

Murray and Lower Darling Valleys

Annual Environmental Watering Plan 2014-2015



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Cover photo: Australian White Ibis, Straw-necked Ibis and Royal Spoonbills nesting in the Common Reed beds at Reed Beds Swamp, Murray Valley National Park (Moirra Precinct), December 2013 (Emma Wilson, OEH).

Summary

The *Murray and Lower Darling Valleys Annual Environmental Watering Plan 2014–15* outlines the objectives and potential actions for environmental water delivery in the NSW Murray and Lower Darling valleys for the 2014–15 water year. This watering plan was developed by the Office of Environment and Heritage, based on advice from the Murray Lower Darling Environmental Water Advisory Group.

Watering proposals have been presented for a range of water availability scenarios. These scenarios provide a guide as to what watering actions may be possible. However, flow conditions that develop during 2014–15 and the availability of allocation will be influential in determining the delivery of environmental water. Early-season predictions by the Bureau of Meteorology suggest that dry conditions will continue, with rainfall likely to be average or below average, which would be reflected in catchment inflow volumes.

The Murray Lower Darling Environmental Watering Advisory Group considered the condition of wetlands, water availability and climate forecasts and has recommended that the focus for environmental water delivery in 2014–15 should be to maintain basic functions and resilience of wetlands and building on the positive environmental outcomes of the recent years.

The 2014–15 water year should provide average storage volumes and environmental water availabilities because of the moderate to low inflows in 2013–14. Up to approximately 146.2 gigalitres (GL)¹ of combined AEW and CEW allocation should become available for environmental water delivery at the beginning of the water year. This volume is made up of NSW environmental water holdings, Commonwealth environmental water holdings and water provided for by the Murray and Lower Darling Regulated Rivers Water Sharing Plan, but excludes the Barmah-Millewa Allowance and The Living Murray Allowance.

Many wetlands in the Murray and Lower Darling valleys require several consecutive years of inundation to restore condition and ensure the survival and health of riparian trees and vegetation communities. Building the resilience of wetlands will support waterbirds, fish and provide habitat for frogs.

Many wetlands also require a drying phase to allow vegetation to complete biological lifecycles and for sediments to stabilise. Wetlands in a dry phase will only be watered as a contingency, for example, if bird breeding commences and needs to be supported to completion.

The available water holdings in the Murray and Lower Darling valleys provide an opportunity to meet priority watering actions for core sites under a range of seasonal conditions. While environmental water holdings will be focused on the sites highlighted in the plan, they will also be used to maximise environmental outcomes and to support in-stream habitat as water is being delivered.

¹ This volume is current from 31 May 2014.

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Abbreviations

AEW	Adaptive Environmental Water
AHD	Australian Height Datum
AWD	available water determination
BMEET	Barkindji Maraura Elders Environment Team
CEW	Commonwealth environmental water
CEWO	Commonwealth Environmental Water Office
CSU	Charles Sturt University
DAAMMP	Darling Anabranch Adaptive Management Monitoring Program
DO	dissolved oxygen
DPI	Department of Primary Industries
EC	electrical conductivity
EWA	Environmental Water Allocation
EWAG	Environmental Water Advisory Group
GL	gigalitres (1,000 megalitres)
ha	hectares
JCGC	Jimaringle, Cockran and Gwynnes Creeks
km	kilometres
LLS	Local Land Services
MDBA	Murray Darling Basin Authority
MDOG	Murray Dissolved Oxygen Group
MDFRC	Murray Darling Freshwater Research Centre
MDWWG	Murray Darling Wetlands Working Group
ML	megalitres (1,000,000 litres)
MLS	Menindee Lakes Storage
MPID	Moira Private Irrigation District
Murray AEA	Additional Environmental Allowance
NOW	NSW Office of Water
NP	National park
NPWS	National Parks and Wildlife Service NSW
EWH	Environmental Water Holdings
OAG	Operations Advisory Group
OEH	Office of Environment and Heritage
PPWP	Private Property Wetlands Project
RAS	Resource Availability Scenario
RRG	River Red Gum
SBF	Southern Bell Frog
SPP	Southern Pygmy Perch

SWC	State Water Corporation
TLMSCG	Thegoa Lagoon Management Steering Committee Group
TLM	The Living Murray
WCPID	West Corugan Private Irrigation District
WSP	Water Sharing Plan (for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2003 version)

1 Introduction

The Office of Environment and Heritage (OEH) is the leading manager of environmental water in New South Wales. OEH works collaboratively with partner agencies and the community to deliver water aimed to protect and improve the environmental values of our rivers and wetlands. At the same time, OEH recognises the economic value of floodplain agriculture and works with its delivery partners to minimise adverse third party impacts.

Environmental water supports the ecological function and condition of important assets in the Murray and Lower Darling valleys – wetlands, floodplains, rivers and creek channels. The freshwater habitats in the Murray and Lower Darling valleys are hydrologically and ecologically complex and contain important ecological assets including floodplains, ephemeral lakes and a variety of wetlands and in-stream habitats. Several sites are recognised internationally under the Ramsar Convention including the NSW Millewa Forests (36,000 hectares) which make up over half of the Barmah–Millewa Forest, recognised as the largest River Red Gum forest in the world. The Millewa Forests are identified in *A Directory of Important Wetlands in Australia* (Environment Australia 2001) and are managed as national park estate. The Barmah–Millewa Forest is also one of the six icon sites supported by The Living Murray program.

Parts of the Murray and Lower Darling valleys are important habitat for several threatened and vulnerable fauna. The Millewa Forest provides suitable habitat for the southern pygmy perch, breeding habitat for colonial nesting waterbirds and migratory birds, with several listed under international agreements, and nesting and foraging habitat for the Superb Parrot. Several mid-Murray sites provide habitat for the bush stone-curlew, Australasian bittern and brolga, and several sites in the mid-Murray and lower Murray Darling support the southern bell frog and may provide breeding habitat for the regent parrot. This *Murray and Lower Darling Valleys Annual Environmental Watering Plan 2014–15* identifies a number of sites that would benefit from environmental water over the coming year, which aims to support the function and condition of these ecological assets.

OEH manages environmental water in the Murray and Lower Darling valleys on behalf of NSW, and assists with the planning and management of Commonwealth environmental water. OEH manages environmental water made available primarily through three main sources:

- NSW Environmental Water Holdings (NSW EWH)
- Commonwealth environmental water (CEW)
- the *Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Sources 2003* (WSP) (NSW Government 2003), which makes provision for an Additional Environmental Allowance derived from high security licence allocations.

Environmental water is also available under The Living Murray initiative (TLM). TLM icon sites in NSW include Millewa, Perricoota-Koondrook, the eastern section of Chowilla Floodplain and the River Murray Channel. Watering of these sites is coordinated by the Murray Darling Basin Authority (MDBA) and undertaken in conjunction with the relevant states. This document does not report in detail on TLM water and further details can be found at www.mdba.gov.au/programs/tlm. OEH assists with the preparation of environmental watering plans for the Barmah-Millewa icon site in collaboration with the Victorian Environmental Water Holder and Goulburn-Broken Catchment Management Authority.

This plan provides the objectives for environmental water use from July 1st 2014 through to June 30th 2015. It describes the range of possible watering actions that may be undertaken during the coming water year, considering the environmental water used during 2013–14, the current condition of assets, and the current and predicted water availability for 2014–15. It outlines the monitoring strategy for the coming year and identifies risks and strategies to address those risks.

This plan was developed by OEH based on advice from the Murray Lower Darling Environmental Water Advisory Group (MLD EWAG). The MLD EWAG is a multi-stakeholder reference group which provides a forum for drawing on expert knowledge, including local knowledge and experience. It advises OEH on the implementation and adaptive management of watering actions through the watering year.

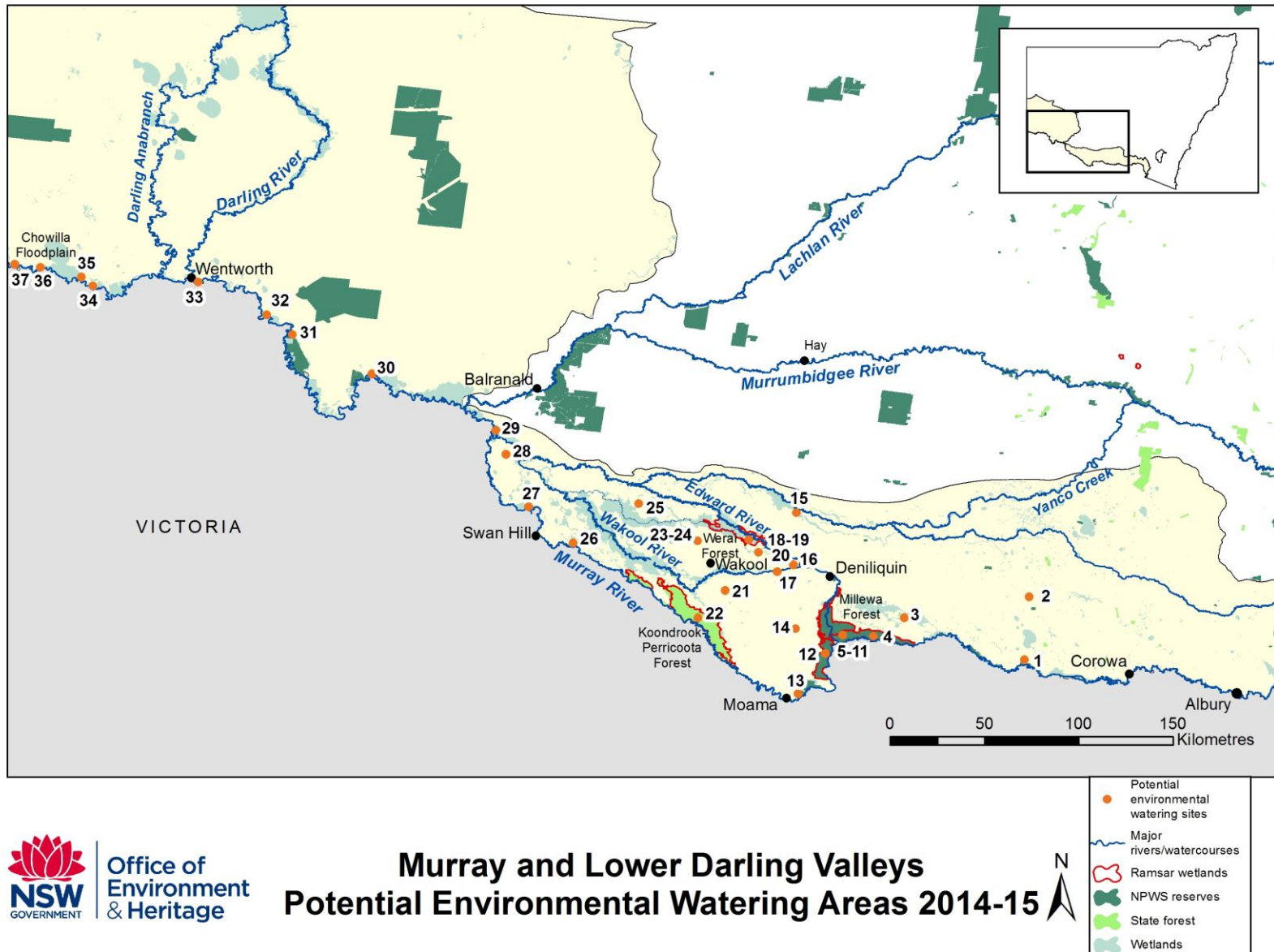
Management of environmental water must be adaptive due to changing water availability, in-stream flows and the event-specific ecological response to flows (for example, waterbird breeding colonies may establish in some years and not others, and nesting may, for various reasons, commence earlier or later than previous years). This plan provides guidance and flexibility so that managers can respond to changes in water resource conditions, opportunities and environmental priorities as the season progresses. At the end of the water year, watering activity is reported in the *Murray Lower Darling Adaptive Environmental Water Use Report* and the *Environmental water use in NSW: Annual Report*.

This plan is consistent with the Water Act 2007 – Murray Darling Basin Plan 2012 implementation, Water Sharing Plan (WSP) for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2003 and The Living Murray Annual Environmental Watering Plan (MDBA 2014). The Commonwealth Environmental Water Office (CEWO) also produces plans and reports in relation to its water holdings.

Table 1-1 identifies the 37 potential environmental watering events for 2014-15. The map (Figure 1) following shows the location of the sites. Map numbering does not indicate the priority or sequence of watering, it is simply a numbering system used for the filing system of the OEH. Additional details for each site are provided in section 5 of this document.

Table 1-1: Murray and Lower Darling Valleys environmental watering events proposed for 2014-15

Number	Site	Number	Site
1	Boomanoomana Swamp (Murray Valley NP)	23	Jimaringle and Cockran creeks
2	West Corurgan PID	24	Gwynne's Creek
3	Tuppal Creek	25	Murrien-Yarrien Creek System
4	Multi-Site Watering (Barmah-Millewa Forest)	26	Brechin
5-11	Murray Valley NP (Millewa) sites: a) Pinchgut Lagoon b) Toupna Creek/Douglas Lagoon c) Reed Beds/Coppingers Swamp/Duck Lagoon d) Walthours Swamp/Clay Island e) Moira Lake/Porters Plain f) McCartneys Creek g) Horseshoe Lagoon	27	Speewa Creek
12	Murray Valley National Park (colonial waterbird nesting)	28	Goodnight (Bingerra Creek)
13	Hypoxic blackwater / low DO mitigation (Murray River)	29	Wee Wee Creek
14	Sandridge (Moira PID)	30	Lock 15 weir pool manipulation
15	Wanganella Swamp (colonial waterbird nesting)	31	Bengallow Creek
16	Hypoxic blackwater / low DO mitigation/ (Edward-Wakool system)	32	Bottle Bend Reserve
17	Edward-Wakool fish flows	33	Thegoa Lagoon
18	Werai Forest (Tumudgery Creek)	34	Lock 8 and 9 weir pool manipulation
19	Werai Forest (Reedbeds Creek)	35	Carrs, Capitts and Bunberoo creeks
20	Elimdale	36	Lake Victoria Station (Yamborah Wetland)
21	Private Property Wetlands Project	37	Cliffhouse
22	Koondrook-Perricoota Forest Flood Enhancement Works commissioning flow		



Murray and Lower Darling Valleys Potential Environmental Watering Areas 2014-15

Figure 1-1: Proposed NSW Murray and Lower Darling environmental watering sites, 2014-15

2 Environmental water releases 2013–14

During 2013-14 100% of the NSW Adaptive Environmental Water (AEW) entitlements were allocated, and therefore nineteen separate wetland and waterway sites received environmental water. Significant volumes were used for a River Murray multi-site trial, Darling Anabranch, Edward-Wakool Fish Flow (which includes Yallakool Creek), and Millewa Forests waterbird rookeries. Smaller volumes were delivered to sites such as the Tuppall Creek, Neimur River and Speewa Creek (tables 2.1 and 2.2). These projects in particular provided immeasurable community and ecological benefits, and helped to strengthen relationships between agencies and stakeholders, which aligns with objectives 9 and 10 for environmental water management (Section 5.3).

The Resource Availability Scenario (RAS) for 2013-2014 was forecast as 'wet' by the NSW Office of Water (NOW) in March 2013. This forecast was substantiated by inflows at the start of the season exceeding those of 2012-2013 and the long-term average, but since September 2013 inflows gradually decreased.

Murray system daily inflows (excluding Snowy and Darling Rivers inflows) for 2012-2013, 2013-2014 the past 10 year's average and the long-term average are shown in the graph below.

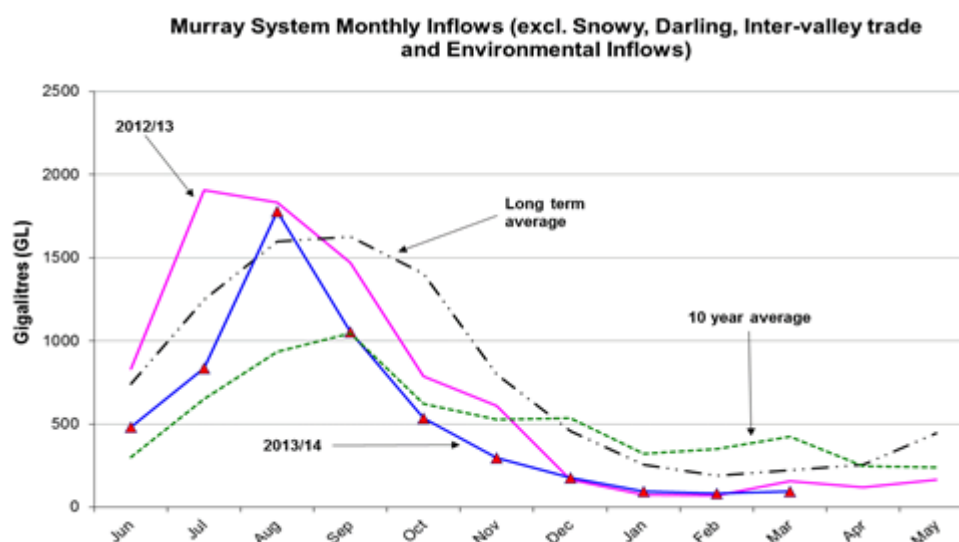


Figure 2-1: Murray system monthly inflows excluding Snowy and Darling Rivers, inter-valley trade and environmental inflows. *Source: MDBA River Murray Weekly Report, 09/04/2014*

Table 2-1: Summary of environmental water volumes available and volumes used in the Murray and Lower Darling valleys during 2013-14.

Water source	Volume available (ML)	Volume used (ML)
NSW AEW Conveyance	30,000	30,000*
NSW AEW High security	2,027	2,027*
CEW [^]	235,208	117,781
Total	267,235	149,808

*Figures include 3,769 ML of water traded

[^]CEW water figure includes only NSW Murray Valley water holdings

Monitoring at most watered sites in 2013–14 was conducted by OEH staff. The Jimaringle, Cockran and Gwynnes Creeks and Tuppal Creek projects were monitored by OEH staff (volume delivery, vegetation, waterbirds, frogs) and Murray Local Land Services (LLS) staff (water quality and flow front). Monitoring for the Edward-Wakool Fish Response project was funded by CEWO and conducted by Charles Sturt University (CSU), in collaboration with OEH, Murray LLS, Department of Primary Industries (DPI) Fisheries and Monash University. Darling Anabranh watering monitoring was conducted by the Murray-Darling Freshwater Research Centre (MDFRC) and OEH and funded under the Darling Anabranh Adaptive Management Monitoring Program (DAAMMP).

Table 2-2: Summary of the 2013–14 Murray-Lower Darling Valley's watering events using water sourced from NSW AEW and/or CEW.

Wetland	Water delivery location	NSW AEW (ML)	CEW (ML)	Date water delivery commenced	Date water delivery ceased	Tenure
Darling Anabranh	Menindee Lakes (Cawndilla)	8,243	47,000	16/09/2013	9/12/2013	NOW, NPWS and private property
Rilverside	West Cororgan PID	230		13/09/2013	14/10/2013	Private property
Private Property Watering Project	Murray Irrigation	430		5/10/2013	4/01/2014	Private property
Tuppal Creek	Murray Irrigation	1,975	2,000	8/10/2013	6/12/2013	NSW Crown Land and private property
Fletchers Creek	MDWWG temporary pump	291		10/12/2013	8/04/14	NOW
Edward Wakool Fish Flows	Edward River (Stevens Weir)		Part of the Multi-site Trial	4/10/2013	16/12/2013	NSW Crown Land and private property
Lock 8 & 9 Weir pool Manipulation	Murray River		216	16/10/2013	30/04/2014	NOW

Wetland	Water delivery location	NSW AEW (ML)	CEW (ML)	Date water delivery commenced	Date water delivery ceased	Tenure
Multi-site Trial	Murray and Goulburn rivers		100,000	4/10/2013	14/12/2013	NSW and VIC state government managed land and private property
Riverside (top-up)	West Cororgan PID	69		6/12/2013	12/12/2013	Private property
Reed Beds Swamp	Murray River (Yarrowonga Weir)	13,016		14/12/2013	6/02/2014	Murray Valley NP
St Helena Swamp	Murray River (Yarrowonga Weir) and Edward River Offtake		750	14/12/2013	30/12/2013	Murray Valley NP
Yallakool recession flows	Edward River (Stevens Weir)		8,494	17/12/2013	6/02/2014	NSW Crown Land and private property
Niemur Continuation Flow	Edward River (Stevens Weir)		5,759	7/02/2014	14/03/2014	NSW Crown Land and private property
Reed Beds Creek (Werai)	Edward River (Reed Beds Creek Regulator)	512		20/02/2014	23/02/2014	National Park/Indigenous Protected Area
Tuppal Creek (top-up)	Murray Irrigation	750	562	26/03/2014	28/04/2014	NSW Crown Land and private property
Sandridge	Moira Private Irrigation District	43		12/04/2014	12/04/2014	Private Property
Speewa Creek	Murray River	500		24/05/2014	28/06/2014	NSW Crown Land and private property
PPWP (Autumn) 'Woperana'	Murray Irrigation/privately owned channel	60		1/4/2014	13/4/2014	Private property
Gwynnes Ck	Murray Irrigation	112		08/04/14	25/04/14	Private property
Bottlebend	Pumping contractor	2,000		21/05/14	21/06/14	NSW Crown Land
Trade		3,769*				
TOTAL		32,027	117,781			

* Includes trade of 1,769 ML to TLM for proposed 2014-15 Koondrook-Perricoota Forest Flood Enhancement Works commissioning flow.

2.1 Ecological response overview

The fauna and flora of Murray and Lower Darling sites that received environmental water in 2013–14 generally responded positively. There was an observed increase in foliage cover on riparian trees such as River Red Gums and Black Box, and understorey lignum throughout the system.

Numerous waterbirds, including colonial nesting waterbirds (Australian White Ibis, Straw-necked Ibis, Little Black and Little Pied cormorants, and Royal Spoonbills) and the threatened Australasian Bittern, responded to environmental water diverted into the Gulpa Creek Wetland Complex (Reed Beds Swamp, Duck Lagoon and Coppingers Lagoon) and St Helena-Black Swamp sections of the Murray Valley National Park (Millewa and Moira precincts).

Nine species of frogs were observed in 2013-2014 in generally high numbers. Frog abundances were similar to observations made in 2012-13 and there was evidence of frog breeding and recruitment at several watered sites throughout the Murray and Lower Darling region.

The use of a 'multisite' watering approach was trialled in 2013-14 by the Murray–Darling Basin Authority, in consultation with Basin states. The aims were to deliver large volumes of environmental water in a coordinated way to provide multiple system benefits such as: native fish migration, recruitment and dispersal; Moira Grass (*Pseudoraphis spinescens*) and *Widgeon Grass (Ruppia spp)* recovery; improvement in water quality (eg. salinity and nutrient export, and organic carbon exchange); native riparian vegetation condition, and; waterbird nesting. Such an approach used approximately 360 GL of environmental water sourced from TLM, CEW, NSW and Victorian environmental water sources.

The Edward-Wakool Fish Response project looked at fish response to flow pulses and how to promote native fish movement and spawning using environmental flows. In the Edward Wakool River system riverbank and submerged vegetation increased in cover during environmental flows following a more gradual recession of managed flows, potentially providing habitat for aquatic fauna. Higher diversity and abundances of native wetland associated plants were also observed at most of the Murray sites.

The delivery of AEW into Thegoa Lagoon was initially planned for early June 2014. The MLD EWAG endorsed this watering event on the proviso that the site was completely dried beforehand so that large numbers of adult carp would be eradicated. However, the lagoon did not completely dry. In May 2014 OEH funded a carp extraction program with the objective of removing all carp from the large residual pool located on the western end of the lagoon. In excess of five tonnes of carp were extracted, but an unknown quantity of large mature fish remained. Considering that complete drying was unlikely to occur before the end of June 2014, the EWAG unanimously voted at its 14th May 2014 meeting to withdraw this event from the 2013-2014 program.

The Darling Anabranch received its first solely environmental entitlement generated flow in 2013-14 and riparian vegetation surveys and intervention monitoring was undertaken as part of the DAAMMP. An increase in foliage cover River Red Gums and Black Box was observed during the DAAMMP, and selected monitoring reports are located at: <http://www.mdfrc.org.au/publications/>.

Further details on individual sites watered and monitoring results will be incorporated in the *Murray Lower Darling Adaptive Environmental Water Use Report 2013–14*. Information on CEW use and availability can be found at

www.environment.gov.au/ewater/about/index.html or in the outcomes and annual reports located at www.environment.gov.au/ewater/publications/index.html.

3 Current condition of assets

A broad spectrum of sites identified across the Murray and Lower Darling valleys range from poor condition to good condition. More description for sites is provided in section 5. The sites nominated for environmental water in 2014–15 are primarily dominated by River Red Gum and/or Black Box communities, which declined in condition during the Millennium drought.

Over the last three years, and coinciding with consecutive high system flows, there has been an overall improvement in these communities in the Murray and Lower Darling, such as increased foliage cover and increased abundances of understorey and associated wetland plant species (Bogenhuber *et al.* 2011; Bogenhuber *et al.* 2013; Bogenhuber and Linklater 2012; Campbell *et al.* 2012; Doody and Overton 2012; Watts *et al.* 2013). Similar vegetation responses have been observed in the mid-Murray in particular at sites within the Private Property Wetlands Project (PPWP) and individual sites including Gwynnes Creek and Tuppal Creek.

4 Estimates of environmental water availability

4.1 Seasonal outlook – rainfall

NSW recorded a state-wide average rainfall of 91.1 mm during summer 2013-14, well below the historical average of 170 mm. This is the driest summer for NSW since 1984-5 when 75.1 mm was recorded in summer, and is the tenth-driest summer on record. The Murray Darling Basin also recorded its driest summer since 1984-5 with 92.4 mm (average 144.6 mm). The dry conditions were associated with the persistence of high pressure across the state and a lack of significant rain events. Both December 2013 and January 2014 had well below average rainfall, particularly in the northeast, with some relief of dry conditions associated with rain events in the second half of February (BOM 2014a).

A drier than normal season is more likely for parts of northeast NSW during 2014-15. The chances of exceeding the median rainfall during April to June are 35 to 40% over parts of northeast NSW. In other words, the chances of below average rainfall are 60 to 65% over these areas (BOM 2014b).

4.2 Storage (as at May 2014)

MDB storages are more than 700,000 ML lower than this time last year and NSW share of resource is only 54 % of what was available at last year's forecast 1 July allocations. Murray Valley inflow conditions have been below the long-term average over summer, with February inflows only 45 % of the long-term average (DPI 2014).

It is anticipated that Hume Dam will be down to approximately 200 GL (include %) by the end of June 2014 thus triggering a need to transfer water from Dartmouth Dam in order to meet demands in 2014-15. Winter and early spring rainfall will determine how full the storages are and therefore how strong early season allocations will be (TLM 2014).

The Menindee Lakes storage volumes are currently 21 % (May 2014) and have subsequently returned to NOW management. As storage levels at Menindee Lakes are considered low, and environmental water for the Darling Anabranch is delivered from Lake Cawndilla, it is very unlikely that the Darling Anabranch will receive environmental allocation in 2014-15.

Furthermore, any environmental water proposed to be delivered from the Lake Cawndilla would need to be reviewed and permitted at NOW's discretion.

4.3 Allocation announcements

NOW has forecast that NSW Murray high security access licences are expected to receive 97 % entitlement. At this stage (April 2014), it is estimated that general security carryover will average around of 30 % of entitlement, however this is highly dependent on weather conditions over the next few months and individual decisions by water users. It is expected that opening general security allocation will be zero percent of entitlement if dry conditions continue.

Under the Water Sharing Plan, the NSW share of the Barmah-Millewa Forest account water may be borrowed to provide for general security where the general security plus average carryover is less than 30 %. The rules for water sharing are outlined in the *NSW Murray and Lower Darling Regulated River Water Sharing Plan*. There was no allocation to Murray Additional Environmental Allowance (AEA) this water year (2013-14), as water was pre-released from Hume for flood management purposes during the year. However, the AEA (~6 GL) will be set aside for potential use in 2014-15 once high security entitlements reach 97 %.

4.4 Trade and environmental water availability

The figures quoted in this section have not been adjusted for possible future trade. OEH trades allocations periodically to cover a proportion of water use charges associated with environmental water holdings. The volume of environmental water to be traded in the valley will be determined by the price in the local market and the targeted level of cost recovery. OEH manages trade of NSW environmental water holdings (including the Murray AEW entitlements) based on state-wide trading opportunities and equity between valleys.

Table 4-1: Environmental water availability in the Murray and Lower Darling Valleys at 1 July 2014.

Account	Maximum capacity (ML)	Volume available at 1 July (ML)
EWA		
Murray Additional Environmental Allowance	29,702	5,940*
NSW AEW		
Murray – conveyance	30,000	18,500 (30% allocation)**
Murray – high security	2,027	1,966 (97% allocation)
CEW***		
Murray – general security	328,743	104,000 (carryover)^
Murray – high security	15,126	Up to 14,672 (97% allocation)
Lower Darling – general security	795	Up to 795 (100% allocation)
Lower Darling – high security	394	Up to 394 (100% allocation)

Note: This table does not include water available under the Barmah-Millewa Allowance and TLM program. See www.mdba.gov.au/programs/tlm

* Minimum Additional Environmental Allowance is based on 198,011 ML high security Murray unit shares x 0.03 ML (5940.3 ML) and maximum 198,011 ML high security Murray unit shares x 0.15 ML (27,701.6 ML) from the WSP.

** Volume based on conveyance licence conversion scale where 56% = 21.52 GL.

*** At 22 May 2014 this information was correct and may change as other CEW holdings become available. These figures only include NSW Murray general security and conveyance entitlements.

^ Estimated CEW carryover as of 31 May 2014.

A proportion of the holdings will be available for use in the Murray and Lower Darling Valleys during 2014–15.

The chances of improved general security allocation based on different inflow conditions shows that a very dry (drought) to moderate conditions are impending (Table 4-2).

Table 4-2: Forecast for general security allocation for the Murray-Lower Darling in 2014-15.

Potential Inflow Conditions*	1 July 2014	1 Sept 2014	1 Nov 2014
99 chances in 100 (drought)	0%	0%	0%
9 chances in 10 (very dry)	0%	6%	22%
3 chances in 4 (dry)	4%	14%	42%
1 chance in 2 (average)	10%	29%	70%

* using all years multi-history modelling

Source: DPI (2014)

5 Objectives for the water year

5.1 Resource Availability Scenario (RAS) for 2014-15

In 2013-14 there was strong early rainfall across the large parts of the basin. Water storages were approaching full from spring to early summer. Conditions since December have been drying with little rainfall forecast for the coming months (TLM 2014). Murray Valley inflow conditions have been below the long-term average over the 2013-14 summer, with February 2014 inflows only 45% of the long-term average. Currently River Operations anticipates Hume Dam will be down to 200 GL by the end of June and there will need to be transfers from Dartmouth in order to meet demands in 2014-15. Winter and early spring rainfall will determine how full the storages are and therefore how strong early season allocations will be. An update to this preliminary forecast of water availability for 2014-15 will be made in mid-May (DPI 2014). For forward planning purposes, five resource availability scenarios (RAS) are used to assist with planning and prioritisation for the following year: very dry, dry, moderate, wet and very wet.

In consideration of this, the RAS for 2014–15 has been determined as dry - moderate. The chances of a very dry, wet and very wet scenarios appear to be highly unlikely at this stage, and therefore, no planning for these scenarios has been included in this plan.

5.2 Relevant approvals and processes anticipated for 2014–15

All prioritised sites outlined in the plan require appropriate approvals and licences granted by NSW Office of Water (NOW) before the start of environmental water delivery, or require written landholder agreements before environmental watering can be undertaken in 2014–15. There are also preparatory works required to complement the environmental watering in some instances which also require permits and/or approvals which also need to be obtained from NOW.

OEH Regional Operations Group undertakes a 'Form A' approval process for each watering event. For the Murray and Lower Darling, the Form A must be approved by the Regional Manager (South West) and/or the Executive Director South Branch. Approved Form A's are then forwarded on to OEH's Environmental Water Governance section, who administer the NSW Governments environmental water licenses and submit water orders to State Water Corporation.

The ability to deliver environmental water is limited by system constraints such as channel capacity, the use of irrigation infrastructure and potential third-party impacts such as the restriction of access to land and/or stock by landholders. Flows will be adaptively managed to integrate with other demands in the system and higher natural flows and will be maintained to not cause inconvenience for landholders where possible. If inconvenience is a risk, discussions with affected landholders to determine how to proceed, and written agreements will likely be sought.

The commissioning of The Living Murray funded works is scheduled for 2014-2015. There is unlikely to be sufficient TLM water for the commissioning of the Koondrook-Perricoota Forest Flood Enhancement Works, so AEW and Murray Additional Environmental Allowance (AEA) is likely be required to assist with the testing of infrastructure and risk mitigation measures.

An agreement between OEH and Murray Irrigation to use Murray Irrigation's infrastructure to deliver environmental water in the mid-Murray is in place. The agreement outlines water accounting and the responsibilities and obligations of each agency for the 2014–15 water year and encourages better management and outcomes for environmental water delivery in this area. Projects which will fall under this agreement include the PPWP, the Jimaringle, Cockran and Gwynnes Creeks, and Tuppal Creek and Murrien-Yarrien System.

Table 5-1: Sites identified in 2014-15 that require approval and/or agreements and/or specific risks identified prior to receiving environmental water.

Site	Relevant approvals required in 2014-15			
	<i>Conditional on Murray Irrigation and OEH agreement and/or NOW's discretion</i>	<i>Written/updated CEWO and/or landholder agreements required</i>	<i>Risk management required</i>	<i>NOW work and use approvals to be obtained</i>
Boomanoomana Swamp (Murray Valley NP)	Yes	No	No	N/A
West Corurgan PID	No	Yes	No	N/A
Tuppall Creek	Yes	Yes	yes – monitoring of salinity levels in sediment and water required	Yes
Toupna Creek/Douglas Swamp (Murray Valley NP)	N/A	No	yes – risk of stranding Murray Cod behind forest regulators if operated inappropriately	obtained
Multi-Site Watering (Barmah-Millewa Forest)	N/A	No	Yes – monitoring of Moira Grass plains required and consideration of third party impacts	obtained
Murray Valley NP sites	N/A	No	No	obtained
Murray Valley National Park (colonial waterbird nesting)	N/A	No	yes – monitoring and reporting (to the OAG) required to ensure nestling to fledgling success	obtained
Sandridge (Moira PID)	No	Yes	No	N/A
Werai Forest (Tumudgery Creek)	N/A	No	No	obtained – however, the regulator urgently requires a meter
Werai Forest (Reedbeds Creek)	N/A	No	No	obtained – however, the regulator urgently requires a meter
Koondrook-Perricoota Forest Flood Enhancement Works commissioning flows	N/A	No	yes – management of potential third party impacts and hypoxic blackwater mitigation measures	obtained
Private Property Wetlands Project	Yes	Yes	no	N/A
Wanganella Swamp (colonial waterbird nesting)	No	No	yes – constant monitoring and reporting required to ensure nestling to fledgling success	OEH is investigating the feasibility of pumping from Wanganella Station

Site	Relevant approvals required in 2014–15			
	<i>Conditional on Murray Irrigation and OEH agreement and/or NOW's discretion</i>	<i>Written/updated CEWO and/or landholder agreements required</i>	<i>Risk management requires investigation</i>	<i>NOW work and use approvals to be obtained</i>
Elimdale	Yes	Yes	no	obtained
Brechin	No	Yes	no	obtained
Gwynne's Creek	Yes	Yes	no	N/A
Murrien-Yarrien Creek System	Yes	Yes	yes – high salinity and PASS issues	Yes
Lock 8 and 9 weir pool manipulation	Yes	No	yes – impacts to downstream users	obtained
Speewa Creek	No	Yes	no	obtained
Goodnight (Bingerra Creek)	No	Yes	no	obtained
Wee Wee Creek	No	Yes	no	obtained
Lock 15 weir pool manipulation	Yes	No	yes – downstream user impacts	obtained
Bengallow Creek	No	No	no	Yes
Hypoxic blackwater/low DO mitigation (Murray River and Edward-Wakool system)	Yes	Yes	yes – hypoxic blackwater mitigation options proposed by the Murray Dissolved Oxygen Group to the OAG.	obtained
Carrs, Capitts and Bunberoo creeks	Yes	No	no	-
Thegoa Lagoon	No	No	no	obtained
Lake Victoria Station (Yamborah Wetland)	No	Yes	no	obtained
Cliffhouse	No	Yes	-	obtained

5.3 Overall objectives for environmental water management

The primary objectives for the management of environmental water to sites in the NSW Murray and Lower Darling valleys are to:

- 1 improve or maintain the condition and diversity of wetland types in the NSW Murray and Lower Darling valleys
- 2 to improve or maintain the condition and resilience of floodplain vegetation communities
- 3 to improve or maintain the condition and resilience of floodplain faunal communities
- 4 develop a wetting–drying watering regime for ephemeral floodplain environments
- 5 to maximise opportunities to complement high river flows (generated from rainfall in upper unregulated catchments) with additional water to benefit fauna and flora communities and abiotic functioning
- 6 to minimise and manage adverse impacts that highly fluctuating flow rates may have on biotic functioning, such as naturally triggered breeding, in particular for colonial nesting waterbirds and/or native fish populations
- 7 minimise and manage adverse impacts that highly fluctuating flow rates may have on abiotic functioning, such as geomorphological issues including erosional and depositional functions
- 8 provide in-stream and off-channel connection to promote floodplain and channel exchange and benefits such as native fish spawning cues, movement and recruitment opportunities, and interchange of nutrients
- 9 to use adaptive management processes to inform and improve the management of water dependent ecosystems, with consideration of the environmental, social, cultural and economic benefits and opportunities
- 10 maintain and further develop working partnerships with community groups, agencies and stakeholders for environmental watering projects

Under the Dry RAS six out of the ten objectives can be achieved. The MDBA's *Guideline for the method to determine priorities for applying environmental water* (2012) includes guidance on how to determine the relevant resource availability scenarios (RAS) and thus the management outcome that apply to that RAS, which is duplicated in Table 5-2. This table outlines the objectives and the main environmental watering actions under different scenarios. The NSW Office of Water provide a public notification of the forecast RAS prior to the commencement of each water year.

The MLD EWAG have considered the conditions of assets, water availability and climate forecasts and has recommended that the focus for the environmental watering delivery in 2014-15 should be to maintain basic functions and resilience of wetlands and build on the positive environmental outcomes of the recent wet years.

Table 5-2: Basin-wide management outcomes for each Resource Availability Scenario.

	Resource Availability Scenario				
	Very dry	Dry	Moderate	Wet	Very wet
Management	<p>Avoid irretrievable loss of or damage to, environmental assets:</p> <ul style="list-style-type: none"> -Avoid critical loss of species, communities, and ecosystems. – Maintain critical refuges. – Avoid irretrievable damage or catastrophic events. – Allow drying to occur, where appropriate, but relieve unusually prolonged dry periods where sites are at risk by threats, such as disconnection and alteration (i.e acidification) 	<p>Ensure environmental assets maintain their basic functions and resilience:</p> <ul style="list-style-type: none"> – Support the survival and viability of threatened species and communities. – Maintain environmental assets and ecosystem functions, including by allowing drying to occur consistent with natural wetting-drying cycles. – Maintain refuges. 	<p>Maintain ecological health and resilience:</p> <ul style="list-style-type: none"> – Enable growth, reproduction and small-scale recruitment for a diverse range of flora and fauna. – Promote low-lying floodplain-river connectivity. – Support medium-flow river and floodplain functions. 	<p>Improve the health and resilience of water-dependent ecosystems:</p> <ul style="list-style-type: none"> – Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna. – Support high-flow river and floodplain functions. 	<p>Improve the health and resilience of water-dependent ecosystems:</p> <ul style="list-style-type: none"> – Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna. – Support high-flow river and floodplain functions.
Objectives addressed	1,2,4 and 5	1,2,4,5,7, 9 and 10	1,2,4,5,7, 9 and 10	1 - 10	1 - 10

5.4 2014–15 watering priorities

5.4.1 Overview

Thirty seven watering events along the Murray and Lower Darling valleys have been identified and prioritised to receive environmental water in 2014-15. Some sites such as the Murray Valley National and Regional Parks sites and Wanganella Swamp will receive environmental water to supplement waterbird breeding events if they are triggered by natural flows. If waterbird nesting does not occur, these sites will be allowed to dry down, or remain dry, to allow floodplain vegetation communities to complete their life cycles.

Drying is an important function of these ephemeral systems by allowing sediments to stabilise and soils to crack and aerate. This improves the soil structure and the ability of surface water to penetrate into the groundwater system. Floodplain vegetation is essential for ecosystem function (eg. by providing shelter, and breeding and foraging habitats), but also filters sediment, stabilises soils, slows flow velocity, and provides organic matter and carbon to the floodplain and river systems. River Red Gums cannot withstand prolonged flooding, so drying cycles are vital to maintain tree condition and build resilience against insect attack, drought and fire.

This plan outlines options for using environmental water from NSW AEW; however, this plan includes sites that often require more allocation than is in NSW-held entitlements. Environmental water may be used from other sources, such as CEW and TLM. The use of a 'multisite' watering approach trialled in 2013-14 by the Murray–Darling Basin Authority, delivered large volumes of environmental water in a coordinated way to provide multiple system benefits and such an approach will likely be used in 2014-15 using environmental water sourced from TLM, CEW, NSW and Victorian environmental water sources.

This plan operates under highly variable climatic conditions and, as a consequence, the availability of water from one year to the next cannot be reliably predicted. Accordingly, water allocation announcements are often variable and there is potential for unregulated flows caused by floods and high system flows; thus there is a need to be flexible when delivering environmental water. As a result, ecological objectives in the plan are often adaptively managed to accommodate such changes, and it is recommended that sites outlined in the plan should be used as a guide to deliver environmental water rather than being strictly adhered to.

The freshwater habitats in the Murray and Lower Darling valleys are hydrologically and ecologically complex and it is important to align the ecological requirements of aquatic organisms/wetland dependant species and/or vegetation communities to the delivery of environmental water. The multiple taxa groups of these habitats each have varying cues and requirements to breed and recruit; again, there is a need to be flexible when delivering environmental water.

There are occasions when management options are overridden due to unanticipated events. For example, bird breeding at Reed Beds Swamp was triggered by high system flows and required environmental water to maintain breeding habitat during October 2013 to February 2014 and, as a result, thousands of waterbirds successfully bred and fledged their young (OEH,2014).

The timing of environmental water delivery should use the best knowledge available. Timing will often differ between individual site requirements, objectives and unexpected interventions.

5.4.2 Watering priorities for a dry scenario

Under the 'dry' Resource Availability Scenario (RAS), 11 watering events have been identified and prioritised for environmental watering during 2014-15.

Table 5-4: Environmental watering priorities for a 'dry' scenario in 2014-15

Asset location & size	Estimated volume (ML)	Timing	Justification	Inundation History**	Recommendations, work required and additional comments
Boomanoomana Swamp* Murray Valley Regional Park (east of Barooga) 70 ha	400	Spring	Follow up watering to improve vegetation condition.	2009-10 E, 2010-11 F, 2011-12 F, 2012-13 F	This wetland is dominated by Giant Rush. Fringing RRG forest with threatened Squirrel Glider colony occurs nearby. A Yellow Box sand ridge occurs along the southeast edge of the lagoon. Black Swans regularly nest at this site and Brolga's have successfully fledged their young in recent years.
Tuppal Creek* Mid Murray - departs Murray River near Tocumwal and joins Edward River near Deniliquin ~60 kms	3,000	Spring	Improve water quality and promote aquatic vegetation recruitment.	2012-13 E, 2013-14 E, R	Ongoing investigation is required to determine Tuppal Creek's importance for native fish recruitment and/or refuge. OEH is investigating the feasibility of delivering much larger volumes of environmental water directly from the Murray River.
Toupna Creek* Murray Valley NP (Millewa) ~20 km	2,000	Spring	Improve habitat conditions for small bodied wetland specialists including Southern Pygmy Perch (SPP).	2010-11 F, 2011-12 F, 1012-13 F, 2013-14 E, F	To be managed as a Southern Pygmy Perch refuge/recovery site. If shut down too quickly, the Mary Ada Regulator will form a barrier to large bodied native fish (eg. Murray Cod) wanting to return to the Murray River after spawning.

Cliffhouse Lower Murray - near SA border 100kms from Wentworth 6 ha	85	Spring	Maintain Southern Bell Frog (SBF) habitat and promote breeding.	2008-09 E, 2009-10 E, 2010-11 E, 2011-12 F	A block bank needs to be repaired so water can be retained within the wetland.
Pinchgut Lagoon Murray Valley Regional Park (Millewa) 5 ha	100	Autumn	Improve habitat conditions for small bodied wetland specialists including SPP.	2010-11 F, 2011-12 F, 1012-13 F, 2013-14 E, F	To be managed as a Southern Pygmy Perch refuge/recovery site.
Horseshoe Lagoon Murray Valley National Park (Gulpa Island) 15 ha	300	Spring and/or Autumn if required	Improve habitat conditions for small bodied wetland specialists including SPP.	2010-11 F, 2011-12 F, 1012-13 F, 2013-14 E, F	To be managed as a SPP refuge/recovery site. The existing regulator is to be replaced with new structure to improve the operating capability and provide a lower commence to flow into the lagoon. The improvement of this structure is likely to benefit native fish.
Walthours Swamp/Clay* Island Murray Valley Regional Park (Millewa) ~1,000 ha	1,500	Spring or Autumn	Promote aquatic vegetation recruitment.	2010-11 F, 2011-12 F, 2012-13 F	Walthours Swamp is a shallow Giant Rush dominated wetland with a braided waterway system (running through high site quality RRG forest with a Common Reed understorey) that eventually terminates into the Edward River.
Koondrook-Perricoota Forest Flood Enhancement Work commissioning flow ~4,000 ha	~50,000 (to be confirmed - including TLM Allowance, NSW AEW and NSW AEA)	Winter	Flows will be delivered into the Koondrook-Perricoota Forest to test the Flood Enhancement Work.	various floods including: 2010-11 F, 2011-12 F, 2012-13 F	An Operating Plan and Environmental Water Management Plan have been developed by the MDBA (TLM), Forestry Corporation NSW and NSW Office of Water.

Elimdale Mid Murray - on Colligen Ck ~15km west of Deni 12ha/km	150	Spring	Follow up watering event to manage River Red Gum regeneration and maintain the current vegetation condition.	2011-12 E	Rock spill is to be installed to prevent scouring of delivery outlet. OEH is monitoring glider activity at this site using motion detection cameras. A metered regulated culvert is required at this site so that water can be gravity fed from Colligen Creek into the wetland. This would reduce delivery costs and the carbon footprint compared to pumping.
Edward-Wakool system* Blackwater/low DO mitigation	Mitigation action/s to be proposed by the Murray Dissolved Oxygen Group to the OAG.		Improve water quality.		Large volumes of environmental water are likely to be required for hypoxic blackwater mitigation. Practicalities such as delivery limitations, irrigation demand, water quality within channel systems, etc must be considered when determining effective mitigation strategies.
Gwynnes Creek Mid Murray - 35km west of Deniliquin in the Wakool Irrigation district ~15 kms	350	Spring	Improve fringing RRG, Black Box and Lignum condition, and promote the re-establishment of groundlayer vegetation and tall macrophytes (eg. Cumbungi and Common Reed). Maintain SBF habitat and promote breeding.	2012-2013 E, 2013-2014 E	The site is severely degraded by extended periods without flows. OEH is developing a rehabilitation program for the Jimaringale, Cockran and Gwynnes system. SBF surveys are required to determine the status of the local population.
Murray River Hypoxic blackwater/low DO mitigation*	Mitigation action/s to be proposed by the Murray Dissolved Oxygen Group to the OAG.		Improve water quality.		Large volumes of environmental water are likely to be required for hypoxic blackwater mitigation. Practicalities such as delivery limitations/constraints and third party impacts must be considered when determining effective mitigation strategies.

*Contribution from CEW.

**Inundation history: E= environmental watering; F = flood event; R = significant rain event

5.4.3 Watering priorities for a moderate scenario

Under the 'moderate' Resource Availability Scenario (RAS), 25 watering events have been identified and prioritised for environmental watering in addition to the 'dry' RAS priorities.

Table 5-5: Environmental watering priorities for a 'moderate' scenario in 2014-15

Asset location & size	Estimated volume (ML)	Timing	Justification	Inundation History**	Recommendations, work required and additional comments
McCartneys Creek* Murray Valley National Park ~20 km	2,000	spring- autumn	Maintain SQ1/SQ2 RRG forest ² . Provide flush through natural waterways to remove tannins/organic matter for blackwater mitigation, and export organic carbon and nutrients from floodplain to Gulpa Creek and Edward River. Waterholes may provide habitat/drought refuge for small bodied native fish such as Southern Pygmy Perch.	2010-11 F, 2011-12 F, 2012-13 F, 2013-14 E + F	Requires winter/spring flooding at least eight years out of ten years to maintain a good RRG stand and understorey condition, and provide flushes through Gulpa Island to help mitigate hypoxic blackwater. Frequent watering is required to fill waterholes to maintain native fish habitats (needs investigation). The McCartneys Creek Regulator is not metered.
Moira Lake/Porters Plain* Murray Valley National Park	Collaborative TLM watering proposal developed for Barmah and Millewa (icon site) by NSW and Victoria.	winter-spring	Moira grass recovery, nesting waterbird foraging and native fish recruitment objectives. Control RRG and Giant Rush encroachment onto Moira Grass plains by ensuring deep frequent flooding. The Limit of Acceptable Change for the Ramsar site will be quickly exceeded if the loss of Moira Grass plains continues.	2010-11 F, 2011-12 F, 2012-13 F, 2013-14 E + F	Stabilisation works are urgently required on the Moira PID channel bank and the 'Breakaway'. Moira Creek Regulator needs upgrading. Carp extraction from Moira Creek can be achieved during draw down of Moira Lake. Long-term research is required to develop an operational strategy for native fish migration/recruitment/dispersal, especially for Murray Cod and Trout Cod.

² Site Quality (SQ) is a forestry term that relates to stand height and is commonly used as a surrogate for topography and flooding frequency within River Red Gum forests.

					In excess of 80 tonnes of carp were removed from Moira Lake in May 2014. Third party impacts, especially for Bullatale Creek landholders, must be considered when planning this event.
Reed Beds/ Coppingers Swamp/Duck Lagoon* Murray Valley National Park 2,000 ha	10,000	spring-summer	Ensure successful breeding of colonial nesting waterbirds, maintain ecological and hydrological function of the wetland complex (i.e. by ensuring flooding and drying phases are achieved).	2010-11 F, 2011-12 F, 2012-13 E + F, 2013-14 E + F	The following works are required at this wetland to ensure flooding and drying phases can be achieved: Reed Beds South – Treatment of willows from southern bank of Gulpa Creek Cutting (by stem injecting with bioactive glyphosate), reinstatement of southern bank and construction of fixed-crest sills. Warrick Creek – removal of block bank and installation of a new regulator. Coolamon Creek – reinstate bank and sills.
Murray Valley National Park (colonial waterbird nesting)	To be determined by the Operations Advisory Group.	spring-summer	Ensure successful breeding of colonial nesting waterbirds to the fledgling stage.	2000-01 F + E	Ensure foraging areas are maintained for juvenile adult waterbirds who generally persist in the area for an extended period after fledging. This is important because these birds will eventually become the next generation of breeding adults.
West Courigan PID Mid Murray - incorporates towns of Berrigan and Oaklands	500	spring-autumn	Maintain/improve condition of various wetland communities including RRG, Black Box and Cane Grass.	Various F + R, 2010-11 E, 2012-13 E, 2013-14 E	Brolga's were observed at 'Rilverside' during the 2013-2014 environmental watering.
Sandridge Wetland (Moira PID) Mid Murray - southwest of the Mathoura township	60	spring-autumn	Maintain remnant Black Box-Lignum woodland within the Green Gully area (i.e. the ancient Murray River channel).	2012-13 E	

Werai Forest (Reedbeds Creek)* Mid Murray - ~ 20km south east of Moulamein 137 ha	2,000	winter-spring	Maintain/improve fringing RRG. To manage in channel RRG sapling recruitment. Maintain condition of RRG and Phragmites beds downstream of Reedbeds Creek Lagoon.	2001 E, 2009 E, 2010-11 F, 2012-13 F, 2013-14 E	Reed Beds Creek Regulator is not metered. Pre-watering consultation/approvals required with Werai Aboriginal Negotiating Team and Balpool Station (water enters private property).
Werai Forest (Tumudgery Creek)* Mid Murray	1500-2000	spring	Maintain condition of RRG forest and Common Reed beds within Werai and assist with hypoxic blackwater mitigation.	2010-11 N, 2013-14 E, 2001 E, 2009 E, 2010-11 F, 2012-13 F, 2013-14 F	Pre-watering consultation/approval is required with the Werai Aboriginal Negotiating Team. The Tumudgery Creek Regulator is not metered.
PPWP (Murray Irrigation Area) Mid Murray- incorporates shires of Deniliquin, Wakool, Berrigan and Murray.	1,000	spring-autumn	Maintain/improve condition of various wetland communities including RRG, Black Box eucalypt woodlands, Lignum shrublands and Cane grass.	various E, F, R	Various minor works are required to ensure effective/efficient delivery and management of environmental water. It is important to protect and conserve specific wetland types (such as these) and provide wildlife corridors in fragmented landscapes.
Wanganella Swamp (colonial waterbird nesting)	To be determined as required, guided by OEH monitoring.	spring-summer	Environmental water will be used as a top-up flow to maintain a stable water height for colonial nesting waterbirds, including Glossy Ibis.	2000-01 E, 2005-06 F+ E, 2010-11 F+ E	OEH is currently investigating the possibility of using Wanganella Station's pump and channel infrastructure to deliver top-up flows. Minor works are needed on the channel system. A formal pumping agreement is required between OEH and Wanganella Station.
Multi-site watering (Barmah-Millewa Forest)*	An MDBA and NOW led program.	winter-spring	Environmental water will be delivered to multiple sites located between Hume Dam and to the Lower Lakes, and including in-stream benefits for the Murray River system.	2013-14 E	Multi-site watering should include Moira Grass objectives for Barmah-Millewa Forest. Third party impacts must be considered when planning this event.

Brechin Mid Murray - 25 km east of Swan Hill on north side of Murray River 26 ha/km	100	spring	Follow up watering is required to maintain the condition of the riparian vegetation (especially RRG).	2008-09 E, 2009-10 E, 2010-11 R part wtl, 2011-12 E part wtl	The appropriate approvals are in place.
Edward-Wakool Fish Flows* Mid Murray	~60,000 (CEW)	TBC	The aims of the trial are to improve our understanding of native fish response to pulse flows, and provide habitat and breeding opportunities for native fish. A CEWO Long Term Intervention Monitoring site.	Various E, F, R	OEH, CSU and Murray LLS have developed a 'scope of works' for a flow gauging system to assist with native fish research, verifying flow modelling, minimising third party impacts, and providing information to the Constraints Management Strategy.
Jimaringle, Cockran & Gwynnes Creeks* Mid Murray - 30km west of Deni in the Wakool Irrigation district ~80 kms	3,000	spring	Improve fringing RRG, Black Box and Lignum condition, and promote the re-establishment of groundlayer vegetation and tall macrophytes (eg. Cumbungi and Common Reed). Potentially maintain SBF habitat and promote breeding. Identify and manage risks arising from salinity and sulfidic sediment issues.	1995 F, 2010-11 F+E, 2011-2012 E, E 2013-14 E (Gwynne's only)	OEH is developing a broad-scale rehabilitation program for the Jimaringale, Cockran and Gwynnes system. SBF surveys required to determine the status of the local population.
Murrien-Yarrein Creek System* Mid Murray	1,500	autumn	Improve fringing RRG, Black Box and Lignum condition, and promote the re-establishment of groundlayer vegetation and tall macrophytes (eg. Cumbungi and Common Reed). Identify and manage risks arising from salinity and sulfidic sediment issues.	2010-11 N (only some sections)	OEH is currently developing a rehabilitation program for the Murrien-Yarrein system (firstly using Jimaringle, Cockran and Gwynnes as a test case).

Lock 8 and 9 weirpool manipulations* Lower Murray - west of Wentworth near Lake Victoria	2000	TBC	Implement small-scale manipulations to measure possible benefits to aquatic and riparian communities within weir pools.	2013-14 trial E	
Speewa Creek* Mid Murray 15 kms from Swan Hill VIC	1,500	spring	Water quality, and RRG and groundlayer objectives.	2010-11 N, 2013-14 E	An outlet point is required into the creek. A pipe culvert with a slide and crushed rock needs to be installed on private property.
Goodnight (Bingerra Creek)	350	spring- autumn	Maintain RRG and Lignum condition. Promote aquatic vegetation recruitment and frog and waterbird refuge.	2009-10 E, 2011-12 E, 2012-13 E	
Wee Wee Creek	2,000	spring- autumn	Maintain RRG and Lignum condition. Promote aquatic vegetation recruitment and frog and waterbird refuge.	2008-09 E, 2009-10 E, 2011-12 F, 2012-13 F	Site identified in early 2000's as SBF habitat and endangered native Catfish recorded prior to drying out in 2004.
Lock 15 weirpool manipulations * Lower Murray - west of Euston	Part of the multi-site event.	TBC	Implement small-scale manipulations to measure possible benefits to aquatic and riparian communities within weir pools.		
Bottle Bend Reserve	2,000	winter	Improve the condition and resilience of vegetation communities, primarily drought stressed Black Box eucalypt woodland.	2011-12 E, 2013-14 E	A Dept. Lands managed site. A strong partnership established with OEH to manage environmental water within the reserve.
Bengallow Creek* Lower Murray – 40km west of Euston	2,500	spring- autumn	Maintain existing native fish habitat (eg. deep waterholes).	2010-11 F, ~2012 F	Works approvals required for block bank construction and pumping for this event. NPWS tenure.

Thegoa Lagoon Lower Murray - d/s of Murray Darling junction, west of Wentworth 80 ha/km	1,200	2014-15	Follow recommendations from the water management plan that recommends the lagoon fills 7 years out of every 10 years. Drying over summer-autumn is important for vegetation, soils and water quality, and will assist in controlling carp (TLMSTG, 2003).	2003-04, 2005-06, 2008-09, 2010-11 E, F	A carp screen (funded by OEH) was installed on the inlet regulator from Lock 10. Frequent watering will assist with the management of RRG encroachment and weeds. The site is proposed to be managed as a SPP recovery site. The Thegoa Lagoon Regulator is not metered.
Carrs, Cappits and Bunberoo Creeks	Guided by OEH and MDWWG.	TBC	Improve the condition and resilience of vegetation communities and connectivity to the Murray River.	F	Several man-made structure and barriers occur along the creeks, and therefore, large scale capital works are required to improve the ecological and hydrological function of this system.
Lake Victoria Station (Yamborah Wetland)	300	spring-autumn	Maintain RRG and Lignum condition. Promote aquatic vegetation recruitment, and SBF and waterbird refuge.	2010-11 F, 2011-12F	Southern Bell Frogs have been recorded at this wetland.

*Contribution from CEW.

**Inundation history: E= environmental watering; F = flood event; R = significant rain event

potentially implemented during a wet scenario

5.4.4 Watering priorities when additional water is available

Supplementary access

NOW is responsible for declaring supplementary access in the Murray Valley. As required under the WSP, NOW considers the ecological needs of an asset prior to the declaration of supplementary access. In the event of this occurring NOW could use this plan to help guide decision-making.

Bird breeding and native fish

In the event that a bird (or other fauna species) breeding is triggered, consideration for the provision of CEW and/or NSW-sourced environmental water would be made available. Furthermore, refuge habitat for native fish during low flow and hypoxic blackwater conditions should be made available.

Unallocated volumes

If unallocated volumes of NSW AEW remain, considerations for the management of the water could include:

- complementing watering in other connected valleys, through trade to other valleys.
- trading on the temporary water market to generate funds to support implementation and on-ground delivery of environmental water.

6 Risks and strategies to manage risk

This section identifies the risks in association with the proposed management of environmental water and notes responses on how best to manage the potential risk (refer to Appendix 1).

Table 6-1: Risks of environmental watering and management responses.

Risk	Rating	Response
Unpredictable weather – turns drier than expected.	High (likely and major)	Review asset condition and future priorities for watering. Consult EWAG.
Unpredictable weather – turns wetter than expected.	High (likely and major)	Additional wetting options possible – continually assess volumes available. Consult EWAG.
Unpredictable weather – turns hotter than expected early.	High (likely and major)	Review timing for watering. Consult EWAG.
Less water available than expected because of water trades. Price and demand for water will vary across catchments as the season unfolds.	Medium (possible and moderate)	Early communication with OEH section involved in trade, adjust watering priorities based on revised water availability.
Flow management is uncoordinated.	Medium (possible and moderate)	Early communication with State Water Corporation (SWC) and River Murray Water.
Water use and works approvals not in place and/or linked to licences.	High (possible and major)	Confirm status with NOW and SWC. Seek discretionary one-off approval if necessary.
Estimated allocation volumes are substantially wrong.	Medium (unlikely and moderate)	Monitor flow delivery and area of inundation closely. Seek adjustments; revise targets for future attempts.
Unforeseen physical impediments to flow delivery e.g. low river levels which prohibit pumping activities.	Medium (rare and major)	Early communication with River Murray Water, Landholders and SWC, where appropriate. Alert NOW if illegal obstructions identified.
Insufficient water available to complete colonial waterbird breeding, if initiated.	Medium (unlikely and severe)	Liaise with CEW on the possibility of acquiring additional water. Liaise with River Murray Water and SWC to look at flow delivery options.
Insufficient delivery of receding water as events comes to an end e.g. potentially causing fish stranding; bank erosion and slumping.	High (possible and major)	Provide where possible gradual recession of flows to mitigate stranding and provide cues for fish to exit systems. Environmental water may be used for gradual drawdown of rainfall rejection flows

Environmental watering received limited ecological response.	Medium (possible and minor)	Capture knowledge of what response there was to inform future watering events. Review knowledge. Have a focus on the timing of future events to test for preferable timing for responses.
Water delivery infrastructure (pump or regulator) faulty or not adequate.	Medium (possible and moderate)	Liaise with contractor, landholder to resolve issue.
Poor water quality in the main water source (for example high salinity, blackwater, low dissolved oxygen) or from wetlands flowing back into main creeks or rivers.	High (possible and major)	Monitor water quality regularly. Refer to fisheries risk matrix in Appendix 2.
Poor water quality threatening aquatic fauna.	High (possible and major)	Liaise with DPI (Fisheries) and other relevant agencies in relation to timing of water delivery and cooperation on monitoring response. Refer to fisheries risk matrix in Appendix 2.
Carp recruitment.	High (possible and major)	Refer to carp recruitment risk matrix in Appendix 2.
High groundwater table near sites.	High (possible and major)	Monitor groundwater levels and conductivity regularly prior to commencing delivery. If reasonable proceed and monitor while inundated. Monitor deep pool zones.
Landholder breaks written agreement with OEH.	Medium (possible and minor)	Engage with interested and willing landholders. Gain landholder support and agreement prior to watering activity. Regularly communicate and monitor water delivery. Discontinue water and potentially seek reimbursement as outlined in agreement.
Change of land ownership or management.	Low (unlikely and negligible)	Review and revise the plan annually. Seek annual landholder agreement that coincides with each water year.

7 Monitoring and Reporting

7.1 Monitoring

The monitoring undertaken at most watered sites in 2014–15 will be conducted by OEH staff, with the exception of the Barmah–Millewa Forest, Darling Anabranh, Edward Wakool Fish Response project, Locks 8, 9 and 15 weirpool manipulations, Murray, Edward and Wakool River systems in-stream freshes or potential Murray and Edward Wakool hypoxic blackwater mitigation.

The Barmah–Millewa Forests are monitored using existing TLM arrangements and the monitoring conducted for the Darling Anabranh project is part of the existing Darling Anabranh Adaptive Management Monitoring Program (DAAMMP) managed by OEH.

Water quality monitoring of potential blackwater mitigation events will be undertaken collaboratively by several agencies including MDBA, OEH, Murray LLS, NPWS, NOW, and Forestry Corporation (as accomplished in 2011–12).

Flood extent and water quality monitoring for Tuppall, Gywnnes, Jimaringle and Cockran Creeks and the Murrien-Yarrein systems will be monitored by OEH and Murray LLS. OEH will monitor other parameters including vegetation and frog responses.

The Edward-Wakool Fish Response project is funded by CEWO and managed by CSU, in partnership with OEH, Murray LLS, Monash and Griffith universities and DPI Fisheries as part of the Long Term Intervention Monitoring Program 2014-2019.

Monitoring arrangements for the Locks 8, 9 and 15 weir pool manipulations are still to be determined by NOW.

Table 7-1: Proposed monitoring for identified sites in 2014–15

Wetland site	Ecological monitoring	Environmental monitoring	Objectives addressed by this watering event
Boomanoomana Swamp Tuppall Creek PPWP, WCPID, MPID, Elimdale Brechin Murrien–Yarrien Creeks system Jimaringle, Cockran and Gwynne’s Creeks Gwynne’s Creek Speewa Creek Wee Wee Creek Bottle Bend Reserve Lake Victoria Station Cliffhouse	Vegetation response ⁵ Frog diversity ⁵ Opportunistic bird observations ⁵ Fish ⁴ Bat diversity ⁵	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using GIS Water and sediment quality at high risk sites (eg. dissolved oxygen and/or salinity levels in water and sediment samples) Photo points Flow front/flood extent	Follow up watering to improve vegetation condition; Improve habitat conditions for small bodied wetland specialists inc SPP Maintain SBF habitat and promote breeding (Cliffhouse, Gwynnes Creek and potentially Lake Victoria Station)

Wetland site	Ecological monitoring	Environmental monitoring	Objectives addressed by this watering event
Millewa Forest Southern pygmy perch sites (Murray Valley National Park Murray Valley Regional Park)	Fish ¹	Volume of environmental water delivered Timing of water delivery Duration of inundation Photopoints	Follow up watering event; Improve water quality; Promote aquatic vegetation recruitment; Manage RRG encroachment. ; Improve habitat conditions for small bodied wetland specialists inc SPP.
Wanganella Swamp	Vegetation response ¹ Frog diversity ⁵ Waterbirds ¹	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using ArcGIS Water quality Photo points Area of inundation mapping via satellite imagery or ground truthing ⁵	Improve habitat conditions for waterbirds.
Werai Forest ²	Tree Condition Vegetation response Frog diversity Fish Birds	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using GIS Water quality (dissolved oxygen) Photo points Area of inundation mapping via satellite imagery or ground truthing ⁵	Improve water quality; Promote aquatic vegetation recruitment; Improve fringing RRG condition; Improve habitat conditions for small bodied wetland specialists including SPP.
Edward-Wakool Fish Response ^{2/5}	Fish Frogs and tadpoles Water quality Biofilms Riverbank vegetation	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using GIS Water quality Photo points	Improve habitat conditions for large and small bodied native fish.

Wetland site	Ecological monitoring	Environmental monitoring	Objectives addressed by this watering event
Murray Valley National and Regional Parks sites ⁵	Colonial nesting waterbirds Water quality	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using GIS Water quality Photo points Area of inundation mapping via satellite imagery or ground truthing ⁵	Follow up watering to improve vegetation condition; Threatened species and migratory species habitat.
Murray channel, and Edward Wakool River system ⁴	Fish Water quality	Volume of environmental water delivered (ML) Timing of water delivery (days) Duration of inundation (days) Water quality	Provide refuge habitat for water dependant fauna such as the endangered Murray Cod during hypoxic blackwater events; Improve water quality (i.e. by increasing Dissolved Oxygen levels).
Koondrook-Perricoota Forest Flood Enhancement Works commissioning flow ⁴	Water quality	Volume of environmental water delivered (ML) Timing of water delivery (days) Duration of inundation (days) Water quality	A scheduled commissioning flow for TLM icon site works.
Bengallow Creek system Goodnight (Bingerra Creek) Carrs, Cappitts, Bunberoo Creeks	Vegetation response ⁵ Frog diversity ⁵ Opportunistic waterbird observations ⁵ Fish ⁴	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using GIS Water quality Photo points Area of inundation mapping via satellite imagery or ground truthing ⁵	Maintain fish passage and remnant pools as fish refuge during prolonged dry periods; Promote aquatic vegetation recruitment.

Wetland site	Ecological monitoring	Environmental monitoring	Objectives addressed by this watering event
Thegoa Lagoon	Vegetation response ⁴ Frog diversity ⁵ Opportunistic waterbird observations ⁵ Fish ⁴	Volume of environmental water delivered Timing of water delivery Duration of inundation Area and extent of inundation mapped using GIS Water quality Photo points Groundwater	Promote aquatic vegetation recruitment; Improve habitat conditions for small bodied wetland specialists inc SPP. Omit introduction of mature carp into system via carp screen installed in 2013-14

1 Monitoring contracted out.

2 Monitoring funded by CEWO and managed by CSU, in partnership with OEH, Murray LLS, Monash and Griffith universities and DPI Fisheries as part of the Long Term Intervention Monitoring Program 2014-2019

3 MDBA managed event.

4 Activity not confirmed.

5 OEH

7.2 Reporting

The following reporting will be undertaken in relation to activities in the water year.

- The Senior Environmental Water Management Officer, OEH, will provide the EWAG at minimum, monthly updates on conditions and flow delivery details; however, EWAG is to be consulted if triggers for changes to this plan occur.
- The Senior Environmental Water Management Officer, OEH, will provide advice to the MDBA River Environmental Water Group and Operations Advisory Group when requested.
- OEH will provide regular environmental water use updates at SWC's Murray Lower Darling Customer Services Committee meetings.
- OEH will undertake regular liaison with CEWO including weekly water usage updates.
- The broader community can find updates on the OEH web-page, in *Water for the Environment News* and in media releases and/or interviews.
- At the end of the water year, watering activity is reported in the *Murray Lower Darling Adaptive Environmental Water Use Report* and the *OEH Environmental water use in New South Wales: Annual Report*.

Appendix 1 Risk assessment matrix (adopted from the Environmental Water Management Manual 2009-2010, DECCW)

Risk is a measure of the likelihood that some external factor will reduce the ability to achieve a desired outcome. In natural resource management risk can be associated with, for example, biophysical, socio-economic, institutional, technical, financial, temporal and cultural factors. Risks associated with occupational health and safety need also be considered at the appropriate time (as part of operational planning for flow delivery).

Impacts are the positive and negative consequences of management actions and may be environmental, economic, social and/or cultural.

It is important to assess risk properly and manage it appropriately. High risk does not necessarily preclude an action but rather dictates the need for a management strategy and appropriately focused monitoring and evaluation.

Possible steps to achieve this outcome include:

- Determine key environmental, economic, social, cultural and institutional risk
- Assess all risks on the basis of potential scale, probability, severity and frequency of identified impacts
- Develop prevention and management strategies for risks of all types commensurate with the significance of investment
- Be aware of all potential impacts and manage or mitigate their effects
- Regularly review risk management strategies and update when necessary
- Incorporate the consideration of risks and impacts and any relevant management strategies into monitoring and evaluation activities.

POSSIBLE APPROACH

The following standard risk assessment matrix could be used to produce a risk rating for each risk, summarised in a table (e.g. below).

		LIKELIHOOD				
		Rare	Unlikely	Possible	Likely	Almost certain
CONSEQUENCE	Severe	Medium	High	High	V High	V High
	Major	Medium	Medium	High	High	V High
	Moderate	Low	Medium	Medium	High	High
	Minor	Low	Low	Medium	Medium	High
	Negligible	Low	Low	Medium	Medium	High

Where:

<i>Risk level</i>	<i>Response</i>
<i>Very high risk</i>	<i>Emergency action necessary. Very high risks have the potential to stop the program or project.</i>
<i>High risk</i>	<i>Immediate action necessary.</i>
<i>Medium risk</i>	<i>Action necessary as soon as practicable.</i>
<i>Low risk</i>	<i>No need to take action to address / manage / mitigate these risks.</i>

Appendix 2 Risk matrices for hypoxic blackwater conditions and carp recruitment

Risk matrix for creating hypoxic blackwater conditions by watering wetland and floodplain habitats (expected fish response)

This matrix assumes flooding of large floodplain wetland systems such as Barmah Millewa, Koondrook-Perricoota, Werai and Lower Murrumbidgee with return flows discharging to the river.

Risk for *terminal* wetland/floodplain system: if there is no return flows to the main river or associated anabranches, the risk is nil for river channels. Risk for floodplain wetlands is shown below.

Risk for *flow-through* wetlands/floodplain systems: if water is returned to main river channel and/or associated anabranches, risk for both downstream river channel and floodplain wetlands is shown below.

	Months when discharge to river is expected											
	July	August	September	October	November	December	January	February	March	April	May	June
Wetland/floodplain area has not been flooded for >5 years	Low	Low	Moderate	High	Very high	Very high	Very high	Very high	High	Moderate	Moderate	Low
Wetland/floodplain area has not been flooded for 2–5 years	Low	Low	Low	Moderate	High	Very high	Very high	Very high	High	Moderate	Low	Low
Wetland/floodplain area has been flooded within last 2 years	Low	Low	Low	Low	Moderate	High	Very high	Very high	High	Moderate	Low	Low

Source: DPI (Fisheries)

Assumptions: 1 Litter build-up and accumulation increases with time since last flooding.
2 Water temperature is a key driver for development of hypoxic blackwater (month of year is used as a surrogate for water temperature)

Risk matrix for carp recruitment by watering wetland and floodplain habitats (expected fish response)

The risk for *terminal* wetland/floodplain systems is nil if there are no return flows to the main river or associated anabranches. This recognises that carp may breed, but offspring will be unable to easily return to the river and would likely perish in the wetland as it dries, although they could return if there were a subsequent high flow before drying was completed.

Risks for *flow-through* wetlands/floodplain systems, if water is returned to the main river channel and/or associated anabranches, are shown below. This assumes that carp will breed and offspring will readily return to the river in return flows.

	Months when discharge to river is expected											
	July	August	September	October	November	December	January	February	March	April	May	June
Wetland/floodplain area contains permanent water (and is therefore likely to contain adult carp).	Low	Low	Moderate	High	Very high	Very high	Very high	Very high	Moderate	Low	Low	Low
Wetland/floodplain area does not contain permanent water (and therefore is unlikely to contain adult carp).	Low	Low	Low	Moderate	High	Very high	Very high	High	Moderate	Low	Low	Low
Wetland/floodplain area contains water from an earlier flow event (and is therefore likely to contain juvenile carp which can escape to the river channel and disperse).	High	High	High	High	High	High	High	High	High	High	High	High

Source: DPI (Fisheries)

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