Final report

Water use within the Australian feedlot industry

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Executive summary

Water is a critical resource underpinning key human, environmental and economic activities. It is consumed by households, used as an essential input to production throughout the economy, and supports many cultural and environmental values.

As a scarce natural resource, government decisions around water allocation are inherently complex and require careful consideration of trade-offs between competing uses. This is particularly important given the need to balance demand across agricultural, industrial, environmental and cultural uses.

This project addresses gaps in the evidence on feedlot water use, focusing on its role, scale and criticality relative to other sectors where it is often aggregated. It applies a multi-pillar framework across feedlots, agriculture and the broader economy. This analysis finds that feedlots are distinct from other water users with which the sector is often grouped. The analysis also highlights the need to consider multiple metrics, as standard measures such as total water use or gross value added per megalitre provide only a partial view when considered in isolation.

Approach to considering water use in feedlot operations

This report examines water use in feedlots, benchmarked against other key users, by exploring its role, as well as the scale and criticality of use, considered through the following pillars of analysis:

- **Quantitative estimates of total industry water usage (megalitres, ML)** to understand the relative demand of water across each user, identifying the greatest sources of absolute water demand.
- **Quantitative estimates of gross value added (GVA, reflecting economic contribution) per unit (ML) of water used** provide a benchmark for understanding how much economic value is associated, on average, with each megalitre of water used across different users, and is our core economic measure.[1]
- **Criticality of water usage,** identified using a bespoke criticality framework, was considered for each user to assess the degree to which water is essential to production processes – a core factor that may not be captured through other economic metrics.

Water is essential to feedlot operations

While water accounts for a relatively small share of industry costs (approximately 1.7%; IBISWorld 2025), it is an essential input to production, alongside other key inputs such as store cattle and feed, **supporting a number of core functions to feedlot operations** (as outlined in **Figure 0.1**).

Unlike some other water users, who may be able to adjust their water demand through changes in timing, production mix, recycling or process substitution, a significant component of feedlot water usage is critical to cattle health and wellbeing and cannot be substituted. This is primarily driven by stock drinking water, which accounts for an estimated 78–91% of total feedlot water use, with some operations also requiring water use to support feed processing (around 1–6%).

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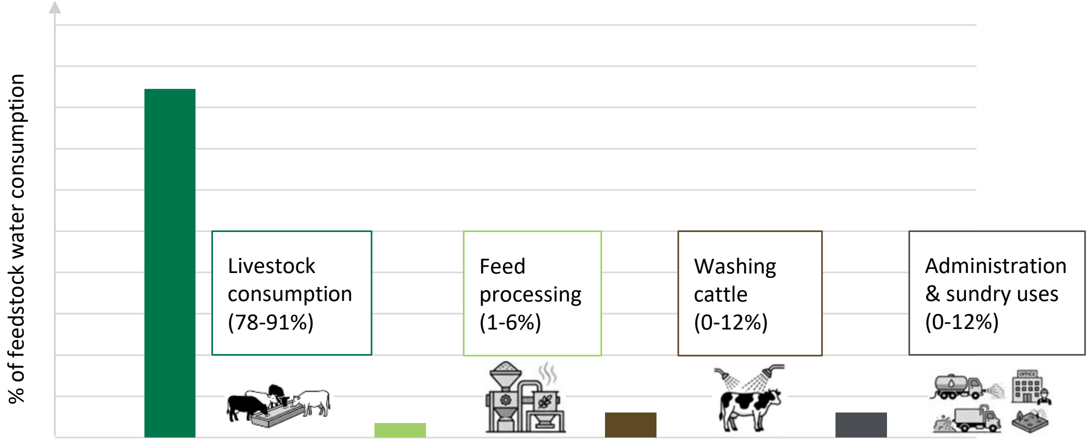
[1] Noting a measure of the marginal productivity of water to estimate value was unable to be produced due to data availability.

Figure 0.1: Water Consumption Profile



Source: Deloitte Access Economics calculations using MLA (2011) and Lean & Golder (in press)
Note: administrative and sundry uses may include watering lawns and gardens for administrative areas, cleaning water troughs, washing vehicles and dust control.

While some uses are ancillary, the primary role of water in feedlots, stock watering, is indispensable – there is no viable economic substitute. Without adequate water, cattle cannot be sustained, rendering feedlot production impossible. **This means feedlots exhibit very limited short-run flexibility in times of scarcity. Thus, water is an essential foundation for the viability and success of feedlot systems.**

Further, any future expansion in Australian feedlot capacity brings with it a growing demand for key inputs, such as water. However, additional supply is not guaranteed, as water is a scarce and highly contested resource.

Volume and value of water usage

This study estimates that **feedlots across Australia used approximately 20,000-23,000 ML** of water in 2023-24, including approximately 18,221 ML of drinking water.[2] While substantial, this represents a relatively small share of aggregate water use in Australia – accounting for **approximately 0.13% of total national extractive water use**, and **0.18% of total extractive use in the Agricultural, Forestry and Fishing sector**.[3]

Compared to other water uses in agriculture, **water use in feedlots is characterised as being high value and low volume.** This means that, in the terms of the most basic measure of gross value added per megalitre of water used ($ per ML), water use is highly valuable – at approximately **$31,000** per ML across the national feedlot industry, compared to approximately **$5,000** per ML for water use in agriculture overall (see Figure 3.4). This average masks a significant diversity in the gross value of production per ML across irrigated agriculture, which ranges from $355 per ML for rice to $23,310 per ML for nurseries.

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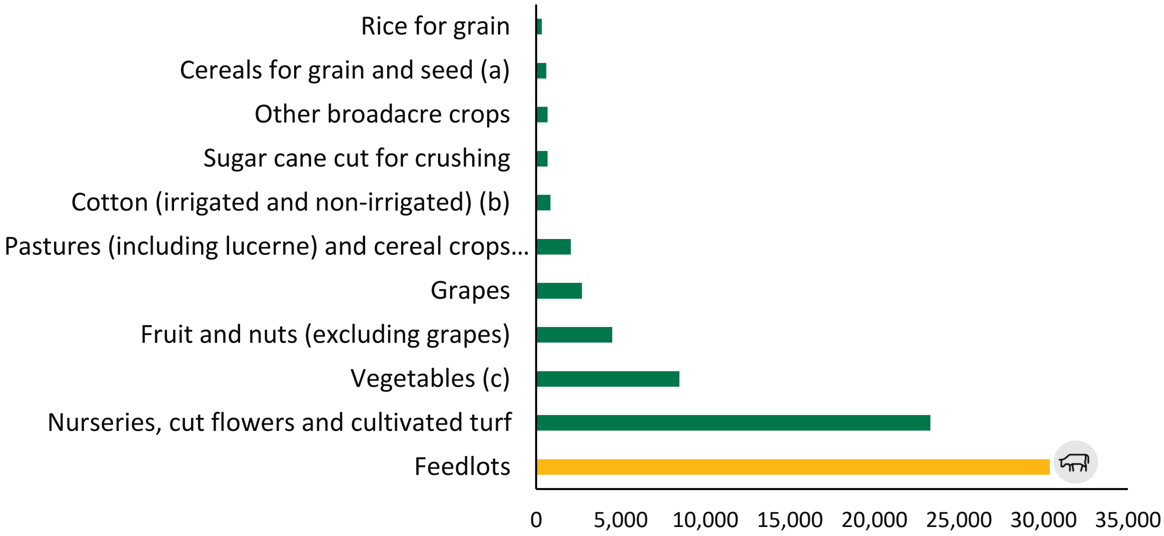
[2] This estimate includes evaporation and wastage. As such, it does not reflect technical drinking requirements, which are likely to be smaller.

[3] Note this report defines extractive water use as the sum of surface water, ground water, distributed water, desalinated water, wastewater and reuse water. It excludes water use in 'Electricity, gas, water and waste services' (see section 3.2).

Figure 0.2: Gross value of production per ML of water used in irrigated agriculture (2017-18) compared to the gross value added per ML used in feedlots (2023-24)



Source: Deloitte Access Economics calculations using ABS (2019),as well as data and methodology informed by Lean & Golder (2026) and MLA (2011)
Note: Irrigated agriculture data is from 2017-18, in GVP terms, and not adjusted for inflation.

When looking outside of agriculture at other water using parts of the economy, manufacturing ($235,692) and mining ($197,435) are on average much higher, drive by both low water use and high GVA in each sector.

While **water use and value per megalitre provide useful benchmarks, they do not fully capture how critical water is to different production**. This report utilises the four-pillar' criticality of water use' framework assessment (outlined in chapter 2.4) to consider the role of water in production for feedlots, other agricultural producers and high-value, low-water-use sectors such as mining and manufacturing.

The criticality framework found feedlots to be highly water-critical across all four dimensions, reflecting the central role of stock drinking water in production. However, this is not entirely unique within agriculture: dairy and irrigated grazing also rely heavily on water, while cropping has high technical essentiality but typically greater flexibility and lower quality-specific requirements.

Some manufacturing and mining sub-sectors also have high technical essentiality, particularly where water is required for safety, regulation or product formulation. However, where water is mainly a process input, substitution, efficiency improvements or recycling are generally more feasible.

Conclusion and next steps

These results not only reinforce the importance of considering several metrics when assessing the relative importance of water-use by different users, but material differences between feedlot water usage from some other key users.

This report provides a strong basis for a more nuanced consideration of feedlots in water policy and planning discussions, particularly distinguishing it from the broader Agriculture, Forestry and Fishing industry. It also identifies a set of possible next steps, including areas for further research and improvements in how feedlot water use is measured, compared and incorporated into decision-making.[4] As such, to build upon these findings this report future next steps may include:

1. **Improve feedlot water data and segmentation**, developing a more detailed evidence base on feedlot water use by region, climate, production system and feedlot size.
2. **Strengthen comparisons with other agricultural users**, particularly other agricultural sub-sectors by aligning time periods, data definitions and economic measures wherever possible.
3. **Estimate marginal water value and willingness to pay:** if required, more detailed analysis could be undertaken though additional approaches to considering value using estimates of marginal willingness to pay and/or the marginal value of water across industries. This would provide an additional perspective beyond average value added per megalitre, helping to show how the value of water changes as availability becomes more constrained.
4. **Extend analysis to embedded and supply-chain water use,** considering water use across the supply chain (e.g. water use in feed production, grazing cattle and downstream processing).
5. **Develop policy-relevant scarcity and allocation scenarios.** Scenario analysis testing how feedlots compare with other users under realistic water scarcity conditions, including drought, allocation reductions and changing water quality to provide insight into how sectors may respond when water availability becomes constrained.
6. **Refine the criticality framework.** The framework could be strengthened through targeted industry consultation, case studies and testing across a broader range of users to validate the assessment approach, sharpen the distinction between sectors, and support more confident application of criticality concepts in future planning and policy work.

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[4] See Chapter 2.5 further detail on limitations and Chapter 4 for Discussion, including possible next steps

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1. Background and objective

1.1 Project background

The feedlot industry has evolved and expanded significantly since the first feedlots were established in the Darling Downs in Queensland in the mid-1960s. It has played an increasingly important role in the beef industry by providing a consistent supply of premium-grade grain-fed beef to the market, smoothing fluctuations in supply driven by seasonal conditions and supporting greater productivity in the grazing industry. This value is recognised across both upstream and downstream components of the beef value chain and is reflected by the number of cattle on feed – which has trended steadily upwards from an average of 2.5 million head in 2000 to around 5.4 million head in 2024 (MLA 2025b).

The expansion of the Australian feedlot industry brings with it a growing demand for key inputs, such as water. Water is essential to feedlot operations. Not only is water consumed by cattle, but it is used to clean yards, troughs, plant and equipment, and dispersed in mister systems used to keep cattle cool in hot weather. As such, an expansion in feedlot capacity necessarily translates to increase in water demand. However, additional supply is not guaranteed – water is a scarce and highly contested resource across the country.

Despite water availability being such a critical constraint to further industry expansion, there remains a knowledge gap regarding the total volume of water use in feedlots and the economic return associated with it when compared to other agricultural and industrial sectors. This gap leaves policymakers and industry leaders without robust, comparative, and clearly contextualised evidence for decision-making around water allocation and industry growth strategies.

1.2 Objective

The objective of this work is to provide a high-level overview of the role of water in the feedlot industry, including its contribution to production and how water use and value in feedlots compare with other uses across the economy.

By considering a number of water uses across the economy, this analysis distinguishes feedlot water use from other agricultural activities with which it is often conflated or aggregated in water use discussions, such as wider agriculture and irrigated grazing. This review of water use in feedlots enables a clearer understanding of the similarities and differences in water use in feedlots compared to other uses.

The specific objectives of this research are to:

1. Quantify total water use volumes in feedlots, other agricultural commodity producers, and major users in the wider economy, identifying where the greatest sources of absolute water demand are.
2. Estimate the gross value added (GVA) per megalitre consumed, to inform a comparison of the economic contribution of different sectors relative to water consumption.
3. Determine the importance of water relative to other production inputs and assess the extent to which water is a major or minor input. This also includes the extent to which water use is critical to production, versus where it is more incidental.

More broadly, the research aims to improve understanding of how water is used in feedlots relative to other parts of the economy in terms of volume, value, and functional role. This is particularly important given that water is both a key production input and a scarce natural resource, requiring careful allocation across competing agricultural, industrial, environmental, and cultural uses.

The results from this study are intended to underpin evidence-based decisions around feedlot sector investment, regulatory frameworks, and future planning for sustainable growth. Ultimately, the findings can be used to support sustainable water management and assist the feedlot industry to continue contributing to both regional and national economies.

2. Methodology

2.1 Overview

Water is a critical resource for society, underpinning a range of human, ecological and economic activities. It is not only consumed by households and used as an input to production, but it plays an important role in support of cultural values and environmental health. As such, decisions in determining water distribution outcomes must account for the complexity of the underlying trade-offs between competing users.

Assessing these trade-offs and analysing the role of water in feedlots and other industries requires a multifaceted approach. Initially, a literature review was undertaken to understand how existing research into similar areas – particularly feedlots and agriculture – had been constructed and how it could be leveraged in this report. The findings of this review are summarised in Appendix A: Value of Water Use Literature review.

A robust base for comparison requires consideration of the scale, the value added per unit of water used and the criticality of water to each user's underlying objectives. The rationale for each is outlined below:

- **Water usage:** The scale of water use is useful to understand where large components of Australia's water demand comes from, and which sectors place the greatest absolute pressure on water resources.
- **Value added per unit of water used:** Gross value added per megalitre of water use was measured to reflect the average economic value supported per unit of water used, rather than a measure of the marginal productivity of water, due to data availability. This metric provides a benchmark to understand how much economic value is generated, on average, with each megalitre of water across different activities, and is our core economic measure.
- **Criticality of water usage:** While volume of usage and economic return are useful measures, they do not capture a comprehensive view of the importance of water across uses and across industries. In certain uses, including stock watering in feedlots, water is required as a direct and essential input to production, versus some other uses that are more ancillary, and not as critical to production. As a result, measures such as GVA per ML may not accurately reflect the true value of water within production processes on its own, without a simultaneous assessment of criticality. Hence, to assess the relative criticality of water to production, a bespoke criticality framework used to assess the degree to which water is essential to production processes in different sectors.

2.2 Water usage

Estimates of total water usage are intended to reflect the strain that different sectors place on water resources. This is intended to capture consumptive uses and exclude uses which are passive and may result in significant return flows to the environment at a similar location, time and quality.

Total water use is defined as the consumptive use of water from self-extracted sources (e.g. groundwater or surface water) and distributed supply. It excludes abstraction from the soil, as well as uses that are passive and/or result in high degree of return flows to the environment (see Appendix B: Methodology – Types of water and industries considered within this analysis for more detail).

2.2.1 Feedlots

This report draws on a meta-analysis of beef cattle feedlot water usage to estimate the water intake per head (L/d) of cattle undertaken by Lean and Golder (in press). This meta-analysis evaluated over 131 experimental comparisons, spanning various regions including the USA, Australia and South America, using a mixed model meta-regression that considers the effects of temperature, temperature humidity, heat load index, body weight, dry matter intake, average daily grain, dry matter percentage of the diet, sex, and shade on water intake. The final model presented by Lean and Golder predicts that water intake per head (L/d) averages 37.4 at an average of 20-degree Celsius average, or 13.7ML per year for standard cattle units (SCU).[5]

Using data from the Farm Transparency Project (n.d.), which has 239 facilities identified via keyword searches for feedlots, it is estimated that Australian feedlots have an average latitude of -29.79 degrees. This aligns broadly with historical maps of feedlots in Australia, such as Watts et al. (2012). The average hourly temperature from 1991-2020 at this latitude in Australia was approximately 20 degrees Celsius (BOM, n.d.), supporting the use of 37.4L per day per head as the average per head water of animals in Australian feedlots.

The MLA database provides estimates of quarterly cattle on feed, which were used to scale the per head daily drinking water estimate to total annual drinking water for all feedlots in Australia – resulting in an estimated at 18,221ML in total drinking water. It should be noted that this assumes the head on feed represent an average number of head on feed over the quarter, with a negligible effect from the volatility created by turnoff and new cattle coming on feed.

Finally, the estimated drinking water usage was scaled by estimates of the proportion of total water use that drinking accounts for, estimated as between 78-91% of total water use in feedlot operations (MLA 2011). The range of uncertainty reflects the variation in water use between feedlots across different activities. The primary driver of the range is cattle washing, which is highly variable between feedlots. When limited cattle washing is conducted, this increases the proportion of total water usage accounted for by drinking. As a result, the GVA per ML and volume metrics must be presented as a range for feedlots.

2.2.2 Other Industries

The ABS Water Accounts (ABS 2025d) provide an environmental-economic account of water usage, following guidelines from the SEEA-Water frameworks. Analysis of these accounts for 2023-24 was undertaken at the ANZSIC 1-digit level for select industries, with sub-sectors breakdowns informed by the distribution of their expenditure on Water Supply, Sewerage and Drainage Services from 2022-23 Input-Output tables.

Additionally, the ABS (2022) publication, '*Water Usage on Australian Farms*,' was also used in the analysis to provide further granularity beyond the '*ABS Water Account, Australia*' release. This publication offers a breakdown of irrigation water used by broad agricultural sub-sectors. It should be noted that this does not include ancillary water uses in these sub-sectors, and therefore should be taken as a lower bound of total water volume usage. Further, the latest data is from 2020-21, while the data for other industries is from 2023-24.

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[5] "20°C average" refers to the assumed ambient air temperature used in the meta-regression model to standardise water intake estimates. It represents a moderate, baseline climatic condition rather than a location-specific or seasonal average, and is used to isolate the effect of typical temperature conditions on cattle water consumption.

When comparing feedlots to these industries, it must be acknowledged that animals do not spend their entire lives in feedlots. Rather, feedlots are generally where animals raised on pasture are finished. Lot feeders purchase livestock from pasture grazing operations, some of which may have irrigated pasture. While feedlots and irrigated pasture have both been considered within this analysis, upstream water usage of feedlot-finished cattle while raised on irrigated pasture have not been counted as part of feedlot water use in this study.

2.3 Value of water

To compare water use across industries with fundamentally different production processes, this analysis considers gross value added (GVA) per megalitre (ML) of water as the main metric. GVA measures the contribution of an activity to the economy after accounting for intermediate inputs, and is equal to the sum of wages, gross operating surplus and the production taxes less subsidies paid by a firm.

GVA per megalitre reflects the *average* economic value supported per unit of water used, rather than a measure of the *marginal* value of water at different levels of water use. GVA per megalitre does not distinguish between the functional roles of water across economic uses, meaning industries with low, non-essential water use may appear highly productive, despite low criticality. It also excludes social, environmental and food security considerations, and can be influenced by industry structure, with capital-intensive or downstream sectors typically showing higher GVA per ML than primary production. Therefore, the metric does not seek to identify the highest priority use of water (which would require marginal productivity estimates), but rather to provide a transparent benchmark for understanding how much economic value is associated, on average, with each megalitre of water across different uses.

The value added per ML by feedlots was calculated by dividing the $659m in direct value added generated by the feedlot industry in 2023-24 by the total value of water used within the sector (MLA 2025a).

For other industries ABS national accounts (ABS 2025c) and water accounts (ABS 2025d) data are used to estimate value added per ML for 2023-24. To calculate value-added per ML for sub-sector (at the input-output industry group (IOIG) level), GVA was calculated based on the 2022-23 IO tables (ABS 2025b). Further, it was assumed that water use within each sub-sector is proportional to the industries spend on Water Supply, Sewerage and Drainage Services, based on the 2022-23 IO tables (ABS 2025b).

To calculate the value-added per ML for irrigated agricultural sub-sectors, an adjustment was required to methodology due to data limitations. The irrigated agricultural sub-sectors reported in the ABS (ABS 2022) '*Water Use on Australian Farms*' publication do not correspond directly to Australian and New Zealand Standard Industry Codes (ANZSIC) or Input Output Industry Groups (IOIG). However, they correspond to a previous ABS (2019) release, '*Gross Value of Irrigated Agricultural Production*,' which provide the gross value of irrigated agricultural production (GVP). This measures the value of commodities produced using irrigated water based on wholesale prices. Therefore, the comparison between gross value added per ML for feedlots, agriculture, mining and manufacturing to gross value of production per ML in irrigated agriculture must be taken with caution.

Gross value of production measures the total value of goods produced, while gross value added removes intermediate expenses. Therefore, using GVP will increase the value per ML measure relative to using GVA. Further, as water use for irrigated agricultural sub-sectors only includes irrigated water use and not ancillary water uses on farms, it will understate the sub-sectors water usage relative to the data used for feedlots, agriculture, mining, manufacturing and other industries – which measures total water use. While the measures are not identical, it nonetheless provides data that can be used for comparison while acknowledging what each does and doesn't capture. The differences generally mean that GVP per ML used of irrigated water in agriculture will be higher relative to an equivalent GVA per ML figure for those sub-sectors.

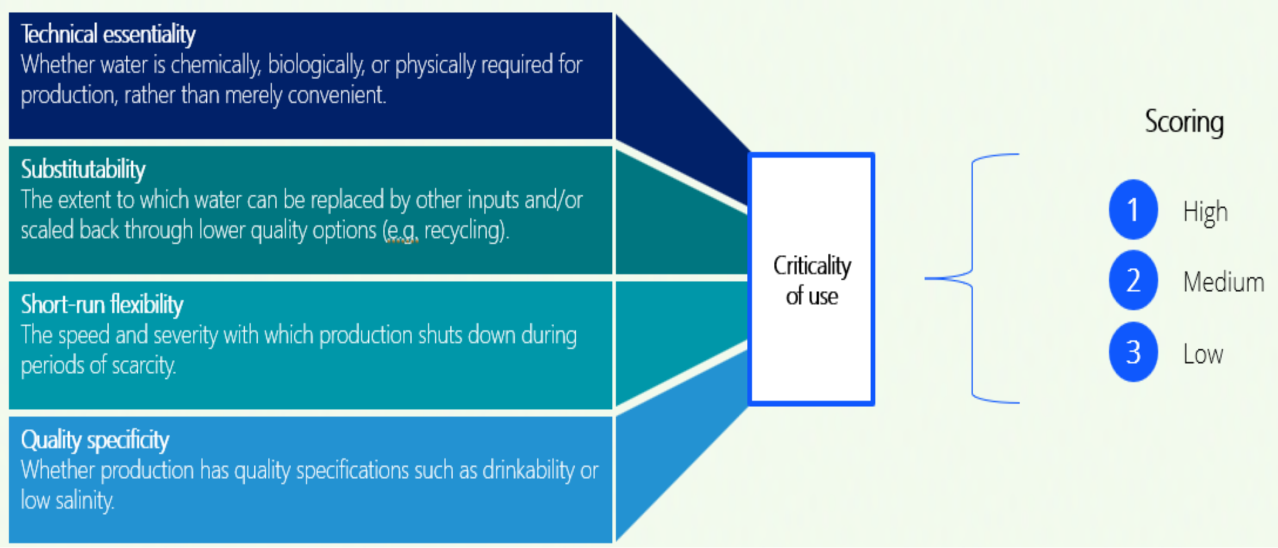
2.4 Criticality of water

While metrics such as volume of water usage and value added per megalitre are informative, they do not encompass the full significance of water across various industries. Notably, certain sectors, particularly much of agriculture, rely on water as a direct and essential input to production, in contrast to others such as recreation, where water use is more ancillary.

However, high water consumption may lead to lower average value added per ML, which can obscure the true value of water in the production process. It also doesn't reflect the flow-on value added generated by downstream industries. Indeed, meat and meat product manufacturing is the leading manufacturing sub-sector of cattle feedlots.

To address these limitations, a 'criticality of water use' framework has been developed for this analysis, structured around four assessment pillars – technical essentiality, substitutability, short-run flexibility and quality specificity (**Figure 2.1**). Collectively, these pillars provide a holistic view of the importance of water for production within an industry.

Figure 2.1: Criticality of water use framework



Source: Deloitte Access Economics

Following the development of this framework, an extensive literature review was undertaken to establish a deepened understanding of feedlots and the key comparable sectors of interest relationship with water as an input. This evidence base was then used to assign qualitative ratings (high, medium, and low) across each level of the criticality framework for each sector. Where possible, these assessments were supported by relevant statistical evidence. To see the detailed assessment across each criteria, please refer to Appendix D: Detailed results – water criticality.

2.5 Limitations of approach

This analysis is subject to several limitations that should be considered when interpreting the results.

First, gross value added (GVA) per megalitre (ML) does not distinguish between the different functional roles that water plays across industries. Industries that use relatively small volumes of water for non-essential purposes (e.g. cleaning or ancillary processes) may exhibit a high GVA per ML, despite water not being critical to their production.[6] A willingness-to-pay survey would inform a more robust measure of value, although there are practical challenges associated with this method. Further, GVA per ML does not account for social, environmental, or food security objectives, and therefore should not be used in isolation to inform water allocation decisions.

Gross value added per ML reflects average value-add rather than the marginal value of water. As a result, it does not capture how changes in water availability would affect production at the margin. In the context of feedlots, where water is a biologically essential and largely non-substitutable input, the marginal value of water is likely to rise sharply as availability falls, despite average GVA per ML appearing relatively stable.

Second, while the report addresses the criticality of water separately in section 3.4, this assessment remains difficult, particularly when comparing these differences across sectors. In part this driven by the scoring of the framework, requiring judgement and affirmative categorisation of high, medium and low. This can make it challenging to compare the relative criticality across multiple dimensions. Further, given data availability the scores are often based on qualitative evidence.

Third, the analysis of feedlots relies on average estimates of water use and returns, which may mask significant variation across operations (e.g. varying water requirements based on feedlot location). There is limited visibility of outliers regarding the distribution of water use and GVA per ML within the sector, meaning that the results may not fully capture the range of operational practices or efficiencies present in the industry.

Finally, data limitations constrain the level of granularity achievable in the analysis. In particular, the lack of up-to-date, disaggregated, water use data across industries and sub-industries necessitated the use of proxy assumptions, such as allocating water use in proportion to industry expenditure on Water Supply, Sewerage and Drainage Services based on 2022-23 input-output tables. Additionally, water use and associated value-to-use ratios for other agricultural sectors are based on a single year of data and may fluctuate from year to year, although these ratios are expected to be more stable for feedlots. While this approach provides a consistent estimation method, it may not fully reflect true water use patterns within specific sub-industries.

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[6] Additional examples include; Industries that are capital intensive or positioned downstream in the production process may record higher GVA per ML, while primary production activities, where water is a fundamental biological input, may appear less productive on this metric.

3. Results

This section presents the results of the water modelling and associated frameworks in the following order:

- *Section 3.1: Role and importance of water use in feedlots*
- *Section 3.2: Scale of water use*
- *Section 3.3: Gross value added per ML of water used*
- *Section 3.4: Criticality assessment*

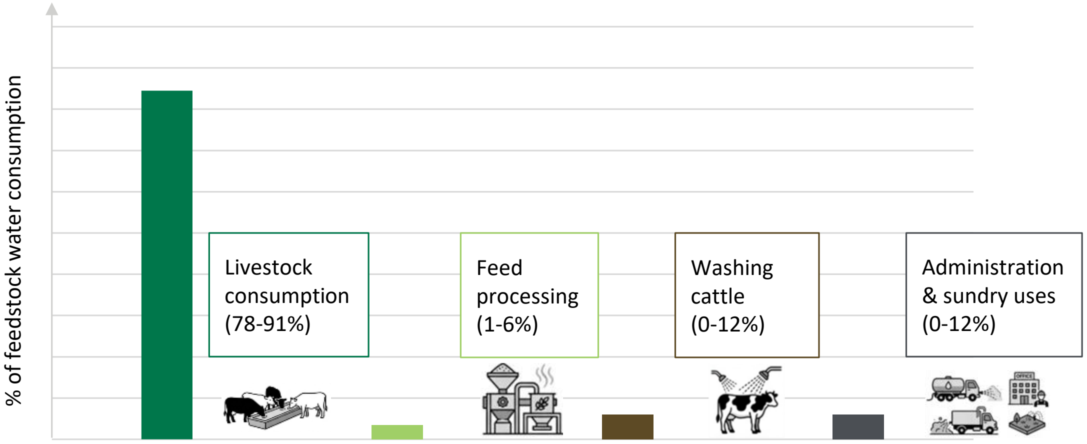
Overall, these results indicate that feedlots return amongst the highest gross value added per ML of water consumed in agriculture (estimated between $28,220 and $32,924), despite holding a fractional share of total water consumption in Australia (an estimated 0.13% in 2023-24) and the agriculture industry (an estimated 0.18% in 2023-24).

3.1 Role and importance of water use in feedlots

Water is a critical input in feedlot production, underpinning cattle health, feed intake and growth, and therefore overall feedlot production. While it is a substantial in volume terms at approximately 20,024 to 23,610 ML (see Section 3.2.1), water use generally represents a minor share of input costs for feedlots. Water costs on average represents less than 1.7% of operating costs (IBISWorld 2025).

Despite this, water has a comparable level of criticality as an input into feedlot production as feeder cattle and feed. It is primarily used for drinking water for cattle, which is essential and non-substitutable, and can act as a binding constraint on production where minimum requirements are not met (see **Figure 3.1**). For further detail regarding each water use category, see Appendix C: Detailed description of water use in feedlots.

Figure 3.1: Water Consumption Profile



Source: Deloitte Access Economics calculations using MLA (2011) and Lean & Golder (2026)
Note: administrative and sundry uses may include watering lawns and gardens for administrative areas, cleaning water troughs, washing vehicles and dust control.

These uses can be broadly divided into life sustaining and operational uses:

- **Life sustaining uses** are those required for biological functioning, without which production cannot occur – most notably drinking water for cattle (78-91% of total water usage). Water used in feed processing (1-6% of total water usage) may also be considered essential in larger operations, although some dry-processing alternatives exist.

- **Operational uses** are those where water demand can be reduced or substituted with limited impact on production. This includes categories such as cattle washing (0-12% of total water usage) as well as administrative and sundry water uses (0-12% of total water usage). Operational water usage may involve watering lawns and gardens for administrative areas, cleaning water troughs, dust suppression, washing feed preparation equipment, and diluting effluent.[7]

It should be noted that feedlots represent only one stage of the broader livestock production system. While feedlots and irrigated pasture have both been considered within this analysis, upstream water usage of feedlot-finished cattle while raised on irrigated pasture have not been counted as part of feedlot water use in this study.

3.2 Scale of water use

3.2.1 Feedlots

Feedlots use water intensively for operations – approximately 20,024 to 23,610 ML in 2023-24. This was based on a central estimate of 18,221 ML of drinking water in 2023-24. It should be noted that this data includes evaporation and wastage, so actual drinking water consumed by livestock is likely to be slightly lower.

3.2.2 Other industries

Relative to other users in the economy, the volume of water use by Australian feedlot operations is modest. In 2023-24, it is estimated that feedlots made up just 0.13% of total water usage,[8] and only 0.18% of all water use by Agriculture, Forestry and Fishing (which include feedlots).

Figure 3.2: Total water use in 2023-24 in Australia

Agriculture (71%)	11.8 Trillion Litres
Feedlots (0.1%)	20-23 Billion litres
Households (11%)	1.9 Trillion Litres
Mining (9%)	1.5 Trillion Litres
Other Industries (5%)	830 Billion Litres
Manufacturing (4%)	830 Billion Litres

Source: Deloitte Access Economics calculations using ABS (2025d); as well as data and methodology informed by Lean & Golder (2026) and MLA (2011)
Note: This project does not include Electricity, gas, water and waste services and therefore is not included within 'Other Industries'. 'Water use' includes surface water, groundwater, sea water for desalination, distributed supply, waste water and return flows. 'Agriculture' refers to Agriculture, Forestry and Fishing.

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[7] While food standards may require cattle to meet certain cleanliness thresholds through cattle washing, the effectiveness of water for cleaning is debated, with some operators suggesting that manual shearing is more effective for removing residues (Davis and Watts 2011).

[8] See Water usage 2.2 for definition of total water use

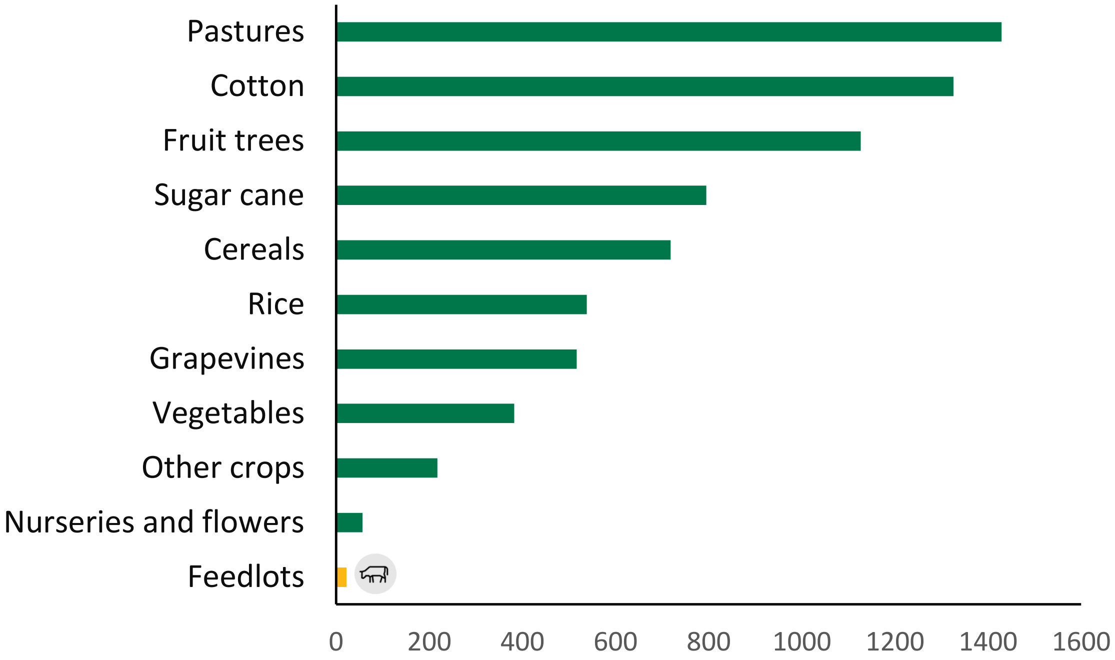
3.2.3 Agriculture, forestry and fishing

Agriculture, Forestry and Fishing is the largest user of water in Australia, consuming a total of 11.8 trillion litres of water (71% of total use) in 2023-24 – approximately 2.5 times all industries combined that were considered in this analysis.[9]

Irrigated Agriculture

The largest irrigated agricultural users are pastures for dairy and other livestock[10], as well as irrigated cereal crops that are grazed or fed off (20%), cotton (19%) and fruit/nut trees, plantation or berry fruits (16%). Notably, feedlots used a significantly lower quantity of water in 2023-24 than even the smallest of the irrigated producers in 2020-21 (not accounting for their ancillary water uses).

Figure 3.3 : Water volume applied to irrigated agriculture (2020-21) and feedlots (2023-24) (GL)



Source: Deloitte Access Economics using ABS (2022), as well as data and methodology informed by Lean & Golder (2026) and MLA (2011)

Note: Feedlots data is from 2023-24 while irrigated agriculture is 2020-21.

3.2.4 Other key Industries

Households

Households used approximately at 1.9 trillion litres of water in 2023-24, making them the second largest category of water users of water in Australia (11% of total use). Each Australian household is estimated to use an average of 174kL of water per year, coming from distributed supply (ABS 2025a). While there are no comprehensive studies that disaggregates these by essential and non-essential uses, some government-owned utilities provide indicative estimates. For example, a study found by Hunter Water (2026) suggests the average household basin and sink water usage – a proxy for essential uses – in the Hunter Region will only account for 4% of total usage, with the largest

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[9] As outlined in the methodology these calculations exclude water use for electricity, gas, water and waste services

[10] Non-irrigated stock uses of water, such as livestock consuming water from a dam, are not metered and hence no data is available.

consumers being showers (29%), garden (20%) and washing machine (15%). Similarly, Sydney Water (2026) suggest that each person in Sydney uses 12% for inside taps, with the largest uses being showers (26%), outdoors (23%) and toilets (20%).

Mining

Mining used approximately 1.5 trillion litres of water in 2023-24, making it the third largest user of water in Australia (9% of total use excluding electricity, gas, water and waste services). Deloitte estimates that sub-sectors with the largest usage include *Non-ferrous Metal Ore Mining* (43%), *Coal Mining* (24%) and *Iron Ore Mining* (13%).

It should be noted that a high proportion of water usage in mining is expected to come from mine dewatering. Indeed, an Australian Water Association report notes that mine dewatering accounts for approximately 65% of water abstraction for mining in Western Australia (Ferguson 2020). If we assume 65% of water use is for dewatering, mining would have only used 533 billion litres for other purposes in 2023-24 – less than manufacturing.

Other Industries

Other industries[11] used 830 billion litres of water in 2023-24, making it the fourth largest user of water in Australia (5% of total use excluding electricity, gas, water and waste services). This is despite capturing all industries in Australia apart from *Mining, Manufacturing, Electricity, Gas, Water and Waste services* and *Agriculture, Forestry and Fishing*. Deloitte estimates that largest users of water in this category were likely *Professional, Scientific and Technical Services* (17%), *Non-residential Property Operators* and *Real Estate Services* (11%) and *Construction Services* (12%).

Manufacturing

Manufacturing used 611 billion litres of water in 2023-24, positioning it as the lowest user of water in Australia (4% of total use excluding Electricity, Gas, Water and Waste services). Deloitte estimates the largest users of water were *Meat and Meat Product Manufacturing* (10%), *Motor Vehicles and Parts* (9%) and *Human Pharmaceutical and Medicinal product manufacturing* (7%).

Given *Meat and Meat Product Manufacturing* is the primary downstream user of feedlot output, water use in this sector represents an important extension of total water requirements across the beef production value chain. It is estimated that 7.4kL of water is used per tonne of hot standard carcase weight (HSCW) when processing beef (Australian Beef Sustainability Framework 2025).

3.3 Gross value added per ML of water used

Gross value added (GVA) per megalitre reflects the average economic value supported per unit of water used, rather than a measure of the marginal productivity of water. This measure will provide a benchmark for understanding how much economic value is associated, on average, with each megalitre of water used across different industries.

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[11] Includes construction, wholesale trade, retail trade, accommodation and food services, transport, postal and warehousing, information media and telecommunications, financial and insurance services, rental, hiring and real estate services, professional, scientific and technical services, administrative and support services, public administration and safety, education and training, health care and social assistance, arts and recreation services, and other services.

Why GVA per ML should be used as a complementary indicator to other metrics when assessing value of water use:

- Does not capture the criticality of water use, social, environmental or food security objectives.
- Sensitive to industry structure; capital-intensive or downstream industries may appear more "productive" than primary producers.
- Ignores variation in water availability by location, timing (e.g. seasonal reliability) and quality, which can impact the value of its use to each economic unit/water user.

3.3.1 Feedlots

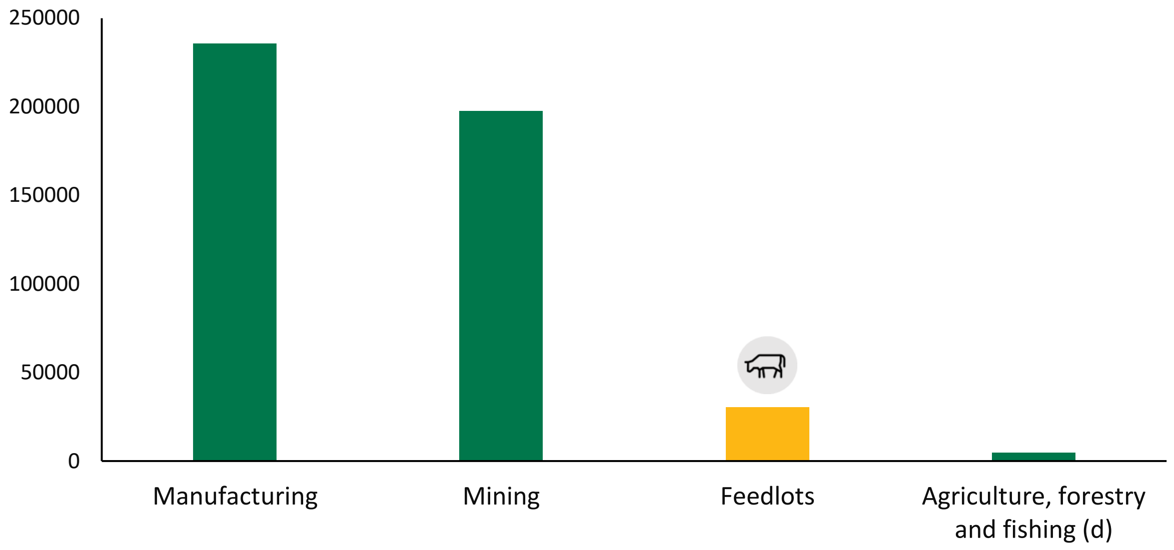
Feedlots were estimated to contribute between $28,220 and $32,924 in gross value-added (GVA) to the Australian economy in 2023-24 for every ML of water used. This was higher than the gross value of production (GVP) per ML of water used in all irrigated agricultural sub-sectors in 2017-2018.

3.3.2 Other Industries

The estimated GVA per ML of water used in 2023-24 across aggregate sectors in the economy was highest in Manufacturing (approximately $235,692), followed by Mining ($197,435), and Agriculture, Forestry and Fishing ($4,639). Therefore, the GVA per ML of water used feedlots is smaller than the average for Mining and Manufacturing, but larger than the average for Agriculture, Forestry and Fishing. This is due to low water usage in manufacturing and mining than agriculture, where it is a biologically essential input.

Given that mine dewatering accounts for a large share of mining's total water use (around 65%), and its return flows to the environment are high, a measure was also calculated excluding the usage due to dewatering. Removing this component results in mining recording the highest GVA per ML among industries ($548,430). This adjustment underscores the importance of distinguishing between different forms of extractive water use when making cross-industry comparisons.

Figure 3.4: Value added ($ per ML) – 2023-24, by ANZSIC digit-1 industry



Source: Deloitte Access Economics using ABS (2025c) and ABS (2025d), as well as data and methodology informed by Lean & Golder (2026) and MLA (2011)

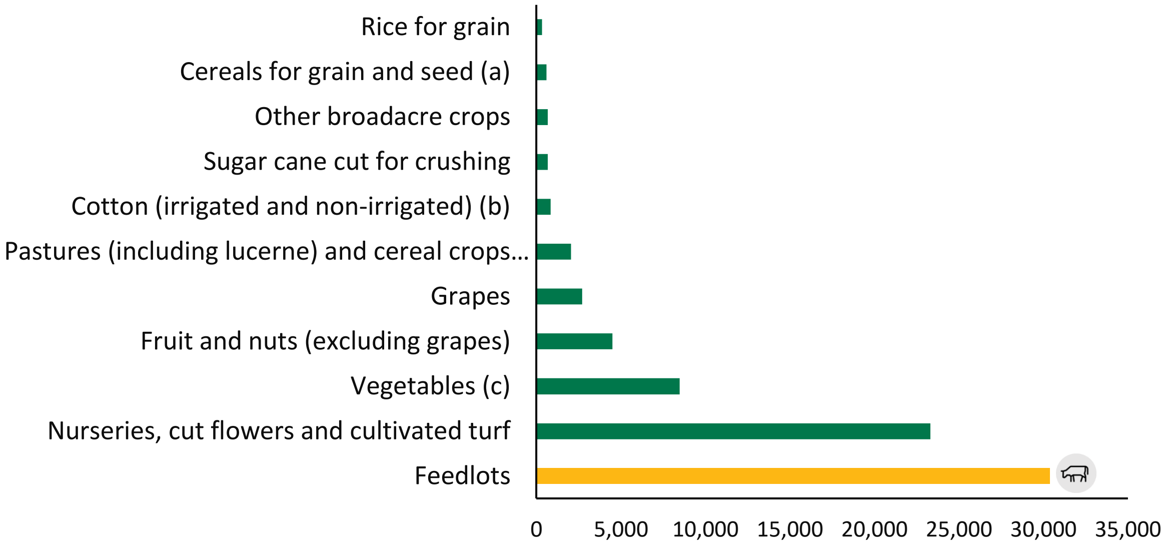
3.3.2.1 Agriculture, Forestry and Fishing

The Agriculture, Forestry and Fishing industry overall in Australia was estimated to return $4,639 in GVA per ML of water used in 2023-24. This is significantly lower than feedlots and highlights key structural differences in feedlot production systems – the comparatively high-value, low-volume role that water plays within feedlot systems relative to other agricultural activities.

Even when disaggregated from the sector-wide average, feedlots continue to exhibit higher GVA per ML than the GVP per ML observed across all irrigated agriculture sub-sectors. The highest GVP per ML for irrigated agriculture in 2017-18 was within the 'nurseries, cut flowers and cultivated turf' sub-sector ($23,310).

This reflects the structural differences of feedlot production systems compared to much of agriculture, particularly the extent to which water use is embedded in upstream and downstream processes for feed production, rather than applied directly on-site. Irrigated agricultural sub-sectors also capture broader production activities (e.g. 'fruits and nuts' capture all fruit and nut varieties in Australia). As a result, feedlots are not directly comparable to other agricultural activities and should be considered separately when analysing water distribution and use across the sector.

Figure 3.5: Gross value of production per ML of water used in irrigated agriculture (2017-18) compared to the gross value added per ML used in feedlots (2023-24)



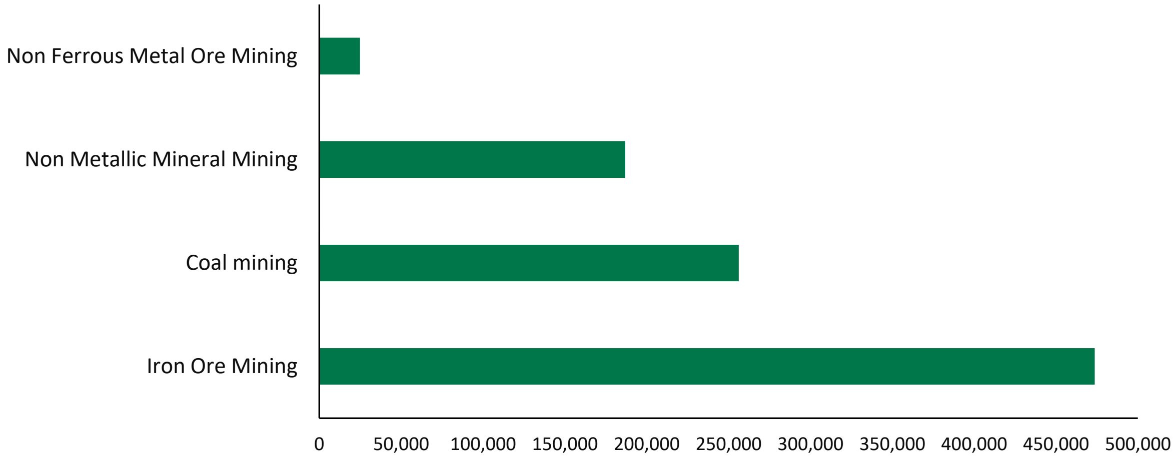
Source: Deloitte Access Economics using ABS (2019), as well as data and methodology informed by Lean & Golder (2026) and MLA (2011)
Note: Irrigated agriculture data is from 2017-18, in GVP terms, and not adjusted for inflation.

3.3.2.2 Mining

The mining industry in Australia was estimated to return $187,435 in GVA per ML of water used in 2023-24. This is significantly higher than feedlots, reflecting the substantially greater economic output of the mining sector – whose gross value added is more than five times that of Agriculture, Forestry and Fishing – combined with its comparatively lower water use. This elevated GVA is driven by factors such as strong global demand for commodities, high export prices, and the capital-intensive nature of mining, which enables large-scale production and the capture of significant resource rents.

Estimates were also derived for GVA per ML at the sub-sector level in 2022-23, focussing on industries where water is a key process input. The highest GVA per ML was within the *Iron Ore* sub-sector ($473,703), followed by *Coal mining* ($256,151) and *Non-metallic Mineral Mining* ($186,891). Notably, *Non-ferrous Metal Ore Mining* records a comparatively low GVA per ML ($24,892), reflecting its smaller share of industry GVA (5%) alongside a disproportionately high share of estimated spend on water (43%). This provides an important counterpoint, demonstrating that even within high-value industries, the gross value added per ML of water can vary substantially depending on the specific production process and its water intensity.

Figure 3.6: Gross value added ($) per ML in mining for 2022-23, by IOIGs where water is a key ingredient

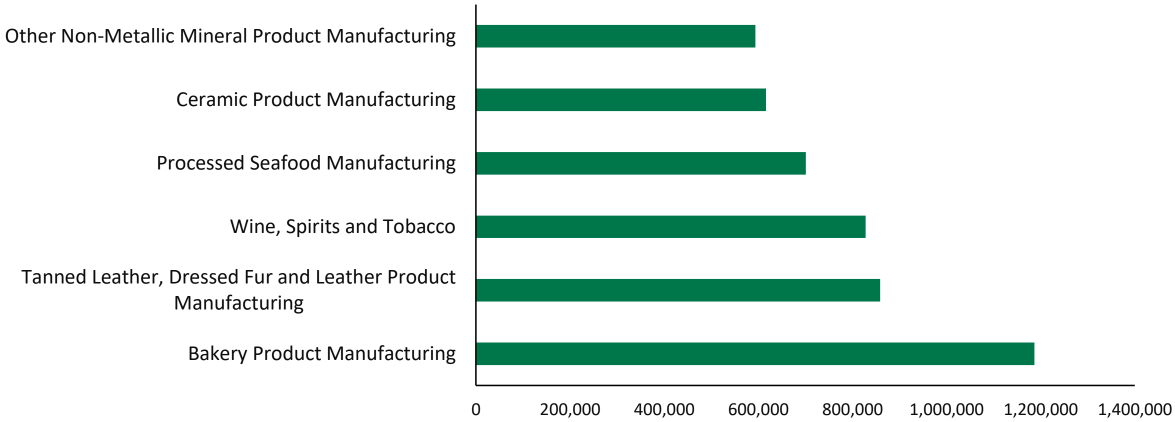


Source: Deloitte Access Economics using ABS (2025b) and ABS (2025d)

3.3.2.3 Manufacturing

The manufacturing industry in Australia was estimated to return $235,692 in GVA per ML of water used in 2023-24. This is significantly higher than feedlots. Similar to mining, the impact of capital intensity and relatively low water usage in manufacturing will contribute to high estimates of GVA per ML. While certain manufacturing sub-sectors will rely on water as a key input (e.g. food processing where water is an ingredient, pharmaceutical manufacturing), its importance varies considerably across the broader industry. Indeed, manufacturing overall was the lowest aggregate user of water (4% of total usage in 2023-24). Estimates of GVA per ML were derived at the sub-sector level for 2022–23, focusing on industries where water is a key process input. The highest GVA per ML was within *Bakery Product Manufacturing* ($1,186,543), *Tanned Leather Dressed Fur and Leather Product Manufacturing* ($858,692) and *Wine, Spirits and Tobacco* ($827,833). Importantly, many of these sub-sectors rely heavily on upstream agricultural inputs (e.g. grains, grapes), where water use is substantial but not captured within manufacturing's direct water use. As a result, while the full value added from processing is attributed to manufacturing, a significant share of the underlying water intensity is embedded upstream, which can inflate GVA per ML when assessed at the manufacturing stage alone. This same factor influences feedlots, where water used in external feed production is not counted.

Figure 3.7: Gross value added ($) per ML in manufacturing for 2022-23, by IOIGs where water is a key ingredient



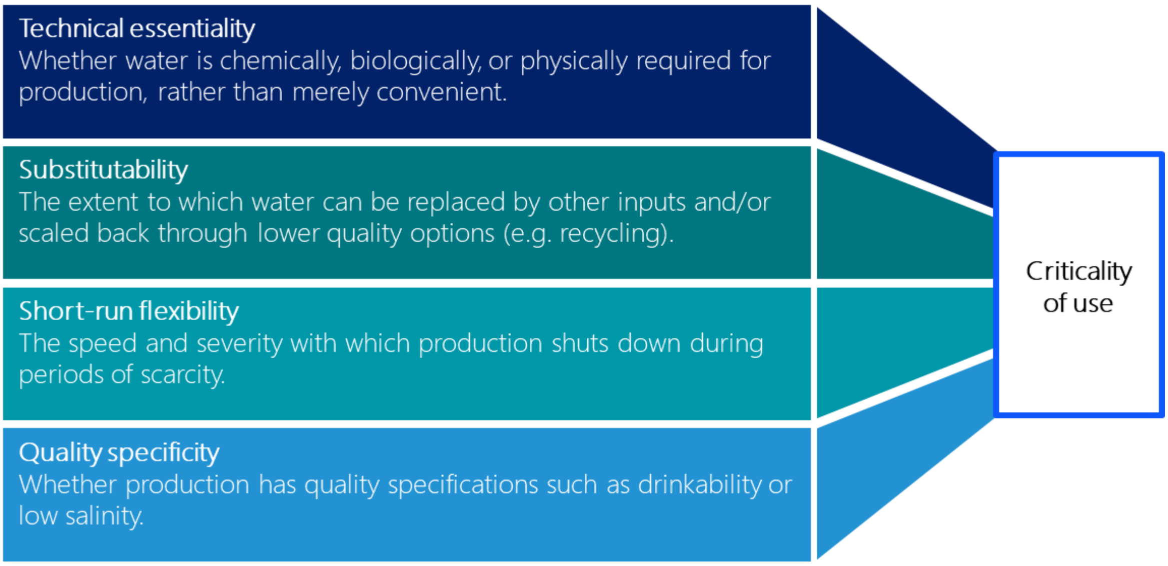
Source: Deloitte Access Economics using data from ABS (2025b) and ABS (2025d)

3.4 Criticality Assessment

To accompany estimates of volume and gross value added per ML, this chapter assesses the criticality of water to industry production using the four-pillar 'criticality of water use' framework (as introduced in **chapter 2.4**).

This framework has been designed to provide a holistic view on industry water use through the consideration of water across four pillars key to industry production: technical essentiality, substitutability, quality specificity and short-run flexibility, as shown in **Figure 3.8**.

Figure 3.8: Water criticality scoring framework



Technical essentiality
Whether water is chemically, biologically, or physically required for production, rather than merely convenient.

Substitutability
The extent to which water can be replaced by other inputs and/or scaled back through lower quality options (e.g. recycling).

Short-run flexibility
The speed and severity with which production shuts down during periods of scarcity.

Quality specificity
Whether production has quality specifications such as drinkability or low salinity.

Source: Deloitte Access Economics

The framework has been applied to 11 key water users across the economy, covering major agricultural, manufacturing, and mining sub-sectors.

For each pillar, ratings reflect the criticality of water to production or use. A high rating indicates that water is more essential, harder to substitute, more quality-specific, or less flexible in the short run; a low rating indicates that water use is more discretionary, replaceable, tolerant of lower-quality sources, or easier to reduce during scarcity.

To help guide the attribution the ratings to each sub-sector, the following types of questions were asked:

- **Technical essentiality:** Is water physically, chemically or biologically required for output to occur? Would reduced access materially affect production, welfare, safety or product integrity?
- **Substitutability**: Can water be replaced or materially reduced through another input, technology or process, such as recycling, dry processing, purchased feed, process changes or closed-loop systems?
- **Quality specificity**: Does the activity require water with specific quality characteristics, such as potable quality, low salinity, low contaminants, defined process chemistry or regulatory-grade water?
- **Short-run flexibility:** Can output continue during short-term scarcity through temporary lower utilisation, timing changes, changed production mix or temporary process adjustments?

Summary of Criticality findings

A high-level overview of findings from the water criticality framework is shown in **Figure 3.9**. Ratings reflect the criticality of each attribute – for example, a high substitutability rating indicates that water is difficult to replace, not that substitution is readily available.

The criticality framework highlights that feedlots and other livestock-related activities are among the most water-critical uses in the economy, driven by the biological necessity of water for animal survival, alongside quality requirements and limited scope for substitution or adjustment. As show in feedlots and dairy score consistently high across all four dimensions. Irrigated agricultural systems also show high technical dependence on water, though with some differentiation in flexibility. Perennial crops remain highly constrained due to ongoing water requirements and sunk investment, while annual crops exhibit relatively more short-run flexibility through adjustments to planting decisions.

In contrast, mining and manufacturing display a generally lower criticality profile. While certain sub-sectors such as meat processing, pharmaceuticals, and some mineral processing activities depend on water as essential to production, others have greater capacity to recycle, substitute or modify processes in response to scarcity. This results in more moderate scores across substitutability and short-run flexibility, particularly in sectors such as motor vehicle manufacturing or bulk commodity mining, where production can often be adjusted without immediate shutdown. A similar pattern is observed in household and recreational water use. Although there is a core essential component (e.g. drinking and sanitation), a larger share of demand is discretionary or more flexible in the short term, meaning these users are less water-critical overall than core production uses such as feedlots.

Taken together, these results reinforce that not all water use is equal in its role within production systems. Sectors such as feedlots combine high technical dependence with limited flexibility, meaning that even small reductions in water availability can have immediate impacts on output. By comparison, sectors with lower criticality or greater flexibility may be better able to absorb or adapt to constraints. This underscores the importance of interpreting water use metrics such as volume or GVA per ML alongside criticality, to provide a more complete and policy-relevant understanding of how water underpins different economic activities.

Detailed industry-by-industry assessment is provided in Appendix D: Detailed results – water criticality.

Figure 3.9: Overall water criticality framework scores for in-scope industries

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Agriculture				
Feedlots	High	High	High	High
Dairy	High	High	High	High
Irrigated Grazing	High	High	Medium	High
Irrigated Crops – Perennial	High	High	Medium	Medium
Irrigated Crops – Annual	High	Medium	Medium	Low
Manufacturing				
Meat and Meat Product; Pharma	High	High	High	High
Manufacturing – Motor vehicles and parts	Medium	Medium	Medium	Medium
Mining				
Non-ferrous metal ore	High	Low	Medium	High
Iron ore	Medium	Medium	Low	Low
Coal	Medium	Medium	Low	Medium

Source: Deloitte Access Economics

4. Discussion

This chapter draws together the main findings of the analysis and highlights the implications for understanding feedlots within broader water allocation and policy discussions.

4.1 Key findings

This project has assessed water use in Australian feedlots, considering its scale, the economic value added associated with its use, and the criticality of its use relative to other agricultural and industrial water users. The key findings from this project are as follows:

- **Feedlots account for a small share of aggregate Australian water use.** Australian feedlots are estimated to have used approximately 20,000 to 23,000 ML of water in 2023-24. This represents around 0.13% of total measured water use in Australia that year, or 0.18% of water use in Agriculture, Forestry and Fishing.
- **Water is a low-cost but critical input to feedlot production.** Although the cost of utilities (which includes water and other inputs such as fuel and power) represent less than 1.7% of feedlot costs, water is essential to cattle survival, health, feed intake and performance.
- **Most feedlot water use is tied to drinking requirements, which is critical to production and non-substitutable.** Stock watering accounts for the majority of feedlot water use, estimated at approximately 78%-91% of total use. This limits short-run flexibility in times of scarcity without significantly affecting feedlot performance and animal welfare.
- **Feedlots generate relatively high economic value per megalitre within agriculture.** Feedlots were estimated to generate approximately $28,200 to $32,900 in gross value added per megalitre of water used. While lower than manufacturing and mining, this is materially higher than the average for Agriculture, Forestry and Fishing and higher than the gross value of production per megalitre observed across the irrigated agricultural sub-sectors considered in this report (noting the measures are not directly comparable for agricultural sub-sectors[12]).
- **Feedlots are not directly comparable to many other agricultural activities.** Other agricultural systems may use larger volumes of water, particularly where irrigation is involved, but may also have different adjustment mechanisms in times of water scarcity, such as reducing planted intensity (or no planting), switching crops, or altering production timing. Feedlots have more limited flexibility because the dominant water use is linked to animal drinking requirements, the meeting of which is essential to any feedlot production at all.

  Criticality is an important complement to water-use and value metrics. Volume of water use and gross value added per megalitre do not independently capture the importance of water to operations and output. The criticality assessment shows that feedlots have high technical essentiality, low substitutability, high quality specificity and low short-run flexibility.

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[12] Due to data availability, irrigated agricultural sub-sectors are measured using irrigated water use rather than total water use, and gross value of production rather than gross value added. These estimates are provided for comparison; however, both measures are likely to inflate the value-per-use ratio relative to if measured through GVA per ML of total water use (which is used for other industries). In addition, the data is only available for FY18, meaning the estimates may be affected by inflation and changes in industry production values or water use over time.

- **Aggregate agricultural benchmarks can obscure feedlot-specific risks and characteristics.** Treating feedlots as part of a broad agricultural category may understate their relatively high economic value per megalitre and overstate their overall water consumption as well as their capacity to adjust water use during scarcity. More disaggregated analysis, teasing feedlot water use out more from other water uses within agriculture, would improve the evidence base for water planning and industry policy.

4.2 Conclusion

The overall conclusion from this analysis is that feedlots should be treated as a distinct water user in policy, planning and comparative assessment, from the rest of agriculture. Their direct water use is small in aggregate terms, but this should not be interpreted as meaning water is of limited importance to the sector. Rather, the relatively low aggregate volume understates the importance of water to feedlot production because it is a biologically essential input and the majority of use is tied to livestock drinking requirements that are immediate, non-substitutable and closely linked to animal health, welfare and production outcomes. This makes feedlots materially different from some other users whose water demand can be adjusted more readily through changes in timing, production mix, recycling or process substitution.

The report also shows that common comparison metrics such as total water use or gross value added per megalitre are informative, but incomplete when used on their own. Feedlots have a higher value added per ML of water used than the average in agriculture, yet the more important insight is that criticality changes how these results should be interpreted. A sector using relatively little water can still face severe consequences from water scarcity if that water is essential to maintaining output and welfare standards. This also means that simple comparisons across industries can be misleading if differences in capital intensity, operational flexibility and the functional role of water in production are not considered. For this reason, decisions about water planning, allocation and drought response should not rely solely on aggregate averages or broad sector categories. They should also account for the functional role of water, the degree of short-run flexibility available to each user, and the consequences of reduced access. On this basis, feedlots warrant more explicit consideration in future water policy discussions than they typically receive when grouped within broad agricultural averages.

4.3 Next steps

The findings from this report provide a stronger basis for considering feedlots in water policy and planning discussions, but they also point to several practical next steps. These are not only areas for further research; they are also priorities for improving how feedlot water use is understood, compared and reflected in future decision-making. In particular, the next phase of work should focus on strengthening the evidence base, improving comparability with other sectors, and translating the findings of this report into policy-relevant guidance.

Next steps could include:

1. **Improve feedlot water data and segmentation:** A priority should be to build a more detailed evidence base on feedlot water use by region, climate, production system and feedlot size. This would allow stronger benchmarking across the industry, better identification of operational efficiency opportunities, and more robust assessment of how water demand changes under different seasonal conditions.
2. **Strengthen comparisons with other agricultural users:** Future work should improve the comparability of feedlots with other agricultural sub-sectors by aligning time periods, data

definitions and economic measures wherever possible. This would reduce the risk of misleading comparisons and provide a clearer basis for assessing where feedlots sit relative to irrigated crops, grazing systems and dairy in both value and water criticality terms.

3. **Estimate marginal water value and willingness to pay:** This study provides a high-level indication of value of water use between different users. Should more detailed analysis be needed in the future, it could be through the collection of additional data required to estimate marginal willingness to pay and/or the marginal value of water across industries. This would provide an additional perspective beyond average value added per megalitre, helping to show how the value of water changes as availability becomes more constrained.
4. **Extend the analysis to embedded and supply-chain water use:** This report has focused on direct water use, but a fuller picture would also consider embedded water across the supply chain. For feedlots, that includes upstream production such as feed production and grazing cattle, lot feeding (currently included) and downstream processing such as meat manufacturing. Extending the analysis in this way would support better end-product comparisons and provide a more complete understanding of the water implications of different production systems.
5. **Develop policy-relevant scarcity and allocation scenarios:** A valuable next step would be to test how feedlots compare with other users under realistic water scarcity conditions, including drought, allocation reductions and changing water quality. Scenario analysis of this kind would make the report more directly useful for policy by showing not only how much water different sectors use, but how each sector is likely to respond when water availability becomes constrained.
6. **Refine the criticality framework through consultation and case studies:** The framework developed in this report is a useful foundation, but it could be strengthened through targeted industry consultation, case studies and testing across a broader range of users. This would help validate the assessment approach, sharpen the distinction between sectors, and support more confident application of criticality concepts in future planning and policy work.

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Appendix A: Value of Water Use Literature review

Literature review

This section outlines the literature reviewed to define the scope of economic units and water use included in the study, as well as the methodology adopted to assess value.

The impact of water use on the environment varies significantly between uses. To enable a fair comparison between feedlots and other industrial users, this report defines water use based on the specific manner in which it is abstracted from the environment.

A review of industry-leading frameworks for water analysis identified the United Nations (2012) System of Environmental-Economic Accounting for Water (SEEA-Water) as a suitable approach. This framework is used to measure water flows and assets between the environment and the economy. The temporary or permanent removal of water from the environment for use by economic units is referred to as 'water abstraction.' This abstraction can be disaggregated by the source, including surface water, groundwater, soil water, and other environmental sources (e.g. the ocean). Return flows are recorded when water leaves the economy and returns to the environment, typically following use or treatment.

The SEEA-Water framework notes that soil water abstraction may be identified separately for analytical purposes, given its unique characteristics when compared to abstraction of surface or groundwater. Rain-fed agriculture is classified as abstraction from soil water; therefore, return flows to the environment must be considered, since not all precipitation is taken up by crops. Other precipitation and evapotranspiration processes also influence the level of soil water abstraction. Given the complexity of soil water abstraction, it was not included as a water source in the analysis.

The SEEA-Water guidelines also recommend disaggregating certain uses like hydroelectric power generation and mine water. Hydroelectric power generation uses large volumes of water to power turbines, but after the water passes through it is returned to the environment immediately. Likewise, mine dewatering allows for significant return flows.

Given the purpose of this research, and the clear distinctions made in the SEEA-Water framework based on the nature of water abstraction and return flows, a reduced set of economic units has been identified for analysis. Further detail on how this has been applied within this analysis can be found in Appendix B: Methodology – Types of water and industries considered within this analysis.

Methods for assessing the economic value of water

Prior to adopting a gross value-added approach to assess the economic contribution of water use across industries, a literature review was undertaken to evaluate alternative methodologies and their suitability for this study. This review identified a range of studies which estimated the value of water use across industries using different approaches depending on data availability and analytical objectives. These methods are outlined below, organised by methodological type. The gross value added method was ultimately adopted in this study given data availability and the broad sectoral coverage required; more complex methods are likely to be restricted by data limitations.

Asset value of water

A 2006 report by the Western Australian Department of Primary Industries and Regional Development (DPIRD 2006) examined the asset value of water in irrigation activities in Western Australia. The analysis is based on the premise that water generates returns similar to other productive assets, with the expected stream of residual profits from water use defining an upper bound on irrigators' willingness to pay for water rights.

The annual return to water is estimated using a gross margin approach, where returns are allocated across land, capital and water inputs. The derived value represents the "long-term" asset value of water. However, this estimate may overstate true willingness to pay, as residual rents also capture returns to risk and entrepreneurship. Estimated asset values in the South West included $13,523/ML for potatoes, $6,275/ML for carrots and $2,599/ML for cauliflower. For perennial horticulture, values include $9,309/ML for apples, $3,834/ML for plums and $3,266/ML for oranges, while table grapes and wine grapes are valued at $4,654/ML and $3,095/ML respectively. Dairy pasture returns are estimated at $629/ML under flood irrigation and $1,860–$4,701/ML under sprinkler systems. For beef production, a comparison of dryland gross margins and irrigated feed costs suggests returns of $10/ML or less, excluding labour and capital costs, implying that the asset value of water in beef production is likely close to zero. In the Kimberley region, irrigated pasture is used for cattle finishing, though available evidence suggests water values are lower than for crop production.

Gross margin

CottonInfo's 2025-26 Australian cotton gross margin budgets, compiled by AgEcon (CottonInfo & AgEcon 2026), estimate gross margin per megalitre using indicative crop budgets that compare gross income with variable production costs. In the latest 2025 spreadsheet, the "hotter, drier" scenario generates a gross margin of $410/ML, while the "wetter, cooler" scenario generates a higher gross margin of $565/ML. This suggests that, under the budget assumptions, lower irrigation requirements can increase the average gross margin generated per megalitre. However, this should not be interpreted as showing that water is less valuable in dry conditions, because gross margin per ML is an accounting measure of average crop return per unit of water used, not a measure of the scarcity price or marginal value of water.

Shadow price

Qureshi et al. (2010) estimate the private economic value of irrigation water in the Murrumbidgee catchment using a residual (shadow price) framework. Water value is defined as the net return remaining after deducting all non-water production costs (capital, fixed and operating) from total output, representing irrigators' maximum willingness to pay (including producer surplus). A key contribution of the study is the explicit modelling of sunk capital and asset fixity, particularly for perennial crops, incorporating crop life cycles, optimal replacement timing and net present value over an infinite horizon. Results show significant variation across activities, with annual crops such as rice, cereals and dairy yielding approximately $55/ML, $64/ML and $67/ML respectively, while higher-value products such as vegetables and perennial horticulture (citrus, almonds, grapes) yield $137/ML, $107/ML, $120/ML and $124/ML respectively. The study also finds that water values for perennial crops are highly sensitive to asset age, with willingness to pay highest in early productive years and declining as assets approach the end of their economic life.

Marginal Substitution

Agripath (2017) estimates dairy irrigators' willingness to pay (WTP) for rural bulk water in the North Coast and South Coast valleys using a marginal substitution approach. The method compares the cost of producing irrigated pasture with the cost of purchased feed (expressed in $/kg of dry matter), with water valued at the point where irrigated pasture reaches cost parity with bought-in feed. The study finds that irrigated pasture was around 8 cents/kgDM cheaper than purchased feed, narrowing to approximately 5 cents/kgDM under proposed WaterNSW prices for 2019–20. Farm-level heterogeneity results in a wide range of estimated WTP, from approximately $17/ML for less efficient irrigators to $166/ML for highly efficient operators with modern infrastructure. These estimates are broadly consistent with observed temporary water prices in inland regions such as the Lachlan ($55/ML) and Murray–Goulburn ($70/ML), although the study notes that these markets are more developed and diversified than coastal valleys.

Gross value added per ML

The GVA per ML metric measures the value of output generated for every million litres of water consumed, after accounting for the costs of intermediate inputs. The GVA per ML approach has historical precedent, including use in governmental reports (Australian Government Treasury 2006; DCEEW 2011) and a CSIRO report (Prosser, Wolf & Littleboy 2011).

Non-economic value

There are alternative ways of conceptualising the value of water beyond direct economic output. In some industries, the use of water contributes to outcomes that underpin broader societal welfare rather than measurable market value. For example, water used in agriculture enables the production of food, which is fundamental to food security and human survival. Similarly, water used as an excipient or processing input in pharmaceutical production supports improved health outcomes, workforce participation, and the accumulation of human capital across the economy.

While these uses may not always generate high gross value added per unit of water, their societal importance is disproportionately large. However, incorporating these dimensions into a unified valuation framework presents significant methodological challenges, particularly in quantifying non-market benefits and comparing them consistently across industries. As a result, although these considerations are acknowledged as critical, they are outside the scope of this report, which focuses on economic and operational measures that can be robustly quantified and compared.

Appendix B: Methodology – Types of water and industries considered within this analysis

To appropriately benchmark the feedlot industry, economic units were identified for assessment within this analysis. Leveraging the SEEA-Water framework outlined in chapter 0, six additional economic units have been identified and captured within this analysis. These units compete with feedlots for allocable water resources based on their abstraction of water in a manner where:

- There are not significant return flows to the environment at the same location, time and quality.
- The abstraction occurs from surface, groundwater or other protected sources (e.g. the ocean), but not from soil. This includes distributed water supply.

The economic units, or water users, in scope for this analysis include:

- **Livestock production (grazing):** Water use by grazing enterprises is included to the extent that they abstract managed water resources. The use of precipitation by pastures is not considered.
- **Dairy production:** Dairy production is included where water is abstracted for livestock drinking and operations. The use of precipitation for pasture growth or fodder is excluded.
- **Irrigated agriculture:** Irrigated cropping is included where water is abstracted from surface or groundwater sources, or from distributed supply systems. A distinction is made between perennial and annual crops, reflecting the differences in criticality of water use between the two when considering factors such as sunk capital investment and long-term production viability. Soil water abstraction from rainfall is not considered.
- **Mining:** Mining is included where water is abstracted for operational and production processes. A large proportion of abstraction may include dewatering, which involves high return flows. Dewatering has been included in headline figures, given the location-specific demands that this process places on water sources, and the significant impact on the quality of the return flow. It is removed from certain water uses by volume estimates for comparison. Given the breadth of the industry, this project focussed on the largest 3 input-output industry groups (IOIGs) by water use within the industry. Assuming water usage in total follows a similar distribution to the expenditure of sub-industries on Water Supply, Sewerage and Drainage Services from 2022-23 IO tables, the largest users of water are non-ferrous metal ore mining (43%), coal mining (24%) and iron ore mining (13%).
- **Manufacturing:** Manufacturing is included where water is abstracted from surface water, groundwater, or distributed supply systems for operational and production activities. Given the breadth of the industry, this project focussed on the largest 3 input-output industry groups (IOIGs) by water use within the industry. Assuming water usage in total follows a similar distribution to the expenditure of sub-industries on Water Supply, Sewerage and Drainage Services from 2022-23 IO tables, the largest users of water are meat and meat product manufacturing (10%), motor vehicles and parts (9%) and human pharmaceutical and medicinal product manufacturing (7%).
- **Recreational and amenity water use:** Recreational and amenity water uses, such as the irrigation of golf courses and maintenance of swimming pools, involves abstraction of managed water resources. The watering of turfs by soil abstraction from rainfall is not considered.

- **Household water use:** Households compete with industries for water through distributed supply systems. Comparison with feedlots considers the differing objectives between households and industry – namely that household water use is for survival, sanitation and utility rather than to produce output. Household water use is conceptually disaggregated into essential and non-essential components. Essential household use comprises water required to meet basic human needs, primarily drinking and food preparation. Non-essential and operational household use includes water used for sanitation, cleaning, laundry, outdoor irrigation, and pool maintenance.

Given the purpose of this research, the report focuses on economic units that compete with feedlots for allocable water resources given their abstraction of water in a manner where:

1. The abstraction occurs from surface, groundwater or desalinated ocean water, but not from soil. This includes use of distributed water supply and reuse water. The focus is on water sources that are actively extracted and allocated for economic use, and therefore may represent consumptive water use that competes with, or is comparable to, feedlot water use. While feedlots may not typically source desalinated ocean water directly, industries that use desalinated water are included because desalination still represents deliberate water abstraction and consumptive use, rather than passive reliance on rainfall or soil moisture.
    a. Water derived directly from rainfall, such as in dryland agriculture, is excluded from this analysis. According to the SEEA-Water framework, soil water abstraction can be identified separately due to its unique characteristics relative to surface or groundwater abstraction. Rainfall occurs independently of industrial activity, and soil water use by economic units – primarily agriculture – has a relatively negligible effect on the hydrological system, with significant return flows to the environment.
2. The abstraction considered does not result in significant return flows to the environment at the same location, time, and quality.
    a. For this reason, the Electricity, Gas, Water and Waste Services sector (primarily hydroelectricity) is excluded, as water used in these activities typically returns to the environment quickly and at a comparable quality. For mining, results are also presented with a sensitivity analysis that excludes mine dewatering, recognising that while return flows are significant, they may occur at a different quality level.

Appendix C: Detailed description of water use in feedlots

In 2023-24, it was estimated that Australian feedlots used between 20,0000 and 23,000 ML of water, allocated across a range of activities within the feedlot system. Current industry estimates suggest water represents a small share of overall costs, with utility costs (which include water), representing around 1.7% of industry costs (IBISWorld 2026). MLA (2011) research that looked at clean water usage between March 2007 and February 2009 across a sample of representative feedlots demonstrates the typical distribution between different activities:

- Livestock consumption (78-91% of total use): Cattle depend on water to sustain vital bodily functions and survival. It supports temperature regulation, growth, digestion and metabolism, as well as waste removal. Water is also essential for breaking down nutrients, maintaining mineral balance, lubricating joints, protecting the nervous system, and enabling sensory functions such as hearing and vision (Davis et al. 2008). Further, reduction in drinking water below minimum requirements will reduce feed intake and cattle performance (Utley et al. 1970). As a critical input in feedlot production, insufficient water supply can limit or halt operations where minimum requirements are not met.
- Feed processing (1-6% of total): Feedlots will process grain prior to being given to cattle in order to enhance its digestibility, which can improve by 8-15% according to previous MLA reports (Davis et al. 2008). The amount of water used will depend on the process used, which can include wet (e.g. steam flaking, tempering and reconstitution) and dry (rolling) methods. Generally, wet methods are required for efficient operations in larger feedlots (>1000 head). Processes that are used in wet preparation involve tempering, steam flaking, or reconstitution.
- Washing cattle (0-12% of total): Cattle cleaning techniques, including washing, may be used to remove dags from cattle and reduce potential carcass contamination during processing (Rowland et al. 1999). This will vary by feedlot based on its operations, including the level of recycling, the cleanliness of the cattle, breed, climate and the cleanliness requirements of the feedlot/abattoir (Davis and Watts 2016). Industry stakeholders have observed a reduction in cattle washing practices in recent years. Since cattle washing is both the most variable and, when undertaken, the second largest use of water in feedlots, this reduction increases the share of water used for drinking. Indeed, past MLA research (Davis and Watts 2016) considering water usage in seven feedlots between 2007-09 noted that 90% of water was used for drinking if no cattle washing occurred, dropping to 84% when cattle were washed. Consequently, because our estimation method relies on drinking water as a proportion of total use, the observed trend towards less cattle washing suggests that total water consumption in feedlots is likely to be at the lower end of our estimated range.
- Administration (0-5%): Water will be required for worker amenities on feedlots, including toilet flushing, washbasins, kitchen and laundry uses, and other uses such as landscape maintenance.
- Sundry uses (0-7% of total): Sundry uses include trough cleaning, hospital cleaning, induction yard cleaning, dust suppression, vehicle washing and evaporation from open water storages. Cleaning is required for drinking troughs, hygiene in processing areas, hospital, induction and dispatch. It should be noted that water use also includes evaporation on open storages. Machinery is required to be cleaned for performance, removing dust, dirt, grease and oil. Dust must be suppressed to reduce irritation for humans and cattle, with water application suppressing the dust temporarily. These estimates vary significantly based on feedlot, influenced by the frequency of certain operations, the characteristics of the feedlot design, and environmental factors (e.g. temperature and humidity) (Davis and Watts 2016).

- Effluent dilution (not assessed): The exact percentage of water required for effluent dilution is not assessed due to high variability. Water is used to dilute effluent runoff before application (e.g. for irrigation) to ensure plant absorption, though some feedlots will rely on evaporation instead for effluent disposal (Davis and Watts 2016). The amount of water required for dilution will depend on the strength of the effluent, which will typically be determined by climate.

These uses can be broadly divided into essential and discretionary applications. Essential uses are those required for biological functioning, without which production cannot occur – most notably drinking water for cattle and staff. Water used in feed processing may also be considered essential in larger operations, although some dry-processing alternatives exist. In contrast, there is no substitute for drinking water. Discretionary uses are those where water demand can be reduced or substituted with limited impact on production. These include activities such as cattle washing, watering lawns and gardens for administrative areas, cleaning water troughs, dust suppression, washing feed preparation equipment, and diluting effluent. While food standards may require cattle to meet certain cleanliness thresholds through cattle washing, the effectiveness of water for cleaning is debated, with some operators suggesting that manual shearing is more effective for removing residues (Davis and Watts 2011).

Appendix D: Detailed results – water criticality

This appendix provides additional detail on the criticality assessment summarised in Chapter 3.4. It explains the drivers of each rating for technical essentiality, substitutability, quality specificity and short-run flexibility across sectors and sub-sectors.

Feedlots

The majority of water use in feedlots is essential, limiting substitution and short-run flexibility.

Table A.1: Water criticality framework scores for feedlots

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Agriculture				
Feedlots	High	High	High	High

Source: Deloitte Access Economics

Technical Essentiality

Drinking water comprises approximately 75-90% of total water use in feedlots, with the remainder used for activities such as cattle washing, dust suppression, feed processing and washdown (Davis et al. 2008). Given the reduction in cattle washing practices over time, the drinking water share is likely closer to 90%. This water usage is biologically essential for cattle survival, impacting their health, feed intake, and overall performance (National Research Council 2016; Wagner and Engle 2021). The volume of water per animal can't be reduced by much, or the animal perishes, meaning not only is there is no production from that animal, all of the animals production value up that point in its life is lost. In this way, water for cattle consumption is not just protecting immediate production, it is also protecting as asset grown over time. Therefore, technical essentiality is regarded as high.

Substitutability

Drinking water for cattle has no viable substitutes. Marginal opportunities exist to reduce non-drinking applications (recycling water for washing, bituminising roads for dust suppression, labour intensive cleaning practises instead of water intensive, dry feed processing methods), but these represent a small share of total water use. The limited scale and impact of substitution options mean overall substitutability remains limited.

Quality Specificity

Whilst non-drinking uses can utilise lower-quality water, drinking water dominates total usage. Stock water must meet specific thresholds for salinity, pH, nutrients, toxic residues, pathogens and temperature (DCEEW 2023). If drinking water does not meet necessary quality requirements, it can reduce cattle intake, slow weight gain and increase disease risk (NSW Government 2026). Therefore, the quality specifcity constraint is regarded as high.

Short-run flexibility

Restrictions on drinking water immediately reduce cattle feed intake and cattle health. Efficiency adjustments in operational uses provide only marginal aggregate reductions. Unless feedlot utilisation is lowered and fewer cattle are accommodated – a process that take significant time – there is little flexibility to lower water use. Therefore, short-run flexibility is very limited.

Agriculture

Water plays a critical role across the broader agricultural industry, reflecting its status as a biologically essential and often non-substitutable input. However, the nature and degree of this criticality can differ across agricultural sub-sectors. In feedlots, water is predominantly required for drinking, making it an immediate and non-deferrable input tied directly to animal survival and performance. In contrast, other agricultural uses may exhibit greater flexibility in timing and management.

Grass-Fed Beef (Dryland & Irrigated) and Dairy

Similarly to feedlots, water is critical and not substitutable in production. Minor flexibility in quality is possible in irrigation.

Table A.2: Water criticality framework scores for grass-fed beef (dryland and irrigated) and dairy

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Agriculture				
Dairy	High	High	High	High
Irrigated Grazing	High	High	Medium	High

Source: Deloitte Access Economics

Technical Essentiality

Drinking water is essential and non-substitutable for cattle survival across all grazing and dairy systems. Irrigated grazing and dairy also require water for pasture and fodder production, increasing overall reliance relative to dryland systems (AgVic 2024). Overall, technical essentiality is regarded as **high** in grazing and dairy operations.

Substitutability

Drinking water cannot be replaced, and operational uses are limited. Whilst irrigated systems can substitute irrigation through purchased fodder or grain, this reflects economic rather than technical substitution, leaving limited overall substitutability.

Quality Specificity

Grazing cattle tolerate broader water quality ranges than feedlot cattle, particularly in dryland systems where gradual acclimatisation occurs (Department of Agriculture and Food Western Australia 2007). Irrigation water can also handle wider quality variation, in fact nutrient rich water can assist in pasture production, though high mineral content slows plant growth and reduces yields (NSW Department of Primary Industries, n.d.). Therefore, quality constraints bind gradually rather than abruptly.

Overall, quality specificity for grazing and irrigated grazing is medium. Dairy requires high-quality water for drinking and milk-contact cleaning, matching feedlot requirements, so quality specificity for dairy is high (Bonanno 2023; AgVic 2026).

Short-run flexibility

Grazing and dairy have limited short-run flexibility as most water use is non-substitutable drinking water. Dairy farms can adapt to sustained reductions in water availability by shifting from year-round milking to seasonal or split-calving systems, though milking contracts often restrict this (Ashton and Gomboso 2020). Irrigated systems may have some flexibility through purchasing supplementary feed and reduce irrigation volumes.

Irrigated Crops & Horticulture

Similarly to feedlots, water is critical and not substitutable in production, however there is lower quality requirements in some subsectors.

Table A.3: Water criticality framework scores for irrigated crops and horticulture

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Agriculture				
Irrigated Crops – Perennial	High	High	Medium	Medium
Irrigated Crops – Annual	High	Medium	Medium	Low

Source: Deloitte Access Economics

Technical Essentiality – High

Water is highly essential for crop growth, supporting crucial processes like photosynthesis, nutrient transport, and cell development (Richmond 2021). Insufficient water reduces yields or causes crop failure (Battaglia et al. 2018). For perennials, water is an ongoing requirement beyond yield considerations, making it technically essential to prevent multi-year production impacts.

Substitutability

Irrigation water cannot be altered without changing crop type, irrigation scheduling, reducing yield or area. Perennial crops cannot experience water below survival levels without impacting multiple years of production. Annual crops allow substitution at the system level (crop switching or area reduction), though water remains technically essential at the crop level.

Quality Specificity

Water quality requirements are regarded as moderate in irrigated cropping, with requirements varying across crops, soil types, and irrigation methods. Tolerance differs significantly – some crops can withstand higher salinity or poorer-quality water, while others are far more sensitive – which directly shapes production choices and risk exposure. Perennials face greater cumulative quality risks with limited adjustment ability, whilst annuals can shift to more tolerant varieties.

Short-run flexibility

Some irrigators can respond to reduced water availability through reductions in planted area, deficit irrigation, or crop switching prior to planting, resulting in lower output rather than immediate shutdown (Zeleke and Luckett 2025). This provides irrigators with a greater degree of short-run flexibility, as observed in water markets in times of scarcity, when broad acre, annual cropping are amongst the first to cease production. It should be noted that perennial crops have lower short-run flexibility, as some water must continue to be applied for plant survival, to avoid irreversible damage to long term assets like fruit trees or grape vines.

Manufacturing

Manufacturing varies in water reliance: some activities are relatively resilient, while those tied to food and medical products depend more heavily on water. Manufacturing typically has a stronger ability to recycle/close loops than agriculture. Criticality has been primarily assessed for the three largest estimated sub-sectors by water use, including *Meat and Meat Product Manufacturing*, *Motor Vehicle and Parts Manufacturing* and *Human Pharmaceutical and Medicinal Product Manufacturing*. This means criticality ratings are likely to be higher than if the industry was considered as a whole.

Meat and Meat Product and Pharmaceuticals

Similarly to agriculture these processes are highly dependent on high quality and a consistent supply of water. Without a source of high-quality water operations would cease.

Table A.4: Water criticality framework scores for meat and meat product pharmaceuticals

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Manufacturing				
Meat and Meat Product; Pharma	High	High	High	High

Source: Deloitte Access Economics

Technical Essentiality

Meat production cannot operate without water supply. This is due to health regulations requiring sterilisation, equipment cleaning, product washing and stockyard drinking water (Meat Research Corporation & Australian Meat Technology 1997).

Water use in pharmaceutical manufacturing is also technically essential. Manufacturers rely on water across synthesis, formulation, reconstitution and cleaning processes, and it is the most widely used excipient in pharmaceuticals (European Medicines Agency 2002; World Health Organization 2012).

Substitutability

In meat manufacturing, hygiene and food safety water use has limited substitutability. Marginal substitution exists – such as UV sterilisation of knives (see Meat Research Corporation & Australian Meat Technology 1997) and air chilling (see Belk et al. 2021) – but these are low consumption activities relative to total operational use.

In pharmaceuticals, water's distinctive chemical properties make it indispensable, and production must meet defined grades (PW/WFI). Some demand reduction is possible through closed-loop systems and reuse (World Health Organization 2012), however overall substitutability remains limited.

Quality Specificity

Meat products must comply with food safety standards, requiring potable water for meat-contact activities (Australian Meat Processor Corporation 2022). Pharmaceutical water must also meet grade-specific requirements (Purified Water, Water for Injection) depending on product and manufacturing step (European Medicines Agency 2002). In both cases, quality specificity exceeds feedlots, where requirements are critical but less stringent.

Short-run flexibility

Strict compliance in both manufacturing sub-sectors limits flexibility. Meat manufacturing requires water across slaughter and processing, which cannot be materially reduced without breaching hygiene requirements. Firms may have some flexibility by keeping cattle in stockyards for longer, however this increases stock watering requirements. Meanwhile, disruptions to high quality water immediately impacts pharmaceuticals production. Therefore, short-run flexibility is highly limited due to regulatory and product safety constraints.

Motor Vehicle and Parts

Water constrains production more gradually in Motor Vehicle and Parts manufacturing than feedlots, with more options for substitution also available through recycling or dry methods of production.

Table A.5: Water criticality framework scores for motor vehicle and parts manufacturing

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Manufacturing				
Manufacturing – Motor vehicles and parts	Medium	Medium	Medium	Medium

Source: Deloitte Access Economics

Technical Essentiality

Australian vehicle manufacturing focuses on trucks and buses (IBISWorld 2026), where water may be used for surface treatment, coating, washing, rinsing, paint spray booths, hosing, cooling and boilers – activities necessary for adhesion, corrosion resistance and quality consistency (Babel et al. 2020). While water-intensive, manufacturing lacks the continuous biological or welfare constraints of feedlots. Therefore, the technically essentiality of water use is more moderate.

Substitutability

Water use can be reduced through recycling and substitution. BMW, for example, report a 30% reduction in water consumption between 2006 and 2020 through paint shop, pre-treatment and body shell cleaning improvements (BMW Group 2021). Dry separation methods can also replace water in paint particle air cleaning. Unlike feedlots where drinking water is non-substitutable, vehicle manufacturing can partially substitute or recycle water.

Quality Specificity

Reduced water quality causes surface defects, corrosion and adhesion problems. Specific uses require decarbonated industrial water or demineralised water (fresh or recycled), but quality requirements are typically lower than feedlots.

Short-run flexibility

Manufacturing can increase water reuse, adjust non-critical uses and substitute dry methods where feasible during scarcity. However, critical operations such as painting lack flexibility.

Mining

Mining is generally less reliant on water for production continuity, with greater capacity to adapt to short-term constraints. Quality specificity is also much lower than feedlots. Criticality has been assessed for the three largest estimated sub-sectors by water use (*Non-ferrous Metal Ore Mining*, *Coal mining* and *Iron Ore Mining*). This means criticality ratings may be higher than other sub-sectors in the industry.

Non-ferrous Metal Ore

Water is an important input in non-ferrous ore mining, particularly where wet beneficiation is required, with limited scope for substitution and low short-run flexibility. However, it has lower quality specificity requirements to feedlots.

Table A.6: Water criticality framework scores for non-ferrous metal ore mining

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Mining				
Non-ferrous metal ore	High	Low	Medium	High

Source: Deloitte Access Economics

Technical Essentiality

Non-ferrous ore mining requires water at various stages, though intensity differs by commodity – gold is particularly water-intensive for example (250,000,000 L per tonne) (Moerk Water 2024b). Water is used for dust suppression and grinding, but becomes critical during wet beneficiation. Copper widely relies on flotation methods, whilst some ores (e.g. aluminium) use simple crushing before export (Geoscience Australia 2025a; Geoscience Australia 2025b). Technical essentiality is high to account for operations requiring wet beneficiation.

Substitutability

Mining companies increasingly adopt water recycling and tailings dewatering (Hamraoui et al. 2024). Reducing water reliance is possible through improved rock fragmentation and alternative dry processing, but fully transitioning to waterless operations requires substantial research, technological innovation and is ore-specific (Luukkanen et al. 2022). Whilst greater reuse improves efficiency, it can degrade process water quality and reduce separation effectiveness (Levay and Schumann 2006).

Water substitutability ultimately varies depending on the commodity and its required processing technique.

Quality Specificity

Water quality is important in wet beneficiation, particularly flotation where water represents 80–90% of mineral pulp volume. Chemical composition directly affects separation efficiency. Increased recycling can degrade process water and reduce plant performance (Levay and Schumann 2006).

Short-run flexibility

Non-ferrous metal ore mining has limited short-run flexibility because many operations rely on water-intensive wet beneficiation processes, such as flotation, that cannot function without adequate water. While mines can temporarily draw on stored water, increase recycling or reduce throughput, sustained supply constraints quickly force processing cuts or shutdowns rather than gradual reductions in use.

Coal and Iron ore Mining

Water is operationally important but generally less technically binding in coal and iron ore mining, with greater flexibility through dry processing, recycling, and the ability to defer water-intensive stages in the short run.

Table A.7: Water criticality framework scores for coal and iron ore mining

Industry	Technical essentiality	Substitutability	Quality specificity	Short-run flexibility
Mining				
Iron ore	Medium	Medium	Low	Low
Coal	Medium	Medium	Low	Medium

Source: Deloitte Access Economics

Technical Essentiality

Iron ore mining primarily extracts hematite through simple crushing and screening before export (Geoscience Australia 2023). Water is used for dust suppression, worker amenities, equipment washdown and, in some cases, wet beneficiation for lower-grade ores.

Coal mining requires around 650 L per tonne produced (Moerk Water 2024b). Black coal (the majority of Australian production) requires minimal processing – typically simple crushing and screening. Water is mainly used for coal processing, dust suppression and vehicle washdowns

(Moerk Water 2024a). Iron ore and black coal rely primarily on crushing and screening where water is operationally important but not technically required.

Substitutability

Iron ore has dry processing options for high-grade ore, including dry crushing, screening, ore sorting and reduced washing intensity (AT Minerals 2023). Research into dry separation for lower-grade magnetite is ongoing (Nadeem 2024).

Coal mining can reduce abstraction through reuse and recycling (Fitzroy Partnership for River Health 2025). Operations can limit coal washing, though washing removes impurities to increase energy content and reduce emissions (World Nuclear Association 2021).

Iron ore has **high** substitutability; coal mining has **medium** substitutability.

Quality Specificity

Iron ore quality requirements are low where simple crushing is used – mainly for washing or dust suppression. Coal washing does not require potable water. Potable water is typically needed only for vehicle maintenance, drinking and cleaning (Overton 2020).

Short-run flexibility

Coal mining has **medium** flexibility as extraction can continue and mines can stockpile run-of-mine coal if washing is temporarily constrained. Iron ore has **high** flexibility where dry processing is viable.

Household and recreational use

Household and recreational water use illustrates how essential and non-essential demands are managed under scarcity, even though these users are rarely in direct commercial competition with feedlots. For households, a core share of consumption is technically essential – drinking, basic food preparation, sanitation and personal hygiene – and must be supplied at potable quality with very limited scope for short-run reduction or substitution. Beyond this, a substantial proportion of use is directed to discretionary activities such as outdoor irrigation, car washing and pool filling, which can be rapidly curtailed or substituted (for example through drought-tolerant landscaping or foregoing certain amenities), generally without large impacts. This is why these activities are often the first to be regulated under water restrictions in times of scarcity.

Recreational facilities, such as sports fields, parks and swimming pools, sit somewhere between essential and discretionary use. Water is technically required to maintain safe and usable assets (for example dust suppression and minimum turf quality, or pool hygiene), but a sizeable share of demand is associated with aesthetic or performance standards that can be relaxed in dry periods. These activities often tolerate lower-quality sources such as recycled water or stormwater. Overall, compared with industries like feedlots, households and recreation have a relatively small, highly protected essential component and a larger, flexible component that is typically targeted first by restrictions, limiting the volume of “recoverable” water that can realistically be reallocated to other sectors.