FEEDLOT DESIGN AND CONSTRUCTION

41. Cattle wash facilities

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Mud and dags on the belly and sides of cattle during prolonged wet pen conditions must be removed before slaughter.

Introduction

Humans can become ill from meat products contaminated by bacteria such as *Salmonella*, *Campylobacter* and *E. coli*. Animals carry these microorganisms within their intestinal tracts and excrete them in faeces. Meat may be contaminated if faecal material is transferred to the meat during the processing phase.

Reducing the manure and dirt on the hides of cattle being presented for slaughter lowers the risk of meat contamination when slaughtermen remove the hide, and most meat processing establishments require that the hides of cattle are visibly clean before slaughter. Dags are accumulated balls of manure and soil that adhere to the coat or hair of cattle, and are most prevalent on the brisket, underbelly, tail and sides (ribs, flank).

The main factors affecting the accumulation of dags are weather, pen conditions and the length of hair on the animal.

Abattoir requirements for cattle cleanliness as specified by AQIS are increasing and this puts pressure on producers to deliver cattle to abattoirs with minimal hide contamination. A number of abattoirs and feedlots have constructed on-site cattle wash facilities for the pre-washing of cattle for mud and dirt removal before pre-slaughter washing.

Design objectives

A cattle wash should be designed and constructed to

- remove loose dirt and manure on cattle
- reduce the level of dags on cattle, particularly on the slaughter cutting lines
- allow safe and efficient movement of cattle
- provide for easy separation and removal of washed hair, manure and soil
- contain durable, non-clogging and non-rusting components
- minimise stress and injury to cattle
- provide a safe working environment for people
- maximise water use efficiency
- safely contain contaminated water.

Mandatory requirements

Compliance with

- National Guidelines for Beef Cattle Feedlots in Australia (MLA, 2012a)
- National Beef Cattle Feedlot Environmental Code of Practice (MLA, 2012b)
- Australian Quarantine and Inspection Service (AQIS) standards.

Design choices

Process design

Cattle washing systems can be automated or manual, or a combination of both. Washing typically involves soaking followed by high pressure washing and in some circumstances, waterless mechanical removal. During soaking, cattle are exposed to low pressure sprays in a soaking yard to soften dags, mud and dirt and to wash loose manure and dirt out of the coat. Cattle are then subjected to a period of high pressure washing which may be manual hosing with high pressure hoses or an automatic system or a combination of both.

The waterless removal of remaining dags involves mechanical means such as combing, shaving or clipping, usually performed manually.

Cattle are usually washed only in winter, and not every winter.

Location

As cattle are washed at the feedlot before dispatch for slaughter, the cattle wash facilities are usually integrated into dispatch facilities or adjacent to them. Factors influencing the location of the cattle wash include proximity to the production pens and dispatch facilities, water supply and drainage. Cattle wash facilities must be within the controlled drainage area.

Sections 2 – Site layout, 21 – Livestock handling and *10 – Pen and drainage systems* outline design choices for receival and dispatch facilities within the overall feedlot layout, livestock handling and runoff control and storage systems. However, a cattle wash will introduce a more regular inflow of water into the runoff control and storage system, and this needs to be considered in the design. Drains from cattle washes stay wet when most cattle drains are dry.

Facility layout

The facility layout will vary with the type of cattle (e.g. large versus small cattle), number of animals to be handled, infrastructure constraints for redeveloped facilities and personal preferences on facility layout.

The design should accommodate all the operations to be performed, be safe, work effectively, and allow cattle to be cleaned as efficiently and economically as possible. Cattle flow through the cattle wash facility should be orderly so that cleaning operations will minimise stress on animals and operators.

Cattle wash facilities may include holding pens, forcing pens, races, catwalks, a restraint device, water delivery and drainage and sediment control systems, some of which may be incorporated with the receival, dispatch and processing facility.

The key design considerations for cattle wash facilities are

- process layout for cattle flow and handling
- type and number of cattle to be washed
- water supply, pumping, reticulation and pipework
- access to restraint facilities for waterless cleandown
- prevention of injuries to and minimise stress on cattle (e.g. non-slip flooring)

Soaking yard with overhead spray system that ensures water flows down the side of the animal's body.

Side by side soaking pens with above-floor pipework and an overhead spray system

Concrete floor draining from right to left with herringbone pattern across the yard. This yard has rubber sheeting on fences and uses RHS steel for water delivery, with nozzles protected by welded covers.

- safe conditions for operators such as protection from adverse temperatures, adequate lighting, access, catwalks, injury prevention and from exposure to spray drift
- sediment control and removal, drainage and recycling of waste wash water
- type of construction materials (steel, concrete) with respect to longevity.

The components of a cattle wash facility are described below.

Holding yard

The design and construction of holding yards for the cattle wash facility is similar to that of receival and dispatch facilities. Design considerations are outlined in *Section 22 – Receival and dispatch facilities.*

Soaking yard

Shape and size

As the soaking phase is the longest of the washing processes, the soaking area usually includes a number of yards, each holding the largest group of animals required for high pressure washing as a batch. A batch may be sized to transport vehicle deck sizes (see *Section 22*)or any other size as appropriate for ensuring operator safety during the cleaning processes.

Actual yard size is based on the preferred stocking density, with typically a minimum of 1.8 m^2 per animal.

Stocking rates should ensure that the full area of the soaking yards is used to improve water use efficiency.

Soaking yards are usually straight sided rectangular or herringbone rather than circular, as these are easier to construct, marry with adjoining pens, can be split into additional yards and incorporate pipework and drainage.

A straight sided soaking yard can be more easily built into an existing set of yards than a circular type.

The soaking yard must be designed so that cattle can be easily moved into it from the holding yard or forcing pens, and then easily moved out of it into the high pressure washing yards when required.

Flooring

The soaking pen surface should provide confident footing for the animals in all conditions, be easy to walk on and should not be slippery.

Floors need to be constructed of concrete for durability and with a non-slip finish in cattle and people traffic areas. Alternatives include heavy duty steel cattle mesh suspended on or above concrete, but these need satisfactory methods of cleaning.

A non-slip surface may be from fresh concrete with poured in place grooves or grooves cut in after the concrete has cured.

Grooves can be stamped in place by pressing, rolling or dragging some form into the wet cement to leave the desired pattern.

A typical pattern is squares ranging from 100 to 150 mm with 20–30 mm wide grooves between squares, or a herringbone pattern with grooves 20–30 mm wide and crossways every 100–125 mm.

The surface finish of the concrete floor (pattern and depth) will have an effect on the drainage of water off the yard surface area, with a herringbone-grooved pattern with the alleyways running parallel with yard fall helping drainage.

The concrete floor should be 125–150 mm thick and reinforced with a final strength of between 25 MPa and 32 MPa. 25 MPa concrete does not become slippery with wear from the action of the animal's feet but concrete at 32 MPa may become slippery as the animals hooves create a smooth, polished finish.

Concrete surfaces in existing or old worn yards may be cut to recreate the textured surface.

Concrete floor with herringbone pattern and above floor water pipework. Drainage flow is parallel with pipework.

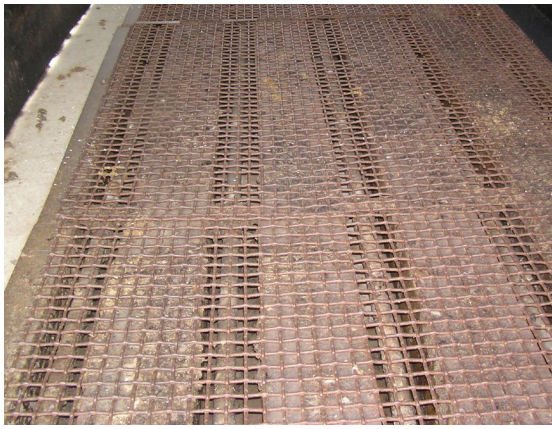
Slope

The degree of slope in a soaking yard may affect cattle flow and comfort as well as cleaning and drainage.

The design should allow gravity drainage of solids and wastewater to the sediment trap. Pens may be designed with a single slope (longitudinal only) or compound slope (longitudinal and cross slope).

Longitudinal slopes of about 3–4% (1:33 to 1:25) and a 1–2% (1:100–1:50) cross slope are desirable for cleaning, although floor patterns and placement of pipework may impede cross-fall drainage flow. The cross-slope is more appropriate for yards with no above floor restrictions and on sites that have a natural cross fall.

Any cross fall should increase to a greater slope at the bottom to direct the effluent to the sediment trap. Longitudinal slopes under 3% do not drain well if there is a buildup of mud/manure. Slopes greater than 4% lead to increased wear and the possibility of more slips and falls. The slope chosen depends on site topography. Lower slopes (<3%) are often chosen for flat sites to reduce earthworks.



Concrete floor with recessed pipework and mesh to provide non-slip surface

Yards with two converging slopes and a centre drain minimise earthworks and make cleaning easier. Most of the manure falls close to the drain and is quick to wash away.

Drains should be positioned away from the entry of the high pressure washing yard lest they impede cattle flow into the yard.

Kerbing

The perimeters of concrete soaking pens may be kerbed to prevent soil and effluent washing from pens into adjacent laneways, and to help direct waste wash water to the sediment trap. A concrete kerb a minimum of 150 mm above the surface level of the pen would be sufficient.

Fencing

Most fencing panels in soaking yards are made of steel. Corrosion-resistant material such as stainless steel may increase longevity of posts in fence lines, especially if using recycled water, but is expensive.

Steel products are available in various profiles (e.g. round pipe, oval pipe, square section (RHS)), and various surface finishes (painted steel, galvanised, stainless). Fencing is typically all steel construction

Gates provide access for cattle and equipment; hinged or overhead sliding gates are commonly used in a cattle wash.

Overhead gates are safer and more practical than hinged gates for operators in confined areas, but are more expensive to construct and require mechanical assistance to operate.

with no cables, as in production pen fencing styles. The design and construction of fencing for soaking pens is similar to that of processing facilities. Design considerations are outlined in *Section 23 – Cattle processing*.

Corrosion is a major problem and use of a more durable material and finish can help slow this.

The sides of the soaking yard are generally sheeted to prevent overspray onto adjacent areas, and to stop cattle from baulking at people or other cattle outside of the wash pen; they also reduce the wind chill factor and minimise cattle discomfort. Sheeting may be steel, rubber and high density polyethylene (HDPE). HDPE and rubber sheeting are available in various thicknesses with 8–10 mm HDPE being adequate. HPDE material is lighter than steel and, like rubber, is not prone to corrosion.

The fencing should have no protrusions or sharp edges in materials and finishes.

Gates

The design and construction of gates for soaking pens is similar to that of receival and dispatch facilities. The gates of the soaking yard are generally sheeted to prevent overspray onto adjacent areas and baulking. Design considerations are outlined in *Section 22 - Receival and dispatch facilities*. Gates between pens are usually sliding/overhead arrangement if there is no external alleyway.

Pipe system

Dags tend to hang from hair on the underbelly, brisket, tail and sides of the animal while dirt tends to be ingrained in the hair along the sides and around the rump and hocks of the animal. Hence, spray pipes are usually located on the floor or recessed into the floor of the wash yard, and may also be installed on the sides of the yard or overhead.

One or more hoses may also be required for manual cleandown in soaking pens.

Location of pipes

The pipe network is placed along the floor. Side-mounted sprays are effective in long narrow pens but are not usually in larger (square shaped) yards as their range is limited. Pipework on the sides of the yards is attached to the fence panels by saddles or U bolts at a height of 600–700 mm above the floor. Piping may also be placed along the top of the fence or over the pen depending on preference.

Exposed pipework should not cause any injuries to cattle. Water pipes may be recessed into the yard floor or installed on top of it.

Pipes recessed into the floor of the yard

Water pipes recessed into the floor are laid in a channel and covered by a grate or false floor so that the grate and spray nozzles are flush with the floor of the yard. Various prefabricated trench grating products incorporate a grated concrete surround that can be encased into the floor for ease of construction.

Recessed pipes protect the nozzles from damage, minimise hoof injury to cattle, provide obstacle-free drainage and cleaning of the yard with a bobcat or similar machinery with a flat-edged bucket.

Recessed pipes have to be installed at the time of construction and are more expensive than installing pipes on top of the floor.

Pipes on the yard floor

This system is easy to install for new or existing facilities with the pipes generally attached to the floor with saddle clamps. Pipes laid on top of the floor may trap sediment (e.g. rocks and manure), obstruct drainage and cleaning equipment and pose a tripping hazard for animals. Rows of above ground piping should not be connected together at the drain end of the pen.

Pipe spacing will depend on the spray nozzle/jet system used but should be distributed across the floor so that all animals in the wash yard are wet by the spray nozzles.

Capping the end of pipes allows the pipe to be opened and flushed to remove any blockages.

Above ground pipes can restrict drainage flow and trap manure. Nozzles can become clogged with manure.

Size

Delivery pipes should not be less than 75 mm.

Above ground pipes may restrict the flow of water to the drainage pit.

Spray system

As most manure is on the belly area, sprays are generally located on the floor and spray upwards.

The spray system used in soaking pens can include

- Low pressure spray – high volume/low pressure rates over an extended period (e.g. 1–2 hours) to fully wet the animals and penetrate the dirt and dags.
- Medium pressure spray –low volume/ high pressure over a shorter period (e.g. 30 mins to 1 hour) to impact the hide and soften the dirt and dags.

The spray system can be a simple design formed by drilling a series of holes in the pipe or installing spray nozzles.

The hole type nozzle costs little with a series of holes in an arc around the top of the pipe to create a fan pattern. Unless the hole is extremely small, the water tends to shoot out like a tiny fire nozzle (not misted) delivering too much water. More importantly, there is little uniformity of flow when using a simple hole e.g. in a long pipe with drilled holes, the holes nearest the water source will have a larger water flow from them than those at the far end.

Holes drilled in pipes create a quick and cost effective spray system.

Tiny holes are easily clogged by small stones or mud which can be trodden into the hole during washing, or by hard water or by impurities in open storage water.

Nozzles inserted in the delivery pipe distribute the water more evenly over a given spray pattern. A full cone nozzle is recommended over flat fan or hollow cone designs; a cone angle of 120° will provide good coverage over a circular area. Spray nozzles of large aperture will provide thorough overall wetting of cattle of all ages, sizes and breeds. The disadvantage is cost and the fact that the nozzles also stand exposed from pipes (some form of protection is required).

Running and maintaining spray nozzles is technically more demanding than holes in the pipe. The nozzles have to be regularly removed and cleaned, and they must be correctly adjusted to have

Spray nozzles need protection from the hooves of animals.

Soaking yard covered with shade cloth which redirects the spray water back down over the top of the animals

Adjacent catwalk with high pressure hose and nozzle

the right pressure and ensure correct coverage. Nozzles can bruise hooves, and damage hide and carcase if an animal falls.

The spray from the nozzles should be directed inwards and upwards so that the point of intersection of the sprays is at a height of between 600 mm and 700 mm above the floor.

Pipe material

Galvanised steel pipe is usually used for spray system pipework. Stainless steel will increase longevity if using recycled water, but the cost may be prohibitive. Plastic pipes can be crushed by cattle hooves.

Drainage

Pipes, drop pits or gutter drains are used to drain soaking yards. The water may be directed to a sediment trap before discharge to the drainage system. See *Section 11 – Sedimentation removal systems* for further information on design and construction of sedimentation systems.

The most practical drains are open concrete ditches sized for the volume and flow rates of the water used during soaking. Square concrete ditches should be constructed slightly wider than the width of a shovel for easy cleaning.

Drain material

Sewer quality PVC is best for underground drainage pipes, having a smooth interior, resistance to acid attack and being easy to install.

Drain slope

A slope of less than 1.5% may have insufficient flow velocity to flush material causing manure and other solid particles to lodge in the pipe.

Drain size

The recommended diameter for main drainage pipes is 200–300 mm with individual drainage pipes of at least 150 mm.

Pumps

The size of the water pump required by the cattle wash facility involves calculating pipe size, length of pipe runs, number and type of fittings and the number of takeoffs. Pumps for the soaking yards should be high volume and low pressure and vice versa for the high pressure yards.

There are numerous pumps and systems suppliers that offer a design and construct service.

Yard cover

The soaking yard may be covered with a shade cloth type material to create a misty environment. The water sprays hitting the shade cloth are directed down onto the backs of the animals. A canopy captures overspray and helps moisten cattle from above.

High pressure yard

High pressure washing may be done by manual hosing or with a fixed spray system or a combination of both. After soaking, the cattle are manually hosed with high pressure hoses, or yarded into a pen fitted with floor and side sprays delivering water at high pressure/low volume.

Cattle may be washed first with fixed sprays and then manually with a high pressure hose.

The target areas are the brisket, underbelly and inside of the hind legs in the flank region. These areas of the body, whilst often the dirtiest, are also along cutting lines where the hide is opened up or handled during slaughter.

Care needs to be taken when using a high pressure hose to avoid bruising and stress to the animal.

Shape and size

The shape and size of the high pressure yard will depend on the batch size to be washed and the method of washing. Design principles from the soaking yard can be applied to the high pressure yard.

Both sides of high pressure pens are usually accessible to allow manual hosing so most designs are walk through with overhead slide gates.

For manual hosing, the pen design should be narrow, similar to a wide race, to allow access to all cattle from the side.

Flooring

The high pressure yard is usually at the same elevation as the soaking yard. However, some facilities have a raised platform race so that the cattle are above the hosing operators who are at ground level.

The design principles from the soaking yard can be applied to the high pressure yard.

Slope and kerbing

Design principles from the soaking yard can be applied to the high pressure yard.

Fencing

Design principles for fencing materials from the soaking yard can be applied to the high pressure yard. Sheeting may not extend the full depth of the panel if access is required through the fence for hose nozzles.

A catwalk is usually constructed and puts the operator at the right level to coax animals in the right direction and access for manual hosing. See *Section 23 – Cattle processing facility* for design and construction details for catwalks.

Gates

The design and construction of gates for high pressure pens is similar to that of receival and dispatch facilities. Design considerations are outlined in *Section 22 - Receival and dispatch facilities*. Gates between pens are usually sliding/overhead arrangement.

Pipe system

Design principles from the soaking yard can be applied to the high pressure yard, but risers or hydrants will need to be installed along the side of the yard for attaching hoses for use in manual hosing. Multiple short hoses (5–7 m) connected at convenient points are more useful than one long hose (>7 m) as long hoses become difficult to handle and heavy to drag.

Raising the high pressure race makes it easier for the operator to view and clean the animals' undersides.

Short hoses from multiple takeoff points are easier to handle than a single long hose. Note the tap on the nozzle for flow control.

Mesh sheeting on high pressure race offers the operator protection from the animal whilst washing.

Manual high pressure washing of an animal inside a crush

Comb for scraping mud and dags off cattle.

A tap should be installed at the nozzle end of the hose for flow control, rather than at the riser/supply end.

Hoses should be fitted with a swivel to allow free hose movement without imparting torque stresses to the connection assembly.

The hose should be 40–50 mm diameter with a nozzle of 20–25mm diameter.

A flow rate of 60–150 L/minute (1–2.5 L/sec) with a pressure of 100–250 kpa (1–2.5 bar) is recommended. Hosing at short distances with higher water pressures (10 bar) can inflict welts on the side of the animal that become visible only when the hide is removed.

Drainage

Soaking yard drainage design and construction principles can be applied to the design and construction of the high pressure yard.

Waterless removal

A final phase of the cleaning process typically involves removal of remaining dags by mechanical means such as combing, shaving or clipping. These operations are usually performed manually and can be risky for operators unless the animal is restrained.

In most cases, the animals are restrained in a crush. *Section 25 – Cattle crushes* provides information on crushes.

Drain yard

An area to temporarily hold washed cattle while they drip off following washing may form part of the cattle wash facility. This may be part of a holding pen, separate from or part of the cattle wash facility. A drain yard is not generally required, as most of the water will drip from the animals if they are held in the high pressure yard for 10–15 minutes after final washing.

A concrete-floored pen at the exit from the high pressure yard has the advantage of returning water to the drainage system if the floor of the draining pen is sloped back towards the cattle wash drainage system.

Design principles for a soaking yard can be applied to the drain yard.

If cattle are not dispatched to the abattoir immediately, they should be held in a pen with bedding (e.g. woodchips, straw) to prevent recontamination with dirt and manure.

Buildings

Cattle are washed mostly during winter months when pens have less opportunity to dry out. Cold temperatures during the washing season also raise issues with operator safety and welfare of the cattle. Some feedlots wash cattle at night when temperatures may be even colder.

A cattle wash facility must provide a safe working environment. This may include a shelter structure that offers some protection from the environment, in particular cold windy weather. *Section 24 – Buildings* provides information on buildings and structures for cattle handling facilities.

Water usage and recycling

Washing of cattle is the second highest user of water in feedlots in the months when it is undertaken. The volume of water used will depend on the amount of mud and dags on the cattle, the cleanliness standard, level or score required at the processing plant, the number of cattle washed and level of wastewater recycled.

Average annual water usage across seven feedlots between 2007 and 2009 ranged from 700 L to 2500 L/head. Large volumes of water were required in periods where prolonged wet weather had resulted in particularly dirty cattle.

Some lot feeders can recycle the cattle wash water, while other use treated effluent for cattle washing. Recycled wash water is mainly used for soaking; it could promote cross contamination, but clean water is then used for high pressure washing.

The introduction of a water treatment system can improve the quality of recycled water for cattle washing. Many water chemical and biological reactions are dependent on dissolved oxygen levels, and water containing a high organic content has low dissolved oxygen and high microbial contaminants.

A simple cost effective treatment system in use within Australia is ozone treatment. Ozone treatment is commercially used in the final step for production of potable water as well as an aid in the degradation of human sewage effluent.

The chemical action of ozone (O_3) is in the creation of highly reactive, oxygen-free radicals that facilitate oxidation reactions. The free radical oxygen is toxic to most waterborne organisms (i.e. protozoa, bacteria, many viruses), reacts with metals and increases water oxygen content.

No chemicals are used in the ozone water treatment so there are no residues. Increasing oxygen levels in water allows greater natural chemical reactions, increasing rate of penetration into dag material for a more rapid degradation or release from hair.

At one feedlot, recycled cattle wash water coliform count was reduced by 85% with the application of ozone treatment. There was also a notable reduction of holding pond odour.

Triple-bay trafficable sediment trap. Drainage water can be directed to other basins to allow sediment to dry out.

Quick tips

- Cattle wash yards are usually straight sided and rectangular or herringbone in shape, rather than circular.
- Herringbone floor patterns with the alleyways running parallel with yard fall drain better than square shaped patterns.
- A herringbone pattern with grooves 20–30 mm wide and crossways every 100–125 mm provides a non-slip surface.
- Laying pipework on top of the yard floor is cheaper but may affect drainage and retain sediment against the pipes. Spray nozzles and/or animal hooves may also get damaged.
- Drilling a series of holes in the pipe provides a cheap spray system but less uniform water coverage.
- Washing cattle can consume a large amount of water.
- Recycling cattle wash water reduces the total clean water requirement for washing but could create safety issues from the high microbial contaminant loading in the effluent.
- Manual removal of dags by mechanical means such as combing and clipping is dangerous to operators unless the animal is restrained.

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