2.9.2.7 Hydrants

Hydrants are often above ground and in an inverted T-shaped single pronged form (refer to Figure 2.9-11) **or** they lie horizontal in underground boxes using flexible lie-flat hose (refer to Figure 2.9-13).

The T-shaped system is not recommended for effluent. Most of the time, a T-shaped hydrant sits unused on the mainline. Periodically, it is connected to the sprayline for effluent application to the area the hydrant services. The dead ends in T-shaped hydrants block up with consolidating effluent when not in use, and the sharp elbows in the system restrict flow, as the effluent is solid in nature and unable to move around elbows easily.

FIGURE 2.9-11

T-SHAPED HYDRANT

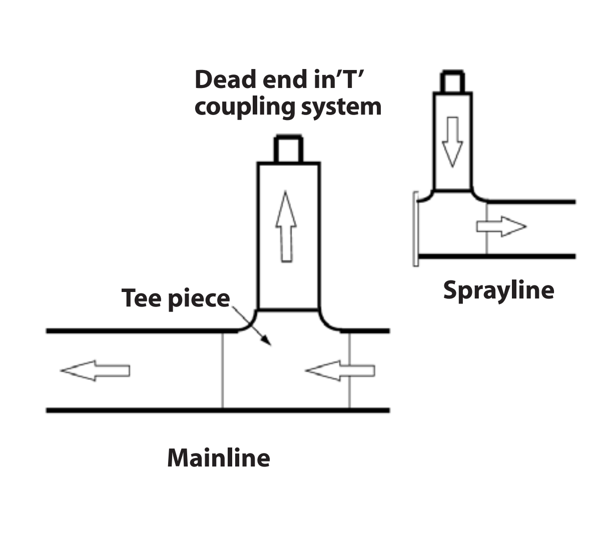
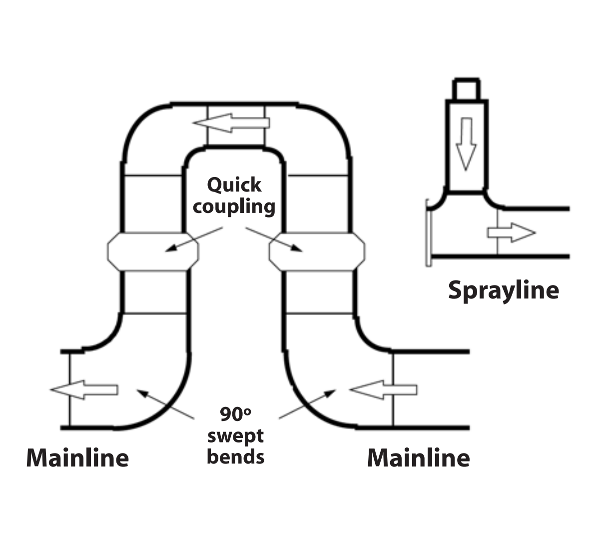


FIGURE 2.9-12

LOOP HYDRANT



It is best to have the effluent flowing continuously through the hydrant regardless of whether it is in use. Such a system requires converting the inverted T-shaped single pronged form to an inverted u-shaped structure called a **loop hydrant** (refer to Figure 2.9-12). With the loop system, effluent continuously moves through the hydrant as it is fed around the mainline. This prevents blockages, as effluent flowing through the whole system pushes any solid material through. When the land around the hydrant is to be treated, the top of the hydrant is taken off and coupled to the sprayline.

Where hydrants are placed in underground boxes, the potential for hydrant damage is reduced and the hydrant is not in the way of farm machinery. Hydrants should be enclosed in a covered timber or concrete box that is strong enough to sustain vehicle and stock loading (refer to Figure 2.9-13). Hydrant boxes should have provision for drainage.

Where hydrant connectors come out of the ground, the pipe should be laid with extra care to ensure that the backfill does not compress the thin walled or collapsible piping.

In undulating locations, hydrants should be placed at both high and low points.

FIGURE 2.9-13

UNDERGROUND HYDRANT

2.9.2.8 Buried mainline

For buried mainlines, Class B PVC and PN6 or PN8 polyethylene pipe is normally used. For very small spray application systems, 65 mm diameter pipe can be used. If higher flow rates are used, 80 or 100 mm diameter PVC pipe or 90mm or 110mm polyethylene pipe will be necessary.

Trenches need to be constructed to bury PVC pipe. Using a hired trencher, farmers can cheaply construct trenches for both PVC and polyethylene mainlines and electric cables. PVC pipe up to 80 mm can be mole ploughed into the ground.

Alternatively, Class B or PN8, 75 or 90 mm polyethylene pipe joined by camlock fittings can be used. This pipe can be easily and cheaply ploughed into the ground because of its flexibility.

The mainline depth is dependent on the likelihood of disturbance from machinery. **Below 600 mm depth** is desirable especially if mole ploughing is likely and if the mainline can not be situated close to the fence line.

Pipes used in buried mainlines should be laid according to the manufacturer's instructions.

For very large systems, it may be necessary to provide concrete thrust blocks to support the pipeline:

- at significant changes of direction or grade
- where there is a change in pipe bore
- at major branch connections
- adjacent to any valves or fittings.

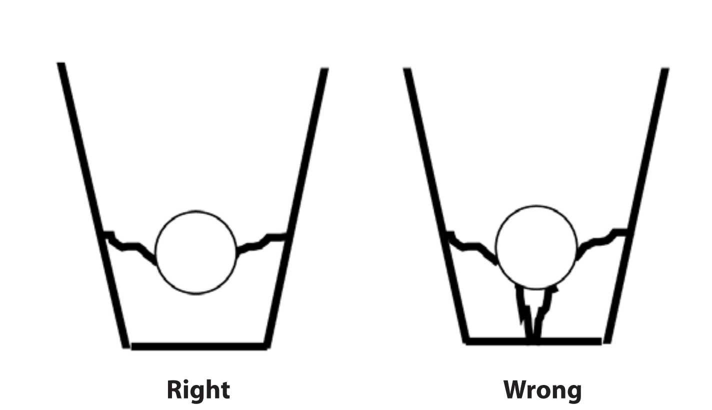
It is at these points that internal pressures create stress on the pipeline system.

The bottom of the trench must have an even grade. Hollows in the pipeline trench will result in solids settlement in these areas and eventual blockages (refer to Figure 2.9-14).

Pipes should not be resting on large stones that may cause stress, pipe weakening and subsequent pipe failure.

FIGURE 2.9-14

LAYING PIPES IN A TRENCH



2.9.2.9 Surface mainline

It is also possible to have the mainline on the surface, rather than permanently buried. Advantages of a surface mainline include:

- **less capital cost**
- **the mainline can be shifted** to extend the system coverage and allow for cultivation and harvesting access
- **maintenance, replacement and cleaning can be easily carried out and pipe blockages removed** as the surface pipe can be uncoupled.

Polyethylene pipe joined by camlock type fittings is better for a surface mainline than PVC. PVC is easily damaged and will break down with exposure to sunlight.

When the surface mainline exceeds 100 m, a 90 mm nominal diameter polyethylene pipe should be used.

2.9.2.10 Sprayline

The sprayline is not usually buried, but is portable across the land surface. It is best made from polyethylene because of pressure rating, shifting loads and resistance to permanent bending, kinking and twisting.

Class B or PN8 63 mm medium density polyethylene pipe joined by camlock type fittings is often used for a sprayline. 90 mm pipe can be used, depending on its required length and flow rate. However, it should be noted that some travelling applicators are unable to pull 90 mm sprayline filled with effluent. Manufacturer specifications for the various travelling applicators available will specify maximum useable draghose sizes and lengths.

Avoid lengths greater than 150 m for the sprayline, as the head loss is too great with the smaller bore pipe, most travelling applicators cannot cope with the drag loads, and the manual shifting of longer pipes is difficult.

For ease of handling the sprayline can be broken down to sections with camlock joints (e.g. a 150 m sprayline of three 50 m sections).

With multiple sprinkler systems, the sprayline may be buried with risers feeding the effluent to the sprinklers (refer to 2.9.3.4 Multiple sprinkler systems). Alternatively, portable sprinkler systems may be used with a surface sprayline linking the 'pods'.

2.9.3 Applicators

When deciding which spray applicator system is best on any specific property, the irrigator's application rate is the key environmental consideration. Consider the following:

- the ability to apply a **low application depth** of effluent (mm) and at a **low application rate** (mm/hr)
- the **sprinkler design and its ability to operate at a low pressure and spray trajectory,** eliminating effluent drift and ensuring even application
- the **wetted width** and the **uniformity** of the application
- the requirement for **maintenance**
- the requirement for **ongoing labour** as all applicators require some degree of shifting to allow the treated area to recover
- the suitability for the **topography and soil type**
- **ease of conversion in order to treat a larger area** should the herd size increase
- **capital outlay.**

Spray applicator systems available include **travelling applicators, stationary applicators** and **multiple sprinkler and 'pod' type systems.**

2.9.3.1 Sprinklers

It is essential that **sprinkler nozzles be large enough to pass the liquid without frequent clogging.** Blockage problems with fine nozzles occur because of suspended solid and chemical build-up, or bacterial growth. Occasional flushing of the system with fresh water may alleviate any existing problem.

The minimum nozzle size will vary depending on the pre-treatment (e.g. straining and solid settling) of the effluent. Preferably, **the nozzle should be at least 12 mm in diameter.** Smaller nozzle sizes are feasible where solids separation is carried out. Corneal (cone shaped) nozzles are less prone to blockages than nozzles with flat ends.

Nozzle flow rates for various nozzle sizes are given in Table 2.9-7. Variations from the specific design operating pressure of a sprinkler should be avoided as these will alter the flow rate and may have an effect on application uniformity.

TABLE 2.9-7

SPRINKLER FLOW RATES (Litres per second)

Operating Pressure	**Diameter of Nozzle**				
	12 mm	14 mm	16 mm	18 mm	20 mm
100 kPa or 15 psi	1.6	2.2	2.9	3.7	4.7
200 kPa or 30 psi	2.3	3.1	4.0	5.1	6.3
300 kPa or 45 psi	2.8	3.8	4.9	6.3	7.7
400 kPa or 60 psi	3.2	4.4	5.7	7.3	8.9
500 kPa or 75 psi	3.6	4.9	6.4	8.1	9.9

Sprinkler size

The wetted diameter of a sprinkler is the diameter of the circle within which the ground is treated by a single sprinkler under calm conditions. The wetted diameters, as well as the flow rates for various sprinkler operating pressures, are usually quoted in sales literature.

Most applicators utilise sprinklers operated at a low pressure because of the shorter and lower spray path, which is less affected by wind. **The usual operating pressure is 100 kPa to 300 kPa** (i.e. 15 psi to 45 psi).

Sprinklers that require higher pressures give a greater wetted width. The usual operating pressure is 300 kPa to 500 kPa (i.e. 45 psi to 75 psi). Such sprinklers, with large nozzles and high flow rates, have the advantage of not becoming easily blocked. However, such sprinklers:

- require high pressures for their operation, with resulting high operating costs
- are more markedly affected by wind, since the effluent spends more time in the air and the high pressure generates mist easily carried by wind. This will result in the wetted pattern becoming distorted and affecting uniformity of coverage
- may result in odour problems for neighbours due to wind effects.

Sprinkler type

The sprinkler most commonly used is the rotating impact driven sprinkler. The impact force of the effluent against a hammer rotates the sprinkler in stages.

Wherever possible, rubber nozzles should be used with the sprinkler as they expand if a stone or any solid material comes through the delivery line and will not block as easily. For applicators where a rotating boom is employed, rubber nozzles at the boom ends will allow for the successful passage of effluent.

Sprinklers manufactured from special plastics are best used with effluent as they are non-corrosive and do not suffer from metal fatigue (refer to Figure 2.9-15).

A tapered, smooth 'cone shaped' nozzle reduces misting and spray drift compared to the flat 'petrol cap' shaped nozzle.

FIGURE 2.9-15

PLASTIC SPRINKLER

Spreading distance restrictions

Since most sprinklers generate a circular spray pattern, sprinkler spacing can have a critical effect on uniformity. Pressure and wind speed have a significant effect on the distortion of sprinkler distribution patterns. Low pressures result in doughnut shaped patterns, with more uniform patterns as the pressure increases. As wind increases, the pattern shape is distorted in the downwind direction. This should be taken into account when shifting to a new area or a new run.

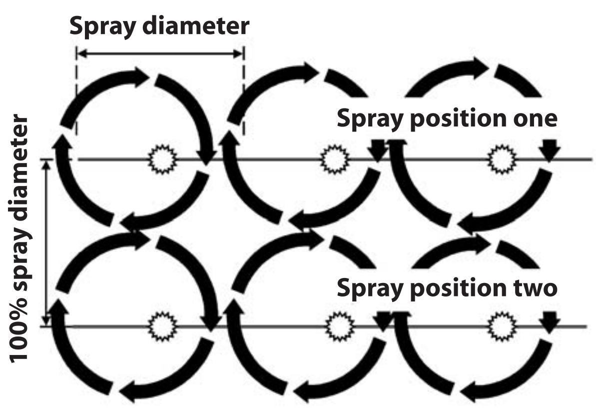
Spacings between sprinklers or shifts acknowledge the following constraints:

- **economy.** Large spacings reduce the number and cost of sprinklers, and the work of shifting
- **uniformity.** Consider uniformity when windy conditions prevail. It is preferable to under-apply in patches than over-apply and exceed nutrient loading rates.

Spacings should be **100% of the wetted diameter** but modified to allow for local wind effects (refer to Figure 2.9-16).

FIGURE 2.9-16

SPRINKLER AND RUN SPACING



Effluent should not be allowed to reach natural waterways. Many Regional Councils and District Councils have restrictions on how close effluent can be applied to waterways and neighbouring properties (check with your Regional and District Council for requirements in your area). Surface runoff or ponding may also cause effluent entry into the watercourse.

2.9.3.2 Travelling applicators

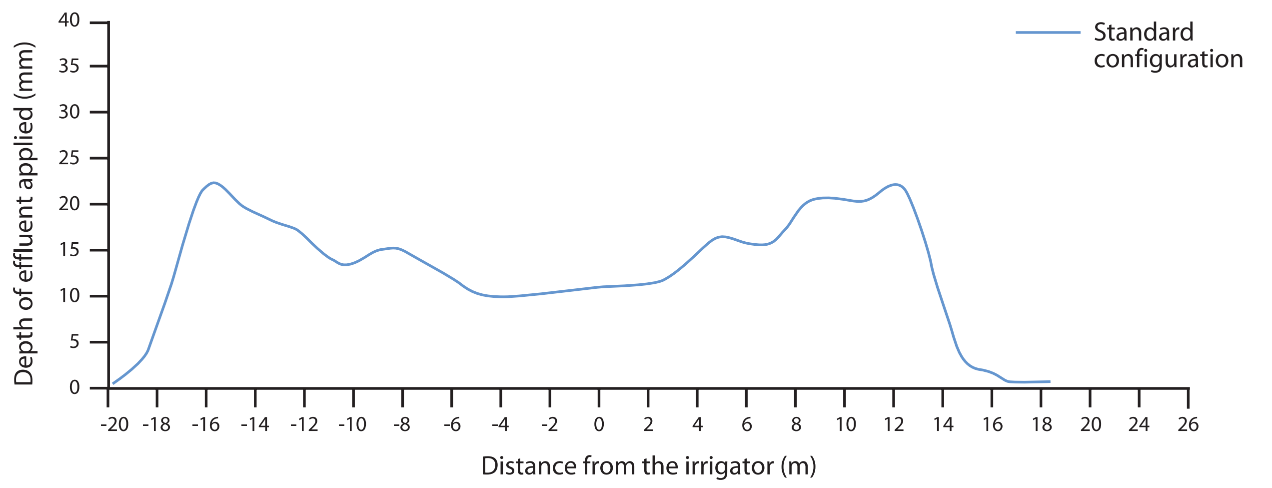
Many different models of travelling applicator are available. They have lower labour input, more uniform coverage and better environmental results than stationary applicators.

In selecting one of these systems, it should be borne in mind that:

- **a significant labour input is still necessary to make shifts between paddocks**
- **the ability to adjust the speed of the irrigator is critical to achieve appropriate rates and depths**
- **on undulating land, continuously moving applicators give variable application rates** with respect to varying heights. Therefore, uniformity and surface runoff may be a problem
- **heavy, easily pugged soils can present accessibility problems** for large and heavy travelling applicators
- **travelling irrigators tend to have a non-uniform spray pattern, typically applying double the rate of effluent at the outer end of the spray trajectory.** This can create issues when applying in wetter months or over mole and tile drains. Figure 2.9-17 illustrates the application profile of a standard rotating irrigator during relatively calm conditions. It is important to note that a cross wind can significantly reduce the performance of a standard rotating irrigator by altering the spread of the effluent and significantly increasing application depth in some areas.

FIGURE 2.9-17

PROFILE FOR THE DEPTH OF FARM DAIRY EFFLUENT APPLIED BY A STANDARD ROTATING IRRIGATOR



- **Instantaneous application rates (the actual rate of effluent applied in any one spot at any one time)** can be very high resulting in surface runoff.

Travelling applicators consist of a boom mounted on a trolley. The reaction force to the spraying effluent causes the boom to rotate. In turn, the rotation of the boom provides the motive force by turning a wire cable winch (refer to Figure 2.9-18).

The winch is driven by the rotating boom in one of two ways:

- through a simple lever mechanism using a ratchet gear with a toothed sprocket (refer to Figure 2.9-19). The heavier the teeth the better, as they are subject to wear
- through a sprocket and chain with a reduction worm gearbox. Consideration should be given to the possibility of chain stretch.

The better systems have high density plastic or nylon roller bearings and bushes, rather than corrosive metal bearings.

With the winch, the effluent applicator pulls itself along the wire attached to an anchor (i.e. fence post or steel peg) at the end of the paddock.

The trolley tows a flexible sprayline so that the total available distance in each run is governed by approximately 1.75 times the sprayline length (refer to Figure 2.9-24).

Moving to a different hydrant requires a positive shut-off to allow disconnection.

Applicators are available with wetted area spreads between 15 m and 60 m diameter. The wider application is useful for larger herds and greater volumes of effluent, as the ground speed does not have to be so great to achieve the same application rate. This means fewer running strips per paddock and, therefore, fewer labour hours to change the applicator over to a new run. A rotary applicator cost between $3500 and $4500.

Alternative travelling applicator systems

Oscillating irrigators (refer to Figure 2.9-20) have been shown to have a more uniform application pattern and therefore give more even fertiliser benefits and pasture growth while creating less risk of surface runoff or leaching. Figure 2.9-21 illustrates the application profile of an oscillating irrigator. As with rotating irrigators cross wind can significantly reduce the performance of an oscillating irrigator by altering the spread of the effluent and significantly increasing application depth in some areas.

FIGURE 2.9-18

APPLICATOR AND TRAILING SPRAYLINE

FIGURE 2.9-19

A LEVER AND RACHET SYSTEM

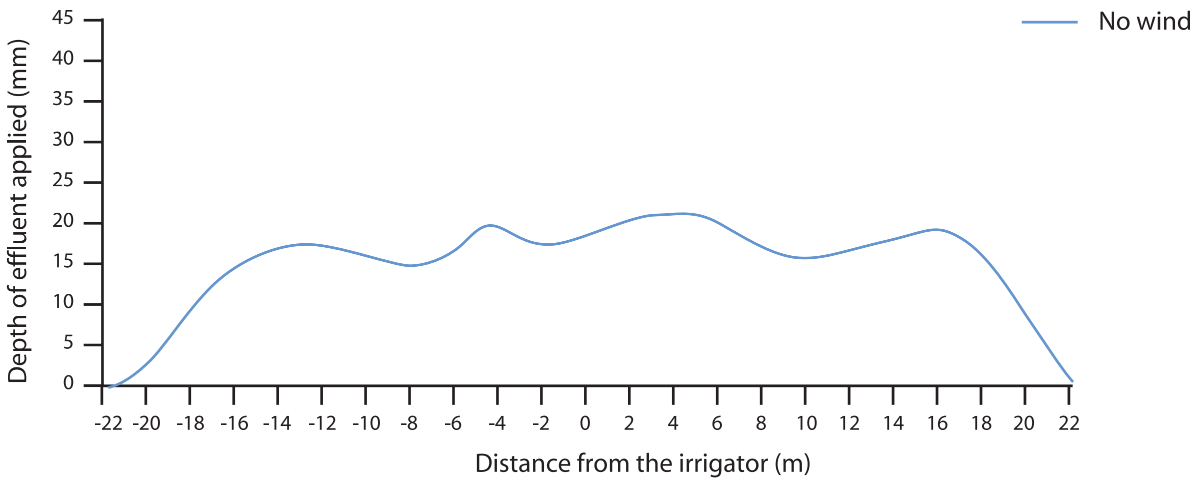
FIGURE 2.9-20

AN OSCILLATING IRRIGATOR

Photo provided by Spitfire Irrigators Ltd

FIGURE 2.9-21

PROFILE FOR THE DEPTH OF FARM DAIRY EFFLUENT APPLIED BY AN OSCILLATING IRRIGATOR



An oscillating irrigator has a long range, flick over nozzle on a single oscillating 18mm boom that allows for 180º coverage. The irrigator is self-propelled, has electronic control of application depth and operates between pressures of 150 - 350 kPa. In New Zealand the Spitfire irrigator is the only oscillating irrigator on the market. More information on this effluent irrigator can be found at www.spitfire.net.nz. Oscillating irrigators are more expensive than conventional travelling irrigators, **costing $8650 - $8750.**

The **hard hose applicator** (refer to Figure 2.9-22) is a self-propelled machine that reels in the sprayline and lays it on a drum. The drum is turned by a small diesel motor or through a water-powered turbine. The action pulls the applicator along as effluent is sprayed from a rotating boom or gun sprinkler. Some systems can travel over 250 m before being ready to be moved on to a new run.

The pipe is flexible polyethylene and usually 75 mm nominal diameter.

The hard hose applicators can apply effluent at a much lower depth than the more common travelling applicators (i.e. down to 3 mm per application). However, they cost substantially more. A general price for the system is **$12,000 - $15,000,** not including the pump.

FIGURE 2.9-22

A HARD HOSE APPLICATOR

System set up

The mainline is best placed along the fence line so that it can service two adjacent paddocks and is away from machinery when cultivating. When the mainline is placed next to a race, building a culvert is practical so that the sprayline can be fed into the adjacent paddocks on either side of the race. Alternatively, a short pipeline buried across the race with couplers at each end may be installed. In this way the sprayline will not impede vehicle traffic and will not be damaged by stock.

Hydrants are best sited by fence lines and half-way down long paddocks so that the applicator can travel both ways from the hydrant (refer to Figure 2.9-24).

The applicator generally trails a 100 m to 150 m polyethylene sprayline which is connected to the hydrant in the mainline. This can create considerable drag on the applicator. Therefore, it is very important that the hose is set in a small loop to trail the applicator and to prevent too heavy a loading on the winch, thereby ensuring effective application and increasing machinery life (refer to Figure 2.9-23 and Figure 2.9-24). The distance between the sprayline and the parallel wire is best set at 2 m.

FIGURE 2.9-23

TRAVELLING APPLICATOR SYSTEM SET UP

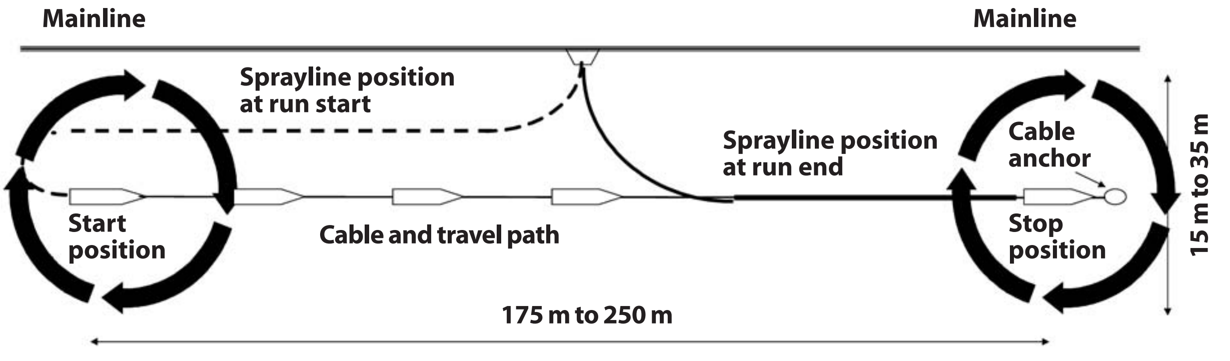


FIGURE 2.9-24

LAYING OUT THE SPRAYLINE – Good and bad examples

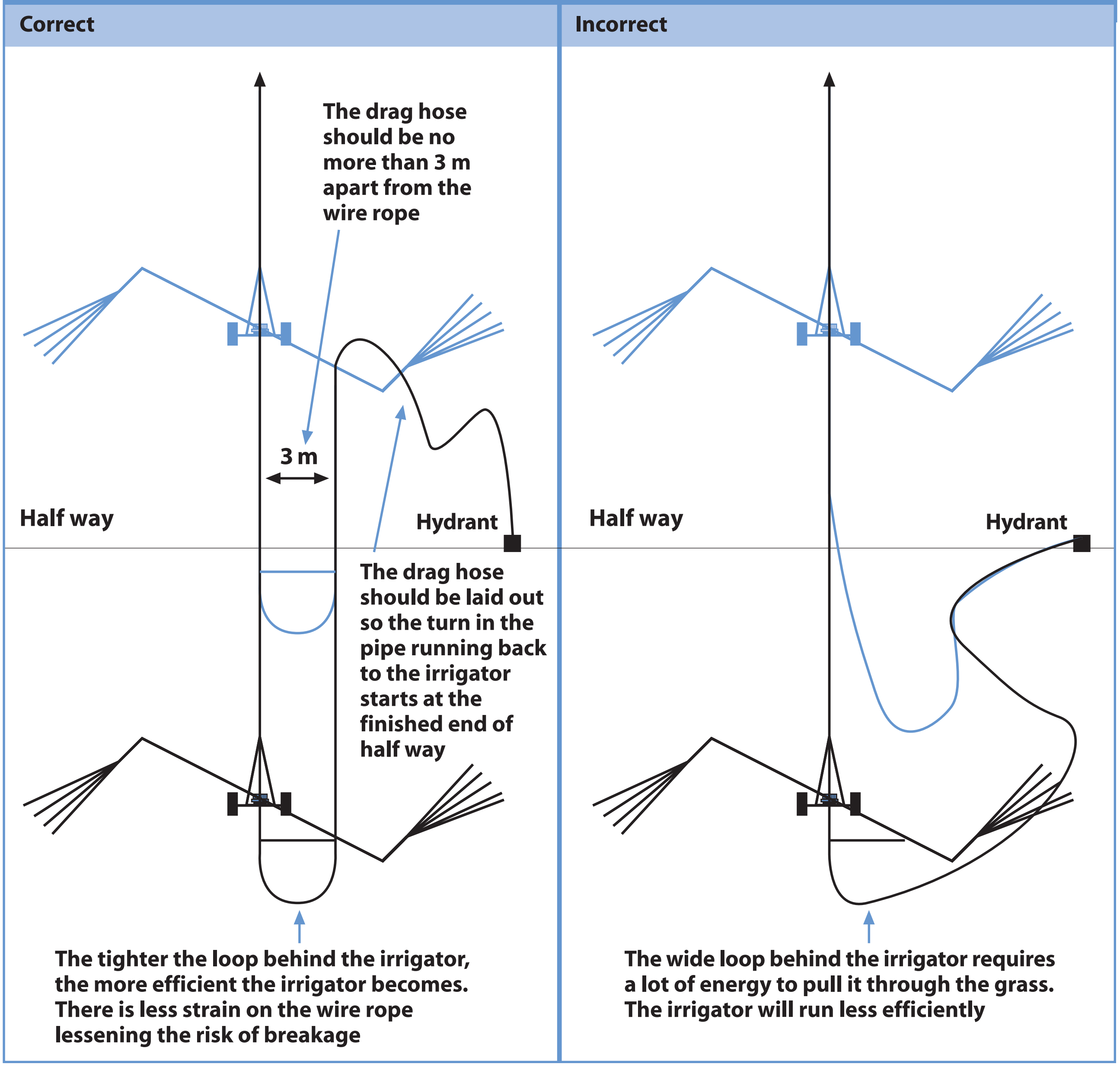


Diagram provided by Effluent and Irrigation Services

The lines and hydrants are best connected by camlock or quick release fittings for universal, quick and easy release and connection (refer to Figure 2.9-8 and Figure 2.9-9). Once the sprayline is broken into sections it can be shifted by towing it behind a four-wheeler. Some applicators have a tow-bar fitting, adaptable to the camlock female end, so that the sprayline can be easily connected and towed behind the applicator.

Application rates

It is critical that the applicator has the ability to apply a **small effluent application depth per pass (mm)** to avoid nutrient overloading, leaching and runoff.

The required application is one that does not cause ponding in low-lying areas or runoff into surface water and is dependent on the infiltration rate. Soil type and soil moisture conditions, slope, vegetation cover and the proportion of solids in the effluent all affect infiltration rates.

The application depth per pass is the amount of effluent applied at one time. If this is too great, the soil may become saturated in the root zone. Plant uptake will be exceeded and excess nutrients lost to groundwater. Suitable depth will depend on a soil's water holding capacity (affected by soil type and weather conditions) and the depth of the root zone.

The self-propelled travelling applicators have a nozzle pressure between 100 kPa and 300 kPa and deliver between 6 and 30 m^3/hour (i.e. 2 to 8 l/s). Some applicators are unable to operate at the required pressures and flow rates, or move across the ground fast enough, to obtain the low application required for **sand, pumice** and **clay** soil types, or soils with **mole and tile drains.** For these sites, a specific low-rate irrigation system (e.g. 'pod' type systems) may be more appropriate.

To achieve the best response from the application of effluent it is better to apply several low-depth applications rather than all the effluent at one time (i.e. down to 15 mm). It is also better to apply the effluent at a low rate to avoid runoff (i.e. down to 10 mm per hour).

For recommendations for various soil types refer to 2.4.2 Recommended applications for common soils and 2.4.3 Planning the periods of application).

The **application depth per pass** and **application rate** can be calculated using the following formulae:

$$\textbf{Application depth (mm)} = \frac{\textbf{Flow (m}^3\textbf{/hour) x 1,000}}{\textbf{Wetted width (m) x Ground speed (m/hour)}}$$

$$\textbf{Application rate (mm per hour)} = \frac{\textbf{Application depth (mm)}}{\textbf{Time system is in operation (hour)}}$$

To achieve the desired low application rate for most soils, applicators and delivery systems must apply effluent with **either:**

- a large wetted width (i.e. up to 60 m)
- **or** a low flow rate (i.e. down to 10 m^3/hour)
- **or** a fast ground speed (i.e. up to 50 m/hour)
- **or** a combination of the above.

However, a large wetted width can create problems with poor uniformity of application across the wetted area.

The required **travel speed** can be calculated using the following formula:

$$\textbf{Travel speed (m/hour)} = \frac{\textbf{Flow (m}^3\textbf{/hour) x 1,000}}{\textbf{Wetted width (m) x Application depth (mm)}}$$

The cable drum on the travelling applicator collects wire causing the applicator to speed up as it progresses down a run. In some cases this may be offset by the hose drag.

System shifting

Travelling applicators are designed to run 200 m to 300 m along a paddock before having to be changed to a new run. Such distances will generally take 4 to 6 hours to cover, depending on the set speed and the type of applicator. Therefore, at a running time of 1/2 to 1 hour per day with a 100-cow herd, **the applicator will need changing over to a fresh run once every week.**

Changing over to a fresh run inside a paddock will take 15 minutes, whereas moving to a new paddock will take up to 30 minutes.

Shifting applicators usually involves towing them behind a four-wheeler, as most designs have a tow bar. Care should be taken if there is no tow bar, especially if towing by lifting the front wheel of the applicator on to the back of the four-wheeler.

The distance between run settings should be **100% of the wetted diameter** modified to allow for local wind effects (refer to 2.9.3.1 Sprinklers).

Lanes for the travelling applicator must be left in crops.

Management of the trailing sprayline is a major problem as it can bend and buckle or be damaged by farm vehicles.

When shifting the sprayline take large sweeping turns to avoid kinks.

It is important also to set the hose in a small loop trailing the applicator (refer to Figure 2.9-23 and 2.9-24).

Where a trolley-mounted reel is used to wind in a lie-flat hose sprayline, a vacuum pump is necessary to collapse the hose prior to winding. Otherwise, the lie-flat hose can be emptied by slowly and carefully driving a motorcycle wheel along it once the far end has been disconnected and can freely drain.

When shifting a hose that is full of effluent, it is easiest to drag it with a rope from a vehicle.

Selecting a travelling applicator

The following points should be considered when selecting a travelling applicator from the vast number of designs available:

- the **uniformity of application** (as this relates to instantaneous application rates and nutrient loading). Oscillating irrigators give the most uniform application of all travelling irrigators. This is most important on soils at risk of subsurface drainage and leaching (e.g. permeable soils over unconfined, shallow aquifers and soils over mole or tile drains)
- it should have a **reasonably level angle of trajectory** (to minimise drift)
- it should have a **wide wetted width** (i.e. at least 25 m)
- it should have a **suitable pressure and sprinkler shapes** to minimise drift (refer to 2.9.3.1 Sprinklers)
- it should have **variable travel speeds**
- it should **automatically shut down** to stop it applying too much effluent at the end of a run
- a **wide wheel base** is preferable for stability. Appropriate ground clearances, and four wheels, are particularly important for effluent application to crops
- if the frame and wheel support is rigid, the applicator may have difficulty moving over uneven ground
- the shape should be such that **it will not catch on fence lines** when moving
- **galvanising is important** as the effluent is very corrosive. Some manufacturers also select various materials most suitable for each component for this reason
- **sealing and covering of the drive mechanism,** as much as is practical, is important
- **teeth on the ratchet gear should be heavy** as they are subject to wear
- a hardy wire rope, **at least 4 mm gauge,** is essential
- **the wire rope and drum set-up is important.** The drum should be placed far enough from the point where the cable first connects to the applicator to allow even winding and laying of the cable. It should be thinner in width rather than wider to allow neat winding, and be of large diameter when empty so that as it fills with cable there is not an excessive change in diameter resulting in the applicator significantly speeding up as it works through the run

- **ease of towing.** A tow bar is useful. Some applicators also have a removable front wheel so that it does not interfere with motorcycle progress over uneven ground.

It may also be worth considering purchasing an applicator large enough to be used for irrigation purposes as well as effluent application.

Costs of a travelling applicator system

Table 2.9-8 gives an estimated cost for a spray application system using a travelling applicator to spread effluent on a property milking 200 cows. The application area is 8 hectares (4 ha per 100 cows) according to the Regional Council annual N limit of 150 kg/ha/year. Delivery pipeline sizes and lengths are taken from the example in Figure 2.9-2 and Table 2.9-1.

TABLE 2.9-8

ESTIMATED COST OF A TRAVELLING APPLICATOR SYSTEM APPLYING FRESH EFFLUENT FROM 200 COWS OVER 8 HECTARES

System section	Cost ($ + GST)	Notes
Travelling applicator	3000 – 3500	Water pressure propelled. Discounts up to 10% for group purchases
Or Oscillating Irrigator	8650 – 8750	Travelling irrigator with more uniform application rate.
Pump (10 hp or 7.5 kW) and coupled electric motor	3900	Costing for a submersible pump. Other pumps can be less expensive.
Mainlines (400 m, Class B) Buried PVC (65 mm)	3900	Polyethylene is the most cost-effective pipe to use.
Or Surface/buried polyethylene (75 mm)	3000	
4 Hydrants	1200	Each hydrant includes four 90° swept bends, a hose tail, two snap-on camlock pairs, and lie-flat hose.
Sprayline (150 m, Class B) Polyethylene (63 mm)	650	Pipe running from hydrant to applicator.
Pontoon for pump	1000-1300	Cost of a manufactured pontoon - either a 2 drum fixed float or a 4 drum drifting float.
Electrical wiring and fittings	2000	Includes timer, float switch or probes for the switching mechanism. Fittings include five gate valves, three reducing couplings and two swept bends.
TOTAL CAPITAL COST: Between $15,000 and $21,000		

Note 1: With good progress, the installation of underground PVC mainlines will require two full days of farm labour. Pipe laying (including trenching and gluing pipes) may cost up to $1500 depending on who provides the labour.

Note 2: Remember also the cost for a large storage sump if not pumping out of an existing pond. Note that a greater cost and size may be necessary depending on the type of storage facility and material used, the herd size and the length of time the effluent may need to be stored.

Note 3: Maintenance and electricity costs need consideration also. In calculating the latter, it can be expected that such a system will be running 1/2 to 1 hour per day.

Top tips to avoid trouble with a travelling applicator system

- **Beware of the wire rope when riding through the paddock as it can be almost invisible from a vehicle.**
- **Travelling applicators have an automatic cut-off in the winch winding facility. Regularly check that the cut-off is working, or the winch, applicator and anchor posts may be damaged.**
- **Beware of using fence posts as an anchor for the wire rope on which the applicator drags as posts can be pulled from the ground. Place the anchor at the base of the post.**
- **Posts that are alongside a drain do not have secure foundations. Tie the wire rope to the posts on the opposite side of the drain so that the forces on the footing are directed horizontally into the land.**
- **When shifting the applicator, watch out for spray booms catching on gateways.**

- **The sprayline between the applicator and hydrant should not be greater than 150 m as head loss increases with increased distance. Consequently, spray coverage will decrease. Many travelling applicators are not designed to drag a delivery hose, full of effluent, that is more than 150 m long.**
- **For the same reason, ensure that there is a small loop in the hose behind the irrigator so it is dragging minimal hose length as it travels.**
- **Ensure the end of the run is well away from any waterways.**

2.9.3.3 Stationary applicators

Generally, stationary applicators are used with permanent buried mainlines, perhaps with surface sub-mains and hydrants, but with portable spraylines. These may be shifted by hand or by towing with a vehicle.

Stationary applicator systems are unacceptable to many farmers and Regional Councils because of the regular shifting needed in order to avoid excessive nitrogen loading and ponding. They can be useful on hilly country for the application of effluent over the side of a ridge. In some regions they do not meet Regional Council rules (check with your Regional Council for requirements).

Often a single sprinkler is attached to a sled. When shifting is required, it is dragged around with a four-wheeler. Figure 2.9-25 illustrates such a sled system, although it should be noted that the sprinkler shown here is unsuitable for effluent application.

An alternative is a stationary rotating boom system where the boom is rotated by a reaction force to the sprayed effluent.

The use of a pot sprayer (i.e. honey pot), is now discouraged by Regional Councils because it applies large volumes of effluent to a relatively small area. In situations where pot sprayers are used, there is greater ponding, pugging and pasture spoilage (refer to Figure 2.9-26).

Costs of a stationary applicator system

Table 2.9-9 gives an estimated cost of installing a stationary applicator system for applying effluent fresh from the farm dairy on a property milking 200 cows. The application area is 8 hectares (4 ha per 100 cows) according to the Regional Council annual N limit of 150 kg/ha/year. Delivery pipeline sizes and lengths are taken from the example in Figure 2.9-2 and Table 2.9-1.

FIGURE 2.9-25

A SPRINKLER AND SLED SUPPORT

FIGURE 2.9-26

PASTURE DAMAGE CAUSED BY POT SPRAYERS

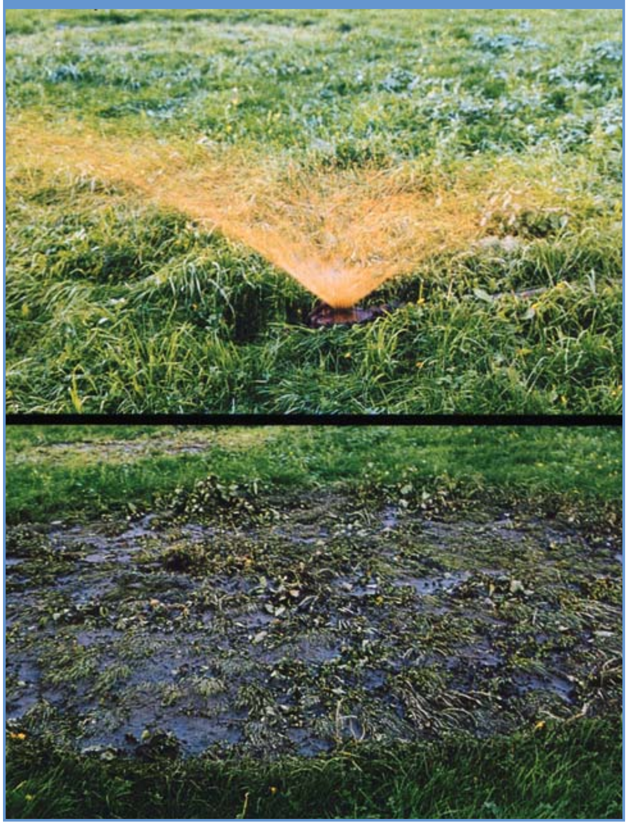


TABLE 2.9-9

ESTIMATED COST OF A STATIONARY APPLICATOR SYSTEM APPLYING FRESH EFFLUENT FROM 200 COWS OVER 8 HECTARES	
System section	**Cost ($ + GST)**
Electric pump (10 hp or 7.5 kW)	3900
Delivery pipeline and hydrant wiring (refer to Table 2.9-8)	9400 – 10500
Stationary rotating boom **or**	850
Sprinkler and sled	600
TOTAL CAPITAL COST: Between 13,900 and 15,000	

Note 1: With good progress, the installation of underground PVC mainlines will require two full days of farm labour. Pipe laying (including trenching and gluing pipes) may cost up to $1500 depending on who provides the labour.

Note 2: Remember also the cost for a large storage sump if not pumping out of an existing pond. Note that a greater cost and size may be necessary depending on the type of storage facility and material used, the herd size and the length of time the effluent may need to be stored.

Note 3: Maintenance and electricity costs need consideration also. In calculating the latter, it can be expected that such a system will be running 1/2 to 1 hour per day.

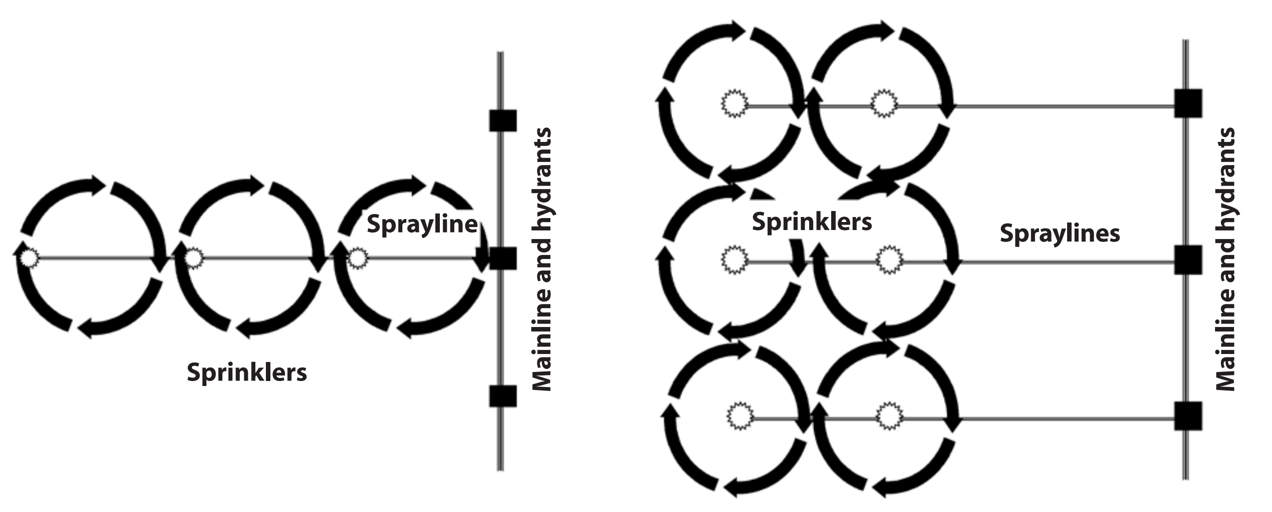
2.9.3.4 Multiple sprinkler systems

Multiple sprinkler systems generally involve either a portable sprayline carrying several sprinklers or a series of fixed spraylines carrying a single or several sprinklers (refer to Figure 2.9-27).

Where the sprayline is portable, flexible polyethylene piping is used and the sprinklers require individual stands, a base, or a pod for support.

FIGURE 2.9-27

MULTIPLE SPRINKLER AND MULTIPLE SPRAYLINES



Frequency of shifting

The frequency of shifting is dependent on the number of sprinklers employed. The larger the number, the greater the capital outlay, but the sprinklers can be shifted less often.

Although multiple sprinkler systems can be shifted less often than stationary applicators, they require more shifting than travelling applicator systems.

Costs of a multiple sprinkler system

The costs for a multiple sprinkler system are similar to those for the stationary applicator system. The larger number of sprinklers required will add some extra expense.

2.9.3.5 Low-rate sprinkler systems

Low application rate technology has been adapted from irrigation systems for effluent application, to avoid problems associated with applying effluent at rates that exceed soil capacity. These systems use irrigation 'pods' linked by 40 mm low density polypipe. With 4.0 mm nozzles at an operating pressure of 250 kPa, they achieve application rates of approximately 4 mm/hr. The depth of application is easily controlled by the pumping time. With time switches it is also possible to have intermittent pumping (e.g. half hour on, half hour off) which further reduces the application rate. This means that irrigation can be carried out in conditions of higher soil moisture or in sensitive areas such as over mole or tile drains.

Typically, 6 pods per line are mounted 15 m apart to create an overall length of 90 m (refer to Figure 2.9-28). Lines may be set up beside each other, 20 m apart, or a single line can be moved 20 m at a time across the paddock. This allows for any wind drift and avoids overlap of the wetted areas. Naan sprinklers have been trialed using 4 mm nozzles and they apply approximately 4 mm /hr. A larger 5 mm nozzle has been trialled but may result in ponding.

The sprinklers are housed within protective plastic pods. With smaller herds 12 pods (2 lines of 6) are recommended to be operated at any one time, applying 9,000 l/hour and covering 0.27 ha.

The lines are moved after 4-5 hours of effluent application, taking a similar time as moving a travelling irrigator. Alternatively, additional lines can be laid out in advance for improved labour flexibility.

The system can be used on undulating and rolling land. It does not have the disadvantages of travelling irrigators such as risk of tipping over, drag hose reducing flow rates or failure to cut out at the end of the run.

For 'pod' type to be effective and trouble free **it is essential the solids are screened out of the effluent prior to irrigation.** Three options have been trialed for this.

1. Where there is a very large storage pond(s) a large suction filter can be installed in the pond to screen the effluent prior to pumping. Since solids tend to settle in ponds this will be quite effective. A 2000 L plastic tank with holes drilled in it and covered in mesh has proven satisfactory as a filter. Purpose built screens are also under development. Mechanical cleaning of the pond will still be required regularly.
2. A solids-settling pit or drying bed can be excavated prior to effluent entering the main pond, designed so that liquid can pass through a permeable wall, leaving the solids behind.

   The drying beds have been constructed 1-2.5 m deep, depending on the site. They are made 8.0m wide with battered banks and as long as is necessary for several months' sludge storage. The current allowance is 2.0 litres sludge per cow per day, but this will vary from shed to shed.

   The narrow width is for ease of cleaning with a digger.

   The weeping walls have been constructed from posts and timber (refer to 2.12 Processing options prior to land application). Timber slats with 5.0 mm gaps should be used.
3. A third alternative is to use a mechanical solids separator. These work on the principal of a screw press. They are an additional expense and need monitoring but do produce a good quality liquid for application through 'pod' type or other irrigation technology. The screened liquid can be applied immediately or stored for later application.

FIGURE 2.9-28

'POD' TYPE IRRIGATION SYSTEM

Photo provided by Otago Regional Council

Once the solids are removed, more efficient surface pumps can be used. These should be self-priming since gas can build up in the suction line. Typically for 12 pods a 4.5 kW pump can be used and for 24 pods a 7.5 kW pump is needed. If there is a pond and irrigation mainline, conversion to 'pod' type need not be expensive. To purchase 12 pods and associated pipe, valves and camlock costs approximately $1,400. There is merit in having 24 pods, or on larger farms 48 pods to provide greater flexibility in the operation of the system.

2.9.4 Contractors

Contracted spray application equipment (i.e. pump, delivery lines and applicator) usually consists of a high-pressure travelling cannon that applies effluent within 300 m from the storage area. Some systems can apply effluent up to 1000 m away.

Most storage ponds (i.e. up to 1,000,000 litres) can be cleared in one day. The applicators generally pump between 100,000 and 150,000 litres per hour. At 100,000 l/hr the time to pump a 1,000,000-litre pond is 10 hours, plus 1 or 2 hours spent setting up the system and intermittently shifting the applicator to a new run. Find out pumping rates and obtain quotes before employing a contractor.

Contractors generally charge in one of two ways for cleaning out ponds and spreading the effluent on the land:

- **by the hour, from the time pumping starts, until it finishes.** This may result in some contractors running the applicator at a slow travel speed, and not shifting the applicator equipment as often as is necessary, as this would involve uncharged labour. Consequently, ponding may result as well as excessive build-up of solids on the pasture. Check that the applicator is set to travel fast enough to avoid ponding. The charges are up to $180 per hour so the cost can be expected to be approximately $1800 for every 1,000,000 litres of stored effluent
- **by the hour, from the time of arrival to the time of leaving the farm gate.** This may encourage some contractors to take longer than necessary. However, correct coverage is ensured and the quality of the application will probably be excellent. The rate is generally up to **$150 per hour.** Therefore, with both pumping and shifting time included, the contractor's charge can be expected to be approximately **$1800 - 1900 for every 1,000,000 litres** of stored effluent.

The annual cost of having a contractor clean out ponds and apply the effluent to the land will generally be **spread over two or more visits** by the contractor over the drier seasons, depending on the capacity of the storage facility.

Contractors must take responsibility for the correct application of effluent to land in compliance with Regional Council standards. Therefore, contractors should guarantee a good job. However, farmers or farm employees can still be held liable, especially if they are aware that the contractor is not operating to the required standard. Farmers have a responsibility to ensure the contractor is aware of Regional Council rules and specific consent requirements.

2.9.5 Using an existing clean water irrigation system

Substantial savings can be made by using an existing irrigation system for effluent application to land. However, it is important to recognise that i**n many cases this is possible only during the irrigation season.** Therefore, a large storage facility is required during the other months or an alternative means of applying effluent to land could be employed in the off-season.

The wearing effects of the solid fraction of effluent will be the most likely cause of any failure to the existing irrigation system. Therefore, **it is preferable to collect and store effluent in a holding pond for a period to allow for settling, then filter** before application through the irrigation system. **Irrigate only surface liquid from a holding pond, not the solid fraction** of the effluent. The solids should be periodically vehicle-spread onto land (refer to 2.8 Land application of sludge). **Suspended solids should not exceed 1% for irrigation.** This is because solids tend to wear the irrigation pump. Also, sprinklers, elbows and flat surfaces within an irrigation system will not allow the easy flow of solids.

A strainer with 5mm to 7mm holes should be placed on the suction end of the pump that conveys the stored effluent into the irrigation system. A filter is required after the pump that will filter effluent down to 1/8th the size of the smallest sprinkler orifice size. Alternatively, **sprinklers specially designed to spray effluent are available and can easily replace those in the effluent application section of the existing irrigation system.** These sprinklers are more hardy than irrigation sprinklers and usually have a rubber nozzle that can expand to allow solids through (refer to 2.9.3.1 Sprinklers). Some sprinkler systems require replacement of the nozzle component only.

Effluent can also be irrigated by attaching nozzles or droppers to the side of the centre pivot irrigator. The effluent gun moves around with the irrigator and can be shifted along it as required. Disadvantages of this option are that the entire irrigator has to move to shift the effluent gun, even when the rest of the irrigation system is not in use. Also, effluent is often applied to soils that have just received irrigation water and may be saturated. This raises the risk of leaching. Attaching an effluent irrigator to the centre pivot is unlikely to give a uniform distribution pattern.

When applying effluent through an existing irrigation system, all irrigation water becomes contaminated. Therefore separation distances to wells and surface water applies for the irrigated area, and runoff must not occur.

2.9.5.1 Design possibilities

There are four major design options for incorporating effluent from the farm dairy sump or from storage ponds into an existing clean water irrigation system:

1. **Pump or gravity-feed the effluent directly into a dam that houses the irrigation water.** From there the effluent is diluted and is applied to the pasture with the irrigation water.
   - There would be no necessity for pre-storage and settlement of the effluent before entry into the dam.
   - This option could require a small pumping system to convey the effluent to the holding pond site. A 3 hp (i.e. 2.2 kW) centrifugal pump would be suitable in most situations. Such pumps cost up to $2000.
   - The effluent should be sufficiently diluted as to not damage the pump, pipe and sprinkler irrigation system through wear. Place the entry point of the effluent into the dam as far as possible from the exit point of the irrigation water, to ensure solids settlement.
   - This method may be unacceptable to the Regional Council, particularly where there is a possibility of dam overflow into a waterway during wet months or when a dam, situated within a large catchment area, is subject to flooding during a storm.
2. **Pump or gravity-feed the effluent directly into a holding pond that houses irrigation water brought up from a waterway.** From there the effluent is diluted and is applied to the pasture with the irrigation water.
   - The effluent storage facility must be capable of storing the effluent during the period that the irrigation system was not in use, or an alternative land application system would be required.
   - A small system to convey the effluent to the holding pond site will be required. A 3 hp (i.e. 2.2 kW) centrifugal pump would be suitable in most situations. Such pumps cost up to $2000.
   - The effluent may not be sufficiently diluted in a small holding pond. Excessive build-up of solids in the pond may result, causing wear of the pump, pipe and sprinkler irrigation system. Pump only surface liquid from the farm dairy sump or storage pond to the holding pond, and vehicle spread the sludge intermittently. Place the entry point of the effluent into the pond quite a distance from the exit point of the irrigation water, to ensure solids settlement.
   - This should be acceptable to Regional Councils as there is unlikely to be re-entry of the irrigation water into a waterway. However, these holding ponds would need to meet Regional Council requirements for sealing (check with your Regional Council for requirements).

3. **Pump the effluent directly into the delivery line carrying the irrigation water to the sprinklers.**
   - The effluent storage facility must be capable of storing the effluent during the period that the irrigation system was not in use, or an alternative land application system would be required.
   - If the irrigation water is sourced from a groundwater well, or direct from surface water, back flow prevention will be required to avoid effluent entering the irrigation bore or surface water.
   - Several possibilities exist to force the effluent into the irrigation water:
     1. A carefully designed tap system, to force the effluent into the irrigation pipeline, is necessary. This would be situated where the pipeline passes the farm dairy. A 3 hp (i.e. 2.2 kW) helical rotor pump (refer to 2.9.1.2 Pump selection) would be appropriate in most situations as the effluent should be pumped at a high head to prevent back-flow of irrigation water into the effluent delivery line. Such pumps cost up to $3500.
     2. Effluent can be fed into the suction end of the irrigating pump along with the water.
     3. A venturi system can be used.
        - A float switch to start the pumping of the effluent when the irrigation system is activated is essential. This is because the internal rubber liner of helical rotor pumps is quickly melted (i.e. in less than 1 minute) when the pump runs dry. A pressure switch is also necessary, as positive displacement pumps will build up extreme pressure in the pipes if the system is blocked.
        - Effluent may not be sufficiently diluted in the delivery line and may cause excessive wear of the pipe and sprinklers. Pump only surface liquid from the farm dairy sump or storage pond into the delivery line, not the solid fraction.

4. **Pump the effluent directly into the delivery line when it is not carrying the irrigation water to the sprinklers.**

- The effluent storage facility would not need to be large as the irrigation system would be used continuously. However, the effluent would require enough time to settle out a proportion of solids before pumping.
- This may not be possible as the irrigation delivery line is often not suited for the effluent flows. Also inverted T-shaped hydrants and a large number of elbows may exist in the system. These will restrict effluent flow.
- Design the system to carry effluent into and through the delivery line at a sufficient flow rate and pressure to drive the sprinklers. Design of a separate branch line for effluent application, within the irrigation system, is practical (i.e. replacing the irrigating sprinklers with sprinklers especially designed for effluent application). The branch line in use should be situated close to the effluent storage facility and be able to be isolated from the rest of the irrigating system.
- The effluent may not be sufficiently diluted in the delivery line and may cause excessive wear of the pipe and sprinklers. Pump only surface liquid from the farm dairy sump or storage pond into the delivery line, not the solid fraction.

2.9.6 Spray application system maintenance

2.9.6.1 Daily

- **Before and after every milking, check that the stormwater, or washwater, diversion is in the correct position.**
- **Assess whether the soil is dry enough and the water table is low enough to allow effluent application** to the pasture without excessive ponding or runoff.
- **Adjust application rates according to soil conditions** to avoid ponding or surface runoff.

2.9.6.2 Regularly

- **Shift the spray applicator system** to a new area that has been recently grazed.
- Make sure the spray application system is **not sending effluent into the water troughs.** Cover troughs if necessary.
- **Waterways including open drains should be checked regularly** to ensure that effluent is not moving into the water. Also check what is coming out of any tile drains.
- **Clean and clear the effluent stone trap and gratings.**
- **Check that the float switches are clear and working.**
- **Grease all moving parts on the applicator.**
- **Check that the sprinklers** are not blocked or damaged.
- **Check that the sprayline** is free of cuts and splits. Ensure above-ground connections are kept clean so that dirt in the joints does not move through the system and block nozzles.
- **Flush clean water through the delivery line and sprinklers** to keep them from blocking.
- **Maintain the correct tyre pressure** on the irrigator.

2.9.6.3 Six monthly to annually

- **Strip down the pump** for oiling and cleaning.
- **Check the pump seals** as these are the components most susceptible to wear.
- **Have a nutrient analysis done** on the stored effluent, soil and pasture.
- Carry out **general storage facility maintenance.** Remove sludge from the storage facility and spray any weeds growing on storage ponds.

2.9.7 Effluent irrigation planning

A written effluent irrigation plan can help plan for possible issues and reduce the time needed to supervise staff. The plan may include good practice policies, a staff training schedule (refer to 2.9.8 Staff training and management) and an equipment maintenance schedule (refer to 2.9.6 Spray application system maintenance) as well as the application plan for the effluent irrigation.

The plan should be kept handy for quick reference, in the farm dairy.

2.9.7.1 Good practice policies

Good practice policies set out how effluent is to be managed and what are acceptable practices (for examples, refer to Table 2.9-10). Most will be common to other dairy farms but there may be some that are farm-specific.

TABLE 2.9-10

EXAMPLES OF GOOD PRACTICE POLICIES FOR EFFLUENT IRRIGATION

Good Practice Policy	Reason for adoption
Only staff who have been fully trained and are competent in operating the effluent system will be given responsibility to manage it.	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 posted in the farm dairy.	Poor maintenance increases the risk of failures especially at busy 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.

2.9.7.2 Application plan

An application plan can be prepared to indicate where effluent will be applied on the farm.

Areas of the farm should be classified into 'low risk', 'high risk' and 'no application' zones.

- Lower risk zones include well-structured soils without a pan and at least 10 metres to groundwater. They include land that is far from waterways and open drains, without subsurface drains to reduce risk of surface runoff or runoff via tile drains.
- Higher risk zones include tile- or mole-drained land or land 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 m of a waterway (including an open drain) that has flowing water, and 150 m from neighbouring dwellings. They may include land with a high density of mole and tile drainage.

Mark the effluent application area on a farm map, then show the zones within this area.

If you have tile drains, mark these on a map. Hang this in a prominent place. It will also be a great aid for future owners and workers.

To prepare an application plan (as in Figure 2.9-29), mark on a farm map:

- waterways and drains
- the area for effluent application
- risk zones (colour coded)
- effluent irrigator runs for each paddock.

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 storage capacity
- write the plan down and use it as a guide, noting changes in soil conditions and adjusting the plan accordingly.

During the season:

- record actual effluent application, making notes after each shift of the system (refer to Table 2.9-11).

FIGURE 2.9-29

EXAMPLE APPLICATION PLAN

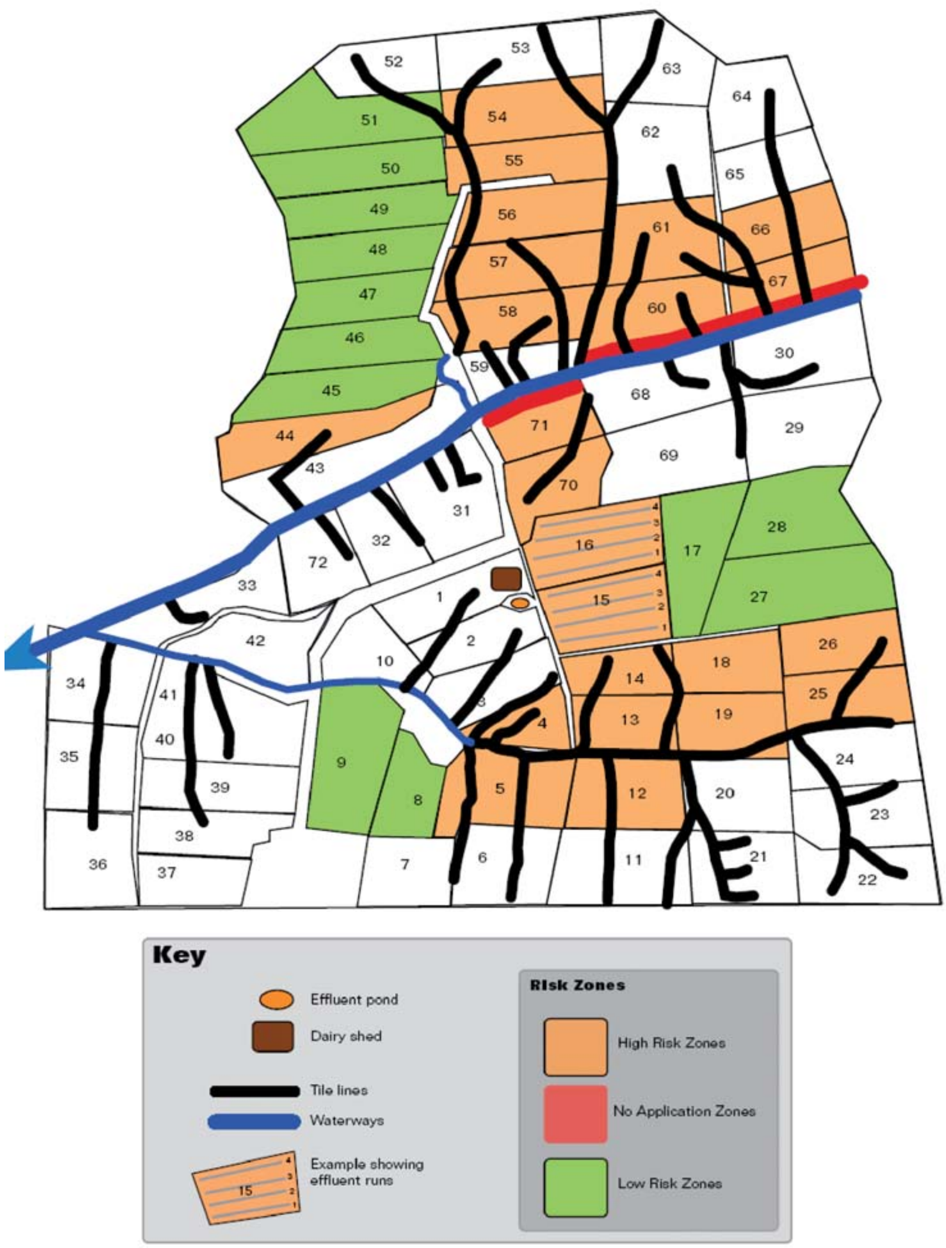


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TABLE 2.9-11

EFFLUENT APPLICATION RECORDING SHEET (Example)				
Date	**Paddock**	**Run number**	**Signature**	**Comments** (e.g. signs of ponding or runoff)
15/8/06	*1*	*7*	*FRP*	

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2.9.8 Staff training and management

Staff need to be trained to operate and maintain the effluent irrigation system. Training can be based on the effluent irrigation plan. Training should cover all aspects of staff responsibility including:

- fertiliser benefits
- the importance of keeping effluent out of waterways
- operating the system to apply the right application rates
- maintaining the system (refer to 2.9.6 Spray application system maintenance)
- minimising water use and effluent volume (refer to 1.6.8 Reducing effluent volume and conserving water)
- monitoring to identify problems
- recording information
- responsibilities and accountability.

Where you have staff shifting irrigators, highlight the importance of doing this job correctly and provide recognition for a job well done.

TABLE 2.9-12

EFFLUENT MANAGEMENT TRAINING RECORD				
Skill	**Date**	**Trainer**	**Trainer signature**	**Employee signature**
Minimising water use Stormwater diversion Yard washdown Checking for leaks Avoiding water wastage				
Effluent pump maintenance Cleaning stone trap Greasing pump nipples				
Irrigator set-up and maintenance Positioning of irrigator and hose Checking nozzles for blockages Checking irrigator for wear 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				

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2.9.9 Top tips to avoid trouble

- **Where sumps or holding ponds are lined with a plastic liner, take care to keep propellers from the stirrers and the suction end of pumps away from the liner surface.**
- **The spray application area is best located close to the farm dairy (but not within 45 m) to reduce capital outlay. The operation of the system can then be monitored easily, and system failure identified quickly, before serious problems develop.**
- **Locate the delivery line and hydrants where they are protected from stock and vehicles. Along fence lines is a good option.**
- **The velocity in the pipes is best set between 1 m/s to 2 m/s (i.e. a flow of 9 to 18 m^3 per hour for a 63 mm nominal diameter pipe). Lower velocity may result in settling of solids, greater velocity may result in pipe damage.**
- **Effluent freezing in the delivery line has been reported in Canterbury, Otago and Southland regions. To avoid this problem, gravity drain the delivery line after use. Lie-flat hose can be drained by driving a motorcycle wheel over the tube after use. If effluent has frozen in the sprayline, disconnection of the sprinkler system, followed by pumping, can force the frozen section through the sprayline and out the open end of the pipe.**
- **Make sure that the basic components of pumps, holding facilities and mainlines are able to cope with any foreseeable increase in herd size and any other need to expand the application area (e.g. if a feed pad or stand-off area is to be connected to the effluent system in future).**
- **Wherever possible, rubber-nozzled sprinklers should be used.**
- **A valve is necessary at any hydrant where the pump applies effluent to land at a positive head (i.e. the pump is at a higher level than the application site), otherwise the effluent storage facility will continue to drain when the pump is turned off. It may be more convenient to have the valve back on the mainline, or even close to the pump, rather than out in the paddocks near the sprayline.**
- **When pumping directly from the farm dairy sump onto land or into a storage facility, it is critical that the flow into the pump emptying the sump is larger than that from the washdown pump. Otherwise the sump will overflow, as it will fill faster than it can empty.**
- **If equipment is to be idle for a long period (i.e. more than one week) flush it with water prior to close down. This will prevent the effluent solidifying and blocking the system.**