Department of Climate Change, Energy, the Environment and Water

Macquarie-Wambuul Water Security Project Full Business Case

Options Shortlisting Report

OFFICIAL: Sensitive – NSW Government

May 2026

NSW GOVERNMENT

Acknowledgement of Country

The Department of Climate Change, Energy, the Environment and Water acknowledge the traditional custodians of the land and pays respect to Elders past, present and future.

We recognise Australian Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to place and their rich contribution to society.

Artist and designer Nikita Ridgeway from Aboriginal design agency – Boss Lady Creative Designs, created the People and Community symbol.

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1 Executive Summary

Purpose

This paper has been prepared to provide the outcomes of options shortlisting for the Macquarie–Wambuul Water Security Project Full Business Case (FBC). It summarises the options assessed, the basis on which they were evaluated, and the resulting shortlisting decision.

Background

The Macquarie–Wambuul Water Security Project was initiated following the NSW Government's February 2024 commitment to investigate long-term solutions to improve drought resilience for towns in the Macquarie–Wambuul Valley. The project is jointly funded by the NSW and Australian Governments under the National Water Grid Fund and is aligned with the Macquarie–Castlereagh Regional Water Strategy.

The FBC focuses on improving the reliability of town water supplies for communities downstream of Burrendong Dam—while maintaining environmental outcomes, including avoiding net reductions in flows to the Macquarie Marshes.

Recent drought experience, including the 2017–2020 Tinderbox drought, highlighted increasing risks associated with prolonged dry conditions, high transmission losses in long distance supply systems, and climate change. While the system has historically avoided total failure, modelling shows declining reliability and increasing frequency of severe water restrictions without targeted intervention.

Options Considered

A structured, multistage options development and filtering process was undertaken while developing the Macquarie-Castlereagh Regional Water Strategy. An initial long list of potential infrastructure and non-infrastructure options was refined to a focused set of four options for detailed assessment in the FBC:

1. Construction of a regional pipeline from Dubbo to Nyngan
2. Replacement of Gin Gin Weir
3. Use of Burrendong Dam's Flood Mitigation Zone (FMZ) to increase water supply
4. Improved access to groundwater for Dubbo

An option originally proposed for consideration relating to increasing water set aside in Burrendong Dam for critical human needs was identified but removed to avoid duplication with the NSW Government's statewide Minimum Inflows Project.

Shortlisting Outcomes

The assessment identified clear differences in performance, risk and value for money across options.

The regional pipeline option was not shortlisted due to its very high capital cost, and poor value for money.

The Gin Gin Weir replacement option was not shortlisted because it does not materially improve town water security and is primarily an asset renewal project, delivering limited benefit against the project's primary objective.

The FMZ option demonstrated drought resilience benefits but was not shortlisted due to likely reductions in Planned Environmental Water (PEW). This option introduced legal risk, as well as significant environmental and biodiversity offset costs, material environmental risks, policy complexity, and uncertainty that impacts could be mitigated to an acceptable level.

Improved groundwater supplies for Dubbo was shortlisted as a lower cost, scalable option that improves drought resilience without material impacts on surface water flows or the Macquarie Marshes.

Outcome

Following completion of Phase 1 shortlisting, the Full Business Case will proceed to Phase 2 (detailed investigations) with **Improved Groundwater Supplies for Dubbo** as the shortlisted option. This option provides a targeted contingency measure to strengthen town water security under severe drought conditions and complements broader water management initiatives being progressed by the NSW Government.

2 Project Background

2.1 Introduction

The Macquarie–Wambuul Water Security Project Full Business Case (FBC) was initiated following the NSW Government's February 2024 commitment to investigate long-term solutions to town water security in the Macquarie–Wambuul Valley. The project is jointly funded by the NSW and Australian Governments under the National Water Grid Fund and gives effect to actions identified in the Macquarie–Castlereagh Regional Water Strategy.

The purpose of the FBC is to assess and compare a targeted set of infrastructure and non-infrastructure options to improve drought resilience for towns downstream of Burrendong Dam, with a particular focus on Dubbo, Nyngan and Cobar. The assessment is undertaken in accordance with NSW Treasury and Infrastructure NSW requirements, including consideration of value for money, delivery risk, environmental outcomes and policy alignment.

The project responds to increasing water security risks driven by prolonged droughts, transmission losses in long-distance supply systems and projected climate change impacts. While the Macquarie–Wambuul system has historically avoided total failure, recent drought experience has highlighted declining reliability and the need for clearer, more resilient arrangements to maintain critical human water supplies during extreme events.

Aligned with the key objectives of the funding, the FBC applies a baseline requirement that options should avoid net reductions in environmental flows to the Macquarie Marshes while investigating improvements to town water security and system wide equity.

2.2 Objectives

The Macquarie-Wambuul system faces escalating water security risks due to severe droughts, inefficient delivery systems, and climate change. The Tinderbox drought (2017-2020) exposed critical vulnerabilities in town supply, agricultural production, and ecological health. Current infrastructure cannot reliably meet essential needs during extended dry periods. The case for change is grounded in the need to improve regional resilience, support economic continuity, and protect the Macquarie Marshes

The primary objective of the project is to secure reliable water supplies for critical human needs in regional towns during severe and prolonged droughts. Secondary objectives include:

- improving delivery efficiency to users in the western part of the catchment,
- supporting water-dependent industries and regional economic activity, and
- ensuring no net reduction in flows to the Macquarie Marshes and downstream river systems.

2.3 Options Considered for Improving Water Security

Four options were considered for shortlisting, covering both infrastructure and non-infrastructure measures:

1. Construction of a regional pipeline from Dubbo to Nyngan
2. Replacement of Gin Gin Weir
3. Use of Burrendong Dam's FMZ to increase water supply
4. Other options identified in the regional water strategy, including
    a. consideration of a Set Aside in Burrendong Dam and
    b. consideration of increased access to Dubbo's groundwater during a drought.

An option to increase the volume of water set aside in Burrendong Dam for critical human needs was identified for inclusion in the FBC (set aside option). This option aimed to improve water security for high-priority users during drought by redefining the reserve volume and planning assumptions used in the water allocation process. Following preliminary assessment, the option was removed from further consideration because the NSW Government's Minimum Inflows Project is addressing the same policy questions. Progressing the set-aside option through the FBC would have duplicated work and risked inconsistent outcomes.

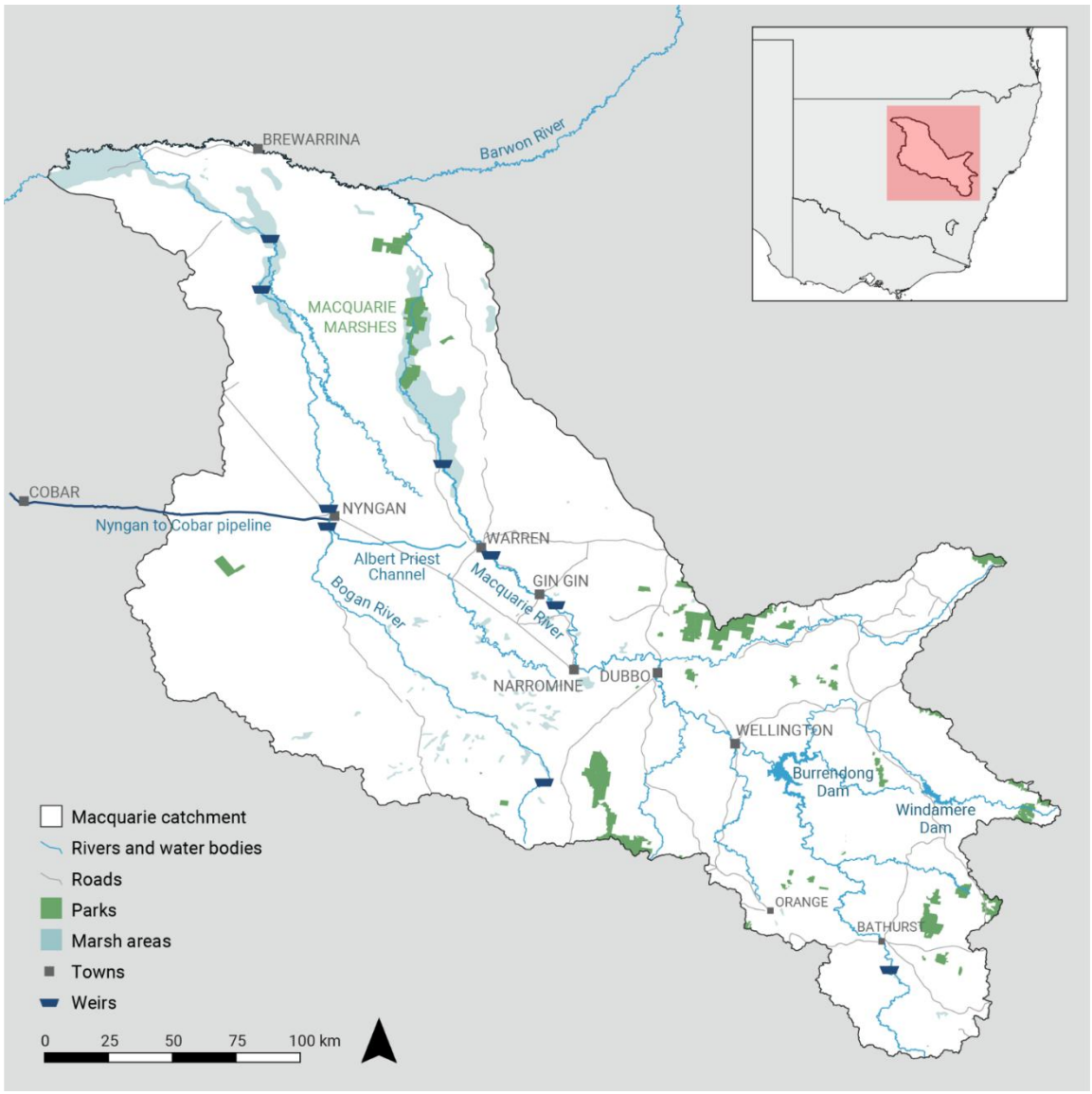
The Minimum Inflows Project - a statewide initiative under the NSW Water Strategy (Action 4.2)—is reviewing the proposed set-aside policies and water allocation frameworks using a sophisticated, risk-based method.

As a result of removing the set aside option, for the remainder of this report, Option 4 focusses solely on Dubbo Groundwater.

2.4 Geographic and System Context

The project area (Figure 2-1) covers the regulated Macquarie–Wambuul River system downstream of Burrendong Dam in central western New South Wales. Burrendong Dam, owned and operated by WaterNSW, is the primary storage asset supplying towns, industry, irrigators and environmental water users under the Macquarie Regulated River Water Sharing Plan.

Figure 2-1 Project area



2.4.1 Economic and population context

Dubbo is the largest urban centre in the Macquarie Valley and serves as a major regional hub for services, infrastructure and population growth. Downstream along the Macquarie River, Narromine and Warren form part of an interconnected network that includes smaller communities and effluent creeks extending toward the upper reaches of the Macquarie Marshes. Further west, Nyngan and Cobar rely on regulated surface water supplies delivered via Gunningbar Creek, the Albert Priest Channel and the Nyngan–Cobar pipeline. Cobar's economy is closely tied to mining, with several major operations dependent on a secure and continuous water supply.

The Macquarie Valley is a highly productive agricultural region covering approximately 74,000 square kilometres. Agriculture is the dominant economic activity, with irrigated cotton, cereal cropping, livestock grazing and horticulture making substantial contributions to regional output. The gross value of agricultural production is estimated at around $686 million per year.

Agriculture and its supporting industries account for approximately 25–30 per cent of regional employment, with Dubbo and Narromine playing key roles as service, processing and logistics hubs for the wider catchment. In addition to agriculture, significant contributors to the regional economy include mining, construction, public administration, healthcare and education.

Population growth across the region is uneven. Dubbo is projected to experience steady growth of around 0.8 per cent per annum, while smaller centres such as Narromine, Warren, Nyngan and Cobar are expected to remain stable or decline modestly over the next two decades. These trends underscore the importance of securing resilient and reliable water supplies to support essential services and long-term regional economic stability.

2.4.2 Macquarie Marshes

The Macquarie Marshes are located at the downstream end of the regulated Macquarie–Wambuul river system and are a Ramsar-listed wetland of national and international significance. They are one of the largest remaining inland, semi-permanent wetlands in the Murray–Darling Basin and support a high diversity of wetland types.

The Marshes provide a crucial refuge for wildlife, particularly during droughts, supporting 233 bird species, 15 frog species, 60 reptile species, and 11 native fish species. The Marshes form a key habitat for several plant and animal species, including Gould's long-eared bat. The Marshes regularly support more than 20,000 waterbirds, and more than 500,000 during large floods. It supports breeding for 16 colonial nesting waterbird species.

The Macquarie Marshes contain a variety of habitat types, and consequently the plant and animal species of the site are particularly diverse. The Marshes support extensive river red gum, coolabah and black box woodlands, which provide habitat for waterbirds and woodland birds, common reed and water couch marsh.

The Marshes are highly sensitive to changes in the volume, timing and frequency of flows from the Macquarie River, making their protection a fundamental consideration for all water security options assessed in the FBC. Management with environmental water ensures that the Marshes provide food, foraging habitat, and successful breeding conditions even during dry periods, benefiting threatened birds like the Australasian bittern and Australian painted snipe.

Past drought events have demonstrated the Marshes' particular sensitivity to reductions in low and medium flow events, which are critical to sustaining wetland vegetation, maintaining channel connectivity and supporting aquatic ecosystems. Degradation under these conditions highlights the dependence of the Marshes' condition on consistent and appropriately timed river flows.

The Macquarie Marshes also hold profound cultural significance for Aboriginal peoples of the region, including the Gomeroi/Kamilaroi, Ngemba, Ngiyampaa, Wiradjuri and Wayilwan nations, with long-standing connections to Country that are closely linked to river flows and wetland condition.[1]

In recognition of this sensitivity, the FBC assessment framework applies a clear constraint: options must avoid any net reduction in flows to the Macquarie Marshes or downstream environmental assets. Environmental outcomes are therefore treated not as a trade-off to be optimised, but as a defining boundary within which improvements to town water security must be delivered.

2.5 Water use and supply characteristics

Town water supplies in the lower Macquarie system rely on a mix of regulated surface water and groundwater, with Dubbo sourcing water from Burrendong Dam supplemented by the Macquarie

[1] https://www.environment.nsw.gov.au/topics/water/wetlands/internationally-significant-wetlands/macquarie-marshes

Alluvium during droughts. Nyngan and Cobar are fully dependent on surface water transferred over long distances, resulting in significant transmission losses during dry conditions.

Dubbo is the largest municipal water user in the region, consistently sourcing between 8,000 and 12,000 ML per year. Water demand in other towns is lower but remains vulnerable due to reliance on long, inefficient delivery systems. High-priority industrial users, particularly mines in the west, also hold substantial high-security entitlements and depend on the same regulated system during droughts.

Key towns in the Lower Macquarie catchment supplied by the system and the primary water sources for each town is summarised below.

Table 2-1: Key towns in the lower Macquarie

Location / User	Water Sources
Dubbo (Town water)	Burrendong Dam (regulated surface) + Macquarie Alluvium (groundwater)
Narromine	Macquarie Alluvium (groundwater)
Warren	Macquarie Alluvium (groundwater) + Burrendong Dam (regulated surface)
Nyngan (Town water)	Burrendong Dam via Gunningbar Creek + Albert Priest Channel
Cobar (Town water)	Pipeline from Nyngan (sourced from the Macquarie River at Warren)
Cobar Water Board	Pipeline from Nyngan (sourced from the Macquarie River at Warren)

2.5.1 High priority users in the west

Several major mines in western NSW—including Peak Gold, CSA Mine, and Endeavour Mine—hold high-security water licences to support continuous operations. These demands are typically met via the shared surface water system comprising Burrendong Dam, Gunningbar Creek, the Albert Priest Channel, and the Nyngan–Cobar pipeline.

These users are considered high-priority industrial consumers, with secure entitlements due to the critical role of water in mineral processing, dust suppression, dewatering, and tailings management. Collectively, these mines are licensed for approximately 4,855 ML per year, with individual entitlements ranging from 700 ML to over 1,600 ML. While entitlement volumes are fixed, actual usage may vary depending on rainfall, production rates, and infrastructure performance.

2.5.2 Water-dependent agricultural production

The Macquarie Valley supports a productive agricultural sector, underpinned by both surface and groundwater availability. Cotton is the dominant irrigated crop, with wheat, barley, and livestock grazing also forming key components of the regional economy. Irrigation activity uses are dependent on general security water entitlements of 458 GL sourced from the regulated Macquarie River system, particularly in districts downstream of Dubbo, including Narromine, Trangie, and

Warren[2]. The gross value of agricultural production in the valley is on the order of $686 million annually[3].

2.6 Drought Experience and Policy Context

The 2017–2020 Tinderbox drought was the most severe drought on record for the Macquarie Valley in terms of inflows to Burrendong Dam. Storage levels fell to 1.5 per cent of capacity in early 2020, placing towns at credible risk of running out of water and triggering prolonged, severe restrictions.

The Macquarie Regulated River Water Source entered Drought Stage 4 under the NSW Extreme Events Policy, requiring prioritisation of water for critical human needs and suspension of general security allocations. Emergency measures, including ceasing regulated flows downstream of Warren, highlighted both the fragility of the system and the economic and social consequences of extreme water scarcity.

The experience underscored the need for more resilient and transparent arrangements to manage future droughts, particularly under climate change scenarios that anticipate increased frequency and severity of dry conditions.

[2] Approximate GS for irrigation based on the current total GS entitlements of Water Allocation Statement: Macquarie and Cudgegong Regulated Rivers Water Source

[3] Gross value figures are drawn from Australian Bureau of Statistics agricultural production data (2020–21) for the following SA2 regions: Cobar, Coonamble, Dubbo – East, Dubbo – South, Dubbo – West, Dubbo Surrounds, Gilgandra, Narromine, and Nyngan – Warren. These regions broadly align with the area represented by Macquarie Food and Fibre. Figures are indicative and reflect the most recent available data for total gross value of agricultural commodities produced.

3 Options Development and Assessment

This section describes the development, description and assessment of the four options considered for the Macquarie–Wambuul Water Security Project Full Business Case (FBC). The objective of the options assessment was to identify proportionate, cost-effective and targeted responses to the identified water security challenges, with a focus on improving drought resilience for towns downstream of Burrendong Dam.

A structured, staged approach was adopted to ensure options were consistent with the Macquarie–Castlereagh Regional Water Strategy, technically feasible, and aligned with the project's objectives and policy framework. All options discussed in the Regional Water Strategy were flagged as requiring further comparative analysis and no option was pre-determined as the preferred solution.

3.1 Option 1: Regional Pipeline from Dubbo to Nyngan

This option proposed the construction of a closed pipeline (approximately 170 km) between South Dubbo Weir and Nyngan to reduce transmission losses and improve drought resilience for Nyngan, Cobar and high-priority industrial users.

Table 3-1 provides an overview of the option assessment. In summary, the pipeline would extend the duration of available supply under zero-inflow conditions and marginally improve severe drought security for western towns. However, capital costs are very high (approximately $800 million), environmental and cultural impacts are significant, and modelling demonstrates limited additional benefit relative to cost.

Table 3-1: Regional pipeline option overview

Element	Description
Option Overview	Construction of a closed pipeline from South Dubbo Weir to Nyngan with 4,500 ML/year capacity to supply Nyngan, Cobar, and high-priority users. Aims to reduce transmission losses, extend effective use of Burrendong Dam storage during droughts, and strengthen water security in western towns.
Hydrological Impacts	• Extends effective storage duration from ~10.5 to 22–24 months under zero inflow conditions. • Improves recurrence interval of critical thresholds (e.g. 45 GL) from 1-in-1,650 years to 1-in-5,000 years (paleo) • Slight improvement in severe drought security for Nyngan and Cobar. • ~0.3–0.5% reduction in long-term flows to Macquarie Marshes.
Preliminary Sizing / Technical Details	• 170 km closed pipeline (DN508–257), co-located with Mitchell Highway. • Two pump stations, two 550 m^3 balancing tanks. • High-pressure intermittent operation (drought resilience mode). • Designed for delivery of up to 4,500 ML/year.

Element	Description
Costs	• Capex (2025): $798 million (PE) [4] • Biodiversity offset estimate: ~$19 million, requires confirmation through further detailed investigation.
Cultural Heritage	• Pipeline traverses Wiradjuri Country. One known registered site; broader area has moderate to high sensitivity. • Full Aboriginal Cultural Heritage Assessment Report (ACHAR) recommended. • Native Title determined at Nyngan; access agreements or ILUAs required.
Ecosystem Credits Estimates (Biodiversity Offsets)	• Up to 300 ha clearing, including Threatened Ecological Communities (TECs) • Offset estimate: $18.94 million (mid-range, excludes species credits)
Environmental	• Vegetation clearance includes Weeping Myall Woodland and Poplar Box TECs • Crosses multiple Key Fish Habitat waterways; S219 permits likely required • Reduces incidental river and floodplain flows (requires offset strategy)
Other Considerations	• Construction aligned to existing roads; minimises land acquisition • Requires coordination on operational responsibility and funding • Removes Nyngan and Cobar reliance on Albert Priest Channel • Land access complexity and long-term Operations and Maintenance (O&M) cost-sharing are key risks
Feasibility and Delivery Risks	• Technically feasible; institutional, land access, and cost estimation risks remain • Requires detailed geotechnical, cultural heritage, power supply and tenure planning
Regulatory Approvals	• REF or EIS (EP&A Act); BDAR (BC Act); Water use approvals (WM Act) • Native Title access agreements; Environment Protection and Biodiversity Conservation Act 1999 (EPBC) referral possible if Matter of National Environmental Significance (MNES) triggered • Cultural heritage approvals based on ACHAR findings

4 The rapid CBA capital expenditure (CAPEX) estimate includes a comprehensive set of cost elements to ensure early-stage project viability is appropriately assessed. It incorporates the base construction cost, covering all physical works, materials, and labour. Design costs are included to account for planning, engineering, and technical documentation. Procurement costs capture expenses associated with acquiring goods and services, including tendering and contract management. Client delivery and handover costs reflect internal efforts related to project management, commissioning, training, and transition to operations. A provision for real escalation is included to reflect expected market cost pressures, independent of general inflation. Risk allowances are captured through both a P50 contingency, representing the mid-range estimate for potential cost variation, and a P90 contingency, which accounts for higher-end risk exposure. Together, these inclusions support a robust early estimate for decision-making under uncertainty.

3.2 Option 2: Replacement of Gin Gin Weir

Two infrastructure arrangements were considered for the replacement of Gin Gin Weir on the Macquarie River:

- Option A involves the construction of a new gated re-regulating weir approximately 200 metres downstream of the existing structure, with the aim of improving delivery efficiency and supporting ecological outcomes through active flow control and reinstated fish passage.
- Option B proposed a like-for-like replacement of the existing fixed-crest weir at its current location, maintaining current service levels but addressing structural integrity and compliance issues.

Following initial assessment, only Option A was progressed for detailed analysis as part of the FBC. Option B was set aside due to limited town water security improvement potential and because a WaterNSW asset assessment in 2023[5], peer reviewed in 2024[6], indicated that the existing structure remains serviceable for 50 to 100 years with continued maintenance. Table 3-2 provides an overview of the option assessment.

Table 3-2 Gin Gin Weir option overview

Element	Description
Option Overview	Construction of a new 6,000 ML gated re-regulating weir approximately 200 m downstream of the existing Gin Gin Weir to enhance delivery efficiency and reinstate fish passage. Designed to capture and re-release surplus operational flows (e.g. rainfall rejection) to support irrigation and ecological compliance.
Hydrological Impacts	• No improvement in town water security for Dubbo, Nyngan or Cobar across historical, paleo-stochastic, or NARCliM climate scenarios. • ~1% increase in General Security diversions due to improved operational control. • ~0.5% reduction in long-term average flows to the Macquarie Marshes.
Preliminary Sizing / Technical Details	• Reinforced concrete gravity weir • Two 10 m × 9 m radial gates • Four 5 m × 4.5 m overshot gates • Vertical slot fishway (5 m head) • Full supply level: 215.5 mAHD • 6 GL active storage volume • Construction ~200 m downstream of existing structure
Costs	• Capex: $107.03 million (2025)

5 AssetReady, *Gin Gin Weir – Condition Assessment*, Technical Memorandum, Document No. 5574.GG-INV-MEM-001, Rev A, 13 September 2023. Prepared for WaterNSW Asset Renewal Replacement Fishways Program
6 Jacobs Group (Australia) Pty Ltd, *Gin Gin Weir Condition Peer Review*, Document No. IA320600-0001-STR-MEM-0001, Version 1, prepared for WaterNSW, 3 July 2024

Element	Description
	• Biodiversity offsets: $0.5–1.2 million, requires confirmation through further detailed investigation.
Cultural Heritage	• Four Aboriginal heritage sites within 500 m: three artefact scatters, one culturally modified tree • No known Dreaming stories or ceremonial sites; however, proximity to water suggests high cultural sensitivity. • Further archaeological fieldwork required.
Ecosystem Credits Estimates (Biodiversity Offsets)	• Estimated 15 ecosystem credits required • Cost estimate: ~$500,000 (may range up to $1.2 million depending on final footprint and habitat mapping)
Environmental	• 0.72 ha total disturbance; includes 0.47 ha native vegetation • Includes 0.36 ha of River Red Gum forest (PCT 36, forested wetland) • Minor aquatic habitat alteration expected; sediment management and fishway design integrated into scope • Upstream flow regime and hydraulic changes likely
Other Considerations	• Inundation of Gin Gin Beach recreation area under new Full Supply Level (FSL); permanent loss of informal camping amenity • Potential sediment deposition changes • Construction includes temporary diversion channel affecting the beach area • Significant community opposition expressed during stakeholder engagement - environmental groups and pastoralists as well as First Nations
Feasibility and Delivery Risks	• Institutional coordination required across agencies • Residual risks include downstream hydrology, cultural heritage disturbance, and community perceptions of environmental trade-offs
Regulatory Approvals	• REF or EIS under EP&A Act • Water supply works and controlled activity approvals under WM Act • Approvals under Fisheries, Biodiversity Conservation, and EPBC Acts likely • Aboriginal Heritage Impact Permit (AHIP) may be required

3.3 Option 3: Utilising Burrendong Dam's Flood Mitigation Zone (FMZ)

This option involves involves operational changes to allow part of the existing flood airspace to be used for water supply, while maintaining flood mitigation through appropriate controls.

Background

The Macquarie-Castlereagh Regional Water Strategy conducted a preliminary investigation of this option that considered an increase of approximately 118GL or 13% of FMZ. This was a theoretical, high level system test to explore the feasibility of the FMZ option. It was not primarily focussed on town water security and did not include the Tinderbox drought in the historical record.

While noting the potential of this option to provide water security benefits, it identified the following assessments would be required to demonstrate the feasibility of the option:

1. Dam safety assessment
2. Planned environmental water provisions and ecological and biodiversity impacts.

FBC options assessment

Table 3-33 provides an overview of the options assessment. Modelling indicates substantial improvements in town water security, including significant reductions in both the frequency and severity of drought restrictions for Dubbo. The flow reductions are typically expressed as ranges or percentages to avoid false precision and reflect uncertainty inherent in modelling a constrained system.

Hydrological modelling shows that changes to the flood mitigation zone with 300 GL reserve reduce **environmental water** availability by **5–9% on average**, equivalent to **4.8–9.3 GL per year**.

However, the impact is **not uniform**. For 1 in 3 (dry years) the change is from **-2 to 10 GL per year**, but during 1 in 10 (wet years) — when environmental flows are most ecologically valuable — the reduction increases substantially, with **10–23 GL per year less water** available in high-flow years.

These wetter-period reductions also translate into **lower downstream flows at Marebone**, with average reductions of **12–16 GL per year**, further limiting floodplain inundation and connectivity.

The FMZ option would reduce environmental flows to the Macquarie Marshes by approximately 5–9 per cent on average and increase flood risk under rare events. The Marshes are highly sensitive to changes in the volume, timing and frequency of flows from the Macquarie River, making their protection a fundamental consideration for all water security options assessed in the FBC (section 2.4.2).

A reduction in planned environmental water (PEW) to the Macquarie Marshes of between 5 and 10 per cent introduces additional legal and planning risk and would breach existing commitments and policy settings under the Murray–Darling Basin Plan (section 10.28), which do not permit reductions in PEW.

The option would also require amendments to allocation and water sharing rules. Developing rules that clearly breach the no-net reduction in PEW policy would likely be unlawful for NSW, even with Ministerial concurrence, and would probably not be accredited by the Commonwealth.

Any option that materially alters flood regimes over extensive downstream floodplains creates exposure to impacts of national and international biodiversity significance, resulting in very high regulatory and reputational risk.

Overall, the option delivers a negative net present value, driven primarily by environmental disbenefits. Quantification of environmental and biodiversity offsets would require a further two to three years of detailed modelling and on-ground investigations at significant cost before any planning approval to change the flow regime could be sought. Even following completion of these studies, there is no certainty that planning approval would be granted, and there is a material risk that the Commonwealth Government could become the consent authority should the proposal be designated a Controlled Actin.

Table 3-3 FMZ option overview

Element	Description
Option Overview	• The FMZ option involves operational changes to allow part of the existing flood airspace to be used for water supply, while maintaining flood mitigation through appropriate controls. This option does not create new water; it is an operational change to how existing water is stored and when it is made available. • Increasing the full supply level in Burrendong Dam may increase water available for high priority needs and increases the system's drought reserves. • Various scenarios explicitly sought to test the sensitivity of the system to higher reserve volumes (300GL), recognising that meaningful town water security benefits would only emerge if the system were operated differently.
Current arrangement	• Burrendong Dam has a total storage capacity (Full Supply Level, FSL) of 1,188 GL, plus an additional 489 GL of FMZ airspace to manage floods. • The Water Sharing Plan (WSP) formed the base case for the FBC. The historical data set was updated to include the 2017–2020 (Tinderbox) drought, in line with stakeholder requests. • Current fixed drought reserves are set at 165 GL at Burrendong Dam and 90 GL at Windemere Dam.
Hydrological Impacts	• Reduces the frequency of level 2 and 3 water restrictions for Dubbo by 50-70%. More severe restrictions do not occur. • All scenarios modelled showed reduction in average annual flows to the Macquarie Marshes of 5-7% • Slight increase in average annual flows at end of system (exiting the Marshes)

Element	Description
Preliminary Sizing / Technical Details	• Non-infrastructure option, although implementation may benefit from construction of additional flow gauging stations
Costs	• The direct financial cost of implementing the option is low. The costs of the option primarily relate to negative environmental impacts associated with reduced flows. The option as currently modelled shows a significant negative net present value. • The costs of terrestrial and aquatic offsets could not be quantified with limited hydrological information available through the initial phase of the FBC, but expert advice was clear that assessing the impacts and determining offset requirements would be extensive, time consuming and costly. (Refer Appendix D).
Cultural Heritage	• No impacts on cultural heritage identified. May be impacts associated with any decline in ecological values. • Access to cultural water has not been assessed at this Phase. This project is not proposing changes to entitlements but any impact to water licence type that may impact would need to be confirmed.
Ecosystem Credits Estimates (Biodiversity Offsets)	• Requires further detailed assessment in relation to ecological impact from change in flow regime to the Macquarie Marshes to quantify offsets. This is expected to be significant, estimated to cost millions of dollars and take 2-3 years to complete. • Initial investigation related to changes to frequency of flooding in the dam impoundment area indicated no upstream offset requirements.
Environmental	• The option will have impacts on the downstream flow regime. All scenarios assessed show a reduction in total flows to the Macquarie Marshes of 5-7% and a reduction in PEW of 5-10%.
Other Considerations	• An increase in flood risk is inherent in the option. • The modelling indicates that there is only a nominal change to flood risk associated with events with a 1 in 100-year frequency. There is greater flood risk and flood damage associated with less frequent events (1 in 2,000-year up to 1 in 5,000-year events).
Feasibility and Delivery Risks	• Feasible. No dam safety issues identified. • Flood model shows low impact but public scepticism likely • Any future flooding likely to be blamed on the changes to the FMZ • Environmental opposition likely
Regulatory Approvals	• Under existing commitments and policy settings associated with the Murray–Darling Basin Plan (section 10.28), net reductions to PEW are not permitted.

Element	Description
	• Any proposed changes (infrastructure or operational) are assessed against three criteria – volume protection, legal protection and effectiveness, to confirm environmental outcomes are maintained. • Consequently, under the Commonwealth Water Act 2007, the Commonwealth could refuse to approve the Water Resource Plans required for operation of the project. • Requires change to water sharing plan and Annual Water Determination process • There is a high likelihood the proposed changed flow regime to the Macquarie Marshes, as a RAMSAR wetland would be deemed a controlled action under Commonwealth environmental legislation, introducing complexity and uncertainty.

3.4 Option 4: Improved Access to Groundwater for Dubbo

This option focuses on increasing Dubbo's access to groundwater during drought through a combination of additional borefield infrastructure and regulatory or policy changes governing groundwater access. Provides an alternative water supply during critical low periods of water storage within Burrendong Dam.

Table 3-4 provides an overview of the option assessment.

In summary the option is technically feasible, comparatively lower cost, and avoids impacts on surface water flows and the Macquarie Marshes. Scenario testing demonstrates its effectiveness in maintaining Dubbo's supply during severe droughts. Key risks relate to groundwater user acceptance, regulatory alignment and management of potential PFAS contamination.

Table 3-4: Dubbo groundwater option assessment

Element	Description
Option Overview	Increase groundwater available to Dubbo Regional Council by: • Increasing Council's infrastructure capacity, via additional groundwater bores and a related pipeline to the south of Dubbo and/or • Changing regulatory arrangements to allow increased access to Dubbo Regional Council and reduce take by other groundwater users during drought This option has both infrastructure and regulatory sub options, which differ materially in cost, risk, and implementation time.
Preliminary Sizing / Technical Details	• Between 5 to 9 groundwater bores located to the south of Dubbo • Up to 35km of connecting pipeline

Element	Description
Costs	• Capital costs of between $77.5 million (5 bore option) and $139.5 million (9 bore option) • Operating costs of $2 million/year • Biodiversity offset of $3.7 million
Cultural Heritage	• Limited and localised impacts on cultural heritage if any
Ecosystem Credits Estimates (Biodiversity Offsets)	• 567 ecosystem credits and 682 species credits • $3.7 million
Environmental	• No impact on environmental flows • Relatively minor localised construction impacts
Other Considerations	• Relies on alignment with policy team on implementation of drought response implementation conditions, including potential compensation arrangements for affected irrigators. • No consultation to date with potentially impacted irrigators
Feasibility and Delivery Risks	• Feasible – sufficient groundwater resources physically available within the aquifer • Straightforward technically • PFAS has been identified as an emerging issue in Dubbo's groundwater systems that could require additional investigation and potentially treatment. • Potential implications for groundwater use as a drought supply source will be explored in further FBC assessment.
Regulatory Approvals	• Requires groundwater policy alignment as it has potential statewide implications

4 Options Shortlisting Outcomes

4.1 Options Assessment Framework

All options were assessed using a multi-criteria analysis (MCA) aligned to the project objectives. The assessment criteria are shown in Table 4-1 MCA criteria.

Table 4-1 MCA criteria

Criterion	Description
Addresses problem statements	
Meets the primary objective of the project	Extent to which the option would increase town water security in the region, with a focus on Dubbo, Nyngan and Cobar, by improving water supply that meets critical human water need during drought.
Meets secondary objectives of the project	Extent to which the option meets the following objectives (listed in order of priority): • better delivery of high priority water in the catchment's west • improved drought security for water dependent industries driving the economy • no net reduction in flows to the Macquarie Marshes
Value for money	
Benefits outweigh the costs	• benefits associated with the option (economic, financial, environmental, cultural and social) • costs associated with the option (economic, financial, environmental, cultural and social) • extent to which the benefits outweigh the costs.
Other considerations	
Alignment with legal, policy and regulatory framework	Extent to which: • option aligns with the existing legal and regulatory framework, or • any required changes to the framework are supported by the relevant line agency
Feasibility and risks	Extent to which the option is feasible to implement having regard to • nature of the risks associated with the option • extent to which the risks are able to be managed • extent to which the residual risk is acceptable.
Environmental impacts	Extent to which the option has a negative impact on environment including: • Impacts on connectivity to the Barwon • Impacts on planned environmental water

Criterion	Description
Heritage and cultural impact	Extent to which the option has a negative impact on heritage and cultural values including those of First Nations peoples.

Each option was assessed against each criterion, with supporting justification documented in Section 3.

Additional information used in assessing the options is summarised in the appendices:

- Appendix A – Town water security assessment
- Appendix B – Hydrology modelling summary
- Appendix C – Rapid cost benefit analysis
- Appendix D – Environmental and biodiversity offset challenges.

4.2 Shortlisting Outcomes

Table 4-2 provides a summary of the shortlisting outcomes.

Table 4-2 Options assessment

Criterion	Description	Option 1: Regional Pipeline (Dubbo to Nyngan)	Option 2: Gin Gin Weir Replacement	Option 3: Use of FMZ in Burrendong Dam	Option 4: Improved Groundwater Supplies for Dubbo
Meets Primary Objective	Improves town water security for Dubbo, Nyngan, and Cobar during drought	• Extends supply at Level 3+ by reducing losses• Limited impact on Level 1–2	• No town water benefit • Only minor benefit to Nyngan	• Improved town water security, being reduction in levels 1-3 restrictions (Dubbo) and levels 1-6 restrictions (Nyngan)	• Groundwater scenario testing confirms Dubbo could be reliably supplied by groundwater during severe droughts such as Tinderbox • Surface modelling shows little benefit
Meets Secondary Objectives	High-priority water delivery, industry drought security, and no net reduction in flows	• Better delivery to west • No change in GS or flows	• Minor improvement in GS • No reduction in PEW	• Likely to have no material impact on GS allocations • Modelling showed a 5 to 10 per cent reduction in planned environmental water (PEW) • 5 to 7 per cent reduction in flows to the Macquarie Marshes.	• No impact on GS or environmental outcomes
Value for Money and Rapid Cost Benefit Analysis	Benefits vs. costs (economic, social, environmental)	• BCR < 1 • Very high cost (>$700M+)	• BCR < 1 • Low benefits • High cost ($100M+)	• BCR < 0 (negative) • Significant disbenefits from reduced environmental flows and the need to pay for	• BCR < 1 • Resilience benefit is hard to quantify but potentially meaningful

Criterion	Description	Option 1: Regional Pipeline (Dubbo to Nyngan)	Option 2: Gin Gin Weir Replacement	Option 3: Use of FMZ in Burrendong Dam	Option 4: Improved Groundwater Supplies for Dubbo
		• Benefits limited to extreme droughts	• No avoided replacement costs	environmental and biodiversity offsets	• Low cost (regulatory change option) has highest BCR (0.24)
Legal, Policy & Regulatory Alignment	Alignment with current frameworks or need for changes	• No major issues • ILUA required at Nyngan	• Statutory approvals and minor instrument changes	• Requires change to allocation and sharing rules • Potentially requires approval under Commonwealth EPBC Act due to potential Ramsar wetland impacts. • Reductions in PEW not permitted under Basin Plan. • Changes to WRP by Commonwealth requires approval which would be at risk due to PEW reduction.	• Requires groundwater policy alignment as it has potential statewide implications. This could be applicable to other groundwater dependent towns in the valley.
Feasibility & Risks	Delivery feasibility and key risks	• Native Title and rock excavation risks • Infrastructure complexity	• Standard infrastructure risks • Concerns about capturing environmental flows • Environmental opposition expressed	• Flood model shows low impact but public scepticism likely • Any future flooding likely to be blamed on the changes to the FMZ • Environmental opposition expressed	• Straightforward technically • Existing groundwater user acceptance and PFAS contamination are key risks

Criterion	Description	Option 1: Regional Pipeline (Dubbo to Nyngan)	Option 2: Gin Gin Weir Replacement	Option 3: Use of FMZ in Burrendong Dam	Option 4: Improved Groundwater Supplies for Dubbo
Environmental Impacts	Effect on ecosystems and flow connectivity	• Loss of incidental flows to Marshes • Major construction footprint	• Increased inundation footprint • Fish passage improves connectivity	• Reduction in PEW and flows to marshes • Changes in size, timing, frequency and duration of flows • Detailed modelling required to confirm but highly likely to require additional environmental offsets	• Localised pipeline impacts • No change to aquifer limits
Heritage & Cultural Impact	Impact on Aboriginal heritage or culturally significant areas	• Moderate–high likelihood of impacts near creeks/floodplains from construction	• Indirect disturbance risk from construction activity	• Impacts limited but require further assessment	• Limited and localised
Recommendation	Suitability for shortlisting	❌ **Do not shortlist** – limited real benefit relative to very high cost.	❌ **Do not shortlist** – not aligned with primary objective of FBC; other issues (fish passage and long term levels of service) are WaterNSW responsibility	❌ **Do not shortlist** due to economic and environmental impacts	☑ **Shortlist** – cost-effective contingency option; aligned with statewide groundwater strategy

Option 1: Regional Pipeline from Dubbo to Nyngan - provides limited incremental benefit at disproportionately high cost

This option was not shortlisted due to its high capital cost (>$700M) and limited additional benefit, even under dry future climate scenarios. While it offers perceived assurance of supply to western towns and mines, modelling indicates limited value for money.

Recommendation: Do not shortlist. The scale of investment is disproportionate to the benefits delivered.

Option 2: Replacement of Gin Gin Weir - does not address the FBC's core town water security objective and is primarily an asset renewal project

This option was not shortlisted due to limited alignment with the core objectives of the FBC and poor value for money. While it addresses ecological compliance and operational efficiency, it does not improve town water security and is primarily focused on asset renewal. The high capital cost (~$100 million) is not justified given the marginal system-wide benefits.

Recommendation: Do not shortlist. The project falls outside the scope of town water security improvements and should be considered through routine asset management planning.

Option 3: Flood Mitigation Zone (FMZ) in Burrendong Dam - delivers strong water security benefits during drought but carries material environmental, flood risk and policy uncertainty

Option 3 delivers strong improvements in town water security across all climate scenarios and directly addresses the core problem statement. However, it comes with significant environmental trade-offs—particularly due to the potential for reduced environmental flows and adverse ecological impacts downstream. While there is some scope for mitigation through refined operational rules, it remains unclear whether these measures will be sufficient to avoid unacceptable ecological outcomes.

The work to provide this evidence is estimated to take an additional 2-3 years. There is a material risk that the environmental impacts cannot be adequately mitigated or will not be approved under relevant legislation.

Recommendation: Do not shortlist. The project is not recommended for shortlisting due to environmental impacts, poor value for money, regulatory and operational complexity, and public perception of potential flood liability.

Option 4: Improved Groundwater Supplies for Dubbo - provides a cost-effective, scalable and targeted improvement in drought resilience without material environmental impacts

Option 4 provides a cost-effective contingency for Dubbo, with demonstrated capacity to support supply during critical periods. It complements long-term resilience objectives and supports the development of a consistent policy for town groundwater use.

Recommendation: Option 4 is recommended for shortlisting as a viable, lower-cost complementary measure to surface water options, particularly under extended drought conditions.

Appendix A - Town water security assessment

Water security for Dubbo and other Macquarie Valley towns has been assessed using long-term hydrological modelling conducted as part of Phase 1 of the Macquarie-Wambuul Water Security Full Business Case.

Under current arrangements, the Macquarie–Wambuul system avoids total failure but exposes towns—particularly Dubbo—to **frequent and prolonged restrictions**, with reliability deteriorating significantly under climate change. Targeted intervention is required to maintain confidence in town water security.

Water security outcomes were evaluated using:

- **Historical data** – Observed hydrological records from the past.
- **Paleo-stochastic data** – 10,000 years of synthetic streamflow data representing natural climate variability.
- **NARCliM-adjusted data** – Climate change projections for 2060–2079 (based on NARCliM) applied to the paleo-stochastic data, representing a drier future climate scenario.

Water security assessment of Dubbo

Dubbo primarily gets its water from Burrendong Dam, which is part of the Lower Macquarie supply system. Long-term modelling shows that the dam does not run dry under either historical conditions or future climate scenarios. However, Dubbo will experience frequent Stage 3 and Stage 4 drought trigger conditions. In the historic climate, Stage 3 droughts occur in approximately half of all years. Under a drier future climate, Stage 3 droughts occur in more than 80 per cent of years and Stage 4 events increase sharply.

Table A-1 and Table A-2 present these results.

These outcomes indicate that while catastrophic failure is unlikely, service reliability and community resilience materially decline without additional drought supply options.

Table A-1 Dubbo water security assessment (long-term stochastic climate sequence)

Event / Restriction Trigger	Average Recurrence Interval (years)	% of Years Affected	% of Days Affected
Level 1 – Stage 3 drought trigger (<382 GL)	2.0	50%	26.1%
Level 2 – Stage 4 drought trigger (<127 GL)	21.5	4.7%	1.6%
Level 3 – 10 months from predicted cease-to-supply (<45 GL)	1,649.7	~0.1%	0.0%
Levels 4–6 (critical thresholds <15 GL, dead storage)	Not simulated	0%	0%

Table A-2 Dubbo water security assessment (long-term stochastic climate sequence + NARCliM)

Restriction Trigger	Storage Trigger Level	Average Recurrence Interval (years)	% of Years Affected	% of Days Affected
Level 1 – Stage 3 drought declaration	<382 GL	1.2	81.6%	57.5%
Level 2 – Stage 4 drought declaration	<127 GL	7.9	12.6%	5.2%
Level 3 – 10 months from cease-to-flow	<45 GL	247.5	0.4%	0.1%
Levels 4–6 – <15 GL, dead storage or failure	Not simulated	–	0%	0%

Water security assessment of Nyngan and Cobar

Nyngan and Cobar remain highly exposed due to their reliance on long distance surface water transfers.

- Low level restrictions are permanent under the base case.
- Severe restriction events are infrequent historically but increase under climate change.
- System modelling assumes equal prioritisation with Dubbo during extreme events.

The following tables Nyngan and Cobar water security assessment show increased frequency of moderate restrictions under future climate scenarios.

Table A-3 Nyngan and Cobar water security assessment (long-term stochastic climate sequence)

Event / Restriction Trigger	Average Recurrence Interval (years)	% of Years Affected	% of Days Affected
Level 1 – Permanent restrictions (normal operations)	1.0	100%	100%
Level 2 – <90% of allocation (<110 GL total storage)	30.3	3.3%	1.1%
Level 3 – <80% of allocation (<100 GL)	39.1	2.6%	0.7%
Level 4 – <70% of allocation (<90 GL)	85.3	1.2%	0.4%
Level 5 – <60% of allocation (<70 GL)	274.9	0.4%	0.1%
Level 6 – <50% of allocation (<60 GL)	395.9	0.3%	0.1%
Critical Threshold – Nyngan storage <304 ML	Not simulated	0%	0%

Table A-4 Dubbo water security assessment (long-term stochastic climate sequence + NARCliM)

Restriction Trigger	Average Recurrence Interval (years)	% of Years Affected	% of Days Affected
Level 1 – Permanent restrictions	1.0	100.0%	100.0%
Level 2 – <90% of Macquarie River allocation (<110 GL)	10.8	9.3%	3.6%
Level 3 – <80% allocation (<100 GL)	13.7	7.3%	2.4%
Level 4 – <70% allocation (<90 GL)	29.5	3.4%	1.3%
Level 5 – <60% allocation (<70 GL)	71.2	1.4%	0.5%
Level 6 – <50% allocation (<60 GL)	116.4	0.9%	0.3%
Nyngan Storage <304 ML (DSV)	Not simulated	0%	0%

Zero Inflow Analysis

The hydrological modelling also tested how long water could have been supplied to Dubbo, Nyngan, and Cobar under a zero inflow scenario, starting from the point when dam supplies were at 45 GL in February 2020 when the Tinderbox Drought broke.

Under the operational assumption that maintains equal priority for all towns, the system would have reached 15 GL by September 2020 and fully depleted to dead storage (0 GL) by December 2020—a drawdown period of 10.5 months.

This closely matches WaterNSW's estimate at the time.

From that point, approximately14 GL would still be available for supply from the dead storage using dead storage access infrastructure.

System Inefficiencies and Transmission Losses

Extreme transmission losses are a defining weakness of the current system during drought.

- Approximately 27 ML must be released from Burrendong Dam to deliver 1 ML to Nyngan or Cobar under dry conditions (as reported in the Regional Water Strategy).
- During the 2017–2020 drought, emergency operational measures—including shortening the regulated system to Warren—were required to preserve town supplies.

These inefficiencies impose escalating risk and cost as drought severity increases.

In response to dwindling storage levels, WaterNSW and the NSW Government introduced emergency drought measures, including shortening the regulated river system to Warren between September 2019 and January 2020—the first such event in over 50 years. During this period, regulated releases downstream of Warren ceased, and flows to Gunningbar Creek for Tritton Mine were suspended from December 2019 to mid-February 2020 in order to preserve remaining storage for town water supply. Temporary delivery methods were engaged to continue operation of the mine through this period.

Treatment of Dubbo, Nyngan, and Cobar During Stage 4 Extreme Events

The NSW Government's Extreme Events Policy requires that available water be prioritised to meet critical human needs during severe drought. However, the policy does not specify which towns must be maintained or how water should be rationed between different communities once system constraints emerge.

The hydrological modelling adopts the assumption that Dubbo, Nyngan, and Cobar are treated equally as towns requiring supply for critical human needs. This means no town's supply is suspended during a drought unless the system fails entirely (i.e. reaches dead storage), and no differentiation is made between upstream and downstream towns in the prioritisation of supply.

This equalised protection approach was adopted to:

- reflect the lack of explicit government guidance on town-level prioritisation during Stage 4 droughts
- reflect that these towns continued to be supplied during the last drought
- test the feasibility of maintaining minimum supply to all major towns under a range of historical and projected future climate conditions
- ensure that the modelled system behaviour reflects a baseline of equitable regional resilience, against which the value of specific interventions (e.g. new infrastructure, operational rules, groundwater substitution) can be assessed.

This treatment also recognises that Dubbo, Nyngan, and Cobar each meet the definition of critical human needs under the NSW framework, and that deprioritising any one of them would represent a significant operational, political, and social decision.

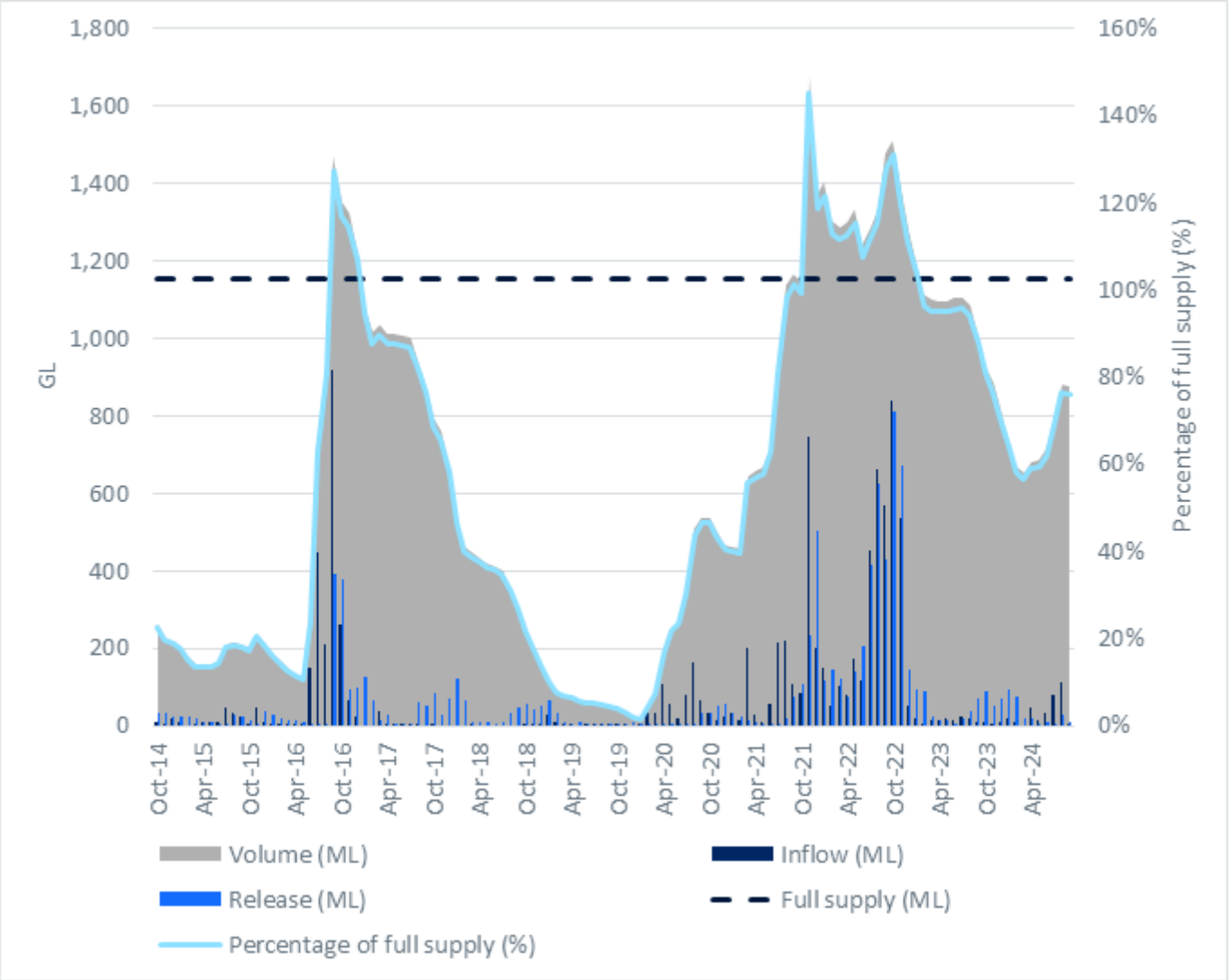
2017-2020 Drought

From 2017 to 2020, NSW experienced the worst drought on record[4] - the 'Tinder Box' drought. The drought was the worst in terms of storage inflows for any 24-month and 36-month consecutive periods for the Macquarie Valley over the historical record (1980 to now):

- 24-month inflows into Burrendong Dam were 70% less than the previous worst recorded period in 1937- 1939.
- 36-month inflows were 72% less than the previous worst recorded period in 1937-1940.

In early February 2020, Burrendong Dam was at its second lowest level ever at 1.5% of full supply as shown in Figure A-1.

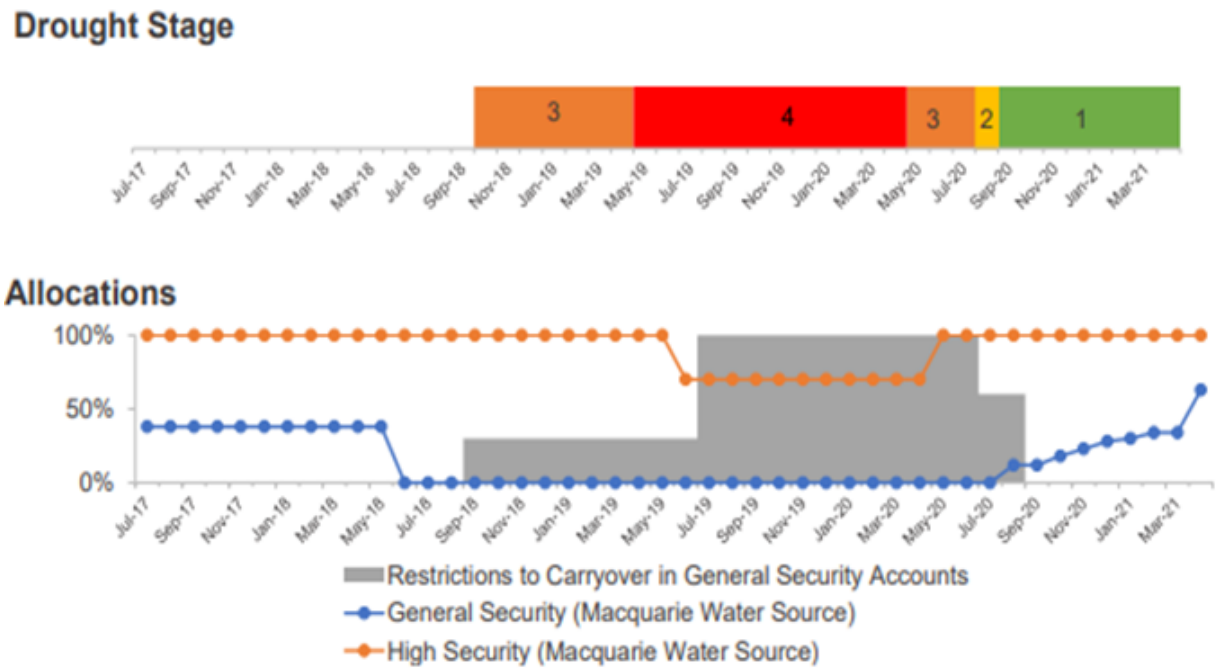
Figure A-1 Burrendong Dam inflows, outflows and storage volumes (ML and % of full supply)



Source WaterNSW, Burrendong Dam historical dam levels

As a result of the drought, the Macquarie Regulated River Water Source reached Drought Stage 4 under the NSW Extreme Events Policy in 2019, exhibiting critical water shortage as shown in Figure A-2.

Figure A-2 Macquarie Water Source during 2017-2020 drought



Priority	Take type/use
First	Meeting critical human water needs, which means the needs for a minimum amount of water, that can only reasonably be provided from the Basin water resources, required to meet: Core human consumption requirements in urban and rural areas Non-human consumption requirements that a failure to meet would cause prohibitively high social, economic, or national security costs.
Second	Not critical human water needs but: domestic purposes by persons exercising basic landholder rights domestic purposes or essential town services authorised by an access licence.
Third	Needs of the environment
Fourth	To the extent these are not critical human water needs, the taking of water for: • stock purposes by persons exercising basic landholder rights • in the case of regulated rivers, the taking of water authorised by a high security access licence • commercial and industrial activities authorised by a major utility access licence or local water utility access licence, subject to the water made available being in accordance with any drought management strategy established by the Minister for that purpose, • stock purposes authorised by stock access licence • conveyance under a conveyance access licence.
Fifth	Other purposes authorised by an access licence, to the extent these are not critical human water needs.

Source: NSW Extreme Event Policy

The key decisions made under the Extreme Events Policy during this period for the Macquarie Regulated River were:

- On 1 July 2019 the Temporary Water Restriction (Macquarie Regulated River) Order 2019 came into effect, restricting access to all general security water remaining in accounts as of 30 June 2019 for those licence holders taking from the Macquarie and Cudgegong Regulated Rivers Water Source downstream of Burrendong Dam (the Macquarie Regulated River Water Source). Clauses in the Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016 were suspended. These regulatory actions were taken to secure water for critical needs. The Macquarie Regulated River Water Source was at Drought Stage 4 under the NSW Extreme Events Policy, exhibiting critical water shortage.
- In September 2019, Warren Weir was raised to extend supplies for critical water needs upstream and cease all regulated flows downstream of Warren.
- By April 2020, there was enough resource to repeal suspended water sharing plan rules, provide full allocation to all high priority products, including town water, domestic, stock and high security entitlements, and ease the temporary water restriction on general security water users.

The RWS noted that the drought placed great pressure on the viability of farm businesses and the resilience of the broader regional economy. The gross domestic product of the Far West–Orana region of NSW, which includes most of the Macquarie– Castlereagh region, declined by approximately 12% in the 2017–2020 drought. This is reflected in lower employment, reduced capital utilisation and productivity losses.

In the Dubbo Regional Council Drought Management Plan, there is a comment that it avoids going into Stage 4 restrictions as there is associated economic impact[7].

[7] Dubbo Regional Council, Drought Contingency And Water, Emergency Response Plan 2020, https://www.dubbo.nsw.gov.au/ArticleDocuments/242/FINAL%20Updated%2013%2007%202020%20-%20Drought%20Contingency%20and%20Water%20Emergency%20Response%20Plan%202020.pdf.aspx?Embed=Y

Appendix B - Hydrology modelling summary

The Department commissioned an independent hydrology report considering the four FBC options. A summary of the hydrology assessment for each option is provided at Table B-1.

Hydrological assessment was based on the following high level assumptions and approach that enabled comparison of options, direction and scale of impacts. The results were intended to provide insights into relative benefits and risks across options, rather than precise forecasts or implementation ready volumes.

Assumptions

System & Governance

- The Water Sharing Plan (WSP) formed the base case for the hydrological assessment. The historical data set was updated to include the 2017–2020 (Tinderbox) drought, in line with stakeholder requests.
- Town water supply priorities during and 2017–2020 drought management were modelled in line with current operational rules (as available).
- No firm future drought operating rules exist for Level 3 and 4 of NSW Extreme Events Policy; therefore **three plausible operational responses** were defined to test sensitivity.
- Town water security performance is assessed using a **Levels of Service (LOS) framework**, measuring **frequency, severity, and duration** of restrictions or supply failure.

Storage & Drought Triggers

- Critical drought response trigger levels are based on **observed Burrendong and Windamere storage volumes from 2017–2020**, including Stage 3, Stage 4, river shortening, and minimum storage thresholds.
- Dead storage is technically available but **never reached** in any long-term simulation.
- Reserve scenarios (300 GL, 400 GL and up to 900 GL) were represented in the model as fixed volumes withheld from allocation before distribution to entitlement holders, directly affecting availability across entitlement classes.
- Water reserve sensitivity scenarios were informed by outcomes experienced during the Tinderbox drought, following activation of the Extreme Events Policy. During the drought, the implementation of the policy resulted in General Security (GS) water users experiencing significant disruption, including allocation suspensions with limited notice.

Assessment approach

- The modelling tested relative impacts on town water reliability, general security availability and environmental flow outcomes.
- The modelling tested the impact of each option on allocations across a range of water users.
- The modelling tested whether changes to system operation (through infrastructure or operation) could improve town water security under extreme drought while offsetting impacts on other entitlement holders.

- The project did not seek to increase General Security volumes; any incidental General Security benefits were assumed to be potentially redirected through water sharing rules or further optimisation to town water and environmental outcomes.

Climate & Hydrology

Three climate datasets are assumed to span plausible current and future conditions:

1. **Instrumental climate** (1889–2021): short-term option screening (note this includes the Tinderbox drought).
2. **Paleo-stochastic climate** (10,000 years): primary long-term risk assessment.
3. **Dry climate change scenario (NARCliM)**: stress-test reflecting mid-century drier conditions.
    - Option-specific Assumptions
    - **Groundwater (Option 1):** Assumed fully reliable and always available.
    - **Pipeline (Option 3):** No material transmission losses; sufficient capacity at all times.
    - **Burrendong FMZ changes (Option 2):** No change to water sharing rules unless explicitly stated.
    - **Gin Gin weir (Option 4):** Stored volume counted in resource availability with no entitlement changes.

Modelled Scenarios - Operational Base Cases (Drought Management)

Three drought operating strategies were modelled:

1. Scenario 1 – Prioritise Dubbo
    - Early suspension of supply to Nyngan/Cobar.
    - Strong protection of Dubbo at very low storage levels.
2. Scenario 2 – Equalised Protection (Reference Case)
    - Burrendong supplies Dubbo and Nyngan/Cobar equally throughout drought.
    - More rapid scheme drawdown under prolonged dry conditions.
3. Scenario 3 – Continued Restricted Supply
    - Ongoing restricted supply to Nyngan/Cobar until very low storage.
    - Intermediate outcomes between Scenarios 1 and 2.

Infrastructure Options (assessed against Scenario 1 operating rules)

- **Option 1:** Regional pipeline from Dubbo to Nyngan
- **Option 2:** New re-regulating weir at Gin Gin (6 GL).
- **Option 3:** Converting part of Burrendong flood mitigation zone to supply storage (two structural variants, with/without increased reserves 300GL, 400GL, 900GL).
- **Option 4:** Increased Dubbo groundwater use.

Each option was tested under:

- Historical climate
- Paleo-stochastic climate

- Dry climate change (NARCliM)

Key Outcomes

Operational Strategy Matters More Than Infrastructure

- Drought operating rules are the dominant driver of water security outcomes.
- Continued supply to Nyngan/Cobar during severe drought:
    - Improves Nyngan security
    - Reduces Dubbo security
    - Accelerates whole-of-scheme drawdown.

System Resilience (Base Case)

- Across 10,000 years of paleo-stochastic simulations:
    - Dead storage was never exhausted.
    - Storage volumes equivalent to the 2019–20 minimum (~45 GL) occurs roughly once every 1,000 years, suggesting the recent drought was extremely severe or operationally atypical.

Option-Specific Outcomes

Option 1 – Dubbo–Nyngan Regional Pipeline

- Clear improvement in Nyngan/Cobar water security.
- Some improvement in Dubbo outcomes, particularly under climate stress.
- Minimal system-wide trade-offs:
    - GSE diversions increase <1%
    - Marsh inflows decrease ~0.5%
- Demonstrates regional resilience benefits.

Option 2 – Gin Gin Re-regulating Weir

- Minimal impact on town water security.
- Small increases in General Security diversions.
- Slight reduction in downstream flows; environmental outcomes largely unchanged.
- Operational rather than strategic benefit.

Option 3 – Burrendong Flood Mitigation Zone Storage

The hydrological modelling generated a range of volumetric outputs under different FMZ and reserve scenarios.

The volumes presented below are expressed as ranges or percentages to avoid false precision and reflect uncertainty inherent in modelling a constrained system.

- No material improvement in town water security for Dubbo, Nyngan or Cobar.
    - The assessed FMZ scenarios resulted in an increase in total town water availability of approximately 0.2–0.3 GL. Note that was finding of the hydrology report is limited to

the total water volume, and did not consider the change in water restrictions per town, which the project assessment used in overall option assessment.

- Significant redistribution effects:
    - General Security diversions - increase~5–10%
        - The assessed FMZ scenarios resulted in an increase in total General Security availability of approximately 10–18 GL
    - No impact on High Security allocations
    - Supplementary water decrease ~10–15%
    - Environmental water outcomes decrease up to ~10%
        - Under the paleostochastic modelling scenario, total PEW is approximately 102 GL per year (average annual flow).
        - This equates to an annual reduction of approximately 5–10 GL, depending on the scenario modelled.
    - Marshes inflows decrease ~5%
        - There was a slight increase in average annual end-of-system flows (i.e. flows exiting the Marshes).
- Would **require water sharing plan changes** if town security is an objective.

Option 4 – Groundwater for Dubbo

- **No material system-wide improvement** in modelled town water security.
- Negligible impact on storage behaviour, environmental flows, or diversions.
- Likely more valuable as an **emergency/contingency supply**, not routine substitution.

Climate Change Sensitivity

- Under NARCliM dry climate scenarios:
    - All towns experience **more frequent and longer restrictions.**
    - None of the options fully offset climate-driven risk increases.
    - Options providing **connectivity or operational flexibility** (e.g. pipeline) perform relatively better than storage-only solutions.

Overall Conclusions

How the system is operated during drought is more important than new infrastructure alone.

- Of the options assessed:
    - **Regional pipeline (Option 1)** provides the most robust improvement in regional water security.
    - **FMZ conversion (Option 3)** mainly redistributes water by shifting water to irrigators and reduces environmental outcomes without improving town security. All FMZ scenarios involved trade offs – improved town water security leading to impacted PEW while providing only minimal General Security benefits. It was noted that further optimisation of the option would be required to realise these benefits.

  - **Groundwater and Gin Gin weir** offer limited system-scale benefits.
- Climate change materially worsens outcomes across all scenarios, reinforcing the need for **flexible, portfolio-based solutions** rather than reliance on single assets. Under **future drier climates**, options that improve **connectivity and flexibility** outperform storage-only solutions.

Limitations

It is not practical or meaningful to list every individual modelling assumption, as it would not provide meaningful answers. Due to model complexity and data governance requirements, detailed modelling files are not released publicly.

Table B-1: Comparison Table – Hydrological Options Assessment

Option	Description	Dubbo Water Security Outcome	Nyngan / Cobar Water Security Outcome	Whole-of-System Impacts	Environmental Outcomes	Performance Under Dry Climate (NARCliM)	Overall Assessment
Option 1 – Dubbo–Nyngan Regional Pipeline	Pipeline supplying Nyngan via Dubbo instead of Albert Priestley Channel	**Some improvement**, particularly in dry scenarios	**Material improvement** in LOS and drought resilience	Minor increase in diversions (<1%); minimal scheme disruption	Small reduction in Marsh inflows (~0.5%)	**Performs best relative to other options**	Strong regional resilience benefits; best balance of outcomes
Option 2 – Gin Gin Re-regulating Weir	6 GL re-regulating weir with fish passage	No material change	No material change	Slight increase in General Security diversions (~1%)	Slight reduction in downstream flows	Limited benefit under climate stress	Operational efficiency only; **not a water security solution**
Option 3 – Burrendong Flood Mitigation Zone Storage	Conversion of part of the FMZ to water supply storage (with sub-options)	**Little to no improvement**	Little to no improvement	↑ General Security diversions (~5–10%); ↓ Supplementary access (~10–15%)	**Reduced environmental water and Marsh inflows (up to ~5–10%)**	Improves storage volumes but **restrictions still increase**	Redistributes water rather than improving town security; would require **water sharing rule changes**
Option 4 – Dubbo Groundwater	Increased use of Dubbo groundwater during drought (assumed fully reliable)	**No material change** in modelled LOS outcomes	No change	Negligible change to storages, diversions, or scheme behaviour	No material change	Very limited buffering; **does not offset increased drought frequency**	Low system-wide benefit; potentially valuable as an **emergency/contingency** supply only

Appendix C - Rapid cost benefit analysis

A rapid cost-benefit analysis was undertaken to assess the likely value for money of the options based on the initial scoping of the options.

A rapid CBA applies standard economic appraisal techniques but focuses only on **material impacts**, using simplifying assumptions appropriate for an early business case phase. It is explicitly intended to **screen options**, not to provide final investment decisions, and will be superseded by a full CBA for shortlisted options.

Table C-1 Rapid CBA results

Option	Net Present Value (NPV)	Benefit-Cost Ratio (BCR)
Gin Gin Weir Replacement	–$135.3	0.07
Regional Pipeline (Dubbo to Nyngan)	–$788.9	–0.03
FMZ (Flood Mitigation Zone)	–$68.2	–2.30
Dubbo Groundwater (three sub-options)	–$8.1 to -$130	0.24 to –0.03

The NPVs and BCRs presented above are best viewed as indicative tools to support decision-making.

Drought impacts are modelled via water restriction costs, emergency supply scenarios, agricultural and stock impacts, floodplain grazing and environmental water outcomes, while broader ecological, recreational and cultural values are excluded from monetisation.

All options return BCRs below 1.0 due to factors including:

- Low-probability assumptions in the hydrology: The modelling indicates that events like the Tinderbox Drought should only occur rarely, despite recent experience showing they can and do occur. This underweights the benefits of drought resilience.
- Phase 1 did not assess ecohydrological impacts on the Marshes due to the detailed hydrological information required (not available at shortlisting assessment). Based on similar dam projects that proposed changes to flow regime, potential offsets are expected to be in the millions, which would further reduce the BCR.

While BCRs help compare options, NPVs should carry more weight where large negative NPVs are driven by high capital and operating costs, and where similar or greater resilience could likely be achieved through less costly interventions.

Key assumptions

Appraisal framework

- Base year: FY2026 (real dollars)
- Appraisal period: 40 operational years, with a sensitivity test at 30 years
- Discount rate:
    - Central case: 5%
    - Sensitivities: 3% and 7%

- **Residual value:** Included for long-lived assets using the **present value of future benefits approach**, with the lower of replacement cost or future benefits retained, consistent with NSW Treasury guidance.

Base case

- A **"do-minimum" base case** is specified for each option.
- Existing assets are assumed to continue operating at current funded levels, with costs that occur in both the base case and project case **netted out**.
- Only **incremental costs and benefits** relative to the base case are included in the CBA.

Hydrology and scenarios

- Under long-term hydrological modelling, Level 6 water restrictions do not occur in Dubbo, Nyngan or Cobar.
- For Option 4 (groundwater), impacts only arise during extreme drought; therefore a scenario approach was adopted assuming Level 6 restrictions occur in 2030 (Tinderbox drought analogue).

Hydrology outputs used in the CBA included:

- Days under each water restriction level for Dubbo, Nyngan and Cobar, used to estimate the economic cost of water restrictions and avoided emergency supply;
- Modelled annual average water supply for General Security and Stock & Domestic users, used to estimate changes in agricultural production;
- Annual water supply to mines around Cobar, used to test changes in mining reliability and economic activity;
- Annual volumes reaching the Macquarie Marshes, used to estimate changes in environmental water value; and
- Modelled changes in Marsh inflows and inundation outcomes, used to estimate annual average changes in floodplain grazing and associated agricultural productivity.
- All hydrological inputs applied in the rapid CBA represent scenario-based, long-term average outcomes, not fixed or guaranteed volumes. Reported values are drawn primarily from median paleostochastic modelling, with sensitivity tested across large numbers of climate replicates, including climate-change-adjusted scenarios.

Long term average approach

- Gigalitre figures are expressed as long term averages because water availability varies significantly year to year under different climate conditions, and the assessment was intended to compare relative benefits and costs rather than predict fixed or guaranteed volumes.
- Averaging allows government to compare options fairly and consistently, rather than relying on single year outcomes that would not be reliable for decision making.
- Using long-term averages also ensures that rare events (extreme droughts or floods) are considered in proportion to how often they occur, avoiding over or under weighting atypical years.

- This approach is consistent with NSW Government water planning and economic appraisal practices, which focus on long-term system performance rather than short-term operational outcomes.
- Average values are easier to understand and compare outcomes so average numbers tend to be used more often in published materials. Detailed sequences and event or spell analysis is always undertaken internally wherever that is required to correctly understand how a proposal will perform in significant events.

Methodology

Options assessed

The rapid CBA assessed **four core options** (with sub-options for groundwater):

1. **Option 1:** Regional pipeline from Dubbo to Nyngan
2. **Option 2:** Gin Gin Weir replacement (2a re-regulating).
3. **Option 3:** Use of Burrendong Dam flood mitigation zone (FMZ – 300GL reserve hydrology scenario)
4. **Option 4:** Dubbo groundwater (sub-options 4a, 4b, 4c)

Costs considered

- **Capital costs** (Class 5 estimates)
- **Operating and maintenance costs**
- **Capital renewal costs**
- **Policy change costs** (Options 4a and 4c)
- **Flood damage costs** (Option 3)
- **Biodiversity offset costs** (where relevant)

All costs are estimated **incrementally** against the base case.

Benefits quantified

Where materially attributable and supported by data, the CBA quantified:

- **Town water security benefits** (avoided town water restriction costs and emergency water supply
- **Agricultural impacts** (cotton and lucerne net margins, increase in irrigation benefit))
- **Environmental water benefits** (value of water reaching Macquarie Marshes)
    - Total planned environmental water (Active and Translucent) was used to estimate changes in environmental value.
- **Floodplain grazing benefits**
- **Stock and domestic water security benefits**

Benefits that could not be robustly monetised (e.g. cultural impacts, fish passage, recreation) were assessed **qualitatively.**

Valuation approaches

- **Water restrictions:** Valued using **willingness-to-pay (WTP)** to avoid restrictions, applied by town, restriction level, and customer segment, based on literature and NSW Regional Water Value Functions.
- **Emergency water supply:** Valued using the avoided cost of water carting from Warragamba Dam.
- **Agriculture:** Net margin approaches using established crop budgets and hydrology-driven changes in water availability.
- **Environmental water:** Valued using the opportunity cost of water based on median NSW Lachlan general security entitlement prices.

It is important to note that terrestrial and aquatic environmental offset costs are unable to be quantified by the rapid CBA, and hence should be considered additional to the environmental water valuation.

Results - Central case (5% discount rate)

- No option delivers a positive NPV or BCR > 1.
- All options return **negative net present values**, indicating that quantified costs exceed quantified benefits under expected assumptions.

Key results:

- Best performing option:
  - Option 4a (Dubbo groundwater with regulatory change)
  - NPV ≈ –$8.1 million; BCR ≈ 0.24
- Next best option:
  - Option 3 (FMZ)
  - NPV ≈ –$68.2 million, Significant modelled disbenefits accrue to the Macquarie Marshes environment and floodplain graziers due to changes in river operations and flow patterns under the project options, which reduce environmental flows and alter inundation extent and timing. These changes affect pasture growth relied on by Marshes graziers following recession of floodwaters, with the rapid CBA capturing impacts through changes in marsh inundation and corresponding economic effects.
  - Note this does not include significant aquatic and terrestrial offset costs.
- **Large infrastructure options (pipeline, new weir)** perform poorly due to **high upfront capital costs** that outweigh benefits under rapid-CBA assumptions.

Sensitivity testing

- Changing discount rates and appraisal period **does not materially change rankings.**
- Option 4 results are sensitive to assumptions about **lucerne irrigation losses**; valuing losses at market water prices improves NPV but does not make the option positive.

Main learnings and implications

1. Rapid CBA supports option filtering, not selection
   None of the options demonstrate standalone economic merit at this stage, reinforcing that the rapid CBA is a **screening tool** and should not be interpreted as a final investment test.
2. Town water security benefits assessed in proportion to their cost.
   Large infrastructure options improve drought resilience for towns but do so at a scale of cost that is not proportionate to the benefits, resulting in poor value for money under standard assessment frameworks.
3. Environmental and floodplain impacts are pivotal
   Options that reduce downstream flows (especially Option 3 FMZ) are highly sensitive to environmental water assumptions and dominate the economic result.
4. Groundwater options remain the least-cost pathway
   While still negative, Option 4 sub-options outperform others by avoiding major capital expenditure and can materially reduce extreme drought risks.
5. Further refinement essential before exclusion
   The rapid CBA focuses on the material impacts required for option shortlisting and produces robust results based on agreed hydrological and economic inputs. Further modelling in a full CBA could provide additional detail and support optimisation and re-distribution of benefits between users.

Appendix D – Environmental and biodiversity offset challenges

Based on the experience of previous proposals, this paper summarises the key implications and complexities associated with assessing significant changes to downstream dam releases, as illustrated by the Wyangala Dam Raising projects.

Any option that materially alters flood regimes over large downstream floodplains creates exposure to impacts of national and international biodiversity significance, triggering very high regulatory and reputational risk.

The Wyangala project demonstrates that producing even a high-level or order-of-magnitude estimate of biodiversity offsets for projects involving hydrology-driven impacts is inherently unreliable and carries significant risk of misinforming decision-making.

Biodiversity Offsets

No standard method for prescribed impacts

At Wyangala, the most significant impacts were prescribed impacts, which are defined under the NSW Biodiversity Conservation Regulation 2017 as impacts to hydrological processes that sustain downstream threatened species and threatened ecological communities. Unlike direct impacts (such as vegetation clearing), there is no standard Biodiversity Assessment Method (BAM) methodology for quantifying offsets for prescribed impacts. In practice, prescribed impacts:

- are not spatially discrete
- are difficult to quantify
- have no standardised offset calculation method
- require bespoke methodologies agreed with regulators
- are highly sensitive to modelling assumptions, spatial scale and interpretation of ecological response.

Projects with hydrology driven impacts face fundamental uncertainty in assessment outcomes, timelines and approval likelihood, even with extensive technical work. As a result, any early estimate of offsets is method-dependent rather than data-driven, and highly unstable as methodologies evolve.

Offset magnitude depends on complex modelling

At Wyangala, detailed consultation was undertaken with the Biodiversity and Conservation Science (BCS) division to agree an approach to assessing prescribed impacts. It was determined that a credible assessment required:

- 2–3 years of detailed hydraulic and floodplain modelling
- Flood frequency, duration and inter-event analysis across large downstream systems
- Ground-truthed, BAM-compliant vegetation mapping and species data collection

Without this level of work, offset estimates are necessarily based on limited data, incomplete mapping and simplified flood extents, which were later found to materially under-represent impacts

Preparation of an offset estimate without necessary data is likely to change by orders of magnitude as information capture and modelling improves.

Offset estimates escalated dramatically over time

Despite using:

- Non-BAM-compliant vegetation mapping
- Simplified flood extent modelling
- Late-2022 offset prices
- Exclusion of some biodiversity values (e.g. aquatic and fish habitat)

The downstream biodiversity offset cost calculated for the Wyangala Final Business Case rendered the project unviable. These estimates were acknowledged as incomplete and likely understated, with further refinement expected to increase costs.

Early rough estimates significantly understated the true exposure and did not provide a reliable basis for investment decisions.

Like-for-like offsets may not exist

Agency feedback regarding Wyangala was explicit that:

- Many impacted wetlands were unique systems of state, national and international significance
- Like-for-like offsets were unlikely or impossible to secure
- Payment into the Biodiversity Conservation Fund represented the highest-cost and least certain option

This means offset estimates are not just about price per credit, but about whether offsets are feasible at all.

Other key challenges

Poor mitigation effectiveness

Multiple mitigation options were explored to address downstream impacts. Findings included:

- No mitigation option achieved a material reduction in prescribed impacts
- Some mitigation options significantly reduced the additional water benefits, undermining the project rationale

- Agencies did not identify credible alternative mitigation measures

For projects reliant on flow capture or altered release regimes, mitigation may not be practicably available to offset downstream ecological impacts.

Strong regulatory agency opposition

Feedback from BCS, Fisheries and Commonwealth DCCEEW included:

- Characterisation of impacts as serious and irreversible
- Conclusion that the project would not meet no reduction requirements for Planned Environmental Water
- View that like for like offsets were unlikely or impossible for unique wetland environments
- Expectation of even more detailed modelling to conclusively assess impacts

Approval pathway complexity

The project required concurrent approval under:

- NSW EP&A Act
- Commonwealth EPBC Act
- NSW Water Management Act
- Commonwealth Water Act

Based on assessment outcomes and agency advice, the project team concluded approval was unlikely, with no known precedents for resolving these issues at the Final Business Case stage.

Why Wyangala is a critical precedent

The Wyangala Dam Raising Project highlights the scale of complexity, uncertainty and risk associated with assessing and offsetting downstream biodiversity impacts driven by altered hydrology, particularly where impacts trigger prescribed impacts rather than direct vegetation clearing.

Despite extensive investigation and mitigation efforts, the project ultimately concluded that approval was unlikely due to serious and irreversible downstream biodiversity impacts.

Overall Implication for Similar Projects

Based on the Wyangala experience, proceeding with options that:

- materially alter downstream flood regimes,
- rely on prescribed impact assessments,
- affect large, sensitive floodplain and wetland systems,

is not advised, due to:

- High assessment complexity and cost
- Long and uncertain timeframes
- Limited or ineffective mitigation options
- Extremely high offset liabilities which are economically prohibitive
- Low likelihood of regulatory approval