Feedlot cattle staging facilities

Best practice manual

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Scope and purpose

The purpose of this document is to provide examples and information about best-practice design and management for existing and greenfield feedlot cattle staging facilities, feedlots, and grazing systems. The key focus of this document is the prevention of impacts to the environment, particularly in relation to the movement of sediment, nutrients, salts and pathogens into groundwaters and surface waters. Best-practice principles have been identified from site visits, soil sampling, literature, research, and guidance from other countries or Australian livestock industries. It also includes concepts which, although not currently applied to feedlot cattle staging facilities, could be reasonably applied in the future.

The information provided in this document should be used in conjunction with future research into the design and management of feedlot cattle staging facilities. Particularly where the outcomes of future research contradicts this document or provides alternate options to achieve best-practice outcomes.

The concepts within this best-practice manual are not minimum standards but are intended to provide ideas to lot-feeders, consultants, and regulators in achieving the requirements of local, state, or federal planning and environmental legislation and regulatory frameworks. It is only applicable to feedlot cattle staging facilities adjacent to, or under the full control of, an approved feedlot and is not intended to be applied to grazing or other livestock activities. Information provided in this document does not override government legislation or policy but may be used to inform the development of new policy. Ultimately, the relevant regulatory authority will make the decision on how feedlot cattle staging facilities are defined in the context of planning and environmental regulations. This may vary between different jurisdictions or different sites.

Some best-practice concepts are aspirational and much of the information provided may not be necessary for all sites. Some of the concepts may be suitable for incorporation into existing facilities. However, the primary goal is to assist in the design, construction and management of new feedlot cattle staging facilities to ensure the continual improvement of design and management across the industry.

Glossary

The following glossary contains plain-English explanations of concepts in the context of their applicability to feedlot cattle staging facilities. The definitions or descriptions stated may not wholistically define the word, phrase or concept, but provide a simple description to assist the interpretation of this document.

All-weather roads	Roads which are trafficable during all weather conditions.
Amenity	The ability for people to enjoy a desirable or positive aspect of a place or location.
Best-practice design and management	Implementing design and management practices that are industry-leading regardless of risk level, even if lesser practices could achieve the required outcome.
Biodiversity	Flora and fauna and all related ecological systems.
Bovine respiratory disease (BRD)	A respiratory disease caused by a combination of viral and bacterial pathogens, which are influenced by animal, environmental and management risk factors.
Bunk space	The lineal length of feeder space available to an individual animal.
Bunk training	The conditioning of grazed cattle to prioritise the feeding from a feed bunk instead of grazing.
Carbon markets	Financial markets where Australian Carbon Credit Units (ACCUs) can be generated through carbon abatement projects and used or sold to offset emissions.
Cattle socialisation	The mixing of cattle, previously unknown to each other, to allow them to form natural social structures and hierarchies.
Comingling	The mixing of cattle to allow for socialisation and exposure to BRD pathogens prior to entry into a feedlot.
Contaminants	Nutrients, pathogens, sediments, chemicals which may be emitted from feedlots or feedlot cattle staging facilities and impact soils, surface water, groundwater, flora, fauna or people's amenity.
Controlled drainage area (CDA):	Engineered stormwater controls that capture runoff from areas, where manure deposition is high, and directs it to an appropriate treatment, holding, or utilisation system.
Crash-grazing	The grazing of a paddock at a high stocking rate for a short period of time to encourage groundcover growth without denuding or overgrazing the paddock.
Drought feeding	Definitions vary between states and territories, but generally involves the supplementary feeding of cattle in a drought declared area. Some states may incorporate seasonal feeding when rainfall is unexpectedly low for a part of the year but the region is not drought declared.
Effluent/holding/ retention pond	A water storage, usually earthen, used to contain runoff from a contaminated area prior to evaporation or irrigation.
Enclosure	A pen, paddock or cell, of varying sizes, which contain mobs of cattle within the feedlot cattle staging facility.
Environmental legislation	Local, state, or federal legislation (and subordinate regulations and policies) which is implemented to protect the natural and built environment.
Feeding systems	Feed bunks (concrete, rubber, or steel) and self-feeders into which feed rations are delivered for cattle to eat.
Feedlot cattle staging facility	Refer to Section 1.1
Feedlot complex	As defined in the National Guidelines for Beef Cattle Feedlots in Australia
Groundcover	The coverage of the soil surface by plant matter, regardless of species or purpose of vegetation. Groundcover may be a mix of clumping or running grasses (pasture or non-palatable), or small shrubs. In the context of this document, the priority of groundcover is for soil conservation, not necessarily grazing.
Groundwater	Any water present under the ground, whether in a confined aquifer or not.
High-intensity areas	Smaller areas, often around feeding and watering points, where cattle impacts prevent the maintenance of grass cover. These may be present in low-intensity systems.
High-intensity system	A feedlot cattle staging facility or enclosure, designed or managed in a way in which it is not possible to maintain at least 50% groundcover during average weather conditions.

Hospital paddocks	Paddocks used to house cattle removed from the feedlot for health or welfare reasons. Cattle in these areas may or may not return to the feedlot.
Jurisdiction	As regulatory jurisdictions vary for feedlots across the country, this term has been used to broadly describe states, territories, regions, local governments, water catchment authorities or any other relevant regulatory agency.
Landscape rehydration	Implementing systems to slow the flow of water across the land to improve infiltration and storage of water under the ground.
Low-intensity system	A feedlot cattle staging facility or enclosure, designed and managed to achieve a groundcover target of at least 50% during average weather conditions.
National Feedlot Accreditation Scheme (NFAS)	An independently audited quality assurance program for the Australian lot-feeding industry.
Natural capital markets	Emerging financial markets where improvements to natural capital (e.g. biodiversity) could result in a tradable credit unit.
Odour dispersion model	A model used to assess the potential impacts of odour from proposed facilities on the surrounding environment. In the context of feedlots, manure and effluent models are also required to develop inputs for a feedlot odour dispersion model.
Outcomes-based design and management	The selection of appropriate design and management practices to achieve a specific outcome. Appropriate design and management may vary but achieve the same performance outcome.
Piezometer	A groundwater bore constructed specifically for the purpose of monitoring groundwater.
Planning legislation	Local or state legislation (and subordinate regulations and policies) which determines the legal use of land in both urban and rural contexts.
Risk-based design and management	The selection of appropriate design and management practices based on the potential of impacts to occur to environmental values. Generally, a greater risk results in greater design and management requirements.
S-factor assessment	Refer to Appendix B of the National Guidelines for Beef Cattle Feedlots in Australia.
Sensitive receptor	An off-site legal dwelling, education, or community building which has the potential to be impacted by emissions (e.g. odour, dust, and noise). This may be defined differently in relevant legislation or government policy.
Setback vs buffer	Setback is a physical distance; a buffer is control in between an emission source and receiving environment. For example, a large setback from a water course may provide an appropriate buffer. Alternatively, a smaller setback with vegetation and runoff controls may also provide an adequate buffer.
Shy-feeders	Cattle which are reluctant to approach a feeder or consume a prepared ration.
Slow-release detention	A water storage, usually earthen, used to temporarily detain runoff from a contaminated area to allow contaminants to settle out prior to release of runoff into the surrounding catchment.
Standard Cattle Units	As defined in the National Beef Cattle Feedlot Environmental Code of Practice.
Stocking density/rate	The number of animals in any given area and may be measured using head of cattle or Standard Cattle Units.
Surface preparation	The physical construction or preparation of soils to achieve the necessary permeability or clay lining described in Appendix C of the National Guidelines for Beef Cattle Feedlots in Australia.
Surface water	Any water flowing across the surface of the ground which may include overland flow, drainage features, creeks, and rivers, and natural or artificial lakes.
Swale	Refer to Section 4.4.3.
Vegetation corridors	Natural or planted vegetation used for shade, soil health, dust control, and/or visual amenity.
Vegetated filter strip	Refer to Section 4.4.4.
Waste utilisation areas	Land where effluent or manure from the feedlot is sustainably applied to land with a nutrient removal system (e.g. cropping).
1% annual exceedance probability (AEP) flood event:	1% chance of the flood event occurring every year. This AEP is often used as the defined flood event (DFE) for flood vulnerability mapping.

1 Introduction

1.1 Definition

Feedlot cattle staging facilities are enclosures used for the receival, feeding, and dispatch of cattle, prior to entry into a feedlot accredited under the National Feedlot Accreditation Scheme (NFAS). These facilities are operated and maintained by the lot feeder receiving the cattle into their accredited feedlot, and may be located adjacent to, or detached from, the accredited feedlot complex. The dietary intake of animals in feedlot cattle staging facilities may be entirely from a prepared ration (total mixed ration) or may include some grazing of pasture or forage plants actively growing within the facility (partial mixed ration).

Stocking density, length of feeding, and infrastructure do not define a feedlot cattle staging facility but influence design and management. Feedlot cattle staging facilities may also include ancillary infrastructure, such as cattle handling yards or feed storage, not directly related to the feedlot. Feedlot cattle staging facilities are primarily used as part of a feedlot production system but may be temporarily used or managed differently during periods of drought or other emergency events. They do not include hospital paddocks primarily used to contain sick cattle which have been removed from the feedlot. However, they may, at times, be used as hospital paddocks.

Feedlot cattle staging facilities incorporate concepts from backgrounding systems but differ from supplementary feeding in a grazing system, backgrounding not under the ownership or management of the NFAS feedlot business, or any other system for the finishing of animals prior to slaughter.

1.2 Benefits

Generally, feedlot cattle staging facilities allow for the introduction of cattle to aspects of the feedlot environment, just at a lower intensity. Three main benefits of feedlot cattle staging are:

- improved socialisation
- improved feed intake
- reduced health issues.

Improved socialisation refers to the establishment of a strong social group prior to entry into the feedlot. The time in the cattle staging facility also allows for shy feeders to be identified and managed, should they not be adequately prepared for feedlot entry.

Feed intake within the feedlot can be improved through bunk training and introduction to a starter ration in the feedlot cattle staging facility. Cattle, which are not accustomed to obtaining their feed from a bunk, take some time to adjust to this new system. Allowing for this adjustment to occur in a lower intensity environment reduces the pressure on animals during this period.

There has been extensive research conducted by MLA on the benefits that the incorporation of feedlot cattle staging facilities can have on the management of Bovine Respiratory Disease (BRD). The key outcomes of this research are provided in the MLA Bovine Respiratory Disease Preventive Practices Handbook (Cusack, 2022). Housing cattle in feedlot cattle staging facilities is a great opportunity to rest, rehydrate, and restore rumen function in a low-stress environment. These elements are important for the restoration of immune function.

Anecdotal advice from lot feeders is that the incorporation of a feedlot cattle staging facility also provides operational benefits such as improved uniformity in cattle entry weights and the ability to increase feedlot throughput, particularly for long-fed cattle, by reducing the days on feed within the feedlot. However, the feeding of cattle within a feedlot cattle staging facility are not 'days-on-feed' under the NFAS grain-fed accreditation rules and standards.

1.3 Guiding principles

These guiding principles have been provided to minimise the potential for sections of this document to be taken out of context or unnecessarily applied to some facilities. This document should be read with the following guiding principles in mind.

1. Risk-based and outcomes-based design and management

This document is intended to provide information to achieve best-practice outcomes. The site-selection, design, and management decisions, required to achieve best-practice outcomes, may vary between sites or landscapes within the same site. The risk of the site and operations will determine which design and management practices are most suitable to ensure that a best-practice outcome is achieved. Essentially, a low-risk site with a low-intensity system will not need the same design and management controls as a high-risk site with a high-intensity system.

2. Incorporation of best-practice feedlot design and best-practice grazing management

Feedlot cattle staging facility design and management can vary from operations aligned with grazing to operations aligned with lot feeding. As such, the intent of the information provided in this document is to incorporate best-practice feedlot design principles where they are most applicable (e.g. high-intensity areas), and best-practice grazing management principles where they are most applicable (e.g. grassed paddocks). Should changes in best-practice for feedlot or grazing systems occur, it may be reasonable to incorporate some of those new concepts into best-practice design and management for feedlot cattle staging facilities.

3. Protection, maintenance, and/or enhancement of sensitive environments

The sensitivity of the surrounding environment may vary between different sites. For some highly sensitive environments, protection of these areas, through cattle exclusion and setbacks, may be the most suitable approach. However, in other areas or environments, sensitive areas can be incorporated into the feedlot cattle staging facility, provided the facility is appropriately designed and managed to prevent or minimise impacts.

4. Provision of appropriate facilities for the monitoring and management of animal welfare and biosecurity

As with all livestock operations, there is a legal obligation to ensure animal welfare and biosecurity are managed in accordance with the relevant legislation and codes. There are minimum requirements for welfare and biosecurity, which must be met by all facilities. However, some aspects of design and management are not minimum requirements and are only recommended as part of best-practice.

5. Varied use of facilities during drought

Although subject to market variations, feedlot cattle staging facilities are normally incorporated into the ongoing operations of the associated feedlot. However, during extreme weather events, such as droughts, flooding, or bushfires, the operations of a feedlot cattle staging facility may be varied. This is often required to respond to changed market conditions and the need to drought-feed cattle in larger numbers or stocking rates to ensure welfare is maintained across the cattle industry. Drought and floods are temporary, but recurring. As such, it is reasonable to use permanent infrastructure in a different way when responding to these events.

2 Regulatory framework

2.1 Planning and environment

All states and territories have planning and environmental legislation that governs which land uses or activities can be undertaken in which locations. Planning and environmental land use definitions, relevant to feedlot cattle staging facilities, are determined by the relevant state or territory. However, these definitions may be enforced by local government. In most circumstances, the land use definition of a feedlot cattle staging facility is not clear and may be based on the definition of a feedlot (intensive animal industry, intensive livestock agriculture, intensive animal agriculture) or grazing (extensive agriculture). There can be substantial variation in the design and management of feedlot cattle staging facilities. As such, two facilities, in a similar location but with different design and management, may be defined differently under the same planning and environmental legislation.

Prior to commencing the construction, purchase, or operation of a feedlot cattle staging facility, it is recommended that operators contact their local council, agricultural department, and/or environmental regulator. The relevant definitions from each jurisdiction are provided in Appendix C. However, as these definitions are subject to interpretation and periodic change, they should not be relied upon without further regulator advice. Ensure that any formal advice from these agencies is provided in writing as legislation is subject to change, and subsequent advice may also change.

Detailed advice on each state or territory land use definitions has not been provided in this document to prevent inaccurate advice following future regulatory changes.

Regardless of regulatory definitions each jurisdiction includes a general environmental duty or obligation. Essentially, this duty requires people to do all reasonable and practicable measures to prevent or minimise environmental harm. This duty or obligation can be enforced even if a feedlot cattle staging facility is not a registered or regulated activity.

2.2 Drought

Currently, most of the relevant legislation and associated land use definitions include an exemption for drought feeding (stock containment areas or drought lots). In some cases, it is assumed that such feeding arrangements would be temporary and only implemented when the region is impacted by drought. Whilst drought is temporary, it is recurring, and the frequency of extreme weather events is expected to increase into the future. As such, feedlot cattle staging facilities may provide a suitable location for centralised drought feeding in proximity to existing feedmill infrastructure.

Feedlot cattle staging facilities which can maintain groundcover during normal seasons, may not be able to maintain groundcover during drought. Should feedlot cattle staging facilities be stocked, during droughts, at a rate at which groundcover cannot be maintained, it is expected that rehabilitation measures should be implemented once the drought has ended. This requires long-term planning, and continuous improvement of management systems.

As drought feeding often occurs in periods of wide-spread destocking, the drought-feeding of cattle within a feedlot staging facility should facilitate cattle growth to assist in quickly removing those animals from the supply chain. This is likely to require the growing and fattening of cattle, not just maintenance.

2.3 Water use

Water regulation varies between jurisdictions and between catchments within each jurisdiction. It is important to consult with the relevant water regulator to determine the licensing requirements for water use in feedlot cattle staging facilities. In many jurisdictions, the licensing of water for stock use relates to how the stock are housed, contained, and/or fed. The use of water in feedlots often requires a specific licence or allocation and the use of stock and domestic or ‘as-of-right’ water may be prohibited. Therefore, the legal use of stock and domestic water in feedlot cattle staging facilities may be subject to relevant planning, environmental, and water legislation in each jurisdiction.

Depending on the specific regulatory environment, water licences, supply and storage for the feedlot should consider the needs of the feedlot cattle staging facility. This is most important during drought when surface water sources may be less reliable, but demand on the feedlot cattle staging facility is highest.

3 Site selection

Site selection is important as it may reduce the risks of adverse impacts on the built and natural environment, reduce capital or operational expenditure, and improve animal welfare and performance outcomes. Advice should be sought from the local council, the relevant department of agriculture, or a suitably experienced consultant prior to selecting a site for a feedlot cattle staging facility.

3.1 Surrounding land use and locality

Generally, feedlot cattle staging facilities are in proximity to feedlots which are, historically, not located near residential or tourist areas. However, if a feedlot has been in such a location for some time, it may have been accepted by the community and maintain a strong social licence. An unexpected change to the operation of this feedlot, by adding a poorly designed or managed feedlot cattle staging facility, may result in the loss of that social licence. As some feedlot cattle staging facilities may not be assessed through the normal town planning or environmental processes, there is a greater risk of losing community support if the community feels like they have not had their opportunity to contribute to the assessment of this change.

The potential for future land-use changes, particularly in peri-urban areas, should be considered before making a substantial investment in the construction of a feedlot cattle staging facility.

A collaborative, site-specific approach is required and could be a combination of thoughtful site selection, minimum setbacks, buffers or screens, management, and community consultation.

3.1.1 Odour

Odour generation is caused by the anaerobic breakdown of manure, which is primarily driven by moisture and temperature (Tucker *et al*., 2015). Odour emissions from a feedlot cattle staging facility area are more likely to be related to areas of high cattle intensity, where feed waste, manure deposition, and moisture are likely to be greatest. In high-intensity systems, this could be large areas, or restricted to smaller areas in low-intensity systems.

Although there is currently no research on odour from feedlot cattle staging facilities, the following areas are more likely to have conditions contributing to odour generation:

- feeding infrastructure
- water troughs
- shade structures
- stock dams
- isolated trees.

Whilst the above examples are more likely to produce odour, this does not mean that they always do.

3.1.2 Dust

Sources of dust from feedlot cattle staging facilities relate to dry, loose surface material from exposed soil, dry manure, or road surfaces.

Odour is usually the most limiting factor for feedlot developments, particularly as moisture from the distribution of manure on the pen surface, reduces the potential for dust emissions. Therefore, the separation required by the S-factor calculation is usually adequate to mitigate feedlot dust impacts. However, large, high-intensity feedlot cattle staging facilities may not maintain the same pad moisture as a feedlot. As such, a more detailed assessment of dust may be required depending on available separation distances to sensitive receptors.

However, research in the Australian pork industry (Banhazi, 2013) identified that vehicle movements across the property are the greatest source of dust emissions in free-range systems, regardless of groundcover.

In most circumstances, best-practice design and management of most low-intensity feedlot cattle staging facilities may be adequate to minimise potential dust impacts on nearby sensitive receptors. The maintenance of adequate groundcover will minimise potential dust emissions by reducing the exposure of loose material to wind.

3.1.3 Noise

Noise emissions from feedlot cattle staging facilities are generally associated with a feedmill, ancillary loading or unloading of cattle, and vehicle movements. These activities may already be associated with the feedlot. If separate cattle loading/unloading facilities are proposed for the feedlot cattle staging facility, the siting of these facilities should consider potential noise impacts. However, providing separation distances are reasonable, operating hours may be adequate to mitigate any substantial noise emissions.

Like dust emissions, research in the pork industry (Banhazi, 2013) identified that vehicle movements were the greatest source of noise in free-range systems.

Regardless, sources of noise associated with the feedlot cattle staging facility need to be considered in any feedlot noise impact assessment.

3.1.4 Visual

As the importance of visual amenity varies across different jurisdictions, and can be specific to each locality, visual amenity issues for high-intensity feedlot cattle staging facilities should be considered like they are for feedlots. Consult with the relevant regulatory body to determine any requirements. Generally, low-intensity feedlot cattle staging facilities align with the rural landscape and have a minimal impact on visual amenity. Regardless, screening feedlot cattle staging facilities from the public or neighbours should be considered as part of a risk-based approach.

3.2 Slope and topography

Well-designed and managed feedlot cattle staging facilities can be located on flat to steeply sloping sites. However, the intensity, design, and management of the system must be adjusted to prevent adverse impacts on landscape values. Steep sites are more prone to erosion and should be avoided if groundcover cannot be maintained. Conversely, flat sites can be prone to drainage issues resulting in the pooling of water against infrastructure. This can lead to increased odour emissions.

3.3 Soils

Soil types are unlikely to prevent the use of a landscape for a feedlot cattle staging facility. However, they will strongly influence the selected design and management practices. For example, sandy soils may require greater controls to prevent the leaching of nutrient from high-intensity areas. Conversely, soils with a high clay content may provide greater protections for groundwater but are more prone to compaction, preventing grass growth which can then result in erosion and impacts to surface water values. Highly erosive soils must also be considered, particularly in relation to groundcover targets and cattle access to the bed and banks of watercourses.

Soil types may also vary substantially across individual properties and much be considered based on a sound understanding of the on-site soils and appropriate management of groundcover and runoff. As with all grazing systems, the management of soil fertility is crucial for plant growth.

There are various publicly available soil maps which can provide an indication of local soil types. However, the most accurate method to map on-site soils is through an electromagnetic (EM) survey to a depth of 1m, with targeted sampling of soils to calibrate and interpret the results of the EM survey. Such a soil survey can also provide an opportunity to obtain baseline data, and identify the most suitable sampling sites, for future soil monitoring (Section 5.9.1). Along with field tests for physical properties, the recommended laboratory analyses are described in Section 5.9.1.

3.4 Biodiversity

There is local, state, and federal legislation in force to minimise clearing of land and impacts to native biodiversity. Clearing can be direct, through removal, or indirect, through damage from livestock or release of contaminants. Depending on the intensity of the feedlot cattle staging facility, approvals relating to biodiversity or vegetation legislation may be required.

The protection of biodiversity requires a multi-faceted approach in which exclusion of cattle from sensitive areas may be necessary. Alternatively, the management of stocking rates and enhancement of groundcover and vegetation may allow for improvements to biodiversity and natural capital within a feedlot cattle staging facility.

Most states and some councils have online mapping to assist in identifying key biodiversity values on your property.

3.5 Groundwater

Although definitions of groundwater vary, it is generally defined as water below the natural surface of the ground, whether it is in a distinct aquifer or not. The sensitivity of groundwater may vary depending on quality, use and associated ecological values. The potential risks to groundwater from feedlot cattle staging facilities are dependent on the intensity of the system, depth to groundwater, and permeability of overlying soil or rock. Generally, potential impacts can be caused by the leaching of nutrients and salts from manure into the soil and underlying groundwater.

3.6 Surface water

Surface water includes the flows of water across the land, and water within formed drainage features, creeks, rivers, and natural or artificial lakes. The value of these waters depends on the associated biological systems, agricultural and domestic use, recreation, and cultural heritage significance. Most states have mapping that identifies different surface water features including stream order (size of watercourse).

Potential impacts to surface water features can be caused by the transportation of sediments, nutrients, and pathogens from manure and exposed soils into adjacent waterways. Direct impacts to the bed and banks of larger watercourses can be caused by unrestricted cattle access. The potential for impacts is dependent on the climate, distance to waterways, land gradient, flow convergence, soil type, land use, vegetative cover, and intensity of the feedlot cattle staging facility.

The location of waterways across the property must be considered as part of design and will also influence operational aspects. Major watercourses should be excluded from the feedlot cattle staging facility area. The location of road infrastructure and potential watercourse crossings also need to be considered as access across on-site watercourses can be impeded during or following storms.

3.7 Flood protection

In most circumstances, feedlots are required to be free from inundation during a 1% annual exceedance probability (AEP) flood event. Generally, this is to protect cattle, prevent the unreasonable release of contaminants, or prevent damage and removal of infrastructure. This can be achieved through site selection or construction. Flood protection for a feedlot cattle staging facility can be achieved through siting, design, and/or management.

The extent of flood immunity or protection required for feedlots is not necessary for most feedlot cattle staging facilities. Flood management will be dependent on the intensity of the feedlot cattle staging facility and should be negotiated between the operator and relevant regulator. It may also be suitable to incorporate a flood contingency plan into management in lieu of siting and design requirements.

Any controls implemented to protect the enclosures from flooding may result in changed off-site impacts during a flood event. As such, substantial changes to the landscape (e.g. levies or diversion banks) need to be carefully considered. The construction of these structures may also require various approvals and modelling.

As the accuracy and availability of flood data and mapping can vary, it may be difficult to determine the impact of a 1% AEP flood event on every property. Generally, flood mapping for smaller flood events is restricted to urban areas and surrounds. For the purposes of siting and designing a feedlot cattle staging facility, it would be costly and impractical to determine impacts from more frequent flood events on rural properties. As such, the use of local landscape characteristics and anecdotal evidence may be the most suitable way of determining the potential flood impacts for a feedlot cattle staging facility.

4 Design

The design of feedlot cattle staging facilities varies significantly, with many facilities growing and evolving over a long period of time. While a full redesign of an existing system may not be possible, small changes may be possible to improve the performance of the system and protection of environmental values. Best-practice design will facilitate best-practice management.

Best-practice design principles for feedlot cattle staging facilities are directly related to the expected intensity of the system. High-intensity systems will incorporate more feedlot design principles, with low-intensity systems incorporating more best-practice grazing management principles. Some facilities may be a combination of both, and this will depend on site-specific constraints and proposed management. There is no 'one-size-fits-all' approach to best-practice design.

Prior to commencing the design or construction of a feedlot cattle staging facility, environmental constraints must first be identified. The protection of sensitive areas such as watercourses with formed bed and banks and native vegetation must be prioritised over operational efficiency considerations like distance to the feedmill or handling facilities. Preventing impacts is more beneficial and cost-effective than resolving issues once they have occurred.

4.1 General

Some best-practice design principles, observed during site visits, are not related to environmental design and management but are valuable to improve operational efficiencies or animal performance.

4.1.1 Enclosure design

The size of the enclosure (pen or paddock) must consider local conditions and whether ground cover targets will be incorporated into ongoing management (i.e. low-intensity systems), or surface preparation and cleaning will be incorporated (high-intensity systems). Stocking densities in one locality or landscape are unlikely to be transferable to other sites. Further, stocking rates or densities at the same facility may have to be varied based on weather conditions. As such, it is not possible to have set stocking rates or limits for feedlot cattle staging facilities.

For operational efficiency and BRD management, the capacity of each enclosure is normally matched to the pen capacities of the associated feedlot. This may be a single pen capacity or multiples of the individual pen capacity. If enclosures are matched to multiples of feedlot pens, stocking density can be scaled back to allow for soil conservation measures without impacting on cattle groupings.

In low-intensity systems, where groundcover management is a key priority, the rotation of cattle or resting of paddocks between use should be considered in the overall design. This allows for the implementation of management concepts from rotational grazing. Based on rotational grazing methods and observations from existing feedlot cattle staging facilities, large paddocks are unevenly used by cattle. This results in an uneven impact on groundcover and faster denudation of high-use areas. The splitting of larger paddocks allows for more even distribution of cattle impacts across the full area combined with resting to encourage the regrowth of groundcover.

Smaller paddocks may require greater investment in infrastructure and increased operational expenditure. The fencing and sharing of a feedpad between two or more paddocks may reduce this expenditure and facilitate cattle rotation (Figure 1).

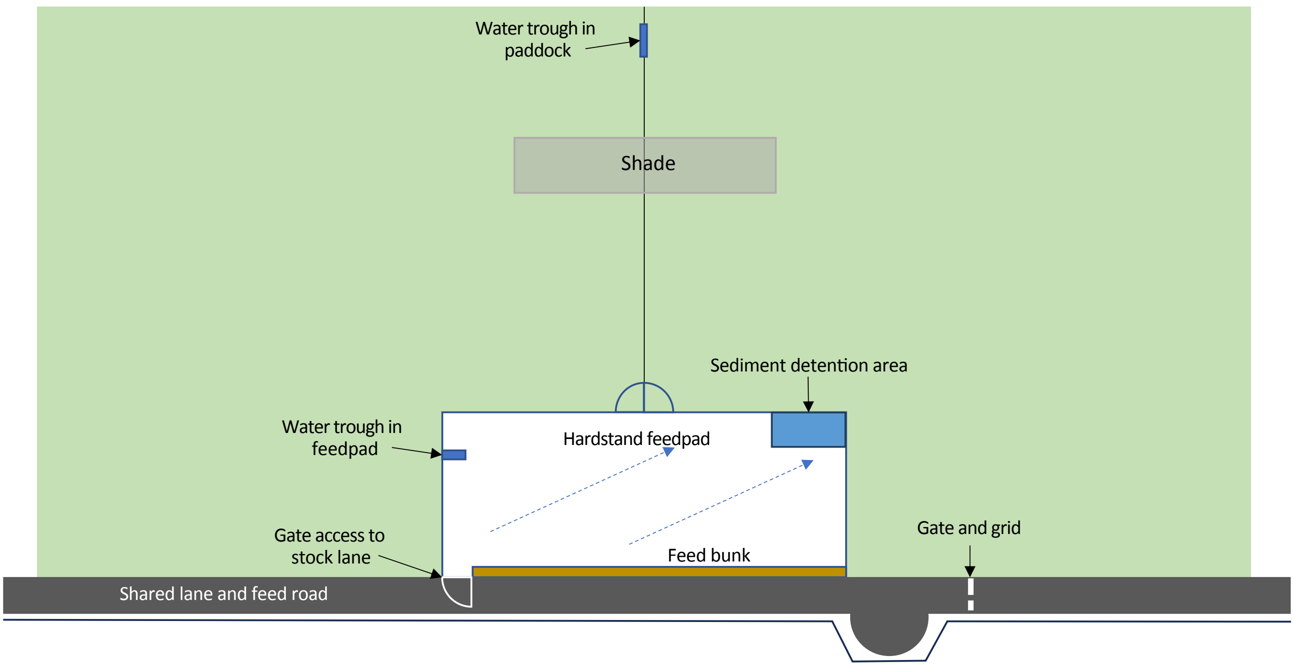


Figure 1: Concept design (not to scale) incorporating a fenced feedpad with sediment detention, split paddocks, constructed shade and a shared feed road and lane with a turning circle

Figure 1 shows one example of an enclosure design with various elements incorporated. However, there are various ways in which a feedlot cattle staging facility enclosure can be designed and alternate concept designs are presented in Appendix A.

In addition to the shared central feedpad, this concept design includes two water troughs, with one within the feedpad and one shared between the two rotational paddocks. This ensures that water can be provided during bunk training, which also attracts cattle to the bunk. Once cattle are bunk trained, the water trough provided in the paddock encourages cattle to make use of the full extent of the paddock.

Shade should be provided within both paddocks, and may be required within the feedpad. Constructed shade is depicted within Figure 1, but natural shade could also be utilised in low-intensity paddocks. Natural shade is not recommended for the fenced feedpad, as it is likely to require a constructed surface (Section 4.2).

This concept also depicts the detention of runoff within the feedpad. However, runoff from this area needs to be managed in accordance with the risk to surface waters. There are various runoff controls which could be utilised in lieu of detention (Section 4.4).

The separation of key infrastructure within the paddocks will also assist in encouraging cattle to use more of the paddock. If shade, water troughs and feed bunks are all co-located, cattle may not use the remainder of the paddock. This is more likely to result in a larger high-intensity area around co-located infrastructure.

The required fence design will vary with the intensity of the system. Like feedlots, steel post and rail fences may be required in high-intensity systems or around high-intensity areas such as feed bunks and water troughs. In low-intensity systems, standard stock fences may be adequate for fencing. Regardless, fencing must be designed to contain cattle with consideration of the varying size of animals that will be fed. This is also important for bunk-rail height.

Like feedlot pens, each enclosure should be clearly signed to facilitate efficient delivery of feed and strong communication between staff (Figure 2). This also assists in developing farm maps, cattle movements, and rotation management.

Figure 2: Clear identification signage on each paddock

4.1.2 Feedpad design

Feedpads are the compacted areas immediately around feeding infrastructure and can be a formed and constructed surface, or an area compacted by cattle. If a constructed surface, they can include a combination of clay, gravel, concrete, or protective mesh. More information on surface preparation is provided in Section 4.2. The feedpad area can consist of a smaller bunk apron or an extended area where cattle congregate prior to or following feeding. Feedpads have been commonplace in dairy systems and design concepts for dairy feedpads are provided in the *National Feedpad and Contained Housing Guidelines* (Dairy Australia and Agriculture Victoria, 2023).

The location and orientation of the feedpad should consider the natural topography and overland flow paths. Utilising natural topography to facilitate drainage away from the feed bunk and pad will reduce the potential for the pooling of water against the feed bunk or apron. This aligns with best-practice feedlot pen design. The adjacent feed road can divert runoff around the pad and stormwater on the pad will flow away from the bunk. To allow flexibility in overall facility layout, bunks aligned parallel with the natural slope will also allow for a free-draining bunk apron. On flat sites, the feedpad may need to be constructed as a raised pad, which slopes away from the bunk.

The construction of a fenced feedpad provides the maximum flexibility for cattle management within the facility. Fencing a feedpad area can limit the movement of cattle to a single point of entry, reducing overall compaction across the enclosure and allowing for maximum groundcover. The denuding of areas immediately around feedpads is likely to occur in all systems, regardless of intensity. Greater deposition of manure around this area will also occur. Fencing a smaller area is likely to intensify the impacts to this area but reduce overall impacts across the paddock. If greater environmental controls are required for high-intensity areas (e.g. surface preparation or runoff controls), the fencing and restriction of these areas reduces the cost of implementing these controls. A fenced feedpad is aligned with stand-off pads which are commonly used in pasture-based dairies to allow for soil conservation and to protect soil structure damage (compaction or pugging).

The fencing of the feedpad allows for cattle to be temporarily locked in this area for bunk training. It also facilitates the rotation of cattle between enclosures. If this is to occur, the stocking density of the fenced feedpad must be considered. The density should be lighter than a feedlot, typically less than half the density. However, improved cattle welfare and performance at lighter stocking densities must be considered against increased costs associated with construction of a larger area. Once cattle are bunk-trained, they will congregate within the fenced area when feed is delivered. This allows for the gate from the current paddock to be closed and the gate to the rested paddock to be opened. Thus, allowing the movement of cattle between paddocks with minimal labour input.

If runoff is controlled, it should be concentrated into a small detention area to prevent the rest of the feedpad becoming wet and odorous. Detention basins are valuable for containing coarse sediment (e.g. manure) and associated contaminants but are less suited to the removal of fine sediments and soluble or suspended contaminants like nitrates (Department of Environment and Science, 2022). The contained runoff can either be evaporated or evenly distributed, following the rainfall event, across a suitable area within the adjacent paddock (e.g. released using perforated lay-flat pipe). Slow-release detention systems may also be suitable. The design of runoff controls is further discussed in Section 4.4.

The design of the feedpad could also incorporate a waterproof (steel or polyethylene) shelter which would provide shade and reduce or remove the need for runoff controls. Although costly, this may provide additional benefits in some climates or landscapes.

Bunk space is a crucial design consideration for animal nutrition and is discussed further in Section 4.6.

Figure 3: Recently fenced feedpad within a larger paddock

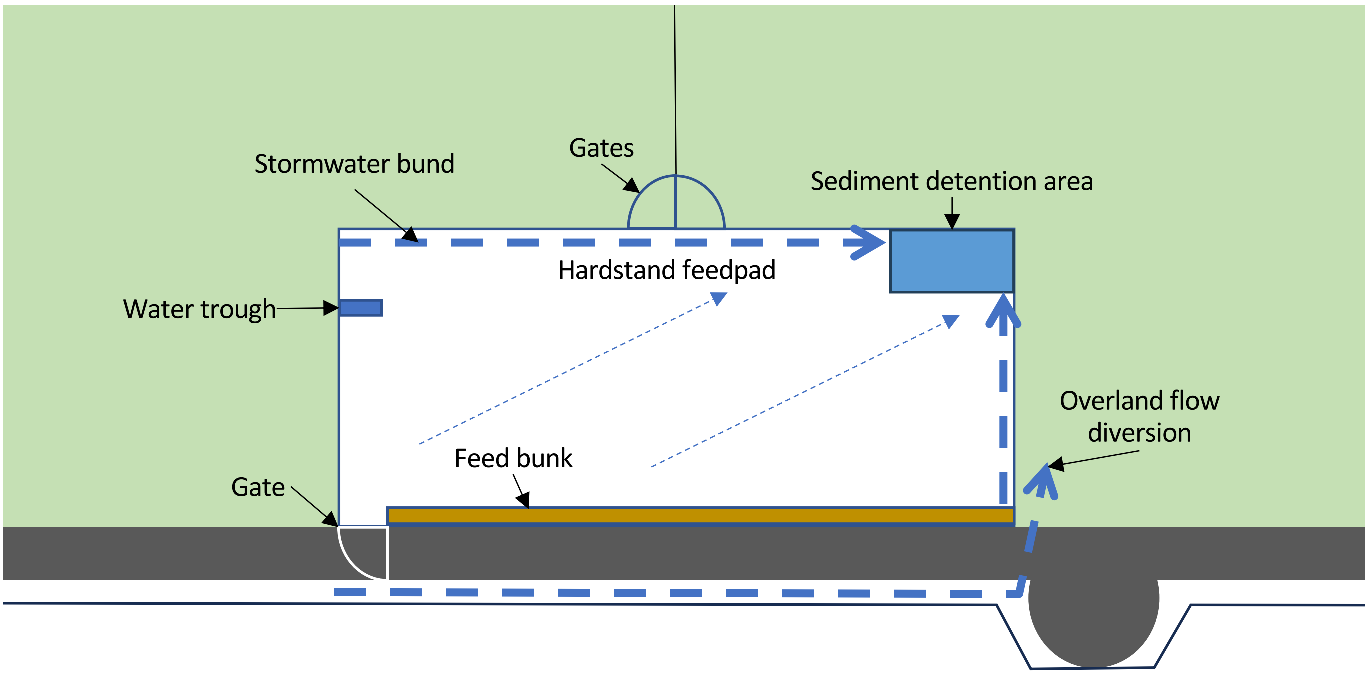


Figure 4: Concept design (not to scale) for a feedpad incorporating runoff diversion and sediment detention

4.1.3 Roads and stock lanes

Road access should be provided to every pen and feeding area. In most feedlot cattle staging facilities, feed roads are also shared with stock lanes. As such, they should be appropriately designed to allow for efficient movement of both feed trucks and stock under all weather conditions. A combination of gates and grids (Figure 5) at specific locations along shared stock lanes and roads will assist in controlling stock movements while not impeding feed truck movements. This includes moving of large mobs of cattle but also ensures that pulled cattle do not wander in the wrong direction before stockpersons are finished inspecting cattle.

Figure 5: Gate and grid to assist in controlling stock movements without impacting feed trucks

As there can often be large distances between feed bunks, it is crucial to have adequate area for feed truck turning at every bunk or group of co-located bunks (Figure 6). If turning facilities are not provided, feed trucks may have to travel long distances until they are able to safely turn around, resulting in greater operational costs. The size of turning circles will depend on the feed truck or wagon used. Turning areas can be constructed in a similar design to feedlot turning circles, or they could consist of a short section of wider all-weather gravel road.

Figure 6: Shared stock lanes and roads designed to allow for feed truck turn around at each bunk. Left: dual feed road servicing bunks on both sides. Right: feed road with one bunk and turnaround at the end of the bunk.

As feedlot cattle staging facilities are often constructed across an entire property, road infrastructure may be located closer than feedlot infrastructure to the property boundary. As the feed roads may be more frequently used than a farm road, roads constructed on or near the property boundary should allow space for vegetative screens to reduce visibility and assist in dust control. The planting and management of vegetation screens is further discussed in Section 5.7 and is dependent on the risk of potential off-site impacts. However, allowing the space for vegetation screens will provide flexibility into the future.

4.2 Separation from sensitive land uses

The assessment of potential odour impacts from feedlots is normally completed using an S-factor assessment or an odour dispersion model. However, due to the low intensity of many feedlot cattle staging facilities, these methodologies may not be suitable.

Until further research is completed on odour emissions from feedlot cattle staging facilities, two conservative approaches to odour impact assessments are recommended. The application of the final assessment methodology should be negotiated between operators and regulatory agencies.

High-intensity systems

In high-intensity systems, paddocks become denuded, and manure accumulation is often identified across large parts of the enclosure (paddock or pen). Stocking densities in these systems are usually higher and they are more closely correlated to feedlot systems than grazing systems.

Although expected to be conservative, the S-factor odour assessment methodology can be used for these systems until further data is available. However, the S-factor method was developed for a minimum stocking density of 25m²/SCU. At lighter stocking densities (>25m²/SCU), the required separation distance may be negative. If the S-factor method is used, a minimum stocking density of 25m²/SCU should be assumed, even if actual densities are lighter.

If feedlot odour modelling is completed, high-intensity feedlot cattle staging facilities may be included as an odour emission source. Expert advice should be sought from a suitably qualified person prior to completing odour modelling for a feedlot cattle staging facility. Generally, each state has a different odour impact assessment methodology, with feedlot odour modelling requiring both a model to estimate manure accumulation and a hydrological model to generate odour emissions data (D'Abreton, 2014). Further, odour emissions in feedlot model calibration were at a stocking density of 15m²/SCU. As such, it may not accurately predict odour emissions from a feedlot cattle staging facility and may be too conservative. Site-specific odour emissions sampling may assist in understanding odour emissions from a high-intensity feedlot cattle staging facility.

Low-intensity systems

Providing localised, high-intensity areas are separated from property boundaries, low-intensity systems are unlikely to emit odour that would be noticeable beyond the property boundary. Research from the free-range pork and meat chicken industries (Banhazi, 2013; Brown and Gallagher, 2015) suggests that odour from those activities is minimal or localised around high-intensity areas. These industries also recommend minimum setbacks from free-range areas to nearby sensitive receptors which range from 250m to 750m depending on the system and receiving environment (single rural dwelling to large town). Although data is not available, it is reasonable to anticipate similar emissions from a low-intensity feedlot cattle staging facility.

Based on a conservative S-factor assessment, the maximum required separation distance for a 500 SCU feedlot is approximately 500m. Achieving this setback between the nearest high-intensity areas (feedpads and water troughs) and nearby sensitive receptors (e.g. dwellings) may mitigate odour and dust impacts with minimal additional design and management controls. It is not intended that this distance be cumulative (i.e. two high-intensity areas would not result in a 600m (120%) distance). If high-intensity areas are within this distance, a site-specific S-factor assessment or additional management practices may be required. In these circumstances, advice should be sought from the relevant regulatory agency, department of primary industries or agriculture, or suitably qualified consultant.

4.3 Surface preparation

As part of the preparation of this best-practice manual, soil samples were obtained from various feedlots with different feedlot cattle staging facilities. Samples were obtained at depths of 0-10cm and 50-60cm at sites adjacent to a feedpad and approximately 50m from a feedpad. One sample was obtained from a site within a shade structure. Although clear conclusions from this data cannot be made, it identified that key soil indicators within high-intensity areas, often used for environmental monitoring (e.g. phosphorous, various forms of nitrogen and electrical conductivity), can be substantially greater than normal agronomic levels.

These preliminary results confirm that surface preparation around high-intensity areas may be necessary to protect soils and groundwater. High-intensity areas may be small, localised areas around feeding systems and water troughs, or they may be whole paddocks/pens if operating with higher stocking densities. This could include the locating of high-intensity areas on low permeability clay soils, or the preparation of a clay, synthetic or concrete liner where in-situ soils cannot provide a low-permeability surface. The *National Guidelines for Beef Cattle Feedlots in Australia* (Meat & Livestock Australia, 2012) and the Feedlot Design Manual (Watts *et al*., 2016) provide more information on the preparation of a clay liner.

The extent of the area with a compacted or low permeability surface is dependent on the design and management of the facility and the hydrogeological characteristics. Surface compaction should not be incorporated in areas where groundcover maintenance is the target management practice. However, compaction of larger areas may be required if reasonable groundcover cannot be maintained during normal condition and operations. As the ground surface of high-intensity systems is denuded, surface preparation will be required across the whole of high-intensity facilities.

In addition to a low-permeability surface, reinforcement may be required in high-intensity areas to ensure these areas remain free-draining with minimal maintenance. Reinforcement could include concrete apron, compacted layer of gravel, grid mesh reinforcement or other suitable protection. The cleaning and removal of manure from these areas should be considered as part of the selected design.

Figure 7: Examples of pad reinforcement. Left: Concrete apron and extended gravel pad. Right: plastic grid mesh reinforcement.

The construction or installation of infrastructure such as feeding systems, water troughs or shade, should include consideration of the natural topography and any changes that may be required to prevent the accumulation of water around these areas. As they are subject to high cattle use, they are also subject to high manure deposition.

4.4 Runoff controls

Specialist advice, from government agencies or consultants, should be obtained before implementing runoff controls as they may require careful planning and design to operate effectively. The following are examples of runoff controls already in use across Australian feedlots, grazing, and farming.

The Queensland Department of Environment and Science Wetland Info webpage for agricultural runoff treatment systems (Department of Environment and Science, 2022) has information on the suitability, design, and management of several runoff controls for agricultural systems. Concepts from some of these controls have been integrated into best-practice runoff controls for feedlot cattle staging facilities. The incorporated concepts have been limited to those already implemented into commercial agricultural operations across Australia.

These are ideas for producers looking to make improvements in managing whole-of-farm runoff. Although they may not be required in all circumstances, the implementation of simple runoff controls is part of best-practice grazing and should form part of best-practice design for feedlot cattle staging facilities. They may also assist in controlling heavy rainfall during or following drought and minimising the transportation of sediment and nutrient into surface waters. The most crucial consideration for runoff controls in feedlot cattle staging facilities is the maximising of groundcover across each paddock. As groundcover reduces, the velocity of overland flow increases and capture of sediment and nutrients decreases, which can lead to erosion of on-site and downstream waterways.

In sandy, free-draining, or flat landscapes, where substantial runoff does not occur from normal farming operations, some of these controls may not be applicable.

4.4.1 Exclusion of high-value waterways

The definition and classification of waterways varies between different states and legislation. Some minor drainage paths may be mapped under legislation but are non-defined pathways where overland flow converges. These may be mapped across existing grazing or farming land and the accuracy of that mapping can vary, particularly if contour banks have been constructed. Other waterways, such as named creeks and rivers, are likely to have a formed bed and banks which are clearly identifiable.

Waterways with formed bed and banks could be impacted by both contaminants within runoff and uncontrolled cattle access. In many circumstances, it is most suitable to design the feedlot cattle staging facility to ensure cattle can be excluded, either permanently or temporarily, from these waterways. Short-term access may be necessary for grass or weed management but should form part of an overarching farm management system. Unrestricted access to these areas, particularly during drought, can cause erosion and damage to the health of the waterway, riparian areas, and downstream catchment.

4.4.2 Controlled drainage area

In high-intensity feedlot cattle staging facilities, the ground surface may become permanently denuded across the full extent of the enclosure. Currently, there is limited data on the impact of contaminants in the runoff from these systems. However, based on the intensity and impact on the soil surface, it is appropriate to consider runoff from this type of system to be closer to feedlot effluent than normal overland flow from a pasture system. Further, preliminary soil sampling data obtained in the completion of this project indicated high nutrient accumulation in high intensity systems, even at a distance from feeding infrastructure. As such, best-practice for these systems is to utilise design principles for a feedlot-controlled drainage area.

Essentially, a high-intensity feedlot cattle staging facility should be designed in the same way as a feedlot. Due to the lower stocking density, but similar potential impacts, this is likely to be very costly on a ‘per head’ basis. The design of a controlled drainage area for a feedlot cattle staging facility will need to be applied to a much larger area relative to the equivalent capacity of a feedlot.

This includes the minimisation of clean runoff entering the controlled drainage area as well as the capture of contaminated runoff in accordance with the design principles in the *National Guidelines for Beef Cattle Feedlots in Australia* (Meat & Livestock Australia, 2012). As the size and intensity of these systems vary, a sedimentation system may not be necessary, but this is subject to site-specific considerations and discussions with the relevant regulator. If a pond or basin is constructed to contain runoff from a high-intensity system or fenced feedpad, it should be constructed to ensure that it can be readily cleaned using an excavator. This may require a narrow width for smaller systems to allow cleaning from outside of the structure. An earthen ramp may be required for larger structures (e.g. effluent ponds).

Should further data become available, alternate runoff controls (below) may be suitable for these systems. Implementation of lesser controls must be subject to rigorous scientific data, a risk-based approach, and ongoing monitoring (Section 5.9).

A controlled drainage area should not be implemented for low-intensity systems as surface preparation would prevent the growth of groundcover. If the system is intended to be a low-intensity system, yet groundcover cannot be maintained, a reduction in stocking density may provide a lower-cost alternative to construction of a controlled drainage area.

4.4.3 Swales

Swales or swale drains are broadly described as vegetated drains used to slow surface water flows and allow for infiltration of water, sediments, and nutrients. Swales can be free-draining and parallel to surface water flows (off-contour), such as those used in urban stormwater settings. Alternatively, they can be constructed with a level base and perpendicular to surface water flows, such as those used in permaculture (on-contour). On-contour swales are intended to slow and detain some water, rather than move it in a certain direction. The overflow point is normally at one end, which directs water into an adjacent watercourse.

Swales can incorporate trees and shrubs, providing non-clumping grass can be maintained. Taller, rigid leaf structures may assist during periods of high flow (Ekka *et al*., 2021). However, poorly located or isolated trees, shrubs, or clumping grasses can result in the concentration of water flows (Prosser and Karssies, 2001), which is counterproductive to the purpose of vegetation filtering. (Ekka *et al*., 2021) provides the most up-to-date and detailed information on swale design. However, this study is targeted to urban stormwater runoff treatment and some aspects may not be applicable to agricultural landscapes. Information from this study is incorporated into the Queensland Department of Environment and Science Wetland *Info* webpage for agricultural runoff treatment systems (Department of Environment and Science, 2022).

Figure 8: On-contour swale with downslope vegetation
Source: Mulloon Institute

4.4.4 Vegetated filter strips

Vegetation filter strips usually consist of strips of non-clumping grass between the cattle staging facility and sensitive areas, where cattle access is minimised to controlled grazing. Strips should be located and designed to run roughly parallel with the natural contours of the landscape (perpendicular to water flows). Preferably, vegetation filter strips are located outside of the area in which cattle are fed to ensure long-stemmed, non-clumping grasses can be maintained. However, additional filter strips, consisting of grasses, shrubs and trees can also be located within the low-intensity parts of feedlot cattle staging facilities. These strips can be combined with swales (above) to provide optimum conditions for water infiltration and tree growth (Figure 8). The deep roots of the downslope shrubs and trees also aid in preventing the infiltration of nutrients into sub-soils and groundwater. In larger paddocks, there may be space for multiple vegetation strips or swales.

A low-cost alternative to planting trees would be to exclude cattle access from specific areas to allow the natural revegetation of the filter strips and tree lines. Restricted grazing of these areas, under expert advice, may facilitate natural regrowth. Such principles are commonly used in regenerative grazing systems. Hydroseeding techniques, used in mine and infrastructure rehabilitation, may also provide a cost-effective alternative to planting of individual trees.

The establishment of vegetation strips within feedlot cattle staging facilities will improve whole-of-farm biodiversity with a negligible reduction, or potential improvement, in on-farm productivity. This may also present opportunities for emerging carbon or natural capital markets.

The establishment of trees and shrubs in feedlot cattle staging facilities needs to be carefully considered to ensure the movements of cattle, vehicles, and stockpersons are not restricted. It can be difficult to move cattle out of large stands of trees with low-hanging branches presenting a safety risk to staff on horseback.

Leaky weirs

Leaky weirs are instream weirs, usually constructed from natural materials, where surface water flows are temporarily detained to reduce flow velocities. They assist in settling sediments and encouraging infiltration of water into soils and groundwater aquifers. They also assist in maintaining vegetation in and along the banks of a waterway. Generally, due to flow depth and velocity, and fish passage regulation, they are more effective higher in the surface water catchment (i.e. low order streams). Depending on state-based regulations, the siting and design of leaky weirs may need to consider upstream and downstream fish passage. The design and construction of leaky weirs requires expert advice to ensure effective operation.

Figure 9: Leaky weir construction
Source: Mulloon Institute

4.4.5 Detention ponds and basins

Detention ponds or basins may be required where small, high-intensity areas are located on landscapes with high convergence or near major creeks and rivers. These structures allow settling of coarse sediments where setbacks and groundcover are unlikely to adequately remove sediment prior to convergence of overland water flows.

As stock dams and detention ponds can attract cattle, resulting in a concentration of manure deposition within or immediately adjacent to waterways, they should be excluded from high-intensity systems where water is provided via troughs.

The capture of overland flow water from low-intensity feedlot cattle staging facilities is not intended to provide an alternate stock drinking or irrigation water source, which may be otherwise restricted by water regulations. Ideally, captured overland flow should be reused on land within the cattle staging facility and not supplement an unrelated farming activity. Water regulations relating to the capture of overland flow will vary between jurisdictions. Further advice should be sought from the local water authority, which may be a catchment authority or a state water department.

Detention ponds and basins can be slow-release systems, where they retain runoff for a short period of time to settle solids, and then passively drain to empty. This may be more suitable for regions where the capture of overland flow is heavily restricted (e.g. Murray Darling Basin). They can also be managed systems where capture runoff is irrigated or evaporated. Both systems are likely to require by-washes or spillways for larger storm events.

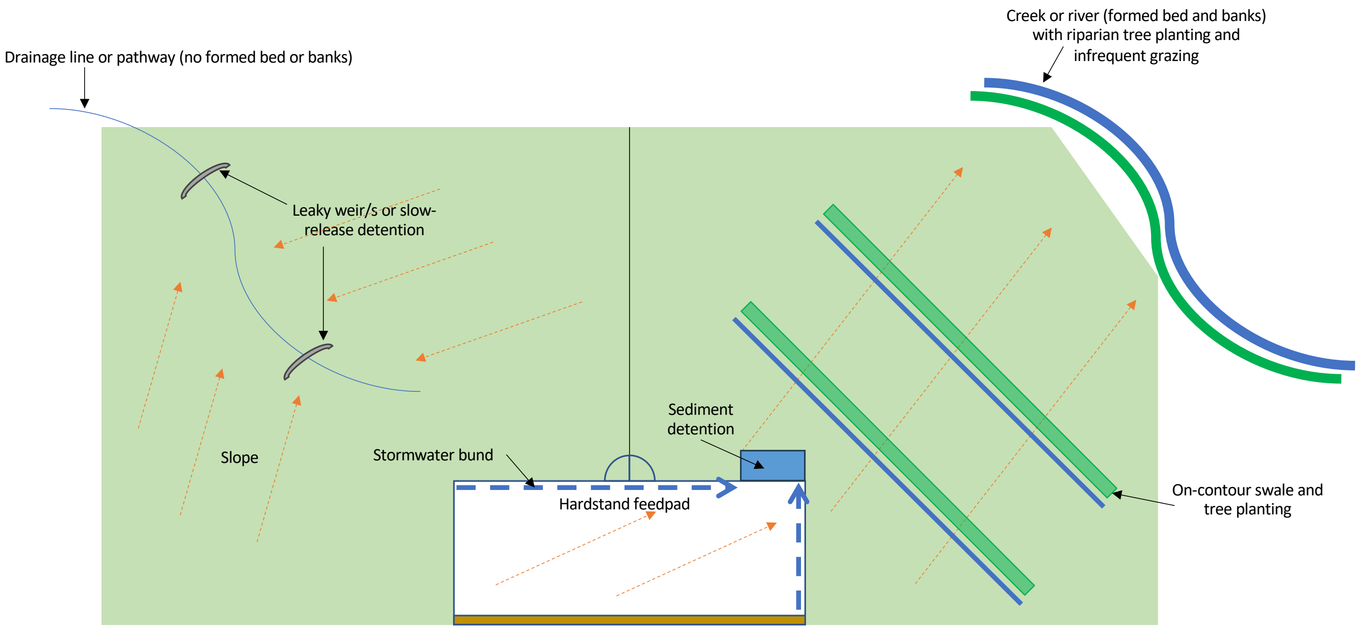


Figure 10: Figure depicting the potential combination of several runoff controls (Note: runoff controls may not be required in all circumstances)

4.5 Vegetation

The maintenance, improvement, and planting of native vegetation is encouraged within low-intensity feedlot cattle staging areas. High-intensity systems may require the clearing of any native vegetation (trees and grasses) to facilitate surface preparation (Section 4.2). However, the location of planted vegetation and species selection must be well-planned, so it doesn't impact on the operation of the facility.

While native vegetation can provide a great form of shade, the overuse of native trees by resting cattle can impact on that vegetation. As such, the temporary or permanent fencing of large areas of trees, or areas of high sensitivity, allows for better management of these areas through exclusion or controlled grazing. The fencing of these areas does not necessarily mean the permanent exclusion of cattle.

The planting of native vegetation will depend on the design of the facility and alternate uses of the land (e.g. cropping within paddocks). The planting of vegetation corridors on a north-south alignment can provide the largest area of shade due to the movement of the sun (Section 4.8). However, this may not be practical if other site constraints require the paddock to be farmed in an east-west direction or if multiple rows of large trees will detract from adjacent cropping operations.

Planned vegetation corridors (planted, retained, or regrown) should be spaced to allow for the simple movement of cattle and stockpersons through the corridors as well as the maintenance of groundcover between the corridors. The planting of vegetation corridors on the outskirts of each enclosure or may provide greater flexibility for activities within the paddock. Vegetation corridors on the property boundary also assist with resolving any potential impacts on visual amenity and improve general aesthetics of the property. They may also assist in reducing dust when planted between high-intensity areas and adjacent sensitive land uses. The planting of native vegetation, commonly found on the landscape is preferred. However, the planting of exotic species may be more suited to some parts of the paddocks as they may be more tolerant of high soil nutrient concentrations.

Planting of individual or small groups of trees may be detrimental to overall soil health and maintenance of groundcover as cattle will congregate around these trees. This is likely to result in greater localised manure deposition and/or compaction resulting in damage to the trees.

4.6 Feeding systems

The use of feed bunks is preferable to self-feeders as the delivery, mixing, and monitoring of feed is more accurate and effective. This allows feed intake to be easily tracked. However, self-feeders may be suitable for many facilities, particularly smaller operations. Using self-feeders makes the daily tracking of feed intake challenging, but can still be estimated over time. The design of feeding systems is similar to feedlots and more information can be sourced from Chapter 19 of *Beef Cattle Feedlots: Design and Construction* (Watts *et al*., 2016).

One key consideration for bunk design in feedlot cattle staging facilities is the large variation in cattle types and sizes that may utilise the facility. The normal position of the bunk rail or cable on feedlot bunks may be too high for young cattle, resulting in cattle frequently escaping from the pen or paddock. However, a low rail or cable may be too restrictive for larger cattle. As such, some feedlot cattle staging facilities have implemented adjustable bunk rails or cables. The height can be adjusted to ensure that cattle cannot escape, but are also not restricted from accessing the bunk. However, the system must be simple and easy to use, as complex or difficult adjustments will result in a permanent position for the rail or cable. This then defeats the purpose of the adjustable system.

Figure 11: Adjustable bunk cable system

The bunk space provided for each animal should be, at minimum, the same as is provided in a feedlot (250mm to 300mm per head). However, as cattle within feedlot cattle staging facilities are often new to bunk feeding, additional space is recommended to allow greater opportunities for shy-feeders to access the bunk. However, reduced bunk space can be managed through more frequent feed delivery. The bunk space allowance should account for the maximum number of animals that will be held in that enclosure. For example, if the feedlot cattle staging facility will be temporarily used for drought feeding cattle in larger numbers, then bunk space should allow for future drought events. This may result in greater bunk space, per animal, during normal operations.

The location of feeding infrastructure will vary depending on the priorities of the facility. Bunks installed into the fenceline allow for greater operational efficiencies as feed trucks can deliver feed without opening and closing gates. However, feed bunks within the pen allow cattle to eat from both sides of the bunk. This increases the practical bunk space, per head, at a lower capital cost. Like bunks, self-feeders can be located on fencelines to facilitate feed delivery from outside the enclosure. Alternatively, they may be located within the enclosures.

Figure 12: Bunk located in the paddock allows for access from both sides

Bunk training should be considered in the design of the facility and may minimise operational inputs. In large paddocks, new cattle may prioritise grazing over bunk feeding. As the main priority for feedlot cattle staging facilities is to prepare cattle for feedlot entry, it may be detrimental for cattle to obtain all their intake from grazing. The design of a fenced feedpad (Section 4.1.2) will simplify the management of bunk training. Such a system, where enclosures are split into smaller cells near the feed bunks, is implemented at two of the feedlots visited in the preparation of this manual. Bunk training was specifically identified as a key reason for this design selection.

Figure 13: Example of a bunk and rail system with a constructed feedpad

4.7 Water supply

As a rough estimate, cattle drink approximately 5L of water for every 50kg of liveweight. However, water intake can vary significantly due to temperature, time of day, feed intake, and the weather. Feedlot cattle staging facilities do not have the same water needs as a feedlot, particularly as troughs are likely to be cleaned less frequently and there are no other cleaning activities (e.g. cattle washing or hosing of concrete surfaces). Davis, Wiedemann and Watts (2008) identified that, on average, cattle in a feedlot drank an average of 40L/head/day with a peak of up to 75L/head/day. As cattle in a feedlot cattle staging facility are likely to be, on average, smaller than feedlot cattle, these estimates are likely to be conservative.

Best-practice for water supply infrastructure within a feedlot cattle staging facility is to provide one or more troughs to each enclosure. While stock dams can provide water supply, the reliability of this water supply is low. Further, unrestricted cattle access to stock dams can cause compaction and erosion around the dam and direct deposition of manure into the water. This also minimises the potential for cattle to become stuck in mud in or near the dams.

By design, stock dams are usually located along minor drainage pathways. As such, impacts to these areas can result in further impacts to sensitive environments downstream. One of the facilities visited during the preparation of this manual had identified this as a concern and was in the process of reconfiguring their paddocks to exclude cattle access to most of their dams. In this situation, their stock dams also provided the water supply for the adjacent feedlot as it is permitted under the local catchment regulation.

When considering the design of feeding systems (Section 4.6), the location of the water point is equally important as the size or number. To encourage animals to the bunk or self-feeder it is important that the water source is located nearby. If the water source is located towards the rear of the enclosure and away from the bunk and/or self-feeder, shy-feeders are encouraged away from the feeding area. However, if the water source is located near the feed source, then cattle are more likely to go from water to feed and vice versa.

However, where the feedlot cattle staging facility implements large, single cell paddocks, co-locating feeding systems and water toughs discourages cattle from using the remainder of the paddock and concentrates impacts in the one area. Locating the water trough and feed bunk on the same extended feedpad may assist in managing the environmental impacts of cattle manure deposition and traffic.

The fencing of the feedpad area is likely to resolve the conflicting issues of shy-feeders and concentrated impacts. If the feedpad is fenced, a water trough can be placed within the fenced feedpad with an additional trough in the adjacent paddock/s. The provision of a water trough in the fenced feedpad will reduce issues with shy-feeders. The provision of a second water trough at a distance to the feedpad will encourage cattle to use more of the paddock, which will distribute the associated impacts (compaction and manure deposition) across a larger area, but at a lower intensity.

If troughs are utilised, space per head should align with, or exceed, trough space in the feedlot. Chapter 20 of *Beef Cattle Feedlots: Design and Construction* (Watts *et al*., 2016), provides detailed information on trough design. A minimum of 25mm/head and up to 75mm/head is recommended during hot conditions. Trough space per head can be adjusted by reducing stocking rates. However, as drought feeding within feedlot cattle staging facilities can result in a higher stocking density during hot weather, each enclosure may need excess trough space during normal operations.

As the emptying and cleaning of these troughs will be required, the discharge from the water trough should be located or designed to minimise the potential for water to pool around the water trough. In many cases, natural slope will be adequate. However, if water trough sites are flat, short sewer lines or formed drains may be required to drain water discharge or overflow away from the trough area.

The design of water troughs is like feedlots and more information can be sourced from Chapter 20 of *Beef Cattle Feedlots: Design and Construction* (Watts *et al*., 2016). Trough aprons, constructed with concrete, compacted gravel, and/or mesh reinforcement are recommended. This will reduce potholes from cattle resulting in the pooling of water around the trough.

4.8 Shade and shelter

Although shade may not be mandatory, it is recommended to provide adequate shade and/or shelter to cattle in a feedlot cattle staging facility, regardless of intensity. Shade provisions in feedlots vary from $2m^2$/head to $6m^2$/head. Shade targets for feedlot cattle staging facilities should be similar or greater than those provided in the feedlot. However, unlike feedlots, natural shade from trees can be utilised in low-intensity operations.

However, isolated trees are unlikely to provide adequate shade for the number of cattle within the paddock. Further, the concentration of cattle around the base of trees can concentrate the impacts from those cattle. Impacts include compaction of the soil, deposition of urine and manure, or the rubbing of cattle against the tree trunk. If natural shade is to be relied upon, it should be adequate to ensure that the subsequent use of these areas by cattle does not result in irreversible damage to the trees. Exotic species may be more tolerant of these conditions than native species and may be more suited for shade. Some of these issues can be resolved through management practices and the provision of supplementary constructed shade or shelter.

Like isolated trees, inadequate or a single constructed shade area can also result in a high-intensity area and concentration of manure deposition. Shade should be located as far as possible from other high intensity areas such as water troughs and feed pads. Where possible, shade should be constructed in a north to south orientation to maximise the movement of the shade across the ground. This aligns with best-practice design for feedlot shade structures. More information on shade design can be sourced from Chapter 16 of *Beef Cattle Feedlots: Design and Construction* (Watts *et al*., 2016).

Figure 14: Constructed shade with a north-south alignment

4.9 Treatment facilities

As feedlot cattle staging facilities are often spread across large areas and may be distant from the adjacent feedlot, walking sick or poor-doing animals back to the feedlot hospital may be detrimental to their recovery. To resolve this issue, two of the facilities visited during the preparation of this document had implemented several small treatment and observation pens. One facility had several of these pens across the extent of the feedlot cattle staging facility. A third facility identified that they will be looking to implement similar treatment pens in the future. This third facility already has a dedicated hospital for their feedlot cattle staging facility but the distance to this facility is over 2.5km from the furthest paddock.

Both treatment facilities were designed to hold individual or very small groups of animals.

Each treatment pen had water troughs to ensure water was always provided to cattle. Feeding systems were not in place at the time of the visit as the pens were empty. Hay racks and other portable feeding equipment would be in use when cattle are being held in these pens for extended periods.

The use of these pens varied, with one facility prioritised for short-term use to allow cattle to have a break from the intensity of establishing new social structures. The small pens allowed for less dominant cattle to have non-competitive access to feed. Whilst personnel access was considered in this design, another site had included a simple race and crush to allow for more extensive animal health care procedures. Both facilities allowed for closer observation of individual cattle. Like most cattle yards, these facilities must be designed with consideration of both animal and staff welfare. Additional shade could also be provided in these pens if cattle are held for extended periods.

Figure 15: Two examples of small treatment or observation pens located adjacent to feedlot cattle staging facility enclosures

5 Management

Whilst the design of a feedlot cattle staging facility will enable optimum cattle performance and environmental protection, the management of the facility must be flexible enough to adapt to the differing landscapes across the property. As much as reasonably possible, it must also consider any changes to the weather and market drivers that may occur across the lifetime of the facility.

Generally, set stocking rates are not suitable within low-intensity feedlot cattle staging facilities unless the enclosures are subject to long rest periods. Like rotational grazing systems, groundcover is dependent on a combination of stocking rates, soil type, plant species, and rainfall.

5.1 Management plan

The management of feedlot cattle staging facilities must adapt to changes in weather and market drivers. Having a plan for the management of these facilities will assist in quick and effective decision-making into the future, particularly when staff changes occur following the development of the facility. It is intended that management is periodically reviewed and continually improved based on recent experience.

It is essential to develop a management plan for each facility which identifies whether the system will be high-intensity, with associated design controls, or low-intensity with clear groundcover targets driving management. This decision needs to be made prior to construction of the enclosures and failure to achieve adequate groundcover may result in unexpected compliance action and the need to retrofit costly design measures, such as surface preparation and a controlled drainage area, to large areas. These facilitates may also require additional approvals, which can be more difficult once the facility is constructed as minor changes can be costly. Figure 15 provides a framework to assist in making early decisions on design and subsequent management to minimise the potential for environmental impacts or costly reconfigurations.

If groundcover targets are established, it may be necessary to reduce stocking rates during dry periods when demands on the feedlot industry production capacity can be highest. Alternatively, active rehabilitation measures must be implemented to ensure at least 50% groundcover in each enclosure is achieved following drought.

The management plan should include a farm map identifying each enclosure (pen or paddock), location of key infrastructure (roads, fences, feed bunks, water troughs, shade, etc), relevant environmental monitoring points (e.g. soil sampling sites), and environmental constraints such as waterways, floodplains, and native vegetation. Known underground infrastructure should also be mapped to assist in problem solving (e.g. leak detection) and planning of future infrastructure. This map should be developed using a digital mapping platform, ideally with the ability to import data from government databases or other programs.

A database or spreadsheet should be developed to track key information for each paddock including variable stocking rates, bunk and trough space allowances (varied based on cattle numbers), groundcover observations, actions completed, and further actions required. Depending on regulatory definitions, it may also be necessary to track feed intake from the ration and estimate feed intake from pasture.

A Microsoft Excel record template has been developed and is available on the MLA website and ALFA Feedlot Tech website.

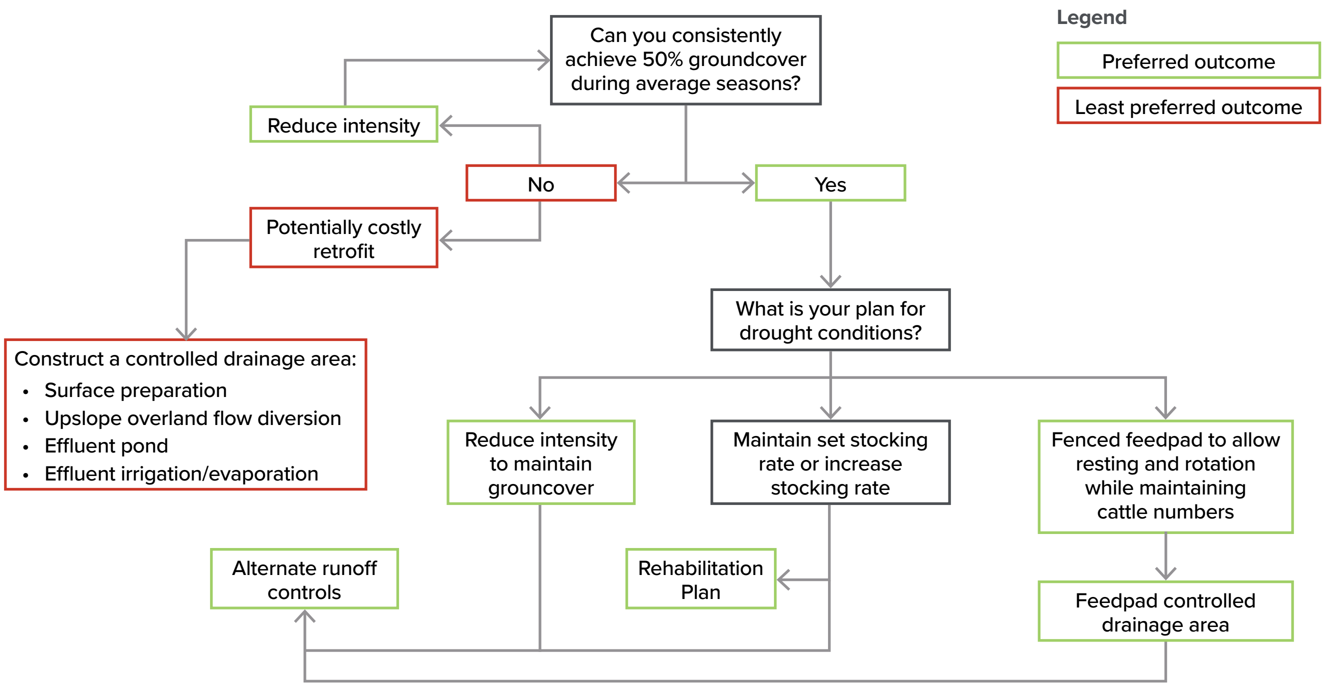


Figure 16: Management decision-making framework

5.2 Manure management

The rate of manure deposition will vary significantly between different facilities and based on the long-term occupation of enclosures within facilities. Nutrient mass and composition will also vary depending on feed intake and sources of feed, being grazed or supplied ration. Further, the deposition of manure across the enclosure is unlikely to be even, particularly in larger paddocks. A nutrient budget method is described in Section 6.2.

The cleaning of manure from high-intensity areas around bunks, water troughs, and shade may be required in some low-intensity systems. However, the regular cleaning of manure is likely to be required in high-intensity systems. Soil sampling and analysis, undertaken as part of this project, indicated that soil nutrient concentrations were beyond normal agronomic levels in high-intensity areas.

Figure 17: Cleaning of accumulated manure

Best-practice manure management will be dependent on the intensity of the feedlot cattle staging facility. In high-intensity systems, manure cleaning may be required at a similar frequency to feedlot pens (at least every 13 weeks). However, in low-intensity systems, where high-impact areas are limited to the area immediately surrounding feed bunks, cleaning may be required once a year, or only required when accumulation is observed. Essentially, manure cleaning should be outcome-based (i.e. no arbitrary or minimum cleaning frequencies) to ensure that the formation of a manure pack does not occur within any part of the enclosure.

The rotation of infrastructure such as water troughs, feeders and shade or shelters is often identified in best-practice management for other industries such as free-range pork and poultry operations. In theory, this would allow for a more even distribution of nutrients across a larger area. These nutrients could then be removed by a resting and cropping rotation. Such a system may be suitable for small, low-intensity feedlot cattle staging facilities. However, the labour and record-keeping required to complete this effectively is likely to result in sub-optimal results.

The cost of moving infrastructure within each enclosure, at the frequency that would be required, is likely to result in portable or relocatable infrastructure being kept in the same location for extended periods. Further, it requires large parts of the facility to be within the resting/cropping phase for a long time, resulting in the inefficient use of land and infrastructure investment. Ultimately, it is unlikely that the even distribution and sustainable removal of nutrients would occur. This method of nutrient management within low-intensity systems is unlikely to be practical for implementation. Such a management system should not be relied upon for nutrient management without a thorough soil monitoring program.

If constructed, runoff detention structures, such as detention basins, swales, or leaky weirs, are also likely to require maintenance and/or removal of sediment. The cleaning or maintenance of these systems should be completed based on their design criteria. However, they should be periodically inspected to identify any maintenance issues.

A US study (Netthisinghe *et al*., 2013) investigated the distribution of nutrients in a paddock under similar operating conditions as a feedlot cattle staging facility. The layout of the enclosure in this study included a fenced feedpad area and adjacent low-intensity paddock. The results identified that all contaminants (nutrients, bacteria, and veterinary pharmaceuticals) were highly concentrated around the feeder area and approximately 5–10 times higher than other parts of the lot. Generally, this aligned with the results of soil sampling obtained as part of the preparation of this document.

This suggested that subsequent management plans should focus on these concentrated areas. A follow up project (Netthisinghe *et al*., 2015) identified that manure removal had the greatest impact on soil nutrient concentrations. Long-term destocking was useful for the reduction of Nitrogen-based compounds (volatilisation or leaching may have contributed) and hay harvesting was marginally beneficial for the reduction of soil nitrogen and phosphorous.

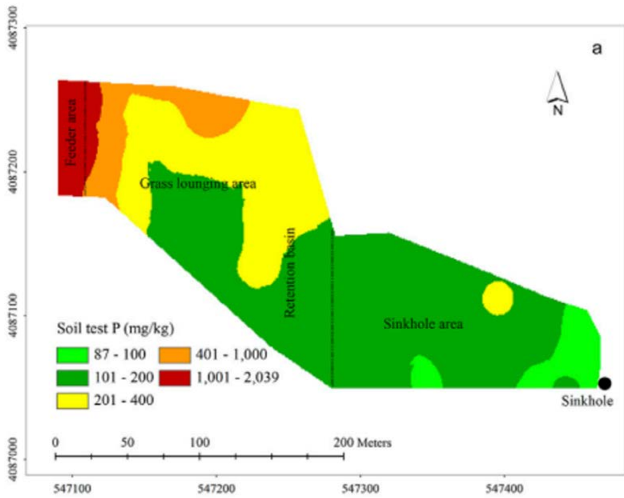


Figure 18: Distribution mapping of phosphorus in Netthisinghe *et al*. (2013)

5.3 Mortality management

As most feedlot cattle staging facilities will be located adjacent to a feedlot, it is likely that the location for the management of mortalities from the feedlot cattle staging facility will be on the feedlot manure or composting pad. Although composting is preferred, smaller feedlots or feedlot cattle staging facilities may utilise burial for carcass disposal. Regardless of the location, mortality management for a feedlot cattle staging facility should align with the practices in the National Guidelines for Beef Cattle Feedlots in Australia (Meat & Livestock Australia, 2012) and Chapter 4.6 in the Handbook of Best Practice Guidelines for the Australian Feedlot Industry (Meat & Livestock Australia, 2021).

5.4 Groundcover

The management of ground cover and vegetation is one of the most crucial aspects of best-practice environmental management for feedlot cattle staging facilities. Further, many regulatory constraints, such as the distinction between grazing and a feedlot, are influenced by or dependent on groundcover and the potential intake of feed from pastures.

Well-managed groundcover, combined with setbacks from sensitive environments may be adequate to achieve the necessary protection of environmental values for low-intensity systems. Best-practice grazing management documents identify a groundcover cover target of between 5% and 70% for flat to gently sloping (<10%) landscapes. Some regulatory agencies may also have specific targets. If steep landscapes are used as part of the feedlot cattle staging facility, groundcover should be maintained at 100% across the paddocks as these areas are at increased risk of erosion and impacts from runoff containing sediment and nutrients. It is also recommended to maintain 100% ground cover in and around drainage lines, minor water courses, or any area where erosion is observed. These groundcover targets are applicable to permanently stocked paddocks and consideration must be given to the opportunistic use of cropped areas (e.g. stubble grazing). However, any necessary soil conservation practices should already be implemented in cropped paddocks.

Stocking rates, paddock resting, and rotation should be managed based on the soil types, weather conditions, and sensitivity of the surrounding environment. This means that, to ensure ground cover is appropriately managed, stocking rates will have to be varied to match the soil types and/or current weather conditions. Set stocking rates may result in inadequate groundcover as weather conditions change. If portable feeding and watering equipment (e.g. self-feeders) is used, these can be rotated to allow high-intensity areas to be rehabilitated.

Optimum groundcover types will vary between soil types, regions, and climatic zones. However, where possible, species diversity should be encouraged with a mixture of palatable and non-palatable species. Ideally, one of the selected species should have a tap root, with another species being a nitrogen fixing legume. The inclusion of non-palatable species assists in maintaining groundcover as cattle will preferentially graze palatable species. If the intention of the feedlot cattle staging facility is to provide most or all feed from a provided ration, it may be beneficial to have more non-palatable species than palatable species as cattle may be less likely to overgraze the paddock.

As the distribution of manure across a paddock is often uneven, it is reasonable to utilise manure cleaned from the adjacent feedlot or high-intensity areas across the broader paddock. Additionally, to ensure proper soil nutrition for optimum plant growth, the application of mineral fertilisers may also be necessary. As with grazing systems, the spreading of fertiliser should be conducted following soil testing and under the advice of an agronomist.

Figure 19: Mixed-species groundcover maintained across a low-intensity, sloping paddock

Once bunk trained, cattle are likely to congregate around feed infrastructure, water troughs and shade. As this can result in concentrated impacts in these areas, other infrastructure can be used as a 'point of interest' to attract cattle away from these areas. Points of interest could include old water troughs or feed bunks, large stands of trees, portable shelters, raised mounds, bales of straw/hay, or old fence posts for cattle scratching. Locating points of interest near sensitive environments (drainage lines, waterways, or native vegetation) should be avoided.

These points of interest need to be carefully considered during the bunk training phase as cattle need to be encouraged to come to the bunk for feed. At one of the sites visited, it was observed that a disused water trough and adjacent contour bank showed signs of high cattle use. These areas were on the opposite side of the paddock to the feed bunk, shade, and water trough. At the same site, it was observed that cattle were attracted to the raised embankment of a small stock dam as a resting area (Figure 19), even though it did not provide an adequate drinking water source. However, the use of stock dams, located on substantial watercourses, as points of interest or for drinking water supply is not recommended as this will concentrate nutrient deposition near watercourses. Stock dams may also present an animal welfare issue with the potential for cattle to become trapped in mud.

Further research is required to understand cattle behaviour and movement patterns within feedlot cattle staging facilities as they are likely to be linked to cattle performance and environmental management.

Figure 20: Stock resting away from high-intensity areas on the embankment of a small stock dam

5.5 Native vegetation

Native vegetation, particularly native trees, may be located within the feedlot cattle staging facility. However, this vegetation needs to be managed to prevent degradation from cattle impacts. Some regulatory agencies may require the permanent exclusion of cattle from some sensitive vegetation. This may be through stocking rate management or fencing, either temporary or permanent. High-intensity areas should not be located within or immediately adjacent to downslope native vegetation. If the enclosure is to be used as part of a high-intensity system, the clearing of vegetation will be required for surface preparation. Relevant clearing restrictions must be considered and the design of a feedlot cattle staging facility should follow the general principles of first avoiding, then minimising clearing. Consequently, these systems should only use constructed shade.

The management plan should identify a trigger for the temporary exclusion of cattle from native vegetation, particularly during extended dry periods. This trigger should be based on periodic observations of cattle damage from rubbing, compaction of the soil surface, or accumulation of manure around trees.

Figure 21: Native vegetation regrowth within a low-intensity paddock

5.6 Odour

Whilst setbacks are likely to minimise the risk of odour impacts on nearby sensitive receptors (Section 3.1.1), the management of high-impact areas, which are likely to have the greatest emissions, is also important. As odour is generated by microbial activity associated with the combination of manure and moisture, the management of these two contributing factors is most important for odour reduction. Where possible, surfaces in high-intensity areas should be maintained to prevent potholes and wet spots to ensure that they are free-draining. This is likely to include the cleaning of manure and maintenance of a uniform slope on the surface.

Section 5.2 provides more information on manure management and the associated reduction in odour emissions.

5.7 Dust

As dust emissions are related to dry, loose surface material from exposed soil, dry manure, or road surfaces, the management of these key areas, will ensure off-site dust impacts are minimised. As with odour, where setbacks are unlikely to completely mitigate dust impacts, additional management may be required. The need for additional management practices is highly dependent on-site selection and design. If there are no off-site sensitive receptors near the feedlot cattle staging facility, additional dust management practices may not be required.

The watering of unsealed roads and maintenance of the surface (e.g. grading) is likely to provide adequate controls in most situations. In some instances, where there are sensitive receptors in close proximity to an internal road, the sealing of a short section of road may be required. Vegetation screens between the road and neighbouring dwelling will also reduce dust impacts, but increased road watering and maintenance frequency may be required until vegetation is established. Vegetation screens should be wide enough and appropriate species selected to provide dense, multi-storey vegetation. Advice should be sought from the relevant authority or suitably qualified person to design such a vegetation screen. Once planted, the vegetation screen may require watering until establishment or the replacement of plants which have died.

In some high-intensity systems, the stocking density results in exposed soil but is inadequate to form a manure pack like a feedlot. As such, dust from these systems may be worse than a feedlot. Sprinkler systems may be necessary if off-site dust impacts at a sensitive place are observed or expected.

5.8 Noise

As per Section 3.1.3, minimal noise emissions from feedlot cattle staging facilities, unrelated to feedlot activities (e.g. feedmill or cattle loading/unloading) are limited to vehicle movements and cattle loading or unloading directly associated with the feedlot cattle staging facility. Appropriate management practices must also consider the distance to sensitive environments which should be identified as part of the site selection (Section 3) and design process (Section 4).

Simple management practices such as a restriction of operations to reasonable operating hours, enforcement of appropriate speed limits on internal roads, and road maintenance, should achieve the amenity expectations for sensitive receptors and/or the necessary restrictions under relevant noise legislation.

Speed limits on internal roads and maintenance should be aligned with the road surface (bitumen, gravel, etc) and subject to site-specific considerations. As such, it is not appropriate to apply broad recommendations. Further monitoring and research are required to accurately determine noise emissions from feedlot cattle staging facilities and how they relate to broader feedlot noise.

5.9 Environmental monitoring

The need for ongoing environmental monitoring (soils, surface water, groundwater, etc) will be based on the requirements of the relevant authority, conditions of the associated feedlot approval, and a site-specific risk assessment. Advice should be sought from the relevant authority or suitably qualified person to confirm the risk and design of a monitoring program.

Best-practice for environmental monitoring is to implement a monitoring program which can be used as an indicator of overall performance. Figure 21 depicts an example of a best-practice environmental monitoring program with potential locations for soil, groundwater and surface water monitoring points. Whilst soil sampling can be undertaken in an individual paddock with minimal consideration of surrounding land use, any surface water or groundwater monitoring programs should be designed to consider different uses on and adjacent to the property. In most cases this will include the feedlot, associated waste utilisation areas, and any conditioned monitoring requirements.

5.9.1 Soils

The monitoring of soil nutrient concentrations in a ‘representative paddock’ will assist in guiding decision-making and continual improvement. The representative enclosure/s should be subject to the most frequent use and is likely to be a ‘worst-case scenario’. If the intensity or operation of the feedlot cattle staging facility varies across different enclosures, with some low-intensity and some high-intensity systems, two or more representative enclosures should be included in the soil monitoring program.

Each representative enclosure should include at least two sampling sites, one near the bunk (within a few metres of the apron), and one at a distance to the bunk which would reflect the management of most of the enclosure area. Samples should be obtained from at least two depths which show topsoil concentrations (e.g. 0-10cm) and a depth that shows the potential for leaching below the root zone (normally 50-60cm). Laboratory analyses should align with monitoring requirements for effluent utilisation areas, which generally include a standard agronomic suite plus all forms of Nitrogen. Other analytes or laboratory calculations may also be required. Annual monitoring is standard practice for effluent utilisation areas and is appropriate for monitoring trends in nutrient concentrations within feedlot cattle staging facilities.

Whilst the sampling is recommended for environmental monitoring, the topsoil analyses can also be utilised by agronomists to inform groundcover management practices to maximise growth. It is reasonable to expect that, in low-intensity areas, some fertiliser application may be required for optimum plant growth.

5.9.2 Surface water

If surface water monitoring is a requirement of the associated feedlot licence or approval, it is reasonable to consider the location and intensity of feedlot cattle staging facilities, and their potential impacts, in the selection of upstream and downstream monitoring locations. The selection of sampling sites should also consider the convergence of waterways and the contribution of these waterways, and land use within their upstream catchment, to overall water quality.

There are default guideline values for freshwater systems defined as part of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines). However, the Water Quality Management Framework, within these guidelines, provides a framework for local, catchment, or state authorities to derive their own water quality guideline values. Many of these guideline values are catchment-wide targets and benchmarks, but not necessarily site-specific thresholds.

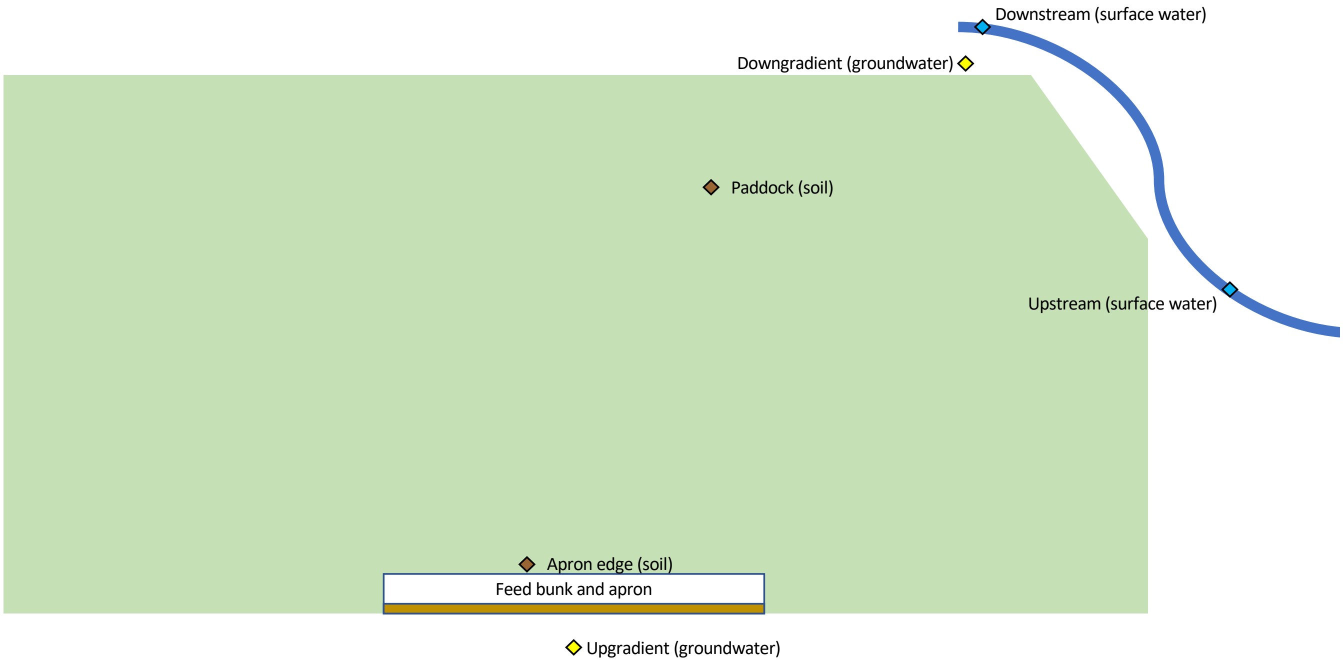


Figure 22: Example of a best-practice environmental monitoring program

Sampling may also be requested by a regulatory authority if they reasonably suspect impacts are occurring because of the feedlot cattle staging facility. If there is a negligible risk to surface water, or sampling of watercourses cannot adequately consider the potential impacts of other activities, surface water monitoring may not be suitable.

Due to the changing flow characteristics for watercourses, the timing of sampling, formation of a baseline, and comparison of data should be subject to advice from a suitably qualified person. Whilst subject to expert advice, surface water monitoring should occur quarterly, with samples obtained from flowing water. Once water quality is understood, it may be reasonable to reduce the frequency.

As flow characteristics will change between events, downstream water quality should be compared to upstream water quality within the same sampling event. A comparison of each sampling site to historic results will assist in identifying variability but is not appropriate to track changes in environmental performance. The relative change between upstream and downstream water quality is a more accurate representative of changes to impacts related to on-site activities. A best-practice feedlot cattle staging facility should have no negative impact on surface water quality. In fact, the exclusion of cattle from waterways and implementation of runoff controls may improve surface water quality over time.

Further, the sampling of surface water should be conducted with consideration of the water flows. Water sampling should not be based on a specific date but aligned with an appropriate flow event within a sampling window. Sampling during high-flow events, should only be undertaken where staff safety allows.

Laboratory analyses should include key indicators, which can be related back to nutrient deposition. Most laboratories have standard analytical suites, which may need to be combined to obtain the required data. Analytes should include, but are not limited to:

- pH
- electrical conductivity
- various forms of nitrogen (total nitrogen, nitrate nitrogen, ammonia, total kjeldahl nitrogen)
- total phosphorous
- suspended solids
- sodium and sodium adsorption ratio
- chloride.

The following approximated trigger values are identified in the superseded ANZECC guidelines:

- total nitrogen – 200–400µg/L
- total phosphorous – 10–50µg/L
- PH – 6.5–8.0
- electrical conductivity – 50–2,000µS/cm
- suspended solids – 5–25mg/L.

However, many rural catchments and waterways are likely to already exceed these values and, as per above, a site-specific comparison to background quality is mor appropriate.

Whilst analysis for pathogens, like *E. coli*, is common, pathogen levels naturally fluctuate in water systems and may not be indicative of impacts from the feedlot cattle staging facility. Sampling and transport of samples for pathogen analysis is also complex and subject to error.

5.9.3 Groundwater

As with surface water, groundwater monitoring should consider broader property activities and conditions of the feedlot licence or approval. If a groundwater monitoring program is a requirement of an associated feedlot, it should consider potential impacts from the feedlot cattle staging facility. The need for a groundwater monitoring program is ultimately decided by a regulatory agency, but should be based on the risk to groundwater, which is influenced by the depth to groundwater and the overlying material (Section 6). Any groundwater monitoring program should be designed by a suitably qualified person.

Having at least two, preferably three, piezometer locations is best practice. Installing two piezometers allows for a comparison of upgradient and downgradient water quality. The third bore will allow for the accurate determination of directional gradients and changes in standing water levels. Groundwater gradients occur based on natural flows but are also influenced by other influences such as extraction rates or leaking water storages.

If groundwater monitoring is implemented, monitoring frequency and laboratory analyses should align with feedlot monitoring requirements. Generally, sampling frequency on environmental licences can vary from quarterly to annually. Best-practice is to undertake sampling quarterly until the nature of the groundwater gradients and quality is better understood. Frequency can then be reduced to half-yearly or annually. Key indicators, like those identified for surface water analysis (above), may be adequate to provide simple information to guide decision-making.

5.10 Animal health and welfare

As one of the main benefits of feedlot cattle staging is the socialisation of animals, it is important to keep groups of cattle within the feedlot cattle staging facility aligned with the capacities of the feedlot pens. As well as socialisation, this is important for BRD management as the splitting of cattle from one enclosure into feedlot pens with cattle from other sources may negate some of the BRD management benefits from the time spent in the feedlot cattle staging facility. (Barnes *et al*., 2015) suggested that short comingling periods of less than seven days increases the risk of BRD in the feedlot, regardless of the number of cattle sources. Based on this, it is recommended that cattle are held in staging facilities for at least 14 days after the last animal has joined the group. If capacities are adjusted to manage groundcover, they should continue to reflect multiples of the feedlot pen capacity.

Although cattle are adept at finding feed and water, in larger paddocks, walking cattle directly to feeding infrastructure and water troughs upon entry to the cattle staging facility may result in a quicker acclimatisation to the facility. This, in turn, may help maintain condition and improve rehydration of cattle following transport.

Good stockmanship is crucial for building trust and confidence in the cattle which will encourage them to eat and drink. This should include 10–15 minutes of positive interaction with cattle every day for the first three to five days. Once trust and confidence has been achieved, cattle will be more willing to show their true state of health and wellbeing to caregivers and the number of non-eaters or shy-feeders will be reduced.

This interaction should be incorporated into the acclimation procedure. The following is provided as an example of an acclimation procedure:

1. Lead cattle into paddock or fenced feedpad, ideally with one stockperson in the lead and one following.
2. Lead cattle to feed bunk and water trough, ideally with a full bunk.
3. Allow horses to drink, alternatively splash water within trough to attract cattle.
4. Provide bedding if cattle require encouragement to rest and recover from processing and travel.
5. If implemented, retain cattle in fenced feedpad for approximately two to three days, to allow for bunk training. If the feedpad is not fenced, utilise bales of hay or other points of interest to attract cattle to the bunk.
6. Cattle might require guided 'tours' of the paddock during or soon after bunk training. This encourages them to become comfortable with all parts of the paddock. Movement during this period is also good for animal health after being on a truck.

Bales of hay can be used to both attract cattle to the bunk, but also provide bedding to encourage cattle to rest after travel (Figure 22). If cattle are to be held in a fenced feedpad for an extended period to allow for bunk training, bedding is crucial to encourage cattle to settle and rest. Cattle in larger paddocks with trees and grass are more likely to find a suitable place to rest without the need for bedding.

Cattle should be checked by stockpersons daily with sick or poor-doing animals removed from the paddock and placed in a separate paddock or relocated to a treatment pen or hospital facility.

A BRD vaccination program should also be implemented, which may commence prior to entry into the staging facility. Any vaccination program should be conducted under the advice of a feedlot veterinarian. BRD management is discussed further in the *BRD Preventive Practices Handbook* (Cusack, 2022).

Figure 23: Bales of hay used to attract cattle to the feed bunk

5.11 Nutrition and feeding systems

As all NFAS feedlots require the engagement of a consulting nutritionist or suitably qualified consultant, it is recommended that ongoing professional advice is obtained for the feeding and nutrition of cattle in a feedlot cattle staging facility. Generally, the ration provided in a feedlot cattle staging facility should include an appropriate balance of protein, energy, and usually includes a formulated supplement.

Staging facilities can use different feeding systems to achieve production objectives. An example is using a limit fed program to enhance bone and muscle growth but limit fat deposition. In general, any feeding system should ensure a balanced diet, enhance digestive health and establishment of the herd, and recover body water and tissue loss associated with previous conditions and transport.

It is much more challenging to start new cattle that are unfamiliar with self-feeders, so care must be taken when using them. The recommended ration for self-feeders must achieve the same minimum protein requirements as feeding in bunks. A source of roughage should be available nearby until cattle become familiarised with eating from self-feeders. If there is plenty of pasture available then after this time period, the roughage source could be diminished, and cattle allowed to graze in the enclosure. Failure to manage roughage intake could cause digestive problems and, in extreme cases, severe bloat.

The use of trace mineral, vitamins, and electrolytes should be considered following a risk-assessment of the animals upon entry into these facilities. Under certain circumstances, that can be most beneficial in improving the health and well-being of highly stressed, drought stricken, or long-haul cattle.

There are advantages and disadvantages to both limit feeding and ad-lib feeding and this will depend on a variety of factors (Table 1). Adequate bunk space must be provided regardless of whether limit or ad-lib feeding methods are implemented (Section 4.6).

In a situation where cattle have access to both sides of the bunk, the hygiene of the bunk is important. Starting with a clean bunk is important to maximise intake and cattle can sometimes step into the bunk, leaving mud are other debris. It is important to ensure that the bunk is clean and free from spoilage and debris before delivering fresh feed.

As the regulation framework in some jurisdictions is determined by animal intake, it is in the best interest of the operator to be able to measure the amount of feed obtained from the provided ration. Most feedlots already have a system in place to determine this within the feedlot and this system should be extended to the feedlot cattle staging facility. Ad lib feeding using self-feeders may be difficult but observations and estimates should be recorded to justify the cattle feed intake.

Table 1: Limit feeding vs ad-lib feeding

Feeding system	Advantages	Disadvantages
Limit feeding	• track feed intake easily • bunk cleaning is easier • increased pasture utilisation between feeding • ration mixing is easier • cattle more likely to evenly eat ration • feeding frequency can be increased or decreased.	• greater infrastructure investment • benefits aggressive cattle and discourages shy-feeders • harder on grass and trees as cattle search for alternate feed intake between feed delivery.
Ad-lib feeding	• greater opportunity for shy-feeders • less frequent feed delivery saves operational expenditure.	• reduced pasture and paddock utilisation • difficulty in cleaning bunks or feeders • requires large volume bunks or self-feeders • difficulty in tracking feed intake. • more feed wastage • cattle more likely to sort through the ration.

5.12 Water troughs

As occurs in feedlots, water troughs in feedlot cattle staging facilities can become dirty from feed transfer from cattle, manure, and subsequent algal growth. Water troughs should be checked and cleaned at least weekly when the enclosure is in use. When not in use, troughs should be emptied, cleaned and left to dry. When not in use, troughs should be periodically checked to ensure leaks can be detected. Alternatively, flow meters may assist with remote monitoring of water troughs.

Appendix 1 of *Beef Cattle Feedlots: Waste Management and Utilisation* (Tucker *et al*., 2015) details a procedure for cleaning water troughs. The area around the water trough should also be inspected for the pooling, around the trough and apron, of water discharged during cleaning.

5.13 Biosecurity

The use of a feedlot cattle staging facility may allow for the quarantining of cattle prior to entry into the feedlot. Animal health inspections during this period will assist in the identification of potential disease prior to entry into the feedlot.

The feedlot cattle staging facility should be incorporated into the existing biosecurity plan for the feedlot. Access to the feedlot cattle staging facility should be restricted and consideration given to the management of feeding infrastructure and water troughs near property boundaries.

If not included in the feedlot biosecurity plan, a farm-wide biosecurity plan should also be implemented for the management of weeds and pests across the property. A farm-wide biosecurity plan may need consideration of the management of Johne's disease, particularly if the feedlot cattle staging facility is used for multiple purposes.

The sharing of water troughs between enclosures is common and reduces the cost of construction. However, the sharing of water troughs between different groups of cattle should be considered in the management of disease. Although cattle may not be held in the same enclosure, the sharing of a water trough may increase the transmission of pathogens between different groups of cattle and increase risk of respiratory disease.

5.14 Drought

Whilst drought is temporary, it is recurring and likely to increase in frequency and intensity due to the impacts of climate change. During drought, throughput pressure on feedlots and feedlot cattle staging facilities means that stocking densities in the enclosures may increase during weather conditions in which maintaining groundcover is already difficult. This pressure is increased due to market considerations but also the opportunity to drought-feed cattle from drought-affected regions to maintain the welfare of those animals. The concentration of cattle within and around feedlots allows grazing systems to destock and protect remaining groundcover.

It is crucial to have a clear management plan for drought conditions to ensure that actions are undertaken in preparation for, during, and following drought. It must be acknowledged that management and impacts will change during drought and, if impacts occur during these periods, they must be actively corrected to prevent long-term impacts. This correction may not be possible until after drought conditions have eased. Regardless, this will require an active rehabilitation plan (Section 5.16) to be in place prior to drought and not developed during or after a drought.

However, the intense use of feedlot cattle staging facilities can result in long-lasting impacts to soil health which, in turn, can cause impacts on vegetation and surface waters. Additionally, drought-breaking rain can often consist of very intense storms exacerbating erosion issues on damaged soils. Runoff controls discussed in Section 4.4 will provide some protection to the environment during these initial rainfall events until groundcover can be returned. Many of the runoff controls are intended to encourage the infiltration of rainfall by providing physical barriers to slow the movement of water across the landscape.

A fenced feedpad allows for soil conservation management where paddocks can be rested. Cattle can be contained within the feedpad for short periods each day. Alternatively, paddocks can be rested for extended periods providing cattle are occasionally allowed access to the paddocks for grazing and to manage mobility following transport. Essentially, the fenced feedpad allows greater flexibility to manage drought conditions.

5.15 Paddock rehabilitation

Generally, cattle market and weather factors result in the need for feedlot cattle staging facilities to be used for a combination of drought feeding (Section 5.15) and staging prior to entry into the feedlot. However, with the combination of high occupancy and dry conditions, the maintenance of groundcover through these periods may be difficult. As such, if part of the management plan is to continue to use feedlot cattle staging facilities at the same or higher stocking rate, then a clear rehabilitation plan should be prepared prior to construction of the facility or as soon as possible afterwards.

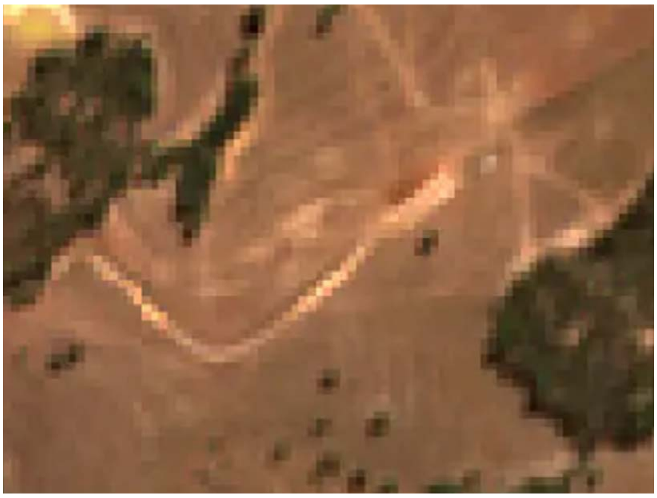
The goal of the rehabilitation plan must be to rehabilitate all low-intensity areas to establish groundcover of at least 50% prior to restocking as part of the feedlot cattle staging facility. This may take up to two or three years to achieve.

Two examples of a rehabilitation plan were observed or discussed during the site visits completed as part of this project.

Example one

A small feedlot in Queensland's Burnett Region operated their feedlot cattle staging facility using a set stocking rate until 2020. This coincided with severe drought conditions. At this time, a decision was made to transition to an actively managed pasture system, with supplementary feeding. A rehabilitation program was implemented, which included the deep ripping of paddocks and spreading of a multi-species pasture mix. The pasture mix consisted of over 10 species including tap root and legume species. The species mix was progressively improved based on trial results.

Prior to the implementation of the rehabilitation program (July 2020), green groundcover was minimal (Figure 23) with African lovegrass dominating more palatable pasture species. Rainfall records show that the summer of 2020–21 and autumn of 2021 had average rainfall, but the region remained drought declared. Figure 24 shows the difference in recovery of green groundcover between a rehabilitated paddock and a non-rehabilitated paddock. The red colouring indicates a low level of green vegetation cover (e.g. feed road and bunk aprons) and blue shows a high level of green vegetation cover (e.g. tree canopy and rehabilitated pasture). The Normalised Difference Vegetation Index (NDVI) colouring below is relative to the surrounding areas and colours cannot be compared between Figure 23 and Figure 24.



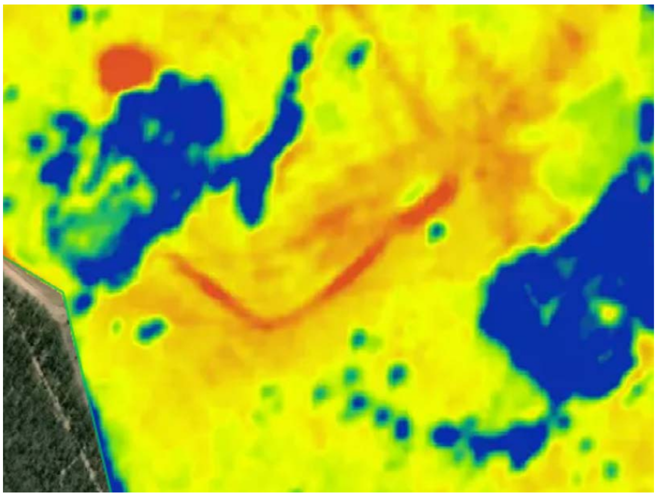


Figure 24: Low resolution imagery and NDVI from July 2020
Source: DataFarming

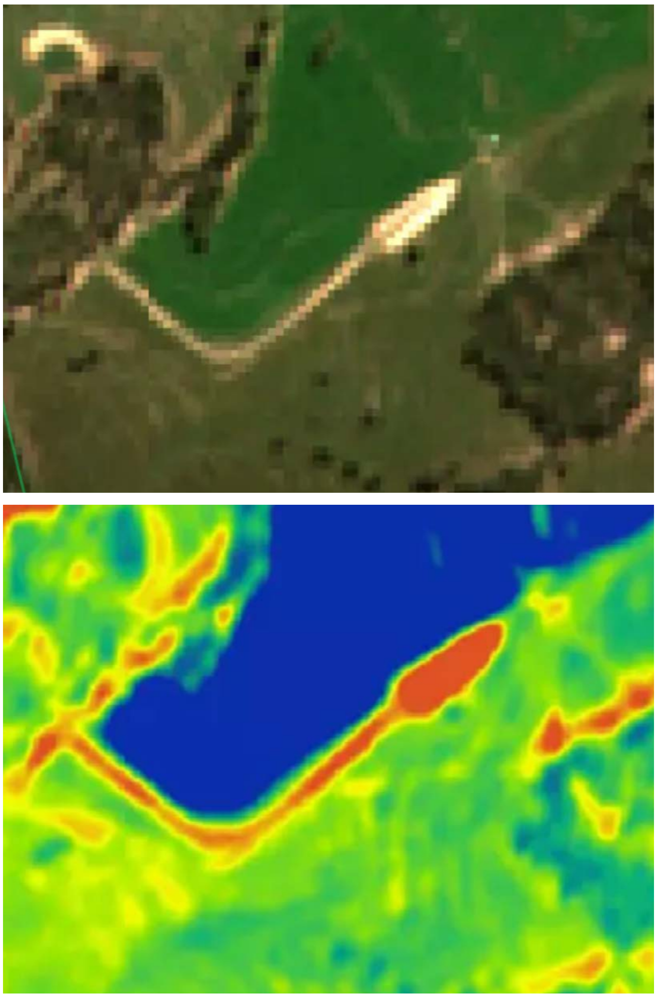


Figure 25: Low resolution imagery and NDVI from May 2021
Source: DataFarming

Example two

A large feedlot in Southern Queensland had utilised their feedlot cattle staging facility at a high intensity for many years. This was exacerbated by the drought conditions between 2014 and 2021 resulting in denuded and compacted paddocks. A management decision was made in 2020 to actively rehabilitate the impacted paddocks. The rehabilitation process for each paddock took approximately two to three years and is part of a staged rehabilitation program. While the procedure was adjusted following each paddock, it generally consisted of the following:

1. Manure was applied directly to the compacted surface without any preparation as deep ripping or blade ploughing would have been difficult and resulted in substantial wear and tear on equipment.
2. Pioneer plants, which were primarily taproot weed species such as mallow weed, established in the manure and taproots penetrated into the compacted soils. This, combined with the organic matter, improved soil structure and reduced compaction. The paddock was left for approximately 12 months to allow this to occur.
3. Following 12 months of rest, the paddock was blade ploughed to break the soil and then disc ploughed to prepare an appropriate seed bed prior to the next rain event.
4. A hardy, fast growing pasture seed, with species such as Rhodes grass and bambatsi was spread when soil moisture and rainfall conditions were adequate for germination. A mixture of pasture and weed species was ultimately established.
5. Once pastures were allowed to seed several times, cattle were reintroduced using crash-grazing methods with no supplementary feed. This allowed organic matter to be further incorporated into the ground and assisted with plant knockdown to establish a mulch layer.
6. Once groundcover conditions were returned to sustainable coverage, cattle were reintroduced, and the paddock returned to use within the feedlot cattle staging facility.

6 Design support tools

Various decision support tools can be used to assist in managing feedlot cattle staging facilities.

6.1 Groundcover assessment

There are several methods for ground cover assessment within low-intensity paddocks. Where possible, the groundcover in stocked and recovering low-intensity paddocks should be inspected at least weekly. Essentially, they are grouped into three tiers in order of accuracy and efficacy:

1. Qualitative assessment (visual inspection)

Observations can include an overall estimate of average ground cover as a percentage of total area, a rating of adequate or inadequate coverage, or other noteworthy observations. A simple method such as this could be employed by pen riders while they are checking on cattle. These observations should be recorded in a form or location which can be easily accessed to assist in determining whether paddocks are being overused and should be rested or reduced in intensity. This record may also be necessary for environmental compliance.

2. Quantitative assessment (measurement)

Module 2 of the MLA 'More Beef from Pastures' online manual describes best-practice management for pasture growth and includes detailed instructions on how to complete visual assessments along with the quadrat method for a more accurate and objective assessment of groundcover. However, pasture assessments often incorporate a measure of pasture mass as cattle rely entirely on pasture for feed intake. As feed intake within feedlot cattle staging facilities is through both pasture and a prepared ration, the available biomass in a paddock is less critical than the amount of groundcover.

3. Digital groundcover assessment using satellite imagery

The Australian Feedbase Monitor was jointly developed by MLA and Cibo Labs and is free to MLA members. It uses satellite technology to identify total groundcover and biomass available across a paddock, farm, or region. It simplifies management decisions and reduces the time spent completing field observations. It also allows for ground cover to be benchmarked against other paddocks or properties, which is useful to delineate the impacts of cattle from the impacts of dry weather.

The Australian Feedbase Monitor is one of many pasture or groundcover mapping or assessment tools which utilise satellite imagery. Most are reliant on similar satellite imagery which is updated every five days and would allow for weekly assessments.

6.2 Nutrient budget method

Due to the uneven distribution of manure within feedlot cattle staging facility paddocks, a nutrient mass balance will only provide an indication of potential nutrient imbalances. Soil monitoring is always recommended to ensure decision making is based on real-time, site-specific data. It is also only relevant for low-intensity systems as engineering controls, such as surface preparation (Section 4.3), are required for high-intensity systems.

Nutrient deposition can be estimated using the following information:

1. Number of cattle in the paddock

As each paddock or enclosure will be a different size, or the number of cattle within a group may change, the number of cattle in the paddock must be accurately recorded to estimate nutrient deposition.

2. Number of days cattle are in the paddock

As the purpose of housing cattle in a feedlot cattle staging facility varies between feedlots, and between groups of cattle, the days animals are kept in a paddock may vary. To estimate annual or seasonal deposition of manure, the number of days each paddock was used must be recorded.

3. Occupancy rate of high-intensity areas (hours/day or estimated percentage)

Cattle use within a paddock is not evenly distributed across all areas. High-intensity areas such as feedpads, water troughs, and shade will attract more cattle for longer periods than other parts of the paddock. As such, nutrient deposition across a given period, will be higher in these locations. The number of hours per day cattle occupy the paddock and high-intensity areas can be used to identify the equivalent number of days spent in these areas across the period of occupancy (e.g. four weeks).

4. Split of low-intensity and high-intensity areas

The bounds (area) of high and low intensity areas must be defined to allow nutrient deposition, on a per hectare (or similar) basis, to be calculated. Defining these areas can be difficult but, as a starting point, is most likely to be related to the ability to maintain groundcover in each location. Groundcover may vary across a year or over several years. If a fenced feedpad is implemented, this area can be easily measured.

5. Cattle manure excretion rates

As site-specific data for manure excretion rates is unlikely to be available, rates from the American Society of Agricultural and Biological Engineers (ASABE) (Erickson *et al.*, 2003) should be utilised (Table 2). Combining this information allows for the calculation of cattle excretion rates (kg/day) and application rates (kg/ha).

Table 2: Cattle manure excretion rates

Component	Daily excretion rates	Unit
Dry matter (DM)	1.76	kg/day
Organic matter (OM)	1.44	kg/day
Nitrogen (N)	0.16	kg/day
Phosphorous (P)	0.02	kg/day
Calcium (Ca)	0.05	kg/day
Potassium (K)	0.06	kg/day
Sodium (Na)	0.01	kg/day
Magnesium (Mg)	0.02	kg/day

Nutrient removal rates may be more difficult to estimate as grazing cattle remove minimal nutrients from the soil. As only a portion of their feed will be obtained from grazing, an understanding of their dietary intake is also required. Essentially, it is likely that there will be negligible removal of nutrients from grazing within a feedlot cattle staging facility.

Removal rates through a cut pasture or crop are more easily understood and can be utilised if this management practice is implemented.

An example nutrient mass balance has been incorporated into the Microsoft Excel record template, which is available on the MLA website and ALFA Feedlot Tech website.

6.3 Summary of environmental design and management

The following tables provide a summary of key design and management practices for feedlot cattle staging facilities, which are relevant to each aspect of the environment. Outcome-based design and management solutions allow for varied requirements, providing the outcome is achieved. Risk-based solutions may not be required in all situations and should be based on the potential for impacts to occur.

An example of an outcome-based practice is the cleaning of manure to ensure a manure pack does not form. This does not require a set cleaning frequency and should be completed to achieve the outcome (i.e. no accumulation).

An example of a risk-based practice is the watering of unsealed roads or loose surfaces to prevent dust impacts. If the potential sources are dust are located centrally on the property, or there are no nearby off-site dwellings, it is unlikely that, regardless of management, dust emissions from these sources will cause an impact. As such, if the risk is low, the management practice is unlikely to be required.

The *NSW Land Use Conflict Risk Assessment Guide* (Department of Primary Industries, 2011) provides an example of a risk-assessment structure which could be applied to feedlot cattle staging facilities.

Table 3: Environmental design and management – surface water

Surface water feature*	Potential design and management solutions	Monitoring
Overland flow	• maintain at least 50% groundcover (low-intensity systems) (outcome-based) • appropriate runoff controls (e.g. swales, contour banks, vegetated filter strips) (risk-based) • minimise pooling of water around high-intensity areas (risk-based) • controlled drainage area (CDA) for high-intensity systems (outcome-based).	• groundcover • erosion • post-construction compaction testing (CDA).
Drainage feature (no formed bed or banks)	• 100% ground cover target around drainage feature (risk-based) • in-stream slow-release detention structures (e.g. leaky weirs) (risk-based) • avoid stock dams or convert to slow-release detention (risk-based) • maintain 30m setback from high-impact areas (high-intensity feeding system, feedpads, water troughs, constructed shade, etc.) (outcome-based) • temporary exclusion if impacts (e.g. erosion) are identified (outcome-based).	• groundcover • erosion.
Minor watercourse (formed bed and banks)	• cattle access should be managed to allow for the exclusion of cattle during adverse conditions (risk-based) • 100% ground cover target within 30m of edge of bank (outcome-based) • periodic controlled grazing for vegetation management (risk-based).	• groundcover • erosion • weeds • quarterly if upstream locations also available.
Major watercourse	• cattle must be excluded from edge of watercourse bank (outcome-based) • 100% ground cover target within 30m of edge of bank (risk-based) • at least 50% ground cover target for other areas.	• if appropriate, quarterly water quality monitoring of on-site or adjacent watercourses.

*Based on mapping (e.g. stream order) and physical properties of watercourse.
Note: This assumes landscape is draining towards the watercourse, consideration should be given of slope, climate, and flow convergence.

Table 4: Environmental design and management – groundwater

Groundwater feature	Potential design and management solutions	Monitoring
Overlying material is highly permeable (e.g. sand or permeable rock with no clay content) and groundwater is present at a shallow or moderate depth.	• import clay material to form compacted pads/aprons or construct with concrete in high-intensity areas (feedpad, water troughs, constructed shade, etc) • maintain at least 50% groundcover • frequent manure removal in high-intensity areas (risk-based) • concrete, gravel, or other reinforcement of aprons and pads.	• annual soil monitoring (low-intensity systems only) • piezometer (monitoring bore) adjacent to, or down-gradient of, representative high-intensity site (e.g. feedpad) • second piezometer at control site away from, or upgradient of, high-intensity site • quarterly monitoring of piezometers.
Groundwater depth is <2m including potential seasonal variation but overlying material provides some protection (e.g. shallow alluvium).	• surface preparation or reinforcement around high-intensity areas • maintain at least 50% groundcover • frequent manure removal in high-intensity areas • avoid use during high-rainfall years when groundwater may be shallow.	• annual soil monitoring (low-intensity systems only) • groundwater monitoring incorporated into feedlot groundwater monitoring program • quarterly monitoring until groundwater conditions understood then half-yearly or annually.
Groundwater is between 2m and 10m and overlain by low-permeability material (e.g. clay or solid rock).	• surface preparation or reinforcement around high-intensity areas • maintain at least 50% groundcover • removal of manure to prevent the formation of a manure pack (outcome-based).	• annual soil monitoring (low-intensity systems only)
Groundwater is greater than 10m and overlain by a low-permeable material.	• maintain at least 50% groundcover • removal of manure to prevent the formation of a manure pack (outcome-based).	N/A

Table 5: Environmental design and management – land (vegetation and soil)

Land feature	Potential design and management solutions	Monitoring
Regulated native vegetation*	• exclusion of cattle in high-intensity systems from native vegetation (clearing required for surface preparation) • fencing to allow for the permanent or temporary exclusion of cattle in low-intensity systems (outcome-based) • controlled grazing of grass within native vegetation for fire and weed management.	• periodic inspection of trees for damage • annual soil monitoring in adjacent paddock (low-intensity systems only).
Non-regulated native vegetation*	• avoidance of native vegetation clearing for high-intensity systems • integration of native vegetation into low intensity systems • planting and improvement of vegetation for shade, dust controls, visual amenity, natural capital, etc (risk-based).	• periodic inspection of trees for damage.
Soils	• maintenance of at least 50% ground cover in low-intensity systems (outcome-based) • maintenance of 100% ground cover on sloping landscapes (>10%) (risk-based) • surface preparation or protection for high-intensity systems or areas (e.g. feedpad) (risk-based) • application of fertiliser (mineral or organic) may be required to ensure optimum plant growth • soil and paddock rehabilitation following drought (outcome-based) • split paddock with a fenced feedpad to allow for resting and rotation and protection of soil structure during adverse conditions (extended rain or drought).	• annual soil monitoring for environmental and/or agronomic purposes (low-intensity systems only) • one representative site near a high-intensity area (e.g. feedpad) and one in a low-intensity area (e.g. paddock) • representative paddocks should reflect soil conditions of the broader facility or property; multiple representative paddocks may be required for different landscapes or soil types.

*Varies and is subject to local, state, and federal regulation

Table 6: Environmental design and management – amenity

Potential impact	Potential design and management solutions	Monitoring
Odour	• utilise S-factor method to identify appropriate separation for high-intensity systems (minimum stocking density of 25m²/SCU) (outcome-based) • 500m setback between high-intensity areas (e.g. feedpad) within low-intensity areas and off-site dwellings (outcome-based) • site-specific assessment using a combination of above, odour sampling, odour modelling, and/or management (risk-based) • cleaning of manure to prevent accumulation of a manure pack (outcome-based) • maintenance of enclosure surface and drainage systems to prevent pooling of water in high-intensity areas (risk-based) • covering of mortalities through burial or composting (outcome-based).	• ongoing discussion and communication with neighbours (social licence) • investigation of potential issues following complaint • scientific monitoring or sampling if required as part of feedlot conditions or requested by the regulator.
Noise	• maximise distance between internal roads and off-site dwellings (risk-based) • noisy activities such as feed truck movements and loading/unloading cattle restricted to reasonable operating hours (risk-based) • enforce internal speed limits (risk-based) • vehicle maintenance to minimise noise • maintenance of road surfaces to minimise noise from vehicle movements • implement noise controls if operating hours and road design/maintenance are unable to control noise (risk-based).	
Dust	• maximise distance between internal roads and off-site dwellings • maintenance of at least 50% ground cover in low-intensity systems • dust suppression in high-intensity systems (risk-based) • road watering of unsealed internal roads near off-site dwellings (risk-based).	
Visual	• maintenance of at least 50% ground cover in low-intensity systems (outcome-based) • application of relevant visual amenity considerations for feedlots to high-intensity systems (risk-based). This will vary between jurisdictions.	

*Varies and is subject to local, state, and federal regulation

6.4 Management record example

The following screenshots are from the Microsoft Excel record template which is available on the ALFA Feedlot Tech website.

AgDSA			
Design & Management Targets	**Grass Cover**	50	%
	Maximum Stocking Density	100	m2/head
	Minimum Bunk Space	300	mm/head
	Minimum Trough Space	25	mm/head
	Maximum Group Number	480	head
	Pasture Measurment Method	Quadrant	
Paddock Rehabilitation Procedure	**Step 1 (Example only)**	Destock cattle	
	Step 2	Deep rip. Maintain 10m setback to vegetation and feed pad	
	Step 3	Application of manure (application rate based on agronomic advice)	
	Step 4	6-12 month rest period and allow weeds to establish and assist in soil aeration. Repair/replace infrastrcuture as required.	
	Step 5	Phyiscal weed/pasture knockdown using tyre drag or crash graze. Selective spray or weed removal as required	
	Step 6	Spread target pasture mix (fast-growing/repairing grass, drought resilient, some non palatable grass species, legume, tap root species, water-logging resilience if in floodplain, etc)	
	Step 7	Restock once grass cover target exceeded	
Soil Sampling Procedure	**Step 1 (Example only)**	Review any regualtory requirements, methods or conditions of approvals and licences	
	Step 2	Confirm sampling sites and depths. Sampling sites should remain consitent across sampling events and should be marked on the farm map	
	Step 3	Contact agronomist or soil scientist to arrange sampling	
	Step 4	Obtain samples, complete labortatory forms and send for analysis	
	Step 5	Review laboratory results and consolidate into a spreadsheet for trend analysis	
	Step 6	Obtain expert advice from agronomist and/or soil scientist	
Agronomist contact details	Name		
	Phone number		
	Email		

Figure 26: Excel template showing design and management targets, specific procedures, and relevant contact details for key people

Repairs, Maintenance & Improvements Register

Action	Priority	Expected Completion	Cost Estimate	Comments
Repair pot holes near Paddock 1 turnaround	Low	Jun-24		
Fence feedpad in paddock 1 and split paddock to allow for rotation				

Figure 27: Excel template showing a repair, maintenance and improvements register

Paddock Summary

Name/Number	1
Internal Folder Link	<insert link to local intranet folder for photos and additional data>
Area	80 ha
Soil Type/s	Heavy Black Clay
Bunk Length	80 m
Trough Length	10 m
Constraints and Limitations	Southern half of paddock is flood prone, native vegetation in north-east corner
Target Pasture Species	Rhodes grass, kikuyu, legume, etc

Operations Record

Date	Cattle Numbers	Bunk Space (mm/head)	Trough Space (mm/head)	Stocking Rate (head/ha)	Stocking Rate (m2/head)	Grass Cover Estimate (%)	Ration Intake (kg/head/day)	Pasture Intake (kg/head/day)*	Feedlot Intake (kg/head/day)	Actions Completed	Pasture Species Present	Comments
30/01/2024	240	333	42	3	3333	50	6	7	13	Pasture estimate, native vegetation inspection, manure removal, maintenance, waterway inspection, etc	Rhodes grass	Grass cover good but high-intensity areas expanding. Need to increase pasture diversity
	480	167	21	6	1667		8	5	13			Drought feeding density, bunk space below target

Figure 28: Excel template showing paddock record including groundcover assessment results

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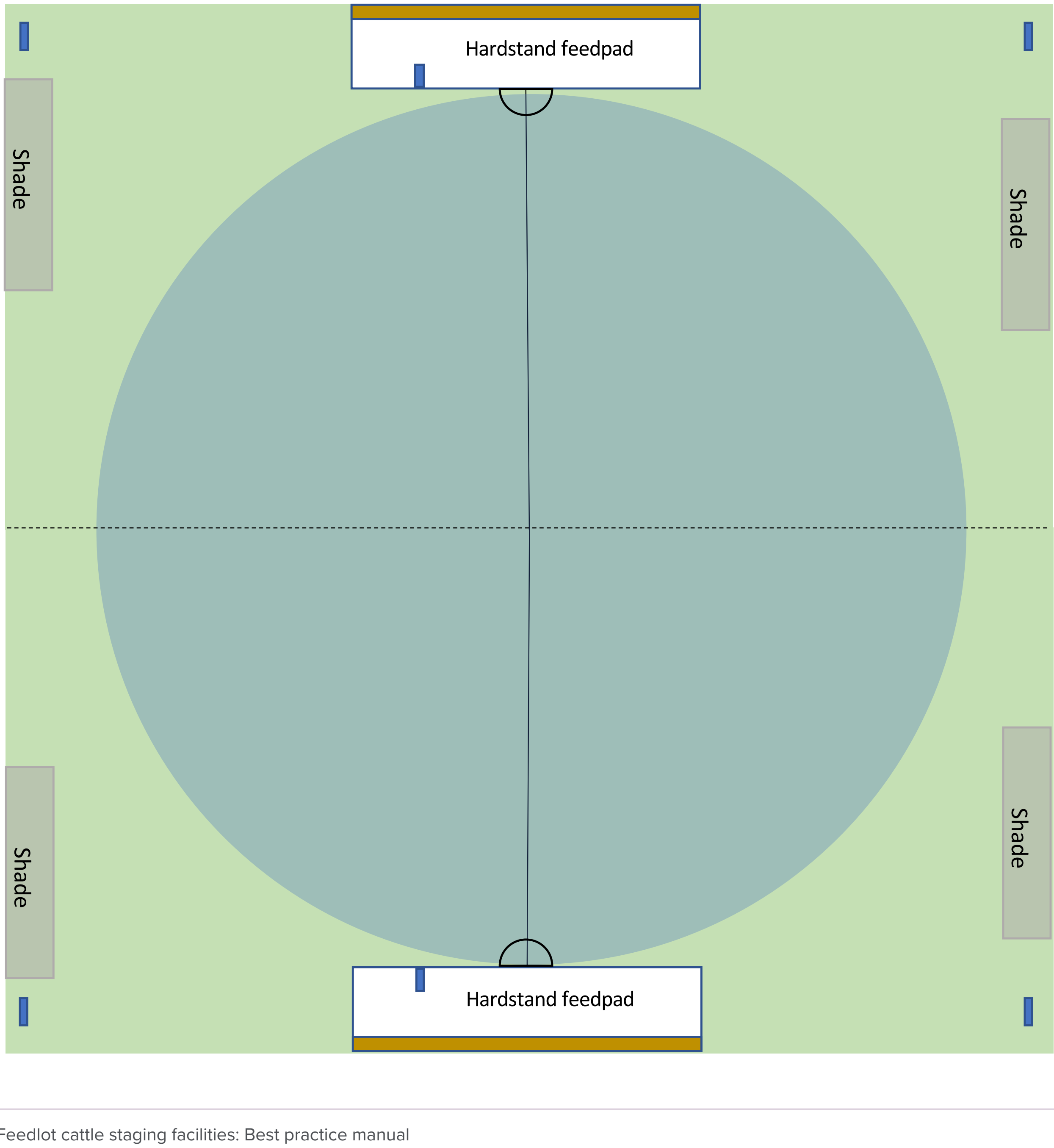
Appendix A – Alternate design concepts

Centre pivot design

This concept design allows for the incorporation of irrigation into the feedlot cattle staging area. The centre pivot would be fenced into four segments with one permanent dividing fence (solid line) and one temporary dividing fence (dotted line). Both fences would have to facilitate the movement of the centre pivot wheels through the fenceline. The temporary fence would be removed to allow for seeding or cutting of pasture. One half of the centre pivot would be used to irrigate fast-growing pasture, using clean water or effluent, while the other half of the pivot area is being used for cattle grazing. Pasture from the irrigated half would be harvested to ensure appropriate nutrient removal. Subject to veterinary advice, cattle should be excluded from any effluent irrigation areas for at least 21 days (Tucker *et al*., 2015). Grazing of cattle is not adequate to remove nutrient from an effluent irrigation area.

The below concept design would allow for two separate mobs of cattle to be fed across one half of the pivot area. Fenced feedpads have also been incorporated to allow for simple rotation between each half of the paddock. Constructed shade is shown but natural shade, or a mixture of natural and constructed shade, would also be appropriate.

Water troughs have been shown both in the fenced feedpad and in each segment of the pivot area. This allows for bunk training within the feedpad and for the feedpad trough to be turned off to encourage cattle to use the paddocks more evenly.

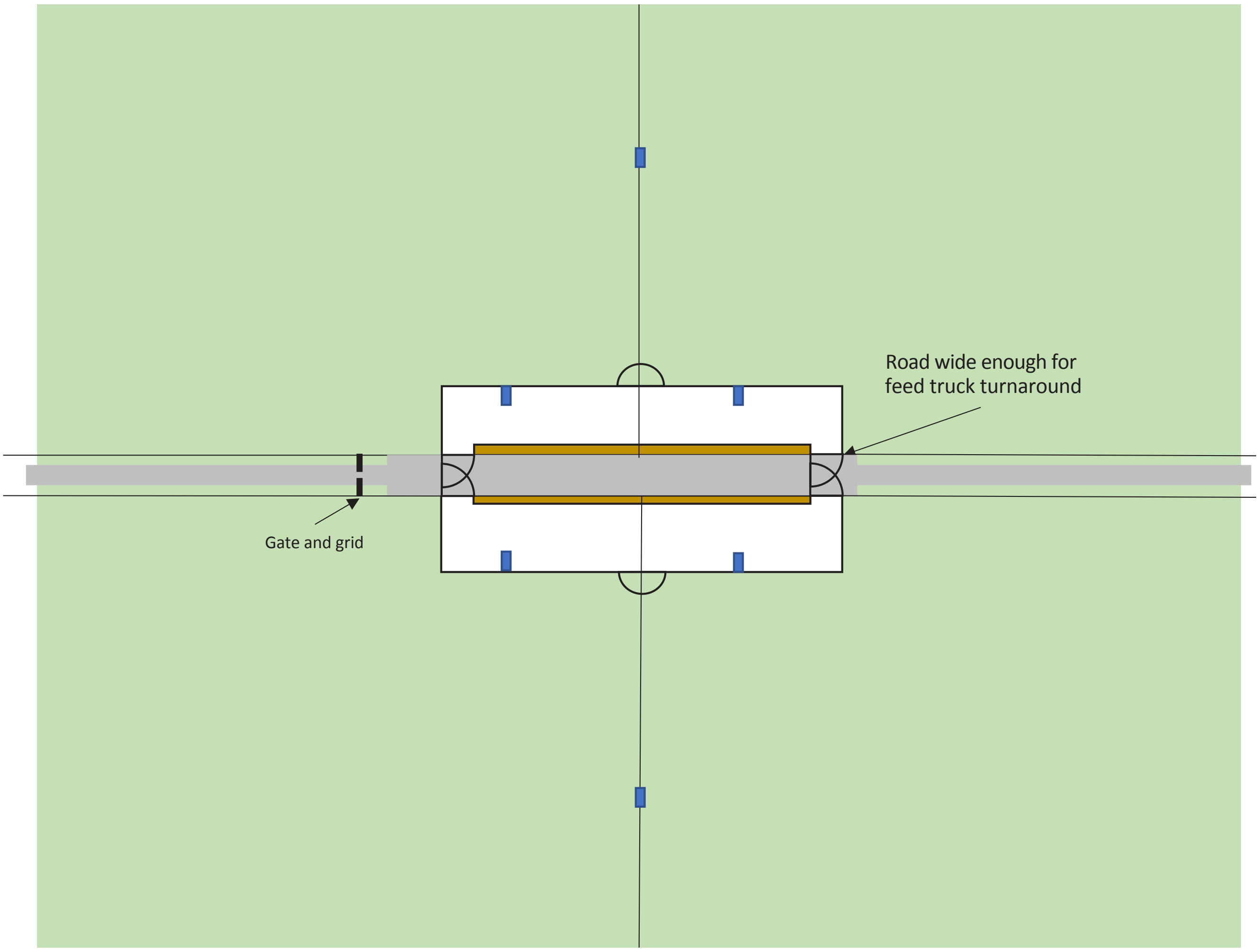


Back-to-back design

This concept is to show the interaction between two back-to-back enclosures with fenced feedpads. The two feedpads need to be adequately separated to ensure a feed truck can complete a turn between the two bunks. The shared lane and road corridor needs to be wide enough to allow for this turning space, but the road can be narrowed in locations where turning is not required. This reduces the cost of construction and maintenance of the road.

The below concept shows each feedpad as having a single adjacent paddock. However, this could easily be reconfigured to provide a split paddock for rotation. Ideally, the shared feed road and stock lane would follow a ridgeline to facilitate drainage away from the bunks. Essentially, this design mimics a back-to-back feedlot design.

A gate and grid control point has been included past the turnaround area to allow for better cattle control. For example, cattle removed from the pens cannot walk far before pen riders are finished with the welfare checks prior to moving the removed animal to a treatment and handling area. The inclusion of both a gate and grid allows feed trucks to move around the feedlot cattle staging facility uninhibited by gates.



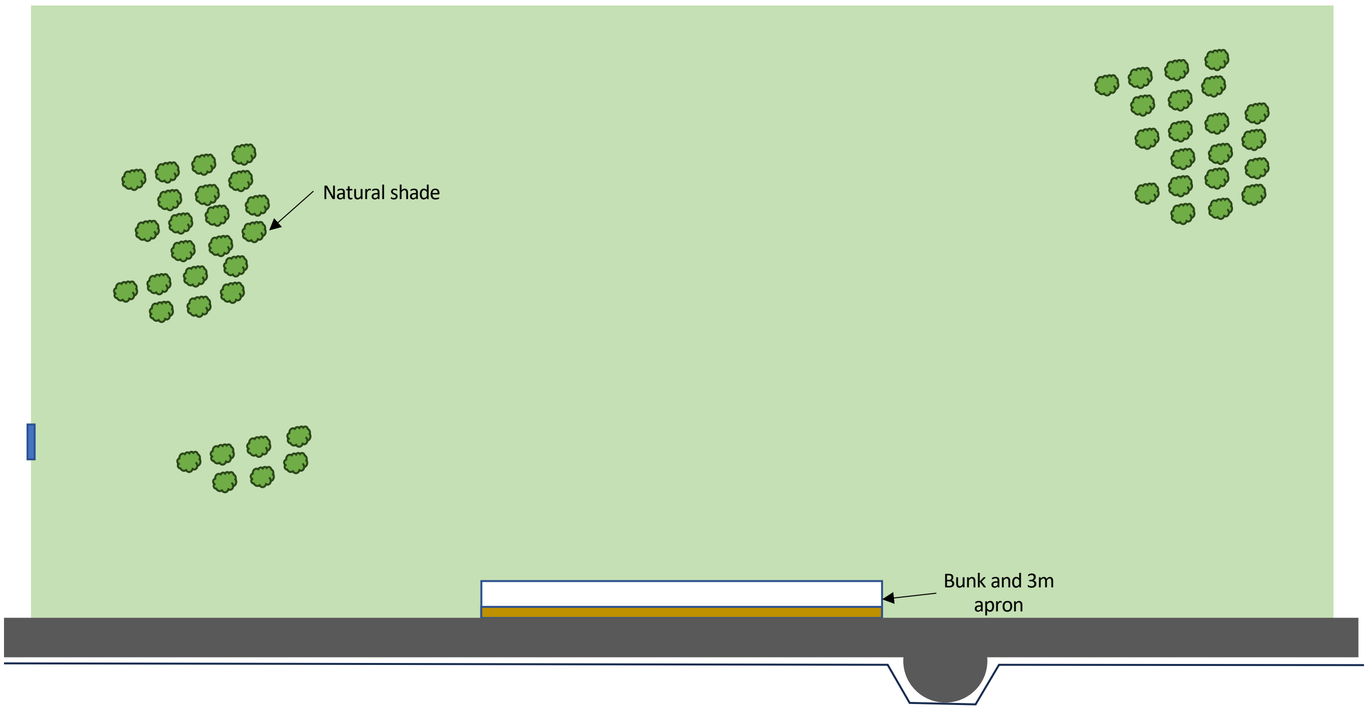
Open feedpad

Whilst fencing the feedpad allows for greater operational flexibility, a single open feedpad is an appropriate design for a feedlot cattle staging facility enclosure. However, the consistent use of a single paddock system requires careful consideration of ground cover maintenance. The paddock should be large enough to adequately maintain at least 50% groundcover across the entire paddock during average rainfall years.

At minimum, the feed bunk should have an apron constructed with concrete, gravel, or other reinforcement which extends approximately 3m into the paddock. The area around this apron should be free-draining and not allow for the accumulation of water around the bunk.

Where possible, water troughs should be separated from the feed bunk to encourage cattle to use more of the paddock. This assists in distributing their impact and preventing large, denuded areas.

Natural shade is appropriate providing the vegetation can be maintained and is not subject to cattle damage from rubbing and soil compaction. Single isolated trees are unlikely to be adequate, even if they provide adequate shade area. Frequent cattle congregation around these trees will ultimately cause damage, removing the shade benefit.



Appendix B – Further reading

- MLA Backgrounding Webpage
- National Guidelines for Beef Cattle Feedlots in Australia (3rd Edition)
- National Beef Cattle Feedlot Environmental Code of Practice
- Beef Cattle Feedlots: Design and Construction
- Beef Cattle Feedlots: Waste Management and Utilisation
- National Guidelines for Dairy Feedpads and Contained Housing
- Treatment Systems for Agriculture (WetlandInfo)
- Land Use Conflict Risk Assessment (LUCRA) Guide
- Module 2 of the MLA 'More Beef from Pastures' online manual
- Australian Feedbase Monitor
- Handbook of best practice guidelines for the Australian feedlot industry
- Bovine Respiratory Disease Preventive Practices Handbook

Appendix C – State-based definitions

Queensland

Planning Regulation 2017 (Schedule 24 – Dictionary)

Animal husbandry (grazing) –

Animal husbandry means the use of premises for –

(a) producing animals or animal products on native or improved pastures or vegetation; or

(b) a yard, stable, temporary holding facility or machinery repairs and servicing, if the use is ancillary to the use in paragraph (a).

Examples of animal husbandry – cattle stud, grazing of livestock, non-feedlot dairy

Intensive animal industry (feedlot) –

Intensive animal industry—

(a) means the use of premises for—

(i) the intensive production of animals or animal products, in an enclosure, that requires food and water to be provided mechanically or by hand; or

(ii) storing and packing feed and produce, if the use is ancillary to the use in subparagraph (i); but

(b) does not include the cultivation of aquatic animals.

Examples of intensive animal industry – feedlot, piggery, poultry, and egg production

Environmental Protection Regulation 2017 (Schedule 2, Part 1, Section 2)

ERA 2 – Intensive animal feedlotting

1. *Intensive animal feedlotting (the relevant activity) consists of keeping more than 150 standard cattle units of cattle or more than 1,000 standard sheep units of sheep in a feedlot.*
2. *The relevant activity does not include keeping cattle or sheep:*
   - a. *in a drought-declared area, if the animals are fed no more than their nutritional requirements; or*
   - b. *on a feed pad in a paddock; or*
   - c. *for no longer than is reasonably necessary for:*
     - i. *sale, slaughter or transport; or*
     - ii. *weaning; or*
     - iii. *animal husbandry; or*
     - iv. *milking; or*
     - v. *shearing*
3. *[irrelevant and intentionally omitted]*
4. *In this section:*

animal husbandry includes:

- a. *branding, dehorning, desexing, treating animals for pests (including preventative treating), vaccinating and veterinary work; and*
- b. *managing or treating animals as required under a law of the State for public health or safety.*

cattle includes:

- a. *beef and dairy cattle; and*
- b. *cattle of all ages.*

drought-declared area means an area that is considered to be severely affected by drought, however the relevant criterion is described, for the purpose of eligibility for assistance under a scheme administered by the State or Commonwealth government.

feedlot means a confined yard or enclosure that—

- a. *contains watering and feeding facilities where cattle or sheep are fed entirely by hand or mechanically; and*
- b. *is designed, constructed or used in a way that does not allow cattle or sheep in the yard or enclosure to graze.*

sheep includes sheep of all ages.

New South Wales

Standard Instrument – Principal Local Environmental Plan (Dictionary)

***Intensive livestock agriculture** means the keeping or breeding, for commercial purposes, of cattle, poultry, pigs, goats, horses, sheep or other livestock, and includes any of the following:*

(a) dairies (restricted)

(b) feedlots

(c) pig farms

(d) poultry farms.

It does not include extensive agriculture, aquaculture or the operation of facilities for drought or similar emergency relief.

***Feedlot** means a confined or restricted area that is operated on a commercial basis to rear and fatten cattle, sheep or other animals, but does not include a poultry farm, dairy or pig farm.*

***Extensive agriculture** means any of the following:*

(a) the production of crops or fodder (including irrigated pasture and fodder crops) for commercial purposes

(b) the grazing of livestock (other than pigs and poultry) for commercial purposes on living grasses and other plants on the land as their primary source of dietary requirements, and any supplementary or emergency feeding, or temporary agistment or housing for weaning, dipping, tagging or similar husbandry purposes, of the livestock

(c) bee keeping,

(d) a dairy (pasture-based) where the animals generally feed by grazing on living grasses and other plants on the land as their primary source of dietary requirements, and any supplementary or emergency feeding, or temporary agistment or housing for weaning, dipping, tagging or similar husbandry purposes, of the animals.

State Environmental Planning Policy (Primary Production) 2021 (Chapter 2, Part 2.4, Section 2.16)

Certain development to temporarily contain livestock permissible without consent:

(1) This section applies to land on which development for the purpose of agriculture may be carried out with or without development consent.

(2) Development for the purposes of intensive livestock agriculture or extensive agriculture that involves the grazing of livestock may be carried out without development consent on land to which this section applies if:

(a) the development is for the purposes of:

(i) a stock containment area or other feeding or housing arrangements, or

(ii) temporary agistment or housing of the livestock for weaning, backgrounding, dipping, tagging or similar husbandry purposes, and

(b) for development referred to in paragraph (a)(i) - the development is carried out on land:

(i) being lawfully used for the purposes of agriculture, and

(ii) during or immediately after a drought, flood, fire or other emergency, and

(c) the development will not be carried out:

(i) in an environmentally sensitive area, or

(ii) in, or within 100m of, a special area within the meaning of the Water NSW Act 2014, or

(iii) within 100m of a natural watercourse, or

(iv) within 500m of a residential zone or residential accommodation on adjacent land.

(3) [irrelevant and intentionally omitted]

(4) (Repealed)

(5) To avoid doubt, this section does not apply to aquaculture development.

(6) In this section:

residential zone means Zone RU4 Primary Production Small Lots, Zone RU5 Village, Zone RU6 Transition, Zone R1 General Residential, Zone R2 Low Density Residential, Zone R3 Medium Density Residential, Zone R4 High Density Residential, Zone R5 Large Lot Residential, Zone B4 Mixed Use, Zone B6 Enterprise Corridor, Zone E3 Environmental Management or Zone E4 Environmental Living.

stock containment area means a fenced area where livestock is temporarily held, fed and watered to protect soil and pasture resources on the property but does not include a feedlot or a hardstand area.

Protection of the Environment Operations Act 1997 (Schedule 1, Part 1, Section 22)

Livestock intensive activities

This clause applies to the following activities:

animal accommodation*, meaning the accommodation of animals for the purposes of sale, auction or exchange or for transportation by road, rail or ship.*

bird accommodation*, meaning the accommodation of birds for commercial production.*

cattle, sheep or horse accommodation*, meaning the accommodation of cattle, sheep or horses in a confinement area for rearing or fattening (wholly or substantially) on prepared or manufactured feed (excluding facilities for drought or similar emergency relief).*

dairy animal accommodation*, meaning accommodation:*

(a) of animals used for the production of milk (dairy animals), and

(b) in free stall complexes, feed pads, loading pads, milking sheds or stand-off areas, but not in pasture, calving areas or calving sheds.

pig accommodation*, meaning the accommodation of pigs for commercial production.*

Victoria

Victorian Code for Cattle Feedlots 1995

*"**Cattle feedlot**" and "**feedlot**" mean:*

Land on which cattle are restrained by pens or enclosures for the purposes of intensive feeding and includes any structure, work or area:

(a) in which such cattle are handled, fed, loaded and unloaded

(b) where the animal wastes from the feedlot are accumulated or treated pending removal or disposal

(c) where the animal wastes from the feedlot are treated, placed or dispersed on the land. (NB: This does not include land that does not form part of the land on which the feedlot pens and associated works are located)

(d) in which facilities for feeding such cattle are maintained and the feed for such cattle is stored

(e) set aside for the purpose of landscaping and planting of vegetation.

It does not include any area in which cattle are penned or enclosed for:

(a) grazing

(b) hand feeding prior to 12 weeks of age or for weaning, or for the provision of subsistence rations due to fodder shortage, abnormal seasonal conditions or other like events

(c) the provision of supplementary rations for cattle which have daily access to pasture.

Victorian Grazing and Intensive Animal Production Guidelines (2018)

Land use term	Definition	Includes	Included in
Agriculture	Land used to: a) propagate, cultivate, or harvest plants, including cereals, flowers, fruit, seeds, trees, turf, and vegetables b) keep, breed, board, or train animals, including livestock, and birds c) propagate, cultivate, rear, or harvest living resources of the sea or inland waters.	• animal husbandry • aquaculture • crop raising	N/A
Animal husbandry	Land used to keep, breed, board, or train animals, including birds.	• animal production • animal training • apiculture • domestic animal husbandry • horse husbandry • racing dog husbandry	Agriculture
Animal production	Land used to keep or breed farm animals for the production of livestock, eggs, fibre, meat, milk or other animal products.	• grazing animal production • intensive animal production • pig farm • poultry farm	Animal husbandry
Grazing animal production	Land used for animal production where the animals' food is obtained by directly grazing, browsing or foraging plants growing on the land. It includes: • emergency, seasonal and supplementary feeding • the incidental penning, feeding and housing of animals for weaning or other husbandry purposes. In this definition: *Emergency feeding* means providing feed to animals when an emergency event such as a flood, bushfire or biosecurity event, restricts or prevents the animals from grazing, browsing or foraging plants growing on the land. *Seasonal feeding* means providing feed to animals when seasonal conditions, including drought, restrict or prevent the animals from grazing, browsing or foraging plants growing on the land. *Supplementary feeding* means providing feed to animals to supplement the food the animals obtain by directly grazing, browsing or foraging plants growing on the land.	N/A	Animal production
Intensive animal production	Land used for animal production where the animals' food is imported from outside the immediate building, enclosure, paddock or pen. It does not include: • an abattoir or sale yard • grazing animal production, pig farm, poultry farm or poultry hatchery.	• cattle feedlot • intensive dairy farm	Animal production
Cattle feedlot	Land used for a cattle feedlot as defined by the *Victorian Code for Cattle Feedlots 1995*.	N/A	Intensive animal production

South Australia

Planning and Design Code V.2022.24, Part 7 (land use definitions)

Intensive animal husbandry (feedlot)

Means the commercials production of animals or animal products where the animals are kept in enclosures or other confinement and their main source of food is introduced from outside the enclosures or area of confinement in which they are kept.

Low intensity animal husbandry (grazing)

Means the commercial production of animals or animal products (e.g. meat, wool) on either native or improved pastures or vegetation where the animals main food source is obtained by grazing or foraging.

Guidelines for the Establishment and Operation of Cattle Feedlots in South Australia (2006)

Definition of a feedlot

A beef feedlot is a confined yard area with watering and feeding facilities where cattle are held and completely hand or mechanically fed for the purpose of production. This includes any adjoining or nearby area where:

- *such cattle are yarded, tended, loaded and unloaded*
- *the animal wastes from the feedlot are accumulated or treated pending removal or disposal*
- *facilities for feeding such cattle are maintained or in which the feed is stored, handled or prepared.*

This definition does not include the feeding or penning of cattle in this way for weaning, dipping or similar husbandry purposes or for drought or other emergency feeding, or at a slaughtering place or in recognised saleyards.

Considerations

A cattle feedlot is a change of land use from agricultural activities to intensive animal keeping.

A cattle feedlot does not include an area where cattle, which have daily access to pasture which is able to sustain more than 50% of their daily feed dry matter intake, are confined for the feeding of supplementary rations.

Supplementary feeding for production or weight gain in a paddock is classed as a feedlot when the paddock is unable to sustain more than 50% of the cattle feed required from pastures or crops which have a yield which is reasonable or commonly accepted for the district.

While a feedlot development may not meet the criteria for accreditation under the National Feedlot Accreditation Scheme (NFAS), it must comply with these guidelines.

Environment Protection Act 1993 (Schedule 1, Part 5)

Cattle feedlots

carrying on an operation for holding in a confined yard or area and feeding principally by mechanical means or by hand:

(a) not less than an average of 500 cattle per day over any period of 12 months

(b) where the yard or area is situated in a water protection area (as declared under Part 8 of this Act)—not less than an average of 200 cattle per day over any period of 12 months, but not including any such operation carried on at an abattoir, slaughterhouse, or saleyard or for the purpose only of drought or other emergency feeding.

Western Australia

Environmental Protection Regulations 1987 (Schedule 1, Part 1 & Part 2)

Category number	Description of category	Production or design capacity
1	Cattle feedlot: premises on which the watering and feeding of cattle occurs, being premises: a) situated less than 100m from a watercourse; and b) on which the number of cattle per hectare exceeds 50.	500 animals or more
68	Cattle feedlot: premises on which the watering and feeding of cattle occurs, being premises: a) situated 100m or more from a watercourse; and b) on which the number of cattle per hectare exceeds 50.	500 animals or more

Planning and Development (Local Planning Schemes) Regulations 2015 (Schedule 1, Part 6, Clause 38)

animal husbandry – intensive *means premises used for keeping, rearing, or fattening of pigs, poultry (for either egg or meat production), rabbits (for either meat or fur production) or other livestock in feedlots, sheds, or rotational pens.*

agriculture – extensive *means premises used for the raising of stock or crops including outbuildings and earthworks, but does not include agriculture — intensive or animal husbandry – intensive.*

Northern Territory

Northern Territory Planning Scheme 2020 (Schedule 2)

agriculture *means, as a commercial enterprise:*

- *(a) the growing of crops, pasture, timber trees and the like, but does not include a plant nursery or horticulture*
- *(b) the keeping and breeding of livestock.*

The use may include where ancillary an office, but does not include animal boarding, intensive animal husbandry or stables.

intensive animal husbandry *means:*

- *(a) the breeding, keeping and feeding of animals, including poultry and pigs, in sheds, stalls, ponds, compounds or stockyards*
- *(b) aquaculture as a commercial enterprise.*

Tasmania

Land Use Planning and Approvals Act 1993 – Tasmanian Planning Scheme – State Planning Provisions (Table 3.1)

Intensive animal husbandry *means use of land to keep or breed farm animals, including birds, within a concentrated and confined animal growing operation by importing most food from outside the animal enclosures and includes a feedlot, poultry farm or piggery.*

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