

NSW Government response

Office of Chief Scientist and Engineer
independent review into the 2023 fish deaths in
the Darling–Baaka River at Menindee

June 2024

dcceew.nsw.gov.au





Acknowledgement of Country

The Department of Climate Change, Energy, the Environment and Water acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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NSW Government response

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Cover image: Aerial view of Menindee Lakes

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Introduction

In November 2023, the NSW Government issued its initial response to the Office of the NSW Chief Scientist and Engineer’s independent review regarding the 2023 fish deaths in the Darling–Baaka River at Menindee (the Review Report). The NSW Government’s full response to the Review Report is outlined in this document.

The Office of the NSW Chief Scientist and Engineer carried out an extensive investigation into the mass fish death incident that occurred in March 2023, as well as earlier events. The Review Report established that hypoxia—resulting from low dissolved oxygen in the water column—was the most likely proximate cause of fish death. The Review Report also outlined that the low dissolved oxygen conditions were driven by a combination of factors including high fish and algal biomass, poor water quality, reduced inflows and high temperatures and that the lack of fish passage options resulted in fish accumulating in the Menindee weir pool.

Consistent with the NSW Government’s initial response, we acknowledge the findings and accept the recommendations made by the Office of the NSW Chief Scientist and Engineer. The Government’s full response is outlined in the following chapters. It includes a progress update on the immediate actions from our initial response and advice on further actions we are undertaking or have planned, to reduce the risk of further mass fish deaths and remediate decades of damage to the Darling–Baaka River ecosystem.

The NSW Government’s actions over summer mitigated further fish deaths

The NSW Government’s initial response to the Review Report committed us to 10 immediate actions. These were guided by the Office of the NSW Chief Scientist and Engineer’s recommendations and aimed to mitigate the risk of further fish deaths at Menindee and the Lower Darling–Baaka over the 2023–24 summer period. Key actions included managing flows from the Menindee Lakes to maintain sufficient dissolved oxygen levels for fish, appointing a Menindee-based Senior Water Implementation Officer to improve local communication, undertaking on-ground water monitoring, upgrading water quality monitoring infrastructure, and scoping options for fish passage solutions and enhancing river connectivity.

Having taken these actions we saw immediate results. Improved water quality monitoring and the continuation of strategic releases of water from Menindee Lakes contributed to maintaining sufficient dissolved oxygen content in the Menindee weir pool¹, which successfully prevented critical hypoxic conditions on at least eight occasions.

¹ The terms “Menindee weir pool” and “Weir 32 weir pool” are used interchangeably in the Review Report and literature. For consistency the NSW Government response will only refer to the “Menindee weir pool”.

Despite these efforts, in late February and early March 2024, the Menindee weir pool experienced a smaller-scale fish death event. It is estimated that more than a thousand fish died, predominantly golden perch. We have undertaken extensive analysis of affected fish to investigate potential causes of death, with assessments confirming the presence of bacteria and internal and external parasites, including a parasitic anchor worm in significant numbers within the fish samples. Although these parasites typically do not directly cause fish deaths, their abundance can signal stress conditions in the fish population. Notably, no indications of hypoxia were observed in the examined fish samples, and no single factor has been identified as the cause of death. It is likely the combined impact of variable water quality over recent years, elevated temperatures over summer and the ongoing impacts of recent mass fish death events are contributing to broader impacts on the health of golden perch in the Menindee weir pool, making them more susceptible to a range of diseases and parasites.

This incident serves as a stark reminder of the challenging conditions and the multiple stressors that regularly impact the riverine environment around Menindee. It also reinforces the urgency for long-term action to improve water quality and connectivity in the Darling–Baaka system.

The NSW Government is committed to rehabilitating the Darling–Baaka

The NSW Government acknowledges what the local community and traditional owners have known for many years, that the Darling–Baaka River is sick. Over decades, human activities have changed the river's flow and reduced connectivity, while growing industries have extracted increasing volumes of water. Now, the river and the communities that rely on the Darling–Baaka economically, socially, and spiritually face a future where climate change is expected to result in hotter summers, longer droughts, uncertain rainfall and further deterioration of river health if mitigating measures are not implemented.

It has taken generations for the river to reach its current degraded state, and it will take many years to bring it back to consistent good health. However, with the response actions outlined in the following chapters, the NSW Government is building a strong foundation to rehabilitate the Darling–Baaka.

The NSW Government has examined all the recommendations in the Review Report and is implementing, or has agreed to implement, the substantive actions suggested by the Office of the NSW Chief Scientist and Engineer. This means a suite of short, medium, and long-term actions to:

- strengthen the regulatory environment
- enhance water quality and improve river system health outcomes at a catchment scale
- review and amend water sharing rules to ensure that there is enough water in the river to sustain fish, humans and stock during critical dry periods
- expand the water quality sensor network to monitor river health
- improve water data collection, management, and transparency to ensure NSW Government and the community have the right data to inform water management decisions
- overhaul the NSW Government's emergency response with a Menindee-specific Mass Fish Death Response Sub Plan, clearly explaining trigger points, agency and community responsibilities, resourcing, and assets in the event of an incident.

Despite our best efforts, we must acknowledge the challenging conditions in which these actions are being implemented and that we are likely to still see fish death incidents around Menindee during low-flow periods or blackwater events, especially until fish passage is improved. The NSW Government does however have a solid plan to improve water quality and mitigate risks at the Menindee Lakes and in the Barwon–Darling catchment and makes a commitment to improving and strengthening communications and engagement with the local community.

Beyond Menindee, we are committed to regulatory and governance improvements that will address riverine water quality risks across NSW. By planning for sustainable, long-term solutions that strengthen the health of our rivers and river ecosystems, we hope to reduce and prevent water quality incidents and more costly short-term emergency measures.

Our commitments are backed with significant funding

The NSW Government has committed \$25 million in new funding over 4 years for the actions outlined in this full response. This investment complements existing funded reforms and programs underway across multiple NSW government and non-government agencies that are involved in water and environmental management.

Several proposed initiatives include new technology and infrastructure, so trials and careful investigation are essential to avoid the risk of major investments in costly and ineffective solutions. The measures outlined in this response aim to create a responsible package that ensures the regulatory, institutional, and funding mechanisms necessary for enhancing water quality and river health are well targeted.

It is important to note that the funding commitment does not include construction and installation costs for permanent fish passage in Menindee and the Lower Darling–Baaka. Additional investment will be required for these activities based on the full business case that will be prepared (refer FR23 for details).



Water quality conditions at Menindee

Between November 2023 and June 2024, Menindee encountered a hot and at times wet summer. Daytime temperatures consistently lingered in the mid-30°C range, with several instances of days in the 40°Cs, while nights remained mild, with lows averaging about 19°C. Maximum and minimum temperatures were generally 1-2°C above the long-term average for this period. There were several significant rainfall events, with November 2023 and January 2024 recording above average rainfall totals of 80.2 mm and 53.4 mm respectively, while the other months were much drier than average.

Water quality monitoring throughout this period revealed that dissolved oxygen levels in the Darling-Baaka River at Menindee remained above critical thresholds for fish health, noting that fish deaths of predominantly golden perch were experienced during this time as mentioned above. NSW Government agencies carefully monitored conditions and strategically released water from Lake Pamamaroo and Lake Menindee to improve dissolved oxygen throughout the water column within the Menindee weir pool to support fish health.

Algal blooms within the Menindee Lakes system – the lakes themselves and Menindee weir pool – as well as the Lower Darling-Baaka River continued to persist from the end of summer into winter. Environmental inflows from the Barwon-Darling were released from Menindee Lakes in June 2024 to improve connectivity between the northern and southern Basin. An additional benefit of this trial was the ability to release better quality water from Lake Wetherell into the Menindee weir pool so it could flow downstream thereby replacing the algae-rich water with more turbid water with lower algae concentrations.

Several water quality and fish survival challenges were, and will continue to be, an issue:

- **Temperature increases:** During summer, heating of surface water caused rapid progress of stratification in the water column. Water releases were undertaken to promote the mixing of the water and, in turn, mix the dissolved oxygen in the water column early enough to ensure that mixing didn't result in levels that were critical for fish survival. Having access to water to undertake this action was critical over the summer months.

- **Algal blooms:** There will be times when algal blooms are present within the lakes and river system. However, as recently experienced, these can last for many months and significantly affect domestic and stock use. The ability to address persistent algal blooms is limited given water needs to be available to use as well as be accounted for against a water account.
- **Weirs affecting fish migration:** Populations of fish, particularly bony herring and carp, experienced a boom over the last 3 years and were trapped between the Main Weir and Weir 32 due to the lack of fish passage for moving upstream of the Menindee weir pool.

In the long term, climate modelling published by AdaptNSW suggests that climate change will bring substantial changes to the Far West region of NSW. By 2030, the region is expected to experience a rise of approximately 0.7°C in maximum temperatures, with this warming trend persisting and reaching an average increase of about 2.1°C by 2070. Although long-term rainfall projections remain uncertain, the indication is for drier conditions. The future for water catchments in the Far West region, including the Darling-Baaka, entails coping with escalating temperatures, increased evaporation rates, modified rainfall patterns, and a high probability of enduring prolonged droughts.

Responsible agency

The NSW Government has assigned the Water Group in the NSW Department of Climate Change, Energy, the Environment, and Water to oversee the implementation of this response to the Review Report and to keep the government and community informed with timely updates. However, rehabilitating the Darling-Baaka is a whole-of-government responsibility, and actions will be led by multiple agencies, including the department's Biodiversity, Conservation and Science Group, NSW Environment Protection Authority (NSW EPA), Department of Primary Industries - Fisheries (DPI Fisheries), NSW Premier's Department, WaterNSW, and Local Land Services.

We will continue to work closely with Australian Government agencies, such as the Murray-Darling Basin Authority (MDBA) and Commonwealth Environmental Water Office (CEWO), as well as local governments, which all have critical roles to play in a comprehensive response and solution.

Reporting and next steps

Table 1 consolidates details for accountability, forming the NSW Government's implementation plan of works to comprehensively respond to, and address each recommendation in the Review Report.

The Water Group will publish half-yearly updates from all NSW Government agencies on the progress of actions in this response on the department's [website](#).

Implementation Plan

Table 1. NSW Government implementation plan

Full Response no.	Action / Commitment	OCSE Recommendation	Budget funding (new unless indicated)	Lead agency	Delivery timeframe
FR1	Develop an Integrated Catchment Management Work Program	Recommendation 1	\$1.71 million	Water Group	30 June 2026
FR2	Make amendments, having considered the independent Connectivity Expert Panel's final report, to water sharing plans in the following northern valleys: NSW Border Rivers, Gwydir, Namoi, Macquarie and Barwon-Darling	Recommendation 1.2	Existing budget commitment, noting that additional investment may be needed depending on the extent of changes to be made	Water Group	31 December 2025

Full Response no.	Action / Commitment	OCSE Recommendation	Budget funding (new unless indicated)	Lead agency	Delivery timeframe
FR3	Make amendments, having considered the independent Connectivity Expert Panel's final report and the Natural Resources Commission's final report, to the Water Sharing Plan for the Murray and Lower Darling Regulated River Water Sources 2016	Recommendation 1.3	Existing budget commitment, noting that additional investment may be needed depending on the extent of changes to be made	Water Group	30 June 2026 unless an extension is granted to 30 June 2028
FR4	Identify and seek improvements to the operating arrangements for the Menindee Lakes to better mitigate environmental incidents arising from declining water quality, including actively engaging in the scoping and delivery of a review requested by the Basin Officials Committee (BOC)	Recommendations 1.4, 1.5	Existing budget commitment	Water Group	NSW will input into the BOC review, to be scoped by July 2024, with delivery of the review in a timeframe to be advised. NSW may also pursue further opportunities for improvements including through actions outlined in 1.3, 1.4 and 1.5.
FR5	Review and update the Menindee water quality incident action plan	Recommendation 1.6	Existing budget commitment	Water Group	30 November 2024
FR6	Complete the review of the Water Quality Incident Management Plan-hypoxic events for managing low dissolved oxygen to reflect water quality issues and mass fish deaths observed in 2022-23 and 2023-24	Recommendation 1.7	Existing budget commitment	Water Group	31 October 2024

Full Response no.	Action / Commitment	OCSE Recommendation	Budget funding (new unless indicated)	Lead agency	Delivery timeframe
FR7	Develop a new NSW water quality monitoring framework	Recommendation 2	\$1.05 million, noting additional investment will be required for implementation	Water Group	30 June 2025
FR8	Conduct a Menindee weir pool scientific study on the impacts of the 2023 mass fish death on water quality in Menindee weir pool; develop a hydrodynamic model to aid water management decision making at Menindee; and purchase dissolved oxygen buoys and data loggers	Recommendation 2	\$2.92 million	Water Group	30 June 2025
FR9	Maintenance and operation of existing dissolved oxygen sensors in the Menindee weir pool, and additional water quality sampling as required	Recommendation 2	\$1 million	WaterNSW	30 June 2028
FR10	Complete the installation of the initial 40 water data monitors in high-risk areas to provide real-time data on dissolved oxygen levels	Recommendation 2.2	Existing budget commitment	Water Group	30 June 2025
FR11	Develop and publish a Menindee-specific Mass Fish Death Response Sub Plan consistent with Recommendations 3.1 (a)-(g)	Recommendation 3.1	\$4.49 million	EPA - Environmental Services Functional Area	31 December 2024

Full Response no.	Action / Commitment	OCSE Recommendation	Budget funding (new unless indicated)	Lead agency	Delivery timeframe
FR12	Test the interim NSW Mass Fish Death Response Sub Plan at Menindee consistent with the Local Emergency Management Committee Exercising Toolkit – Spontaneous Volunteers	Recommendations 3.2 and 3.7	Existing budget commitment	EPA – Environmental Services Functional Area	30 June 2024
FR13	The Menindee-specific Mass Fish Death Response Sub Plan is tested by the Central Darling Local Emergency Management Committee and NSW Government agencies	Recommendations 3.2 and 3.7	Part of \$4.49 million for recommendation 3.1	EPA – Environmental Services Functional Area	30 June 2025
FR14	Update the Local Emergency Management Committee Information Guide	Recommendation 3.3	Part of \$4.49 million for recommendation 3.1	NSW Premier’s Department	30 June 2024
FR15	Complete a resource review as part of the preparation to develop the Menindee-specific Mass Fish Death Response Sub Plan	Recommendation 3.5	Part of \$4.49 million for recommendation 3.1	EPA – Environmental Services Functional Area	31 October 2024
FR16	Complete a capability assessment of the emergency services functions and resources (assets/equipment) in Menindee, Central Darling Shire local government area, and the Far West Emergency Management Region	Recommendation 3.6	Part of \$4.49 million for recommendation 3.1	NSW Premier’s Department	31 August 2024
FR17	Confirm the lead agency for communications (Public Information Services Functional Area) and communications plan under the Menindee-specific Mass Fish Death Response Sub Plan	Recommendation 3.9	Part of \$4.49 million for recommendation 3.1	EPA – Environmental Services Functional Area	31 December 2024

Full Response no.	Action / Commitment	OCSE Recommendation	Budget funding (new unless indicated)	Lead agency	Delivery timeframe
FR18	Improved and ongoing non-emergency communications and engagement plan in the Menindee region that addresses the regional requirements of the community, the proactive release of information, and includes community consultation and feedback (such as two-way communication)	Recommendation 3.9	Ongoing (business as usual)	Water Group and WaterNSW	Ongoing
FR19	Deliver enhanced education materials and links to relevant information on partner websites from the Water Group website	Recommendation 3.10	Existing budget commitment	Water Group	31 December 2024
FR20	Complete the trial and evaluate the feasibility of oxygenation infrastructure	Recommendation 4c	\$1.6 million existing budget commitment, noting that the ongoing use of oxygenation technology may require additional investment	WaterNSW	30 September 2024
FR21	Complete a trial of new fish passage technologies including the tube fishway with fish sorting opportunities	Recommendation 4e	\$6.52 million	DPI Fisheries	30 June 2028
FR22	Complete replacement of existing fishway at Burtundy Weir	Recommendation 4 mid-term	\$6 million Australian Government commitment	DPI Fisheries	31 December 2026
FR23	Deliver a full business case for permanent fish passage in the Menindee Lakes and Lower Darling-Baaka below Menindee	Recommendations 4 mid-term, 4.1 mid-term actions	\$6 million	Joint lead of WaterNSW as asset owner and DPI Fisheries as client for fish health outcomes	30 June 2027

Full Response no.	Action / Commitment	OCSE Recommendation	Budget funding (new unless indicated)	Lead agency	Delivery timeframe
FR24	Develop a Native Fish Recovery and Resilience Program, initially focused on a strategic plan for on-ground rehabilitation works along the Darling-Baaka to improve water quality and ecological outcomes	Recommendation 4 mid-term	\$0.6 million, noting that additional investment will be required for implementation	Western Local Land Services/ DPI Fisheries	30 June 2026
FR25	Support the Australian Government and states and territories to deliver the National Carp Control Program (NCCP) and address outcomes of a national integrated invasive fish species management strategy	Recommendation 4 mid-term	Existing budget commitment	DPI Fisheries	To be confirmed, noting that the Australian Government's Department of Climate Change, Energy, the Environment and Water is leading this work
FR26	Scope "trap and transport" by fish sorting as part of Action: FR21 Complete a trial of new fish passage technologies including the tube fishway with fish sorting opportunities	Recommendation 4.1 immediate term	Part of \$6.52 million for recommendation 4e	DPI Fisheries	30 June 2028

Actions delivered in the first 6 months of our response

Following the 2023 fish deaths and the subsequent Office of the NSW Chief Scientist and Engineer's review, the NSW Government promptly implemented immediate actions to mitigate the risk of further fish deaths. An outline of these actions was contained in the NSW Government's initial response to the review report, published in November 2023 and available [here](#).

These actions have successfully contributed to avoiding hypoxic events on at least eight occasions at Menindee over the summer of 2023–24.

Table 2 provides an update on the actions committed to in the NSW Government's initial response. Some of these actions are now complete and some of these actions remain underway. Actions identified in the initial response that remain underway and new actions that are being committed to through this response are covered in the implementation plan in Table 1 and in more detail in the sections below.



What is being delivered in the first 12 months of our response

Figure 1. Summary of actions over 12 months

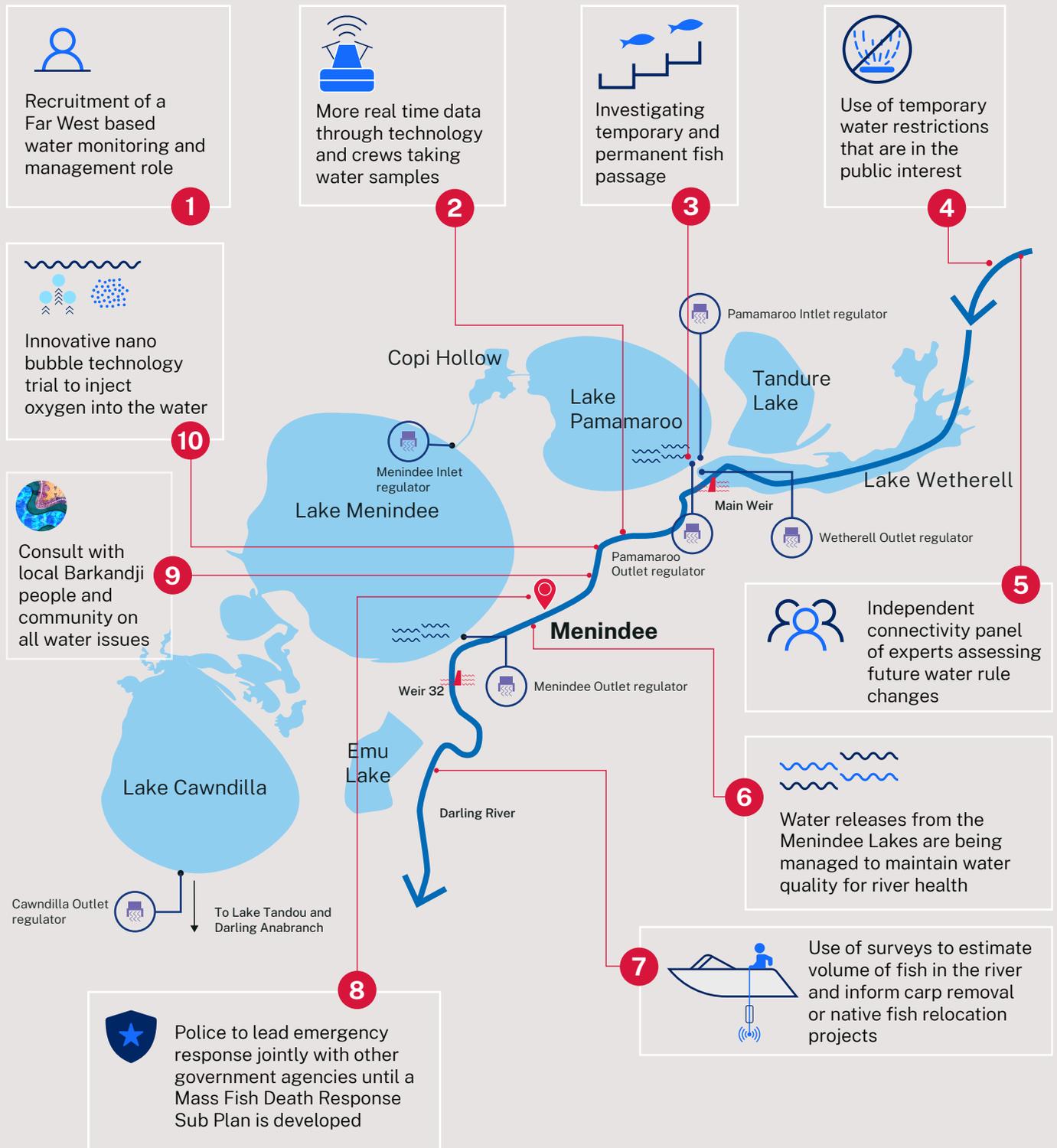


Table 2. Status update of immediate actions in the NSW Government's initial response

Initial action no.	Action / Commitment	OCSE Recommendation	Budget funding	Lead agency	Status
IR1	<p>Employ staff based in Far West NSW:</p> <p>The NSW Government has been holding regular listening and update sessions with the Menindee and Lower Darling–Baaka community. We have heard that staff based in the local community will help improve communication with government. We have advertised for the role of Senior Water Implementation Officer, based in Far West NSW, to better connect with the community on water quality and water management issues and incorporate local knowledge.</p>	Supports all recommendations	Existing budget commitment	Water Group	<p>Complete</p> <p>The NSW Government has employed a Senior Water Implementation Officer based in Menindee.</p> <p>See response to Recommendations 1 and 3.</p>
IR2	<p>Better data to inform decisions over summer:</p> <p>The NSW Government has already installed a telemetered buoy to provide real time data on water quality and guide decisions. Another two buoys will be installed this year. Government agencies are also deploying a monitoring crew twice a week to undertake on–ground sampling of the water. The WaterInsights Portal is progressively making all routinely collected open–source data publicly available in near–real time to the public in one location.</p> <p>This includes data for dissolved oxygen levels and water temperature to allow agencies to better forecast and respond to deteriorating water quality conditions.</p>	Recommendation 2	Existing budget commitment	Water Group	<p>Complete, with ongoing review and evaluation</p> <p>Biodiversity, Conservation and Science Group, and WaterNSW have installed multi–depth monitoring buoys in the Menindee area.</p> <p>Crews from several NSW agencies including WaterNSW, DPI Fisheries, Biodiversity, Conservation and Science Group and Essential Water have been collecting additional data on water quality, fish community and town water supply.</p> <p>Investment will be made to improve the water data framework, transparency and access.</p> <p>See response to Recommendation 2.</p>

Initial action no.	Action / Commitment	OCSE Recommendation	Budget funding	Lead agency	Status
IR3	<p>Fish passage:</p> <p>The NSW Government has secured a commitment from the Australian Government of \$2.3 million to support NSW progressing planning for permanent fish passage solutions at Menindee Lakes and the Lower Darling–Baaka River. Permanent fish passage solutions can take years to implement. In the short term, we are investigating the feasibility of temporary fish passage solutions and are seeking community views on temporary fish passage options. We will also remove the remainder of Old Town Weir from the weir pool in winter 2024, subject to environmental conditions at that time, to help improve flows in the Lower Darling–Baaka River</p>	Recommendation 4	Existing budget commitment, including \$2.3 million from the Australian Government to support NSW progressing planning for permanent solutions	DPI Fisheries and WaterNSW Water Group are leading removal of Old Town Weir	<p>On track</p> <p>Investigations and planning for both short term and long–term fish passage options are in progress.</p> <p>See response to Recommendation 4.</p>
IR4	<p>Embargoes:</p> <p>The NSW Government will implement temporary water restrictions under section 324 of the <i>Water Management Act 2000</i> to restrict low priority licences as drier conditions escalate, when it is in the public interest. We will proactively communicate when these restrictions will be put in place to allow businesses and the community to plan and respond to the restrictions. We will remove reliance on embargoes once enduring changes are made to water sharing plans to better protect downstream flows in response to Recommendation 1 of the Review Report.</p>	Recommendation 1	Existing budget commitment	Water Group	<p>Not required</p> <p>Temporary water restrictions were not needed during summer 2023–24. Section 324 orders remain a statutory tool that can be used if needed.</p> <p>The work of the independent Connectivity Expert Panel, and any subsequent changes to northern water sharing plans will provide an enduring solution so that temporary water restrictions are no longer required.</p>

Initial action no.	Action / Commitment	OCSE Recommendation	Budget funding	Lead agency	Status
IR5	<p>Rule changes:</p> <p>The NSW Government has set up an independent Connectivity Expert Panel to provide recommendations on changes needed to NSW water sharing plans to improve downstream outcomes. Water sharing changes resulting from this work will be consulted on in 2024 with the necessary amendments to water sharing plans made by the end of 2025. Other rule changes will also be investigated as part of the current review of the Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016.</p>	<p>Recommendations 1.1 and 1.3</p>	<p>Existing budget commitment</p>	<p>Water Group</p>	<p>On track</p> <p>The Panel’s terms of reference have been expanded to examine the adequacy of rules in relevant unregulated northern Basin water sharing plans in contributing to hydrological connectivity with the Lower Darling–Baaka River and southern Basin.</p> <p>The panel’s interim findings and recommendation report was released in April 2024 and the final report will be provided to the Minister in July 2024.</p> <p>The NRC have brought forward their review of the Water Sharing Plan for the Murray and Lower Darling Regulated River Water Sources 2016 and will focus on its adequacy to meet environmental and water quality objectives.</p> <p>These actions will inform changes to water sharing plans for the NSW northern Basin catchments–NSW Border Rivers, Gwydir, Namoi, Macquarie and Barwon–Darling by the end of 2025 and subsequent changes to the Murray–Lower Darling water sharing plan in the southern Basin.</p> <p>See response to Recommendation 1.</p>

Initial action no.	Action / Commitment	OCSE Recommendation	Budget funding	Lead agency	Status
IR6	<p>Water releases:</p> <p>The NSW Government has been actively managing and modifying releases from Lake Pamamaroo to maintain water quality in the Menindee town weir pool and reduce the risk of more mass fish deaths. The Menindee/Lower Darling Water Quality Working Group (Working Group) continues to monitor water quality including dissolved oxygen levels and temperature in the Menindee Lakes system. As conditions dry, adaptive decisions will be made on when to reduce water releases and conserve the remaining water for drought security. We will continue monitoring conditions and provide the community with early communications on any decisions to release or hold back water, as well as implement drought preparedness activities as needed.</p>	<p>Recommendations 1.6 and 3</p>	<p>Existing budget commitment</p>	<p>Water Group</p>	<p>On track</p> <p>Water releases have been actively managed and communicated to WaterNSW to deliver, at the recommendation of the Menindee/Lower Darling Water Quality Working Group.</p> <p>Development of water quality triggers to guide when a change in releases from the top Lakes are needed to minimise risk of fish deaths in the Menindee town weir pool are now complete. However, conditions in the weir pool remain dynamic and there may be other situations where a change to the documented release strategies are recommended, noting that releases above minimum requirements can only be made when additional water is available and can be accounted for against a licence's water allocation account.</p> <p>Recommendation 1.3 has brought forward the review of the Water Sharing Plan for the Murray and Lower Darling Regulated River Water Sources 2016, with the intent that this reduces the amount of active management that is required to address water quality issues.</p> <p>See response to Recommendations 1 and 3.</p>

Initial action no.	Action / Commitment	OCSE Recommendation	Budget funding	Lead agency	Status
IR7	<p>Fish surveys:</p> <p>The NSW Government has undertaken preliminary surveys to estimate the volume (biomass or equivalent metric) of fish in the Menindee town weir pool. The results of these surveys and existing knowledge of the habitat and fish community will inform actions such as removing carp and relocating native fish. We will explore opportunities to remove or relocate fish in partnership with local businesses, community groups and River Rangers.</p>	Recommendation 4	Existing budget commitment	DPI Fisheries	<p>Complete</p> <p>Preliminary surveys to estimate the composition of fish community in the Menindee town weir pool including the numbers of fish, species composition and their biomass were completed by the end of December 2023.</p> <p>A removal and relocation program was not needed during summer 2023–24.</p> <p>See response to Recommendation 4.</p>
IR8	<p>Emergency response:</p> <p>The NSW Government will develop protocols and interim responses for when an emergency will be triggered if water quality drops over summer. Ahead of a Mass Fish Death Response Sub Plan being prepared, the NSW Environment Protection Authority (EPA), will develop an interim response plan by the end of 2023. Unless otherwise specified by the Sub Plan, the NSW Police Force will lead the emergency response for any mass fish death events over summer as the Emergency Operations Controller (EOCON) in accordance with emergency management arrangements.</p> <p>NSW Police to lead emergency response jointly with other government agencies until a Mass Fish Death Response Sub Plan is developed</p>	Recommendations 3, 3.1 and 3.2	Existing budget commitment	NSW Police NSW EPA	<p>Complete</p> <p>The NSW EPA developed an interim Mass Fish Death Response Sub Plan by the end of 2023 which provides for NSW Police to lead an emergency response. It was not needed during summer 2023–24.</p> <p>See response to Recommendation 3.</p>

Initial action no.	Action / Commitment	OCSE Recommendation	Budget funding	Lead agency	Status
IR9	<p>Aboriginal engagement:</p> <p>The NSW Government will work with the Barkandji people to understand the community's cultural water objectives, explore options for water access and ownership and establish monitoring mechanisms. As a first step, the Water Group of the Department of Planning and Environment (DPE Water) is working with Aboriginal people and community groups to develop six pilot cultural watering plans. The results of these cultural watering plans will inform a broader program across NSW.</p>	Recommendations 1 and 2	Existing budget commitment	Water Group	<p>On track</p> <p>Consultation has been adopted as business as usual and will be ongoing.</p> <p>Water Group's Aboriginal Water Program team is working with 6 diverse Aboriginal community groups across NSW to develop <u>Cultural Watering Plans</u> for their communities.</p> <p>NSW EPA's Baaka River Recovery Project integrates Aboriginal cultural knowledge and values into river health monitoring and disaster recovery under an agreement with the Barkandji Native Title Prescribed Body Corporate.</p> <p>The Darling Baaka River Health Project, led by the Biodiversity, Conservation and Science Group also delivers cultural monitoring by the Barkandji Rangers and engagement with the Barkandji community and complements other aquatic investment and activities.</p> <p>See response to Recommendations 1–4.</p>
IR10	<p>Increasing oxygen in the water:</p> <p>The NSW Government will trial innovative nano-bubble technology in the Menindee town weir pool to help inject oxygen into the water.</p>	Recommendation 4	Existing budget commitment	WaterNSW	<p>On track</p> <p>One micro-bubble unit was installed in January 2024 and is currently being trialled.</p> <p>See response to Recommendation 4.</p>

Full response and detailed actions

The NSW Government supports in full, in part or in-principle all the recommendations made by the Office of the NSW Chief Scientist and Engineer in its Review Report.

The following sections articulate the NSW Government's full response to Recommendations 1–4 in the Review Report. Each response outlines the actions that are underway and new actions that are being committed to for the future, new funding allocated in the NSW 2024-25 budget, the lead agency responsible for executing the action, and the timeframe for completion.



Recommendation 1:

Regulatory environmental protections must be enforced

OCSE Recommendation 1:

Regulatory environmental protections must be enforced

The regulatory framework must be upgraded to include legally enforceable obligations and powers to give effect to environmental protections and whole of catchment ecosystem health, as expressed in the objects of water, environmental and biodiversity legislation. Changes should:

- a. draw on scientific, cultural and local community insights and be developed in partnership with these knowledge communities
- b. address risks to the Lower Darling–Baaka and its water-dependent ecosystems
- c. be informed by an independent review of existing water rights, water accounting systems, exercise of rules and operational parameters, and their impact on riverine catchment health. This includes provisions in Water Sharing Plans to improve water flow across the system
- d. be based on much improved real-time data and monitoring of the whole river system.



Support

The NSW Government is investing \$1.71 million over 2 years to develop an Integrated Catchment Management Work Program (Figure 2) for a new, enhanced integrated catchment management framework and governance model.

Integrated catchment management is an approach to coordinating the management of land use, water and natural resources across a catchment to improve ecosystem outcomes. It involves integrating policy frameworks across land use planning, water planning, biodiversity and other natural resources, which all influence water quality and water availability in a catchment. Water catchments are recognised as interdependent socio-ecological systems to assess the cumulative impacts of land use on water resources, with a recognition that upstream impacts and activities beyond the riverbank influence downstream waterway health.

Over the next 2 years, an Integrated Catchment Management Work Program will develop critical reforms aimed at enhancing water quality and improving river system health outcomes at a catchment scale and is intended to deliver sustained focus on:

- improving water quality and catchment management with clearer governance and accountabilities and reduced duplication between agencies
- enhancing policy, regulatory and legislative frameworks (including the *Water Management Act 2000*) to improve water quality outcomes
- better connecting land use planning and water management by improving water quality considerations within environmental planning instruments
- addressing the divergence in focus on water quality across the disciplines of land use planning, water planning and natural resource management and across geographical scales (such as inland/coastal/groundwater).

This work aligns with the [NSW Water Strategy](#) commitment to adopt a more intense, statewide focus to enhance water quality outcomes. The value of an integrated catchment management approach has been recognised in various reports and analyses undertaken, including the [NSW Productivity Commission White Paper 2021](#) and, more recently, work undertaken as part of the NSW Water Strategy and the NSW Government's Water Quality Governance Roadmap, which identifies transitioning to an integrated catchment management approach as a key pathway towards improving water quality governance arrangements in NSW.

The statewide Integrated Catchment Management Work Program will be led by the Water Group in close consultation with key agencies involved with land use planning, water planning and natural resource management in NSW including the department's Biodiversity, Conservation and Science Group, NSW EPA, Local Land Services, DPI Fisheries and Agriculture, Department of Planning, Housing and Infrastructure – Planning, NSW Health, NSW state owned corporations and local water utilities. Development will also involve extensive consultation with a variety of stakeholders. Key reform options will be confirmed by 30 June 2026, with additional funding and resources needed to implement actions to deliver the preferred reform option(s) in the future.

As flagged in the NSW Government's initial response, an independent review has been completed of water and land use legislation and its impact on riverine health in the Darling–Baaka. The review is an accelerated deliverable of the Integrated Catchment Management Work Program and, together with learnings from existing NSW water quality governance initiatives and interjurisdictional approaches, will inform the options analysis and assessment of potential future catchment planning and governance models.

The NSW Government will take the following actions to deliver Recommendation 1:

Action: FR1 **Develop an Integrated Catchment Management Work Program to identify critical reforms aimed at enhancing water quality and improving river system health outcomes at a catchment scale**

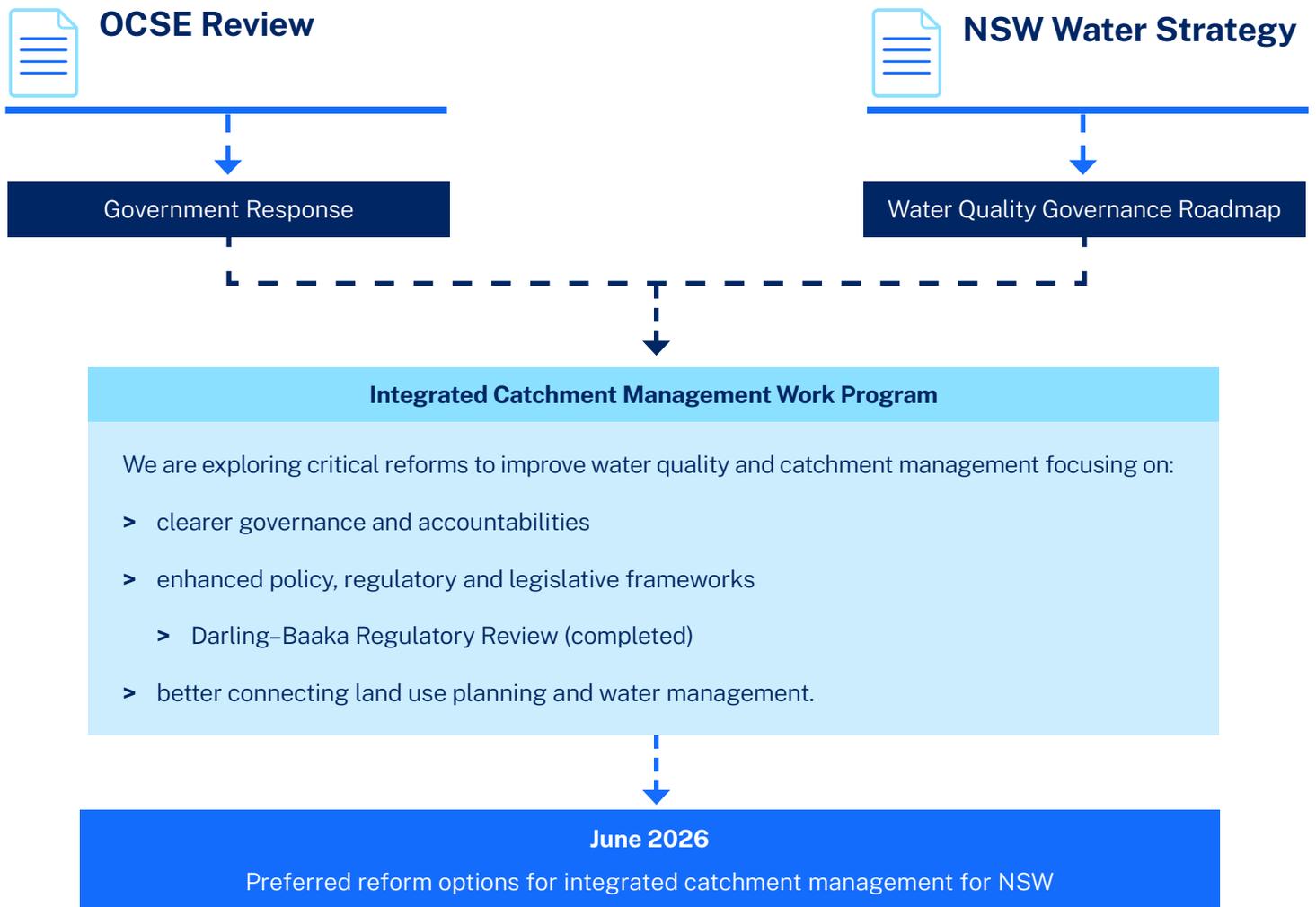
Rec(s): 1

Funding: \$1.71 million new budget commitment, noting that additional investment will be required to implement reform options

Lead agency: Water Group

Delivery timeframe: 30 June 2026

Figure 2. Integrated Catchment Management Work Program



OCSE Recommendation 1.1:

Ensure the newly convened Connectivity Expert Panel examines the adequacy of rules in all northern Basin water sharing plans (regulated and unregulated) in contributing to hydrological connectivity with the Lower Darling–Baaka River and southern Basin.

Support – Complete

The NSW Government has delivered on Recommendation 1.1 by expanding the independent Connectivity Expert Panel's terms of reference to examine the adequacy of rules in relevant regulated and unregulated northern Basin water sharing plans in contributing to hydrological connectivity with the Lower Darling–Baaka River and southern Basin. The updated terms of reference are available on the department's [website](#).

The NSW Government is also continuing with the other components of the [Northern Basin Connectivity Program](#), which has existing funding of \$3.2 million up to 30 June 2025. The Northern Basin Connectivity Program is undertaking action to enable water to flow across connected catchments of the northern NSW Murray–Darling Basin and downstream at important times for the following outcomes:

- protect the first flush of water after an extended dry period to protect critical human and environmental needs and support recovery post droughts
- reduce the impact of cease-to-flow periods and improve low-flow connectivity
- support water quality and reduce the risk of algal blooms forming
- support fish migration.



OCSE Recommendation 1.2:

Prioritise changes to water sharing plans in the northern Basin based on findings of the Connectivity Expert Panel, with the intent of improving outcomes through the system including in the Lower Darling–Baaka River.

Support

The NSW Government is prioritising the consideration of changes to relevant water sharing plans in the northern Basin which will aim to improve outcomes through the system including in the Lower Darling–Baaka River. The independent *Connectivity Expert Panel Interim Report – March 2024* and recommendations were provided to the Minister for Water and published on 18 April 2024. The Panel is expected to provide its final report to the Minister for Water in July 2024. The NSW Government will consider the final report before making amendments to water sharing plans for the NSW northern Basin catchments – NSW Border Rivers, Gwydir, Namoi, Macquarie and Barwon–Darling, and Murray–Lower Darling in the southern Basin.

Proposed changes to the northern water sharing plans will undergo public consultation later in 2024, with the necessary changes to be made by the end of 2025. While the NSW Government intends to implement changes to water sharing plans through its existing budget for water sharing plan implementation, depending on the extent of changes to be made, additional funding and resources may be needed to support the Water Group and partner agencies. Actions relating to the Water Sharing Plan for the Murray and Lower Darling Regulated River Water Sources 2016 are detailed in Recommendation 1.3 below.

The NSW Government will take the following action to deliver Recommendation 1.2:

Action: FR2 **Make amendments, having considered the independent Connectivity Expert Panel’s final report, to water sharing plans in the following northern valleys: NSW Border Rivers, Gwydir, Namoi, Macquarie and Barwon–Darling**

Rec(s): 1.2

Funding: Existing budget commitment, noting that additional investment may be needed depending on the extent of changes to be made

Lead agency: Water Group

Delivery timeframe: 31 December 2025

OCSE Recommendation 1.3:

Prioritise the review of the Water Sharing Plan for the Murray and Lower Darling Regulated River Water Sources 2016 with a focus on the adequacy of Plan provisions for meeting environmental and water quality objectives.

Support

The review of the Water Sharing Plan for the NSW Murray and Lower Darling Regulated River Water Sources 2016 has been prioritised. The Natural Resources Commission (NRC) commenced their review in late 2023 following a request from the Minister for Water to bring the process forward and to assess the plan's effectiveness in achieving environmental and water quality objectives.

The NRC public comment period opened on 6 December 2023 and ended on 25 February 2024. The NRC is expected to share its draft report and recommendations with the NSW Government in Quarter 3 of 2024. The NRC's final report will be published on the NRC website.

The NSW Government will consider the NRC's report and prepare any required changes to the Water Sharing Plan for the NSW Murray and Lower Darling Regulated River Water Sources 2016. The Water Group intends to prepare changes to the northern water sharing plans by the end of 2025 (see response to Recommendation 1.2) and seek an extension to 30 June 2028 to replace the downstream Water Sharing Plan for the NSW Murray and Lower Darling Regulated River Water Sources 2016, which is due to expire in June 2026. This extension is required to ensure adequate time to understand how those changes will impact this plan and complement NSW's connectivity reforms. The usual public exhibition processes will apply to all proposed changes to these water sharing plans.

Action: FR3 **Make amendments, having considered the independent Connectivity Expert Panel's final report and the Natural Resources Commission final report, to the Water Sharing Plan for the NSW Murray and Lower Darling Regulated River Water Sources 2016**

Rec(s): 1.3

Funding: Existing budget commitment, noting that additional investment may be needed depending on the extent of changes required

Lead agency: Water Group

Delivery timeframe: 30 June 2026 unless an extension is granted to 30 June 2028

OCSE Recommendation 1.4:

Explore the extension of existing provisions for water releases when the lakes are under the direction of the MDBA that are currently only available when the combined volume of Menindee lakes is below 480 GL.

Support

The Basin Officials Committee (BOC) is a statutory body consisting of representatives from the Australian and basin states and territory governments. At their meeting on 22 November 2023, BOC agreed, in response to calls from NSW to manage ongoing water quality issues at Menindee, for the MDBA to adjust their operations to target a minimum of 195 GL of active storage in the upper Menindee Lakes when the Lakes fall below 480 GL total storage volume for the 2023–24 water year.

Operational arrangements beyond the 2023–24 water year will be considered as part of the BOC's agreement to review the operating arrangements of Menindee Lakes. At its meeting on 26 October 2023, BOC tasked the River Murray Operations Committee (RMOC), in consultation with the Environmental Water Committee (EWC) to scope the review by July 2024. RMOC and EWC are inter-jurisdictional committees that report to the BOC. NSW is an active participant in both forums, with NSW being represented by officials from the Water Group, the department's Biodiversity, Conservation and Science Group and WaterNSW.

In June 2024, BOC approved bringing forward a trial to recognise the additionally protected held environmental water (HEW) from active management rules in the northern Basin which has been protected into Menindee Lakes. An additional 45 GL of water was protected, and this water was released into the Lower Darling/Baaka to achieve connectivity from the northern Basin to the southern Basin. Further trials will occur over the next 12 months, as conditions provide, and then be evaluated to develop longer-term arrangements.

As part of the Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2016, when the water level in Menindee Lakes rises above 640 GL, and then remains above 480 GL, 30 GL of Environmental Water Allowance is available annually for the management of water quality (salinity, blue-green algal blooms and hypoxia) in the Lower Darling. Currently, the Environmental Water Allowance is not able to be used when the Menindee Lakes fall below 480 GL and reverts to NSW control. NSW will seek to explore changes to this provision as part of the review of the water sharing plan that is being undertaken under Recommendation 1.3.

Through these committee processes, the NSW Government will continue to work with Basin governments to closely consider the implications of changing operating arrangements to better address water quality in the Menindee weir pool, including broader ecological implications in other parts of the system including lakes Menindee and Cawndilla, and sustainable populations of native fish. NSW will actively engage in the review process in accordance with its determined scope and will seek input from relevant NSW agencies.

As noted in the initial NSW Government response, the release of operational water down the Great Darling Anabranch has the potential to save water in lakes Wetherell and Pamamaroo and provide for a higher drought reserve. The trial release of operational water via the Great Darling Anabranch in late 2023 was commenced by the MDBA. As wet conditions continued in the River Murray system and water was sufficient to meet downstream requirements under the Murray–Darling Basin Agreement, the trial was paused and not completed. The MDBA will provide interim accounting results to NSW on the partial trial and intends to resume the trial once there is a need to call on water from the Menindee Lakes system again.

Noting that delivery of long-term solutions to address Recommendations 1.4 and 1.5 requires interjurisdictional agreement and commitment, the NSW Government will take the following action to address Recommendations 1.4 and 1.5:

Action: FR4 Identify and seek improvements to the operating arrangements for the Menindee Lakes to better mitigate environmental incidents arising from declining water quality, including actively engaging in the scoping and delivery of a review requested by the Basin Officials Committee (BOC)

Rec(s): 1.4, 1.5

Funding: Existing budget commitment

Lead agency: Water Group

Delivery timeframe: NSW will input into the BOC review, to be scoped by July 2024, with delivery of the review in a timeframe to be advised. NSW may also pursue further opportunities for improvements including through actions outlined in 1.3, 1.4 and 1.5.

OCSE Recommendation 1.5:

In consultation with the MDBA, explore how the management of Menindee Lakes as a shared interjurisdictional resource can be better managed to mitigate water quality and fish deaths in Weir 32 weir pool (or Menindee weir pool).

Support

As outlined in response to Recommendation 1.4, the NSW Government is working closely with Basin jurisdictions and the MDBA to review the operation of Menindee Lakes as a shared interjurisdictional resource to mitigate poor water quality impacts and fish deaths in the Menindee weir pool and to trial the protection of environmental water flowing from the northern Basin into and through the Menindee Lakes system.

Use of the annual Lower Darling Environmental Water Allowance can support fish health impacted by river regulation at Menindee and in the Lower Darling–Baaka. The Environmental Water Allowance for 2023–24 was fully depleted on 16 February 2024 and held environmental water (predominantly sourced from The Living Murray licence) has been used to maintain flows above baseflows, when required, to maintain adequate levels of water quality in the Menindee weir pool.

The NSW Government has delivered a water quality incident action plan that was operational for summer 2023–24 to support improved operations of the management of the Menindee Lakes to mitigate against poor water quality and fish deaths. This plan was prepared by the Water Group in consultation with NSW and Australian Government agencies including the MDBA and the CEWO. During the MDBA’s call on water in 2023–24, the MDBA agreed for a portion of this water to be released from the upper lakes to improve water quality in the weir pool. See also response to Recommendation 1.6.



The Menindee Main Weir on the Darling River

OCSE Recommendation 1.6:

Develop triggers for when water is to be delivered from the upper lakes into Weir 32 Weir pool (or Menindee weir pool) for mitigating water quality issues and the risk of mass fish deaths recurrence.

Support – Complete

To address the immediate risk of poor water quality leading to further mass fish deaths in the Lower Darling–Baaka, the NSW Government delivered a water quality incident action plan that was operational for summer 2023–24. This action plan informed decisions by consensus of the Menindee/Lower Darling Water Quality Working Group (chaired and co-ordinated by the Water Group) to actively undertake variable water releases from the upper Lakes into the Menindee weir pool in response to specific water quality triggers which are based on data collected from 4 real-time water quality monitors located in the Lower Darling–Baaka and Menindee Lakes.

The action plan will be reviewed by the Water Group following learnings from the interventions to date and expanded to encompass additional early warning signals for fish deaths related to water quality by the end of November 2024 ready for summer 2024–25. Additionally, the terms of reference of the Working Group will be reviewed and updated, based on the experience of managing for water quality over the previous summer.

Even though this action is complete, the NSW Government will take the following action to strengthen its response to Recommendation 1.6:

Action: FR5 **Review and update the Menindee water quality incident action plan**

Rec(s): 1.6

Funding: Existing budget commitment

Lead agency: Water Group

Delivery timeframe: 30 November 2024

OCSE Recommendation 1.7:

Review the risk assessment and mitigation strategies for managing low dissolved oxygen included in the Murray and Lower Darling Water Quality Management Plan to reflect water quality issues and mass fish deaths observed in 2018–19 and 2022–23.

Support

The NSW Government has commenced a review of the Water Quality Incident Management Plan – hypoxic events, including mitigation strategies for managing low dissolved oxygen to reflect the issues and events in 2022–23 and 2023–24. The Water Group is leading the review in consultation with relevant agencies including WaterNSW, the department’s Biodiversity, Conservation and Science Group and DPI Fisheries, with the aim to have this complete by October 2024.

The NSW Government will take the following actions to deliver recommendation 1.7:

Action: FR6 Complete the review of the Water Quality Incident Management Plan – hypoxic events for managing low dissolved oxygen to reflect water quality issues and mass fish deaths observed in 2022–23 and 2023–24

Rec(s): 1.7

Funding: Existing budget commitment

Lead agency: Water Group

Delivery timeframe: 31 October 2024

Recommendation 2:

Better decisions require better data

OCSE Recommendation 2:

Better decisions require better data

An integrated, open, whole-of-system approach to data collection, analysis and management needs to be established. This is essential to enable timely and transparent decision making and build trust in the community. This water data regime should be based on the following principles:

- a. the data must cover the whole of the river system as all parts are connected. The monitoring network needs to be expanded to address key gaps (for example sites, resolution, and indicators)
- b. the data must minimally cover water flow rates and water quality (including dissolved oxygen), fish and algal biomass, and monitoring cause and effect variables to provide early warning of deteriorating conditions and ecosystem response
- c. the data must be open and accessible to all (Findable, Accessible, Interoperable, and Reusable – FAIR <https://ardc.edu.au/resource/fair-data/>)
- d. investment in new sensors and technology platforms (including telemetry), and their maintenance, to provide adequate coverage and warning
- e. development and use of probabilistic models and baseline steps towards a catchment digital twin, drawing on real time data, machine learning algorithms and insights
- f. recognition and integration of community observations and Aboriginal Traditional Knowledge as important sources of evidence.

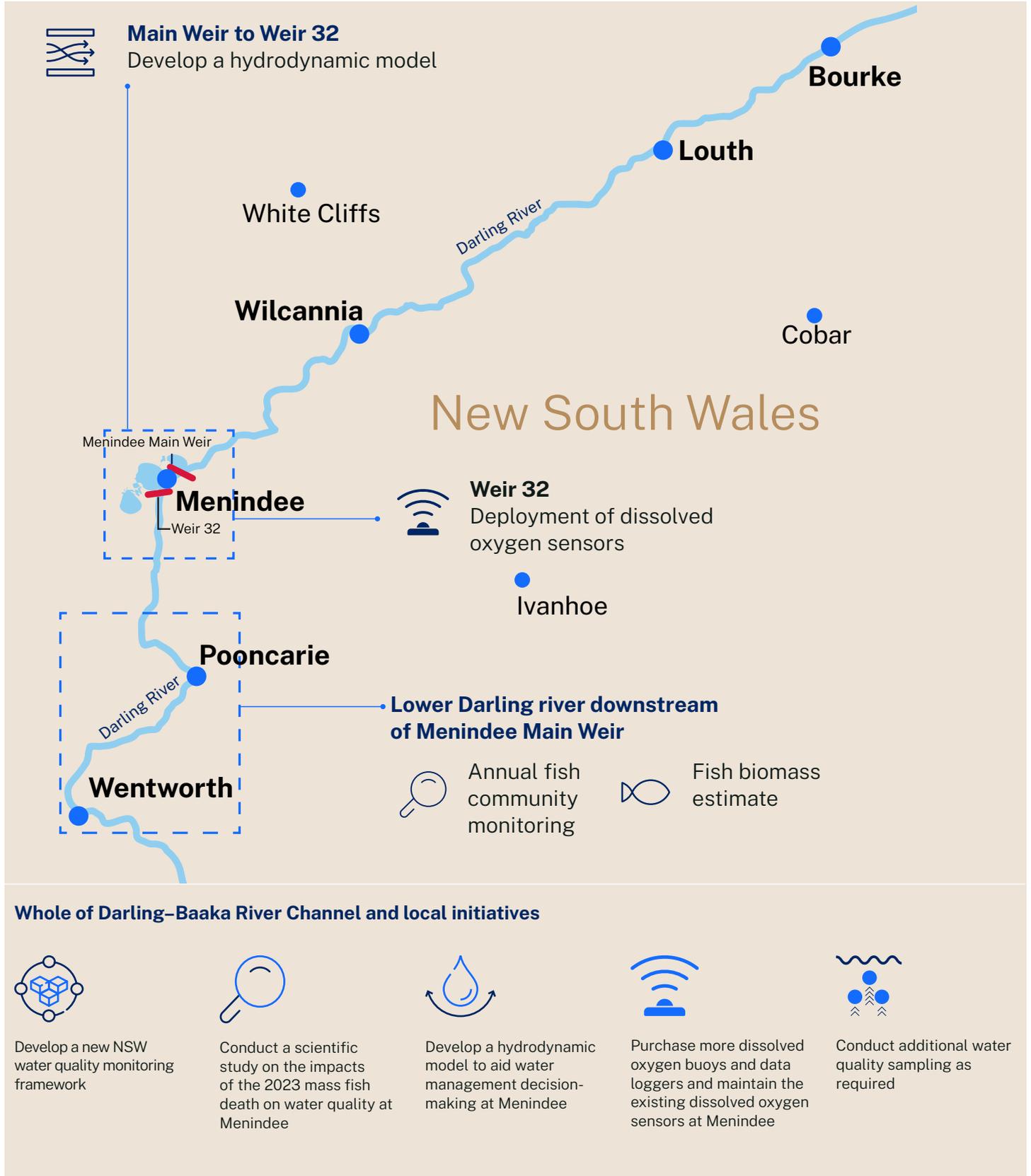
Statewide approach that supports a better Darling–Baaka River Channel

NSW will continue to provide timely access to quality assured water quality data and information statewide. We will publish water quality data and ensure water quality information, insights and visualisations are made publicly available. We will identify all agencies involved in water quality related programs and groups that require access to real time water quality information. Project and program management will ensure efficient coordination and implementation of multi-agency initiatives.

Barwon–Darling and Lower Darling Focus

We are expanding and maintaining the water sensor network around Menindee to support ongoing active water management during periods of water quality risk.

Figure 3. Overview of data and monitoring initiatives



Support

A new NSW water quality monitoring framework

Water quality data is collected, stored and used by a range of state government agencies as well as councils. However, it is important to improve visibility among agencies and enhance transparency with the wider community regarding which organisations hold water quality data, the nature of the data, its completeness, accuracy and how to access it.

The NSW Government has acknowledged the need to improve the sharing and publication of water quality data, not only for the Menindee region but also across the whole state. In response to this, the NSW Government is allocating \$1.05 million to deliver a new water quality monitoring framework for NSW.

The Water Group will lead development of the water quality monitoring framework by 30 June 2025, in consultation with relevant NSW agencies, including the department's Biodiversity, Conservation and Science Group, WaterNSW, NSW EPA and DPI Fisheries which will:

- confirm the agency that will hold the role of water data custodian, or owner of all water data
- set the standards for collecting and sharing data to ensure a 'whole of system' and integrated approach is taken to water data, and linking the Sharing and Enabling Environmental Data (SEED) portal operated by the department's Biodiversity, Conservation and Science Group with the WaterInsights portal operated by WaterNSW
- identify the priority gaps in water quality monitoring programs and where enhanced water quality monitoring needs to occur
- provide for an early warning system, implemented by WaterNSW, and based on water quality metrics to assist strategies and operations that have the potential to mitigate mass fish death events
- be designed incorporating evaluation, adaptive learning processes and draw on real-time data wherever possible.

The NSW water quality monitoring framework will enable data to be used more effectively to manage water quality issues in a timely manner for incident response and broader catchment health. This framework aspires to a future where any person will be able to easily access information on the quality of the water in their local area, or area of interest, through any connected device.

Addressing gaps in water quality and river health data

The NSW Government has delivered on its commitment in the initial response to gather more real time data over the 2023–24 summer through technology and crews from several NSW agencies. WaterNSW, DPI Fisheries and Essential Water took water samples for water quality, fish monitoring and town water supply purposes. The department's Biodiversity, Conservation and Science Group and WaterNSW installed 2 and 3 multi-depth monitoring buoys² respectively in the Menindee area, to monitor water quality at specific depths down through the water column. The department's Biodiversity, Conservation and Science Group and WaterNSW also undertook manual sampling on a regular basis throughout the river system between Lake Wetherell and Pooncarie, including within the Great Darling Anabranch. The data collected within the weir pool can be used to indicate when stratification starts, how long it has been present and if it has broken down, allowing the mixing of dissolved oxygen.

The Water Group undertook sediment sampling to better understand the possible causes of golden perch deaths in February 2024 which will improve our understanding of the groundwater and benthic sediment influences on water quality and aquatic ecosystem health as part of the Weir 32 science program.

The NSW Government will continue to deliver water quality and river health data collected via the Biodiversity, Science and Conservation Group's Darling–Baaka River Health Project, funded until June 2025 and the department's Weir 32 science program. This data continues to contribute to the ongoing management of water quality issues within the Darling–Baaka, enabling real-time informed decisions and actions to address water quality issues and reduce the incidence of mass fish deaths. The data also provides insights into and prioritisation of future management actions to improve the overall health of the Darling–Baaka River, including those that mitigate the impact of extreme events. This may include analysis of possible management actions that will improve river connectivity in the northern Basin.

The NSW Government is providing \$2.92 million in new funding for continued monitoring, as well as a scientific study on the impacts of the 2023 mass fish death event on water quality in the Menindee weir pool, development of a hydrodynamic model to aid water management decision making at Menindee and the purchase of new dissolved oxygen buoys and data loggers. The hydrodynamic model will allow forecasts and predictions of dissolved oxygen conditions under various scenarios, and the associated risk of fish deaths.

The scientific study will also examine the possible contributing influences to the February 2024 golden perch deaths in the Menindee weir pool. Collection of water samples from the Lower Darling–Baaka River will be used to assess land use impacts and undertake nutrient analyses, the data of which will contribute to the Water Quality Index and update the NSW River Condition Index within the Lower Darling water sharing plan area. This will provide information on river health and inform our model development to manage land and water in a coordinated manner.

As part of this commitment, the NSW Government will provide funding for Lower Darling–Baaka native fish monitoring, including fish biomass surveys that complement investment in Recommendation 4. This fish specific monitoring component will consider known gaps in monitoring and explore the potential for expanded activities linked to longer-term fish community monitoring in our response to the medium and longer-term aspects of Recommendation 4. Funding will also be committed to continued dissolved oxygen monitoring including the ongoing operation of multi-depth monitoring buoys in the Menindee area that complement and are additional to the installation of 40 high priority monitoring sites across the Basin (see Recommendation 2.2).

The Water Group is developing a proof of concept for the use of on-water autonomous technologies in areas not currently covered by sampling or fixed sensors (for example, remote-controlled boats to collect water quality, flow and bathymetry data to inform early warning of changed environmental conditions).

During the 2023–24 summer, the data from the existing real-time dissolved oxygen sensors in the Menindee weir pool proved critical for guiding the active management of thermal stratification by releasing water during high-risk periods. Consequently, the NSW Government will provide an additional \$1 million towards maintaining and operating these sensors on onsite buoys in the Menindee weir pool.

² NSW DCCCEW – Biodiversity, Conservation and Science buoy data here: <https://sss.tago.run/dashboards/info/6574473bc8b74d0008344b05?anonymousToken=00000000-5ee2-f600-e0f3-6100270c936d> and WaterNSW buoy data here: <https://waterinsights.watarnsw.com.au/updates>



Water quality testing

Incorporating community observations and Aboriginal knowledge

Working closely with the community and water operators, including environmental water managers, will be critical to deliver these reforms. The NSW Government is committed to ensure that acquiring and publishing data does not become disconnected from the experience on the ground and genuinely achieves greater transparency and better decision-making.

The NSW Government has employed a staff member based in Menindee to help make sure the implementation of these commitments is undertaken in close consultation with the community. This was an action committed to in the NSW Government initial response.

The NSW Government has been maintaining regular communications with the Menindee and Lower Darling–Baaka community. Staff based in the local community are helping to improve communication with the community on water quality and water management issues and better enable government to incorporate local knowledge into water management.

The NSW Government has also established a Regional Aboriginal Water Committee for western NSW and will continue to engage with local Aboriginal communities on the management of water quality risks. The NSW Government will continue to have Aboriginal communities represented on the Murray Lower Darling Environmental Water Advisory Group to ensure engagement on the planning and use of held environmental water.

The NSW Government will take the following actions to deliver Recommendation 2:

Action: FR7 Develop a new NSW water quality monitoring framework

Rec(s): 2

Funding: \$1.05 million new budget commitment, noting additional investment will be required for implementation

Lead agency: Water Group

Delivery timeframe: 30 June 2025

Action: FR8 Conduct a Menindee weir pool scientific study on the impacts of the 2023 mass fish death on water quality in Menindee weir pool; develop a hydrodynamic model to aid water management decision making at Menindee; and purchase new dissolved oxygen buoys and data loggers

Rec(s): 2

Funding: \$2.92 million new budget commitment

Lead agency: Water Group

Delivery timeframe: 30 June 2025

Action: FR9 Maintenance and operation of existing dissolved oxygen sensors in the Menindee weir pool, and additional manual sampling as required

Rec(s): 2

Funding: \$1 million new budget commitment

Lead agency: WaterNSW

Delivery timeframe: 30 June 2028

OCSE Recommendation 2.1:

A NSW (statewide) water quality and monitoring strategy, implemented within 12 months, which is publicly available and updated regularly, including quarterly progress reports on its development. The strategy should encompass or be linked to:

- a. an early warning system drawing on improved monitoring and modelling and a plan to activate strategies to mitigate fish death events
- b. an evaluation and adaptive learning program informed by improved real-time data, modelling and assessment of the effectiveness of interventions to improve water quality and system health and resilience

Support in principle

See response to Recommendation 2 that outlines the new NSW water quality monitoring framework that will be developed to meet the requirements of the strategy outlined in Recommendation 2.1. However, the scale and need to work across several agencies means that implementation of this framework will take longer than 12 months to deliver.

The framework in response to Recommendation 2 will be complete by 30 June 2025. Framework implementation under this action will be delivered by 30 June 2026, subject to funding.

OCSE Recommendation 2.2:

Accelerate the work program for installing dissolved oxygen sensors in high-risk areas, particularly the Lower Darling–Baaka where several major fish death events have occurred in recent years.

Support

The NSW Government has already invested in improved data to support better decision making and ensure a whole of system approach can be taken. An existing work program led by Water Group is underway to accelerate installation of dissolved oxygen sensors in high-risk areas. Ten of the 40 water data monitors referred to in the initial response have been installed, with 30 on track for installation by 30 June 2025.

In addition to these 40 monitors, five real-time, telemetered multi-depth water quality monitors with dissolved oxygen sensors have been installed in the Menindee region, as shown in Figure 4, as well as a buoy upstream at Wilcannia and in the Great Darling Anabranh. These additional sensors in high-risk areas of the Lower–Darling Baaka, have enabled real-time management decisions to prevent fish deaths due to thermal destratification, as well as monitor the quality of inflows. These assets have been critical in guiding management decisions over the 2023–24 summer to avoid conditions that lead to fish deaths on several occasions.

Figure 4. Location of vertical profile monitoring buoys



The NSW Government will take the following actions to deliver Recommendation 2.2:

Action: FR10 Complete the installation of the initial 40 water data monitors in high-risk areas to provide real-time data on dissolved oxygen levels

Rec(s): 2.2

Funding: Existing budget commitment

Lead agency: Water Group

Delivery timeframe: 30 June 2025



Smart-buoy measuring multi-depth water quality in real time

Recommendation 3:

Effective emergency management

OCSE Recommendation 3:

Effective emergency management

A local, detailed and effective emergency management framework is required. The current system is dysfunctional and not well understood at the local level.

- a. a NSW Mass Fish Death Sub Plan, under the Emergency Management Plan NSW (EMPLAN) should be developed and implemented as a matter of urgency (including a specific Menindee appendix)
- b. a simultaneous assessment of emergency management resources should be undertaken. This includes a review of membership and training; assessment of current prevention and response resourcing, capability and volunteer capacity
- c. resources should include development of a communications plan and an educational resource package

Support in part

The NSW Government actively supports the development of a Mass Fish Death Response Sub Plan for the Menindee region (the Sub Plan) and ensuring adequate emergency management resourcing and improved communications. We are investing \$4.49 million to ensure appropriate emergency management arrangements are in place with rigorous testing, comprehensive training, and local resource reviews to equip responders to act swiftly and effectively in Menindee emergencies. We have detailed these commitments in our response to Recommendations 3.1, 3.2, 3.3, and 3.9.



OCSE Recommendation 3.1:

That a NSW Mass Fish Death Sub Plan is developed as an immediate priority, with a specific annexure dedicated to the Menindee region. This Sub Plan should:

- a. reflect learnings from previous fish deaths across NSW, including locations and frequency.
- b. include defined triggers that:
 - address the breadth of issues affecting the community for example public health, quality of drinking water, disease to fish and animals, water quality measures, etc
 - are consistent with the NSW EMPLAN Prevention, Preparation, Response and Recover (PPRR) framework, with thresholds and levers that can be actioned to prevent or mitigate fish deaths, and interaction with other plans and policies (such as the Extreme Events Policy)
 - consider the future impact of climate change, with particular reference to drought and floods.
- c. identify the nature of the event, regardless of whether it is under a Natural Disaster and/or subject to another Sub or Supporting Plan and identify the responsibility of each agency (noting that multiple agencies have different responsibilities that may overlap)
- d. facilitate scalable responses, with consideration of higher-threshold triggers through to actual triggers of a Local and/or actual EOC, ensuring that the key knowledge holders and agencies are informed and there is consistency maintained throughout the emergency process
- e. include triggers to be considered by the relevant knowledge experts and have the ability for a scalable emergency response, which includes higher-threshold triggers that bring together the relevant knowledge holders (such as expert advisory groups, akin to the HBWG but with expanded remit) prior to a fish death occurrence that then informs the emergency process
- f. that, given the nature of the region, whilst the virtual attendance of expert advisory groups and the LEMC/EOC is appropriate, it is also critical to ensure key positions on-the-ground.
- g. consider the inclusion of identified health service providers (including Aboriginal health services) as trusted messengers to the community.

Support in part

The NSW Government actively responded to the immediate risk of fish death during the summer of 2023–24 by developing the interim [Mass Fish Death Event Response Plan](#) (the interim plan). The interim plan was endorsed by the NSW State Emergency Management Committee (SEMC) on 13 December 2023 and published in January 2024. This plan describes the interim state-level emergency management arrangements for a mass fish death event in NSW, including freshwater, marine, estuarine environments, and impoundments.

Under the interim plan, the Local Emergency Management Committee (LEMC), led by the NSW Police, is responsible for coordinating the response to a mass fish death event. Supporting agencies include the NSW EPA, NSW Public Works, the local council, DPI Fisheries, NSW Health, WaterNSW and the Water Group. The interim plan will remain in force until the Sub Plan is developed and endorsed.

The NSW EPA – Environmental Services Functional Area will develop the final Sub Plan on behalf of the NSW Government, as per emergency management arrangements. Rather than creating a statewide plan with a Menindee appendix, a Regional Sub Plan will focus specifically on the Menindee area. This approach will help address the unique conditions and risk factors specific to the Menindee region that make it so susceptible to mass fish death events.

The Menindee-specific Mass Fish Death Response Sub Plan (the Sub Plan) will be submitted for consideration and endorsement by the SEMC before 31 December 2024.

The Sub Plan will be consistent with Recommendations 3.1 (a)-(g), noting some variation may be required as the Sub Plan will apply only to the Menindee region. It will confirm triggers for action and lead agency and emergency management arrangements. It will also ensure all emergency service organisations, functional areas and supporting agencies are aware of their roles and responsibilities. The Sub Plan will be informed by insights gained from the application and exercising of the interim plan and community feedback and will be published on the [State emergency management sub plans](#) webpage once approved.

During development of the Sub Plan, consideration will be given to the need to develop a response mechanism for fish deaths below numbers that trigger an emergency response and the provision of training to Central Darling Shire Council and Barkandji Rangers to support implementation. The response to clean up fish deaths below an emergency scale could be set out in a standalone document or via an update to DPI Fisheries – Protocol for Investigating and Reporting Fish Kills.

All agencies with functions under the Sub Plan will be consulted during its development including the Water Group, the department’s Biodiversity, Conservation and Science Group, DPI Fisheries, WaterNSW, Premier’s Department, NSW Health, Local Land Services, Central Darling Shire Council, Office of Local Government, NSW Police and the Department of Regional NSW – NSW Public Works.

A commitment of \$4.49 million has been made to resource the planning, communications and delivery of the Sub Plan, delivery of complementary actions referred to further below and to assist resourcing the response to future mass fish death emergencies which are expected to continue. This funding will allow for the preparation and delivery of a well-coordinated, efficient and evidence-based approach to emergency response.

The NSW Government will take the following action to deliver Recommendation 3.1:

Action: FR11 Develop and publish a Menindee-specific Mass Fish Death Response Sub Plan consistent with Recommendations 3.1 (a)-(g)

Rec(s): 3.1

Funding: \$4.49 million new budget commitment

Lead agency: NSW EPA – Environmental Services Functional Area

Delivery timeframe: 31 December 2024



OCSE Recommendation 3.2:

That the NSW Mass Fish Death Sub Plan, once developed, is exercised by the Central Darling LEMC and NSW Government agencies. Once a NSW Mass Fish Death Sub Plan is developed, a multi-agency desk top exercise should be undertaken by the LEMC, with support from the REMC as required, to ensure agencies clearly understand their roles and responsibilities and if any amendments need to be made to the Sub Plan. This exercise will also assist in the development of a communications list for key positions within agencies, which should be updated on an annual basis.

Support

The NSW Government supports practical emergency management exercises to ensure that all responding agencies are familiar with response plans and agency responsibilities, enabling them to respond quickly and effectively.

To confirm the emergency management response to a fish death incident in Menindee, a multi-agency desktop exercise based on the interim plan took place on 20 December 2023. During this exercise, participants worked through a scenario involving mass fish deaths. The session was independently facilitated and attended by functional heads and delegates from the Central Darling LEMC and NSW Government agencies including NSW EPA, NSW Police, Water NSW, DPI Fisheries, NSW Department of Climate Change, Energy, the Environment and Water, NSW Health and NSW State Emergency Service. The final report resulting from this exercise will inform the resources review and capability assessment, in line with Recommendations 3.5 and 3.6.

Additionally, the NSW EPA has arranged another practical exercise to be conducted before the end of June 2024 to test emergency management arrangements under the interim plan and the Local Emergency Management Committee Exercising Toolkit – Spontaneous Volunteers (see also response to Recommendation 3.7).

When the Sub Plan is completed, it will be tested and actively exercised within the framework of NSW emergency management with the Central Darling LEMC and NSW Government agencies.

The NSW Government will take the following actions to deliver Recommendations 3.2 and 3.7:

Action: FR12 Test the interim Mass Fish Death Response Sub Plan at Menindee consistent with the Local Emergency Management Committee Exercising Toolkit – Spontaneous Volunteers

Rec(s): 3.2, 3.7

Funding: Existing budget commitment

Lead agency: NSW EPA – Environmental Services Functional Area

Delivery timeframe: 30 June 2024

Action: FR13 The Menindee-specific Mass Fish Death Response Sub Plan is tested by the Central Darling Local Emergency Management Committee and NSW Government agencies

Rec(s): 3.2, 3.7

Funding: Part of \$4.49 million new budget commitment for Recommendation 3.1

Lead agency: NSW EPA – Environmental Services Functional Area

Delivery timeframe: 30 June 2025

OCSE Recommendation 3.3:

That the REMC, LEMC and NSW Government agencies undertake a review and update the membership of the LEMC, with a view to including appropriate representation (if not already present) from NSW Health (Far West Local Health District), National Parks and Wildlife Service, Crown Lands and/or Local Land Services, and nominated representative from Aboriginal Affairs (and/or local representation). This review should maximise efficiency in membership, facilitating agility and flexibility whilst also ensuring that all the required agencies are represented at an appropriate decision-making level.

Support

The Capability Development Sub-Committee (CDSC) collaborated with the NSW Police Force and the Regional Emergency Management Committee (REMC) to supervise a comprehensive review of the Central Darling LEMC, which is now complete. The REMC provided a report to the CDSC on the current membership of the committee including agency and representatives, as well as a record of attendance of existing members at meetings. No obvious gaps in membership were identified, however attendance at meetings has been fragmented. There is ongoing work happening across all LEMCs to improve auditing and reporting of the LEMC membership through an updated Local Emergency Management Plan template.

Additionally, the NSW Premier's Department is in the process of updating the Local Emergency Management Committee Information Guide which is also due for completion by 30 June 2024. This update aims to align the Information Guide to current good practice and reflect recent amendments made to the NSW EMPLAN 2023. Once updated, the Information Guide will be published on the [Emergency Management Policy website](#).

The NSW Government will take the following actions to deliver Recommendation 3.3:

Action: FR14 Update the Local Emergency Management Committee Information Guide

Rec(s): 3.3

Funding: Part of \$4.49 million new budget commitment for Recommendation 3.1

Lead agency: NSW Premier's Department

Delivery timeframe: 30 June 2024

OCSE Recommendation 3.4:

Emergency Management training is undertaken by agencies involved in the LEMC and any EOC that may arise from a mass fish death scenario.

The recommended minimum training (administered and offered by NSW Premier's Department) is:

- a. Emergency Management overview (1 x 40-minute module), noting that it is a prerequisite for all other courses.
- b. Introduction to Emergency Management (1 day face-to-face)
- c. Emergency Operations Centre Concepts (1 day face-to-face)
- d. General Managers should also consider undertaking the Local Emergency Management Committee Foundations Course (4 x 20-minute modules)

Support – Complete

The NSW Government supports practical training to ensure that agencies and staff are well-prepared for mass fish death scenarios. In the Menindee region, relevant NSW Government agencies, who are members of the current Central Darling LEMC, have participated in emergency management training courses in line with Recommendation 3.4 (a) - (d). These courses include Evacuation Management, Introduction to Emergency Management, and Emergency Management Operations Centre Concepts. When a new permanent General Manager is appointed to the Central Darling LEMC, they will undertake the Local Emergency Management Committee Foundations Course. The NSW Premier's Department will continue to provide free online emergency management courses throughout the year.

Additionally, the NSW Police Force has successfully piloted an EOCON (Emergency Operations Controller) Development Program, which is now being implemented. This program is open to all local and regional emergency operations controllers, aiming to enhance their capabilities in emergency management.

OCSE Recommendation 3.5:

That the LEMC and NSW Government agencies involved in any emergency response undertake a resource review. This would include examining and streamlining the tender/standing procurement process, with contractual arrangements in place to cover future events.

This should be reviewed on an annual basis.

- a. As an immediate action, those assets identified in the March 2023 event should be contracted until this more thorough procurement is concluded.
- b. This should also include pre-identification and potential pre-positioning of resources and disposal sites that can be utilised under different fish death event scenarios and consider the process (including funding arrangements) for water carting in future events.

Support in part

The NSW Government has learned from the March 2023 incident and allocated resources to prepare for possible fish death incidents over summer. Consistent with Recommendations 3.5 (a)-(b), assets such as boats, booms, and nets in the Menindee township have been contracted for the removal and clean-up of fish carcasses and related waste as an interim measure. This preparation has also included pre-identifying disposal sites around Menindee with the capacity to manage a range of events.

Consistent with the initial NSW Government Response, the NSW EPA - Environmental Services Functional Area has committed to lead a resource review as part of the preparation to develop the Sub Plan. Consistent with the government's initial response, this review will build upon the [2019–20 Native Fish Drought Response](#), which established an initial framework for preparedness and response. This framework included procurement and tender processes that identified a preferred supplier list for various response activities, such as aeration, clean-up, and rescue and relocation. Water carting will also be considered in the development of the Sub Plan. Some of this information was used during the emergency response to the March 2023 fish death incident and is intended to serve as the baseline for the resource review.

A review of resourcing is not proposed annually as per the recommendation in the Review Report but is proposed to align with the requirements to review Sub Plans every 5 years, after an event or by request.

Action: FR15 Complete a resource review as part of the preparation to develop the Menindee-specific Mass Fish Death Response Sub Plan

Rec(s): 3.5

Funding: Part of \$4.49 million new budget commitment for rec 3.1

Lead agency: NSW EPA – Environmental Services Functional Area

Delivery timeframe: 31 October 2024

OCSE Recommendation 3.6:

That the relevant agencies and the LEMC, with support from the REMC, undertake a resource capability assessment of emergency services in this remote area (Menindee) to have a true and accurate picture of the available resources, and an understanding of their capabilities.

Support

The LEMC with the support of the NSW Premier's Department and the Regional Emergency Management Officer (REMO), will conduct a capability assessment of the emergency services functions and resources (assets/equipment) in Menindee, the Central Darling Shire local government area, and the Far West Emergency Management Region. The LEMC's capability assessment will be reported to the Capability Development Sub-Committee by August 2024 and may inform the additional multi-agency exercise to be conducted before the end of June 2025 as committed to in our response to Recommendation 3.2.

The NSW Government will take the following action to deliver Recommendation 3.6:

Action: FR16 Complete a capability assessment of the emergency services functions and resources (assets/equipment) in Menindee, Central Darling Shire local government area, and the Far West Emergency Management Region

Rec(s): 3.6

Funding: Part of \$4.49 million new budget commitment for Recommendation 3.1

Lead agency: NSW Premier's Department

Delivery timeframe: 31 August 2024

OCSE Recommendation 3.7:

Once developed, the SEMC and LEMC should consider Menindee as a key location in which to test the new Local Emergency Management Toolkit.

Support

In December 2023, the SEMC endorsed the Local Emergency Management Committee Exercising Toolkit – Spontaneous Volunteers (LEMC Toolkit). The LEMC Toolkit will be accessible to all LEMCs in early 2024. As outlined in the response to Recommendation 3.2, the NSW EPA will conduct an exercise in June 2024 to test the interim plan at Menindee and will ensure this exercise is aligned with the LEMC Toolkit.

See also the response to Recommendation 3.2.

OCSE Recommendation 3.8:

That the Capability Development Sub-Committee (CDSC) of the State Emergency Management Committee (SEMC) has oversight of the implementation of the emergency management recommendations of the Review and is provided with half-yearly progress reports.

Support – Complete

The CDSC and the SEMC have established governance and reporting structures that are consistent with Recommendation 3.8. The CDSC has been formally assigned responsibility for implementation of the Office of the NSW Chief Scientist and Engineer's emergency management recommendations and will coordinate six-monthly progress reports to the SEMC. The SEMC will provide a report on the progress of implementing the emergency management recommendations from the Review in its annual report.

OCSE Recommendation 3.9:

That the LEMC, with guidance from the REMC and the agencies with responsibility for communicating with the community, jointly develop a communications plan that addresses the regional requirements of the community in the Menindee region, the proactive release of information, and considers better ways to engage with different audiences within the community including community consultation and feedback (such as two-way communication). This communication plan should acknowledge the most appropriate methods for communication, including:

- a. consistency in information provision: time, locations available, regularity in updates in nonemergency situations (such as weekly/fortnightly/monthly) that should be tied to various higher threshold triggers
- b. collated information from all agencies, to reduce community confusion and provide comprehensive and aligned messaging.
- c. methods of communication: in noting that not all residents have equal access to the internet, using sources such as:
 - information sessions with experts
 - trusted voices within the community, such as the local health service
 - local media (radio, TV)
- d. provision of physical hardcopies of communication packages at key locations are important; for example, the Menindee Health Service, Police Station, Council (and utilising the Council's electronic sign), Men's Shed, etc.
- e. engaging with local Aboriginal groups and Elders to disseminate information amongst the community.
- f. development of pre-planned and agreed upon (by the relevant agencies) information packages that can be deployed as a proactive measure as required, such as prior to and during an emergency situation and provision of the latest real-time monitoring data, including explanation of timeframes for analysis.

Support

The NSW Government acknowledges that our past engagement with the local Menindee community has not met community expectations and we are committed to:

- improving our approach and fostering better communication
- maintaining transparency through early and effective engagement by building on existing work that is designed in coordination with the community
- confirming a process for future events
- collaborating closely with local communities, including councils, Aboriginal organisations, health agencies, utilities, and scientific and environmental groups.

Currently under the interim plan, NSW Police, as the Public Information Services Functional Area will lead communications if a mass fish death emergency is declared. The lead agency for communications in a mass fish death emergency under the Sub Plan will be confirmed when NSW EPA-Environmental Services Functional Area completes the final Sub Plan by December 2024. The Sub Plan will include a communications plan that considers the specific needs and best way to engage with the Menindee community to ensure timely and two-way communication during any fish death emergency (both low-scale death events and mass death events). Each element of this recommendation will be considered in the development of the communications plan.

The Water Group has a comprehensive communications and engagement approach in place for Menindee that guides communications generally as opposed to specific fish death matters. Regular community updates have continued to be published on the Water Group website as well as local social media, to share proactive information on conditions, actions being taken by NSW Government agencies to reduce the risk of fish deaths and the effectiveness of these responses.

The Water Group will continue to lead community communications and engagement activities, including broader education activities, when agencies are not operating under a mass fish death emergency, consulting with other agencies including the department's Biodiversity, Conservation and Science Group, DPI Fisheries, WaterNSW, Local Land Services as required. See also response to Recommendation 3.10.

WaterNSW will continue consultation with its customers, the Barkandji Native Title group, Menindee Local Aboriginal Land Council, Barkandji Rangers and other representatives in the Menindee community on all WaterNSW controlled operational matters occurring at Menindee. These include updates on maintenance programs, projects (including for example the Menindee oxygenation trial), dam releases (including the early warning network notifications), river quality and flow and height information, as well as partnership opportunities. This information is distributed to the community by emails, posters, phone call, radio and face to face meetings. WaterNSW has commenced a process to develop a better coordinated communication and engagement protocol, including with other agencies, to improve communication with the community, following a commitment from its Flood Review, released early in 2024.

Following feedback from the Menindee and Lower Darling–Baaka community, the NSW Government has employed a Senior Water Implementation Officer based in Menindee to support the community and bring on-the-ground expertise in water monitoring and management. The NSW Government will review the role and has committed to further funding.



The NSW Government will take the following actions to deliver Recommendations 3.9:

Action: FR17 Confirm the lead agency for communications (Public Information Services Functional Area) and communications plan under the Menindee-specific Mass Fish Death Response Sub Plan

Rec(s): 3.9

Funding: Part of \$4.49 million new budget commitment for Recommendation 3.1

Lead agency: NSW EPA

Delivery timeframe: 31 December 2024

Action: FR18 Improved and ongoing non-emergency communications and engagement plan in the Menindee region that addresses the regional requirements of the community, the proactive release of information, and includes community consultation and feedback (that is, two-way communication).

Rec(s): 3.9

Funding: Ongoing (business as usual)

Lead agency: The Water Group and WaterNSW

Delivery timeframe: Ongoing

OCSE Recommendation 3.10:

Develop an education package for the impacts of fish deaths in regional and remote communities in NSW, which outlines the current science on possible triggers (such as blackwater and hypoxic events) and the groups that are involved in the monitoring and/or response.

Support

The Water Group in consultation with DPI Fisheries, WaterNSW, the department's Biodiversity, Conservation and Science Group and the NSW EPA will enhance its education materials including fact sheets and web text on impacts of fish deaths in regional and remote communities in NSW by the end of 2024. The Water Group website will be updated, and links will be published to relevant partner agencies' websites by 31 December 2024.

The NSW Government will take the following action to deliver Recommendation 3.10:

Action: FR19 Deliver enhanced education materials and links to relevant information on partner websites from the Water Group website

Rec(s): 3.10

Funding: Existing budget commitment

Lead agency: Water Group

Delivery timeframe: 31 December 2024

Recommendation 4:

Interventions to mitigate against future mass fish deaths

OCSE Recommendation 4:

Interventions to mitigate against future mass fish deaths

An integrated suite of strategies should be designed and implemented to reduce the risk of further mass fish deaths and restore the health of the broader river ecosystem. These strategies should include improved monitoring, data collection and sharing, and be integrated with other recommendations in this report. The strategies should ensure risks are identified and managed, impacts quantified and adaptive learning implemented. These interventions should at least include:

Immediate term measures (0-12 months)

Immediate measures to manage water quality should focus on maintaining dissolved oxygen in the Menindee weir pool. Potential interventions include:

- a. modifying the nature of environmental and other water releases (such as pulsing releases) to maximise desired benefits
- b. pumping/recirculation infrastructure to enable water release from Pamamaroo outlet without exhausting environmental water holdings
- c. investigating the feasibility of oxygenation infrastructure to maintain refugia in designated areas
- d. reducing oxygen demand in the Menindee weir pool by reducing biomass-including fish removal (especially carp) and suppression of algal growth
- e. applying short-term technical fish passage solutions to create temporary opportunities for fish to progress upstream

Support

The NSW Government took several immediate actions to reduce the risk of mass fish deaths before summer 2023–24, as outlined in the initial response. Some of the actions are now complete and some remain underway as shown in Table 2 and detailed below. Each of the recommended short-term interventions have been explored.

Regarding Recommendation 4(a), the Menindee/Lower Darling Water Quality Working Group have continued to agree by consensus to actively undertake variable releases from Lake Pamamaroo and Lake Menindee to manage dissolved oxygen levels in the weir pool to prevent conditions that could lead to mass fish deaths. These efforts were successful on at least 8 occasions over the period 10 November 2023 to 23 January 2024.

In response to Recommendation 4(b), WaterNSW provided preliminary analysis and cost-estimates for a pumping system that would transfer water from Lake Menindee to Lake Pamamaroo. This proposal involved redirecting water that would typically be released from the Menindee outlet to the Pamamaroo storage, potentially increasing the accessible water for critical drought needs in Lake Pamamaroo. Based on WaterNSW’s experience during the previous drought and preliminary estimates from known contractors, it was estimated that costs would be approximately \$1.1 million for infrastructure and ongoing operational costs of \$24,000 per day. WaterNSW expects that this option would have advantages relating to ease of operation and a reduction in evaporation from Lake Pamamaroo, compared to Lake Menindee.

However, WaterNSW assessed and determined that substantial flows are necessary to alter the oxygen profile in the water and sustain destratification. Consequently, only marginal improvements in water quality were anticipated. Indeed, intermittent mixing of flows could cause mixing of anoxic water and the transfer of water with high algal biomass from one system to another, potentially intensifying stratification may intensify stratification (this occurred in the 2019–20 fish death event). On balance, WaterNSW considers that this option should not proceed at this time, especially while trials of other options are underway.

The NSW Government is testing the feasibility of oxygenation infrastructure suggested by Recommendation 4(c). WaterNSW is currently conducting a trial of microbubble technology in the Menindee town weir pool. This involves a machine which pumps small bubbles of oxygen through devices suspended in the water column. As these bubbles dissolve into the water, and the highly oxygenated water jets into the water column, they drive water circulation to prevent destratification and the dissolved oxygen bubbles increase dissolved oxygen levels.

The NSW Government allocated \$1.6 million to acquire and trial the technology in the 2023–24 financial year. One microbubble unit was installed at the end of January 2024 and early results from using this technology to June 2024 have shown that dissolved oxygen saturation levels of 90%–95% are being achieved in the vicinity of the machine. When the flows were higher, it was difficult to properly assess the microbubble unit’s zone of influence. However, in more recent months, as the flows dropped, the benefit of the machine in reducing stratification and increased dissolved oxygen became more apparent. WaterNSW will evaluate and report on the results before September 2024 which will inform whether to continue the use of the microbubble technology, subject to the availability of funding and water quality conditions.

As an initial response to Recommendation 4(d), DPI Fisheries conducted fish surveys in the Menindee town weir pool during November and December 2023. These sonar surveys aimed to undertake a preliminary estimate of the composition of fish community in the Menindee town weir pool including the numbers of fish, species composition and their biomass. DPI Fisheries also undertook site inspections and explored potential short-term “trap and transport” solutions, in the event it would be needed as an interim solution to allow native fish to move upstream of the Menindee town weir pool and remove carp at the same time. Based on analysis of this work, it was determined that a standalone “trap and transport” system retrofitted to existing infrastructure was not a viable option to address immediate short-term fish passage needs.



Microbubble technology trial

Preliminary analysis of the fish survey data estimated that there were approximately 37,000 fish above 20cm in the Menindee town weir pool during November and over 33,000 fish greater than 20 cm in December 2023³. Due to constraints in sonar technology and data processing, fish under 20 cm were not included in the initial estimates, resulting in a conservative estimate of the fish numbers. Initial species assignments indicate fish detections above 20 cm were dominated by carp, however, some native species were detected including bony herring and golden perch. Comparative analysis of the survey results are being undertaken with DPI Fisheries datasets for the weir pool to increase confidence in the species assignments and to inform biomass estimates. The interim fish community composition results are being used to guide feasibility and planning for further actions, including temporary fish passage options that incorporate trap and transport of fish and carp removal activities.

The DPI Fisheries Aboriginal Fishing team engaged existing NSW commercial fishers in a program to deliver an introduction to freshwater commercial fishing operations and develop capacity within the community to respond to assist with biomass removal and respond to fish death events as soon as possible. DPI Fisheries will continue to look at the need for carp removal and native fish relocation initiatives, in partnership with the community including Aboriginal people, while also progressing a business case for long-term options in the region (see also response to Recommendation 4.1). Fortunately, due to fair conditions over the summer 2023–24, it was determined by DPI Fisheries that a fish removal and relocation program was not needed.

The NSW Government is responding to Recommendation 4(e) with a commitment of \$6.52 million for DPI Fisheries to undertake a trial of new fish passage technologies that could be applied at Menindee. The trial seeks to assess the suitability of new technologies, particularly the tube fishway, for attracting and facilitating the movement of sufficient numbers of native fish and examine the impacts on, and survival of fish as well as explore the potential for sorting of fish as part of the process. There will be a consultation to ensure cultural and local knowledge and community views are given consideration. The trial could run for up to 4 years to 30 June 2028, with preliminary findings expected to be presented to the government after the first year of trial.

The NSW Government will take the following actions to deliver the immediate term elements in Recommendation 4:

Action: FR20 Complete the trial and evaluate the feasibility of oxygenation infrastructure

Rec(s): 4c

Funding: \$1.6 million existing budget commitment, noting that the ongoing use of oxygenation technology may require additional investment

Lead agency: WaterNSW

Delivery timeframe: 30 September 2024

Action: FR21 Complete a trial of new fish passage technologies including the tube fishway with fish sorting opportunities

Rec(s): 4e

Funding: \$6.52 million new budget commitment

Lead agency: DPI Fisheries

Delivery timeframe: 30 June 2028

³ a further 31,000 fish were identified between 5-19cm in December, noting detections are less accurate for fish less than 15cm.

Mid-term strategies (1-5 years) include:

- Construction of fishways identified in the NSW Fish Passage Strategy, focusing on priority Menindee Lakes sites for fishways. Priority and resourcing should be given to the construction of effective fishways to maximise fish mobility above the Menindee weir pool. Specifically, movement between Lakes Wetherell, Pamamaroo and Menindee, and the Darling River below Weir 32. These fishways should be designed in consultation with the local community, consider cultural knowledge and address the specific needs of the location.
- An integrated national invasive fish species management strategy be finalised and resourced, including physical, biological and chemical controls. Implementation of the strategy should be accompanied by an information, communication and education plan, informed by local and Aboriginal knowledge, and subject to monitoring and annual reporting of actions, impacts and adaptive management responses.
- Work with other states and territories to consider the National Carp Control Program (NCCP) and deployment of the carp virus, including how to manage the uncertainties (biomass estimates, potential for genetic resistance, herd immunity, latency and recrudescence)

Support

The NSW Government is committed to restoring unimpeded fish passage at the 165 high-priority weirs identified in the [NSW Fish Passage Strategy](#). This significant infrastructure investment is being planned for delivery in stages over a 20-year timeframe. DPI Fisheries is progressing its plan to replace the existing fishway at Burtundy Weir, downstream from Pooncarie by 31 December 2026. This project entails replacing the current fishway with a modern vertical slot fishway, which will significantly enhance fish passage at the site across a broader range of flow conditions.

In 2022 and 2023, DPI Fisheries conducted separate investigations into the functionality and potential for simple modifications of Pooncarie Weir and Weir 32 to improve fish passage at these sites. Both reports concluded that while some issues could be addressed by temporary adjustments, the technical challenges associated with these fishways is much more difficult to address, necessitating medium to long-term permanent solutions. It was also determined that full replacement of the existing fishway at Pooncarie with a modern design would be a more cost-effective solution, while uncertainties associated with the future operation of Weir 32 at the time of assessment meant it was not cost-effective to pursue any short-term temporary adjustments. As a result, DPI Fisheries have determined the most appropriate way to address the fish passage needs at both locations is via the business case process for permanent fish passage works detailed below.

The NSW Government has committed \$6 million to develop a full business case for permanent fish passage at the Menindee Lakes, as well as in the Lower Darling–Baaka at Weir 32 and Pooncarie Weir. The business case will be a collaborative process led by DPI Fisheries as client for fish health outcomes, with WaterNSW as the owner and operator of the assets.

The business case will guide investment decisions and support a funding proposal to undertake the recommended fish passage works. The three-year work plan to deliver the business case is based on experience delivering similar projects and considers the specific site-based complexities at Menindee and the Lower Darling–Baaka as well as the engineering and regulatory challenges of working in the aquatic environment.

In designing a three-year work plan to deliver the business case, the NSW Government acknowledges the importance of ensuring these fishways are designed in consultation with the local community, consider cultural knowledge and address the specific needs of the locations. It is important to note that the business case development has been aligned with NSW Treasury (2018, 2023) Policy and Guidelines, and is an iterative process with the preparation of a strategic business case first, that will be revisited and further refined with additional analyses to prepare a full business case.

Controlling invasive fish species such as carp is extremely challenging. In response to this threat and to progress complementary recovery actions for native fish, the NSW Government will invest \$0.6 million to progress the development of a Native Fish Recovery and Resilience Program, initially focused on a strategic plan for on-ground rehabilitation works along the Darling–Baaka to improve water quality and ecological outcomes. This program, once funded for implementation, would provide a coordinated and holistic approach to native fish and river health activities in the Lower Darling–Baaka, and focus on priority reaches, species, key fish habitat and communities.

Development of the Native Fish Recovery and Resilience Program will be led by DPI Fisheries and Western Local Land Services who will engage closely with the Water Group, the department's Biodiversity, Conservation and Science Group, and the local community, with the strategic planning due to be completed by June 2026. NSW's Native Fish Recovery and Resilience Program will also complement the national Native Fish Recovery Strategy being led by the MDBA.

Nationally, efforts are also underway to progress priority actions under the National Carp Control Program (NCCP) led by the Australian Government's Department of Climate Change, Energy, the Environment and Water, with investment focused on progressing the next phase of research and management activities.

DPI Fisheries supports efforts to control carp and also continues to provide input and collaborate with the Australian Government other states and territories to deliver the NCCP. The NCCP is a program of scientific research to investigate the feasibility of using the cyprinid herpesvirus 3 (carp virus) as a biological control agent for common carp to improve water quality in waterways across Australia. The goal of this research is to provide essential decision-making information, including whether releasing the carp virus would be safe, effective, or feasible. Implementation of the NCCP, as well as other complementary integrated pest management activities as part of the NCCP, will contribute to addressing the outcomes of an integrated invasive fish species management strategy as recommended in the Review Report. NSW will continue to work with the Australian Government including the MDBA to ensure these efforts and programs are strategically aligned and delivered in a coordinated and collaborative approach.

The NSW Government will take the following actions to deliver the mid-term elements in Recommendation 4:

Action: FR22 Complete replacement of existing fishway at Burtundy Weir

Rec(s): 4 mid-term

Funding: \$6 million Australian Government commitment

Lead agency: DPI Fisheries

Delivery timeframe: 31 December 2026

Action: FR23 Deliver a full business case for permanent fish passage in the Menindee Lakes and Lower Darling–Baaka below Menindee

Rec(s): 4 mid-term, 4.1 mid-term actions

Funding: \$6 million new budget commitment, in addition to the Australian Government contribution of \$2.3 million

Lead agency: Joint lead Water NSW as asset owner and DPI Fisheries as client for fish health outcomes

Delivery timeframe: 30 June 2027

Action: FR24 Develop a Native Fish Recovery and Resilience Program, initially focused on a strategic plan for on-ground rehabilitation works along with Darling–Baaka to improve water quality and ecological outcomes

Rec(s): 4 mid-term

Funding: \$6 million new budget commitment, noting that additional investment will be required for implementation

Lead agency: Western Local Land Services / DPI Fisheries

Delivery timeframe: 30 June 2026

Action: FR25 Support the Australian Government and states and territories to deliver the National Carp Control Program (NCCP) and address outcomes of a national integrated invasive fish species management strategy

Rec(s): 4 mid-term

Funding: Existing budget commitment

Lead agency: DPI Fisheries

Delivery timeframe: To be confirmed, noting that the Australian Government's Department of Climate Change, Energy, the Environment and Water is leading this work

Long-term strategies (ongoing)

- restoration of flow regimes and connectivity across the catchment
- water quality – accounting and management of nutrient inflows across the catchment
- coordinated and systemic ecosystem regeneration strategies, inclusion of Aboriginal people's knowledge, including R&D and scale up of refugia for fish, invertebrate and other species
- in addition to other performance and impact metrics, the strategy should include monitoring of iconic long-lived animal, plant and invertebrate species recognised for their contribution to river health, including species identified as culturally significant to Indigenous communities

Support

The NSW Government is committed to a sustained, strategic approach to improve ecosystem health across NSW and especially in the Darling–Baaka catchment.

As outlined in our response to Recommendations 1.1 and 1.2, the independent Connectivity Expert Panel are examining the adequacy of rules in relevant northern Basin water sharing plans. Their independent advice to government will chart a pathway for greater hydrological connectivity from the northern Basin into the Lower Darling–Baaka River and southern Basin. The Panel's final report will be considered prior to making any changes to water sharing plans in the NSW Border Rivers, Gwydir, Namoi, Macquarie and Barwon–Darling Northern Basin and Lower Darling–Baaka valleys.

Water quality in the Darling–Baaka is directly influenced by both water flows and land use practices in the northern and surrounding catchments. The Water quality technical report for the Murray Lower Darling surface water resource plan area (SW8) indicates that water quality outcomes in the Lower Darling are strongly correlated to river flow and that the Lower Darling experiences periods of poor water quality due to a range of natural, human and introduced causes. The Office of the NSW Chief Scientist and Engineer found that further to altered flows, scientific and significant anecdotal evidence supports decadal changes in key components of a health riverine ecosystem in the Darling–Baaka. These flow rates, and human activities are leading to increases in nutrients and sediments flowing into creeks, rivers and wetlands. Low water flows lead to sediment and nutrient build-up, preventing oxygen replenishment and high levels of nutrients contribute to and accelerate algal growth, reducing oxygen levels.

As outlined in our response to Recommendation 1, the Integrated Catchment Management Work Program led by the Water Group will examine options for regulatory and governance reforms to deliver improved waterway and catchment outcomes over the long term. The NSW Government will also build on lessons from existing programs such as the Northern Basin Connectivity Program (referred to in response to Recommendation 1.1) and the Clean Coastal Catchments project under the Marine Estate Management Framework to deliver better flow regimes, connectivity and catchment health across the entire state.

OCSE Recommendation 4.1:

Short, medium and long-term fish passage solutions are implemented

Immediate actions (0-12 months)

Install temporary fish passage solutions that can be rapidly retrofitted to the site. Temporary fish passages from Finland and a recently prototyped new tube design show promise but are presently untested in Australian conditions. Any immediate measure considered would need to be installed by December 2023. This would require rapid scoping and design, and assurances that installation could be progressed provided funding and approvals were rapidly secured, as an experimental pilot. Ideally, a comparative trial of both designs would be implemented and rigorously assessed in the coming season to determine whether their long-term deployment would represent effective mitigation measures.

Design and implement a “trap and transport” program in partnership with local communities and/or indigenous ranger groups. Trap and transport systems involve the physical capture and relocation of fish over a barrier. In early 2019, DPI Fisheries trapped and relocated 20 stressed Murray cod from a pool downstream of Weir 32. At Menindee this would require the regular movement of fish “accumulating” downstream of Pamamaroo outlet or Menindee Main Weir and release into upstream sections. It would require an investment of resources and training to ensure fish safety and minimise stress during handling

- Monitor water quality and subsequently close fish passages at Burtundy, Pooncarie and Weir 32 at low levels of dissolved oxygen. The closure of these fish passages would prevent the further concentration of fish into the impacted zone
- Accelerate and implement modifications to existing Burtundy, Pooncarie and Weir 32 fishways. Both the MDB Native Fish Strategy and the NSW Fish Passage strategy note that existing fish passage solutions at Burtundy, Pooncarie and Weir 32 are sub-optimal designs that require modifications to improve operations over a wider range of flows. Further, these designs do not take into account Traditional Aboriginal knowledge or cultural considerations
- Publicly release results of the temporary fish passage pilot at Pamamaroo inlet.
- Develop a detailed, stand-alone business case for fishways at Menindee Lakes and at the high priority sites to enable funding to be considered separate to broader works or larger programs that are often beset by implementation delays

Support

The NSW Government is committing \$6.52 million for DPI Fisheries to undertake a trial of new fish passage technologies, particularly tube fishway designs that could be applied at Menindee.

DPI Fisheries completed site inspections at Menindee in November 2023 to explore a “trap and transport” short-term solution, in the event it would be needed as an interim solution to allow native fish to move upstream of the Menindee town weir pool and remove carp at the same time. Trap and transport refers to attracting native fish into a trapping cage housed within a structure and then transferring them into a specialised fish transporter truck and driving them to the designated release point upstream.

Two potential options for fish transport and haul facilities were considered as part of investigations. Based on analysis of this work, it was determined that a standalone ‘trap and transport’ system retrofitted to existing infrastructure was not a viable option to address immediate short-term fish passage needs. Instead, DPI Fisheries is focusing on the trial of new fishway technologies that could be implemented in a relatively shorter timeframe and help inform future fish passage options at Menindee and other priority sites.

The Menindee Lower Darling Water Quality Working Group has integrated ongoing water quality monitoring, including reviewing real time data (see response to Recommendation 2.2) into standard operations when conditions deteriorate, whilst other actions to reduce risks to native fish have also been implemented such as temporarily blocking fish passage at Weir 32. During periods of hypoxic risk, the fishway at Weir 32 will remain closed and the Lake Pamamaroo inlet regulator is closed when pulses are released from Lake Pamamaroo to prevent poor-quality water from Lake Wetherell moving downstream.

In 2020 and 2021, NSW DPI Fisheries researchers identified multiple cohorts of juvenile golden perch in the Menindee Lakes and downstream in the Lower Darling–Baaka. As the lakes began to fill to capacity, in late October and early December 2021 WaterNSW and DPI Fisheries staff undertook a trial of a temporary fishway in the Lake Pamamaroo inlet regulator to facilitate movement of native fish from Lake Pamamaroo ‘upstream’ into Lake Wetherell. DPI Fisheries subsequently conducted trapping trials, which confirmed golden perch did pass from Lake Pamamaroo to Lake Wetherell via the temporary fishway when the difference in water level across the regulator was less than 60 cm. Dozens of golden perch from 100 mm juveniles to 400 mm long adults were detected passing through the fishway in just a few hours of monitoring. Due to the opportunistic nature of the trial and subsequent trapping, results have not been published but more information can be found here [Making the Connection: Providing Temporary Fish Passage at the Menindee Lakes – Finterest](#).

Our response to Recommendation 4 immediate term measures above covers other elements of this recommendation.

In addition to the actions outlined in response to Recommendation 4 above – immediate term measures, the NSW Government will take the following action to deliver the immediate term element in Recommendation 4.1:

Action: FR26 Scope “trap and transport” by fish sorting as part of Action: FR21 Complete a trial of new fish passage technologies including the tube fishway with fish sorting opportunities.

Rec(s): 4.1 immediate term

Funding: \$6.52 million new budget commitment for Recommendation 4e

Lead agency: DPI Fisheries

Delivery timeframe: 30 June 2028



Weir 32, Menindee

Mid-term actions (1-2 years)

- Investigate (through detailed engineering designs) permanent fish passage solutions for the Pamamaroo outlet and inlet and the Menindee Main Weir/Wetherell outlet:
- Lake Pamamaroo outlet and inlet: this solution would allow fish to migrate upstream into Lake Pamamaroo and downstream, to complete the connection to the Darling–Baaka.
- Menindee main weir: This site is problematic as it serves to act as an overflow weir and does not constantly release water under current operating rules. Provision of passage at this location would require an operational rule change to facilitate flows more frequently. As this site also contains sluice gates, which are harmful to fish, the installation of an overflow LayFlat gate would be required to provide adequate upstream and downstream pathways.

Support

Permanent fish passage solutions for the Pamamaroo outlet and inlet and the Menindee Main Weir/Wetherell outlet will be investigated (including through detailed engineering designs) as part of development of the full business case under Action FR23 (see response to Recommendation 4 mid-term strategies in above section).

Long-term actions (3-5 years)

Implement a long-term program with local communities and indigenous groups. This would integrate and operationalise the suite of solutions needed to protect fish passage, and water quality, in the Darling–Baaka. Reconnecting the Darling–Baaka will require a long-term commitment, funding and detailed works program. Annual checks should be performed to ensure all implemented solutions are operating efficiently and appropriately and that there are positive changes to fish communities throughout the Lower-mid Darling–Baaka system.

Support

See response to Recommendation 4 long-term strategies in above section.



Lake Pamamaroo, Menindee

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