Department of Planning and Environment

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Lachlan Regional Water Strategy

Detailed economic analysis

October 2023

Acknowledging First Nations people

The NSW Government acknowledges First Nations people as the first Australian people and the traditional owners and custodians of the country's lands and water. First Nations people have lived in NSW for over 60,000 years and have formed significant spiritual, cultural, and economic connections with its lands and waters.

Today, they practice the oldest living culture on earth.

The NSW Government acknowledges the Nari Nari, Ngiyampaa, Wiradjuri, Barkandji, Maljangapa and Yita Yita people as having an intrinsic connection with the lands and waters of the Lachlan Regional Water Strategy area. The landscape and its waters provide the First Nations people with essential links to their history and help them maintain and practice their traditional culture and lifestyle.

We recognise the Traditional Owners as the first managers of Country. Incorporating their culture and knowledge into management of water in the region is a significant step towards closing the gap.

Under this regional water strategy, we seek to establish meaningful and collaborative relationships with First Nations people. We will seek to shift our focus to a Country-centred approach; respecting, recognising and empowering cultural and traditional Aboriginal knowledge in water management processes at a strategic level.

We show our respect for Elders past and present through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places where First Nations people are included socially, culturally and economically.

As we refine and implement the regional water strategy, we commit to helping support the health and wellbeing of waterways and Country by

valuing, respecting and being guided by First Nations people, who know that if we care for Country, it will care for us.

We acknowledge that further work is required under this regional water strategy to inform how we care for Country and ensure First Nations people hold a strong voice in shaping the future for all communities.

Artwork by Nikita Ridgeway.

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Lachlan Regional Water Strategy

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Cover image: Lachlan River, Fishway at Cargelligo Weir (Amanda Ind).

Contents

Introduction

The NSW Government is developing 12 regional and 2 metropolitan water strategies that bring together the best and latest climate evidence, with a wide range of tools and solutions to plan and manage each region's water needs over the next 20 to 40 years.

The *Draft Lachlan Regional Water Strategy*, including a long list of options, was released in October 2020[1]. The long list of options were analysed and shortlisted into a proposed set of actions which has been published in the *Draft Lachlan Regional Water Strategy: Shortlisted Actions — Consultation Paper* first released in October 2022[2] and re-released in September 2023 following the postponement due to flooding in the region.

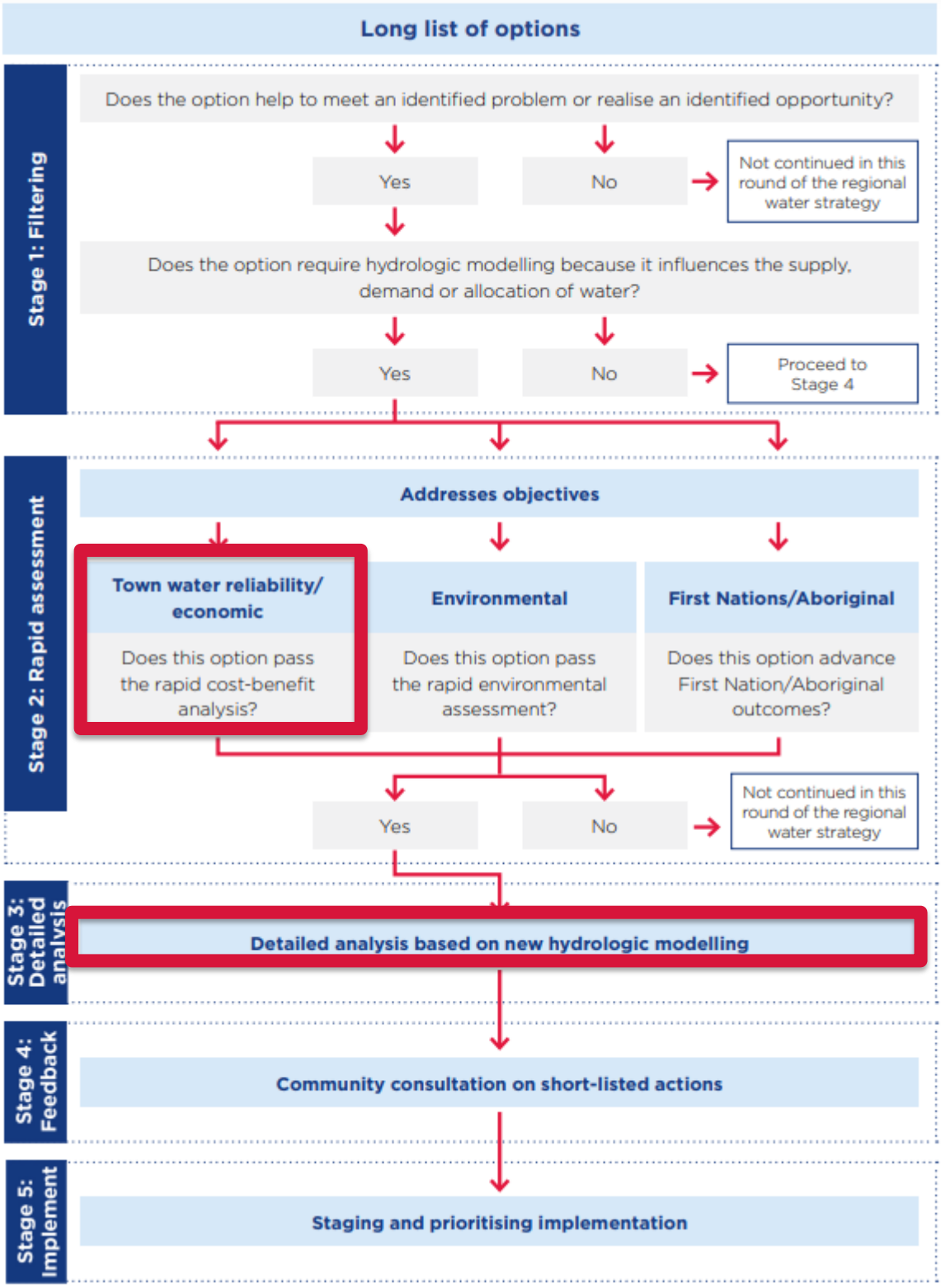
Figure 1 sets out the options assessment process, with the complete options assessment process is described in the Options Assessment Process: Overview[3]. This report provides the outcomes of detailed and rapid economic assessments that were used to inform which of the long list options that influence the supply demand or allocation of water, should be included as shortlisted actions in the *Draft Lachlan Regional Water Strategy: Shortlisted Actions — Consultation Paper.*

[1] The *Draft Lachlan Regional Water Strategy* and long list of options can be viewed at www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/upcoming-public-exhibition

[2] Available for download at: www.water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/public-exhibition

[3] Available at: www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing

Figure 1: Options assessment process



Options that influenced the supply, demand or allocation of water underwent a rapid economic assessment. Where the rapid economic assessment, or other assessments suggested that there was merit in further investigating the options, additional detailed economic assessments were

conducted. Options that passed detailed assessments then progressed to being shortlisted actions for the Draft Lachlan Regional Water Strategy: Shortlisted Actions — Consultation Paper.

Table A shows the Lachlan long list options that underwent rapid and detailed economic assessments:

Table A. Options that underwent rapid and detailed economic assessments

Options for the Lachlan Regional Water Strategy	Long list option number
20% increase in Resource Assessment (increase from 120,000 ML to 144,000 ML)	Option 34[4]
20% reduction in Resource Assessment (decrease from 120,000 ML to 96,000 ML)	Option 34
Increase annual take account limit to 1.1 ML/share (policy option)	Option 34
Lower Lachlan efficiency (50% reduction of replenishment flow requirements comprising: 12,500 ML/a Booberoi, 12,000 ML Willandra, 9,000 ML Merrowie, 4,500 ML Muggabah, 4,500 ML Merrimajeel – meaning 42,500 ML in total reduced to 21,250 ML)	Option 25
Lachlan re-reg Weir: 3,000 ML capacity weir located near Whealbah GS	Option 39
Belubula R Weir: 3,000 ML capacity weir located near Needles GS	New option not in the 2020 long list
Conversion of 10% of non-HEW GSE to HSE entitlements. (Series of iterative runs with results shown for 3:1 and 4:1 conversion ratios – 4:1 ratio brings GSE back to near Base Case performance (in terms of ML/a diversion per unit entitlement and also with regard to AWD outcomes). Additional HSE located near Forbes/Parkes)	Option 35
Conversion of 20% of non-HEW GSE to HSE entitlements. (Series of iterative runs with results shown for 3:1 and 4:1 conversion ratios – 4:1 ratio brings GSE back to near Base Case performance (in terms of ML/a diversion per unit entitlement and also with regards to AWD outcomes). Additional HSE located near Forbes/Parkes)	Option 35

[4] Further information about the relevant options from the draft Lachlan Regional Water Strategy long-list (2020) referred to in this table can be found here: wwwwater.dpie.nsw.gov.au/__data/assets/pdf_file/0019/313282/draft-rws-lachan-options.pdf

These rapid cost benefit analyses were evaluated based on the instrumental record (data collected over approximately 130 years). The rapid economic assessment was applied to all relevant options that influence the supply, demand or allocation of water.

The options considered for detailed analysis were informed by a series of rapid cost-benefit analyses against the more comprehensive stochastic and NARCliM data sets with 10,000 years of data. These options also underwent a detailed ecological assessment.

This report should be read in conjunction with the Detailed Ecological Assessment for the Lachlan.

Option assessment overview

Identifying the key challenges for the region and understanding the base case

The first step in the options assessment process is to define the priority challenges in the region that we need to focus on over the next 40 years.

While all the challenges and options identified in the draft strategy are important, it is not possible or feasible to tackle every challenge at once. The issues need to be prioritised to tackle those that are likely to cause the most significant long-term impacts to the region.

Key challenges have been identified by understanding what the future could look like, and what could be the consequences, if we do nothing. This process is articulated in the Economic Base Case which interprets the outcomes of the hydrology for the major extractive users of water.[5] The key challenges were used to filter and match the options in the *Draft Lachlan Regional Water Strategy*, as well as additional options identified through stakeholder consultation to address the key challenges identified for the region. This step was critical in making sure that the options selected adequately address the key challenges in the region. It was also the primary analysis used to prioritise the options that could not be quantitatively assessed.

Rapid economic assessment

Once the filtering process was undertaken, the options were assessed to determine if they influence the supply, demand or allocation of water. Options requiring hydrologic modelling were subject to further quantitative assessment. Options that influence the supply and demand for water, were initially assessed through a rapid cost-benefit analysis of what they are trying to achieve.

Options aiming to improve the economic activity of the region are evaluated according to how they change the expected total economic benefits in the region. This assessment is made against the available historic record in the region, referred to as the instrumental record of approximately 130 years (1890 to 2020).[6]

Options aiming to reduce town water security risks were first assessed against the effectiveness of the option in reducing those risks, and then which options best address the challenge at least cost.

[5] The ecological challenges for the region were already identified in the *Draft Lachlan Regional Water Strategy*.

[6] The exact time period of the instrumental record is detailed in the report hydrologic analysis of options for the Lachlan, accessible from the department's website.

These decision criteria should be used as a guide only for assessing the economic viability of an option. The outcomes of the rapid cost-benefit analysis are a decision-supporting tool (as opposed to a decision-making tool) and an outcome that is not strictly positive (i.e. with a benefit-cost ratio of less than 1) may not necessarily preclude an option from being progressed to a detailed assessment in Stage 3.

Options can still pass through to the detailed assessment if they are of significant community interest.

Detailed economic assessment

Options that passed through the filtering and rapid assessment processes were then assessed against the new stochastic and climate change data:

- long-term historic climate projections (stochastic data): these data assume that our future climate is similar to what the science is indicating the long-term paleoclimate was like and are based on a 10,000-year dataset
- a dry climate change scenario (NARCliM[7] modelling): this data assumes that there is a dry, worst-case climate change scenario in the future and is also based on a 10,000-year dataset.

Assessing options against the new stochastic and climate change data helped to understand the resilience of the options in more extreme scenarios. This stage of the assessment measured economic and environmental outcomes.[8] It is recommended that the *Detailed economic assessment report* be read in conjunction with the *Detailed ecological assessment report*.

The full options assessment process has been published in the *Options Assessment Process: Overview report*.[9]

Economic analysis overview

The key information that informed the cost-benefit analysis of each option included:

- **Understanding what happens if the approach is to do nothing:** hydrological modelling was undertaken for the two different hydrologic models. These models are sampled to each provide 1,000 40-year forecasts of the future of the region and how much water is available

[7] NARCliM (NSW and ACT Regional Climate Modelling) is a partnership between the NSW, ACT and South Australian governments and the Climate Change Research Centre at the University of NSW. NARCliM produces robust regional climate projections that can be used to plan for the range of likely climate futures. Further information about NARCliM modelling can be found at www.climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/About-NARCliM.

[8] See *Scenario Analysis: the relevant region* attachment and *Relevant Regional Water Strategy: Ecological assessment of options*

[9] The *Options Assessment Process: Overview* can be found at: www.water.dpie.nsw.gov.au/__data/assets/pdf_file/0006/506463/options-assessment-process.pdf

to different licences under the base case and under each option. More detail on the base case is available in the Lachlan Economic Base Case[10].

- **High-level cost estimates** were prepared for each option including capital and operational expenditure for infrastructure options[11], and operational costs for non-infrastructure options. These costs were very broad and high level. Further investigation of any option will require more detailed cost estimates.
- **Benefit estimates:** the economic value of water for towns and industries has been developed and used as the primary benefit to assess the costs against. This is referred to as the Regional Water Value Function. A summary of the value of water for each major water user is detailed below. More details about how these values were calculated are in the Lachlan Economic Base Case.

Key outcomes of the detailed analysis are defined using two metrics or decision criteria: the net present value and the benefit-cost ratio.

The net present value is the summation of the present value economic outcomes of the option case minus the summation of the present value economic outcomes of the base case. It is the marginal difference between the two outcomes, with the option cost (and the timing of costs and benefits) taken into account. A positive net present value indicates that there is potential economic benefit from pursuing an option, while a negative net present value indicates that the option creates more costs than it generates benefits, when the time value of money is incorporated. Net present value can be expressed as Equation 1:

Equation 1 Net Present Value (NPV)

$$NPV_{option} = (PV_{option\ scenario} - PV_{base\ case}) - PV_{option\ cost}$$

The benefit-cost ratio divides the incremental benefits of an option to the region by the discounted whole-of-life cost (capital and operational expenditure) of the option. A benefit-cost ratio of 1 or greater indicates that the project is economically feasible as the benefits outweigh the costs. benefit-cost ratio is illustrated in Equation 2.

Equation 2 Benefit-Cost Ratio (BCR)

$$BCR = \frac{PV_{benefits}}{PV_{costs}}$$

[10] See Marsden Jacobs Associates. 2020, *Regional Water Value* Function for all regions. Available at: www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing

[11] The department engaged ARUP to develop high level cost estimates of the options in the draft Lachlan Regional Water Strategy long list.

These decision criteria should only be used as a guide only for assessing the economic viability of an option. The outcomes of the rapid cost-benefit analysis are a decision-supporting tool (as opposed to a decision-making tool) and an outcome that is not strictly positive (such as an outcome with a benefit-cost ratio less than 1) should not preclude an option from being progressed to the detailed analysis stage.

In addition to these decision-making tools, the detailed analysis also conducts:

- sensitivity analysis: was used to identify the extent to which changes to the key assumptions influence the outcomes of the detailed analysis. The sensitivity analysis was carried out across:
    - the discount rate (3% and 10%)
    - capital and operational expenditure (+30% / -30%)
    - the value of water assigned to each economic activity
    - reactive infrastructure solutions
- distributional impacts: was used to look at how the option impacts different water users and classes of licences
- breakeven analysis: was used to determine what price for a megalitre of water would result in the costs being equivalent to the benefits. This analysis assumes the proposed option is viable on the balance of outcomes within the economic analysis framework presented and determines what price for a megalitre of water would make the benefits equal the cost of the option.

It is not always possible to determine a breakeven point, so some options may not have a breakeven analysis described.

The detailed assessment was completed by applying the Regional Water Value Function to the outputs of the hydrologic modelling to determine the incremental change between the base case and the option, while taking into account the cost of the option.

An Economic Impact Assessment, or Input-Output Analysis, was not undertaken as per the NSW Cost-Benefit Analysis guidelines.[12] Economic Impact Assessments are concerned with measuring economic activity. They are not a tool to measure economic wellbeing created from projects, nor does it take account of the alternative uses (opportunity costs) of resources. Finally, they do not necessarily measure net benefits. For example, poor investments in heavily subsidised fields of endeavour could be associated with greater levels of activity than good investments.

[12] TPP March 2017, NSW Government Guide to Cost-Benefit Analysis, page 65.

Economic assumptions

The economic valuation of water to these key user groups (Table 2) has been drawn from the regional water value function and is applied as a $/ML supplied (or not supplied in the case of town water supply and permanent crops). For the Lachlan, the values for town water supply shortfalls are given in Table 3 and for agricultural users in Table 4.

Due to the high level of uncertainty regarding environmental valuations within a cost-benefit analysis context, no attempt has been made include an economic ecological assessment within this cost-benefit analysis. Separate quantitative and qualitative ecological assessments have been undertaken for options that progressed past the rapid cost-benefit analysis stage.

Table 2. Key water users

Key water user	Water licence	Economic benefit of water use
Town water supply (Parks, Cowra, Forbes, Condobolin, Lake Cargelligo, Hillston)	Local water utility	• Reduction in economic cost of water supply shortfalls
Annual crop producers (eg. cotton, wheat)	General security Supplementary (Belubula only)	• Marginal increased yield of crop due to irrigation, compared to dryland production.
Permanent crop producers (e.g. oranges, almonds, olives)	High security	• Marginal increased yield of crop due to irrigation, compared to dryland production • Reduction in cost associated with growing replacement crops to maturation due to crop-perishing in dry periods

Table 3. Economic cost of town water supply shortages in the Lachlan region

	Parkes	Cowra	Forbes	Condobolin	Lake Cargelligo	Hillston	Central Tablelands Water
Population*	14,683	12,838	10,023	4,406	1,950	2,095	24,597
System type	Regulated	Regulated	Regulated	Regulated	Regulated	Regulated	Unregulated
Time in water shortage	Cost per ML						
0 - 6 months	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
6 to 12 months	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500
More than 12 months (alternative supply)	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Continued shortages (more than 24 months) (alternative supply)	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000

*2016 populations, sourced Australian Bureau of Statistics census data. *Australian Statistical Geography Standard 2019 Urban Centres and Localities*

Table 4. Lachlan agricultural water supply economic benefit[13]

Crop	Cropping	Water licence	Marginal economic benefit of water ($/ML)
Cotton	Annual	General security Supplementary (Belubula only)	250
Wheat	Annual	General security Supplementary (Belubula only)	175

[13] Note: Only values used in the analysis that represent the highest value crop were used. Other values on crop type groups in the region are in Marsden Jacobs Associates (2020) *Regional Water Value Functions.*

Crop	Cropping	Water licence	Marginal economic benefit of water ($/ML)
Oranges	Permanent	High security	450 *(2,300)
Almonds	Permanent	High security	1,100 *(1,300)
Olives	Permanent	High security	1,200 *(2,800)

*Refers to $/ML during shortfall periods

Population increases have been included in accordance with the NSW Government's Common Planning Assumptions' high population growth forecasts (2022). These planning assumptions predict that some towns within the Lachlan region will have reductions in population. For these towns, analysis undertaken for the regional water strategies assumes that population levels will be flat, rather than decreasing, to ensure conservative estimates across all outputs.

Infrastructure option costings

The capital and operational expenditure for infrastructure options are derived from cost models built to allow a consistent comparative assessment across regions. They are not site-specific cost estimates and are not intended to be used beyond the scope of this study. The cost models rely on the relationship between the physical characteristics of infrastructure, such as dam size or pipeline length, and the expected cost to construct, with each category of infrastructure—dams, pipelines, desalination plants, etc.—having its own unique valuation method. These relationships are arrived at through analysis of similar projects and professional assessment.

Capital and operational expenditure costs of options were discounted to present day values with the following assumptions:

- the option is constructed and fully operational from the start of Year 1 (that is, at Year 0), indicating no discounting is applied to the construction costs
- operational costs occur annually for the full period of the cost-benefit analysis from Year 1.

A residual value for infrastructure was considered through the addition of an end-of-life value for it, discounted at a linear rate at the end of the analysis period.

Policy option costings

Policy options were calculated as the cost of the number of full-time equivalent staff required to implement an option. The costs are incurred at the beginning of Year 1 (that is, at Year 0) and there is no annual cost associated with the option. It is assumed there is no measurable change between the effort required to administer the region each year with and without the policy change implemented.

Economic assessment results – options for Lachlan River

The following section outlines the key economic values used for the economic detailed analysis, and the outcomes of the analysis for each option. The analysis of each option considered their net present value and benefit-cost ratio as described in Table 5 below.

Table 5. Rapid cost-benefit analysis outcomes summary

Option	Description	Long-list option	Net present value ($m)	Benefit-cost ratio
1	20% increase in Resource Assessment (increase from 120,000 ML to 144,000 ML)	Option 34[14]	-17	<0
2	20% reduction in Resource Assessment (decrease from 120,000 ML to 96,000 ML)	Option 34	31	>1
3	Increase annual take account limit to 1.1 ML/share (policy option)	Option 34	-4	0
4	Lower Lachlan efficiency (50% reduction of replenishment flow requirements comprising: 12,500 ML/a Booberoi, 12,000 ML Willandra, 9,000 ML Merrowie, 4,500 ML Muggabah, 4,500 ML Merrimajeel – meaning 42,500 ML in total reduced to 21,250 ML)	Option 25	-287	0
5	Lachlan re-reg Weir: 3,000 ML capacity weir located near Whealbah GS	Option 39	-33	0.5

[14] Further information about the relevant options from the draft Lachlan Regional Water Strategy long-list (2020) referred to in this table can be found here: www.water.dpie.nsw.gov.au/__data/assets/pdf_file/0019/313282/draft-rws-lachan-options.pdf

Option	Description	Long-list option	Net present value ($m)	Benefit-cost ratio
6	Belubula River Weir. 3,000 ML capacity weir located near Needles GS	New option not in 2020 long-list	-18	<1
7	Conversion of 10% of non-HEW General Security Entitlement (GSE) to High Security Entitlement to (HSE) entitlements. Series of iterative runs with results shown for 3:1 and 4:1 conversion ratios – 4:1 ratio brings GSE back to near Base Case performance (in terms of ML/a diversion per unit entitlement and also with regard to AWD outcomes). Additional HSE located near Forbes/Parkes.	Option 35	1	1.1
8	Conversion of 20% of non-HEW GSE to HSE entitlements. Series of iterative runs with results shown for 3:1 and 4:1 conversion ratios – 4:1 ratio brings GSE back to near Base Case performance (in terms of ML/a diversion per unit entitlement & also w.r.t AWD outcomes). Additional HSE located near Forbes/Parkes.	Option 35	19	>1

Option 1: 20% increase in Resource Assessment

Option 1 would involve increasing resource assessment by 20%. This option would increase the existing storage from 120,000 ML to 144,000 ML.

Table 6 – Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit-cost ratio
1	+20% RE term in Resource Assessment	-17	-3

The results of the rapid cost-benefit analysis show the option would lose $17 million in economic value. The benefit-cost ratio is negative, as the option produces no benefits.

Table 7. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m, (% change))	Annual crops ($m, (% change))	Permanent crops ($m, (% change))
1	0.2 (14.5%)	-13 (-2.1%)	0.3 (0.7%)

The distribution of outcomes of the option show that there are limited changes for town water security and permanent crops, but the option decreases the value of annual crops in the Lachlan due to the requirement of increasing the resource assessment by 20%.

Table provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 8. Average results for +20% Resource Assessment

Option	Net present cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit-cost ratio	NARCliM benefit-cost ratio
1	4	-12	-2	-1.9	0.6

Increasing the resource assessment has a negative average net present value of $12 million using the stochastic dataset and negative $2 million using the NARCliM dataset. The average benefit-cost ratio rises from negative 1.9 to positive 0.6 under the drier climate scenario, also indicating that the costs of this intervention under the modelled conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

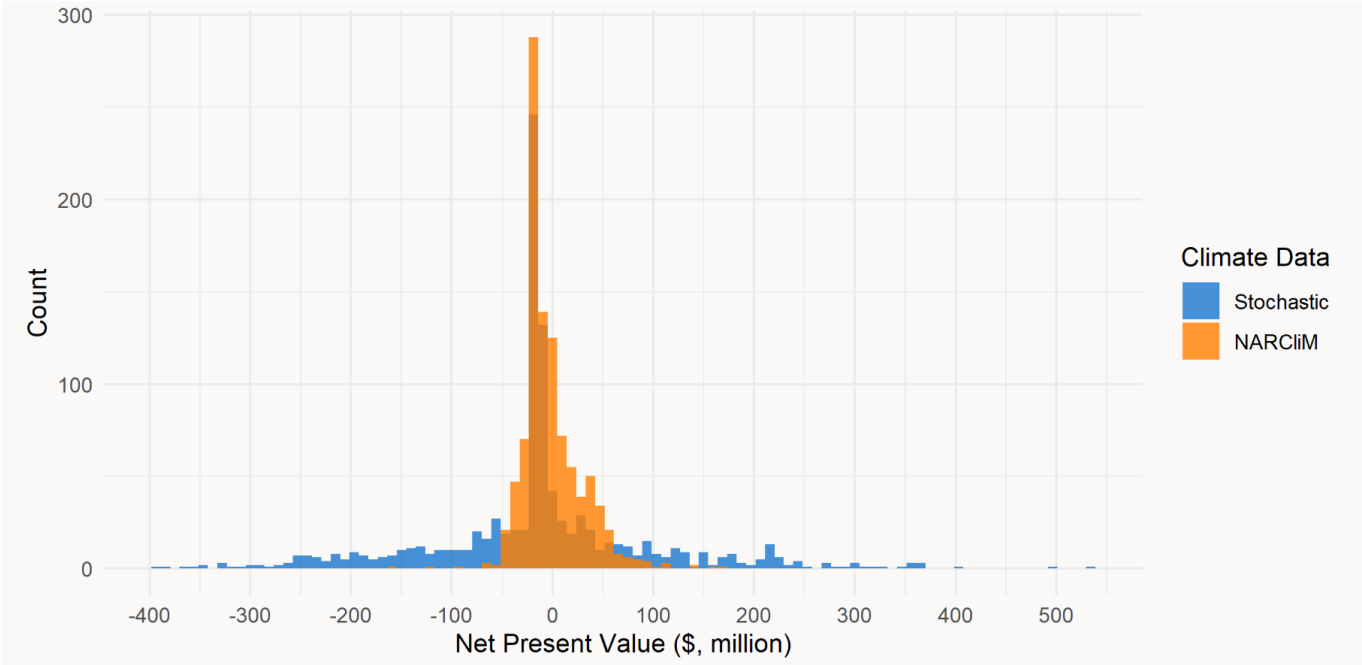
Table 9 presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 60% of outcomes in the stochastic dataset and 50% of outcomes in the NARCliM dataset produce negative benefit-cost ratios. In the higher percentiles for both climate datasets positive outcomes for the region are achieved.

Table 9. Decile and extreme centile results for +20% Resource Assessment

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-313	-73.1	-48	-10.4
10%	-147	-33.8	-29	-5.9
20%	-64	-14.2	-21	-3.9
30%	-23	-4.4	-18	-3.2
40%	-18	-3.3	-15	-2.5
50%	-15	-2.6	-11	-1.5
60%	-12	-1.7	-3	0.4
70%	-0.6	0.9	5	2.2
80%	37	9.8	19	5.5
90%	120	29.3	39	10.2
99%	330	79.2	92	22.7

Figure 2 presents the information in Table 9 graphically. This histogram shows that the proposed option typically performs better under the climate change NARCliM scenario.

Figure 2. +20% Resource Assessment net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 10 provides the summary results data for increasing the resource assessment by 20% for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 10. Sensitivity analysis for +20% Resource Assessment

Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	4	-12	-1.9	-92.4	127.2	29.8%
Low discount rate (3%)	4	-18	-3.3	-152.8	189.8	31.0%
High discount rate (10%)	4	-10	-1.5	-71.5	103.6	29.0%
Option cost (+30%)	6	-14	-1.5	-71.1	97.9	29.4%
Option cost (-30%)	3	-11	-2.8	-132.0	181.8	30.4%
Economic values (high)	4	-14	-2.2	-112.9	157.2	30.5%
Economic values (low)	4	-11	-1.7	-72.0	97.2	29.1%

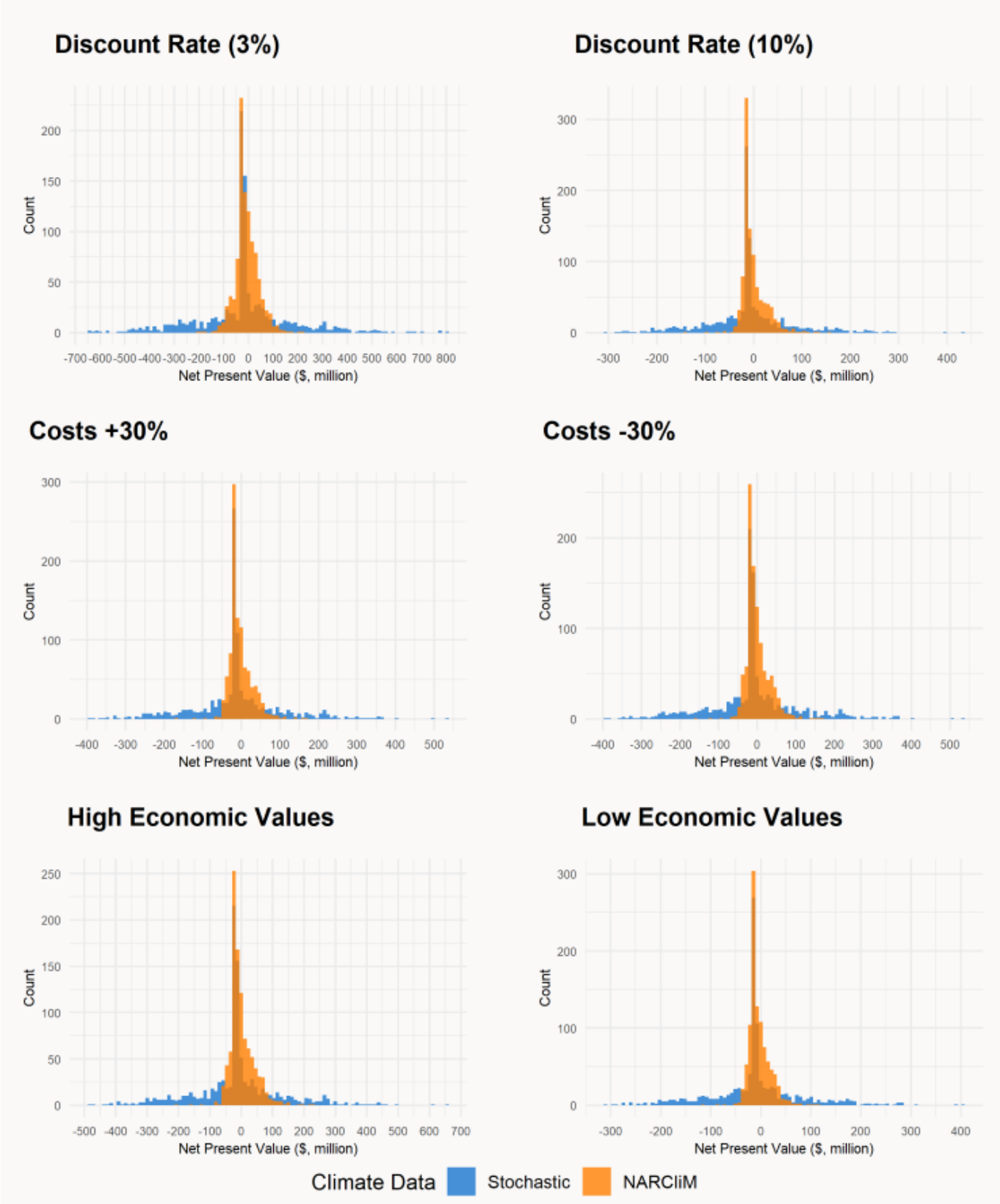
NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	4	-2	0.6	-37.5	41.7	36.6%
Low discount rate (3%)	4	-8	-0.8	-46.5	52.3	37.4%

NARCliM dataset						
High discount rate (10%)	4	-1	0.8	-32.5	39.0	33.8%
Option cost (+30%)	6	-3	0.5	-28.9	32.1	34.6%
Option cost (-30%)	3	-1	0.8	-53.6	59.6	38.0%
Economic values (high)	4	1	1.1	-48.5	54.6	39.2%
Economic values (low)	4	-4	0.1	-26.6	28.8	31.7%

The sensitivity analysis suggests that the option is not sensitive to any of the economic variables in the stochastic dataset, failing to produce a positive net present value. In the NARCliM dataset, high economic values produce a positive net present value, however the option is not sensitive to the other economic variables. On average the options percentage of benefit-cost ratio greater than 1 is not sensitive across all economic variables.

Histograms of the results of the sensitivity are shown in Figure 3 supporting the results of Table 10, which suggests that there is not a set of conditions under which the proposed option regularly produces economic benefits higher than its costs.

Figure 3. +20% Resource Assessment sensitivity case net present value shown as histograms



Distributional analysis

Table 11 highlights the average distributional changes that would impact the Lachlan region if the resource assessment was increased by 20%.

Table 11. Average distributional impacts from +20% Resource Assessment compared to the economic base case across both datasets

Stochastic dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
+20% resource assessment	-4	582	46	619
Change ($m)	3	-13	2	-8
Change (%)	43.9%	-2.1%	3.5%	-1.3%
NARCliM dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
+20% resource assessment	-192	424	0	226
Change ($m)	9	-14	8	3
Change (%)	4.5%	-3.2%	100.4%	1.1%

The distributional results indicate that the target of increasing the resource assessment by 20% and securing town water supplies is somewhat achieved, showing improvements in the economic outcomes for towns by 43.9% under the stochastic dataset and 4.5% under the NARCliM dataset. Additionally, the small amount of existing high security licences also sees an improvement in reliability due to the increased water set aside for dry conditions. This translates to economic benefits to users of these licences of 3.5% under the stochastic dataset and 100.4% under the NARCliM dataset. These improvements come at the expense of impacts to annual crops within the

region, which see smaller—relative to the base case—changes of negative 2.1% in the stochastic dataset and negative 3.2% in the NARCliM dataset. Due to the large size of this industry in comparison to permanent crops, and the small towns within the region, the absolute loss of economic output is larger than the benefits gained by the other user groups.

Option 2: 20% reduction in Resource Assessment

Option 2 would involve reducing resource assessment by 20%. It would result in the existing entitlements decreasing from 120,000 ML to 96,000 ML.

Table 12. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit–cost ratio
2	-20% RE term in Resource Assessment	31	8.3

The results of the rapid cost-benefit analysis show the option would gain $31 million in economic value. Additionally, the benefits exceed costs by more than 8 times the overall project cost.

Table 13. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m, (% change))	Annual crops ($m (% change))	Permanent crops ($m (% change))
2	-1.5 (-135.3%)	37 (5.9%)	-0.8(-1.6%)

The distribution of the outcomes of the option show that there are negative changes for town water security and permanent crops, but a material impact on annual crops. In fact, the option increases the value of annual crops in the Lachlan significantly.

Table 14 provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 14. Average results for -20% Resource Assessment

Option	Net present cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit-cost ratio	NARCliM benefit-cost ratio
2	4	-0.1	-27	1	-5.3

Decreasing the resource assessment has a negative average net present value of negative $0.1 million under the stochastic dataset, falling to negative $27 million under the NARCliM dataset. The average benefit-cost ratio falls from 1 to negative 5.3 under the drier climate scenario, indicating that the costs of this intervention under the modelled conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

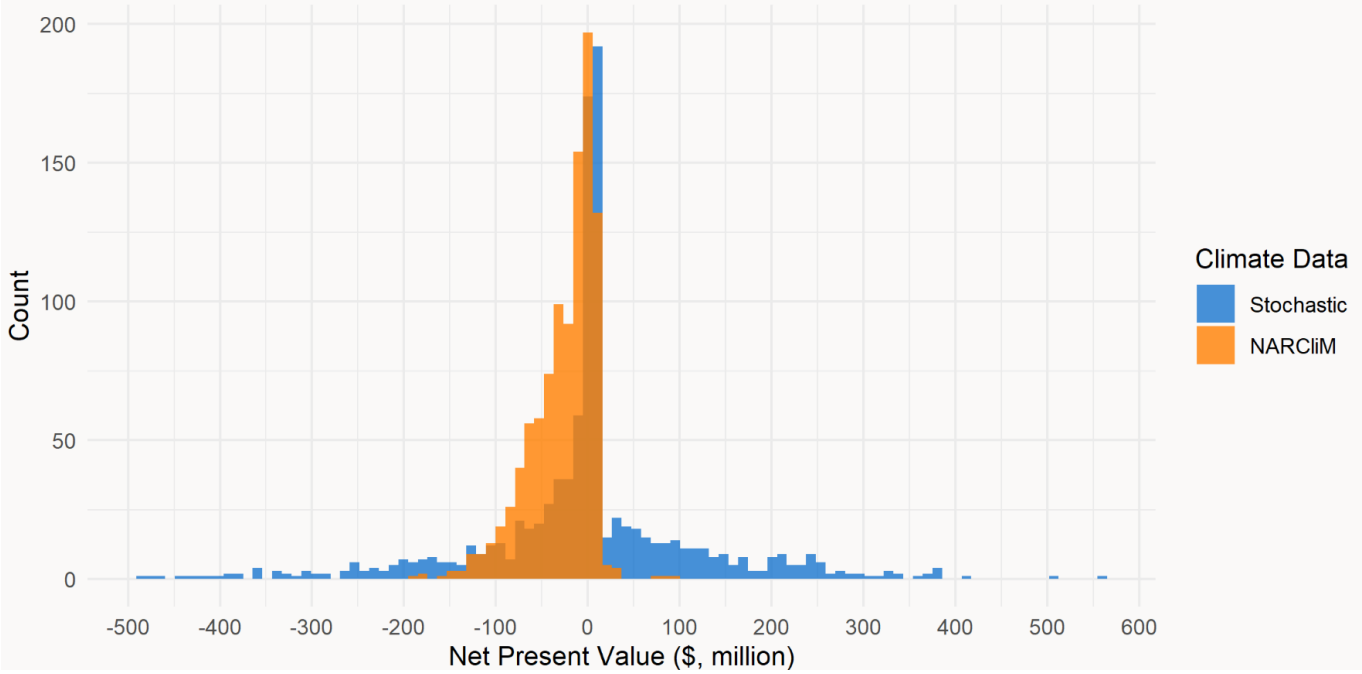
Table 15 presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 30% of outcomes in the stochastic dataset and 60% of outcomes in the NARCliM dataset, indicating a net negative outcome for users during drier climates in the region. In the higher percentiles for both climate datasets positive outcomes for the region are achieved.

Table 15. Decile and extreme centile results for -20% Resource Assessment

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-386	-90.3	-130	-29.8
10%	-128	-29.2	-75	-16.8
20%	-52	-11.3	-54	-11.8
30%	-18	-3.2	-38	-8.1
40%	-1	0.9	-28	-5.7
50%	4	1.9	-16	-2.8
60%	7	2.6	-10	-1.3
70%	10	3.4	-3	0.3
80%	53	13.6	3	1.7
90%	138	33.7	7	2.7
99%	343	82.1	19	5.4

Figure 4 presents the information in Table graphically. The histogram shows that the proposed option typically performs better under the stochastic scenario.

Figure 4. -20% Resource Assessment net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 16 provides the summary results data for decreasing the resource assessment by 20% for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 16. Sensitivity analysis on -20% Resource Assessment across the stochastic and NARCliM datasets

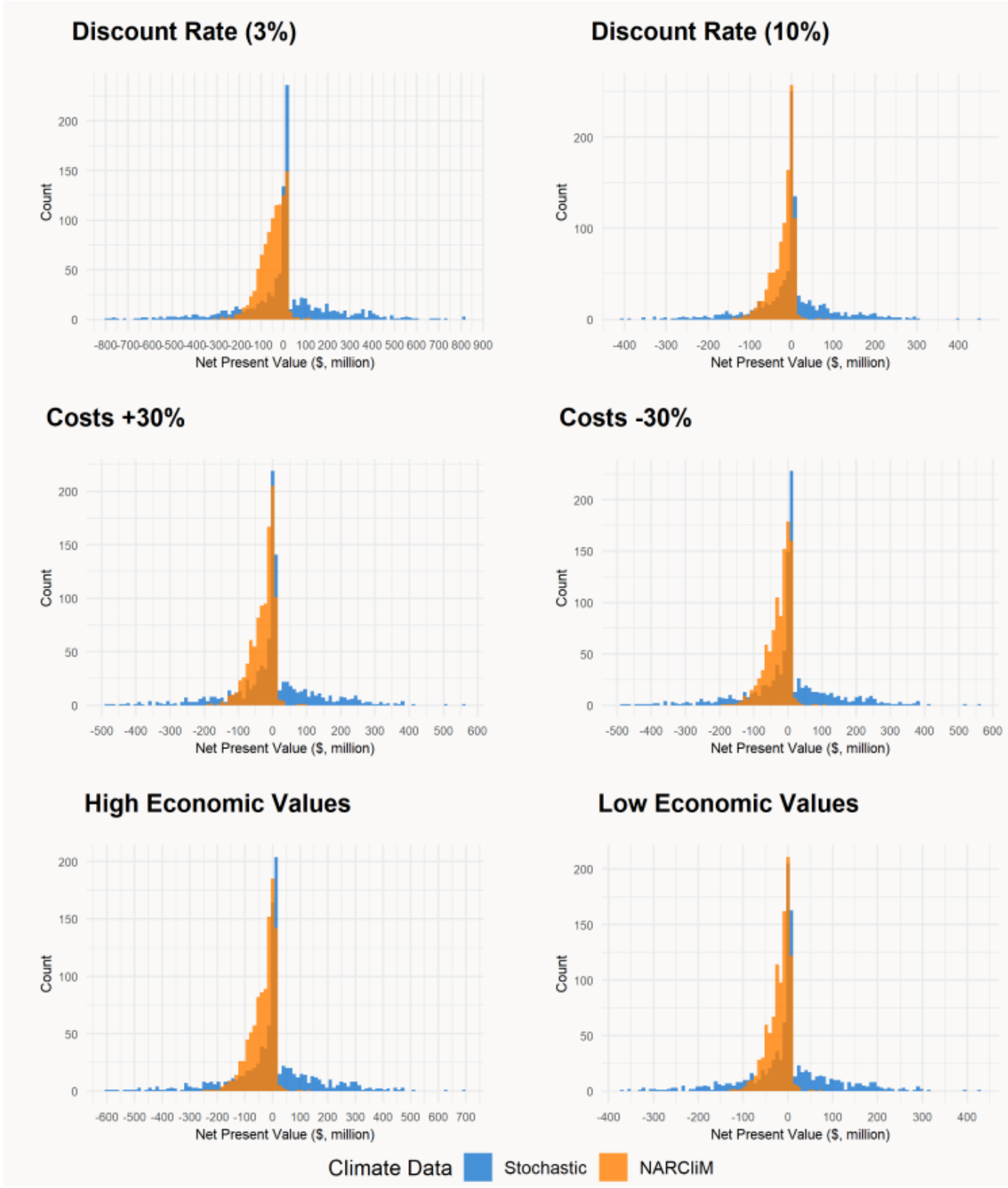
Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	4	-0.1	1.0	-114.5	133.1	58.5
Low discount rate (3%)	4	1	1.3	-185.8	195.3	60.1
High discount rate (10%)	4	-1	0.8	-94.4	108.1	56.3
Option cost (+30%)	6	-1	0.8	-88.1	102.4	56.5
Option cost (-30%)	3	1	1.4	-163.5	190.2	60.9
Economic values (high)	4	0	1.0	-142.2	164.3	59.7
Economic values (low)	4	-0.1	1.0	-86.8	102.0	57.3

NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	4	-27	-5.3	-43.5	24.6	24.5
Low discount rate (3%)	4	-48	-10.3	-71.8	29.2	22.7
High discount rate (10%)	4	-19	-3.6	-31.3	22.2	26.6
Option cost (+30%)	6	-28	-4.1	-33.5	19.0	22.6
Option cost (-30%)	3	-26	-7.6	-62.1	35.2	26.5
Economic values (high)	4	-35	-7.3	-56.8	31.7	24.2
Economic values (low)	4	-19	-3.4	-30.2	17.6	24.7

The sensitivity analysis suggest that the low discount and low economic costs are important in the stochastic dataset. Both produce some realisations that are positive. However, the option is not sensitive to any of the economic variables in the NARCliM dataset. On average the options percentage of benefit-cost ratio greater than 1 is not sensitive across all economic variables.

Histograms of the results of the sensitivity are shown in Figure 5, supporting the results of Table 16, which suggests that there is not a set of conditions under which the proposed option regularly produces economic benefits higher than its costs.

Figure 5. -20% Resource Assessment sensitivity case net present value shown as histograms



Distributional analysis

Table 17 highlights the average distributional changes that would impact the Lachlan region if the resource assessment was decreased by 20%.

Table 17. Average distributional impacts from -20% Resource Assessment compared to the economic base case across both datasets

Stochastic dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
Increase dam reserve	-12	606	42	631
Change ($m)	-5	12	-2	4
Change (%)	-78.7%	2.0%	-4.9%	0.7%

NARCliM dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
Increase dam reserve	-229	451	-15	201
Change ($m)	-28	13	-8	-23
Change (%)	-13.8%	3.0%	-107.1%	-10.1%

The distributional results indicate that the target of decreasing the resource assessment by 20% and securing town water supplies is not achieved, showing a reduction in the economic outcomes for towns by 78.6% under the stochastic dataset and 13.8% under the NARCliM dataset. Additionally, the small amount of existing high security licences also sees a reduction in reliability due to the decreased water set aside for dry conditions. This translates to a reduction in economic benefits to users of these licences of 4.9% under the stochastic dataset and 107.1% under the NARCliM dataset. Annual crops within the region experience a marginal improvement —relative to the base case—of 2% in the stochastic dataset and 3% in the NARCliM dataset. The absolute gain of economic output to is smaller than the benefits lost by the other user groups.

Option 3: Increase annual take limit

Option 3 involves increasing the annual take limit to 1.1 ML/share.

Table 18. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit–cost ratio
3	Increase annual take account limit to 1.1 ML/share	-4	0

The results of the rapid cost-benefit analysis show the option would lose $4 million in economic value. The is reflected through a benefit-cost ratio of zero and a marginal decrease on annual crops, as shown in Table 19.

Table 19. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m, (% change))	Annual crops ($m (% change))	Permanent crops ($m (% change))
3	0 (0.7%)	-0.1 (-0.01%)	0 (-0.01%)

Table 20 provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 20. Average results for increasing annual take limit

Option	Net present cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit-cost ratio	NARCliM benefit-cost ratio
3	4	-3	-5	0.3	-0.1

Increasing the annual take limit has a negative average net present value of $3 million under the stochastic dataset, and negative $5 million using the NARCliM dataset. The average benefit-cost ratio falls from 0.3 to negative 0.1 under the drier climate scenario, also indicating that the costs of this intervention under the modelled conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

Table 21 presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 30% of

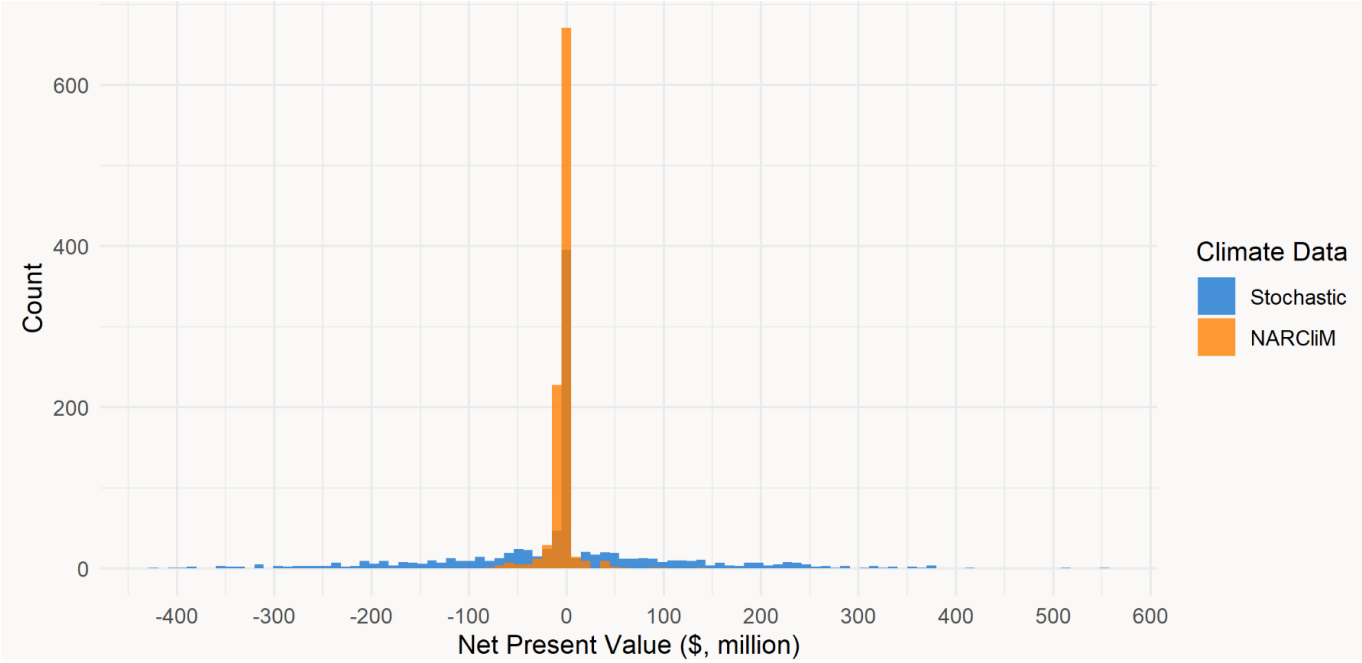
outcomes in the stochastic dataset and 30% of outcomes in the NARCliM dataset produce negative benefit-cost ratios. In the higher percentiles for both climate datasets, positive outcomes for the region are achieved.

Table 21. Decile and extreme centile results for increasing annual take limit

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-338	-79.0	-56	-12.3
10%	-135	-30.9	-9	-1.1
20%	-53	-11.5	-6	-0.4
30%	-9	-1.1	-5	-0.2
40%	-4	0.2	-4	0.0
50%	-3	0.3	-4	0.1
60%	-2	0.4	-3	0.2
70%	-1	0.7	-3	0.3
80%	46	11.9	-2	0.5
90%	132	32.3	-1	0.7
99%	337	80.7	42	10.8

Figure 6 presents the information in Table 21 graphically. The histogram shows that the proposed option typically performs better under the climate change NARCliM scenario.

Figure 64. Increasing annual take limit net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 22 provides the summary results data for increasing the annual take limit by 1.1 ML/share for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 22. Sensitivity analysis on increasing annual take limit across the stochastic and NARCliM datasets

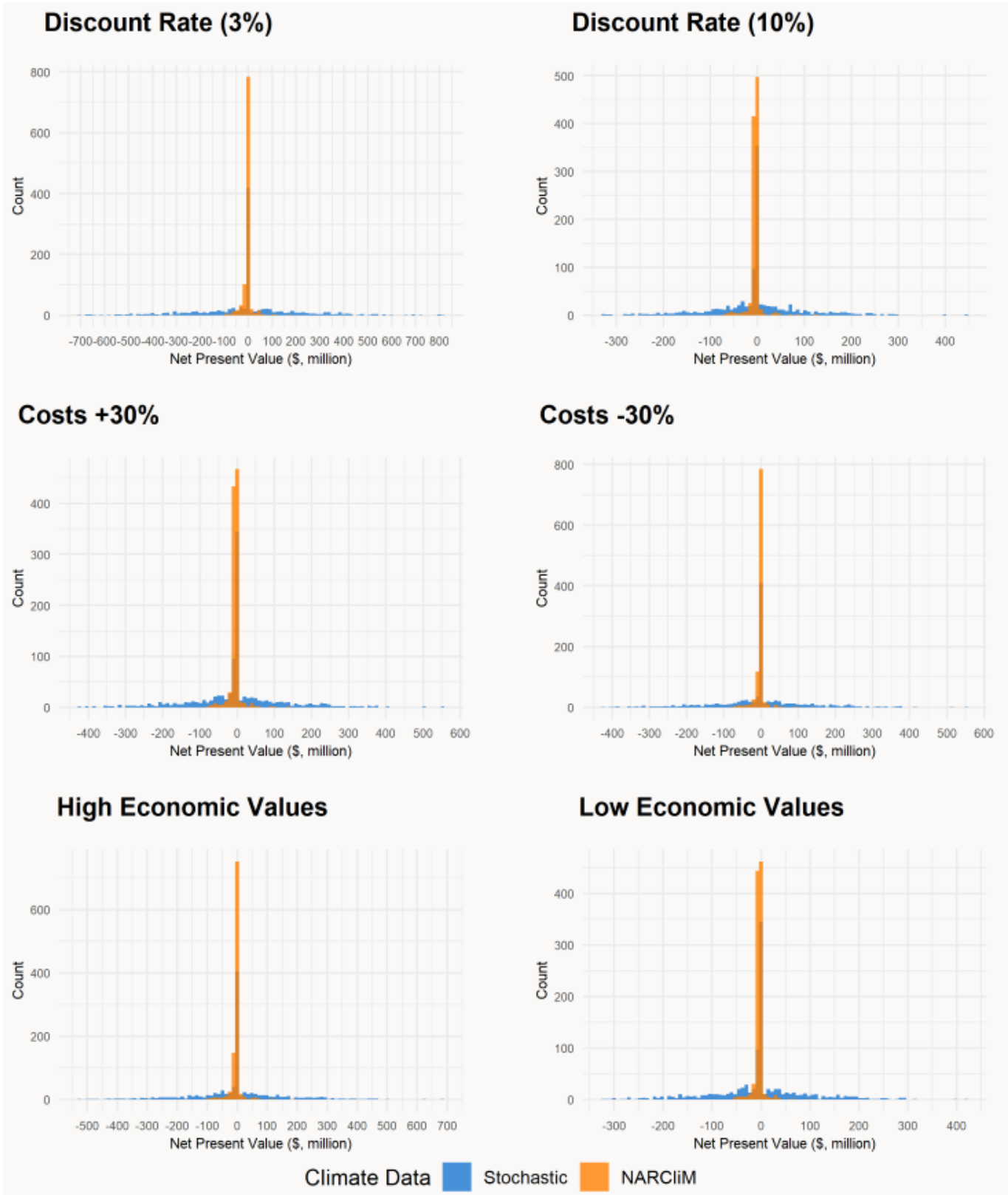
Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	4	-3	0.3	-100.1	131.1	28.4
Low discount rate (3%)	4	-3	0.4	-165.5	194.0	32.1
High discount rate (10%)	4	-3	0.2	-76.4	106.5	27.7
Option cost (+30%)	6	-4	0.2	-77.0	100.9	28.3
Option cost (-30%)	3	-2	0.4	-143.0	187.3	29.8
Economic values (high)	4	-3	0.3	-124.7	161.9	28.7
Economic values (low)	4	-3	0.2	-75.5	100.3	28.3

NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	4	-5	-0.1	-17.6	34.4	6.3
Low discount rate (3%)	4	-5	-0.1	-21.0	41.1	14.0
High discount rate (10%)	4	-4	-0.1	-15.5	30.3	4.4
Option cost (+30%)	6	-6	-0.1	-13.5	26.5	5.2
Option cost (-30%)	3	-3	-0.1	-25.1	49.2	10.8
Economic values (high)	4	-5	-0.1	-22.9	44.7	8.8
Economic values (low)	4	-4	0.0	-12.3	24.2	5.0

The sensitivity analysis suggests that the option is not sensitive to any of the economic variables in both the stochastic and NARCliM datasets. Both fail to produce a positive net present value. The percentage of benefit-cost ratio greater than 1 in both the stochastic and NARCliM datasets shows that low discount rate and low economic costs are important.

Histograms of the results of the sensitivity are shown in Figure 7, supporting the results of Table 22, which suggests that there is not a set of conditions under which the proposed option regularly produces economic benefits higher than its costs.

Figure 7. Increasing annual take limit sensitivity case net present value shown as histograms



Distributional analysis

Table 23 highlights the average distributional changes that would impact the Lachlan region if the annual take limit was increased to 1.1 ML/share.

Table 23. Average distributional impacts from increasing annual take limit compared to the economic base case across both datasets

Stochastic dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
Increase dam reserve	-7	596	45	628
Change ($m)	0	2	0	1
Change (%)	-3.6%	0.2%	-0.1%	0.2%

NARCliM dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
Increase dam reserve	-202	439	-8	223
Change ($m)	-1	1	0	0
Change (%)	-0.4%	0.2%	-3.7%	-0.1%

The distributional results indicate that the target of increasing the annual take limit and securing town water supplies is not achieved, showing a decrease in the economic outcomes for towns by 3.6% under the stochastic dataset and 0.4% under the NARCliM dataset. This translates to negative economic outcomes to users of high security licences of negative 0.1% under the stochastic dataset and 3.7% under the NARCliM dataset. There were marginal increases —relative to the base case— to annual crop growers within the region of positive 0.2% in the stochastic dataset and positive 0.2% in the NARCliM dataset. The absolute gain of economic output to is smaller than the benefits lost by the other user groups.

Option 4: Lower Lachlan Efficiency Measures

Option 4 involves a 50% reduction of replenishing flow requirements in the Lachlan from 42,500 ML to 21,250 ML.

Table 24. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit–cost ratio
4	Lower Lachlan efficiency (50% reduction of replenishment flow requirements comprising: 12,500 ML/a Booberoi, 12,000 ML Willandra, 9,000 ML Merrowie, 4,500 ML Muggabah, 4,500 ML Merrimajeel – meaning 42,500 ML in total reduced to 21,250 ML)	-287	0.2

The results of the rapid cost-benefit analysis show the option would lose $287 million in economic value. The is reflected through a benefit-cost ratio being close to zero.

Table 25. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m, (% change))	Annual crops ($m (% change))	Permanent crops ($m (% change))
4	-1 (-118%)	-3 (-0.5%)	60 (126.1%)

* Note that the percentage change is a large number because it is coming from a very low base.

The distribution of the outcomes of the option show that there are negative changes for town water security and annual crops, but a material impact on permanent crops. In fact, the option increases the value of permanent crops in the Lachlan significantly.

Table 26 provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 26. Average results for lower Lachlan efficiency measure

Option	Net present cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit-cost ratio	NARCliM benefit-cost ratio
4	342	-295	-377	0.1	<0

A 50% reduction of replenishing flow requirements in the Lachlan from 42,500 ML to 21,250 ML has a negative average net present value of $295 million under the stochastic dataset, and negative $377 million using the NARCliM dataset. The average benefit-cost ratio decreases from 0.1 to less than one in the drier climate scenario, indicating that the costs of this intervention under the modelled NARCliM conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

Table 27**Error! Reference source not found.** presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 20% of outcomes in the stochastic dataset and 90% of outcomes in the NARCliM dataset produce negative benefit-cost ratios, indicating a net negative outcome for users of the region under the NARCliM dataset. In the higher percentiles for the stochastic dataset positive outcomes for the region are achieved. The NARCliM results indicate that a 50% reduction of replenishing flow requirements results in a net negative economic outcome under the full range of realisations examined.

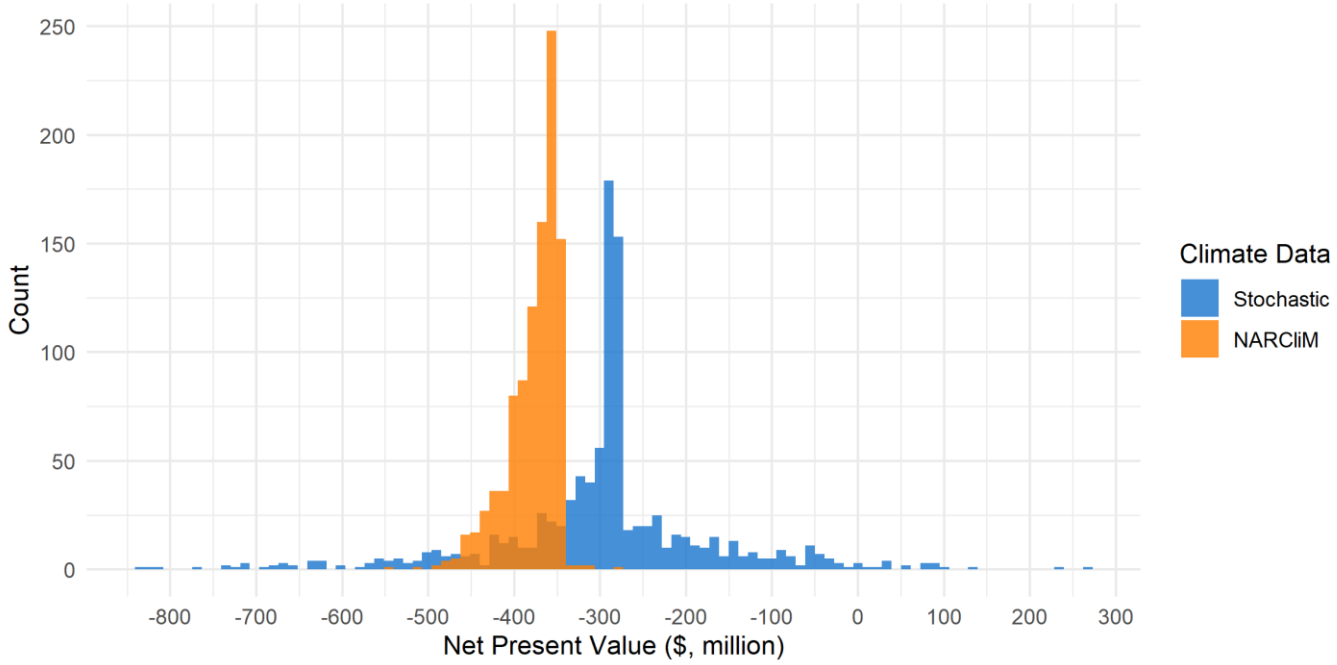
Table 27. Decile and extreme centile results for lower Lachlan efficiency measure

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-691	-1	-466	0
10%	-429	0	-420	0
20%	-356	0	-398	0
30%	-319	0	-386	0
40%	-295	0	-377	0

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
50%	-287	0	-368	0
60%	-284	0	-362	0
70%	-281	0	-357	0
80%	-234	0	-353	0
90%	-150	1	-348	0
99%	57	1	-343	0

Figure 8 presents the information in Table 27 graphically. The histogram shows that the proposed option typically performs better under the stochastic scenario.

Figure 8. Lower Lachlan efficiency measure net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 28 provides the summary results data from a 50% reduction of replenishing flow requirements from 42,500 ML to 21,250 ML for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 28. Sensitivity analysis on lower Lachlan efficiency measure across the stochastic and NARCliM datasets

Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	342	-295	0.14	-1.44	1.78	2.1
Low discount rate (3%)	281	-201	0.28	-2.8	3.28	12.5
High discount rate (10%)	350	-315	0.1	-1.17	1.41	0.2
Option cost (+30%)	445	-397	0.11	-1.11	1.37	0.3
Option cost (-30%)	240	-192	0.2	-2.06	2.55	6.9
Economic values (high)	342	-280	0.18	-1.78	2.22	4.8
Economic values (low)	342	-309	0.1	-1.1	1.35	0.3

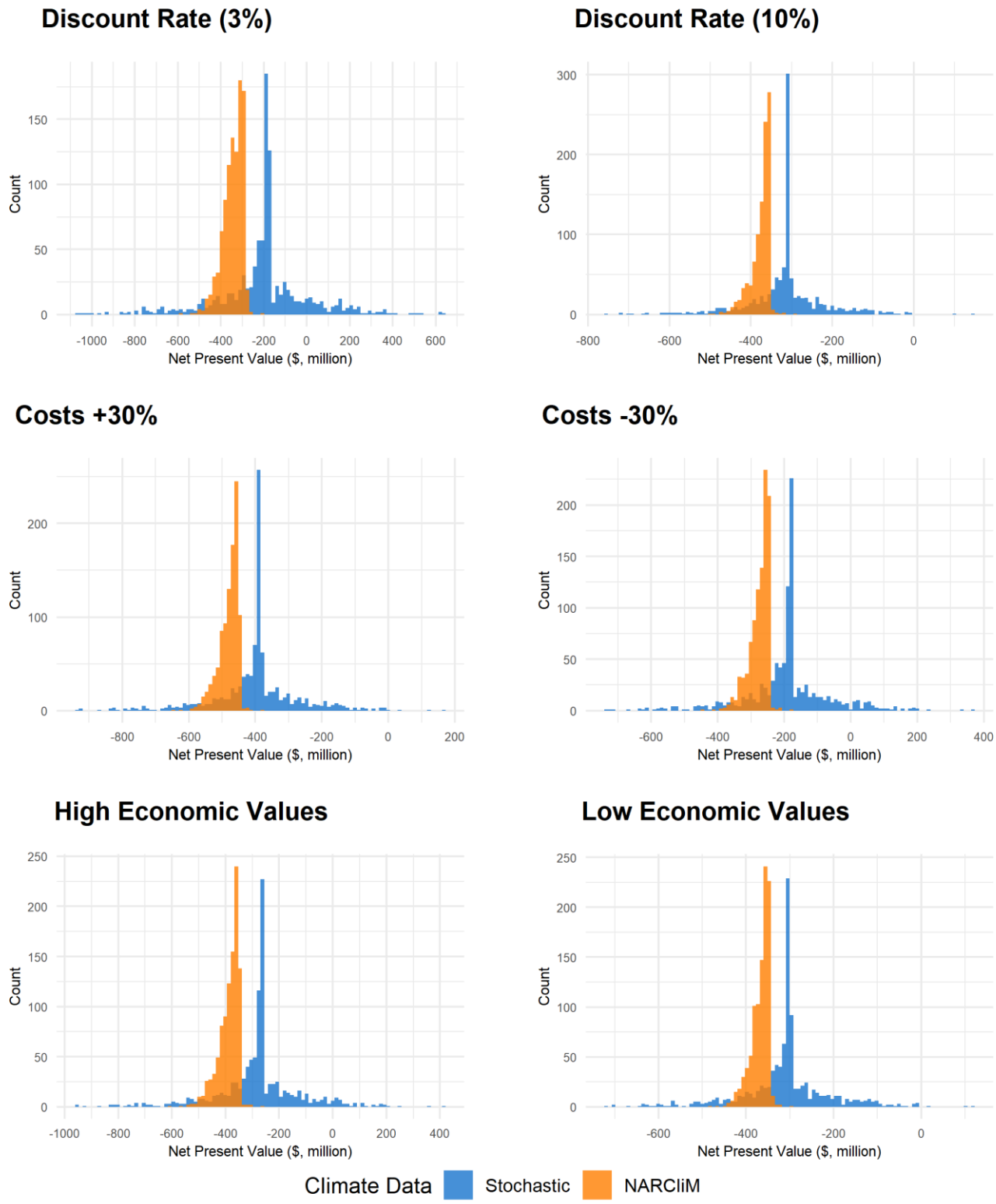
NARCliM dataset

Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	342	-377	-0.1	-0.59	0.19	0
Low discount rate (3%)	281	-343	-0.22	-1.11	0.26	0
High discount rate (10%)	350	-375	-0.07	-0.44	0.17	0
Option cost (+30%)	445	-480	-0.08	-0.45	0.14	0
Option cost (-30%)	240	-274	-0.15	-0.84	0.27	0
Economic values (high)	342	-387	-0.13	-0.76	0.24	0
Economic values (low)	342	-367	-0.07	-0.41	0.13	0

The sensitivity analysis suggest that the low discount and low economic values are important in the stochastic dataset. However, the option is not sensitive to any of the economic variables in the NARCliM dataset. The NARCliM dataset produces negative net present values against all economic variables. On average the options percentage of benefit-cost ratio greater than 1 is not sensitive across all economic variables.

Histograms of the results of the sensitivity are shown in Figure 9, supporting the results of Table 28, reinforcing that the proposed option typically performs better under the stochastic scenario compared to the NARCliM scenario.

Figure 9. Lower Lachlan efficiency measure sensitivity case net present value shown as histograms



Distributional analysis

Table 29 highlights the average distributional changes from a 50% reduction of replenishing flow requirements in the Lachlan region from 42,500 ML to 21,250 ML.

Table 29. Average distributional impacts from lower Lachlan efficiency measure compared to the economic base case across both datasets

Stochastic dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
Increase dam reserve	-11	591	100	674
Change ($m)	-4	-4	55	47
Change (%)	-61.9%	-0.6%	123.9%	7.6%

NARCliM dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
Increase dam reserve	-224	433	-14	188
Change ($m)	-23	-5	-7	-35
Change (%)	-11.6%	-1.1%	-87.0%	-15.6%

The distributional results indicate that securing town water supplies is not achieved, showing a decrease in the economic outcomes for towns by 61.9% under the stochastic dataset and 11.6% under the NARCliM dataset. Additionally, the small amount of existing high security licences only sees an improvement to users of these licences of 123.9% under the stochastic dataset, but a negative economic outcome of 87% under the NARCliM dataset. These improvements come at the

expense of impacts to annual crops within the region, which see negative—relative to the base case—changes of 0.6% in the stochastic dataset and negative 1.1% in the NARCliM dataset. Due to the large size of this industry in comparison to permanent crops, and the small towns within the region, the absolute loss of economic output is larger than the benefits gained by the other user groups.

Option 5: In-stream storage (near Whealbah) for the Lower Lachlan

Option 5 involved the installation of a new re-regulation weir to provide an additional 3000 ML of in-stream storage near Whealbah in the Lachlan region.

Table 30. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit–cost ratio
5	Lachlan re-reg Weir: 3,000 ML capacity weir located near Whealbah	-33	0.5

The results of the rapid cost-benefit analysis show the option would lose almost $70 million in economic value. This is reflected through a benefit-cost ratio of zero and a decrease on annual crops, as shown in Table 31.

Table 31. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m, (% change))	Annual crops ($m (% change))	Permanent crops ($m (% change))
5	0.1 (11.8%)	-2.3 (-0.4%)	39.5 (83.4%)

The distribution of the outcomes of the option show that there are limited changes for town water security and negative changes to annual crops, but a material impact on permanent crops. In fact, the option increases the value of permanent crops in the Lachlan significantly.

Table 32 provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 32. Average results for Lachlan re-reg weir

Option	Net present cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit-cost ratio	NARCliM benefit-cost ratio
5	71	-69	-46	0	0.3

A new re-regulation weir, providing an additional 3000 ML of in-stream storage in the Lachlan region has a negative average net present value of $69 million under the stochastic dataset, and

negative $46 million under the NARCliM dataset. The average benefit-cost ratio rises from 0 to 0.3 under the drier climate scenario, also indicating that the costs of this intervention under the modelled conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

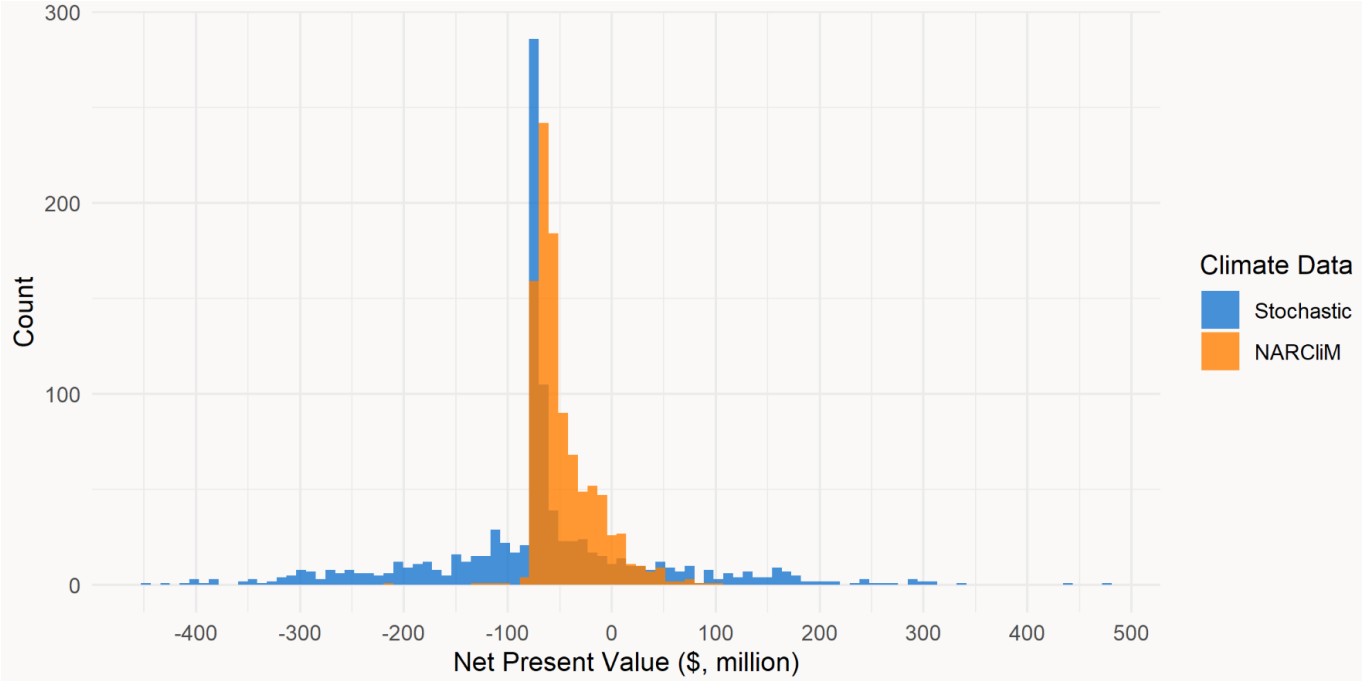
Table 33 presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 30% of outcomes in the stochastic dataset and 1% of outcomes in the NARCliM dataset produce negative benefit-cost ratios, indicating a slightly better performance under the drier climate scenario. The net present values indicate a net negative economic outcome under 80% of realisations examined under the stochastic dataset, and 90% under the NARCliM climate dataset.

Table 33. Decile and extreme centile results for Lachlan re-reg weir

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-360	-4.1	-79	-0.1
10%	-203	-1.9	-72	0.0
20%	-118	-0.7	-69	0.0
30%	-78	-0.1	-65	0.1
40%	-74	0.0	-61	0.1
50%	-72	0.0	-56	0.2
60%	-69	0.0	-51	0.3
70%	-59	0.2	-40	0.4
80%	-22	0.7	-24	0.7
90%	61	1.9	-5	0.9
99%	267	4.8	51	1.7

Figure 10 presents the information in Table 33 graphically. The histogram shows that all of the represented realisations under both datasets deliver negative net present values and benefit-cost ratios, with the costs of the proposed option outweighing the benefits received.

Figure 10. Lachlan re-reg weir net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 34 provides the summary results data for a re-reg 3000 ML capacity Weir in the Lachlan for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 34. Sensitivity analysis on Lachlan re-reg weir across the stochastic and NARCliM datasets

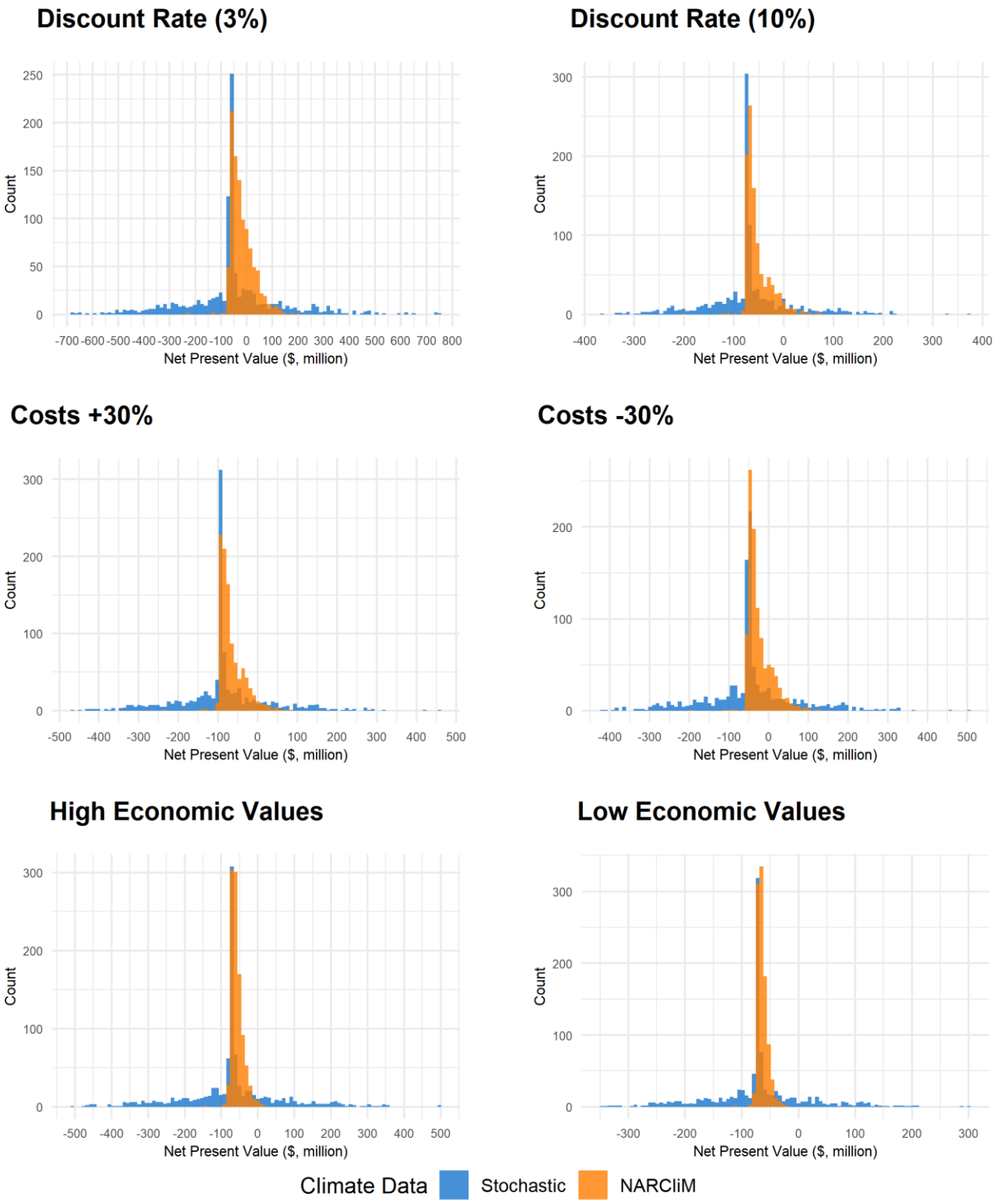
Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	71	-69	0.0	-5.3	7.8	16.7
Low discount rate (3%)	61	-57	0.1	-10.1	13.2	24.6
High discount rate (10%)	71	-70	0.0	-4.1	6.3	13.0
Option cost (+30%)	92	-90	0.0	-4.1	6.0	14.1
Option cost (-30%)	49	-48	0.0	-7.6	11.1	19.7
Economic values (high)	71	-68	0.0	-6.5	9.6	18.8
Economic values (low)	71	-70	0.0	-4.1	6.0	14.1

NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit-cost ratio > 1
Central	71	-46	0.3	-2.1	2.5	8.4
Low discount rate (3%)	61	-18	0.7	-2.8	4.2	28.5
High discount rate (10%)	71	-54	0.3	-1.8	2.1	4.3
Option cost (+30%)	92	-67	0.3	-1.6	1.9	4.0
Option cost (-30%)	49	-25	0.5	-3.0	3.6	19.3
Economic values (high)	71	-39	0.5	-2.7	3.3	16.5
Economic values (low)	71	-54	0.2	-1.5	1.8	2.6

The sensitivity analysis suggest that the low discount, low economic cost, and high economic value are important in both the stochastic and NARCliM dataset. However, the option produces high negative net present values against all economic variables under both datasets.

Histograms of the results of the sensitivity are shown in Figure 11, supporting the results of Table which suggests that there is not a set of conditions under which the proposed option regularly produces economic benefits higher than its costs.

Figure 11. Lachlan re-reg weir sensitivity case net present value shown as histograms



Distributional analysis

Table 35 highlights the average distributional changes that would impact the Lachlan region from the installation of a new re-regulation weir, providing an additional 3000 ML of in-stream storage.

Table 35. Average distributional impacts from Lachlan re-reg weir compared to the economic base case across both datasets

Stochastic dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
Increase dam reserve	-4	592	46	629
Change ($m)	3	-3	1	2
Change (%)	46.8%	-0.4%	3.0%	0.3%

NARCliM dataset	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
Increase dam reserve	-179	434	-1	248
Change ($m)	22	-4	7	24
Change (%)	10.7%	-0.9%	89.3%	10.9%

The distributional results indicate that securing town water supplies is somewhat achieved, showing marginal improvements in the economic outcomes for towns by 46.8% under the stochastic dataset and 10.7% under the NARCliM dataset. Additionally, the small amount of existing high security licences also sees an improvement. This translates to economic benefits to users of these licences

of 3% under the stochastic dataset and 89.3% under the NARCliM dataset. These improvements come at the expense of impacts to annual crops within the region, which see smaller—relative to the base case—changes of negative 0.4% in the stochastic dataset and negative 0.9% in the NARCliM dataset. Due to the large size of this industry in comparison to permanent crops, and the small towns within the region, the absolute loss of economic output is larger than the benefits gained by the other user groups.

Option 6: New weir in the Belubula Regulated River

Option 6 involves the construction of a new 3000 ML capacity re-regulating weir on the Belubula River to allow for re-regulation of water released from Carcoar dam in the Lachlan region.

Table 36. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit-cost ratio
6	Belubula River Weir: 3,000 ML capacity re-regulating weir.	-18	0.7

The results of the rapid cost-benefit analysis show the option would lose $18 million in economic value, resulting in a benefit-cost ratio of 0.7.

Table 37. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m (% change))	Annual crops ($m, (% change))	Permanent crops ($m, (% change))
6	-0.4 (-36.6%)	-1.2 (-0.2%)	54.3 (114.7%)

The distribution of the outcomes of the option show that there are negative changes for town water security and annual crops, but a material impact on permanent crops. In fact, the option increases the value of permanent crops in the Lachlan significantly. However, this is dependent on high level assumptions on how permanent crops respond and are the increase is relatively small.

Table 38. Average results for Belubula Weir

Net Present Cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit–cost ratio	NARCliM benefit–cost ratio
71	-38	-120	0.5	-0.7

The construction of a new 3000 ML capacity re-regulating weir on the Belubula River has a negative average net present value of $38 million under the stochastic dataset, and a negative $120 million under the NARCliM dataset. The average benefit-cost ratio is 0.5 in the stochastic dataset and negative 0.7 under the NARCliM dataset. These results indicate that the costs of this intervention under the modelled NARCliM conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

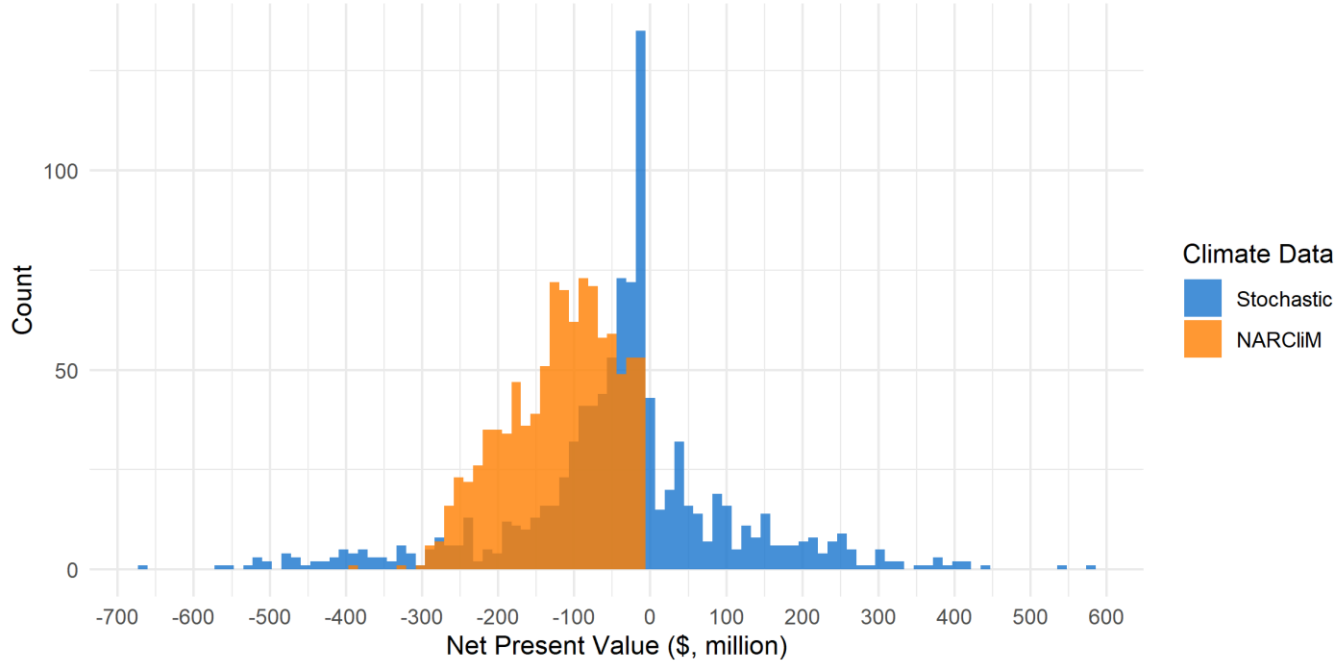
Table 39Error! Reference source not found. presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 30% of outcomes in the stochastic dataset and 10% of outcomes in the NARCliM dataset produce negative benefit-cost ratios. The net present values indicate a net negative economic outcome under 40% of realisations examined under the stochastic dataset, and 60% of realisation under the NARCliM climate dataset.

Table 39. Decile and extreme percentile results for Belubula Weir

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-477	-5.8	-129	-0.8
10%	-216	-2.1	-82	-0.2
20%	-109	-0.5	-68	0.0
30%	-75	-0.1	-63	0.1
40%	-48	0.3	-57	0.2
50%	-29	0.6	-53	0.3
60%	-15	0.8	-50	0.3
70%	-6	0.9	-47	0.3
80%	40	1.6	-44	0.4
90%	137	2.9	-38	0.5
99%	374	6.3	-27	0.6

Figure 12 presents the information in Table 39 graphically. The histogram shows that all of the represented realisations under both datasets deliver negative net present values and benefit-cost ratios, with the costs of the proposed option outweighing the benefits received.

Figure 12. Belubula Weir net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 40 provides the summary results data for the construction of a new 3000 ML capacity re-regulating weir on the Belubula River in the Lachlan region for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 40. Sensitivity analysis on Belubula Weir across the stochastic and NARCliM datasets

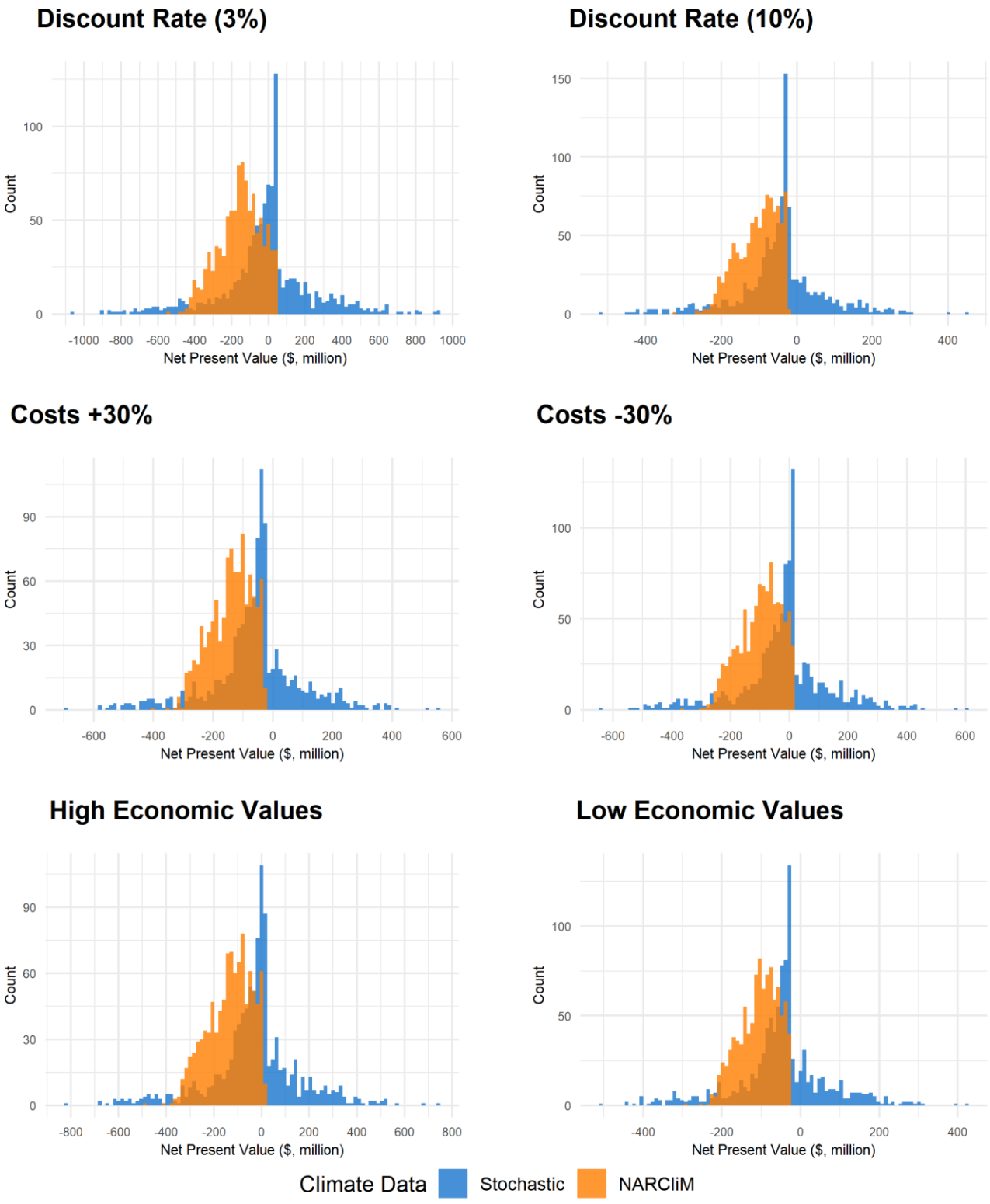
Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit–cost ratio > 1
Central	71	-38	0.46	-8.48	9.18	26.8
Low discount rate (3%)	61	-12	0.81	-16.24	16.17	50.1
High discount rate (10%)	71	-45	0.37	-6.35	7.27	22.9
Option cost (+30%)	92	-59	0.36	-6.52	7.06	24.1
Option cost (-30%)	49	-17	0.66	-12.11	13.11	45.7
Economic values (high)	71	-28	0.6	-10.7	11.42	41.5
Economic values (low)	71	-48	0.32	-6.26	6.94	23.4

NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit–cost ratio > 1
Central	71	-120	-0.69	-4.48	0.89	0
Low discount rate (3%)	61	-156	-1.54	-7.82	1.72	9
High discount rate (10%)	71	-104	-0.46	-3.57	0.66	0
Option cost (+30%)	92	-141	-0.53	-3.45	0.69	0
Option cost (-30%)	49	-98	-0.99	-6.4	1.28	6.4
Economic values (High)	71	-134	-0.89	-5.83	1.16	4.2
Economic values (Low)	71	-105	-0.49	-3.14	0.63	0

The sensitivity analysis suggest that high economic costs and low economic values are important in both the stochastic and NARCliM datasets. The NARCliM dataset produces negative net present values against all economic variables. On average the options percentage of benefit-cost ratio greater than 1 is not sensitive across all economic variables.

Histograms of the results of the sensitivity are shown in Figure 13, supporting the results of Table , which suggests that there is not a set of conditions under which the proposed option regularly produces economic benefits higher than its costs.

Figure 13. Belubula Weir sensitivity case net present value shown as histograms



Distributional impacts

Table 41 highlights the average distributional changes that would impact the Lachlan region from the construction of a new 3000 ML capacity re-regulating weir on the Belubula River.

Table 41. Average distributional impacts from Belubula Weir compared to the economic base case across both datasets

Stochastic dataset				
	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-22	598	46	615
Bulk licence conversion	-23	598	80	648
Change ($m)	-1	-1	34	32
Change (%)	-4.9%	-0.1%	75.0%	5.3%

NARCliM dataset				
	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-243	441	-15	175
Bulk licence conversion	-252	436	-50	126
Change ($m)	-9	-5	-35	-49
Change (%)	-3.6%	-1.1%	-239.8%	-27.9%

The distributional results indicate that securing town water supplies is not achieved, showing a decrease in the economic outcomes for towns by 4.9% under the stochastic dataset and 3.6% under the NARCliM dataset. Additionally, the small amount of existing high security licences only sees an improvement to users of these licences of 75% under the stochastic dataset, but a negative economic outcome of 239.9% under the NARCliM dataset. These improvements come at the expense of impacts to annual crops within the region, which see negative—relative to the base case—changes of 0.1% in the stochastic dataset and negative 1.1% in the NARCliM dataset. Due to the large size of this industry in comparison to permanent crops, and the small towns within the

region, the absolute loss of economic output is larger than the benefits gained by the other user groups.

Option 7: Conversion of 10% of non-HEW GSE to HSE entitlements

Option 7 would involve converting 10% of general security licence entitlements to high security licence entitlements in the Lachlan region. This bulk conversion of general security to high security licences would result in a major shift away from annual crops (cotton) to more permanent crops like oranges. The cost associated with this option is the effort required to implement the policy change. This is estimated to cost approximately $8 million and is considered as an upfront cost, like those for the infrastructure options. No recurring costs are considered for this option, as any changes relating to the execution of the water sharing plan—which will take place regardless of the policy implementation—are considered insignificant.

Table 42. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit-cost ratio
7	Conversion of 10% of non-HEW GSE to HSE entitlements. Series of iterative runs with results shown for 3:1 and 4:1 conversion ratios – 4:1 ratio brings GSE back to near Base Case performance (in terms of ML/a diversion per unit entitlement & also w.r.t AWD outcomes). Additional HSE located near Forbes/Parkes	1	1.1

The results of the rapid cost-benefit analysis show the option would gain $1 million in economic value and produces a positive benefit cost ratio greater than 1. Whilst these results are positive, only a low capital outlay was considered. By removing 264 GL of general security water licences and replacing this with 85 GL of high security water, the modelling approach has assumed that almost all water users would shift from producing annual crops to high value permanent crops.

Table 43. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m (% change))	Annual crops ($m, (% change))	Permanent crops ($m, (% change))
7	0.1 (10.1%)	-62 (-9.8%)	71 (150.2%)

The distribution of the outcomes of the option show that there are limited changes for town water security, while annual crop growers experience a significant decline in the value of their crops. The decline in value for annual crops is compensated by the increase in value for high security entitlements.

Table 44 provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 44. Average results for bulk licence conversion (10%)

Net Present Cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit–cost ratio	NARCliM benefit–cost ratio
8	7	-41	1.8	-3.9

A bulk conversion of general security licences to high security licences in the Lachlan region has a positive average net present value of $7 million under the stochastic dataset, but a negative average net present value of $41 million under the NARCliM dataset. The average benefit-cost ratio is 1.8 in the stochastic dataset but is negative 3.9 under the NARCliM dataset. The results indicate that the actual level of water security provided for farmers under this proposed option will be much less as we move into a drier climate, as it causes a net negative economic impact amongst the aggregated key user groups. However, this outcome could be a result of modelling assumptions.

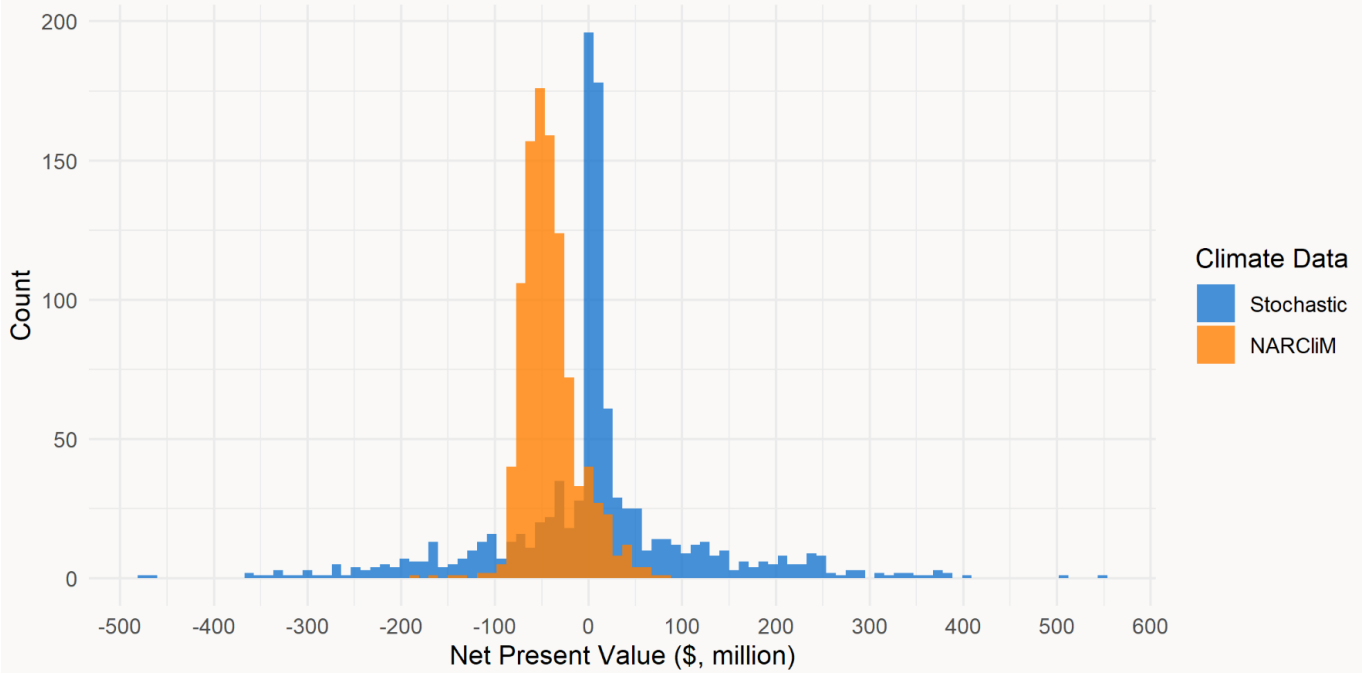
Table 45 presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 20% of outcomes in the stochastic dataset and 80% of outcomes in the NARCliM dataset produce negative benefit-cost ratios indicating a net negative outcome for users during drier climates in the region. While the bulk licence conversion performs well across most realisations under stochastic conditions, the results are not as strong under NARCliM. The distribution of outcomes suggests that there are not very many reliability concerns for high security entitlements in the stochastic dataset. That cannot be said for the climate change dataset, with 80% of the NARCliM scenarios showing negative outcomes for the region.

Table 45. Decile and extreme percentile results for bulk licence conversion (10%)

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-313	-36.0	-93	-10.0
10%	-119	-13.1	-73	-7.6
20%	-43	-4.1	-65	-6.7
30%	-5	0.4	-58	-5.8
40%	2	1.2	-52	-5.2
50%	5	1.6	-46	-4.4
60%	11	2.3	-40	-3.7
70%	19	3.3	-32	-2.8
80%	52	7.2	-22	-1.6
90%	136	17.1	0	1.0
99%	342	41.5	46	6.4

Figure 14 presents the information in Table 45 graphically. This histogram reinforces the results discussed above, showing that the proposed option typically performs better under the stochastic scenario compared to the NARCliM scenario. The drier climate and associated increased risk to town water supply security is not being effectively mitigated by the proposed option.

Figure 14. Bulk licence conversion (10%) net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 46 provides the summary results data for bulk licence conversion for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

Table 46. Sensitivity analysis on bulk licence conversion (10%) across the stochastic and NARCliM datasets

Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit–cost ratio > 1
Central	8	7	1.8	-55.6	65.8	64.0

Stochastic dataset						
Low discount rate (3%)	8	19	3.3	-85.9	97.2	70.8
High discount rate (10%)	8	2	1.3	-44.0	53.1	54.2
Option cost (+30%)	11	4	1.4	-42.7	50.6	57.7
Option cost (-30%)	6	9	2.6	-79.4	94.0	67.5
Economic values (high)	8	17	3.0	-68.4	82.1	70.6
Economic values (low)	8	-4	0.6	-42.8	49.5	40.2

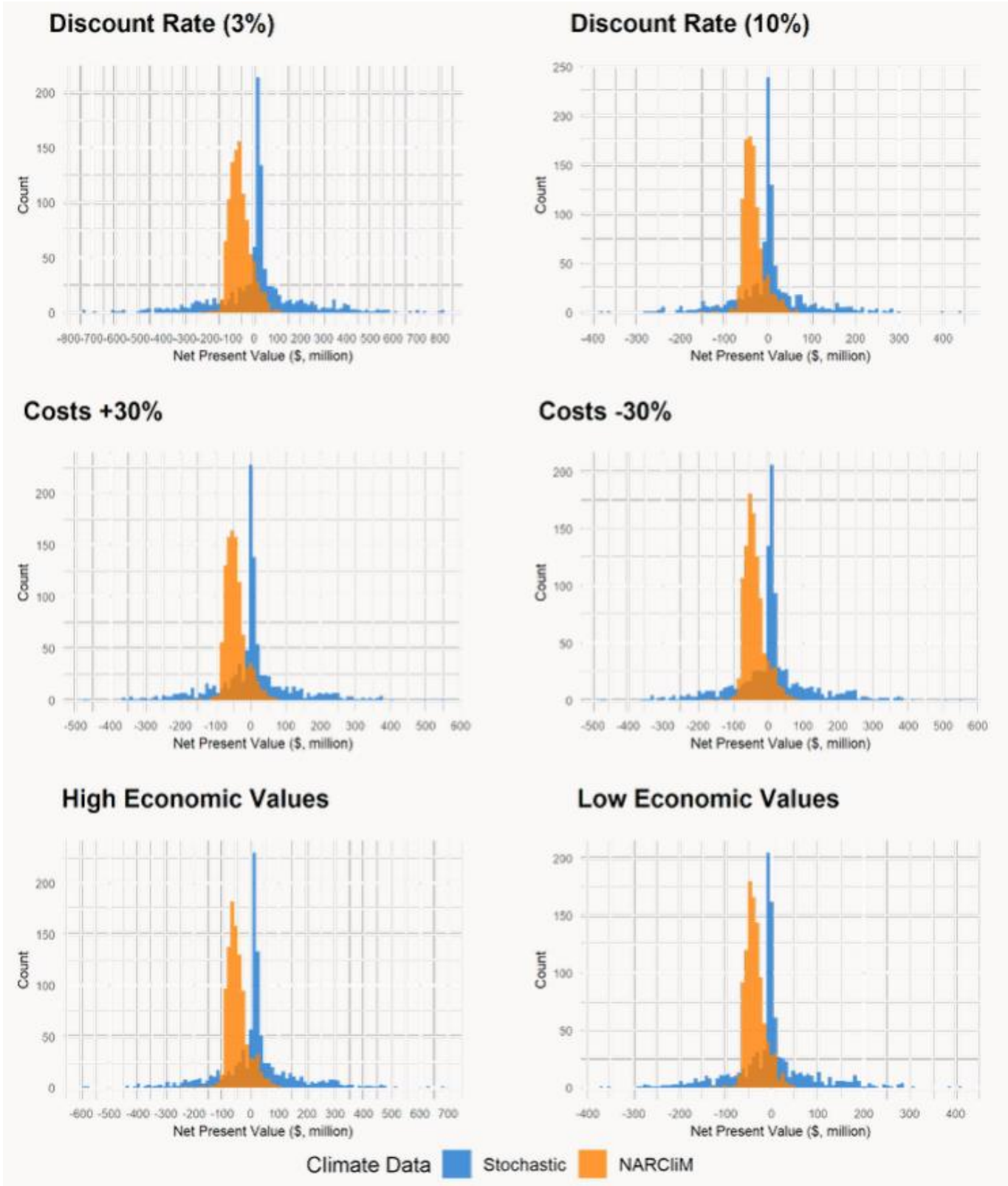
NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit–cost ratio > 1
Central	8	-41	-3.9	-20.6	10.2	10.3
Low discount rate (3%)	8	-62	-6.4	-27.6	13.8	10.4
High discount rate (10%)	8	-34	-3.0	-17.4	9.1	9.7
Option cost (+30%)	11	-44	-3.0	-15.8	7.9	9.2
Option cost (-30%)	6	-39	-5.6	-29.4	14.6	11.3

NARCliM dataset						
Economic values (High)	8	-47	-4.5	-26.4	13.6	12.1
Economic values (Low)	8	-36	-3.3	-14.8	6.9	7.6

The sensitivity analysis shows the option produces a positive net present value under all economic variable, with exception to low economic value, using the stochastic dataset. However, the option produces negative net present value under all economic variables, using the NARCliM dataset. The percentage of benefit-cost ratio greater than 1 in the stochastic dataset shows a high level of sensitivity to the low discount rate and high economic values. The percentage of benefit-cost ratio greater than 1 in the NARCliM dataset shows a high level of sensitivity to the low economic costs and high economic values.

Histograms of the results of the sensitivity are shown in Figure 15, supporting the results of Table 46, reinforcing that the proposed option typically performs better under the stochastic scenario compared to the NARCliM scenario.

Figure 15. Bulk licence conversion (10%) sensitivity case net present value shown as histograms



Distributional impacts

Table 47 highlights the average distributional changes that would impact the Lachlan region from a bulk conversion of general security licences to high security licences.

Table 47. Average distributional impacts from bulk licence conversion (10%) compared to the economic base case across both datasets

Stochastic dataset				
	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
Bulk licence conversion	-5	538	114	642
Change ($m)	2	-56	70	15
Change (%)	26.8%	-9.5%	156.4%	2.4%

NARCliM dataset				
	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
Bulk licence conversion	-193	393	-4	190
Change ($m)	8	-45	4	-33
Change (%)	4.0%	-10.2%	49.1%	-14.7%

The distributional results indicate that under both climate scenarios, converting all general security to high security licences may increase the incidence of shortfalls in town water supplies. The relative impact to cotton growers is similar across both climate scenarios; however, the absolute

impact is much larger under the stochastic dataset, which exhibits a higher level of water availability. The introduction of a large contingent of permanent crops made possible by the introduction of the increased high security licences results in very large increases to the average outputs over 40-years of this user group. There are significant caveats to these numbers—some of which were previously discussed—that should be kept in mind when interpreting the results of permanent agriculture. The increase in the value of permanent crops under the NARCliM dataset is far lower than under the stochastic dataset, which is a reflection on the lower reliability of the large amount of high security licences under a drier climate.

Option 8: Conversion of 20% of non-HEW GSE to HSE entitlements

Option 8 would involve converting 20% of general security licence entitlements to high security licence entitlements in the Lachlan region. This bulk conversion of general security to high security licences would result in a major shift away from annual crops to more permanent crops like oranges. The cost associated with this option is the effort required to implement the policy change. This is estimated to cost approximately $8 million and is considered as an upfront cost, like those for the infrastructure options. No recurring costs are considered for this option, as any changes relating to the execution of the water sharing plan—which will take place regardless of the policy implementation—are considered insignificant.

Table provides the rapid assessment, using just the instrumental data series, results in very positive net present values and very high benefit-cost ratios.

Table 48. Rapid cost-benefit analysis outcomes overview

Option	Description	Net present value ($m)	Benefit-cost ratio
8	Conversion of 20% of non-HEW GSE to HSE entitlements. Series of iterative runs with results shown for 3:1 and 4:1 conversion ratios – 4:1 ratio brings GSE back to near Base Case performance (in terms of ML/a diversion per unit entitlement & also w.r.t AWD outcomes). Additional HSE located near Forbes/Parkes	19	3.2

The results of the rapid cost-benefit analysis show the option would gain $19 million in economic value. The benefits exceed costs by more than 3 times the overall project cost. Whilst these results are positive, only a low capital outlay was considered. By removing 264 GL of general security water licences and replacing this with 85 GL of high security water, the modelling approach has assumed that almost all water users would shift from producing annual crops to high value permanent crops.

Table 49. Rapid cost-benefit analysis distributional analysis

Option	Town water supply ($m (% change))	Annual crops ($m, (% change))	Permanent crops ($m, (% change))
8	0.1 (12%)	-115 (-18.17%)	142 (300.4%)

The distribution of the outcomes of the option show that there are limited changes for town water security, while annual crop growers experience a significant decline in the value of annual crops. The decline in value for annual crops is compensated by the increase in value for high security entitlements.

Table provides the summary data for the modelled proposed option. The results represent the averages across all 1,000 realisations undertaken in the analysis. As each 40-year analysis period has an equal likelihood of occurrence, the averages also represent the expected values—or outcomes—for the proposed option.

Table 50. Average results for bulk licence conversion (20%)

Net Present Cost ($m)	Stochastic net present value ($m)	NARCliM net present value ($m)	Stochastic benefit–cost ratio	NARCliM benefit–cost ratio
8	-113	-74	-12.3	-7.8

A bulk conversion of 20% of general security licences to high security licences in the Lachlan region has a negative average net present value of $113 million under the stochastic dataset, and negative $74 million under the NARCliM dataset. The average benefit-cost ratio is negative 12.3 in the stochastic dataset and negative 7.8 under the NARCliM dataset, indicating that the costs of this intervention under the modelled conditions outweigh the economic benefits and that it causes a net negative economic impact amongst the aggregated key user groups.

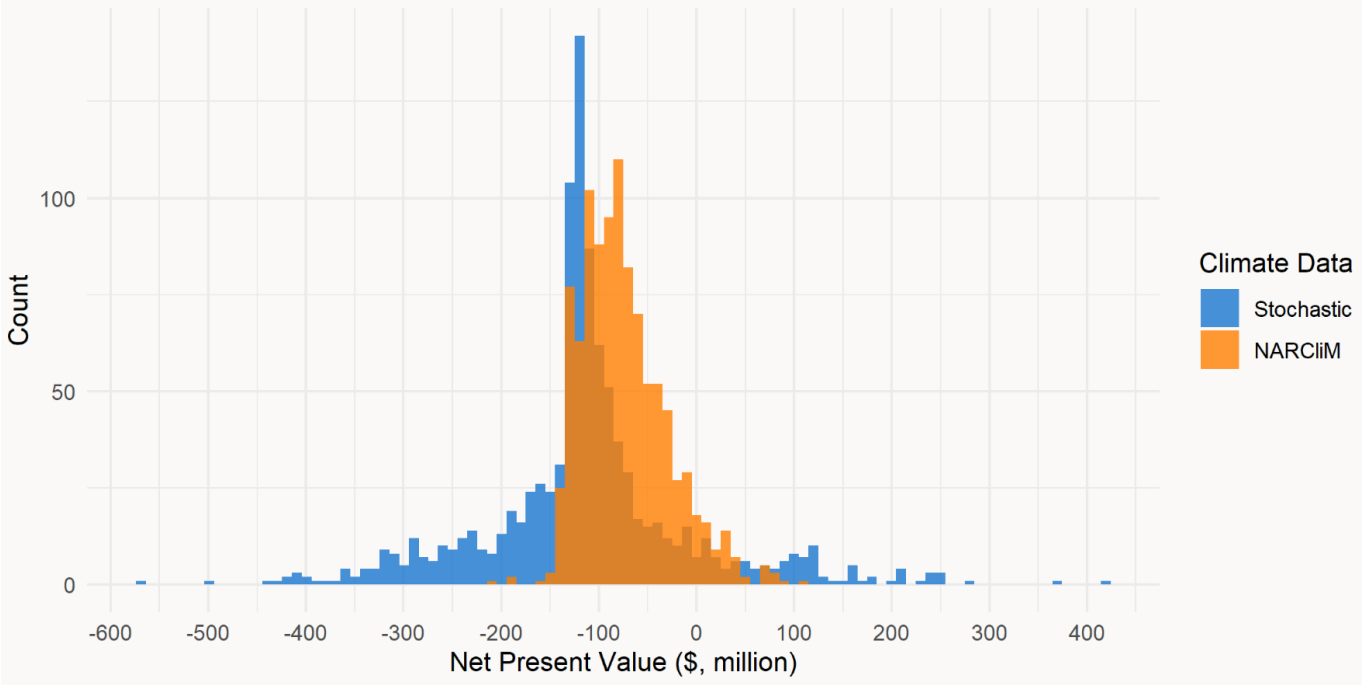
Table 51 presents the range of possible outcomes for the proposed option's performance over any 40-year period. The 1st percentile is effectively the worst outcome while the 99th is the best. 80% of outcomes in the stochastic dataset and 90% of outcomes in the NARCliM dataset produce negative benefit-cost ratios indicating a net negative outcome for users in the region. The bulk licence conversions perform slightly better under the stochastic conditions but poorly across all realisations under the NARCliM conditions, except for the 99th percentile. This indicates that the actual level of water security provided for farmers under this proposed option will be much less as we move into a drier climate.

Table 51. Decile and extreme percentile results for bulk licence conversion (20%)

Percentile	Stochastic net present value ($m)	Stochastic benefit–cost ratio	NARCliM net present value ($m)	NARCliM benefit–cost ratio
1%	-396	-45.8	-142	-15.8
10%	-240	-27.4	-126	-13.9
20%	-169	-19.0	-112	-12.2
30%	-133	-14.7	-102	-11.1
40%	-125	-13.7	-91	-9.8
50%	-118	-12.9	-82	-8.7
60%	-107	-11.6	-71	-7.4
70%	-92	-9.9	-57	-5.7
80%	-65	-6.7	-39	-3.6
90%	11	2.3	-14	-0.7
99%	213	26.2	54	7.4

Figure 16 presents information in Table 51 graphically. The histogram shows that all of the represented realisations under both datasets deliver negative net present values and benefit-cost ratios, with the costs of the proposed option outweighing the benefits received.

Figure 16. Bulk licence conversion (20%) net present value histogram



Sensitivity analysis

Sensitivity analysis was undertaken for the combined option which included the following cases:

- higher (10%) and lower (3%) discount rates
- higher (+30%) and lower (-30%) combined option costs
- higher and lower economic costs, the magnitude of which varies depending on the marginal value altered.

Table 52 provides the summary results data for bulk licence conversion for the central case and sensitivity analysis for the stochastic and NARCliM datasets.

The sensitivity analysis suggests that the option is not sensitive to any of the economic variables in both the stochastic and NARCliM datasets. The option produces high negative net present values against all economic variables. On average the options percentage of benefit-cost ratio greater than 1 is not sensitive across all economic variables under the stochastic dataset. The percentage of benefit-cost ratio greater than 1 in the NARCliM dataset suggests that low economic costs and economic values are important.

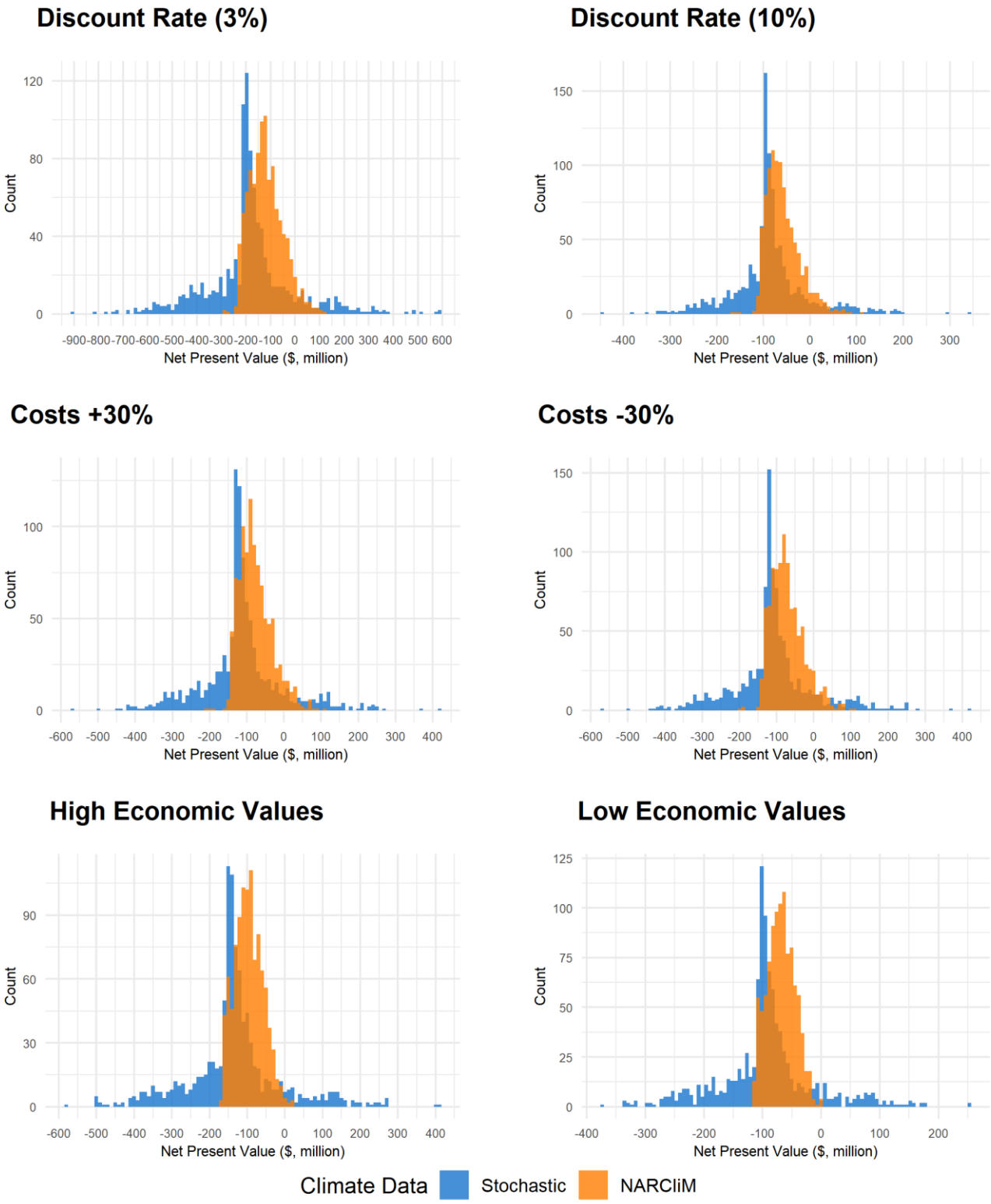
Histograms of the results of the sensitivity are shown in Figure 17, supporting the results of Table 52, which suggests that there is not a set of conditions under which the proposed option regularly produces economic benefits higher than its costs.

Table 52. Sensitivity analysis on bulk licence conversion (20%) across the stochastic and NARCliM datasets

Stochastic dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit–cost ratio > 1
Central	8	-113	-12.3	-66.6	50.4	11.0
Low discount rate (3%)	8	-184	-20.7	-105.5	71.6	11.6
High discount rate (10%)	8	-87	-9.2	-51.7	41.5	10.4
Option cost (+30%)	11	-115	-9.5	-51.2	38.8	10.7
Option cost (-30%)	6	-110	-17.6	-95.2	72.0	11.2
Economic values (high)	8	-133	-14.7	-82.3	62.8	11.1
Economic values (low)	8	-92	-9.9	-50.9	38.0	10.5

NARCliM dataset						
Sensitivity case	Present value capital cost ($m)	Net present value ($m)	Benefit–cost ratio average	Benefit–cost ratio minimum	Benefit–cost ratio maximum	% of benefit–cost ratio with benefit–cost ratio > 1
Central	8	-74	-7.8	-23.3	13.8	6.6
Low discount rate (3%)	8	-119	-13.0	-32.7	14.7	5.1
High discount rate (10%)	8	-58	-5.9	-18.8	14.0	6.9
Option cost (+30%)	11	-77	-6.0	-17.9	10.6	5.9
Option cost (-30%)	6	-72	-11.1	-33.3	19.8	7.1
Economic values (High)	8	-86	-9.2	-29.6	18.8	8.3
Economic values (Low)	8	-63	-6.5	-17.0	8.8	4.8

Figure 17. Bulk licence conversion (20%) sensitivity case net present value shown as histograms



Distributional impacts

Table 53 highlights the distributional changes that would happen to the Lachlan region if bulk licence conversion was introduced. Bulk conversion of general security to high security licences would result in a major shift away from annual crops to permanent crops. Under the NARCliM climate change dataset, the economic value of this shift is lower than under the stochastic dataset.

Table 53. Average distributional impacts from bulk licence conversion (20%) compared to the economic base case across both datasets

Stochastic dataset				
	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-7	595	45	627
Bulk licence conversion	-4	487	46	523
Change ($m)	3	-108	1	-104
Change (%)	37.1%	-18.1%	2.7%	-16.6%

NARCliM dataset				
	Town water supply ($m)	Annual crops ($m)	Permanent crops ($m)	Totals ($m)
Economic base case	-201	438	-7	223
Bulk licence conversion	-190	354	-2	157
Change ($m)	11	-84	6	-66
Change (%)	5.6%	-19.1%	79.4%	-29.5%

The distributional results indicate that under both climate scenarios, converting all general security to high security licences may increase the incidence of shortfalls in town water supplies. The relative impact to cotton growers is similar across both climate scenarios; however, the absolute impact is much larger under the stochastic dataset, which exhibits a higher level of water availability. The introduction of a large contingent of permanent crops made possible by the introduction of the increased high security licences results in very large increases to the average outputs over 40-years of this user group. There are significant caveats to these numbers—some of which were previously discussed—that should be kept in mind when interpreting the results of permanent agriculture. The increase in the value of permanent crops under the NARCliM dataset is far lower than under the stochastic dataset, which is a reflection on the lower reliability of the large amount of high security licences under a drier climate.

Conclusions

The information presented in this technical document has helped provide a strategic analysis of options that could merit further investigation through the Gwydir Regional Water Strategy.

The conclusions from this report should be read in conjunction with the following accompanying technical documents:

- Economic Base Case: Lachlan region
- Hydrologic analysis of options for the Lachlan Regional Water Strategy
- Detailed ecological analysis: Lachlan.