


FEEDLOT DESIGN AND CONSTRUCTION

14. Water reticulation system

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Introduction

An adequate supply of water is required for cattle to drink, in feed preparation and for sundry other uses.

Planning and designing a feedlot water reticulation system for each feedlot depends on its access to water, location, site, size and operation.

The basic principles in the design of a water reticulation system are reliability, redundancy, utility and economy. Utility can be defined as a reliable, easy to operate, trouble-free system that delivers water in the quantity and at the points required, with no more attention than routine maintenance. Economy can be defined as a system installed at a minimum expense, without sacrificing utility that will operate for its design life without ongoing capital expenditure or excessive maintenance costs.

Design objectives

The water reticulation system should

- ensure the layout, pipe size and pump capacity of the system can efficiently supply the feedlot with water
- be sized to supply water throughout the feedlot during peak demand periods
- incorporate a storage system to cater for fluctuations in supply and demand and to act as an emergency supply in the event water supply failure
- allow easy maintenance to pipes, valves and pumps
- allow maintenance on some parts of the system while maintaining a continuous water supply to all areas of the feedlot
- be protected from damage by cattle and machinery
- supply fresh, cool, clean palatable and high quality drinking water to the cattle.

Mandatory requirements

Compliance with

- Australian Animal Standards and Guidelines for Cattle (DAFF, 2013).
- National Guidelines for Beef Cattle Feedlots in Australia (MLA, 2012a). These state that a feedlot requires a secure water supply, that security must be in both a legal (i.e. a legal right to the required volume) and a physical sense (i.e. the physical ability to pump, store, and deliver the required volume of water).
- National Beef Cattle Feedlot Environmental Code of Practice (MLA, 2012b). Performance measure 1.5.2 states that a feedlot has a water supply able to sustain the operations of the feedlot under normal conditions.
- National Feedlot Accreditation Scheme (AUS-MEAT, 2013).

Technical requirements

Factors to be considered when planning and designing a water reticulation system include

Volume of water required

Water is needed for cattle drinking, feed processing, cleaning (including yards, machinery and cattle washing) and other general operations around the feedlot.

Section 4 – Water requirements provides information on the water requirements at Australian feedlots.

Distance

Moving water takes energy to overcome pipe resistance and changes in ground elevation. The distance between water sources, temporary supply and delivery point will affect capital expenditure and operational costs.

Design flow rate and pressure

A reticulation system must be sized to supply water at sufficient pressure throughout the feedlot during peak demand periods.

Peak water demand can be estimated by understanding the diurnal pattern of intake and by studying historical climate records. See *Section 4* for calculation of peak demand.

Water reticulation system

Designing a feedlot water reticulation system can be complex. Professional assistance from a suitability qualified and experienced water engineer or a company specialising in water supply and reticulation systems should be obtained to determine system layout, pumping capacity and pressure, pipeline sizes and valve locations. The designer should locate air relief valves, vacuum relief valves, isolation valves, water storage and thrust blocks as well as pipeline and fittings.

Water reticulation systems can be either gravity flow or pressurised or a combination of both. Gravity flow avoids any potential equipment failure in a pumped system.

Gravity flow

In a gravity pipeline system, the water storage is higher than all points in the delivery pipeline and no pump is required downstream of the storage. For example, the water supply may be located at the highest point at the site and at the end of a pumped pipeline. This is the preferred type of system for cattle drinking water supply as it has less reliance on infrastructure (e.g. electrical power, pumps).

A gravity system is usually characterised by being installed on a positive grade in the direction of flow for its entire length. Air locks at significant high points in the pipeline are prevented by installing air valves or stand pipe vents. Air valves will not work if pressure is too low.

Water storage at a higher elevation than the feedlot allows gravity flow of water.

A turkey nest storage situated high above the feedlot allows gravity flow of water around the site.

Gravity flow available from elevated placement of water storage.

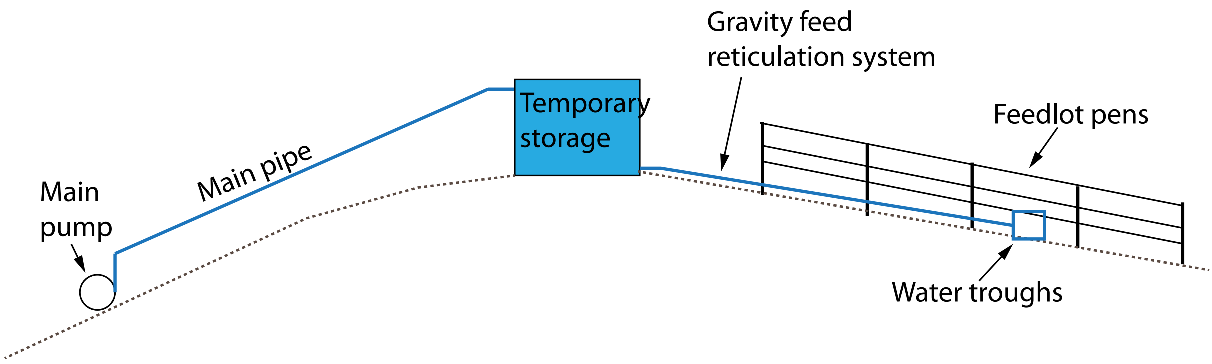

Figure 1 Components of a water reticulation system

Pressurised system

Pumps are commonly used to lift water from a bore or water stream (creek, river) to a water storage at a higher elevation, or to pressurise the water system to deliver it through a pipeline around the feedlot.

The design considerations in a pressurised system include pump type (centrifugal, turbine and positive displacement), pump capacity (single, multi-pump, distance and volume of water to be transferred) and pump control (automatic pressure, timed, manual).

Pumped reticulation system with a standby pump and associated controllers and valving

Pipeline network

The delivery pipeline is sized to carry the amount of water required by the length of line, the difference in elevation and water demand at each outlet. Pipeline sizes and features must be planned for each specific system based on the site and system requirements.

Types of distribution networks

Branched network

This network is similar to the branching of a tree. It consists of

- main (trunk) line
- sub-mains
- branches.

The mainline is the main source of water supply. There is no water distribution to watering points from the mainline. Sub-mains are connected to the main line and are usually located along the main service or feed delivery roads. Branches are connected to the sub-mains and the watering points are located on the branches (Figure 2).

Advantages

- simple method of water distribution
- simplified delivery calculations
- economical dimensions of the pipes
- fewer cut-off valves.

A pumped reticulation system manifold with various take-offs and shut-off valves for flow control

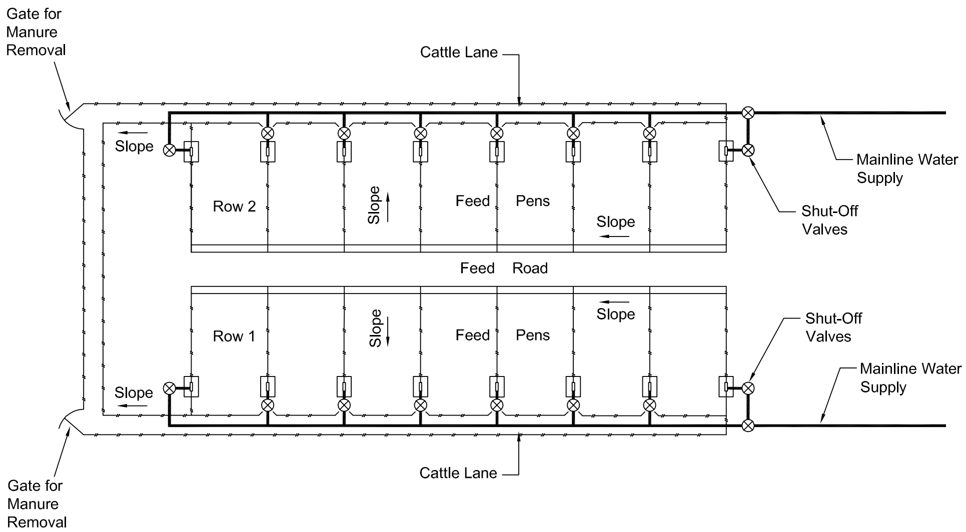

Figure 2. Branched water reticulation network

Disadvantages

- The area or zone receiving water from a pipe that is broken is without water until the repair is completed. This can be a major issue when supplying drinking water to cattle.
- There are many dead ends where water does not circulate but remains static.
- Sediments can accumulate in the dead end with potential bacterial growth. Drain valves at dead ends allow stagnant water to be drained out periodically, wasting a significant amount of water.
- If the feedlot undergoes expansion, the pressure at the end of the line may become undesirably low as additional areas are connected to the water supply system.

Grid pattern with loops

In a grid pattern with loops supply system, all the pipes are interconnected in loops with no dead ends. Water can reach any point from more than one direction thus providing supply in case of pipeline blockage or breakage, and more even pressure at all outlets.

Advantages

- As water in the supply system can flow in more than one direction, stagnation is reduced.
- Water will flow to an area from an alternative direction in case of repair or break down in a pipe.
- Strategically located valves allow sections of line to be isolated for maintenance or repairs whilst supply continues to other watering points.
- Water reaches all points with minimum head loss.

Disadvantages

- Higher cost of pipe infrastructure because extra pipe is required.
- More valves are required.
- The calculation of pipe sizes can be more complicated. A pipe network analysis may be required to ensure sufficient flow rate and pressure at all locations or off-take points.

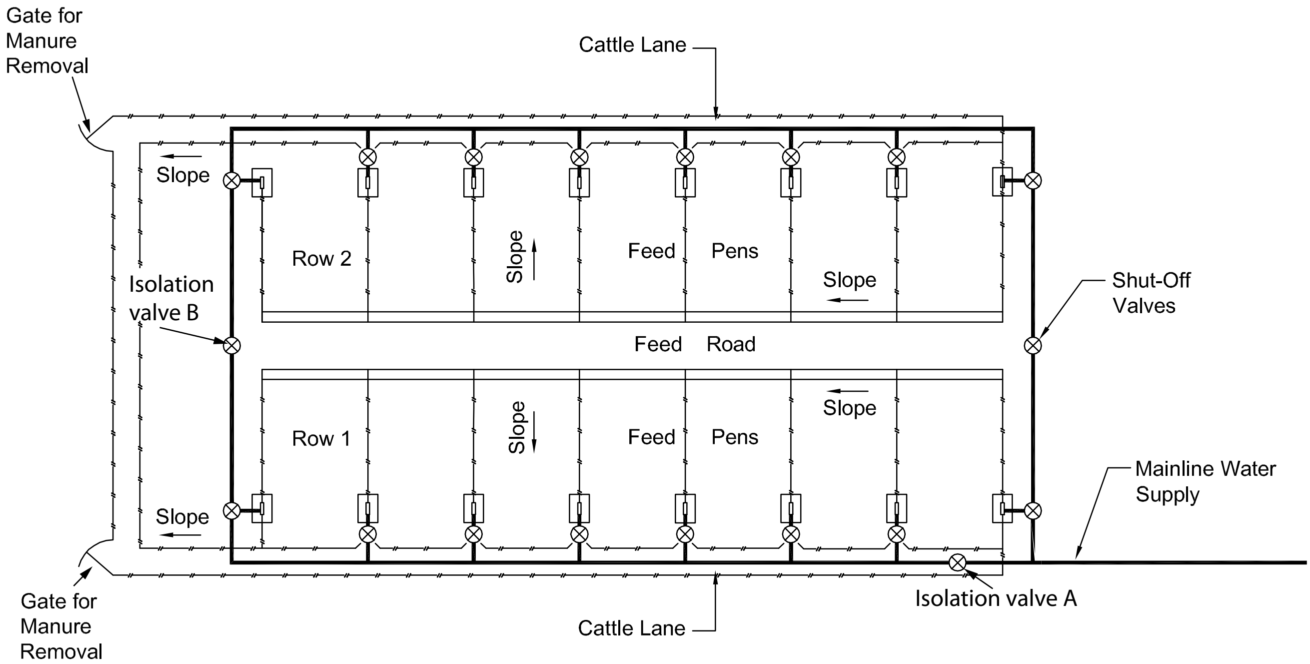

Figure 3. Loop water reticulation network (Refer to page 8 for explanation of isolation valves A and B)

Isolation valves allow water supply to be cut off for repairs.

Design considerations

Sizing

Each segment of the water pipeline network must allow the required amount of water to be delivered to each water delivery outlet at an acceptable pressure. Pressure losses can be attributed to the diameter and length of a segment of the water system; pipeline specification incorporates the operating pressure, pressure surges and the strength of the pipe.

It may be cheaper to use a heavier-walled pipe than the delivery pressure requires to provide durability, lengthen service timeframes and reduce potential repair costs. Fittings must be at least as strong as the pipeline.

Although demand flow rates in a feedlot can vary significantly, pipe size should accommodate maximum flow rates to ensure proper water distribution. The ultimate size of the feedlot should also be considered when selecting mainline and branchline pipe sizes.

The design flow rate for drinking water can be estimated using the information given in this section.

For most feedlots, pipelines to individual troughs will be 25 mm or 32 mm inside diameter. Main feeder line sizes will depend on the flow required and may range from 32 mm to 102 mm.

Coiled polyethylene pipe is usually used when pipe sizes 51 mm or less are required, and rigid PVC is used for larger piping. As a rule of thumb, lines to individual troughs should supply at least the daily peak consumption in a four-hour period (MLA, 2006). For example, in a pen of 100 head with a daily peak consumption of 60 L/head/day, the supply line should be able to provide about 25 litres per minute.

The relative elevations of water delivery points can be a factor in sizing. For example, if one trough is on top of a hill and a second trough is at the base of the hill, the trough at the base will require less pressure to operate and will get priority for the water supply. Inadequate water supply or under-designed piping will result in the lower trough getting all the water and the top trough getting none.

Materials

Whereas pumps, tanks and other water reticulation system components are replaceable, buried pipe has to remain in use for a long time. Therefore the quality of the pipe and fittings and the pipe size need to accommodate the ultimate size of the feedlot.

Typical materials used are polythene, PVC, galvanised steel, black steel and copper. Considerations for selecting the type of pipe include

- life expectancy
- resistance to corrosion
- resistance to deposits forming inside the pipe
- safe working pressure
- resistance to puncture and soil movement
- resistance to vehicle loads (traffic)
- standardised pipe size and fittings allows for easy repairs
- thrust blocks at all bends and junctions
- lengths available
- ease of bending
- comparative cost
- ease of installation
- type of pipe connection required.

Air relief valve

An air relief valve allows air that accumulates at high points of the water line to be released automatically so that it does not restrict water flow. If the water line velocity is high enough to force the air through the line, it can be released at a water delivery point.

Vacuum relief valve

When there are large differences in elevation, a vacuum relief valve will prevent vacuum in the line which can cause the pipe to collapse or break. This valve is typically used in conjunction with an air relief valve to minimise the number of fittings and reduce cost.

Advice should be sought on the location and requirements for check valves and air release valves. The pressure heads should be calculated to ensure that the correct pipe class is selected.

Shut-off valve

The pipeline network should include shut-off valves that allow sections of the line to be isolated for repairs and maintenance. The cost and location of valves should be evaluated against the benefit of having the water system remaining functional during repairs or service. A grid pipe network with loops enables most of the water system to remain pressurised and thus usable while a portion of it is isolated and depressurised.

Galvanised steel mainlines have been largely replaced by PVC and polyethylene because of its workability, ease of repair and cost.

PVC piping is a common mainline material, easy to install and repair. This installation incorporates a polyethylene pipeline take-off to the trough. Polyethylene pipe is now available in larger diameters (100 mm plus).

Shut-off valves allow individual troughs or rows of pens to be isolated without disrupting the water supply to other pens, or for purging pipes.

The PVC sleeve fitted over polyethylene pipe underneath the proposed concrete apron will make any replacement of the polyethylene pipe easier.

Polyethylene water pipeline attached to top rail of fence will allow water to heat up during hot weather and is not recommended.

Shut-off valves on each row of pens will allow maintenance to be performed on sub-mains without disrupting the whole feedlot. For example in Figure 3, if the sub-main to Row 1 was broken, valves A and B could be closed and the water supply to Row 2 is maintained.

The water supply to each trough should be controlled by individual shut-off valves on each unit (Figure 3). This will allow individual troughs to be shut down if a pen is empty or if a specific trough needs maintenance, without shutting down the rest of the system. If the pen has two troughs, its water supply will only be partially disrupted.

In smaller feedlots, this can be accomplished by using individual supply lines from the water supply to each trough. Separate lines installed to hospital pens will allow in-line medication to these pens only.

Valves should be installed at the low points in the system to allow flushing of any accumulated residue in the pipe network.

Location

The key issues to consider when locating water pipelines are physical damage by cattle or machinery, accessibility for maintenance or repairs and minimising heating of the water. Sub-mains may be located within pens or in cattle lanes/drains.

In some feedlots, the water pipe is attached to the top rail of the feedlot fence or water is reticulated through the top rail. Top rail piping must be steel since plastic pipes can be easily damaged. Although the water pipe is readily accessible for repairs, the cattle drinking water will become heated through solar radiation. This system is not recommended even though hot water can be partially overcome by continuous circulation. Cattle prefer water at or below body temperature (see *Section 5 – Water quality*).

Buried water pipes are less susceptible to physical damage by cattle or machinery but maintenance is more difficult and they can be damaged by soil movement.

Pipes buried at a depth of about 600 mm will maintain the water at a relatively constant temperature year round, with 300 mm giving fairly consistent temperature on a daily basis.

Most water pipelines are polyethylene or PVC as buried metal pipelines do corrode.

All buried pipeline joints should be watertight and tested before back filling with loose material such as sand or fine aggregate; rocks or coarse aggregate can damage the pipeline.

The relevant Australian Standards such as AS/NZS 2032 – 2006 and AS/NZS 2033 – 2008 should be referred to for design and installation of PVC and polyethylene pipelines.

A post-construction survey should mark pipeline locations. An accurate map showing locations of installed pipelines, valves and off-take points is an invaluable reference to limit damage in any future earth works.

Water meters

Water usage should be recorded regularly using water flow meters to monitor resource efficiency. Water flow meters are positioned in a straight length of pipe, typically with 10 pipe diameters of length upstream and 5 pipe diameters of length downstream of the meter. Various types of water flow meters are suitable for measuring water consumption in feedlots (Refer MLA Tips and Tools *Factsheet 4: Additional water measuring equipment*).

Flow meters are also useful for detecting possible leaks by measuring 'standing still' water consumption when equipment is not operating.

Flow meters may have a digital or an analogue display, and many can have data loggers fitted to record not only total flow but also provide profiles on how much water is used at various times of the day, month or year.

The cost of installing water flow meters will vary according to size and functionality. Factors to consider include pipe size, flow rate (L/min), fluid quality (e.g. incoming potable water, wastewater, process water), type of power supply (mains, battery or solar) and installation costs. There will also be costs for maintenance and recalibration for accuracy on a regular basis or according to the manufacturer's recommendations. Remember that any informed decision making must be based on accurate data.

Maintenance

Regular checks and maintenance of the watering system should ensure that an adequate supply of water is available to cattle at all times. Common problems are leaking blocked troughs, pipes and float valves which can usually be repaired quickly and inexpensively. Water leaks diminish feedlot appearance, propagate odour and enhance nuisance fly breeding while cattle may become bogged if the leak is significant or is allowed to persist.

Protection

Exposed items such as pumps, valves and pipelines need to be protected from damage by machinery and cattle.

Flow meters may have analogue or digital display. Digital meters can have data loggers.

Marking and recording the location and depth of underground mainlines will prevent unnecessary and costly damage.

Quick tips

- Gravity flow systems are preferred as they have less reliance on powered infrastructure and can provide cattle with water at all times.
- Whilst branched networks are simple, some areas will be without water until repairs are completed.
- A grid pattern pipe network with loops ensures that there is multiple supply of water to any one area.
- Minimise the heat gained by the water within the delivery system by running water pipes underground.
- The design of a reticulation system incorporates many factors including sizing, flow rates, pressure losses and valving. Consult a suitably qualified and experienced person in the design phase.
- Including water metering equipment in the reticulation system allows ongoing monitoring of water usage.
- Develop a water reticulation location map for future reference.

Further reading

MLA, 2011, A framework for water and energy monitoring and efficiency in feedlots, Factsheet 11: Drinking Water Usage. ISBN: 9781741915969 Meat & Livestock Australia, North Sydney NSW.

MLA, 2011, A framework for water and energy monitoring and efficiency in feedlots, Factsheet 4: Additional water measurement equipment. ISBN: 9781741915969 Meat & Livestock Australia, North Sydney NSW.

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