ECONOMIC SIGNIFICANCE OF WATER IN THE MARNE SAUNDERS PRESCRIBED WATER REOURCE AREA

Final Report for: Murraylands and Riverland Landscape Board

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"Economic significance of water in the Marne Saunders prescribed water resource area"

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1. INTRODUCTION

1.1 PURPOSE AND SCOPE

The scope of this engagement was to quantify the direct and indirect value of water for consumptive use across the Hills and the Plains of the Marne Saunders Prescribed Water Resource Area (PWRA). For this analysis, consumptive use means water used in agriculture, industry, and towns that is taken up by crops or products or used by people or livestock.

The findings of this analysis will support the Murraylands and Riverland Landscape Board (MRLB) in reviewing the Water Allocation Plan (WAP) for the Marne Saunders PWRA and may inform amendments to the WAP should they be required. This economic analysis is one of several data points to assist the MRLB understand:

- The value of water resources managed under the WAP
- Broader economic activities that benefit from this water.

Figure 1 presents the geographical area for this project. In the Marne Saunders PWRA, most streamflow starts in the upper catchments to the west (the Hills) represented by the green area, where there is more rain. In the lower catchments to the east (the Plains) represented by the brown area, there is little local runoff, with most surface water coming from upstream.[1]

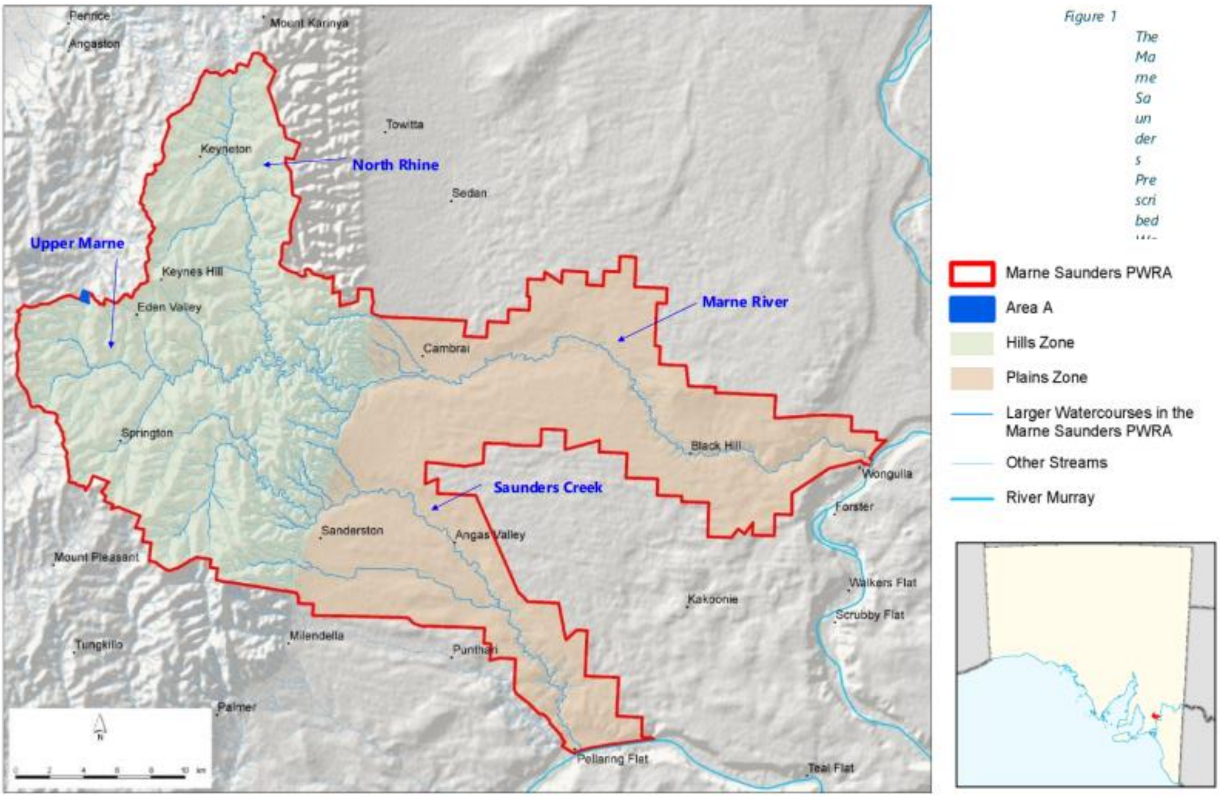

Figure 1 Marne Saunders PWRA Hills and Plains zones

This report considers water use and the economic value generated from this use across the Hills and Plains regions separately and in aggregate.

[1] South Australian Murray-Darling Basin Natural Resource Management Board, 2019. The Water Allocation Plan for the Marne Saunders Prescribed Water Resources Area, p. 22. https://cdn.environment.sa.gov.au/landscape/images/marne-and-saunders-wap-ammended-2019-plan.pdf [Last accessed 16 May 2025].

2. APPROACH TO ECONOMIC ANALYSIS

2.1 APPROACH TO ECONOMIC ANALYSIS

Our approach integrates water use data provided by MRLB with regionally specific agricultural farm production and crop water use data to estimate the economic significance of water resources in the Marne Saunders PWRA.

We tested, refined, and agreed upon the economic method with MRLB at each stage to ensure its fitness for purpose. Below, we present an overview of the economic method. Appendix B describes the economic method in more detail including the approach to estimating each economic unit-vale.

Total annual economic value = Sum of annual water use (ML)* x economic unit-value ($/ML) which varies by water use type

* Megalitre (ML) is a unit of volume, in this report it is used to indicate a unit volume of water. One Megalitre is equal to one million litres.

2.1.1 Estimating water use

The process of estimating annual water use involved four key steps:

1. Define the geographic boundaries and assign water use data to each study area
2. Estimate the total annual water use in each study area using available data sources
3. Break down total water use by end use (e.g., irrigated agriculture, industry) to identify where water is consumed
4. Estimate annual water use for each end uses within the study areas.

The dataset provided by MRLB[2] used the following water sources:

- Watercourse - water flowing in a defined natural channel (or one changed by humans) such as rivers, creeks, and streams
- Surface water - water that flows over land except in a watercourse
- Groundwater - water that occurs naturally beneath the earth's surface, in aquifers and other underground formations.

The analysis did not consider recycled water.

2.1.2 Water users

This analysis assessed water use across irrigation, stock and domestic (S&D), industrial, and recreation. Industrial water supports activities such as wineries, quarries, dairy washdown, and food processing. Recreational water is used to irrigate parks and sporting grounds. S&D water users are households, small gardens (up to 0.4 ha, non-commercial), and stock watering (not intensive farming). [3] Irrigation water is used for crops, pasture, or feed. Historical land use surveys show little change in irrigated land use within the PWRA since 2010.[4, 5]

Table 1 shows the estimated annual water use in the Hills and Plains by use type and water source. Total use across the PWRA is around 2,513 ML per annum. The Plains accounts for the majority of irrigation water use, whereas S&D use is greater in the Hills. Very little water is used for industrial and recreational purposes. This analysis used median values from 2010 to 2023 to account for variability during wet and dry periods. Appendix A describes the approach to allocating water across different end users in more detail.

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[2] Landscape South Australia Murraylands and Riverlands, 2024. Dataset to support the 2019 Marne Saunders WAP plan review provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 25 May 2025.

[3] Natural Resources Management Act 2004 (South Australia). https://www.legislation.sa.gov.au/__legislation/lz/c/a/natural%20resources%20management%20act%202004/2008.11.05/2004.34.auth.pdf [Last accessed 23 May 2025].

[4] Dataset used to determine entitlements for existing users in the Marne Saunders PWRA, provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 31 May 2025.

[5] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

Table 1 Estimated annual water use (ML per annum) split across the Hills and Plains regions, use types and water source from 2010 to 2023

Region	Water resource	Irrigation (ML)	S&D (ML)	Industrial (ML)	Recreational (ML)	Total (ML)
Hills	Surface water	408	305	1	-	**1,151**
	Watercourse	17		-	-	
	Groundwater	326	94	-	-	
Plains	Surface water	-	4	-	-	**1,362**
	Watercourse	27		-	-	
	Groundwater	1,132	176	2	21	
MARNE SAUNDERS TOTAL		1,909	579	3	21	**2,513**

Note totals may not sum due to rounding.

2.1.3 Estimating economic unit values

Our approach integrated water use data provided by MRLB with regionally specific agricultural farm production, crop water use data and SA Water pricing data to estimate the economic significance of water resources in the Marne Saunders PWRA. Figure 2 illustrates our conceptual approach.

The first step in determining the economic significance of water was to estimate the volume of water used across all water sources and identify the associated water uses (e.g. irrigated agriculture) within the study area. We then applied multiple economic valuation methods to estimate the value of water across the different water uses and locations within the PWRA.

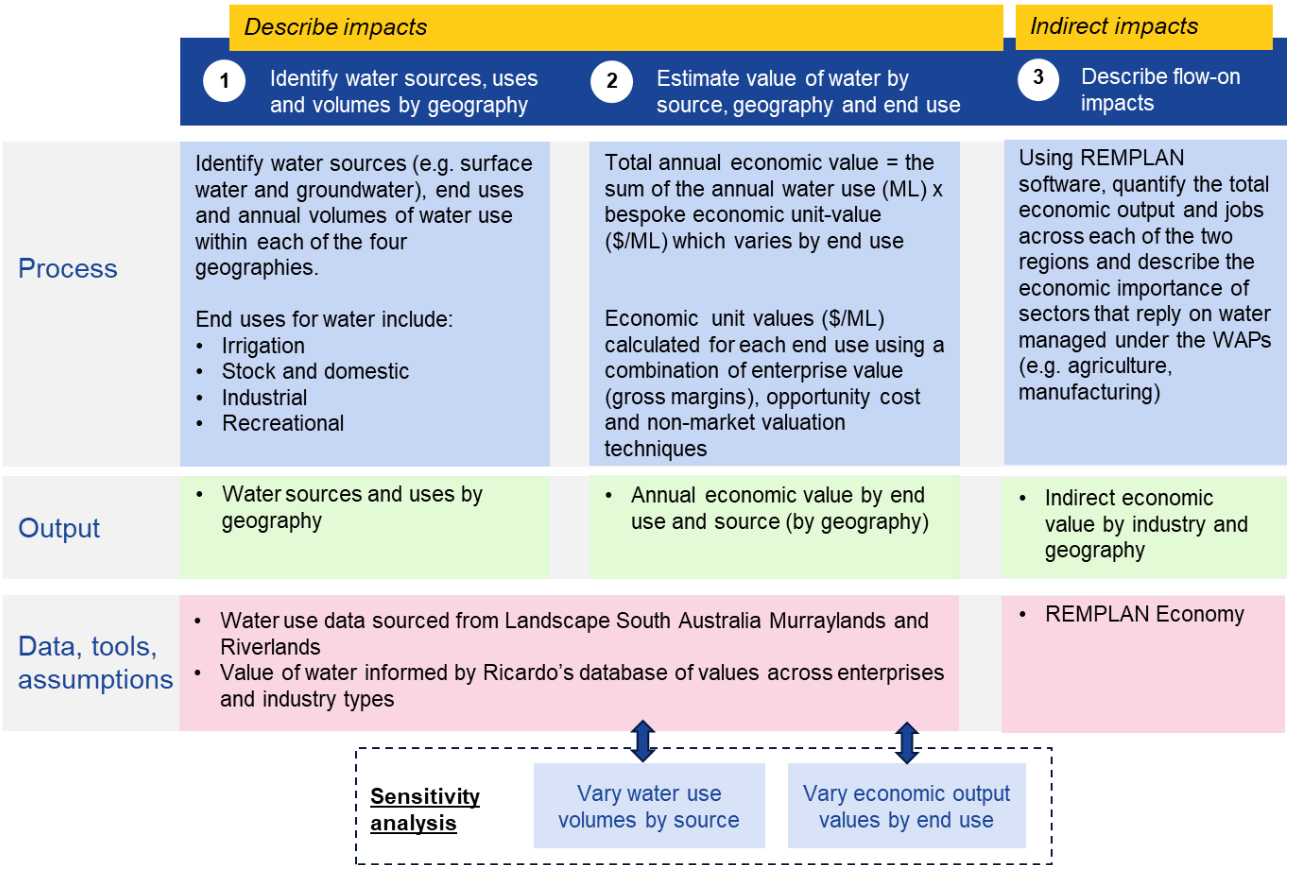

Figure 2 Conceptual approach to valuing water resources

Below, we describe the economic valuation framework. More detail on the economic valuation approach is presented in Appendices A and B.

2.1.3.1 Margin models

The best approach for valuing consumptive water use is to estimate an enterprise's margin earned on each unit of water that enables production. There are two types of margins that are commonly used to estimate the economic value: net margins and gross margins.

Gross margin is the revenue from the sale of agricultural products *less* the variable (direct costs) associated with production. Variable costs include items such as seeds, plants, fertiliser, chemicals, fuel and contracted labour costs. The net margin approach considers both variable and fixed costs. Fixed costs include items such as farming equipment, land, capital costs and depreciation.

The analysis used a gross margin approach and reported it on a $/ML basis for irrigation. Measuring the gross financial return of water before subtracting fixed costs is the gross margin. The analysis used this approach because fixed costs (including establishment costs) are often not material with existing agricultural enterprises relevant to this study. The Australian Bureau of Statistics (ABS) commonly reports gross margins. We outline the limitations of this approach in Section 2.3.

2.1.3.2 Opportunity costs

Where it is not possible to estimate gross margins (e.g. because of data availability), the next best approach is to value the opportunity cost of replacing the water. Opportunity cost is the value or cost of the next best alternative water source.

We can estimate the opportunity cost of water using two main methods. The first method uses the water trading market, where one can replace water with a similar product while accounting for the practicalities of sourcing water from the next best source, such as River Murray allocation prices, as the opportunity cost for replacing water supplied to industrial users.

The second approach to calculating the opportunity cost is to use the long-run marginal cost (LRMC) of water, which is generally defined as the cost of supplying an additional unit of water, assuming that all factors of production, including capital, can be varied. In the water sector the best approach to estimating the LRMC is using the cost forecasts to meet future increments in demand over a long period.[6] This approach to LRMC works well for water, as it explicitly includes the capital costs of future augmentations and stabilising prices over time.

SA Water prices have been used as a proxy for LRMC to value the opportunity cost of water supplied to industrial and S&D users. Although not all water users in the PWRA have access to SA Water mains, this price provides a reasonable and conservative estimate of the opportunity cost of this water.

2.1.3.3 Non-market valuation for recreation

A portion of the water use in the Marne Saunders PWRA is used to irrigate sporting fields and support other recreation activities. The benefits, including improved wellbeing, physical health, amenity, and lifestyle, are non-market, so we cannot assess their economic value through traditional water market prices. Economists use a range of methods to estimate non-market values, and there is extensive academic literature on non-market values for water. In this analysis we have quantified non-market values by using values reported in existing studies (called a benefit transfer).

Care has been taken when applying benefit transfers because of differences in the population and location from which a study was undertaken and the population and location to which a reported value is ultimately applied.

2.2 ASSUMPTIONS AND MODEL INPUTS

The following assumptions were used to develop the economic model and results. Appendix A includes water use method and assumptions in greater detail. Appendix B provides a detailed list of the inputs used in the economic model. Section SourceNote presents a sensitivity analysis to understand the extent to which changing the assumptions and variables influences the results.

2.2.1 Irrigated water use

In calculating the value of irrigated water in a region, we applied the following irrigated water use assumptions:

- Crop application rates were estimated using historical land use survey data[7] and metered water use data. Where application rates could not be calculated from survey data, the best available published sources were used. Section 2.3 details the limitations of this method.
- Irrigated crop area was estimated using irrigated land use classified by the SA ALUM dataset[8]. Some of the ALUM classifications, classify land use by the level of landscape intervention, rather than by

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[6] Essential Services Commission of South Australia, 2014. LRMC Pricing for Water Services – Background Paper on LRMC Pricing. p. vii https://www.escosa.sa.gov.au/ArticleDocuments/434/140711-WaterInquiry-LRMCPricingWaterServicesBackg.pdf.aspx?Embed=Y [Last accessed 21 May 2025].

[7] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[8] Dataset of Australian Land Use and Management (ALUM) in SA provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 30 May 2025.

crop type[9]. For these broad categorisations, such as 'Perennial horticulture', historical land use survey data[10], [11] was used to determine the likely crops grown under these classifications.

- The MRLB project team validated the ALUM land use classifications by comparing them to historical land use survey data[12], [13].
- Each crop's share of total water use was estimated using representative crop application rates and land use data. These proportions were applied to total metered irrigation water to estimate water use by each crop.
- Turf is only grown on the Plains and accounts for 17%[14] of PWRA water use. Turf water use volumes were deducted from the pasture and annual crop water use estimates for the Plains.

2.2.2 Economic value inputs and assumptions

2.2.2.1 Irrigated economic values

The economic value of water is sensitive to changes in gross margins and business profitability over time. The commodity price, yield and cost assumptions used in this analysis provide a reasonable estimate of the economic and growing conditions for agricultural businesses in this region. Box 1 in Section 2.3 describes limitations of the analysis.

Table 2 presents the economic values and units (e.g. $/ML), and the method used to derive each economic value. The analysis used a range of values for the farm gate gross margins to capture the variability across the regions, growing seasons and farming enterprises.. Appendix B describes the economic method used to calculate the values in more detail.

For some land use categories, we grouped similar crops and used a representative crop to reflect their value. For example, in the Hills, 'perennial horticulture' made up less than 1% of total land use. Historical records showed this was mainly stone fruit orchards, including apricots. Apricots were chosen as the representative crop because their gross margins are similar to other stone fruit reported in the grouped area. The analysis applies a similar approach to annual crops in both the Hills and Plains, using representative gross margins for the mix of annual crops grown.

2.2.2.2 Recreational value

To estimate the recreational value of water used to irrigate green spaces in the PWRA, a 2017 CRC[15] study used house prices to value urban parks. This method, known as hedonic pricing, looks at how much more people are willing to pay for homes near or with views of parks. To link this value to water, we assumed that irrigation accounts for 50% of the benefit of green spaces, meaning that without irrigation, about half their value would be lost. Unlike other water uses in this analysis, this approach gives a one-off estimate of the perpetual value water provides that carries though subsequent years, rather than an ongoing annual value.

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[9] ABARES 2016. The Australian Land Use and Management Classification Version 8. https://www.agriculture.gov.au/sites/default/files/abares/aclump/documents/ALUMCv8_Handbook4ednPart2_UpdateOctober2016.pdf [Last accessed 23 July 2025].

[10] Dataset used to determine entitlements for existing users in the Marne Saunders PWRA, provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 31 May 2025.

[11] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[12] Dataset used to determine entitlements for existing users in the Marne Saunders PWRA, provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 31 May 2025.

[13] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[14] Barnett SR (2020). Analysis of the water use and economic value of irrigated production in South Australia. DEW Technical report 2022/28, Government of South Australia, Adelaide

[15] CRC for Water Sensitive Cities, 2017. How much do we value green spaces? p.1 https://watersensitivecities.org.au/wp-content/uploads/2017/05/IN_A1-1_How_much_do_we_value_green_spaces_V1.pdf [Last accessed 21 May 2025].

Table 2 Economic value and valuation method used

Economic values	Central value	Minimum of range	Maximum of range	Valuation method	Source
Irrigated crop gross margins ($/ML) ($2024/25)					
Perennial horticulture (Apricots)	6,262	3,107	8,072	Gross margin	Hort Innovation, 2024[16] Government of SA, 2016[17] Australasian Farmers & Deals Journal, 2019[18] RIRDC, 2024[19] The Weekly Times, 2017[20]
Irrigated pasture - Hills (Lucerne)	331	209	478	Gross margin	Australian Fodder Industry Association, 2025[21] Australian Fodder Industry Association, 2023[22] GRDC, 2022[23] S&W Seed Company, 2023[24]
Irrigated pasture - Plains (Lucerne and Wheat)	274	163	402	Gross margin	Australian Fodder Industry Association, 2025[25]

[16] Hort Innovation, 2024. Decision support models for Australian dried tree fruit. https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/dt23001/dt23001-final-report.pdf [Last accessed 31 July 2025].

[17] Government of SA, 2016. Irrigation Glove Box Guide. https://cdn.environment.sa.gov.au/environment/docs/2016_Irrigation-Glove-Box-Guide_Guide.pdf [Last accessed 31 July 2025].

[18] Australasian Farmers & Dealers Journal, 2019. Apricots have potential to lift earnings for producers. https://afdj.com.au/apricots-potential-lift-earnings-producers/ [Last accessed 31 July 2025].

[19] Rural Industrials Research and Development Corporation (RIRDC), 2024. Apricot Pollination Aware Cast Study. https://www.planthealthaustralia.com.au/wp-content/uploads/2024/01/10-110.pdf?utm_source [Last accessed 31 July 2025].

[20] The Weekly Times, 2017. Riverland orchards: Stone-fruit grower Jason Size adds muscle to industry. https://www.weeklytimesnow.com.au/agribusiness/riverland-orchards-stonefruit-grower-jason-size-adds-muscle-to-industry/news-story/7cc3e5c1b2ad5a94194dec98f5059a78 [Last accessed 31 July 2025].

[21] Australian Fodder Industry Association, 2025. Hay Report 30 May 2025. https://afia.org.au/wp-content/uploads/2025/05/2025_05_30_HayReport-Web.pdf [Last accessed 22 August 2025].

[22] Australian Fodder Industry Association, 2023. Hay Report 30 June 2023. https://afia.org.au/wp-content/uploads/2023/06/2023_06_30_HayReport-Web.pdf [Last accessed 22 August 2025].

[23] Grains Research and Development Corporation, 2022. Farm Gross Margin and Enterprise Planning Guide. https://grdc.com.au/__data/assets/pdf_file/0032/571496/21112.01-Gross-Margins-Guide-2022_WEB.pdf [Last accessed 22 August 2025].

[24] S&W Seed Company, 2023. Lucerne Advisor. https://alfagenseeds.com.au/app/uploads/2023/04/SW-Lucerne-Advisor-2023-1.pdf [Last accessed

[25] Australian Fodder Industry Association, 2025. Hay Report 30 May 2025. https://afia.org.au/wp-content/uploads/2025/05/2025_05_30_HayReport-Web.pdf [Last accessed 22 August 2025].

Economic values	Central value	Minimum of range	Maximum of range	Valuation method	Source
					Australian Fodder Industry Association, 2023[26] GRDC, 2022[27] S&W Seed Company, 2023[28] SAGIT 2025[29] Irrigated Cropping Council, 2022[30]
Turf	5,241	5,241	6,582	Gross margin	Barnett SR 2020[31]
Wine grapes (Barossa Valley)	2,131	-3,186	9,423	Gross margin	S. Wheeler et al., 2022[32] PIRSA, 2024[33] Wine Grapes Council SA, 2020[34], 2023[35] & 2024[36]
Olives – Plains	453	-690	3,309	Gross margin	HortInnovation, 2018[37]
Olives – Hills	3,309	453	3,309	Gross margin	HortInnovation, 2018[37]

[26] Australian Fodder Industry Association, 2023. Hay Report 30 June 2023. https://afia.org.au/wp-content/uploads/2023/06/2023_06_30_HayReport-Web.pdf [Last accessed 22 August 2025].

[27] Grains Research and Development Corporation, 2022. Farm Gross Margin and Enterprise Planning Guide. https://grdc.com.au/__data/assets/pdf_file/0032/571496/21112.01-Gross-Margins-Guide-2022_WEB.pdf [Last accessed 22 August 2025].

[28] S&W Seed Company, 2023. Lucerne Advisor. https://alfagenseeds.com.au/app/uploads/2023/04/SW-Lucerne-Advisor-2023-1.pdf [Last accessed

[29] SAGIT, 2024. 2024 Farm Gross Margin Guide. https://sagit.com.au/2024-farm-gross-margin-guide/ [Last accessed 22 August 2025].

[30] Irrigated Cropping Council, 2022. Spring research field day September 2022. https://faraustralia.com.au/wp-content/uploads/2022/12/Final-ICC-Research-Field-Day-Notes_low-res.pdf [Last accessed 22 August 2025].

[31] Barnett SR, 2020. Analysis of the water use and economic value of irrigated production in South Australia. DEW Technical report 2022/28, Government of South Australia, Adelaide

[32] S. Wheeler, C. Seidl, J. Tingey-Holyoak, A. Zuo, Y. Xu and J. Kandulu, 20222. The economics and financial benchmarking of Riverland Grape production, and potential benefits of Vitivisor technology, University of Adelaide.

[33] PIRSA, 2024. Optimising the agriculture uses of varying water qualities in the Barossa Region. https://www.pir.sa.gov.au/__data/assets/pdf_file/0008/470465/Optimising_agricultural_uses_of_water_qualities_in_the_Barossa_Region.pdf [Last accessed 22 August 2025].

[34] Wine Grape Council SA, 2020. Sa Winegrapes Crush Survey – Barossa Valley Wine Region. https://www.wgcsa.com.au/uploads/1/1/5/5/115509859/barossa-report-2020.pdf [Last accessed 22 August 2025].

[35] Wine Grape Council SA, 2023. Sa Winegrapes Crush Survey – Barossa Valley Wine Region. https://www.wgcsa.com.au/uploads/1/1/5/5/115509859/sa_winegrape_crush_survey_2023_regional_summary_report_barossa_wine_region.pdf [Last accessed 22 August 2025].

[36] Wine Grape Council SA, 2024. Sa Winegrapes Crush Survey – Barossa Valley Wine Region. https://www.wgcsa.com.au/uploads/1/1/5/5/115509859/sa_winegrape_crush_survey_2024_regional_summary_report_barossa_wine_region.pdf [Last accessed 22 August 2025].

[37] HortInnovation, 2018. Australian Olive Industry Benchmarking Program. https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/ol16001/ol16001---final-report-complete.pdf [Last accessed 22 August 2025].

Economic values	Central value	Minimum of range	Maximum of range	Valuation method	Source
S&D	3,482	N/A	N/A	Opportunity cost	SA Water, 2024[38]
Industrial use	3,214	N/A	N/A	Opportunity cost	SA Water, 2024[39]
Non-market valuations (green open space) – one off economic value					
Value per ha	~$322	N/A	N/A	Non-market valuation	CRC for Water Sensitive Cities, 2017

[38] SA Water, 2024. Pricing Schedule. p. 3. https://www.sawater.com.au/__data/assets/pdf_file/0011/941348/2024-25-Price-setting-Water-and-Sewerage-prices.pdf [Last accessed 22 August 2025].
[39] SA Water, 2024. Pricing Schedule. p. 5. https://www.sawater.com.au/__data/assets/pdf_file/0011/941348/2024-25-Price-setting-Water-and-Sewerage-prices.pdf [Last accessed 22 August 2025].

2.3 LIMITATIONS

The economic analysis is subject to the limitations outlined below and the assumptions and approach presented in Section 2.2 and Appendices A and B.

Box 1: Data limitations

Water use data

- Annual water use data and water allocation data provided by MRLB underpin the results. The proportion of water use apportioned to irrigation, recreation and industrial activities assumes that the proportion of water allocated for each licence across these end uses represents the proportion of water used. While all care was taken to ensure water use data was appropriately allocated across uses, there was no dataset that captured actual water use by user group and crop type.

Irrigated crop application rates

- The approach to estimating crop application rates assumes that all water used by a licence holder in a year applies to the crop type they reported in the Annual Water Use Survey.[40] For licence holders growing multiple crops, this assumption likely overestimates the volume of water applied to each crop. However, for all crop types except lucerne in the Hills, the application rates estimated were lower than those used to allocate water to Existing Users in the Marne Saunders in 2010 Entitlement Dataset[41]
- Incorrect units and implausible values, such as reporting errors, limit the reliability of the Annual Use Survey data.[42] Where multiple estimates were available for a crop, the median value was used to reduce the influence of outliers

Economic values

- A multiple lines of evidence approach was used to estimate a representative set of crop margins for the Marne Saunders PWRA. The central estimate for irrigated agriculture represents this. Ranges of irrigated agriculture's economic significance show the potential range of economic values depending on the profitability of farms in each irrigated agriculture enterprise
  - Gross margins are appropriate for this analysis for existing (i.e. brownfield) irrigated agricultural enterprises such as those that exist in the study area. Gross margins exclude fixed costs and will therefore slightly overestimate the value of water on-farm. Estimates of inputs and production can vary from what occurs. Although a crop might have the highest gross margin, it might be the most sensitive to variation. Commodity prices, seasonal conditions, pests and disease can significantly affect the eventual gross margin. Uncertainty can be assessed by comparing gross margins calculated with varying values for an input[43]
  - The farm gate models used in this analysis use a combination of simplified generic assumptions for each crop type. The inputs for this type of modelling can be highly variable from the Hills to the Plains due to (including but not limited to) soil quality, temperature (typical growing season temperatures and temperature extremes), solar exposure, rainfall zones and proximity to markets for key inputs and the sale of product. Further variability exists for farming operations that are next door to one another including farm size, land-owner's skills and approaches to risk management. For these reasons we produced a range of outcomes for each farm gate model.
  - Farm gate models estimate the value of water at the farm gate. Other indirect economic benefits and value such as the economic value and up and downstream of the farm gate is not captured in the farm gate models.

[40] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[41] Dataset used to determine entitlements for existing users in the Marne Saunders PWRA, provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 31 May 2025.

[42] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[43] South Australian Grain Industry Trust, 2022. Farm Gross Margin and Enterprising Planning Guide. P. 3. https://grdc.com.au/__data/assets/pdf_file/0032/571496/21112.01-Gross-Margins-Guide-2022_WEB.pdf [Last accessed 19 June 2025].

REMPLAN

- REMPLAN draws on data sourced from the Australian Bureau of Statistics (ABS), mainly from the 2001-2021 census. As this data is several years old, recent changes in the economy may not be reflected. The REMPLAN data provides a point-in-time estimate of the economy and does not capture short-term fluctuations or seasonal variations.
- REMPLAN data is derived from ABS datasets and input-output modelling rather than directly observed local data. This means results are estimates and may not fully reflect local conditions.

3. RESULTS

3.1 ECONOMIC VALUE OF WATER RESOURCES

3.1.1 Quantitative analysis

3.1.1.1 Economic significance split across the Hills and the Plains and end uses

Table 3 and Figure 3 present the direct economic significance of water split across the Hills and the Plains and its end use. Overall, the economic significance of water estimated for the Marne Saunders PWRA is small because of the small proportion of the region used for irrigated agriculture. In the Hills, irrigated agriculture accounts for 3% of total land use area, and in the Plains it only accounts for 1%.

In summary, the results are that:

- The Hills ($2.5 million per annum) provides the greatest direct economic value of water resources in aggregate, generated from around 1,151 ML of water used annually. Additional value in downstream processing (e.g. for wine grapes) and upstream goods and services is discussed in Section 3.2.
- The Plains use more water than the Hills and generates $2.6 million per annum in direct economic value from this water. The economic value in the Plains is generated from around 1,362 ML of water used annually. Additional value in downstream processing (e.g. for livestock) and upstream goods and services is estimated in Section 3.2.
- The Hills has an average direct per ML value of $2,196 per ML per annum, while the Plains has an average direct value of $1,959 per ML per annum. The largest users of water in the Plains is for lower value annual crops as such lucerne and wheat
- Irrigated agriculture generates the greatest economic contribution (60%) across the different user groups, followed by S&D use (39%)
- The average direct economic value of water across the whole region is $2,068 per ML per annum.

Table 3 Economic significance of water split across regions and end uses ($million/annum, 2024/25)

	Irrigated agriculture	Industrial	Recreational	S&D	Total	$/ML per annum*
Hills	1,133,577	4,146	0	1,389,318	2,527,041	2,196
Plains	1,992,534	6,139	15,464	627,770	2,641,906	1,959#
Grand Total	**3,126,111**	**10,285**	**15,464**	**2,017,088**	**5,168,947**	**2,068#**

Note *$/ML for each region is calculated by dividing total economic significance by the total water use as presented in Table 1.

Note ^ This is a one-off willingness-to-pay of residents, different to the annual (p.a.) economic value of other water uses in the analysis.

Note # Value excludes recreation use and value as this is a one-off value rather than an annual value.

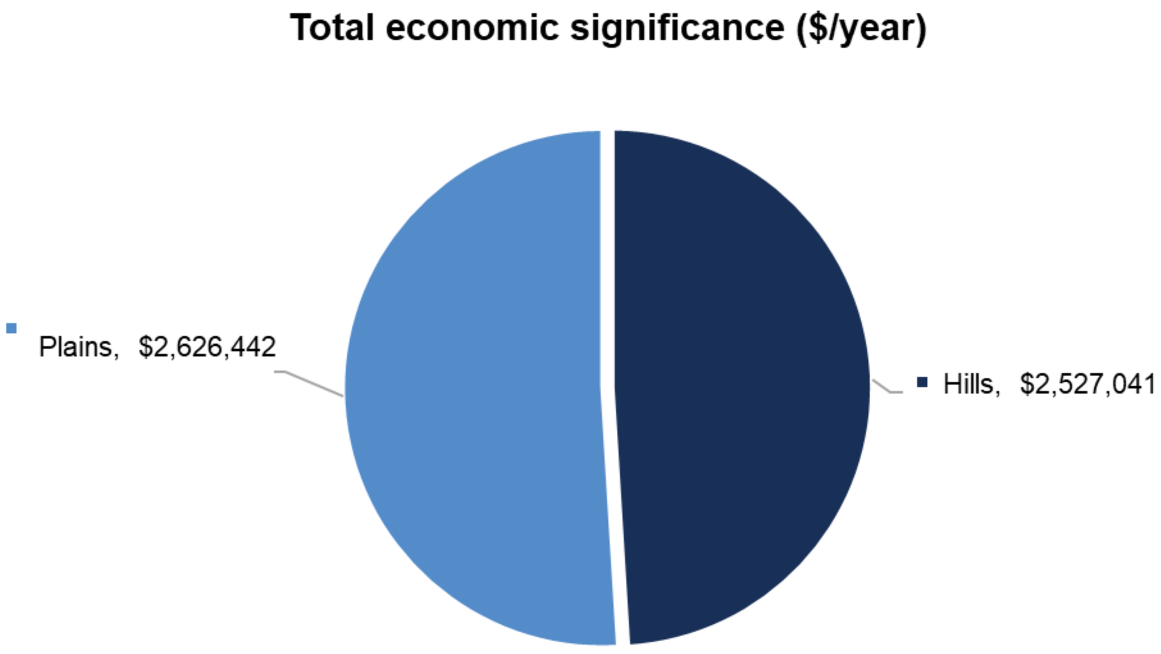

Figure 3 Economic significance split by Hills and Plains regions

Note Figure 3 excludes recreation value as this is a one-off value rather than an annual value.

3.1.1.2 Economic significance split by end use

Figure 4 below illustrates the economic significance of different water uses. Irrigated agriculture generates the highest economic value of all end uses ($3,126,111) and uses the largest volume of water. S&D use generates the second highest economic value of all end uses ($2,017,088) but uses significantly less water than irrigated agriculture. Industrial use generates significantly lower total value ($10,285) due to the small volume of water applied.

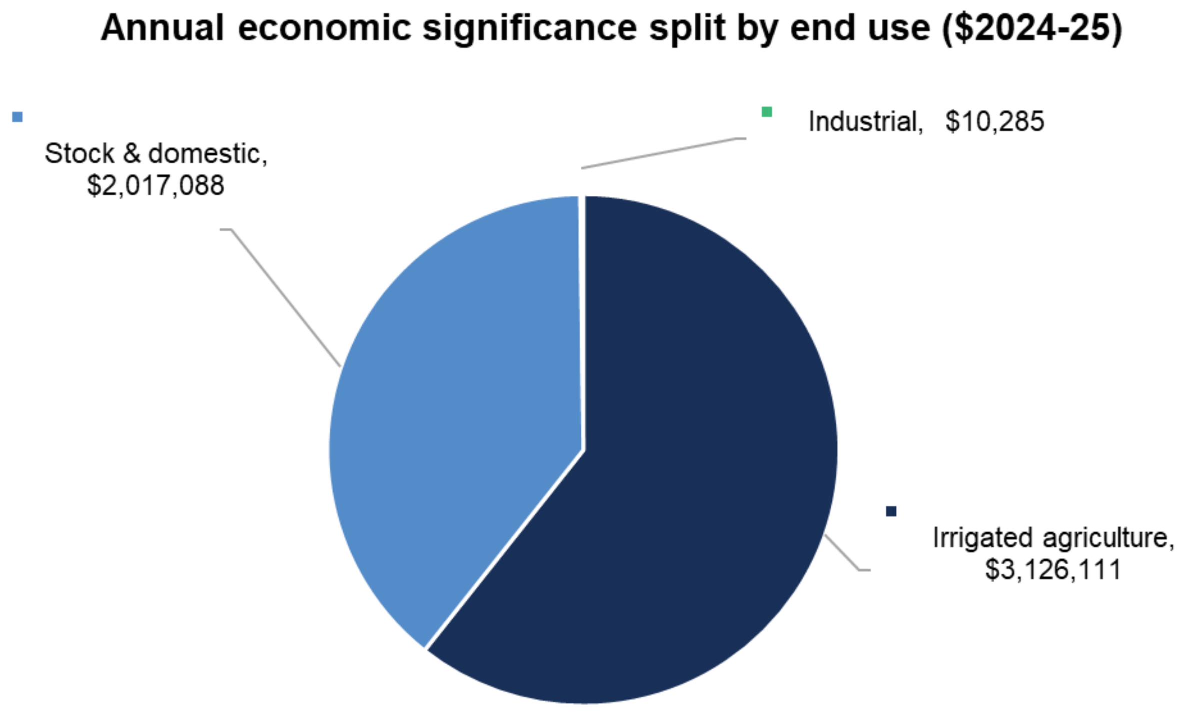

Figure 4 Economic significance by end use for PWRA

Note Figure 4 excludes recreation value as this is a one-off value rather than an annual value.

3.1.1.3 *Economic significance of irrigated agriculture by crop type*

Figure 5 and Table 4 illustrate the economic significance of irrigated agriculture by crop type at the farm gate across the PWRA. We can make the following observations from this breakdown:

- Turf accounts for 54% ($1,695,949) of the value of irrigated agriculture, despite using only 17% of the region's irrigated water. This reflects significantly higher turf gross margins relative to other crops
- Wine grapes account for 25% ($792,843) of the value of irrigated agriculture from 19% of the region's irrigated water
- Wheat and lucerne use the most water but contribute significantly less economically than turf or grapes, accounting for 7% of farm gate value from irrigated agriculture.[44]

Table 4 Irrigated agriculture economic significance broken down by crop type

	Economic significance – Central ($2024-25)	Economic significance (%)
Apricots	103,460	3%
Annual crops (represented by Lucerne and Wheat)	231,871	7%
Turf	1,695,949	54%
Grapes	792,843	25%
Olives	301,987	10%

[44] Noting that lucerne is used to feed livestock; the value of which has not been accounted for in this analysis due to data constraints.

	Economic significance – Central ($2024-25)	Economic significance (%)
Total	3,126,111	100%

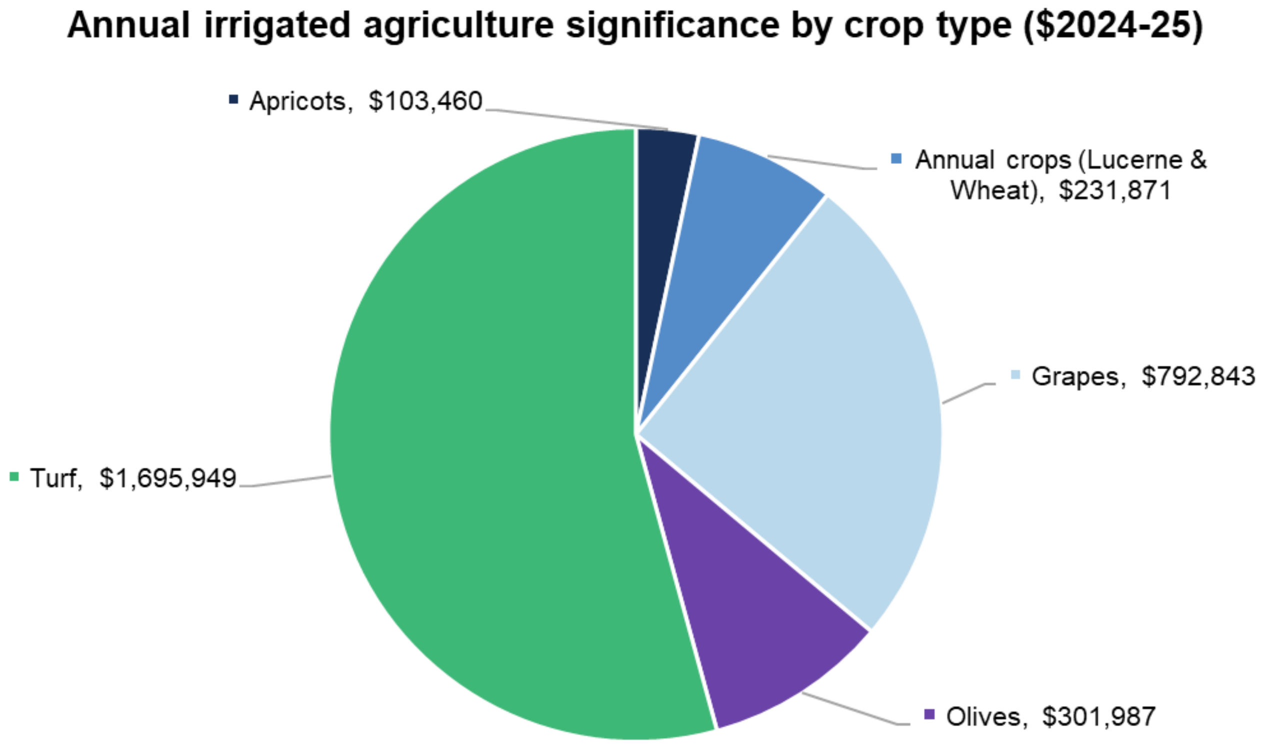

Figure 5 Economic significance by irrigated crop type for the PWRA

3.1.1.4 *Economic significance by water source*

Table 5 and Figure 6 present the economic significance of water split across surface water, watercourses and groundwater across the PWRA.

- Groundwater has a higher economic value than surface water. While the volume of groundwater is more than double that of surface water, on a per-unit basis, groundwater is used for higher-value purposes.

Table 5 Economic significance split across water sources and end uses ($ per annum) ($2024-25)

<table>
<tr><th></th><th>Irrigated agriculture</th><th>Industrial</th><th>Recreational</th><th>S&D</th><th>Total</th></tr>
<tr><td>Surface water</td><td>615,946</td><td>4,082</td><td>-</td><td rowspan="2">1,076,948</td><td rowspan="2">1,731,775</td></tr>
<tr><td>Water course water</td><td>71,707</td><td>129</td><td>-</td></tr>
<tr><td>Groundwater</td><td>2,438,458</td><td>6,074</td><td>15,464</td><td>940,140</td><td>3,400,136</td></tr>
<tr><td>Grand Total</td><td>3,126,111</td><td>10,285</td><td>15,464</td><td>2,017,088</td><td>5,168,947</td></tr>
</table>

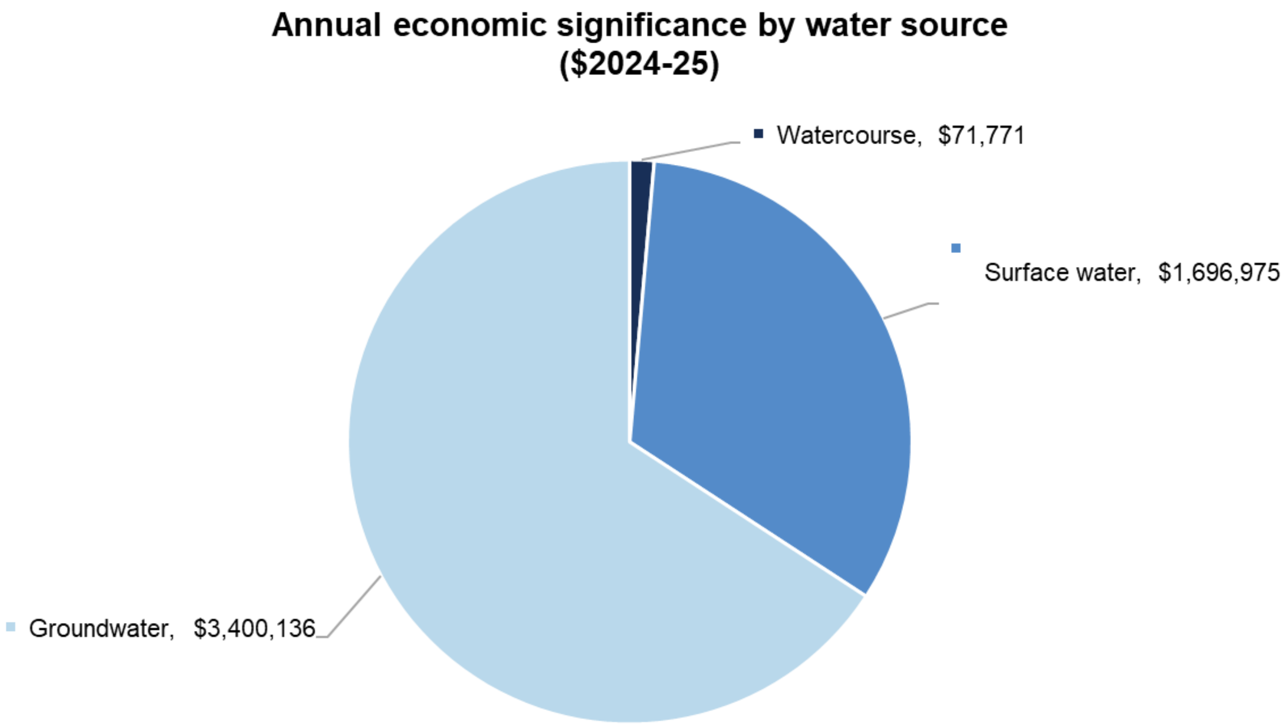

Figure 6 Economic significance split by water source

Note Figure 6 excludes recreation value as this is a one-off value rather than an annual value.

3.1.2 Sensitivity analysis

Sensitivity testing varies modelled inputs to reflect uncertainty, then examines the effect on modelled outputs. Typically, several key variables contribute disproportionately to modelled outcomes. We have varied parameters to reflect alternative values within the likely upper and/or lower bounds (as informed through robust projections, historical water use and assumptions). Comparing these provides a likely range of output values, given credible assumptions, regarding uncertainty and known risk.

We varied the key model variables of water use and economic output values by fixed proportions (e.g. -20% or +20%).

All values are reported against the 'central case' results to highlight the significance of each assumption to the total economic value of water resources in the region.

Adjusting the opportunity cost for S&D water use results in an 8% variation of the total economic value generated in the PWRA. Changing the volume of water for each use has a directly proportional effect on economic value generated in the region. Varying price for irrigated crops has the greatest influence of all tested model parameters, with a 30% variation, while adjusting yield had the smallest impact at 5%. The sensitivity tests excluded turf prices and olive yields (Table 6).

Table 6 Sensitivity test results: annual total economic significance ($2024-25, million)

Scenario	-20%	Central case	+20%
Water use volumes (ML)			
Water use (ML)	4.75	5.15	5.56
Economic values ($/ML)			
S&D value	4.12	5.15	6.18
Economic parameters			
Price^	4.92	5.15	5.39
Yield*	3.56	5.15	6.72

^ Turf price was not adjusted under the price sensitivity test as the gross margins for turf were calculated as GVIAP per ML.

* Olives yield was not adjusted under the yield sensitivity test as the gross margins for olives were calculated as gross income less total variable costs.

Note Sensitivity analysis presented in Table 6 excludes recreation value as this is a one-off value rather than an annual value.

3.2 WIDER ECONOMIC BENEFITS[45]

The direct economic value of water presented in Section 3.1 excludes up and downstream economic value generated by using water in consumptive and non-consumptive uses. It therefore underestimates the total economic value. We used REMPLAN Economy[46] to present an overview of broader economic activity across the Hills and Plains study areas. The results are reported for the PWRA, with sub-regions aligned to the geographical boundaries of the Hills and Plains. The modelled results show economic activity by industry, including output, value-added, and employment. We have used REMPLAN solely to understand the structure and scale of the local economy, not to undertake any form of impact analysis or to suggest that all of the economic output, value-added and employment is directly attributable to water managed and used in the PWRA.

Output: is the gross revenues generated by businesses in each industry in the region.

Value-added: is the gross revenue generated less the input costs for each business in each industry in the region. The REMPLAN analysis calculates this variable by subtracting local expenditure and expenditure on regional imports from the output generated.

Employment: is a measure of the number of people employed by businesses / organisations in each of the industry sectors in the Hills and Plains. The data represents where the people work, not where they live.

Table 7 highlights the relative importance of all the industry sectors in the PWRA in terms of output. Water essential industry sectors are highlighted in blue.

Table 7 Relative contribution of all industry sectors to the Marne Saunders PWRA area economy by output in percentage terms

Industry sector	Hills (%)	Plains (%)
Agriculture	50	61
Manufacturing	11	6
Rental, Hiring & Real Estate Services	10	13

[45] The data presented in this section was created using REMPLAN, a third-party software provider that specialises in providing area-specific data for economic analysis.

[46] REMPLAN Economy. https://www.remplan.com.au/economy/ [Last accessed 29 May 2025].

Industry sector	Hills (%)	Plains (%)
Construction	6	4
Wholesale Trade	5	0
Professional, Scientific & Technical Services	4	1
Transport, Postal & Warehousing	3	3
Accommodation & Support Services	2	3
Information, Media & Telecommunications	2	0
Electricity, Gas, Water & Waste Services	2	0
Administrative & Support Services	1	1
Arts & Recreation Services	1	3
Retail Trade	1	2
Health Care & Social Assistance	1	0
Other Services	0	3

REMPLAN data sourced September 2025.

3.2.1 Agriculture

Agriculture is the largest industry, and largest water-dependent industry, contributing the most output, value-added and employment in both the Hills and Plains. The data excludes landowners working on their own farms. We expect that the number of jobs in both the Hills and Plains would be higher than values reported in Table 8.

Table 8 Regional contribution of agriculture to output, value-added and employment

	Output ($, million)	Value-added ($, million)	Employment (Jobs)
Hills	63	29	142
Plains	13	6	29

REMPLAN data sourced September 2025.

3.2.2 Road transport

Agriculture drives activity in other sectors, particularly road transport, as farm inputs and outputs rely on transport and logistic related services for input products to reach farms and final products to be sent to markets (Table 9).

Table 9 Regional contribution of road transport to output, value-added and employment

	Output ($, million)	Value-added ($, million)	Employment (Jobs)
Hills	4	2	13
Plains	1	0.2	2

REMPLAN data sourced September 2025.

3.2.3 Food and beverage manufacturing

Agriculture, predominantly wine grape growers, contribute to manufacturing in the Hills. Wine and spirits manufacturing accounts for most manufacturing output generated in the Hills (Table 10). Wineries such as Stonegarden and Phase Three Wines make wine within the Hills region, contributing to the economic output of the region.

Table 10 Hills contribution of manufacturing by type to output, value-added and employment

	Output ($, million)	Value-added ($, million)	Employment (Jobs)
Wine and spirits manufacturing	9	2	20
Food products	1	0.3	3

REMPLAN data sourced September 2025.

APPENDIX A – WATER USE METHOD AND ASSUMPTIONS

3.3 ESTIMATING WATER USE

The process to estimate annual water use involved four key steps:

1. Define geographic boundaries and allocate water use data to each study area
2. Estimate total annual water use for each study area using relevant data sources
3. Disaggregate total use by end use, such as irrigated agriculture or industrial use to understand where water is being used
4. Estimate annual water use and end uses within the study areas.

MRLB's dataset specified the water sources, and the process above was repeated across each water source. The following water sources were assessed:

- Watercourse - water flowing in a defined natural channel (or one modified by humans) such as rivers, creeks, and streams
- Surface water - water that flows over land except in a watercourse
- Groundwater - water that occurs naturally beneath the earth's surface, in aquifers and other underground formations.

This analysis did not consider recycled water.

3.3.1 Geography

There are two distinct parts of the Marne Saunders PWRA, the Hills and the Plains (Figure 7). The Hills in the west have an elevated topography and higher rainfall, the Plains in the east have a flatter landscape and lower rainfall.[47] We considered water use across both the Hills and Plains zones. These two major regions of the Marne Saunders PWRA, correspond to the two main types of groundwater aquifers in the study region, with fractured rock aquifers found in the Hills zone and sedimentary aquifers found in the Plains.[48]

MRLB guided the manual reassignment of licensed surface water and watercourse sources to the Hills or Plains zones, as defined in Figure 7.

[47] Landscape South Australia Murraylands and Riverlands, 2024. Water demand and use in the Marne Saunders Prescribed Water Resource Area Data summary to support review of the 2019 water allocation plan, p. 7. Provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 25 May 2025.

[48] South Australian Murray-Darling Basin Natural Resource Management Board, 2019. The Water Allocation Plan for the Marne Saunders Prescribed Water Resources Area, p. 22. https://cdn.environment.sa.gov.au/landscape/images/marne-and-saunders-wap-ammended-2019-plan.pdf [Last accessed 16 May 2025].

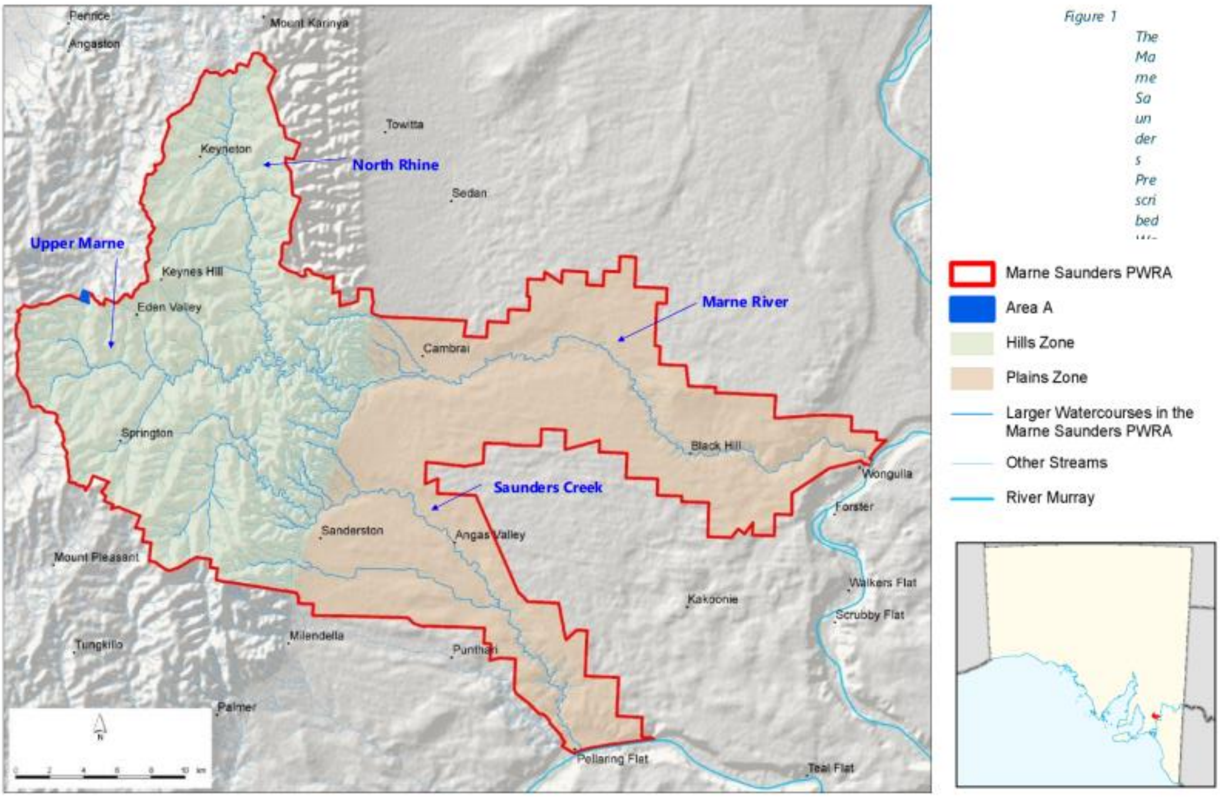

Figure 7 Marne Saunders PWRA Hills and Plains zones

In the Marne Saunders PWRA, most streamflow starts in the upper catchments (the Hills), where there is more rain. In the lower catchments (the Plains), there's little local runoff with most surface water coming from upstream.[49]

3.3.2 Water uses

The 2019 Marne Saunders WAP review dataset was used to estimate water use across all uses as annual volumes (ML per annum).[50] This analysis initially considered 11 categories of water use across three different water sources (Table 11).

Table 11 Water uses across the Marne Saunders PWRA

Initial water use categories	Description of water use
Irrigation	Irrigating crops, pasture, turf or feedstock
Intensive farming	Keeping animals for primary production, where they are typically confined to a small area and fed manually or mechanically
Industrial	Using water for industrial activities including wineries, quarries, dairy washdown and food processing
Recreational	Irrigation of recreational and sports grounds

[49] South Australian Murray-Darling Basin Natural Resource Management Board, 2019. The Water Allocation Plan for the Marne Saunders Prescribed Water Resources Area, p. 22. https://cdn.environment.sa.gov.au/landscape/images/marne-and-saunders-wap-ammended-2019-plan.pdf [Last accessed 16 May 2025].

[50] Landscape South Australia Murraylands and Riverlands, 2024. Dataset to support the 2019 Marne Saunders water allocation plan review provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board.

Initial water use categories	Description of water use
S&D	Using water for household needs and for watering up to 0.4 ha of garden (non-commercial), and for watering stock (not for intensive farming)[51]
Holding allocations	Reserving non-usable volumes for licence holders within the consumptive pool
Rollover water	Carrying over of unused allocated water into the next water year
Extra safety net	Additional volumes of allocated water beyond typical amounts under specific circumstances such as very dry periods
Wild flooding	Flood irrigation where water spreads without guidance
Roof runoff	Rainfall runoff from roofs
Dam evaporation	Evaporation from dams

After interrogating the data further, we did not consider the following water use categories for this analysis:

- Intensive farming has around 4% of total water allocations across the PWRA. This was not quantified as it is difficult to quantify due to the lack of location-specific and reputable margin model data to quantify the impacts
- Rollover water – no allocations were made between 2010 and 2023 so this was excluded
- Holding allocations - are not available for immediate use and has been excluded
- Allocations to 'extra safety net', 'wild flooding', and 'roof runoff' were reassigned to more descriptive purposes (e.g. irrigation) in the dataset provided for the analysis.[52] This reassignment was based on the other water use purposes listed on the same licence and water source. For example, if a 'wild flooding' allocation appeared alongside an 'irrigation' allocation for surface water on the same licence, it was reassigned to 'irrigation'
- Dam evaporation – contributes to total estimated use within the dataset but has been excluded for this analysis.

The water use categories considered in this analysis are irrigation, S&D, industrial and recreational. The 2019 Marne Saunders WAP review dataset provided these categories.

3.3.2.1 Estimating water use

Metered data from each individual water licence holder was used to determine water use for irrigation, industrial and recreation. Where individual licence holders had multiple use categories (e.g. irrigation and industrial), water use for each category was based on the proportion of the licence holders' entitlements for each category. For example, if a licence holder used 3 ML and 60% of their entitlement was for irrigation and 40% for industrial, then 1.8 ML was allocated to irrigation and 1.2 ML to industrial.

Figure 8 shows total water use in the PWRA from 2010 to 2023 and its breakdown by use category. The black line (right axis) represents total water use in each year. The coloured bars (left axis) indicate the proportion of water use across each category. Recreational (purple) and industrial use (green) as a proportion of total water use is small compared to irrigation and S&D use. Table 13 provides the volume of water use for each category.

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[51] Natural Resources Management Act 2004 (South Australia). https://www.legislation.sa.gov.au/__legislation/lz/c/a/natural%20resources%20management%20act%202004/2008.11.05/2004.34.auth.pdf [Last accessed 23 May 2025].

[52] Landscape South Australia Murraylands and Riverlands, 2024. Dataset to support the 2019 Marne Saunders WAP plan review provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 25 May 2025.

Estimating S&D use

S&D water use in the Marne Saunders PWRA is not metered. MRLB provided estimates of S&D water use (Table 12).[53]

Table 12 S&D estimation methods across each water source

Water source	S&D estimation method
Surface	Surface water and watercourse sources were estimated together. Surface water models estimated annual S&D demand. In the Hills zone, S&D demand was estimated at 30% of non-licensed dam capacity. In the Plains, estimates were based on local stock carrying capacity, household water requirements, and survey data on water sources.
Watercourse	
Groundwater	Groundwater S&D use volumes were calculated by the estimated long-term annual domestic water and stock drinking water needs in the Marne Saunders WAP as no information was readily available on annual demand.[54]

[53] Dataset of estimated S&D use provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 23 May 2025.

[54] South Australian Murray-Darling Basin Natural Resource Management Board, 2019. The Water Allocation Plan for the Marne Saunders Prescribed Water Resources Area, p.60-61. https://cdn.environment.sa.gov.au/landscape/images/marne-and-saunders-wap-ammended-2019-plan.pdf [Last accessed 23 May 2025].

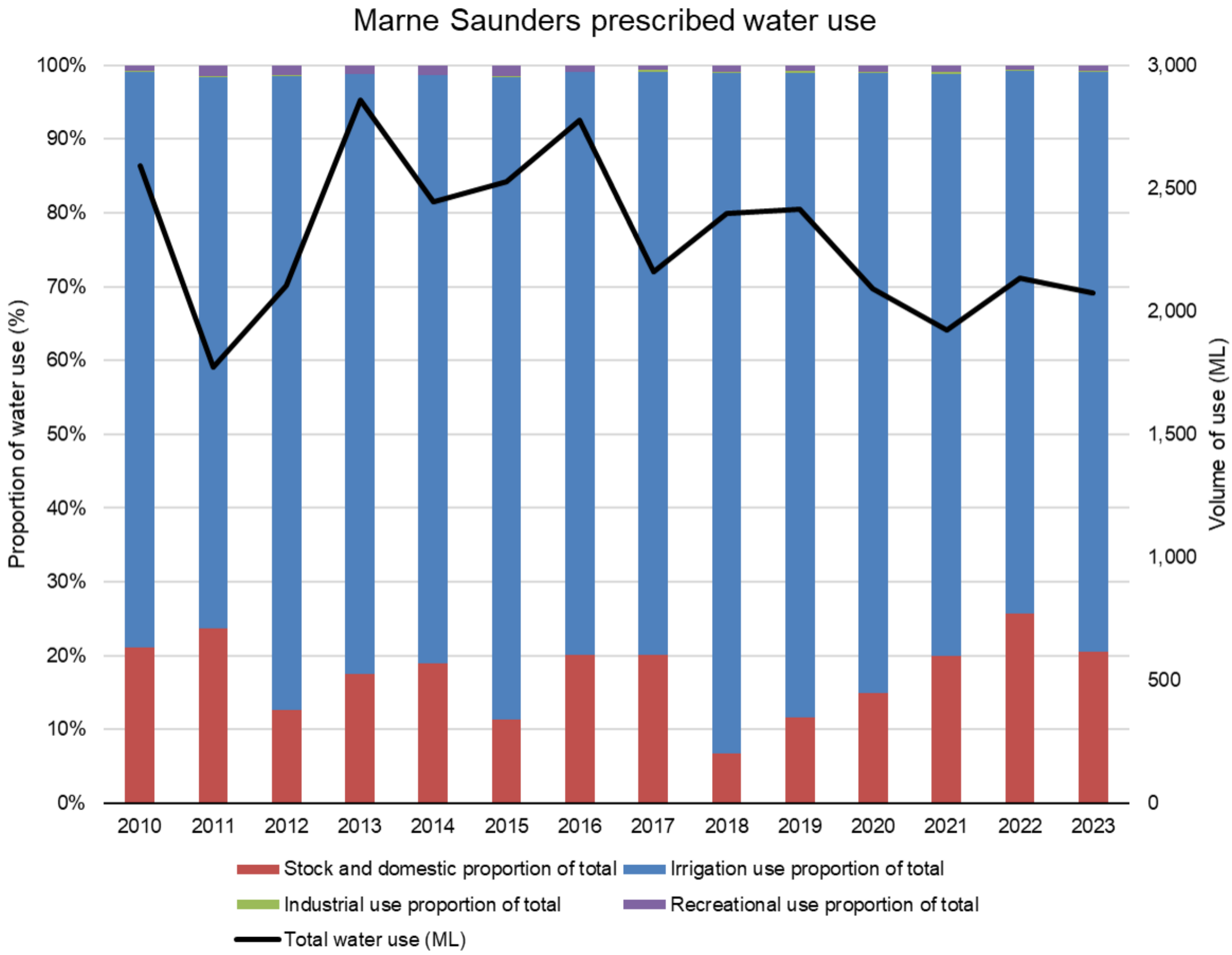

Figure 8 Summary of annual Marne Saunders PWRA water use data

3.3.2.2 Irrigated water use

The following irrigated water use inputs and assumptions were used calculate the value of water in a region:

- Crop application rates were estimated using land use area reported by licence holders in the 2018 and 2019 Annual Water Use Surveys for the Marne Saunders PWRA.[55] Clearly invalid responses were excluded. Metered water use for the corresponding year was used to calculate the volume of water applied to each crop type. The median application rate was adopted as the representative rate for each crop. Where application rates could not be calculated from survey data, the best available published sources were used. Section 2.3 details the limitations of this method.
- Irrigated crop area was estimated using irrigated land use classified by the SA ALUM dataset[56]. Some of the ALUM classifications, classify land use by the level of landscape intervention, rather than by crop type.[57] For these broad categorisations, such as 'Perennial horticulture', historical land use survey data[58], [59] was used to determine the likely crops grown under these classifications.

[55] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[56] Dataset of Australian Land Use and Management (ALUM) in SA provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 30 May 2025.

[57] ABARES 2016. The Australian Land Use and Management Classification Version 8. https://www.agriculture.gov.au/sites/default/files/abares/aclump/documents/ALUMCv8_Handbook4ednPart2_UpdateOctober2016.pdf [Last accessed 23 July 2025].

[58] Dataset used to determine entitlements for existing users in the Marne Saunders PWRA, provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 31 May 2025.

[59] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

- Using representative application rates and land use areas to estimate water use by crop type initially overestimated total irrigation use in the Marne Saunders PWRA. Further investigation found that:
    - the ALUM dataset included land use parcels likely irrigated with River Murray water. The MRLB project team validated the ALUM land use classifications by comparing them to the 2010 Entitlement Dataset[60] and the 2018 and 2019 Annual Use Survey data.[61] This process identified and corrected classification errors, with general alignment found across the three datasets.
    - Using the validated ALUM land use dataset and representative application rates to estimate water used by crop type still overestimated total irrigation use in the PWRA. Instead, representative crop application rates and land use data were used to estimate each crop's share of total water use. These proportions were then applied to total metered irrigation water to estimate water use by each crop.
- Applying the process and method above resulted in water use estimates that are representative of the likely proportions of water used by each crop.
- Turf is only grown on the plains and accounts for 17%[62] of PWRA water use. Turf water use volumes were deducted from the pasture and annual crop irrigation water use estimates for the plains.

Table 13 shows the estimated annual water use in the Hills and Plains by use type and water source. Total use across the PWRA is around 2,513 ML per annum. The Plains accounts for the majority of irrigation water use, whereas S&D use is greater in the Hills. Industrial and recreational purposes use minimal water. To account for variability during wet and dry periods, median values for the 2010 to 2023 period were used.

[60] Dataset used to determine entitlements for existing users in the Marne Saunders PWRA, provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 31 May 2025.

[61] Dataset of Annual Water Use Survey for 2018 and 2019 provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 6 June 2025.

[62] Barnett SR (2020). Analysis of the water use and economic value of irrigated production in South Australia. DEW Technical report 2022/28, Government of South Australia, Adelaide

Table 13 Median annual water use (ML per annum) from 2010 - 2023 by use type and water source

Region	Water resource	Irrigation (ML)	S&D (ML)	Industrial (ML)	Recreational (ML)	Total (ML)
Hills	Surface water	408	305	1	-	**1,151**
	Watercourse	17		-	-	
	Groundwater	326	94	-	-	
Plains	Surface water	-	4	-	-	**1,362**
	Watercourse	27		-	-	
	Groundwater	1,132	176	2	21	
MARNE SAUNDERS TOTAL		1,909	579	3	21	**2,513**

Note totals may not sum due to rounding

APPENDIX B - ECONOMIC METHOD

3.4 OUTLINE OF OUR ECONOMIC APPROACH

An overview of the economic methodology is presented below:

Total annual economic value = Sum of annual water use (ML) x bespoke economic unit-value ($/ML) which varies by water use type

Our approach to valuing water across each end use prioritised using a gross margin (bottom-up) approach to estimate the gross return for each ML of water use. Where gross margins were unable to be used (due to data availability), representative opportunity costs to replace the water with the next best alternative were used. Non-market valuation approaches were used to value water used for recreation purposes.

Table 14 shows the valuations methods used for each water use in this analysis.

Table 14 Valuation method applied to each water use type

End user	Gross margin ($/ML)	Opportunity cost ($/ML)	Non-market values
Irrigation	✓		
S&D		✓	
Industrial		✓	
Recreational			✓

3.4.1 Margin models

The best approach for valuing consumptive water use is to estimate an enterprise's margin earned on each unit of water that enables production. There are two types of margins that are commonly used to estimate the economic value: net margins and gross margins.

Gross margin is the revenue from the sale of agricultural products *less* the variable (direct costs) associated with production. Variable costs include items such as seeds, plants, fertiliser, chemicals, fuel and contracted labour costs. The net margin approach considers both variable and fixed costs. Fixed costs include items such as farming equipment, land and capital costs and depreciation.

The analysis used a gross margin approach and reported it on a $/ML basis. Measuring the gross financial return of water before subtracting fixed costs is the gross margin. The analysis used this approach because fixed costs (including establishment costs) are often not material with existing agricultural enterprises relevant to this study. The ABS commonly reports gross margins. We outline the limitations of this approach in Section 2.3.

3.4.2 Opportunity costs

Where it is not possible to estimate gross margins (e.g. because of data availability), the next best approach is to value the opportunity cost of replacing the water. Opportunity cost is the value or cost of the next best alternative water source.

We can estimate the opportunity cost of water using two main methods. The first method uses the water trading market, where one can replace water with a similar product while accounting for the practicalities of sourcing water from the next best source, such as River Murray allocation prices as the opportunity cost for replacing water supplied to industrial users.

The second approach to calculating the opportunity cost is to use the long-run marginal cost (LRMC) of water, which is generally defined as the cost of supplying an additional unit of water, assuming that all factors of production, including capital, can be varied. In the water sector the best approach to estimating the LRMC is using the cost forecasts to meet future increments in demand over a long period.[63] This approach to LRMC works well for water, as it explicitly includes the capital costs of future augmentations and stabilising prices over time.

SA Water prices have been used as a proxy for LRMC to value the opportunity cost of water supplied to industrial and S&D users.

3.4.3 Non-market valuation for recreation

A portion of the water use in the Marne Saunders PWRA is used to irrigate sporting fields and support other recreation activities. The benefits, including improved wellbeing, physical health, amenity, and lifestyle, are non-market, so we cannot assess their economic value through traditional water market prices. Economists use a range of methods to estimate non-market values, and there is extensive academic literature on non-market values for water. In this analysis we have quantified non-market values by using values reported in existing studies (called a benefit transfer).

An overview of non-market valuation techniques is presented in Box 2. Care has been taken when applying benefit transfers because of differences in the population and location from which a study was undertaken and the population and location to which a reported value is ultimately applied. The benefit transfer study used, unit value and description of how it was applied is presented in Table 17.

Box 2: Valuing non-market benefits

Water is delivered for a range of critical services that are valuable and can be valued. However, some of these services, such as greenspace, clean air, clean water, and biodiversity are not traded in markets. The economic value of these services – how much people are willing to pay for them – is generally not fully revealed in market prices.

These services contribute value to those who use the resource (use values), but also to non-users or passive users (non-use values). Non-use values refer to values that services provide for the mere reason that they can be used by others or for the knowledge that they exist. The combination of use values and non-use values is often referred to as the 'Total Economic Value' (TEV) or Triple Bottom Line (TBL) (see below).

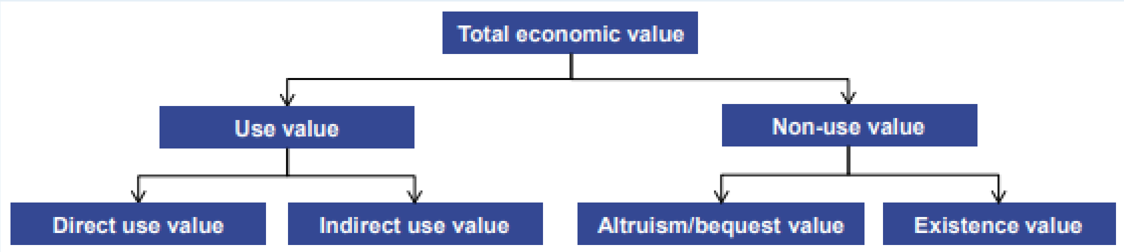

Figure 9 Total economic value

Source Productivity Commission, 2014

Because they are not readily revealed in market prices, the value of these services can be neglected in decision-making. One option for assigning monetary values to environmental goods and services is to use non-market valuation.

Economists have developed a number of methods for measuring non-market benefits. These are broadly captured under the following definitions:

- **Revealed preference** approaches rely on observations of people's actions in buying and selling goods and services that are related to the non-market impact under consideration. For instance, people's preferences for housing – as reflected by the prices paid for property – can be used to infer

[63] Essential Services Commission of South Australia, 2014. LRMC Pricing for Water Services – Background Paper on LRMC Pricing. p. vii https://www.escosa.sa.gov.au/ArticleDocuments/434/140711-WaterInquiry-LRMCPricingWaterServicesBackg.pdf.aspx?Embed=Y [Last accessed 21 May 2025].

the values they hold for environmental and social factors that affect house prices but which themselves are not marketed directly. Examples would include clean waterways that surround a property

- An alternative approach to non-market valuation is to estimate **avoided costs** associated with an option or options. For example, the benefits of improved water quality (reflected as a reduction in pollutant loads) can sometimes be quantified by considering the costs of an efficient alternative means of achieving the same outcome; in other words, the avoided cost to deliver similar pollution abatement
- **Stated preference** approaches involve people being asked questions in the format of a survey regarding the strength of their preferences for a specified environmental or social change. For example, people might be asked how much they are willing to pay for improved recreational opportunities in a certain area. Alternatively, they might be asked how much they would be willing to accept for the removal of certain environmental outcomes.

Non-market valuation techniques are not perfect, but they represent best-practice for ensuring the full range of costs and benefits of a proposed action are captured in economic appraisal. There are over 4,500 published environmental valuation studies listed in the Environmental Valuation Reference Inventory. The extensive application of non-market valuation methods has led to a better understanding of design issues and common pitfalls, and how these may be overcome. Understanding and articulating the limitations of non-market valuation approaches is important for non-market valuation to best contribute to the decision-making process.

The non-market valuation approach selected should align with the type and importance of the non-market benefits or costs being quantified. For example, **non-use values** are best estimated through **stated preference** approaches while **use values** are frequently best estimated **through revealed preference** approaches.

Benefit transfer can be applied to give a sense of the magnitude of costs and benefits. Benefit transfer approaches, which draw on existing non-market valuation studies to estimate non-market values, can be a cost-effective alternative to undertaking primary data collection and analysis. However, care needs to be taken in the application of benefit transfer. For example, non-market valuation may result in a range of values. The simplest way to manage this uncertainty effectively is by undertaking sensitivity analysis. The upper and lower bounds of that range can be included in the economic analysis as sensitivity tests.

In summary, when applied carefully, non-market valuation techniques can play an important role in improving decision making. Particularly in instances where there may be substantial social and environmental impacts, non-market valuation can ensure that decisions are made based on an understanding of the total economic value comprising social, environmental, and economic costs and benefits.

3.5 VALUATION METHOD FOR EACH WATER USE TYPE

3.5.1 Irrigation

Across the Hills and the Plains study areas, water use has been allocated across crops and ranked by land use type using the ALUM methodology.[64] Table 15 and Table 16 shows the irrigated ALUM land classifications and magnitude of land and water use, used in the analysis across the PWRA.

Table 15 Land use by ALUM classification and crop margins for the Hills

Number	Classification	Representative crops used for crop margins	Land use (%)	Water use (%)*
340	Perennial horticulture	Apricots	0.4%	1.8%

[64] Dataset of Australian Land Use and Management (ALUM) in SA provided by the Senior Project Officer, Water Planning, Murraylands and Riverland Landscape Board, 30 May 2025.

Number	Classification	Representative crops used for crop margins	Land use (%)	Water use (%)*
440	Irrigated perennial horticulture	Apricots	0.1%	0.4%
420	Grazing irrigated modified pastures	Lucerne	9.8%	37.2%
424	Irrigated sown grasses	Lucerne	1.0%	3.8%
422	Irrigated pasture legumes	Lucerne	0.5%	1.9%
449	Irrigated grapes	Wine grapes	85.6%	49.6%
442	Irrigated Olives	Olives	1.3%	2.6%
342	Olives	Olives	1.3%	2.6%

Note * Water use for each crop (ML/year) is calculated by multiplying the total actual water use by the proportion of estimated water use for that crop, based on its land area (ha) and application rate (ML/ha).

Table 16 Land use by ALUM classification and crop margins for the Plains

Number	Classification	Representative crops used for crop margins	Land use (%)	Water use (%)*
422	Irrigated pasture legumes	Lucerne (70%) and Wheat (30%)^	8.0%	9.7%
424	Irrigated sown grasses	Lucerne (70%) and Wheat (30%)^	36.8%	44.2%
420	Grazing irrigated modified pastures	Lucerne (70%) and Wheat (30%)^	8.3%	10.0%
430	Irrigated cropping	Lucerne (70%) and Wheat (30%)^	1.4%	1.7%
431	Irrigated cereals	Lucerne (70%) and Wheat (30%)^	1.4%	1.7%
342	Olives	Olives	6.0%	4.5%
442	Irrigated olives	Olives	37.9%	28.2%

* Water use for each crop (ML/year) is calculated by multiplying the total actual water use by the proportion of estimated water use for that crop, based on its land area (ha) and application rate (ML/ha).

^ Lucerne and Wheat crop margins were used for annual crop land use to capture the range of likely crops grown across this identified area.

Note Turf was identified subsequent to the ALUM land use classification shown in Table 16. The approach to include Turf in the analysis is described below and in Sections 2.2.1 and 3.3.2.2.

All land use types were aggregated where appropriate, informed by historical land use survey data. For example, in the Hills perennial horticulture (340) and irrigated perennial horticulture (440) were allocated to apricots as in the 2018 and 2019 Annual Use Survey data and the 2010 Entitlement Dataset these areas were reported as Apricots and other stone fruit.

Turf is only grown on the Plains and accounts for 17%[65] of PWRA water use. Turf water use volumes were deducted from pasture and annual crop (irrigated pasture legumes, irrigated sown grasses, grazing irrigated modified pastures, irrigated cropping and irrigated cereals) water use estimates for the Plains.

[65] Barnett SR (2020). Analysis of the water use and economic value of irrigated production in South Australia. DEW Technical report 2022/28, Government of South Australia, Adelaide

3.5.1.1 Gross margin approach for calculating the value of water in irrigated agriculture

A farm gate model was developed for each crop type. Model inputs were varied between the Hills and Plains regions to represent the variability of farm inputs between these regions (such as rainfall and soil types). Variability that exists for farming operations that are next door to one another including farm size, and land-owner's skills and approaches to risk management, was accounted for by using range values across the model inputs.

The economic returns of irrigated crops were valued using gross margins. Gross margins are the difference between the total variable costs and total revenues of the farming enterprise expressed as a per hectare or per-megalitre basis. A representative crop margin was developed for each crop type using a variety of simplified generic assumptions. The model we have used to develop the gross margin is an industry standard approach to farm gate modelling:

Our standard approach to farm gate modelling:

$$GM_{t,i} = \frac{R_{t,i}\left(p_y, y(\boldsymbol{x}, \boldsymbol{z_{t,i}}, \bar{\boldsymbol{z}})\right) - VC_{t,i}(\boldsymbol{p_x}, \boldsymbol{x})}{W_{t,i}}$$

Where:

$GM_{t,i}$ - gross margin per ML of irrigation water applied

$R_{t,i}$ - total revenue per hectare

$VC_{t,i}$ - variable cost per hectare

W - megalitres (ML) applied per hectare

y - crop yield

p_y - output price

$\boldsymbol{p_x}$ - range of input prices

$\boldsymbol{x}$ - range of input quantities

$\boldsymbol{z_{t,i}}$ - range of all other inputs that change over time (e.g. diseases, temperature, rainfall)

$\bar{\boldsymbol{z}}$ - inputs that are constant over time (e.g. soil type)

A summary of the economic values, valuation method and sources is presented in Table 17.

Table 17 Economic values and valuation method

Economic values	Central value	Minimum of range	Maximum of range	Valuation method	Source
Irrigated crop gross margins ($/ML) ($2024/25)					
Perennial horticulture (Apricots)	6,262	3,107	8,072	Gross margin	Hort Innovation, 2024[66] Government of SA, 2016[67] Australasian Farmers & Deals Journal, 2019[68] RIRDC, 2024[69] The Weekly Times, 2017[70]
Irrigated pasture - Hills (Lucerne)	331	209	478	Gross margin	Australian Fodder Industry Association, 2025[71] Australian Fodder Industry Association, 2023[72] GRDC, 2022[73] S&W Seed Company, 2023[74]
Irrigated pasture - Plains (Lucerne and Wheat)	274	163	402	Gross margin	Australian Fodder Industry Association, 2025[75]

[66] Hort Innovation, 2024. Decision support models for Australian dried tree fruit. https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/dt23001/dt23001-final-report.pdf [Last accessed 31 July 2025].

[67] Government of SA, 2016. Irrigation Glove Box Guide. https://cdn.environment.sa.gov.au/environment/docs/2016_Irrigation-Glove-Box-Guide_Guide.pdf [Last accessed 31 July 2025].

[68] Australasian Farmers & Dealers Journal, 2019. Apricots have potential to lift earnings for producers. https://afdj.com.au/apricots-potential-lift-earnings-producers/ [Last accessed 31 July 2025].

[69] Rural Industrials Research and Development Corporation (RIRDC), 2024. Apricot Pollination Aware Cast Study. https://www.planthealthaustralia.com.au/wp-content/uploads/2024/01/10-110.pdf?utm_source [Last accessed 31 July 2025].

[70] The Weekly Times, 2017. Riverland orchards: Stone-fruit grower Jason Size adds muscle to industry. https://www.weeklytimesnow.com.au/agribusiness/riverland-orchards-stonefruit-grower-jason-size-adds-muscle-to-industry/news-story/7cc3e5c1b2ad5a94194dec98f5059a78 [Last accessed 31 July 2025].

[71] Australian Fodder Industry Association, 2025. Hay Report 30 May 2025. https://afia.org.au/wp-content/uploads/2025/05/2025_05_30_HayReport-Web.pdf [Last accessed 22 August 2025].

[72] Australian Fodder Industry Association, 2023. Hay Report 30 June 2023. https://afia.org.au/wp-content/uploads/2023/06/2023_06_30_HayReport-Web.pdf [Last accessed 22 August 2025].

[73] Grains Research and Development Corporation, 2022. Farm Gross Margin and Enterprise Planning Guide. https://grdc.com.au/__data/assets/pdf_file/0032/571496/21112.01-Gross-Margins-Guide-2022_WEB.pdf [Last accessed 22 August 2025].

[74] S&W Seed Company, 2023. Lucerne Advisor. https://alfagenseeds.com.au/app/uploads/2023/04/SW-Lucerne-Advisor-2023-1.pdf [Last accessed

[75] Australian Fodder Industry Association, 2025. Hay Report 30 May 2025. https://afia.org.au/wp-content/uploads/2025/05/2025_05_30_HayReport-Web.pdf [Last accessed 22 August 2025].

Economic values	Central value	Minimum of range	Maximum of range	Valuation method	Source
					Australian Fodder Industry Association, 2023[76] GRDC, 2022[77] S&W Seed Company, 2023[78] SAGIT 2025[79] Irrigated Cropping Council, 2022[80]
Turf	5,241	5,241	6,582	Gross margin	Barnett SR 2020[81]
Wine grapes (Barossa Valley)	2,131	-3,186	9,423	Gross margin	S. Wheeler et al., 2022[82] PIRSA, 2024[83] Wine Grapes Council SA, 2020[84], 2023[85] & 2024[86]
Olives – Plains	453	-690	3,309	Gross margin	HortInnovation, 2018[87]
Olives – Hills	3,309	453	3,309	Gross margin	HortInnovation, 2018[37]

[76] Australian Fodder Industry Association, 2023. Hay Report 30 June 2023. https://afia.org.au/wp-content/uploads/2023/06/2023_06_30_HayReport-Web.pdf [Last accessed 22 August 2025].

[77] Grains Research and Development Corporation, 2022. Farm Gross Margin and Enterprise Planning Guide. https://grdc.com.au/__data/assets/pdf_file/0032/571496/21112.01-Gross-Margins-Guide-2022_WEB.pdf [Last accessed 22 August 2025].

[78] S&W Seed Company, 2023. Lucerne Advisor. https://alfagenseeds.com.au/app/uploads/2023/04/SW-Lucerne-Advisor-2023-1.pdf [Last accessed

[79] SAGIT, 2024. 2024 Farm Gross Margin Guide. https://sagit.com.au/2024-farm-gross-margin-guide/ [Last accessed 22 August 2025].

[80] Irrigated Cropping Council, 2022. Spring research field day September 2022. https://faraustralia.com.au/wp-content/uploads/2022/12/Final-ICC-Research-Field-Day-Notes_low-res.pdf [Last accessed 22 August 2025].

[81] Barnett SR, 2020. Analysis of the water use and economic value of irrigated production in South Australia. DEW Technical report 2022/28, Government of South Australia, Adelaide

[82] S. Wheeler, C. Seidl, J. Tingey-Holyoak, A. Zuo, Y. Xu and J. Kandulu, 20222. The economics and financial benchmarking of Riverland Grape production, and potential benefits of Vitivisor technology, University of Adelaide.

[83] PIRSA, 2024. Optimising the agriculture uses of varying water qualities in the Barossa Region. https://www.pir.sa.gov.au/__data/assets/pdf_file/0008/470465/Optimising_agricultural_uses_of_water_qualities_in_the_Barossa_Region.pdf [Last accessed 22 August 2025].

[84] Wine Grape Council SA, 2020. Sa Winegrapes Crush Survey – Barossa Valley Wine Region. https://www.wgcsa.com.au/uploads/1/1/5/5/115509859/barossa-report-2020.pdf [Last accessed 22 August 2025].

[85] Wine Grape Council SA, 2023. Sa Winegrapes Crush Survey – Barossa Valley Wine Region. https://www.wgcsa.com.au/uploads/1/1/5/5/115509859/sa_winegrape_crush_survey_2023_regional_summary_report_barossa_wine_region.pdf [Last accessed 22 August 2025].

[86] Wine Grape Council SA, 2024. Sa Winegrapes Crush Survey – Barossa Valley Wine Region. https://www.wgcsa.com.au/uploads/1/1/5/5/115509859/sa_winegrape_crush_survey_2024_regional_summary_report_barossa_wine_region.pdf [Last accessed 22 August 2025].

[87] HortInnovation, 2018. Australian Olive Industry Benchmarking Program. https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/ol16001/ol16001---final-report-complete.pdf [Last accessed 22 August 2025].

Economic values	Central value	Minimum of range	Maximum of range	Valuation method	Source
S&D	3,482	N/A	N/A	Opportunity cost	SA Water, 2024[88]
Industrial use	3,214	N/A	N/A	Opportunity cost	SA Water, 2024[89]
Non-market valuations (green open space) – one of economic value					
Value per ha	~$322	N/A	N/A	Non-market valuation	CRC for Water Sensitive Cities, 2017

Note ~ An assumption relating to the value that water provides to green open spaces is required to derive the economic value of water. It is assumed that 50% of the value of green open spaces is lost if the area is not irrigated. It is important to note that this approach estimates economic value as a one-off willingness-to-pay of households within the PWRA, different to the annual (p.a.) economic value of other water uses in the analysis.

[88] SA Water, 2024. Pricing Schedule. p. 3. https://www.sawater.com.au/__data/assets/pdf_file/0011/941348/2024-25-Price-setting-Water-and-Sewerage-prices.pdf [Last accessed 22 August 2025].
[89] SA Water, 2024. Pricing Schedule. p. 5. https://www.sawater.com.au/__data/assets/pdf_file/0011/941348/2024-25-Price-setting-Water-and-Sewerage-prices.pdf [Last accessed 22 August 2025].

3.5.2 Industrial

Industrial uses in the Marne Saunders PWRA include wineries, quarries, dairy washdown and food processing.[90] These industrial users of water are generally highly capital intensive and likely have a high proportion of fixed costs. If these businesses shutdown due to a lack of water this would have a significant impact on their profitability and long-term economic viability. Valuing water based on a net margin would be the preferable approach as opposed to gross margins. Profit margins per ML of water (excluding fixed costs) could be used to value the value of water in these industries but would be dependent on obtaining relevant cost information on the relevant industries, which is not publicly available.

Given industrial users need a reliable water supply to maintain normal operations, we considered the opportunity cost of water use a suitable method.

Given that the typical industrial user requires a reliable water supply, the current SA Water commercial water use charge of $3.214 per kL ($3,124 per ML)[91] has been used as a proxy for the opportunity cost of water for industrial uses. The current water price is based off the 2024 to 2028 pricing period under the SA Water regulatory determination.

3.5.3 Recreational

Groundwater in the Marne Saunders PWRA is used to irrigate recreational and sports grounds.[92] A review of non-market valuation studies identified the most appropriate economic value to apply to water used for this purpose. Based on a 2017 CRC for Water Sensitive Cities study,[93] which estimated that a 178-hectare park provided $32,139–$57,991 in benefits per property ($2017), we derived an average value of $322[94] per hectare per property in $2024–25. To reflect the contribution of irrigation to these benefits, we applied a 50% discount assuming half the economic value of open space is attributable to irrigation. We applied this one-off value to recreational area in the Plains watered using Marne Saunders PWRA groundwater.

3.5.4 S&D

S&D refers to the right to take water without a licence (or authorisation) for the purposes of:

- watering stock – e.g. from a dam or bore, less often from a water course
- domestic use – which can include household use but most often relates to watering a garden. Under the definition there is a limit on the area that can be watered and can't be used for commercial purposes (e.g. growing cut flowers for profit, watering the lawn of a cellar door outlet).

Our approach to value S&D is to estimate the cost to replace the water if it had to be sourced through the next best, lowest cost alternative, the opportunity cost.

S&D water is classified as a class 1 water access entitlement under the WAP for the River Murray[95] and holders have generally received a 100% allocation if South Australia's full state entitlement flow has been received. Since the 2007–08 water use year, water allocations have been prioritised for classes of water access entitlement deemed to be for critical human water needs (CHWN). CHWN includes Class 1 water access entitlements and are currently considered the highest priority water use in accordance with South Australia's

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[90] South Australian Murray-Darling Basin Natural Resource Management Board, 2019. The Water Allocation Plan for the Marne Saunders Prescribed Water Resources Area, p. 63. https://cdn.environment.sa.gov.au/landscape/images/marne-and-saunders-wap-ammended-2019-plan.pdf [Last accessed 16 May 2025].

[91] SA Water, 2024. Pricing Schedule Water and Sewerage Prices 2024-2025. p. 5. https://www.sawater.com.au/__data/assets/pdf_file/0011/941348/2024-25-Price-setting-Water-and-Sewerage-prices.pdf [Last accessed 21 May 2025].

[92] Murraylands and Riverland Landscape Board, (2021). Minutes of water advisory committee. p. 8. https://cdn.environment.sa.gov.au/landscape/docs/mr/210627-minutes-water-advisory-committee.pdf [Last accessed 21 May 2025].

[93] CRC for Water Sensitive Cities, 2017. How much do we value green spaces? p.1 https://watersensitivecities.org.au/wp-content/uploads/2017/05/IN_A1-1_How_much_do_we_value_green_spaces_V1.pdf [Last accessed 21 May 2025].

[94] Original value of $253 per hectare waste estimated in $2016-17 and escalated to $2024-25 using ABS (2025), 6401.0 Consumer Price Index, Australia.

[95] Murraylands and Riverland Landscape Board, 2019. Water Allocation Plan for the River Murray Prescribed Watercourse p. 22. https://cdn.environment.sa.gov.au/landscape/docs/mr/rmwap_final_web_ready.pdf [Last accessed 16 May 2025].

River Murray Water Allocation Framework and the Natural Resources Management Act 2004 (South Australia).[96]

With S&D classified as being a CHWN, we adopted the residential water use charge per kL at the Tier 3 level (use volumes over 1,427kL) of $3.482 per Kl[97] which has a similar ranking in the hierarchy to class 1.

[96] MDBA, 2023. South Australian Murray – Class 1 (Stock, domestic and stock and domestic purposes). https://www.mdba.gov.au/water-use/water-markets/water-markets-product-information/south-australia-water-markets-product-0 [Last accessed 16 May 2025].

[97] SA Water, 2024. Pricing Schedule Water and Sewerage Prices 2024-2025. p 3. https://www.sawater.com.au/__data/assets/pdf_file/0011/941348/2024-25-Price-setting-Water-and-Sewerage-prices.pdf Last accessed 21 May 2025].

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