of laneway construction, needs to be considered to achieve satisfactory compaction.

To ensure stable compaction, soft clay must not be used to form the base of the laneway. However, clay surfaces can be stabilised by mixing hydrated lime to a depth of 125 mm. Cement can also be used for stabilisation.

A power grader, with an experienced driver, will produce the best and most economical result for forming up the desired surface. A tractor mounted blade and pneumatic tyred roller or loaded vehicle with high-pressure tyres may reduce cost.

The width of the laneway depends on topography, drainage requirements, intended uses and the size of the herd. Providing a metre of width for each 20 cows, up to a maximum 8 metres, is generally adequate. A slope of 10% across the track is enough to shed water and still be comfortable for the cows. Contractors commonly use slopes of 5% - 10%. Avoid right angle bends as these slow cow movement. Use curves or two 45 degree bends if possible to change laneway direction.

The gradient of laneways influences the ease of stock and vehicle movement. Steep gradients reduce the speed of vehicles and limit the pace of stock movement. Excessive slopes also complicate the design and increase the cost of construction and maintenance. However, this is not usually an issue in WA.

Junctions

Where the dairy yard or the concrete section of laneways meet gravel, it is critical that drainage does not run onto the gravel as this will erode the laneway. Slope the concrete back from the junction or form a kerbing on the edge of the concrete to control drainage. Cows should be encouraged to move away from the shed after milking as accumulated manure will form a barrier to drainage along the edges of the laneway in the vicinity of the shed, ultimately causing breakdown of the laneway. If cows must stand around after milking, have a concrete holding area near the shed exit, or run the cows back into the holding yard behind the backing gate rather than allowing them to damage the laneways.

Wet areas

As most dairy farms are located in high rainfall zones, drainage is commonly needed. Wet areas cannot always be avoided on farms and sometimes a drainage system is precluded by lack of outfall. If a laneway is to traverse a wet area and cannot be built to incorporate drainage, the only option is to reinforce the laneway. This is best achieved by installing either a concrete pavement, a cement stabilised pavement or by using geotextile sheeting to stabilise and maintain a flexible pavement. In locations prone to become boggy, planting trees that actively soak-up water and nutrients in the vicinity can help drain the area while converting the nutrients into a valuable resource that can be harvested later for profit. Local native eucalypts are preferable but pines are also an excellent choice for this purpose because they pull the same amount of water but are more drought tolerant than broad-leaf species. It is important to assess individual site characteristics before deciding which tree species to plant.

Milking shed approaches

Most dairy farmers would agree that the 100 metres or so of a laneway closest to the shed contributes most to lameness in cows due to excessive stock loading caused by cows funnelling and by abrasive materials and sharp projections on the surface of the yard and the approaches to it. Bunched up cows cannot see obstructions and thus hoof and leg injury can result.

All obstructions on the laneway approaches and yard surfaces should be removed. This includes any concrete edges. Wood chips, pine bark or sawdust can be spread on the laneway close to the shed to minimise the amount of gravel trailed into the yard.

Costs

Laneway construction costs vary according to materials, configuration and supplier/contractors. You will be better off shopping around for those that best satisfy your needs.

Further Information

Dairy Industry Nutrient Strategy Working Group. 1998. Environmental management for animal based industries- dairy farm effluent. Department of Agriculture, Western Australia.

Wrigley. R. and Bell. I. 1999. Farmnote 112/99 Farm Laneways: Design and Construction. Department of Agriculture, Western Australia.





6.3.2 FEED SHEDS AND PADS

Feed sheds and pads are used to feed out hay, silage and concentrates from troughs. Effluent collection and handling is relatively easy for those with concrete floors. Drainage should be directed to the effluent sump located at the dairy and solids should be scraped and either stockpiled or composted for later use on-farm or sale (sections 6.1.8 & 6.1.5). If a pad does not have a concrete or clay base, it is not possible to direct runoff into an effluent management system. However, if the floor is covered with an organic bedding material such as pine bark or sawdust, the nutrients deposited in dung and urine will be trapped for later spreading on pasture. If no bedding material is used on sandy soils, soluble nutrients will be lost to leaching caused by autumn and/or winter rains. If you find this is happening on your farm you may want to plant an interception barrier of trees down gradient of the area to utilise these nutrients. By absorbing water from the area, lateral movement of the leached nutrients can be reduced.

Implementation

Site Selection

When selecting a site for a feed pad, look at existing feed pads on neighbouring farms to see what does and doesn't work. Consider the following issues:

- Proximity to effluent management facilities if the pad has a concrete base. Run-off should be managed in this facility (see sections 6.1 through to 6.1.8)
- Proximity to supplement stores and races. A good site is usually near the exit of the milking shed so the cows can feed on their way back to pasture after milking. The pad must be at least 20 metres from the dairy, tanker access loop and water supply
- Design the pad with good access for stock and feed-dispensing vehicles
- Face pads north or north-east for maximum exposure to the sun and protection from the prevailing wind
- Site the pad on the lee side of residence and dairy to minimise nuisance odours
- If the pad is used in summer, shade needs to be provided to keep both animals and their water supply cool

Space required

If all cows are going to periodically enter and feed at the same time, allow 600 to 700 mm per cow of trough space, regardless of the type of trough used. If feed will be continuously available allowing the cows access to feed at will, only 300 mm per cow of space is needed.

Type of feed pads

Concrete pads are usually 4 to 5 m wide. The concrete should be 100 mm thick if only stock will be on the pad or 125 mm thick and reinforced to support vehicles access. Slope the feed pad to prevent water gathering and to assist slurry movement (the maximum slope for cattle is 1:30 and 1:10 for machinery). A lip is needed along the edge of the concrete to direct runoff into the effluent management system, unless the pad is sloped away from the edge towards the centre of the pad. Placing the troughs on the outside edges points the rear of the cows away from the edge making it easier to scrape the manure.

Raceway feeding pads can be either stand alone or adjacent to a stand-off pad. They utilise similar construction principles as farm laneways but are either purpose built or reinforced areas to prevent race damage. See section 6.3.1 for information on laneway construction.

When designing the feeding facilities, take into account:

- **Wastage.** A trough is essential to reduce wastage
- **Ease of feeding.** Feed pad/shed design must allow access for all equipment used to handle the feeds you are using
- **Trough wall height.** Ensure that feed trough walls are high enough to prevent cows falling or being pushed into them.
- **Feed trough size.** Sufficient storage is necessary if troughs are filled irregularly.

Effluent and solids management

Tractor mounted scrapers can be used to shift slurry off concrete feed pads into a storage sump or a pond system. Scrapers minimise the amount of water required to wash down pads. Flood washing or high volume, low pressure blaster systems are an excellent alternative to hoses over large concrete surfaces. Pond effluent, if managed correctly, can be an excellent water source, especially in combination with a high head effluent pump to clean pads.



Feed troughs reduce wastage

Herd management

- Do not use dogs in or around the pad. The more stressed the animal, the more frequently it will poo and wee
- Do not put loose metal on the race leading into the feed pad as it will eventual find its way on to the pad and injure cows' feet
- Rats are common where supplement storage facilities are close to the feed pad area and need to be controlled.





Benefits

- Reduced pugging of pasture in wet conditions
- More available pasture for milkers
- Less wastage of supplementary feed
- Protected environment
- More convenience in checking and treating animals
- Peace of mind
- Less cold-stress on productive animals.

Liabilities

- Capital cost
- Regular cleaning needed to keep risk of infection low
- Bullying of younger animals
- Maintenance required.

Costs

For a 200 cow herd, a concrete feed pad will cost around \$25,000 in 2005. The majority of expense is in the concrete and reinforcing steel for the main floor slab and the apron. There are also costs associated with feed troughs, drainage, fencing posts, wire and insulators, gates and labour.

Further Information

Dairy Industry Nutrient Strategy Working Group. 1998. Environmental management for animal based industries- dairy farm effluent. Department of Agriculture, Western Australia

Dexcel Limited. Farm Fact 3-18: Feed pads. Dexcel Limited, New Zealand.

www.dexcel.co.nz

Moran. J. 2001. Farm Fact AGO015: Feeding and calving pads for cattle. Department of Primary Industries, Victoria.

www.dpi.vic.gov.au

6.3.3 FEED AND NIGHT PADDOCKS

Many dry land farmers confine their milkers to paddocks close to the dairy over summer and feed hay or silage. A few farmers use night paddocks close to the dairy and house for convenient, easy stock movement for the morning milking. Calving paddocks are located close to the dairy or house to be able to keep a watch over animals close to calving and provide them with feed, shade and water.

By the end of summer, there is usually little pasture cover on these paddocks and rain can wash soil and effluent into the nearest watercourse. On sandy soils, opening rains will move nutrients through the soil before pasture has developed enough of a root system to take them up. High levels of nitrates in drinking water can cause serious health problems and high bacterial levels can affect milk quality. These paddocks should never be located directly up-gradient of drinking water supplies.



Nutrient build-up and runoff in sacrifice paddocks can be a serious issue

Night paddocks are not as heavily grazed as feed paddocks as supplementary feed is often provided at the end of the day after milking. Managing effluent in night paddocks is less of a problem than feed paddocks because growing pasture is utilising some of the nutrients deposited by the milkers.

Implementation

Soil nutrient levels in feed and night paddocks are generally high. As such, these areas do not normally require additional fertiliser. Try not to use the same paddocks year after year or try and rotate stock round a number of paddocks over summer.

Sacrifice paddocks are similar to feed paddocks except that they may only be used for a few weeks over the break of the season so that other paddocks are allowed time for pasture to establish. Nutrient build-up is likely to be less of a problem but surface runoff can still be a serious issue.

As stock spend long hours in night paddocks, large amounts of effluent are deposited at these sites. They are usually the most fertile areas on the farm and soil test results commonly indicate no need for additional fertiliser.

The convenience of a small number of night paddocks is outweighed by reduced pasture production from continuous grazing and by having too many nutrients concentrated in a small area where they cannot be used effectively.

Water draining from these intensively grazed paddocks can only be managed as part of a whole farm drainage management plan. For these paddocks in particular, look for ways of diverting runoff from the first rains into a sediment basin or sump to settle out some of the suspended solids. This first runoff generally contains high concentrations of nutrients and you should be looking for ways to keep it on the farm. Once a pasture cover has been established, drainage water is likely to be less of a problem.

Revegetation with native species to soak up nutrients, provide shade and wind protection is worth considering. Revegetation work should be included in your farm plan. Planting intervention vegetation, such as eucalypts and pine trees, provides a cost-effective means of further utilising run-off nutrients. For the species most suited to your area, contact your local landcare group, the Farm Forestry group or your local CALM office.

Costs

Time and labour is needed to move stock on a more regular basis. Tree site preparation costs about \$1500 per hectare and tree seedlings are worth about \$0.35 each. African Black Beetle mesh is an additional \$0.15 per seedling.

Further Information

Dairy Industry Nutrient Strategy Working Group. 1998. Environmental management for animal based industries- dairy farm effluent. Department of Agriculture, Western Australia.





6.3.4 CALF PADDOCKS

Calf rearing is one of the most important jobs on a dairy farm and, as herds become larger and seasonal calving more common, systems and facilities need to change.

Most dairy farmers house calves in individual pens for the first few days of life - until they learn to drink from a bucket or trough. Calves are then usually moved into groups which become larger as the calves get older. Younger calves are normally housed in a shed but older ones are generally run outside with access to shelter.

Some pens have a slatted floor raised above a concrete floor which allows for regular hose cleaning into the dairy effluent system. Bedding material can cause pump clogging problems. These can be overcome by straining or using a pump that can handle larger particle size. Abrasive material (sand and gravel) are of minor concern.

Other pens use straw or other organic material as bedding which absorbs dung and urine. This bedding is replaced before a new batch of calves is put into the pen. Used bedding should be stored and managed with the other solids.

Implementation

As calves are still developing their immune system, they should not be exposed to effluent-fertilized paddocks during their first twelve months.

Calves are susceptible to a variety of maladies during this time including grass tetany (hypomagnesemia) and exposure to high levels of potassium common to effluent may serve as a predisposing factor for this disease.

Bovine Johne's Disease (BJD) is a chronic, incurable bacterial infection of the gut of older cattle. Although a similar form of the disease can be found in our sheep flocks, the bovine disease has not yet been recorded in WA, despite it being relatively common across in south-eastern Australia. Young calves are most susceptible to becoming infected and cattle over 12 months of age appear highly resistant to infection. As the BJD bacteria can survive in effluent for up to 12 months and the likelihood that we may eventually see the disease in our herds, a wise precaution is to prevent the exposure of young calves to adult faecal effluent until they are at least 12 months old.

Further Information

Crawford, H. 1998. Farmote 45/98: Calf rearing : Sheds and other structures. Department of Agriculture, Western Australia.

6.4 FINANCIAL ANALYSES

The cost of implementing an effluent management plan will vary according to individual farm designs and component costs. The presentation of case studies provides a meaningful assessment of what others have done and what it cost them. This is provided merely as an indication of the budget for those planning similar investments. The term *Partial Adaptation* is used to describe system implementations that have improved or upgraded an existing system. *Full adaptation* assumes the cost of a purpose-built effluent management system, well over and above traditional effluent disposal systems.

6.4.1 CASE STUDY 1 (PARTIAL ADAPTATION) PIGGOTT DAIRY, HARVEY

Stephen, Robyn, Jamie and Vanessa Piggott milk between 140 and 160 cows on their farm. They enjoy dairy farming but don't intend to increase their herd size anytime soon. The Piggott's decided to upgrade their effluent management system to deal with their herd's excess liquid effluent and growing community concerns about the environment. With technical advice from Tom Long and \$5,000 of matching funds from DairyCatch they implemented their plan in June 2004. They are now eligible for a further \$2,000 grant from DairyCatch and this has been included in this analysis. They claim their effluent management system provides them with savings and peace of mind.



Stephen and Robyn Piggott at their dairy in Harvey

This type of adaptation to an existing smaller dairy operation encompasses the following adaptations and associated costs:

• Base material for concrete work	\$230
• The extension of the existing concrete apron together with the construction of an effluent catchment bunker	\$3,100
• Construction of an adjoining trafficable sump.	\$1,900
• Additional electric pump to operate out of the trafficable sump	\$4,480
• Electrician to wire the additional pump	\$750
• 2 inch (50mm) poly pipe to distribute the liquids ¹	\$2,220
• Provision of own labour & front-end loader	\$1,320
• Less DairyCatch Implementation grant	(\$7,000)

Total Cost of Adaptation is: \$2,000

¹ Based on estimated length of 1,000 metres @ \$2-25 per metre installed and is a 'work in progress.'

This system has left the primary pump still operating to move the effluent from the dairy to the newly constructed effluent bunker, bypassing the “traditional” settling pond. The effluent liquid is then separated via the adjoining trafficable sump and pumped through a 2 inch (50mm) poly pipe system to irrigation head ditches where it is diluted while irrigating onto the pastures. The remaining solids in the effluent bunker are removed and spread on the paddocks. Currently, traditional settling ponds are used to hold winter effluent. Future expansion of the system involves using a travelling irrigator to disperse winter waste water.

According to Stephen and Robyn, the benefit of their type of system includes:

- Easier to operate/manage effluent, particularly in colder, wetter months, with no reliance on settling ponds
- Environmentally responsible and should comply with any existing or future environmental policy
- Expectation of reduced fertiliser costs ²



Newly constructed effluent bunker with adjoining trafficable sump at Piggott dairy in Harvey

²Reduction amount not quantifiable at this time by means of soil test results.



EFFLUENT MANAGEMENT



Estimated Value of Benefits:

Preliminary survey results and discussion with producers indicate a labour cost saving could vary from 0% to 2.5%. In the case of a family owned farm, it is unlikely that there will be any real cost savings in labour and therefore 0% gain has been included in the analysis. Table 6.3 presents the various combinations of benefit values in monetary terms.



The traditional settling pond at the Piggott dairy that will eventually be filled-in and by-passed once the travelling irrigator comes into play

Table 6.3 Benefits of the adaptation over 10 years at the Piggott Dairy

Fertiliser/Labour		0% - (\$0)	1.25% - (\$3,060)	2.5% - (\$6,120)
8%	\$5,040	\$5,040	\$8,100	\$11,160
10.5%	\$6,620	\$6,620	\$9,680	\$12,740
13%	\$8,190	\$8,190	\$11,250	\$14,310

The above calculations do not take into account any form of discounting as the discount on future benefits may well be more than compensated for with wage rises and fertiliser cost increases.

Table 6.4 establishes the Benefit to Cost Ratio of such an investment, solely from an economic point of view.

Table 6.4 Benefit to Cost Ratios for the Piggott Dairy

Fertiliser/Labour		0% - (\$0)	1.25% - (\$3,060)	2.5% - (\$6,120)
8%	\$5,040	0.72	1.16	1.59
10.5%	\$6,620	0.95	1.38	1.82
13%	\$8,190	1.17	1.61	2.04

Within the range of benefits tested here a benefit to cost ratio greater than one is achieved in 7 of the 9 scenarios assuming a 10 year investment period.³

³ Analysis is based on fertiliser costs of \$450/tonne @ 175kg/ha over 80 hectares; Case 1





6.4.2 CASE STUDY 2 (FULL ADAPTATION) BELL DAIRY, GELORUP

Nevel Bell is a fourth generation dairy farmer. He employs two full time and two part time staff to help him milk between 300 and 360 cows. Nevel believes cost-effectiveness and looking after natural resources are the keys to successful dairy farming. Nevel decided to install a gold-class effluent management system after learning first hand how effluent was managed in the US almost 15 years ago. Once construction of his new dairy was complete in 2002, he began putting in place what he describes as world best practice effluent management. Tom Long offered some friendly “fine tuning” and DairyCatch contributed \$5,000 in matching funds for concrete work. A further \$2,000 is now available from DairyCatch and this analysis assumes it is received.



Nevel Bell

‘Based on estimated length of 1,000 metres @ \$2-25 per metre installed and is a ‘work in progress.’

This type of establishment encompasses the conversion of a traditional Effluent Disposal System to a complete Effluent Management System. The following analysis is based on a dairy operation with a capacity of between 300 and 360 head:

• Base material for concrete work	\$550
• The extension of the existing concrete apron together with the construction of an effluent catchment bunker.	\$5,500
• Construction of an adjoining trafficable sump.	\$2,500
• Electric pump to operate out of the trafficable sump	\$5,500
• 2” (50mm) poly pipe to distribute the liquids ⁴	\$3,400
• Provision of own labour & front-end loader.	\$2,000
• Incidentals	\$800
• Less DairyCatch Implementation grant	(\$7,000)

Total Cost of Adaptation is: \$13,250



Pop-up portals used to flood wash yards at the Bell Dairy

This system makes the primary pump that moves the effluent from the dairy to settling ponds obsolete as the effluent is drained directly from the apron to the newly constructed effluent bunker. The effluent liquid is then separated via the adjoining trafficable sump and pumped through a piping system to a centre pivot irrigator through which the effluent is applied to pasture. The remaining solids in the effluent bunker are removed and spread on paddocks.



Wash down water is channelled into the effluent bunker at the Bell Dairy



Solid separation device produces liquid ready for reticulation onto pastures at the Bell dairy

Estimated Value of Benefits:

Preliminary survey results and discussion with producers indicate a labour cost saving could vary from 0.625% to 2.5%. In this case it is unlikely that there will be sufficient family labour available and therefore real cost savings in labour are expected.





The following table represents the various combinations of benefit values in monetary terms.

Table 6.5 Benefits of the adaptation over 10 years at the Bell Dairy

Labour / Fertiliser		0.0% - (\$0)	1.25% - (\$13,125)	2.5% - (\$26,250)
8%	\$8,100	\$8,100	\$21,225	\$34,350
10.5%	\$10,630	\$10,630	\$23,756	\$36,881
13%	\$13,160	\$13,160	\$26,288	\$39,413

The above calculations do not take into account any form of discounting as the discount on future benefits may well be more than compensated for with wage rises and fertiliser cost increases.

Table 6.6 establishes the Benefit to Cost Ratio of such an investment solely from an economic point of view.

Table 6.6 Benefit to Cost Ratios for the Bell Dairy

Fertiliser/Labour		0% - (\$0)	1.25% - (\$13,125)	2.5% - (\$26,250)
8%	\$8,100	0.61	1.60	2.59
10.5%	\$10,630	0.80	1.79	2.78
13%	\$13,160	0.99	1.98	2.97

Within the range of benefits tested here a benefit to cost ratio greater than one is achieved in 6 of the 9 scenarios assuming a 10 year investment period.

The results indicate that the analysis is sound and that the feasibility will depend on the scale adopted⁵ versus static level of subsidy granted. Neville is currently trying to develop a local organic garden fertiliser market for the dried solids his separation device can produce. If established, the income generated may also offset his system's implementation and operational costs.

⁵ Analysis is based on fertiliser costs of \$450/tonne @ 225kg/ha over 100 hectares; Case 2



6.4.3 CASE STUDY 3 (PARTIAL ADAPTATION) HANKS FARM, HARVEY

Dale and Leanne Hanks milk between 200 and 250 cows on their farm. Their family has been dairying for close to 65 years. They employ one full-time and two casual staff members on weekends. Their goal is to achieve sustainable growth to remain viable without curtailing their quality of life. In 2003, Hanks was chosen as a DairyCatch Monitor Farm and developed an effluent management plan with assistance from Tom Long. The Hanks are eligible for matched funding of \$7,000 from DairyCatch. They are hoping to end up with a better yard design that allows washdown waters to easily gravitate into the sump. They describe the improvements they have made so far as quite successful.



Dale Hanks on his farm in Harvey

⁶Based on estimated cost @ \$2-25 per metre installed.

This type of adaptation to an existing (200-250 milkers) dairy operation encompasses the following adaptations and associated estimated costs:

- | | |
|--|-----------|
| • Earthworks | \$3,000 |
| • Solids sump | \$10,000 |
| • Poly pipe to distribute the liquids ⁶ | \$1,000 |
| • Less DairyCatch Implementation Grant | (\$7,000) |

Total Cost of Adaptation is: \$7,000



Milking shed and adjoining yard at the Hanks Dairy in Harvey



Newly constructed sump at the Hanks Dairy in Harvey

Estimated Value of Benefits: Preliminary survey results and discussion with producers indicate a labour cost saving could vary from 0% to 2.5%. In the case of family operated farms, it is possible that no real cost savings in labour will result; therefore 0% gain has been included in the analysis. However as external part-time labour is utilised in this instance, real labour savings could be realised.



EFFLUENT MANAGEMENT



The following table represents the various combinations of benefit values in monetary terms.

Table 6.7 Benefits of the adaptation over 10 years at Hanks Farm

Fertiliser/Labour		0% - (\$0)	1.25% - (\$8,750)	2.5% - (\$17,500)
0%	\$0	\$ -	\$ 8,750	\$ 17,500
8%	\$57,600	\$ 57,600	\$ 66,350	\$ 75,100
10.5%	\$75,600	\$ 75,600	\$ 84,350	\$ 93,100
13%	\$93,600	\$ 93,600	\$102,350	\$ 111,100

The above calculations do not take into account any form of discounting as the discount on future benefits may well be more than compensated for with wage rises and fertiliser cost increases.

Table 6.8 establishes the Cost Benefit Ratio of such an investment solely from an economic point of view.

Table 6.8 Benefit to Cost Ratios for Hanks Farm

Fertiliser/Labour		0% - (\$0)	1.25% - (\$8,750)	2.5% - (\$17,500)
0%	\$0	0.00	1.25	2.50
8%	\$57,600	8.23	9.48	10.73
10.5%	\$75,600	10.80	12.05	13.30
13%	\$93,600	13.37	14.62	15.87

Within the range of benefits tested here a benefit to cost ratio greater than one is achieved in 11 of the 12 scenarios assuming a 10 year investment period.

This case study has such high cost benefit values in comparison to the previous case studies because the cost of the development to the farmer is reasonably small while the possible benefits due to fertiliser savings are huge. The reason for this is that the annual fertiliser bill is approximately \$72,000 and even small percentages of this accumulate to significant sums over ten years .



6.4.4 CASE STUDY 4 (FULL ADAPTATION) SCOTT DAIRY, BUSSELTON

Farm manager Martyn Hole has been dairying for as long as he can remember. He milks between 450 and 500 cows with the help of three full-time staff members. Wayne anticipates that one day he will milk between 600 and 650 cows all year round to achieve maximum efficiency and sustainability. The Scotts incorporated effluent management into their dairy expansion plans back in 2003. With technical advice from Tom Long and \$15,000 in matched funding through the Water Corporation's Bussleton Environmental Improvement Initiative (BEII), the effluent management system was fully implemented that same year. Although Wayne describes the current system as highly efficient and very clean, in hindsight he would have liked to have had a better understanding of pumping systems earlier in the piece.



Martyn Hole outside the milking shed at the Scott Dairy in Busselton

This type of establishment encompasses the conversion of a traditional Effluent Disposal System to an improved Effluent Management System. The following analysis is based on a dairy operation with a capacity of around 450 -500 head:

• Base material for concrete work	\$1,000
• The extension of the existing concrete apron	\$13,000
• Supply, installation & wiring of three pumps	\$12,000
• Incidentals	\$4,000
• Less BEII Implementation grant	(\$15,000)

Total Cost of Adaptation is: \$15,000

Estimated Value of Benefits: Again preliminary survey results and discussion with producers indicate a labour cost saving could vary from 0% to 2.5%. In this case it is real cost savings in labour are expected based on external labour savings as the owners of the dairy are not involved in the day to day activities. The remaining solids in the effluent bunker are removed and spread on the paddocks or provided to local vineyards at no charge.

The following table represents the various combinations of benefit values in monetary terms.

Table 6.9 Benefits of the adaptation over 10 years at the Scott Dairy⁷

Fertiliser/Labour		0% - (\$0)	1.25% - (\$13,125)	2.5% - (\$26,250)
0%	\$ -	\$ -	\$ 13,125	\$ 26,250
8%	\$ 46,080	\$ 46,080	\$ 59,205	\$ 72,330
10.5%	\$ 60,480	\$ 60,480	\$ 73,605	\$ 86,730
13%	\$ 74,880	\$ 74,880	\$ 88,005	\$ 101,130

The above calculations do not take into account any form of discounting as the discount on future benefits may well be more than compensated for with wage rises and fertiliser cost increases.

Table 6.10 establishes the Cost Benefit Ratio of such an investment solely from an economic point of view.

Table 6.10 Cost Benefit Ratios for the Scott Dairy

Fertiliser/Labour	0%	1.25	2.5%
0%	0.00	0.88	1.75
8%	3.07	3.95	4.82
10.5%	4.03	4.91	5.78
13%	4.99	5.87	6.74

Within the range of benefits tested here a benefit to cost ratio greater than one is achieved in 10 of the 12 scenarios assuming a 10 year investment period.

⁷ Analysis is based on fertiliser costs of \$400/tonne @ 400kg/ha over 360 hectares; Case 4





6.4.5 CASE STUDY 5 (PARTIAL ADAPTATION) LINDBERG DAIRY, DENBARKER

Henry, Annette and Neville Lindberg milk between 270 and 300 cows on their farm. They have been in the dairy industry for 40 years. They employ two full-time employees. Their goal is to build and operate a profitable, productive and environmentally sound business. In 2003 the Lindbergs developed an effluent management plan with assistance from Tom Long and implemented the plan in 2004. Matching funds of \$5,000 have been received from DairyCatch and a further \$2,000 is now available. This analysis assumes it is received. The adoption of this effluent management plan has stopped accession of nutrients to the nearby creek.



Henry and Neville Lindberg at their dairy in Denbarker

The Lindbergs have concreted the area where the cows enter and exit the dairy yard. In the past this area became boggy and impeded cattle movement and the pooling of water allowed nutrient rich water to enter the nearby creek.

Cost

- | | |
|-------------------------|-----------|
| • Earthworks | \$2,530 |
| • Concrete and labour | \$16,000 |
| • Less DairyCatch grant | (\$7,000) |

Total cost of Adaptation \$11,530

Estimated value of Benefits: One of the benefits of the concreted entry/exit area is that the area is now much easier to clean with a tractor. In the past the area was cleaned 4 times a year taking 2 ? to 3 hours per time. Now with the concrete base the area is cleaned 5 times a year but each cleaning takes 1 to 1 1/2 hours. Assuming the tractor, fuel and operator cost \$60 per hour, the saving in cleaning cost is around \$300 per annum. Prior to the area being concreted the manure that was scraped up would contain rocks and gravel making it unsuitable for spreading. Now the manure that is scraped off the concrete is sold to viticulturists and earns approximately \$150 to \$300 per annum.



Some Lindberg milkers



Lindberg dairy laneway

Another benefit was improved flow of stock in and out of the dairy. The value of this is not estimated here as it is difficult to determine accurately as much of the benefit is in increased grazing time.

The development has stopped accession of nutrients to the creek and improved the environmental sustainability of the business.





Table 6.11 Benefits of the adaptation over 10 years at the Lindberg Dairy

		Saving in scraping cost		
		\$1,500	\$3,000	\$4,500
Manure Sales	\$1,500	\$3,000	\$4,500	\$6,000
	\$3,000	\$4,500	\$6,000	\$7,500
	\$4,500	\$6,000	\$7,500	\$9,000

The above calculations do not take into account any form of discounting as the discount on future benefits may well be compensated for with wage and fuel cost rises.

Table 6.12 establishes the Benefit to Cost Ratio of such an investment, solely from an economic point of view.

Table 6.12 Benefit to Cost Ratios for the Lindberg Dairy

		Saving in scraping cost		
		\$1,500	\$3,000	\$4,500
Manure Sales	\$1,500	0.26	0.39	0.52
	\$3,000	0.39	0.52	0.65
	\$4,500	0.52	0.65	0.78

Within the range of benefits tested here a benefit to cost ratio greater than one is not achieved in any scenario assuming a 10 year investment period. It should be noted that the Lindbergs do not currently apply effluent to their pastures. They intend to start fertigating and spreading solid wastes in 2006 and anticipate significant savings by reducing their reliance on chemical fertilisers.

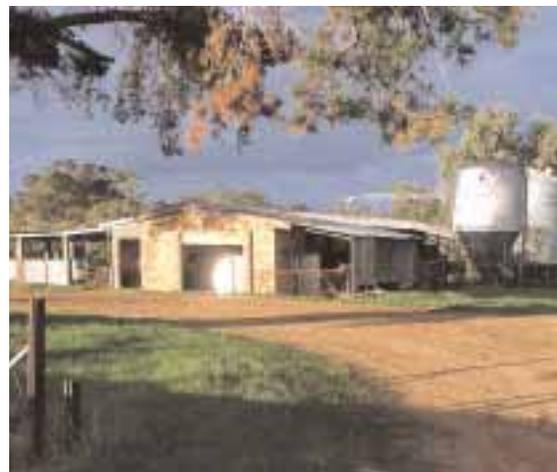
6.4.6 CASE STUDY 6 (PARTIAL ADAPTATION) BETTINK DAIRY, NORTHCLIFFE

Wally and Julie Bettink milk between 180 and 220 cows on their farm in Northcliffe. The Bettinks have been farming the same property for the past 52 years. To help on the farm they regularly have one international Agricultural Exchange Association trainee plus the occasional casual worker. The Bettinks aspire to be successful and profitable with minimal environmental impact. They developed and implemented their plan in 2004 with the assistance of Rob Kuzich (Irrigation consultant) and Tom Long (Effluent Management consultant).

The Bettink effluent system has developed over a number of years. Initially the system involved a single pond that overflowed onto surrounding land. In 1997 the construction of a centre pivot and a second pond allowed the application of effluent water on to pasture. The most recent addition to the system has been the construction of a third dam which has significantly increased the capacity of the system which is now capable of storing more than a year's effluent production. In conjunction with this development, an extra section was added to the centre pivot to increase the area that effluent could be applied by 10.1 hectares. Initially storm-water pipe was used as a suction line however it collapsed and had to be replaced at extra expense.



Julie and Wally Bettink at the farm in Northcliffe



Bettink Dairy



The extra section added to the centre pivot has increased the fertigated area by 10.1 hectares.

To realise the full benefits of the increased pasture production associated with the increased irrigated area herd size was increased by 20 cows. The cows will be valued at \$1,000 per head. There were also annual costs associated with the development primarily increased herd and concentrate costs due to the extra cows and increased fertiliser costs. There was negligible extra cost associated with running the larger pivot and no extra labour was employed.

Extra annual cost

• Fertiliser ⁸	\$5,000
• Herd costs ⁹	\$2,000
• Concentrated costs	\$10,000

⁸ 10 t at \$500/t

⁹ 20 cows at \$100 per cow per year over 10 years

Matching funds of \$5,000 have been received from DairyCatch and a further \$2,000 is now available. This analysis assumes it is received.

Cost

• Dam construction	\$3,500
• Storm water pipe	\$1,800
• Replacing storm water pipe	\$2,500
• Extension to centre pivot (installed)	\$18,000
• Less dairy catch grant	(\$7,000)
Total cost of Adaptation	\$16,400



EFFLUENT MANAGEMENT



Benefits: The increased storage capacity means that effluent no longer has to be applied during winter and can instead be applied when the plants can make better use of the water and nutrients. The increase in area irrigated has resulted in increased pasture production. The total amount of fertiliser applied to the farm has increased but not as much it would have if the effluent were not being applied. The amount of silage that is made and fed out has reduced and milk production has increased by around 100,000 litres. In Wally's opinion the main benefit has been in better nutrient control and maintenance of the natural environment.



A centre pivot is used to apply liquid effluent onto pasture

Estimated value of Benefits

- | | |
|--|----------|
| ● Extra Milk ¹⁰ | \$24,700 |
| ● Reduced silage production cost ¹¹ | \$13,000 |
| ● Reduced silage feeding costs ¹² | \$2,250 |

In this case most of the benefit comes from increased milk production so it was appropriate to discount value of the future benefits. To achieve this, a discounted cash flow was undertaken with a period of 10 years and a discount rate of 7%. The resulting Net Present Values are presented below.

¹⁰ 100,000 litres at 24.7 cents per litre

¹¹ 500 bales at \$26 per bale to cut, bale and wrap

¹² \$15 per hour for one hour every day for 5 months

Table 6.13 Net Present Value of annual benefits over 10 years¹³ for the adaptation at the Bettink Dairy

		Increased Milk production		
		\$19,760	\$24,700	\$29,640
Reduced silage	\$12,200	\$68,811	\$103,508	\$138,204
	\$15,250	\$90,233	\$124,930	\$159,626
	\$18,300	\$111,655	\$146,351	\$181,048

Table 6.14 establishes the Cost Benefit Ratio of such an investment solely from an economic point of view.

Table 6.14 Cost Benefit Ratios for the Bettink Dairy¹⁴

		Increased Milk production		
		\$19,760	\$24,700	\$29,640
Reduced silage	\$12,200	1.77	2.67	3.56
	\$15,250	2.33	3.22	4.11
	\$18,300	2.88	3.77	4.67

Within the range of benefits tested here a benefit to cost ratio greater than one is achieved in all scenarios assuming a 10 year investment period.

¹³ Note; NPV's and BCR's are calculated before tax

¹⁴ Includes the capital cost of the extra cows.

