Environmental considerations

for managing dairy effluent application to land in Otago

Otago Regional Council

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Foreword

The Otago Regional Council wants to promote sustainable and environmentally safe farming. In Otago the dairying industry is significant in its land use and as a contributor to the regional economy.

Dairy expansion in recent years has meant more effluent, which in turn increases the potential for major impacts on water quality.

Council's aim is for the quality of water in Otago's waterways to be maintained and where necessary improved. Careful management of effluent by dairy farmers is a key element in achieving this aim.

Many of the problems that occur as a result of dairy effluent irrigation occur because effluent is treated as a waste product rather than as a valuable nutrient source that can be used to boost soil health and pasture growth. This booklet contains detailed technical information and tips on how to manage effluent efficiently and economically, and prevent adverse environmental impacts. It also provides information on how to maximise the benefits from effluent irrigation.

In support of the issues covered in this booklet, the Otago Regional Council provides an integrated package of information and regulatory services including:

- advice for those considering making a dairying conversion or expansion
- information sharing via the dairy industry, landcare and community group meetings and field days
- resource information on water, soils, climate and natural hazards
- resource consents for water use and waste discharge
- consent compliance inspections and enforcement.

I am pleased to acknowledge the information and feedback given by dairy farmers as well as environmental and research agencies, particularly Dexcel and AgResearch, that have helped make the booklet such a useful reference.

This publication complements the Environmental Considerations for Dairy Farming booklet, which covers a broader range of issues. I recommend both to farm owners and sharemilkers, as guidelines to protect and enhance their properties.

Duncan Butcher
Chairperson

Introduction

Dairying is an important land use in Otago and a significant contributor to the regional economy. Dairy cow numbers have increased in recent years through expansion of existing herds and conversions from other land uses. Although not the only contributor to environmental degradation, dairy expansion can increase risks to the health of our environment.

Managing dairy effluent, which is generated through the farm dairy and from feed pads, is a key environmental concern and is subject to Regional Council and industry regulations. These in turn are governed by community water quality standards and international market perceptions on how New Zealand obtains and provides its export dairy products.

The biggest concern about dairy effluent is the potential to contaminate water by increasing nutrients and/or bacteria levels. Contamination can occur in surface water or ground water. Irrigating effluent over tile drained country or free draining gravels over unconfined aquifers increases the risk of contamination. The important thing to remember is that careful management can prevent adverse environmental impacts.

The Otago Regional Council's preferred approach to effluent management is land application – collecting effluent in a sump or storage pond and applying it directly to land where the soil filters the effluent and absorbs nutrients.

A well-designed system, properly maintained and managed, ensures minimal effect on waterways. Pasture and soil microorganisms use nutrients and organic matter for growth. Volatilisation and denitrification processes disperse the nitrogen into the air.

Planning is the key to managing environmental risk. Environmental management should not be thought of as something else to do after other jobs around the farm are completed. You can apply basic procedures to environmental management just as you would do for herd management.

The main environmental issues associated with dairy effluent management are contamination of surface waterways or groundwater and effects on soil nutrient status and soil physical properties.

The environmental risks directly relate to:

- the sensitivity of the receiving environment
- the system design
- how well the system is maintained, and
- how well the system is managed.

The application of dairy effluent to land is a permitted activity under the Otago Regional Council Regional Plans. This means you can do it without obtaining a resource consent, provided you meet all of the conditions associated with the permitted activity.

This booklet does not cover other issues that may be affected by plans produced by your City or District Council.

Quicktips

These tips summarise much of this booklet. Pin a copy on the wall of your farm dairy as a quick reference.

- ✓ Ensure staff are fully trained in the use and maintenance of the effluent system and know and understand their responsibilities.
- ✓ Make sure pipes and sprinklers are not blocked or damaged and the pump is in good working order.
- ✗ Do not apply effluent to land when conditions are too wet and the risk of effluent run off is high.
- ✓ Maintain sufficient freeboard in storage ponds at all times to cover periods when conditions are unsuitable for effluent application.
- ✓ As a guide allow at least 8ha/100 cows for effluent irrigation, for a nitrogen application rate of approximately 75kg/ha/year.
- ✓ Apply effluent on to short pasture but not sooner than 3–4 days after the paddock was grazed. Withhold cows from treated pastures for at least 10 days to minimise animal health risks, and for 15–20 days to avoid reduced pasture intakes.
- ✓ Maintain an effluent management plan (EMP) to help you manage your effluent system. A full EMP describes your approach to effluent management, staff training, machinery and equipment maintenance schedules, and has a map showing the effluent irrigator runs.
- ✓ Maintain a farm map with the location of mole and tile drains marked on it.
- ✓ Effluent application to land is a 'permitted activity' under Otago Regional Council Water Plan rules. A permitted activity means that you don't have to apply for a resource consent but conditions do apply.

Minimising farm dairy effluent

Why this is important

The more effluent your farm produces the bigger the application problems. Reducing the amount of effluent and yard wash water can save you money and improve the efficiency of your effluent system.

Driving cows.

How do I achieve this?

To reduce the amount of manure on the farm dairy floor:

- ✓ Treat the herd gently before yarding and milking.
- ✓ Be even tempered. Quiet handling in the farm dairy will minimise cow stress.
- ✓ Reduce excessive or unusual noise.
- ✓ Whenever possible, avoid or reduce situations that upset the cows and their routine, such as:
  - slippery surfaces
  - dogs
  - unusual activity
  - stray electricity.

Storm water collection.

To reduce the total effluent volume:

- ✓ Ensure holding tanks, drink troughs and other clean water systems do not overflow. When the tank that collects the milk cooling water does overflow, direct this clean water to a drain and not into the effluent system.
- ✗ Do not run hoses unnecessarily.
- ✓ Repair leaks.
- ✓ Maintain stormwater diversion drains around effluent treatment and storage ponds.
- ✓ Install effective guttering on farm dairy roofs and pipe the rainwater to a farm drain or to storage tanks for reuse.
- ✓ Pre-wet the yard before milking to speed up hosing down afterwards.
- ✓ Use a scraper to remove most of the solids before hosing. A chain on the backing gate helps break up pats.
- ✓ Use a high-flow (3.5 – 4.5 litres/second), low pressure (100 kpa – 150 kpa) wash-down system as the most water efficient method. Hose diameter should be at least 40 mm with a nozzle diameter of 20 – 25 mm.
- ✓ Store cooling water to reuse in wash-down.

System design and setup

Features of an environmentally friendly land-based system

From an environmental perspective the 'best' land-based system is one that:

- Can deliver effluent to the site at rates that achieve maximum assimilation of nutrients and minimal or no runoff to surface or groundwater, *and*
- Is flexible and can be varied to suit the season and conditions, *and*
- Has enough capacity. For example, a system designed for 400 cows will not be sufficient under the load of 700 cows.

Achieving these goals requires careful design and planning. Pump type and size, pipe sizes, paddock layout, topography, applicator type, storage requirements and energy losses must all be considered.

Pump and part reticulation system.

✓ For a new system, consult an expert first. This will save you money in the long term by avoiding design mistakes.

✓ For existing systems, consider all components. What limits the present environmental performance?

- Does the pump have enough capacity?
- Does the stone trap operate effectively? Do you clean it out regularly?
- Does the system have the right combination of reticulation pipes?
- Is the irrigator capable of delivering effluent at the right application rate and depth?
- Do you have enough storage for flexibility in wet periods?
- Does your system include a vacuum release valve to stop siphoning when the pump is not running?
- Does your system have a warning system to indicate overflow of sump or storage?

✓ Ensure your system is laid out correctly.

- Are the guide wires that secure the pump in the storage pond correctly aligned? They should be secured behind the pump (not in front) to ensure it stays level.

- Are you using the best irrigator nozzles? There is a range of nozzles on the market so experiment to find the best for your system. Cone nozzles are successful in many situations.
- Are you laying the supply pipe out correctly in front of the irrigator? A poorly laid pipe increases drag, slowing the irrigator down and increasing the risk of applying excess effluent.
- Are you irrigating land where the risk of contaminating waterways is minimal? Areas without tile and mole drainage should be irrigated in preference to land with tile and mole drains.

Pipe layout behind irrigator.

Storage

Why do I need storage?

Storage (or holding) ponds collect effluent before it is applied to land. This is particularly important in wet periods when land application is impractical and undesirable.

Applying effluent directly from the farm dairy rather than from a pond system will recapture the most nutrients but has disadvantages. These include:

- Careful management is required to avoid environmental contamination from surface runoff, leaching or flow into tile drains.
- Direct application provides the least opportunity for the control of any harmful pathogens.
- There is very limited opportunity to manage application to suit other farm management. Applying effluent to waterlogged soils is obviously detrimental, and applying effluent to pastures at times that don't suit the grazing rotation is also inappropriate.
- The high solids content of the effluent increases wear on pumps, pipes and spray equipment. These need continuous maintenance to avoid failures.

Pumping effluent from a storage pond has advantages. These include:

- Applications can be flexibly timed to suit plant nutrient and soil moisture requirements.

- Application can fit in when time and labour are available.
- If pumping from the aerobic (second) pond, the low solids content means less problems with pumps, pipe blockages and spraying equipment.
- Effluent stored in spring may provide valuable irrigation in early summer when conditions are generally drier.

You may need two smaller storage ponds rather than a single large pond if:

- The pond is likely to be too large for effective pumping, desludging and stirring.
- Pond length interferes with existing structures such as fences. In this case, two smaller ponds could be placed side by side.
- Herd numbers are high or you plan to increase herd size.

How much storage do I need?

You need enough storage to hold all effluent generated in periods when it is too wet to apply effluent.
This will depend on:

- the number of cows
- the amount of effluent generated at wash-down
- additional effluent sources such as feed pads or stand-off facilities, and
- soil type and rainfall pattern.

✕ Effluent should not be applied when the ground is saturated or at field capacity because there is a high risk that effluent will run off in overland flow or through field tiles.

The minimum recommended required storage volume is 50 litres/cow/day. If you use more than 50 litres/cow for wash-down you will need more storage.
This assumes roof water is collected from the milking shed roof and diverted, and that no extra water or effluent comes into the pond from surrounding areas (e.g. feed pads).

Storage pond.

When calculating pond size, consider the length of time that you may need to store effluent because of unsuitable soil conditions.

Obviously this will vary from year to year but it is better to be conservative.

Approx volume of storage required (cubic metres) based on 50 litres/cow/day.			
Number of cows	Number of weeks storage needed		
	4 weeks	8 weeks	12 weeks
Per cow	1.4m^3	2.8m^3	4.2m^3
200	280	560	840
300	420	840	1260
400	560	1120	1680
500	700	1400	2100

- If your effluent irrigation area is poorly drained and/or has tile drains then it is good practice to have at least one month storage and some farms may require up to 3 months capacity. Extra storage provides you with the flexibility needed to effectively manage your system in these situations.
- For maximum flexibility and effectiveness, maintain as much storage within your ponds at all times without compromising the 'too wet - no spread' rule. Even in wet periods there are usually drier spells when it is ok to irrigate. If your pond is full most of the time then you probably need more storage.
- Empty the pond in late autumn (assuming soil conditions are suitable) to go into the new season with maximum storage.
- Ensure that the pond does not overflow, especially if it is close to a stream or drain. Install a warning system to indicate storage overflow.

Do I need to line my storage pond?

Effluent must not leak out of your pond into groundwater or a nearby waterway and equally, groundwater intrusion into your pond should be avoided. If your pond is near a waterway, over a groundwater protection zone (see map under Rules Relating to Dairy Effluent Irrigation – Rules for storage ponds) or on a free-draining gravel or soil, you may need to consider lining or sealing it.

- Silt or clay soils are ideal for storage ponds, since the floor tends to self-seal as the soil is clogged with fines settling out from the effluent. Generally soils with more than 20% clay content (i.e. fine sandy clay loam, silt clay loam or clay soil types) minimise seepage.
- Maximise compaction on the inside of ponds to minimise seepage and erosion. Specialised earth moving and compaction equipment will do the best job in the least time.

✓ If your soil has less than 10% clay or the pond is located over a groundwater protection zone, consider lining or sealing it by

- bringing in clay soil to line the pond. This should be at least 150mm deep and compacted with machinery, or
- buying specially made liners, or
- concreting.

Talk to an expert about the best design for your property.

Concrete lining of a storage pond.

Desludging

Most storage ponds will require desludging at some stage.
Like effluent, sludge is a valuable organic fertiliser that can be used to improve soil health and boost pasture and crop growth. However, special care is needed when applying sludge to land as nutrient concentrations are higher than in straight effluent. Desludging ponds and sludge application to land should be performed during summer months when conditions are drier to avoid run-off.

Storage for deferred irrigation

Deferred irrigation is an economical and environmentally friendly option for mole-tiled land where there is a high risk of effluent flow through tiles from August until October/November, and where pasture growth is reduced due to low soil moisture (typically from December until March).

Deferred irrigation requires storing the effluent for at least 60 days from calving through to mid-October. The stored effluent can then be used for irrigation purposes from December through to February.

Storage for yard wash water

A large amount of water is often used during yard wash down, all of which must ultimately be disposed of through the farm effluent system.

✓ Recycling from a multiple pond system (one with 3-4 ponds) is an option that can significantly reduce the volume of effluent requiring irrigation to land.

✓ Use recycled water from the last pond to wash down the yard.

✗ For hygiene reasons, recycled water cannot be used in the shed.

Dungbuster used to reduce the amount of washdown water.

Effluent application

What should I look for in an irrigator?

The irrigator's application rate is the key environmental consideration. Your irrigator should apply effluent low to the ground, have a wide wetted width and variable speed control, and shut down automatically at the end of the run.

What application rate and depth should I aim for?

Depth and rate affect the risk of surface runoff and/or effluent flow through the soil profile. Soil type and soil moisture conditions at the time of application will affect the desired application depths and rates.

- Application rate (mm per hour) is the maximum rate possible without causing ponding in low-lying areas or runoff into surface waterways, and depends on the infiltration rate. Soil type, slope, vegetation cover and the proportion of solids in the effluent all affect infiltration rates. Ideally application rates should not exceed 10mm/hr.
- Application depth (mm) is the amount of effluent applied at one time. If this depth is too high, soil may become saturated in the root zone and affect pasture growth. Suitable depth will depend on the soil's water holding capacity and the depth of the root zone.
- Minimum application interval (days) is the time between effluent applications. Effluent can be applied repeatedly but there should be a minimum interval between applications to allow for infiltration and soil uptake of solids. Other factors may also influence your decision on when to reapply including stock rotation, pasture length, the prevailing weather, fertiliser value of the effluent and animal health risks. 15-20 days is normally taken as the minimum return period.

Guidelines for effluent application depth, rate and return interval for various soil types are given in the table under Rules Relating to Dairy Effluent Irrigation – Rules for land application.

✓ Measure the application depth by placing ice cream containers at 2 metre intervals across the path of the irrigator. Do this at least once a year to check that you get maximum performance from your system.

Irrigator with ice cream containers set across path.

When to irrigate?

A number of factors will influence your decision on when to irrigate.

- ✓ Only irrigate when soil conditions are suitable. Do not irrigate if the soil is at or near saturation, as this will cause direct leaching through the soil and into the groundwater, reaching into tile drains and overland runoff to open drains and eventually waterways. Adding effluent to already wet soils also compounds grazing management problems. Good storage capacity reduces the risk of this.
- ✓ Apply effluent to short pasture but not to pasture that has just been grazed. Leave a minimum of 3–4 days after grazing to let the soil surface recover after being 'scuffed' and 'sealed' by cow hooves. If you apply effluent to pasture straight after grazing you may find that it ponds on the surface longer.
- ✓ During spring and autumn, adjust the irrigator to its fastest ground speed if applying effluent to mole and tile drained land. This will minimise application depths, reducing the risk of overloading the soil's ability to retain the effluent.
- ✓ When irrigating near tile or mole drains check for effluent discharges during and after irrigation.

Application area

The application area is the area of pastoral land set aside for receiving effluent. You must have a large enough application area to cope with nutrients and water volumes applied. Many systems have failed because they received too much effluent.

Adequate land area:

- Ensures sustainability of the land application operation
- Reduces nitrate leaching
- Avoids eventual physical deterioration of the soil
- Helps prevent ponding and surface runoff
- Reduces weed invasion
- Improves the use of the extra pasture grown.

An area of 4 hectares per 100 cows will apply effluent N at about 150kg/ha/yr. This is recognised nationally as the minimum area for land application. In Otago an area of 8ha/100 cows is recommended, to achieve an N application rate from effluent of 75kgN/ha/yr.

Stonetrap.

Do I need to check the system?

It is a good idea to check on the system regularly as you go around the farm.

- ✓ Check tile drain outlets while irrigating to ensure that effluent is not running out of the drains. It should be absorbed by the soil before reaching these.
- ✓ Check the end of the irrigator run to make sure the irrigator switches off and effluent is not ponding.
- ✓ Check low-lying areas in the irrigator run. If effluent is ponding here then you are applying too much effluent or applying it too quickly.
- ✓ Check irrigator nozzles for blockages.

Note: Grease the nipples on your irrigator once a week or as per the manufacturer's specifications to minimise the risk of breakdowns.

'K' line irrigation system used for effluent irrigation.

Other application systems

Ground spreader

Ground spreading may be the preferred option ahead of reticulated effluent irrigation in some areas. Situations where this may apply include:

- when the area which is to be used for irrigation is some distance from the farm dairy
- when there are areas of the farm outside of reticulated effluent irrigation areas where you want to use the effluent to increase soil fertility and
- when the risks to the environment are high and greater precision of application is required.

When ground spreading take the same precautions as you would if using an irrigation type system (don't spread across the top of tile drain lines, maintain separation distances to waterways, and be careful to avoid soil compaction etc).

'K' Line application

The use of 'K' line irrigation systems for effluent irrigation is still in its infancy, although initial trials look very promising. Potentially the use of 'K' lines or similar systems could revolutionise effluent irrigation by providing a means of application at low application rates.

As part of the 'K' line set–up a means of separating the solid out is likely to be required.

Application with irrigation water

Mixing of effluent with irrigation water is an option for both border-dyke and sprinkler systems provided you meet all permitted activity conditions. (See rules section).

Note: If emptying effluent into an irrigation race a **resource consent is required** to operate this approach.

Big gun application

Big gun application is a useful approach for emptying large storage ponds in as short a time as possible. Application is best during summer months when the risk of run-off is minimal.

Effluent irrigation to trees

If you have a forest patch or a poor producing patch on your farm which can be converted to trees, effluent irrigation amongst the trees is an option. Typically soil moisture levels under trees are lower than under pasture which means that effluent can be safely irrigated even when conditions in adjoining pasture areas are too wet for application. Trees generally used for such purposes include pines, eucalyptus, and poplars. The trees can be used for coppice purposes or for timber.

Effluent management plans

An effluent management plan (EMP) documents the way you manage your effluent. A formal plan shows that you have thought about the issues and have done everything possible to avoid problems.

A plan will save you money in the long term by:

- Reducing opportunities for system failure and costly repairs
- Reducing the time that you need to spend supervising staff
- Reducing the likelihood of mistakes that result in enforcement action, and
- Ensuring that maximum fertiliser benefit is gained from the effluent application.

Components of an effluent management plan include:

- good practice policies
- staff training schedule
- machinery and equipment maintenance schedule
- an application plan.

Keep your EMP in the farm dairy (e.g. in a clear file folder) so that staff have easy access to it.

Good practice policies

Good practice policies set out how you manage your dairy effluent system and guide others on what you see as acceptable practice. Most policies will be common to other dairy farms but there may be some that are specific to your property. The table below shows examples of good practice policies and the reasons for them.

Good practice policy	Reason for adoption
Only workers who have been fully trained and are competent in operating the effluent system will be given responsibility for management of the system.	Problems can occur with even the best set up system if not managed correctly. Staff training in use and operation of the system reduces the risk of management errors.
The effluent system will be inspected and maintained according to the maintenance schedule. A copy of this schedule can be found on the office wall in the farm dairy.	Poor maintenance increases the risk of failures especially at inopportune times.
Effluent will be applied at every opportunity when soil conditions are suitable.	Storage provides flexibility and the opportunity to defer irrigation when soil is wet. If the pond is not emptied when conditions are suitable, the pond's capacity to cover wet periods is reduced.
Hay bales are to be used to contain effluent in the case of leakages in the reticulation system.	Uncontained effluent can easily flow through tiles or waterways causing contamination.

Cows in a milking shed.

Staff training schedule

Staff need to be trained to operate and maintain the effluent irrigation system. Use your EMP as the basis for this training. Training should cover all aspects of staff responsibility including:

- fertiliser benefits
- the importance of managing the effluent system to avoid contaminating waterways
- operating the system to apply the right application rates
- maintaining the system
- reducing water use and minimising effluent generation,
- monitoring to identify any problems, and
- accountability.

Be sure to avoid under-training or under-explaining concepts.

Steps for effective training:

1. Break the skill into simple components.
2. Explain why the skill is important.
3. Discuss what the employee already knows about the skill and decide what knowledge is missing.
4. Demonstrate and explain the skill to the employee slowly. Pause between steps and be sure all steps are clearly seen.
5. Allow the employee to go through the skill step by step while you talk through what is to be done. Help out where needed.
6. Allow the employee to demonstrate the skill on his or her own without input from you.
7. Ask the employee to comment on his or her performance, then give your feedback on how they did. Remember to mention the positives!
8. Repeat steps **4**,**5** and **6** as needed.

A training schedule is a good idea, to document the training that has been given and when it occurred. It will also highlight skill areas that the employee has not been trained in. An example training record is provided below – adapt it to suit your farm.

Farmer talking to staff members.

EFFLUENT MANAGEMENT TRAINING RECORD

Name:

Skills	Date	Trained by	Signed by	
		Print name	Trainer	Employee
Minimising Water Use				
• Storm water diversion • Yard wash-down • Checking for leaks • No water wastage.				
Effluent Pump Maintenance				
• Cleaning stone trap • Greasing pump nipples.				
Irrigator Setup & Maintenance				
• Positioning of pipes • Checking nozzles for blockages • Checking irrigator for worn components • Greasing irrigator nipples • Changing speed of irrigator • Measuring application rate				
Monitoring				
• Checking for ponding or runoff • Checking irrigator for problems • Checking for tile and mole drain discharges • Checking storage freeboard				
Other?				

Machinery and equipment maintenance schedule

The EMP should have a maintenance section including nozzle replacement, pump maintenance and procedures for checking the pressure in the system. An example schedule is provided below.

Equipment and machinery maintenance schedule	
Task	**Person responsible**
Regularly	
• Clean and clear the effluent stone trap and gratings. • Check float switches are clear and working. • Grease irrigator at least once per week or as per manufacturer's specifications. Grease nipples should be evident. • Check that the nozzles are not blocked or damaged. • Flush clean water through the delivery line and nozzles to keep them from blocking. • If over ground piping is used ensure that connection joints are kept clean. Dirt caught in the joints will move through the lines and block nozzles.	
Six monthly to annually	
• Strip the pump for oiling and cleaning as per manufacturer's specifications. • Check pump seals as they are most susceptible to wear. • Check the pump impeller and casing for wear. • Check reticulation lines for leaks. • Do general storage facility maintenance. Remove sludge and spray any weeds growing on storage ponds. • Check pump capacity.	

Record who is responsible for maintaining the system and when maintenance was done. Equipment failure can lead to waterway pollution but good maintenance reduces the risk. Gradual deterioration can also increase contamination risks – e.g. worn nozzles can result in higher application rates than expected.

Landowner explaining Effluent Plan to worker.

Application plan

Risk mapping

Risk mapping classifies your effluent application area according to the degree of environmental risk posed by effluent application. Divide the area into lower risk, higher risk and no application (i.e. 'too high risk') zones.

- Lower risk zones include well-structured soils without a pan and at least 10 metres to groundwater. They include land that is far enough from waterways and open drains to ensure no risk of problems with surface runoff or runoff via tile drains.
- Higher risk zones include tile-drained land or land without tiles but which is excessively wet for prolonged periods. They also include excessively free-draining land with underlying gravel and accessible groundwater, and areas with a high water table.
- No application zones include all land within 50 metres of a waterway (including an open drain) that has flowing water, and 150 metres from neighbouring dwellings. They may also include land with a high density of tile and mole drainage.

Use soil information and your knowledge of the farm to identify these areas. Some farms may have all three zones within their effluent area while others may have only one. Mark the effluent application area on a farm map, then show the zones within this area.

If you are on tile-drained country, draw the tile lines on a map. This map can be included as part of your effluent plan map or as a separate document. Hang this map in a prominent place in the farm dairy to remind you and your staff where the tiles are and where to be careful. It will also be a great aid for future owners and workers.

Plan preparation

Step 1: Mark the following on a farm map:

- waterways and drains
- the area set aside for effluent irrigation
- risk zones - colour code these (and note what each colour means)
- effluent irrigator runs for each paddock.

Step 2: At the start of the season:

- Work out an irrigation plan that takes account of the proportion and area of different risk zones, desired application rates and depths, and the amount of storage that you have.
- Write your plan down and use it as your guide for the season, noting changes in soil conditions as they occur and adjusting your programme to suit.

Step 3: Pin up the effluent plan map in a handy position.

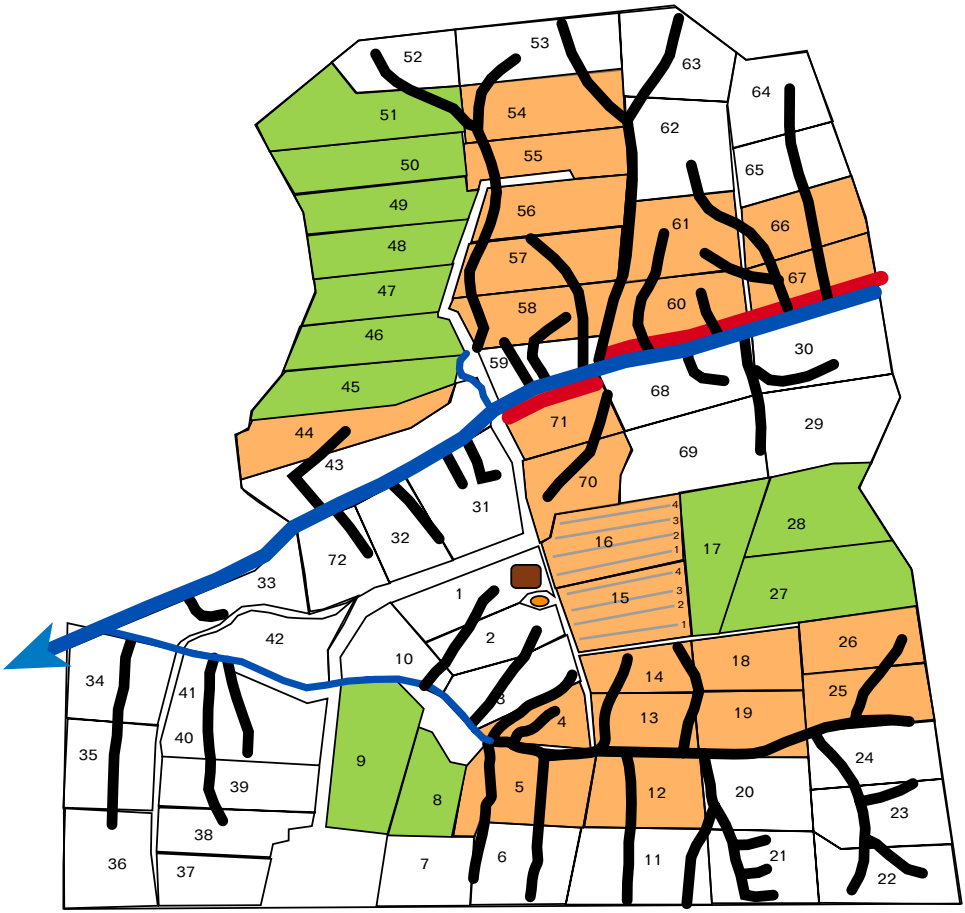
- Pin it on the wall of the farm dairy and keep your effluent irrigation record sheet nearby.
- Make sure the person responsible for shifting the irrigator fills in the record sheet after each shift of the system.

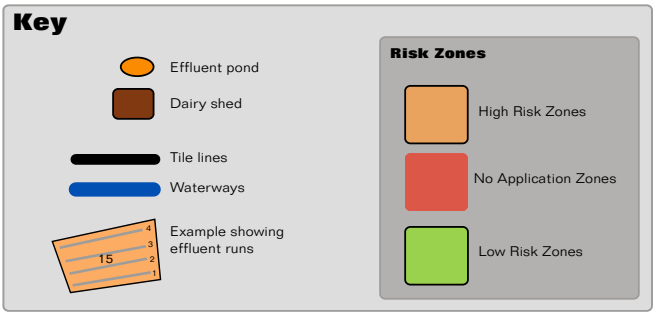
An example application plan is provided on the next page.

Example application plan recording sheet:

Date	Paddock number	Run Number	Signature	Comments
15/8/04	1	7	FRP	
6/9/04	2	10	FRP	Ponding at the south end – too wet?
7/9/04	3	10	JMM	

Example application plan





Nutrient management considerations

What is the fertiliser value of effluent?

Farm dairy effluent provides nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) as well as trace elements to increase pasture or crop production. Organic matter in the effluent will also improve soil water holding capacity, soil aeration and drainage, and soil tillage characteristics. Applying effluent to pastoral soils may also increase earthworm numbers.

Managing application rates will help you get maximum benefit from these nutrients while avoiding potential negative environmental impacts.

The composition of effluent from the farm dairy is extremely variable, due to differences in the nutrient content of dung and urine (which varies with diet, age and season) plus differences in the amount of wash-down water used at the farm dairy. The nutrient content of the effluent also changes during storage.

The only way to know the content of your dairy effluent is to have a sample analysed. During spring collect a sample from your irrigator using an ice cream container and forward this to a laboratory that does soil, herbage and fertility analysis. The values in the table below are a rough guide.

Nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) content of farm dairy effluent from 100 cows.

Nutrient (kg/year) from 100 cows

N	P	K	S
590**	70	540	50

**** Applying this amount over an area of 8 hectares is equivalent to applying 75 kg N/ha.**

Recent research shows that one kilogram of nitrogen from effluent is equivalent to one kilogram of nitrogen from urea, in terms of pasture production, composition and nitrate leaching. The economic value of this to you is in the order of $2500 / 200 cows.

This means farm dairy effluent can produce a good pasture response – e.g. 10 to 15 kg DM per kg N applied in effluent. Most of the potassium in effluent is also available for pasture but phosphorus will take time to break down into plant available forms.

Avoiding metabolic problems

Over time the application of farm dairy effluent increases both soil and pasture potassium levels, especially in winter and spring. This can increase the risk of metabolic problems at calving and in early lactation but management can help overcome this, as follows:

- ✓ Where milk fever and grass staggers are likely, avoid grazing effluent irrigation areas with springing cows and recently calved cows. If this is not possible, take additional measures such as increasing magnesium supplementation.
- ✓ Avoid potassium fertiliser application to effluent irrigation areas.
- ✓ Analyse pasture from effluent and non-effluent areas for chemical composition and adjust magnesium supplementation levels and supplements fed. Talk to your farm consultant or veterinarian if necessary.
- ✓ On farms with high pasture potassium levels, consider the potassium content of the effluent when deciding effluent application rates and maintenance fertiliser applications. Soil test effluent areas separately, as they probably won't need additional potassium fertiliser.
- ✓ Increase the area irrigated to reduce nitrogen and potassium applied per hectare. The area irrigated may need to double to bring potassium application rates down to maintenance levels.
- ✓ Increase the amount of on-farm storage to enable application over a larger area.
- ✓ Consider using a contractor to spread stored effluent to remote paddocks outside the usual effluent spray irrigation area.

Nutrient budgeting

The movement of nutrients within a farming system is important in sustainable farming. If sufficient nutrients are not provided then soil fertility and production will decrease. If excessive nutrients are provided there may be negative effects on the environment and/or animal health.

Tracking nutrient movement in a farming system is called **nutrient budgeting.**

Nutrient budgeting looks at nutrient inputs and outputs from all sources of the farming system. The aim is to ensure that inputs match outputs, to prevent adverse environmental effects and run a cost effective fertiliser regime.

Nutrient inputs into your farm can include fertiliser applications and conserved feed (e.g. hay and silage) brought onto the property for feeding. Nutrient outputs or losses include produce (e.g. milk and animals sold) and pasture or crops cut and removed from the property.

Overseer computer package.

AgResearch's 'Overseer' computer package calculates nutrient budgets. Download a free copy of the software from the internet (www.agresearch.co.nz\overseerweb), send your name and address to overseer@maf.govt.nz or call 07 856 2832. It is a good idea to run the programme for the first time with someone who is familiar with it. Most fertiliser representatives are trained to use it and can do this with you.

To use Overseer you enter information about your farming operation including fertiliser use, stocking rates, soils, rainfall and supplements. You will see whether soil fertility is increasing or decreasing, whether you are using too much fertiliser or not enough, and whether you are likely to be harming the environment. In particular, nutrient budgeting will give you a clear understanding of whether you are applying too much or too little nutrient to your effluent block.

- ✓ It is a good idea to do a separate nutrient budget for the effluent area. Effluent adds significant amounts of nutrients, particularly N and K, and you should adjust fertiliser inputs to compensate for this.
- ✓ Make sure your fertiliser representative uses nutrient budgeting when calculating your fertiliser requirements.

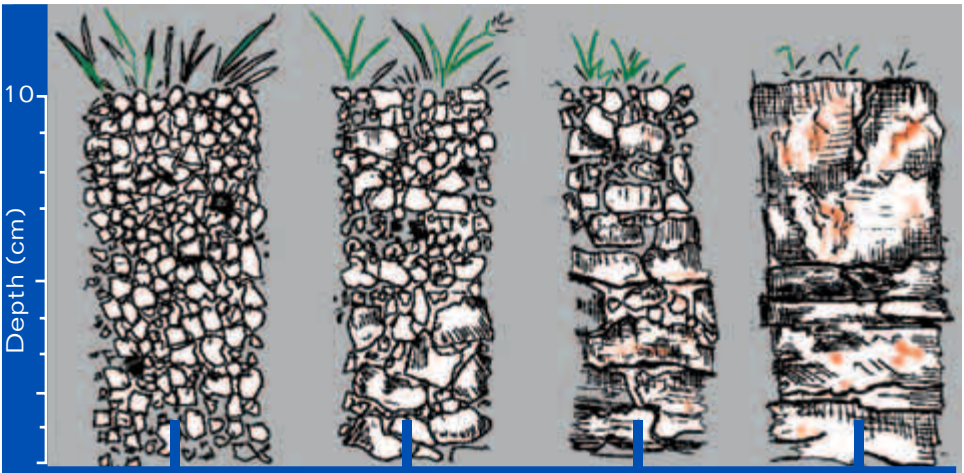
Soil physical properties and effluent management

The importance of good soil structure

As well as having an important influence on plant production, physical condition also influences the soil's ability to absorb nutrients and water applied in dairy effluent.

Soil physical condition or 'structure' refers to the arrangement of soil aggregates ('clods') and pores within the soil. A well-structured soil has many aggregates with a wide range of sizes and a large number of pores within and between those aggregates. Poorly structured soil either does not have aggregates of many different sizes or the aggregates are tightly packed together with few pores.

In a well-structured soil, over half the total soil volume consists of pores. About 60% of these are large pores, important for root growth, aeration and drainage. Large pores allow water and dissolved nutrients to move down through the soil for roots to absorb.



Unaffected by compaction	Slightly affected	Moderately affected	Severely affected
Topsoil is loose and crumbles easily into small, granular aggregates. Abundant roots throughout topsoil. Earthworms are common.	Upper part of topsoil is loose. Some larger, firmer aggregates between 10 to 15 cm. Roots do not commonly penetrate firmer aggregates.	Larger, firmer aggregates more common - sometimes have a horizontal appearance. Roots grow around rather than through aggregates. Reddish stains along some root channels.	Lumpy, irregular surface. Aggregates are coarse or absent. Few roots below 5 cm Reddish stains along root channels - soil often greyish in colour and may have an unpleasant smell when wet. Few earthworms present.

Diagram courtesy of AgReasearch.

Heavy machinery and stock treading can both damage soil structure. Cattle can cause 3–4 times more damage to soils than sheep so careful management of heavyweight cattle in winter, spring and when land is under irrigation is a major challenge.

Soil compaction is the compression or 'squeezing' of a soil, reducing the number and volume of large soil pores and increasing soil density. It occurs when forces acting upon the soil (e.g. cattle treading) are greater than the soil's strength, packing the aggregates and particles closer.

The wetter a soil is, the greater its susceptibility to compaction. Compaction can cause more frequent and persistent ponding or wetness, inadequate soil aeration, nutrient losses, reduced nutrient uptake efficiency, reduced root penetration and reduced nutrient accessibility to plants.

Such changes make soils more difficult to manage, affecting the root environment and decreasing pasture growth. Resulting off-site effects often include greater runoff of water and pollutants to streams and rivers.

How do I know if my soils are compacted?

Soil susceptibility to compaction varies. Look at topsoil structure first. If the structure is loose, fine and open, and the soil appears brown, red or yellow, then the soil's aeration, root penetration and drainage should be okay. Use a spade to inspect topsoil in a paddock that you suspect is compacted and compare this with another paddock or part of a paddock that you know is uncompacted. Look for damage signs such as large soil aggregates, few worms, hard aggregates with few large pores, and most roots going around, but not through, soil aggregates. Damaged soil may appear blue or grey.

Compacted soil.

Loose soil stucture.

Photo's courtesy of AgResearch.

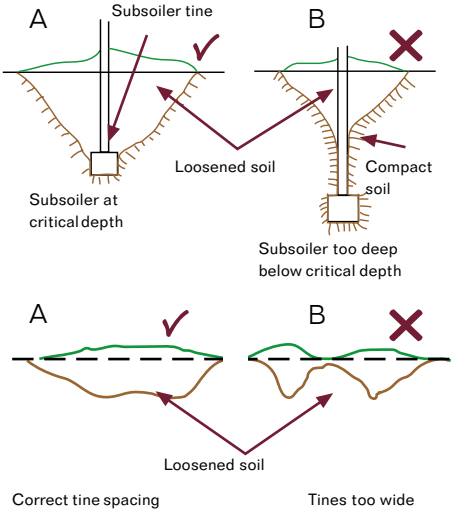
Visual assessment is often only helpful when structure is very good or very bad and the 'macroporosity' test may be a better way to determine the degree of compaction. AgResearch developed the macroporosity test, which involves taking soil cores similar to those used for soil fertility tests. See the booklet 'Managing Treading Damage on Dairy and Beef Farms in New Zealand' for more information about this test. Contact AgResearch for a copy.

How can I fix a compacted paddock?

Some soils may recover on their own if you encourage strong pasture growth, particularly in spring and early summer. Taking the paddock out of the rotation or using it for silage may also help.

Subsoiling (sometimes called aerating, ripping or subtillage) can mechanically loosen compacted soil. It uses rigid tines to loosen the soil without cultivation and without mixing the different soil depths. There is a wide range of subsoiling equipment, usually operated at depths of 20–50cm to loosen the compacted layer.

Assess soil structure to decide the need for subsoiling. Professional advice is recommended because unwarranted subsoiling is a needless expense that won't show a positive return.



- ✓ Satisfactory soil disturbance is only achieved when subsoiling is carried out at a suitable soil water content.
- ✓ If soil is too wet, the subsoiler will not lift and crack the soil but, instead, will create additional compaction.
- ✓ Poor shattering will occur if the soil is too dry because large blocks of soil will lift without breaking up.
- ✓ The best times for subsoiling are autumn or spring when soil is moist and friable. A small block of soil should crack or crumble when pressed between your fingers.
- ✓ For each combination of implement type and soil condition, there will be a particular depth at which the subsoiler is most effective.
- ✓ If an implement is operated too deeply, below its critical depth, much less soil will be loosened. Soil around the passage of the tines will actually be compacted instead.
- ✓ For uniform loosening, horizontal tine spacings on conventional subsoilers should be greater than 1.0–1.5 times the operating depth. Spacings of up to 2.0 times the working depth may be satisfactory for winged implements.
- ✓ Always subsoil along the contour. Subsoiling up and down slope will increase effluent irrigation runoff.

Rules relating to dairy effluent irrigation

The Regional Plan: Water for Otago and the Regional Plan: Air for Otago include rules relating to dairy effluent. The summary of rules outlined below is intended as a guide only. For complete details of the rules, please contact the Otago Regional Council.

Rules for land application

Under the Water and Air Plans, land application of dairy effluent is a **permitted activity** provided:

- The discharge is more than 50 metres from any waterbody, bore or the coast;
- Effluent does not directly enter any drain, water race or groundwater;
- Effluent does not pond, and does not run off to any other person's property;
- You apply less than 150 kg N/ha/yr. If you are in the Lower Waitaki Plains Zone A groundwater protection zone, N applications need to be less than 75 kg N/ha/yr. If you are in any other Zone A ground water protection zone, you need a consent to discharge effluent, (See map at the end of this chapter.) If you are unsure, check with the Otago Regional Council as to where these zones apply;
- The discharge does not occur on saturated soils;
- Odours are not noxious, dangerous, offensive or objectionable at or beyond the boundary of the property;
- Outdoor stockpiles of material like waste animal bedding and manure are more than 150 metres from the farm boundary;
- Land application does not occur within:

  (a) 150m from any residential dwelling on a neighbouring property or from a building used for employment purposes on a neighbouring property, and

  (b) 20m from a formed public road, and

  (c) 150m from any public amenity area or place of public assembly;

If you cannot meet all the permitted activity conditions you will need a **resource consent** to discharge effluent to land.

Rules for storage ponds

Under the Water and Air Plans, storage ponds are a **permitted activity** provided:

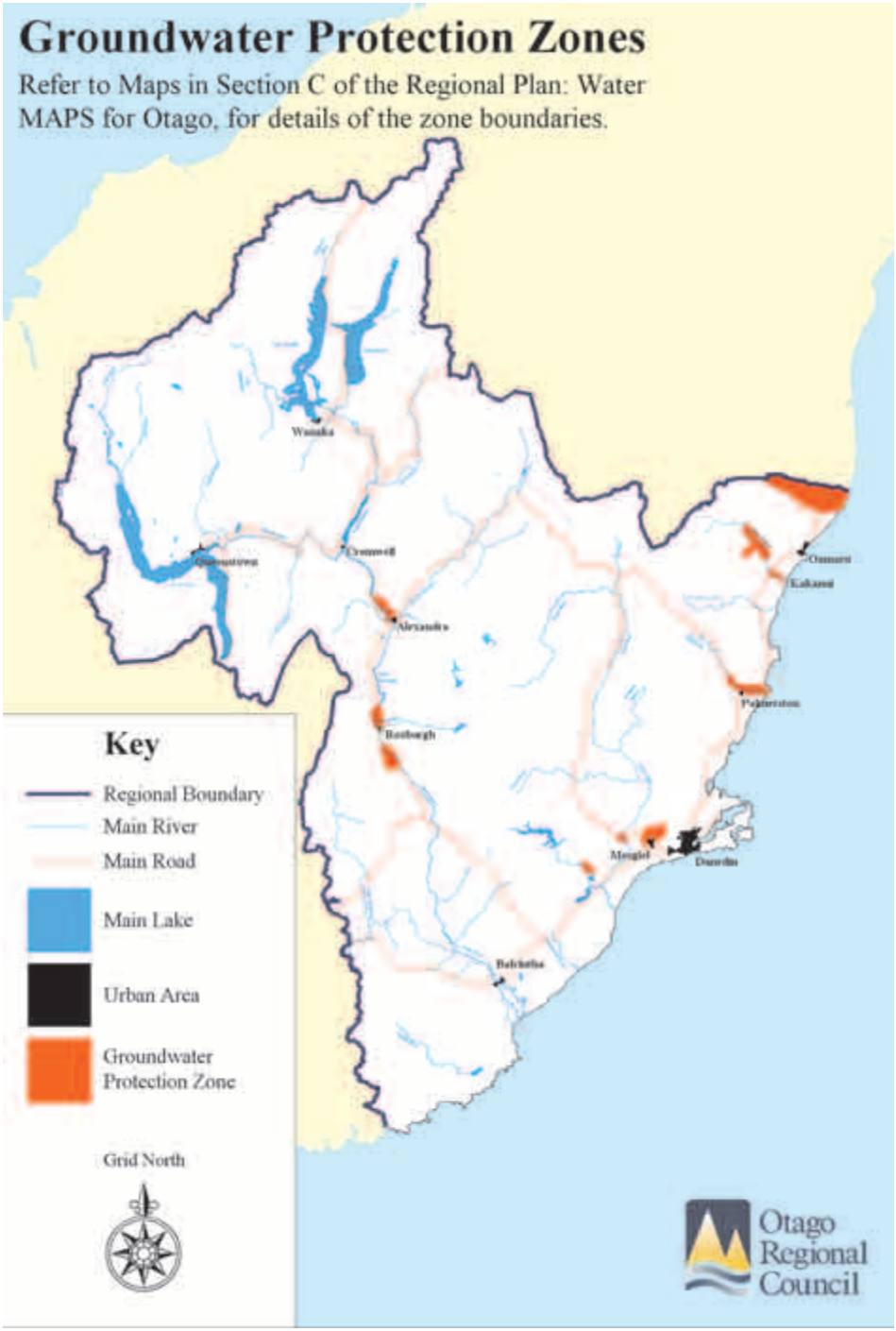
- Any odours are not noxious, dangerous, offensive or objectionable at or beyond the boundary of the property;
- Effluent storage or treatment ponds constructed after 30 June 2001 must be at least 150 metres from the property boundary;
- The ponds are sealed and there is no leakage;
- There is no overflow of material that runs off onto any other person's property, or into water.

If you cannot meet all the permitted activity conditions you will need a **resource consent**.

Dairy cows in the milk shed.

Groundwater Protection Zones

Refer to Maps in Section C of the Regional Plan: Water MAPS for Otago, for details of the zone boundaries.



How does my system stack up?

So how does your system compare? Read through this table, assess your farm's performance and identify areas where you think improvement is needed. Make the changes, then review again after a reasonable time.

Component	Your assessment 1 - 5 (poor to excellent)	Improvements required?
System design and setup		
Staff training & supervision in use of system		
Machinery & equipment maintenance		
Effluent management planning		
Nutrient management		
Soils management		

Sources of further information

References

Dairying and the Environment: Managing Farm Dairy Effluent (1996) Dairying and the Environment Committee

*Dairying and the Environment: Farm Management Issue*s (1998) Dairying and the Environment Committee

Managing Treading Damage on Dairy and Beef Farms in New Zealand (2003) AgResearch

Environmental Considerations for Dairy Farming in Otago (2003) Otago Regional Council

GrowOtago soil maps (2004) Otago Regional Council

Acknowledgments

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Council also acknowledges the contributions of Dexcel and AgResearch staff, as well as staff from the land resources, compliance and resource planning sections of Council.

Check list

- [ ] Have you evaluated the environmental risks associated with managing your effluent system?
- [ ] Do you have appropriate systems to manage the risks identified?
- [ ] Have you talked to the Otago Regional Council about any resource consents you may require?
- [ ] Do you understand the conditions attached to the permitted activity rules relating to dairy effluent irrigation?
- [ ] Have you checked with your District or City Council about District Plans and implications for your farm?

Otago Regional Council

For resource consent information, and the full wording for permitted activities, contact the consents administration team at the Otago Regional Council.

Contact an Otago Regional Council land resource officer to discuss in more detail any of the information contained within this booklet.

Otago Regional Council
Private Bag 1954
Dunedin
Phone: 03 474 0827
Freephone: 0800 474 082
Fax: 03 479 0015
Email: info@orc.govt.nz

Visit the Otago Regional Council web site:
www.orc.govt.nz

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