Amendment date: 16 Feb 2017

	Title of measure	**The Living Murray- Mulcra Island**
	Proponent undertaking the measure	**Victoria, NSW and SA**
	Type of measure	**Supply**
1.	**Confirmation**	
	Date by which the measure entered into or will enter into operation *Must be before 30 June 2024*	The measure is operational. The works were commissioned over two years, from 2013-2015.
	Confirmation that the measure is not an 'anticipated measure' *'Anticipated measure' is defined in section 7.02 of the Basin Plan to mean 'a measure that is part of the benchmark conditions of development'.*	Yes. It is a new project (not already included in the benchmark conditions).
	Confirmation that the proponent state(s) undertaking the measure agree(s) with the notification ***Basin Plan 7.12(3)(c)*** *Joint proposals will need the agreement of all proponents*	Yes.
2.	**Details of the measure**	
	Capacity of the measure to operate as a supply measure *'Supply measure' is defined in section 7.03 of the Basin Plan to mean 'a measure that operates to increase the quantity of water available to be taken in a set of surface water SDL resource units compared with the quantity available under the benchmark conditions of development'.*	Yes.
3.	**Description of the works or measure**	
	Mulcra Island is part of the Lindsay-Wallpolla Islands Icon Site. The works have been funded through the Living Murray program and will assist in achieving the ecological objectives that have been set for the icon site by increasing the frequency, duration and extent of wetland and floodplain inundation, improving fish access to the creek and introducing flows to the upper Potterwalkagee Creek. The works enable watering of 820 ha included the construction of seven environmental regulators and associated works, including sill lowering, stream rehabilitation and upgrading access tracks.	
4.	**Geographical location of the measure**	
	Mulcra Island is located on the River Murray floodplain in north-west Victoria, approximately 70 km west of Mildura.	
5.	**Representation of the project in the MDBA modelling framework**	
	The MDBA has represented the proposed infrastructure, operating strategies and water use in the MSM-BigMod model. **Attachment A** shows a schematic of the model representation of Mulcra Island. Spatial data (derived using a hydro-dynamic model) describes the areas inundated through the operating of the works. The areas inundated are combined with the timing of modelled operation by the Environmental Outcomes Scoring Tool to quantify the change in environmental outcomes, relative to the Benchmark environmental outcomes. The level-volume-area relationships for Lock 9, Potterwalkagee Creek, Victorian Floodplain Retention, NSW Floodplain Retention, Mulcra Horseshoe and Lock 8 used in the model are shown below.	

Lock 9		
Level (mAHD)	**Storage (ML)**	**Area (ha)**
18.5	0.0	0.0
19.0	756.0	105.0
19.5	1424.0	166.0
20.0	2433.0	226.0
20.5	3739.0	300.0
21.0	5447.0	379.0
21.5	7567.0	460.0
22.0	9974.0	497.0
22.5	12527.0	524.0
23.0	15198.0	543.0
23.5	17958.0	560.0
24.0	20790.0	573.0
24.6	24270.0	588.0
25.0	26644.0	599.0
25.5	29676.0	614.0
26.0	32800.0	636.0
26.5	36030.0	656.0
27.0	39353.0	674.0

Potterwalkagee Creek (weir pool)		
Level (mAHD)	**Storage (ML)**	**Area (ha)**
19.5	0.0	0.0
20.0	0.0	0.0
20.5	0.0	0.0
21.0	0.0	0.0
21.5	0.0	0.0
22.0	13.0	5.0
22.5	63.0	15.2
23.0	153.0	20.8
23.5	276.0	28.2
24.0	539.0	77.3
24.6	1185.0	138.0
25.0	1921.0	230.0
25.5	3567.0	429.0
26.0	6217.0	631.0
26.5	10656.0	1145.0
27.0	17281.0	1485.0
27.0	17281.0	1485.0

Victorian Floodplain Retention		
Level (mAHD)	**Storage (ML)**	**Area (ha)**
21.0	0.0	0.0
24.6	0.0	0.0
24.8	137.6	24.1
25.0	275.2	50.2
25.3	481.6	76.8
25.6	688.0	96.5
29.0	3035.0	96.5

NSW Floodplain Retention		
Level (mAHD)	**Storage (ML)**	**Area (ha)**
21.0	0.0	0.0
24.6	0.0	0.0
24.8	51.1	19.0
25.0	102.2	21.0
25.3	178.8	21.5
25.7	281.0	22.8
29.0	1131.0	22.8

Mulcra horseshoe wetland			
Level (mAHD)	**Storage (ML)**	**Area (ha)**	**Inlet Capacity**
24.60	0.0	0.0	100
24.80	245.4	18.5	100
25.00	303.1	23.6	100
25.20	371.2	29.8	100
25.40	452.6	39.2	100
25.50	515.2	43.4	100
25.60	571.4	49.7	100
25.70	644.7	56.3	100

Lock 8 Wetland			
Level (mAHD)	**Storage (ML)**	**Area (ha)**	**Inlet Capacity**
23.00	0.0	0.0	0
23.20	240.6	27.2	15
23.30	268.7	28.0	57
23.40	297.3	28.6	108
23.50	326.7	29.2	164
23.60	356.7	29.8	221
23.70	387.2	30.4	278
23.80	418.4	31.0	336
23.90	450.3	31.7	394
24.00	482.7	32.3	452
24.10	603.0	46.6	510
24.20	651.2	48.0	568
24.30	769.7	61.8	626
24.40	836.6	64.9	723
24.50	905.7	68.0	888
24.60	978.5	71.4	1078
24.70	1054.0	74.8	1277
24.80	1135.2	79.7	1421

In addition to the level-volume-area relationships for the weir pools provided above, the storage and area in the Upper Potterwalkagee and Weir pool reaches are affected by flow routing and travel time, flow-travel time-area relationships are shown in the tables below. An explanation of the calculation of combined reach and weir storage and area is provided in MDBA Technical Report 2015/15.

Upper Potterwalkagee		
Inflow (ML/d)	**Travel time (day)**	**Area (ha)**
0	1	0
16.1	1	41
26	1	44.8
39.7	1	50
41	1	50.2
66	1	53.1
147	1	62.5
349	1	86
510	1	104.7
2000	1	104.7

Potterwalkagee Creek and Weir Pool		
Inflow (ML/d)	**Travel time (day)**	**Area (ha)**
0	1.75	0
41	1.75	36
87	1.8	39
144	1.9	55
226	2	55
330	2	55
487	2	55
1314	2	147
3112	2	304
5000	2	304

In the model, there are two offtake locations describing flow movements from the river to the site. The interaction is driven by water level differences between the river and site. The model uses plug-in like functions, special code No 183 and No 199,) to derive inflow to Potterwalkagee Creek as a function of water level difference between offtake and weir pool (as described at table below) so that weir pool manipulation operation can be modelled effectively and efficiently. Inflows at the two offtake points are calculated using the equation with head difference.

$$inflow = min(Minimum\ inflow, Conveyence\ \sqrt{level\ at\ offtake - level\ at\ wier\ pool})$$

Upper Potterwalkagee Creek			Lower Potterwalkagee Creek		
River Level at offtake (mAHD)	Minimum inflow (ML/d)	Conveyance	River Level at offtake (mAHD)	Minimum inflow (ML/d)	Conveyance
24.602	0	0	24.000	0	0
24.613	0	0	24.200	41	49.5
24.653	0	0.6	24.400	87	133.5
24.717	0	12.7	24.601	142	237.1
24.802	15	28.9	24.606	144	239.8
24.905	26	47.9	24.624	151	249.6
25.022	41	69.0	24.655	163	267.7
25.176	66	105.1	24.697	179	292.3
25.539	147	200.4	24.749	201	322.8
26.184	355	365.4	24.810	228	358.5
26.744	538	508.6	24.911	273	427.0
			25.265	487	715.9
			25.892	1341	2154.0
			26.433	3112	3590.4

Water flows to the river from the site via the Potterwalkagee regulator. Depending on the operating strategy, the regulator is raised until required duration is met then lowered to drain stored water back to the river. The model limits the return flow if downstream level, calculated by the relationship below with a given flow, is higher than storage level.

Potterwalkagee Creek weir	
Flow (ML/d)	**Level (mAHD)**
0.0	19.500
0.1	22.150
141.0	22.179
143.0	22.240
150.0	22.437
161.0	22.708
191.0	23.005
224.0	23.426
265.0	23.805
335.0	24.147
629.0	24.465
1690.0	25.085
3643.0	25.756
15000.0	27.000
100000.0	27.800

A standard evaporation loss is applied by MSM–Bigmod with evaporation and rainfall calculated using monthly data from the Lake Victoria climate station and a pan evaporation factor of 0.660. Seepage is applied at a rate of 2 mm/day.

6. Representation of each operating strategy in the MDBA modelling framework.

The operating strategy, hydraulic and hydrologic models and outputs have been provided to the MDBA and are presented below. Further details are available in the Lindsay-Wallpolla Islands Environmental Water Management Plan (**Attachment B**) and interim operating strategy for the icon site (**Attachment C**).

Operating strategy	Frequency	Resilience period	Raising Lock 8	Equivalent natural flow
Spring Freshes[1]	Every one to two years	1 yr	By 20 to 60 cm	-
Floodplain inundation (PWC)	1 in 2 yrs	4 yrs	To the top of piers (25.7 mAHD)	50,000 ML/d
[1]Not modelled given no significant benefit				

7. Spatial data describing the inundation extent associated with the operation of the measure

The area of inundation associated with the operation of the works has been modelled with the MDBA's hydraulic model developed for TLM projects. The total area of inundation as a result of operating the works is 826 ha.

For the purpose of calculating scaling factors for the ecological outcomes scoring method, the map of the inundation area associated with the works was combined with maps of site-specific flow indicator (SFI) flow bands and maps representing the ecological elements used in the scoring method. The areas for the resulting hydrological assessment units are provided in tables below.

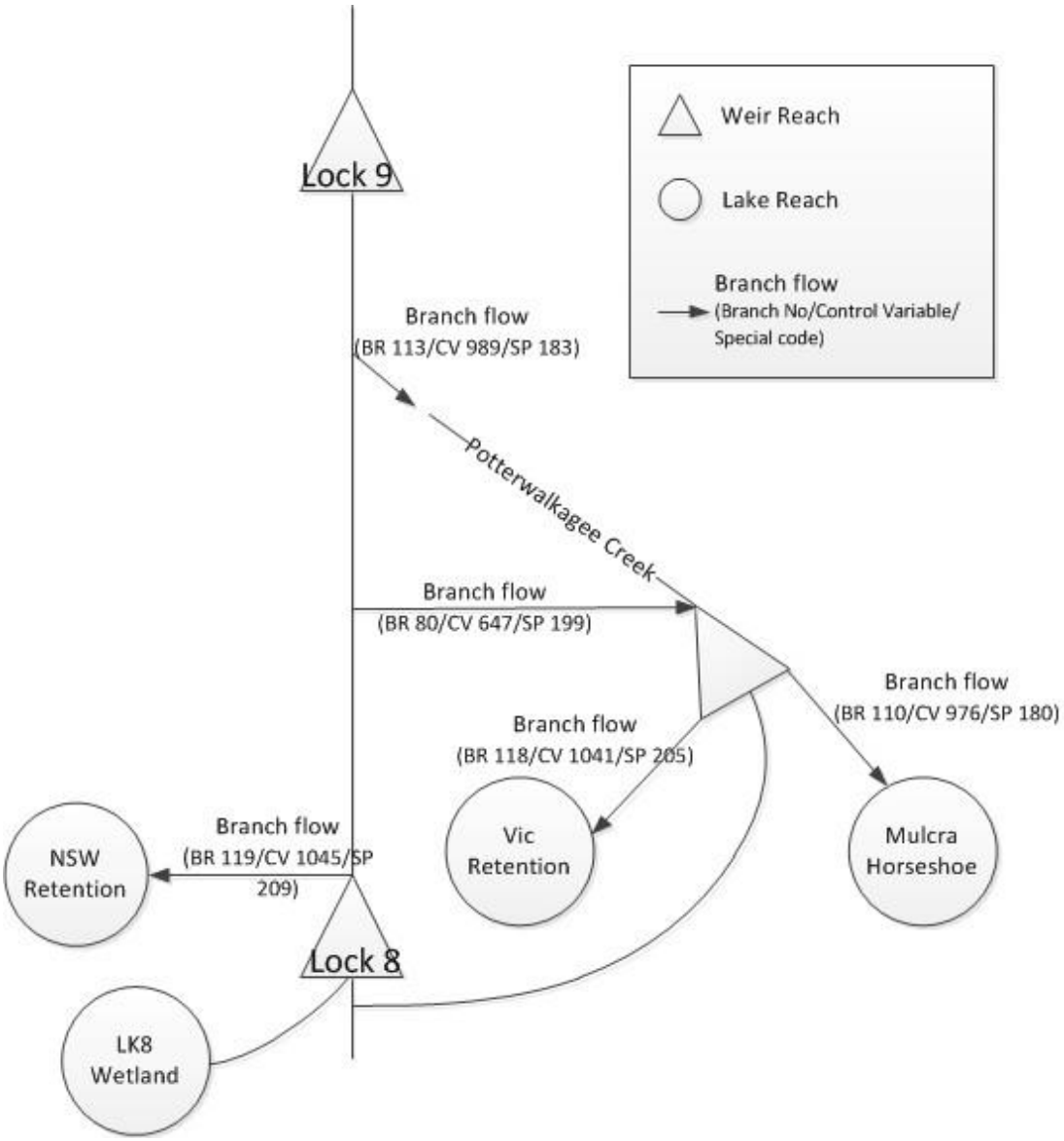
Inundation area (ha) of PWC	**SFI flow bands**					
Ecological Element	**40,000**	**60,000**	**80,000**	**100,000**	**125,000**	**>125,000**
General health and abundance - all Waterbirds	89.0	267.0	391.0	47.0	10.0	22.0
Bitterns, crakes and rails	79.7	120.3	97.0	5.4	0.5	1.3
Breeding - Colonial-nesting waterbirds	89.0	267.0	391.0	47.0	10.0	22.0
Breeding - other waterbirds	79.7	120.3	97.0	5.4	0.5	1.3
Redgum Forest	8.0	35.2	30.7	8.3	1.9	2.3
Redgum Woodlands	1.6	11.0	13.1	2.9	0.9	1.5
Forests and Woodlands: Black Box	26.2	125.9	137.1	22.9	5.1	16.1
Lignum (Shrublands)	0.7	13.8	121.5	10.2	0.8	1.6
Tall Grasslands, Sedgelands and Rushlands	79.7	120.3	97.0	5.4	0.5	1.3
Benthic Herblands	0.0	0.0	0.0	0.0	0.0	0.0
Short lived fish	79.7	120.3	97.0	5.4	0.5	1.3
Long lived fish	89.0	267.0	391.0	47.0	10.0	22.0

8.	Surface water SDL resource units affected by the measure
	This measure identifies all surface water resource units in the Southern Basin region as affected units for the purposes of notifying supplying measures. The identification of affected units does not constitute an agreement between juristictions on apportioning the supply contribution, which will be required in coming months.
9.	**Details of relevant constraint measures**
	Relevant constraint measures include the Hume to Yarrawonga, Yarrawonga to Wakool and Lower Murray proposals. Implementation of these constraint measures could have implications for the operating strategy at Mulcra Island.

Attachments:

A	MDBA, 2017	Mulcra Island representation in Murray model
B	MDBA, 2012	Lindsay-Wallpolla Islands Environmental Water Management Plan
C	Mallee CMA, 2013	Interim Operating Plan: Mulcra Island (Version 1.1)

Appendix A Mulcra Island representation in Murray model (based on Bigmod Rev. 254)



Australian Government

MURRAY–DARLING BASIN AUTHORITY

MURRAY-DARLING BASIN AUTHORITY

Lindsay–Wallpolla Islands

Environmental Water Management Plan

February 2012

Lindsay–Wallpolla Islands

Environmental Water Management Plan

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Cover image: Floodplain on Wallpolla Island

Photographer: Corey Brown © MDBA

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Contents

About this plan

This environmental water management plan consists of:

i. A long-term strategic plan, (per Clause 117 of the TLM Business Plan), which outlines the icon site's environmental water requirements and how to broadly achieve them with a combination of environmental water and works and measures.

ii. Schedules detailing operational information about the icon site such as Operating, Condition Monitoring, Risk Management and Communication Plans. These Schedules will be added to the environmental water management plan as they become available and updated to reflect learnings from the operation of works, the results of environmental waterings and the latest science.

The environmental water management plans provide context for an icon site's water planning, delivery, monitoring and consultation processes. While the environmental water management plans include proposed operating strategies, annual water planning and implementation will be responsive to changing water resource conditions, opportunities and environmental priorities throughout the season and from year to year.

This environmental water management plan and associated schedules have been prepared by TLM partner governments in consultation with the relevant stakeholders. The MDBA would like to acknowledge the significant contribution of all those involved in the development of the environmental water management plans.

Summary

The Living Murray Initiative is one of Australia's largest river restoration programs, established in 2002 following evidence of declining health in the River Murray system. The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians. Since 2004, a total of $700 million has been committed to improve environmental outcomes at the six icon sites:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands
- Lower Lakes, Coorong and Murray Mouth
- River Murray Channel.

With the recovery of almost 500 gigalitres (GL) for environmental waterings, The Living Murray is in a phase of design, construction and operation of infrastructure works to facilitate environmental water delivery and maximise the associated environmental outcomes at the icon sites.

The Chowilla Floodplain and Lindsay–Wallpolla icon site spans South Australia, New South Wales and Victoria, with Chowilla in South Australia and New South Wales, and Lindsay–Wallpolla Islands in Victoria.

The icon site is important because it retains much of the area's natural character and attributes. It is typified by complex anabranch systems, including streams, billabongs and backwaters, and swamps (Victorian Department of Sustainability and Environment 2010). It has a high diversity of both terrestrial and aquatic habitats, supports populations of rare, endangered and nationally threatened species and contains heritage protected sites of cultural significance. The area is also important for its recreational and economic values.

The Lindsay–Wallpolla Islands include three separate anabranch systems within the Murray–Sunset National Park: Wallpolla Island, Mulcra Island and Lindsay Island. Wallpolla Island, Lindsay Island and Lake Wallawalla are listed in *A Directory of Important Wetlands in Australia* (Environment Australia 2001).

Environmental water management plans have been developed for each icon site with the aim of describing The Living Murray objectives and targets, water delivery arrangements and the watering regimes for each site. This document is the Lindsay–Wallpolla Environmental Water Management Plan and supersedes the Chowilla Floodplain (including Lindsay–Wallpolla Islands) Environmental Management Plan 2005–06. Although the South Australian—New South Wales (Chowilla) and Victorian components of the icon site are contiguous, separate environmental watering management plans have been prepared for each as they are managed by different jurisdictions and agencies, and have separate governance and management committee structures. Each component also has specific ecological objectives and environmental watering management options.

Altered flow regimes in the River Murray are the key threat to the values of the icon site. River regulation and water extraction have reduced the frequency and duration of natural flooding regimes across the islands, degrading flora, fauna and cultural values associated with waterways and wetlands.

A suite of works have been developed for the icon site that aims to achieve the ecological objectives set for Lindsay–Wallpolla Islands, such as increasing the diversity and abundance of wetland vegetation and maintaining the current condition and extent of river red gum (*Eucalyptus camaldulensis*) communities. These works include:

- Regulators and ancillary works on Mulcra Island that enable inundation of the floodplain when Lock 8 is raised at regulated flows. This will water 800 ha of floodplain and increase flows through 20 km of Potterwalkagee Creek.
- Regulators at Horseshoe Lagoon (Wallpolla Island) and Webster's Lagoon (Lindsay Island) that can be flooded by the weir pools of locks 9 and 6 respectively. Regulators allow annual drying phases to be introduced, as would have occurred under natural conditions. Wetlands can also be surcharged using temporary pumps to water the large fringing river red gums.
- Replacing pipe culverts on the inlet channels of Lake Wallawalla (Lindsay Island) with large regulators to allow water to be retained in the wetland when it fills from high flows in the Lindsay River. This will water fringing vegetation and provide more than 800 ha of wetland habitat. The regulators also facilitate pumping environmental water into the lake during long dry periods.

- Replacing stop banks with regulators on two Lindsay River inlets to increase flows into the upper Lindsay River. This will provide an additional 20 km of anabranch habitat when Lock 7 is raised at regulated flows. An existing fixed crest weir on the Mullaroo Creek will also be replaced with a regulator and fishway to maintain high quality habitat for Murray cod (*Maccullochella peelii*).

Together, the works will enable more natural water regimes to be reinstated across Lindsay–Wallpolla Islands, targeting over 1,800 ha of floodplain and wetlands. Operation will include maintaining base flows and providing spring freshes in anabranches on Mulcra and Lindsay islands (Potterwalkagee Creek and Lindsay River), broadscale floodplain inundation at Mulcra Island and managing the water regime of regulated wetlands (Wallpolla Horseshoe Lagoon, Mulcra Horseshoe Lagoon, Webster's Lagoon and Lake Wallawalla).

Annual ecological monitoring occurs across the icon site, through the Icon Site Condition Monitoring Program. Monitoring examines the condition of waterbird and fish populations, and vegetation communities, tracking the progress towards achieving the ecological objectives for the icon site. It is anticipated that additional monitoring will be undertaken during and following watering events, including activities such as groundwater monitoring, compliance monitoring and vegetation response (as part of the Native Vegetation Offset Management Plan).

The Environmental Water Management Plan promotes an adaptive management approach through 'learning by doing'. Ecological information collected during and after environmental watering events will be incorporated into the icon site operating strategy to ensure it remains relevant and effective.

The Environmental Water Management Plan recognises the importance of ongoing community consultation and communication in the delivery of the plan's components. Several committees have been established for Lindsay–Wallpolla Islands. These committees (together with The Living Murray Indigenous Facilitator, various project working groups, other established community groups and activities under communication plans and strategies) provide a mechanism for consulting with a range of community and agency stakeholders.

1. The Living Murray

The Living Murray (TLM) Initiative is one of Australia's most significant river restoration programs. Established in 2002, it is a partnership of the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory. The initiative is coordinated by the Murray–Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

The Living Murray aims to improve the environmental health of six icon sites chosen for their significant ecological, cultural, recreational, heritage and economic values:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands (including Mulcra Island)
- River Murray Channel
- Lower Lakes, Coorong and Murray Mouth.

Through its First Step water recovery initiative, TLM has acquired a water portfolio consisting of environmental water entitlements. As of May 2011, there was 478.97 gigalitres long-term Cap equivalent (LTCE), with another 7.1 GL to be recovered in 2011–12. The actual volume of water available against these entitlements depends on the allocations.

This portfolio will be used to achieve environmental objectives at the icon sites. Regulating structures, water delivery channels and fishways, known as works and measures, will deliver and manage the environmental water at the icon sites. On-ground works for each icon site were being progressively constructed from 2010 to 2012. The success of the environmental watering against the objectives is monitored using fish, birds and vegetation as an overall indicator of the icon site's health.

Once finalised, TLM will seek to align itself to the requirements of the Basin Plan Environmental Watering Plan.

Further information on TLM is available on the MDBA website at <**www.mdba.gov.au/programs/tlm**>.

Figure 1.1: Location of The Living Murray icon sites

The Living Murray icon site environmental water management plans

The Lindsay–Wallpolla Islands Environmental Water Management Plan establishes priorities for the use of TLM water within the icon site, and identifies environmental objectives and targets (where appropriate), water delivery options and regimes for the site that can use The Living Murray water portfolio.

Development of the environmental water management plans has been coordinated by MDBA in consultation with the Environmental Watering Group to ensure a consistent approach to planning and management across the icon sites.

This revision builds on previous iterations of the Lindsay–Wallpolla Islands Environmental Water Management Plan (previously known as 'environmental management plans') and incorporates consultation, research into icon site key species, learning from water behaviour modelling and outcomes from previous environmental watering.

The Lindsay–Wallpolla Islands Environmental Water Management Plan reflects the larger volume now held in The Living Murray water portfolio, and uses TLM works and measures (as construction is completed) and monitoring information gathered at the icon site.

This environmental water management plan deals specifically with the Victorian component of the Chowilla–Lindsay–Wallpolla icon site—Lindsay–Wallpolla Islands. A separate environmental water management plan for the Chowilla Floodplain has been prepared by South Australia and New South Wales.

Planning context and legislation framework

The Australian Government, Victoria, New South Wales and South Australia have comprehensive legislative frameworks addressing natural resource and environmental management. For activities associated with management of The Living Murray icon site, including construction of works under TLM, the principal pieces of legislation and planning strategies are detailed below.

Agreements

Ramsar Convention on Wetlands of International Importance

The Ramsar Convention on Wetlands of International Importance (the Ramsar Convention) is an international treaty with the broad aim of halting the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. For wetlands to be listed as Ramsar wetlands, they need to be representative, rare or unique in terms of their ecological, botanical, zoological, limnological or hydrological importance. Ramsar-listed wetlands can be natural, artificial, permanent or temporary swamps, marshes, billabongs, lakes, salt marshes or mudflats classified as wetlands.

Signatories to the Ramsar Convention, including Australia, are required to formulate and implement their planning so as to promote the conservation of wetlands included in the Ramsar list, and as far as possible the wise use of all wetlands in their territory. Ramsar wetlands in Australia are protected under the *Environment Protection and Biodiversity Conservation Act 1999* as a matter of national environmental significance (Department of the Environment, Water, Heritage and the Arts 2009).

Bilateral migratory bird agreements

Over the past 30 years Australia has signed three bilateral migratory bird agreements in an effort to conserve migratory birds in the east Asian and Australian regions: China–Australia Migratory Bird Agreement (signed in 1986); Japan–Australia Migratory Bird Agreement (signed in 1974); and the Republic of Korea–Australia Migratory Bird Agreement (came into effect in 2007).

These agreements protect terrestrial, water and shorebird species that migrate from Australia to Japan or China. The Japan–Australia Migratory Bird Agreement also provides for cooperation on the conservation of threatened birds, while the Republic of Korea–Australia Migratory Bird Agreement ensures conservation of migratory birds and collaboration on the protection of migratory shorebirds and their habitat (Department of Sustainability, Environment, Water, Population and Communities, 2011a).

Murray–Darling Basin agreements

The Murray–Darling Basin Ministerial Council established The Living Murray in 2002. In 2004, the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory signed the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin, which gave effect to a funding commitment (made in 2003) of $500 million over five years for TLM. The Living Murray program's First Step aimed to recover 500 GL of water for the River Murray and focused on improving the environment at the six icon sites. A supplementary Intergovernmental Agreement was signed in 2006 which provided increased funding of $200 million to The Living Murray.

The role of the Intergovernmental Agreement on Murray–Darling Basin Reform, signed by the Council of Australian Governments, is to:

- promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water and other natural resources of the Murray–Darling Basin (Council of Australian Governments 2008).

This Agreement was the foundation for the *Water Act 2007*, which established the MDBA whose role is to manage the Basin's water resources through the development of a Basin plan.

Commonwealth legislation

Water Act 2007

The Intergovernmental Agreement on Murray–Darling Basin Reform was the foundation for the *Water Act 2007*, which established the MDBA to manage the water resources of the Murray–Darling Basin in an integrated, consistent and sustainable manner. The Water Act requires MDBA to prepare and oversee a Basin Plan as a legally enforceable document that provides for the integrated and sustainable management of water resources in the Basin.

The Basin Plan's Environmental Watering Plan will provide a strategic framework for coordinated environmental water planning and environmental watering throughout the Murray–Darling Basin. In the future, TLM will align with the Environmental Watering Plan in the development of Basin states' long-term and annual environmental watering plans and through the annual environmental water prioritisation processes.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (including natural, historic or Indigenous places) —defined in the EPBC Act as matters of national environmental significance. There are eight matters of national environmental significance to which the EPBC Act applies.

The EPBC Act aims to balance the protection of these crucial environmental and cultural values with our society's economic and social needs by creating a legal framework and decision-making process based on the guiding principles of ecologically sustainable development (Department of Sustainability, Environment, Water, Population and Communities, 2011b).

Native Title Act 1993

Section 24KA of the *Native Title Act 1993* requires that native title claimants are notified of any future act consisting of the grant of a lease, licence, permit or authority under legislation that relates to the management or regulation of surface or subterranean water.

Victorian legislation

The principal Acts listed in this section operate in conjunction with other state legislation that deals with the management and conservation of Victoria's natural resources, and outlines obligations relating to obtaining approvals for structural works within TLM icon sites.

Aboriginal Heritage Act 2006

The *Aboriginal Heritage Act 2006* provides for the protection of Indigenous Australian cultural heritage in Victoria. The Act also provides for the introduction and management of a system of Registered Aboriginal Parties that allows Indigenous groups with connection to country and others to be involved in decision-making processes around cultural heritage. Regulations enabled under this Act require a cultural heritage management plan to be prepared when undertaking high impact activities in culturally sensitive landscapes.

Figure 1.2: The white-bellied sea eagle is listed as threatened in Victoria under the Flora and Fauna Guarantee Act

Environmental Effects Act 1978

The *Environmental Effects Act 1978* aims to ensure that development occurs in an ecologically sustainable manner and provides for assessment of any project or development that could have significant effects on the environment. This Act enables the Victorian Minister for Planning to decide whether an environmental effects statement should be undertaken for proposed projects. Projects should be referred to the minister if they meet any referral criteria, as set out in ministerial guidelines (Victorian Department of Sustainability and Environment 2006). A project can be referred by the proponent, a statutory authority or any minister.

Flora and Fauna Guarantee Act 1988

The aim of the *Flora and Fauna Guarantee Act 1988* is to conserve threatened flora and fauna species and communities, and to manage potentially threatening processes. This Act provides for the establishment and maintenance of lists of threatened species, potentially threatening processes and excluded species, which are those not to be conserved because they constitute a serious threat to human welfare (i.e. human disease organisms).

The Act directs that action statements (brief management plans) are to be prepared for listed species to track the progress of management actions, and recovery plans are to be prepared for species also listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Forests Act 1958

The *Forests Act 1958* governs forest management in Victoria. This Act and associated regulations are supported by Victoria's five regional forest agreements. Under the Act's provisions, detailed forest management plans are developed for each area following a complex assessment process that considers all forest values. These management plans provide for the control, maintenance, protection and taking of forest produce and fire management in state forests.

Planning and Environment Act 1987

The *Planning and Environment Act 1987* establishes a framework for planning the use, development and protection of land in Victoria in the present and long-term interests of all Victorians. Local planning schemes are enabled under this Act.

This Act enables the Gannawarra and Campaspe planning schemes. Under these schemes, planning permits are required for proposed works under The Living Murray initiative in these areas, with applications prepared and submitted to the relevant councils.

Murray–Darling Basin Act 1993

The *Murray–Darling Basin Act 1993* enables the Murray–Darling Basin Agreement 2008, which was entered into by the Australian Government and the governments of New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory with regard to the water, land and other environmental resources of the Murray–Darling Basin. This Act provides for the referral of selected powers under the Victorian Constitution that enable the Australian Government to manage specific aspects of water resource management within the Basin.

National Parks Act 1975 and Parks Victoria Act 1998

In Victoria, national parks are managed by Parks Victoria. Under the *Parks Victoria Act 1998*, Parks Victoria's responsibilities are to provide services to the state and its agencies for the management of parks, reserves and other public land. Under s. 27 of the *National Parks Act 1975*, works by a public authority within a park reserved and managed under the provisions of the Act are subject to consent by the minister. A condition of this consent is that the proposed works comply with the management objectives and strategies for the park.

Water Act 1989

The Victorian *Water Act 1989* governs the way water entitlements are issued and allocated in Victoria. The Act defines water entitlements and establishes the mechanisms for managing Victoria's water resources. Part 10 of the Water Act establishes waterway management and general river health management as the responsibility of catchment management authorities and Melbourne Water (where applicable). For TLM works, s. 67 of the Water Act identifies catchment management authorities as the responsible authorities for issuing licences for conducting works in a designated waterway.

New South Wales legislation

Crown Lands Act 1989

The *Crown Lands Act 1989* ensures that Crown land is managed for the benefit of the people of New South Wales and, in particular, provides for the management, proper development, conservation and regulation of the conditions under which Crown land is permitted to be used, or otherwise dealt with. The Land and Property Management Authority is responsible for the sustainable and commercial management of Crown land in New South Wales. A Crown land licence is a contractual agreement that grants the licensee a personal right to occupy and use Crown land for a particular purpose.

Environmental Planning and Assessment Act 1979

This Act forms the statutory framework for planning approval and environmental assessment in New South Wales. Implementation of the *Environmental Planning and Assessment Act 1979* is the responsibility of the Minister for Planning, statutory authorities and local councils. The need or otherwise for development consent is set out in environmental planning instruments — state environmental planning policies, regional environmental plans or local environmental plans.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* lists threatened aquatic species, endangered populations and ecological communities, and key threatening processes. Potential impacts on species, populations and communities subject to this Act are assessed by Industry and Investment NSW.

Water Management Act 2000

The *Water Management Act 2000* provides for the sustainable and integrated management of the water sources of the state to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality. Any activity that affects the quantity or flow of water in a water source requires consent under this Act.

Planning frameworks and strategies

Management objectives outlined in the environmental watering management plan are complementary to objectives and outcomes in Victorian regional planning strategies.

Regional catchment strategies

The Victorian *Catchment and Land Protection Act 1994* established overarching strategic documents aimed at halting biodiversity decline through the implementation of priority programs, including those that protect and manage wetlands. The catchment management authorities are responsible for coordinating the implementation of the Regional Catchment Strategy and its sub-strategies and action plans under the Water Act (Vic.).

Victorian Northern Region Sustainable Water Strategy

Regional sustainable water strategies were legislated through 2005 amendments to the Water Act (Vic.) and fulfil Victoria's commitment to the National Water Initiative to carry out open, statutory-based water planning. Sustainable water strategies take a long-term view of water resource planning and, as such, they guide the development, integration and implementation of management plans prepared by water corporations and catchment management authorities operating within each region.

Victorian River Health Strategy

The Victorian River Health Strategy was released in 2002 with the statewide objective of achieving healthy rivers, streams and floodplains that meet the environmental, economic, recreational and cultural needs of current and future generations. The strategy provides the policy direction and planning framework for communities to work in partnership with government to manage and restore Victoria's rivers over the long term.

Regional river health strategies

These strategies were established as a part of the Victorian Government's response to the Victorian River Health Strategy. They provide regional frameworks for catchment management authorities, as regional caretakers, to achieve regional river health outcomes.

Victorian Native Vegetation Management: A Framework for Action

The *Native Vegetation Management: A Framework for Action* was released in 2002. The framework establishes the strategic direction for the protection, enhancement and revegetation of native vegetation across the Victorian landscape.

Improving the quality and amount of native vegetation in Victoria is critical to maintaining land and water health. The framework's main goal is to achieve a reversal across the entire landscape of the long-term decline in the extent and quality of native vegetation, leading to a net gain.

Mallee Parks Management Plan

The Mallee Parks Management Plan 1996 sets out the broad directions for future management of Mallee Parks and provides management objectives and strategies to achieve a high standard of conservation and recreation management. One of the major directions is to restore a more natural water regime.

Governance and planning arrangements

The Living Murray is a joint initiative and is managed collaboratively by partner governments. The Murray–Darling Basin Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin (Council of Australian Governments 2004) outlines the governance arrangement for implementing The Living Murray program. The 2004 intergovernmental agreement is complemented by The Living Murray Business Plan, which provides operational policies to guide TLM implementation.

Groups with a direct role in TLM governance are the Murray–Darling Basin Ministerial Council, MDBA, Basin Officials' Committee, The Living Murray Committee and the Environmental Watering Group (see **Figure 1.3** for The Living Murray governance structure).

While MDBA plays a key coordination role at a TLM-wide level, management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located.

In Victoria, the Department of Sustainability and Environment coordinates TLM delivery across all Victorian icon sites. A statewide governance framework has been developed, with a state steering committee and state construction committee to ensure high-level engagement of stakeholder agencies.

The icon site manager for Lindsay–Wallpolla Islands is the chief executive officer of the Mallee Catchment Management Authority, as catchment management authorities are responsible for river health and environmental water management in Victoria. The Mallee Catchment Management Authority therefore coordinates delivery of The Living Murray program at icon site level, working in partnership with Parks Victoria (the land manager) and supported by a number of icon site-specific committees. These committees are composed of representatives from relevant agencies and communities. For more detail on the roles and responsibilities of individual committees and groups, please refer to **Appendix A**.

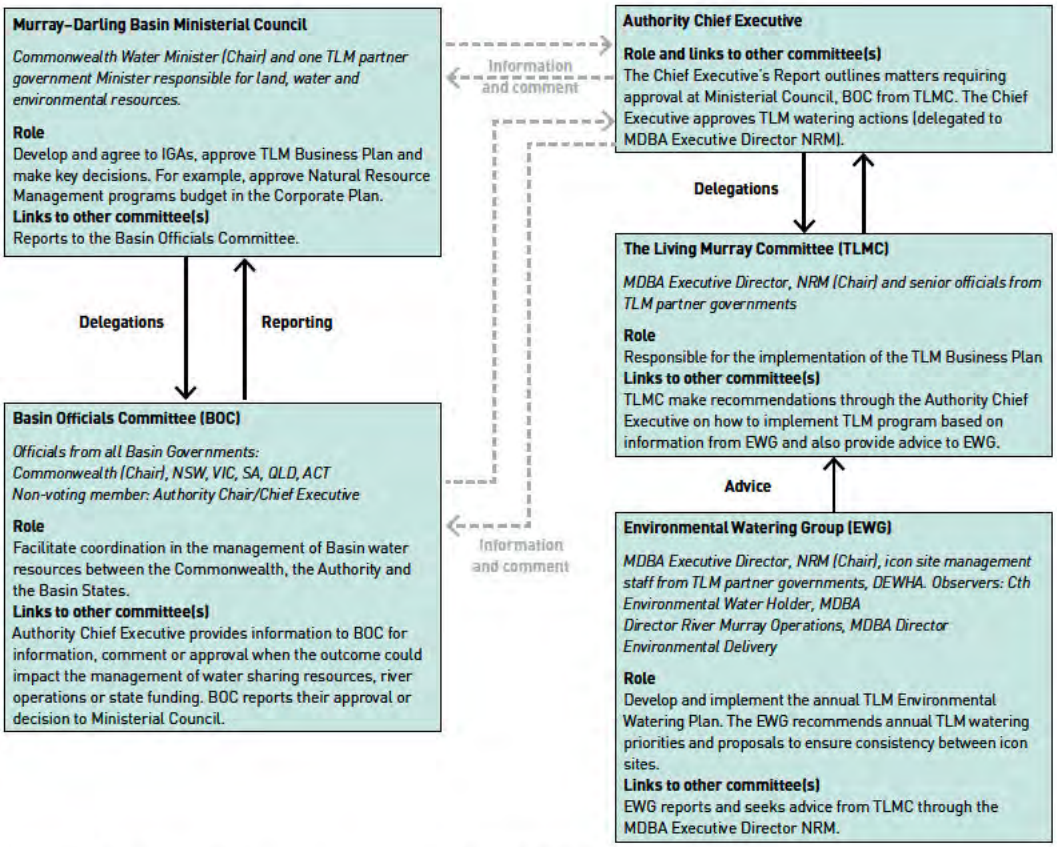

Figure 1.3: The Living Murray governance structure (MDBA)

2. Icon site description

The Chowilla–Lindsay–Wallpolla icon site is a cross-border icon site, having components in South Australia, New South Wales and Victoria (see **Figure 2.1**). The icon site covers 43,856 ha and has four main components — the Chowilla Floodplain (17,700 ha), which spans South Australia (74%) and New South Wales (26%), as well as the Lindsay, Mulcra and Wallpolla islands in north-west Victoria, which collectively cover 26,156 ha downstream of Mildura.

The Chowilla Floodplain and the Lindsay–Wallpolla Islands have specific physical differences and water delivery constraints that affect their management and the development of options for environmental watering. They lie within different states and are managed by different agencies, although consultation between icon site staff in New South Wales, South Australia and Victoria occurs regularly. While having similar values and hydrology, their geographical locations means that different water management infrastructure (e.g. River Murray weirs, small block-banks) influences the hydrology of each component. Accordingly, separate works options have been developed. However, there are clear opportunities to coordinate future operations, share technical knowledge and collaborate on monitoring and consultation activities.

Wallpolla Island is closest to Mildura and is bounded by Wallpolla Creek and the Lock 9 weir pool of the River Murray. It covers 9,000 ha and, together with Mulcra Island, was added to the Murray–Sunset National Park in June 2010. Mulcra Island covers 2,000 ha between Lindsay and Wallpolla Islands and is formed by the Potterwalkagee Creek and the weir pools at locks 7 and 8. Lindsay Island covers 15,000 ha and is bounded by the Lindsay River anabranch and both the locks 6 and 7 weir pools.

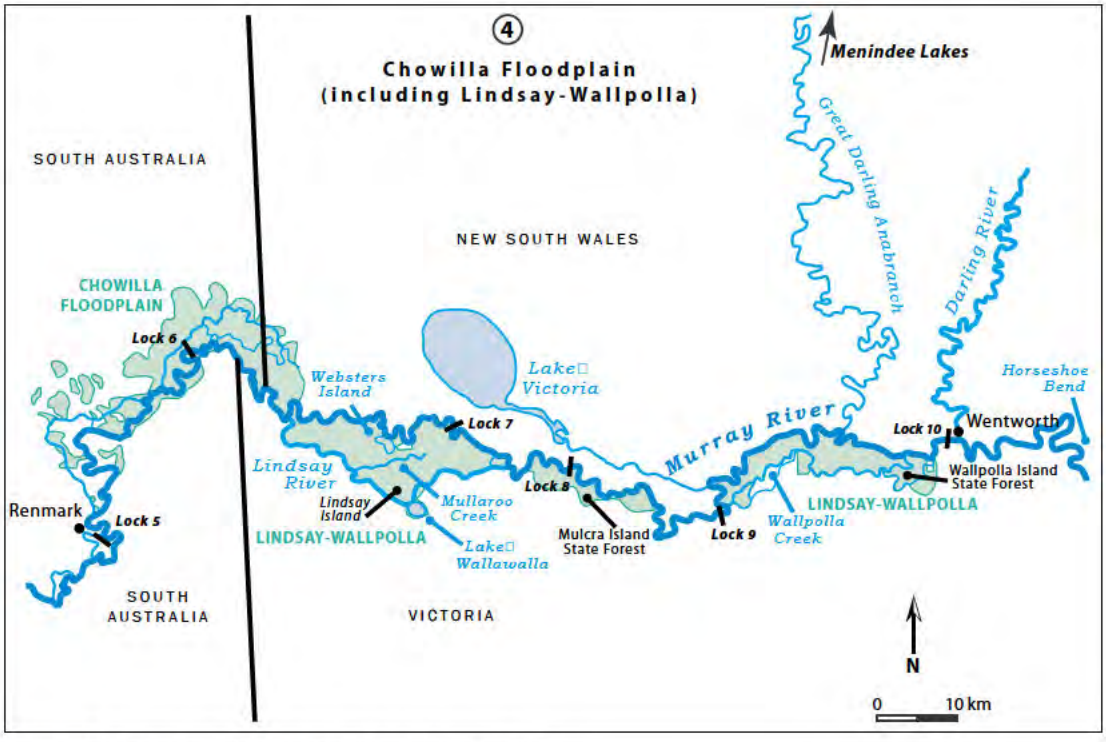

Figure 2.1: The Chowilla–Lindsay–Wallpolla icon site

The Lindsay–Wallpolla Islands lie within the Murray–Sunset National Park and are managed by Parks Victoria. Lindsay Island was included when the park was declared in 1991, with the Mulcra Island and Wallpolla Island state forests added in 2010. Ned's Corner lies to the south of Mulcra and Lindsay islands. Formerly a sheep and cattle station, this property was purchased by Trust for Nature in 2002 and is now managed for conservation.

Description of key ecological assets of the icon site

The Lindsay–Wallpolla floodplain lies within the Murray Scroll Belt bioregion, which is typified by the River Murray floodplain, oxbow lakes, ephemeral lakes, swamps and active meander belts (Victorian Department of Sustainability and Environment 2010). Here, red-brown earths, cracking clays and texture contrast soils support a range of vegetation types, including terrestrial, floodplain and aquatic ecosystems (Victorian Department of Sustainability and Environment 2010). The islands feature a number of waterways and wetlands.

This floodplain is relatively flat and is dissected by a network of anabranches, small creeks and permanent and ephemeral wetlands. Lindsay Island, Wallpolla Island and Lake Wallawalla are listed as nationally important wetlands (Environment Australia 2001).

Values of the icon site

The Lindsay–Wallpolla floodplain is an area of high ecological significance. When inundated, the waterways and wetlands of the floodplain provide refuges and resources for a range of flora and fauna, including threatened species; they also provide important waterbird breeding habitat.

Fauna

The floodplain supports diverse aquatic, wetland-dependent and terrestrial species. It provides important habitat for native fish, frogs, turtles and waterbirds, including many considered threatened at a national and state levels. Thirty-five species listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* have been recorded there. The regent parrot (*Polytelis anthopeplus*), growling grass frog (*Litoria raniformis*)and the Murray cod are also listed as nationally threatened under the federal *Environment Protection and Biodiversity Conservation Act 1999* (Ecological Associates 2007).

Mullaroo Creek, a permanent Lindsay Island anabranch, supports one of the most significant populations of Murray cod (Figure 2.2) in the lower River Murray and Victoria, exhibiting significantly better age structure and population size than in any other Victorian system (Saddlier *et al*. 2008; Sharpe *et al*. 2009). It is the robustness of the Mullaroo Creek population that makes it of particular importance to the sustainability of broader regional populations (Sharpe *et al*. 2009). Key habitat features contributing to the viability of the population include the sustained moderate flows (e.g. >400 ML/d) and the hydraulic diversity, including sections of variable water velocity and high densities of submerged woody debris in the creek (Saddlier *et al*. 2008; Water Technology 2009).

The islands also provide resources for the growth and breeding of an additional four fish species listed under the Flora and Fauna Guarantee Act — freshwater catfish (*Tandanus tandanus*), silver perch (*Bidyanus bidyanus*), Murray–Darling rainbowfish (*Melanotaenia fluviatilis*) and unspecked hardyhead (*Craterocephalus stercusmuscarum fulvus*). Australian smelt (*Retropinna semoni*), bony bream (*Nematalosa erebi*), carp gudgeon (*Hypseleotris* spp.), dwarf flathead gudgeon (*Philypnodon macrostomus*) and flathead gudgeon (*Philypnodon grandiceps*) also occur (Mallen-Cooper *et al*. 2010).

During dry periods, floodplain wetlands (e.g. Lake Wallawalla) support terrestrial species such as small mammals and reptiles (Ecological Associates 2007). When flooded, these wetlands provide important habitat for a range of wetland-dependent species, including many waterbirds (MDBC 2006). When freshly inundated, these wetlands promote the growth of microbes, algae, macroinvertebrates, crustaceans and frogs, providing food for fish and birds such as dabbling ducks (*Anatidae* f.) and grazing waterfowl (Ecological Associates 2007).

Figure 2.2: The Murray–Darling rainbowfish was formerly widespread across the Basin but has declined in the Murray region. (Gunther Schmida © MDBA)

As the water level drops, the muddy lake bed becomes exposed, providing conditions for lakebed herbland to establish, and ideal grazing for wading birds such as the great egret (*Ardea alba*), greenshank (*Tringa nebularia*) and the red-necked stint (*Calidris ruficollis*), all of which are listed under the Japan–Australia, Republic of Korea–Australia and the China–Australia Migratory Bird agreements (Ecological Associates 2007; MDBC 2006; SKM 2003). Fish and carrion feeding birds such as the China–Australia Migratory Bird Agreement-listed white-bellied sea eagle (*Haliaeetus leucogaster*) (**Figure 1.2**) are also supported by the lake (Ecological Associates 2007).

Some 210 bird species, 49 of which are dependent upon water habitats, are known to use the Lindsay–Wallpolla floodplain for breeding, feeding and roosting. Of these bird species, 40 are considered threatened in Victoria; 24 are listed under the *Flora and Fauna Guarantee Act 1988* (Vic.) and three are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (Ecological Associates 2007).

Flora

Together, the island floodplains support a number of plant species of national and state significance, including nine species listed as endangered under the Victorian Flora and Fauna Guarantee Act, and eight, such as bignonia emu-bush (*Eremophila bignoniiflora*), which are listed or nominated for listing (Ecological Associates 2007; MDBC 2006; SKM 2004). Plant communities on the floodplain have been mapped in detail and described by White and others (2003) as ecological vegetation classes (Ecological Associates 2007). Vegetation of the Lindsay, Mulcra and Wallpolla floodplain and wetlands consists of 21 individual ecological vegetation classes and one ecological vegetation class complex, the conservation significance of which range from 'least concern' to 'endangered' (Ecological Associates 2007; Victorian Department of Sustainability and Environment 2010).

Table 2.1: Ecological Vegetation Classes and their conservation significance: Lindsay–Wallpolla floodplain

Ecological Vegetation Class	Bioregional conservation significance
Floodplain vegetation	
Grassy riverine forest (106)	Depleted
Intermittent swampy woodland (813)	Depleted
Shrubby riverine woodland (818)	Least concern
Riverine grassy woodland (295)	Depleted
Lignum (*Muehlenbeckia florulenta*) swampy woodland (823)	Depleted
Riverine chenopod woodland (103)	Depleted
Lignum shrubland (808)	Least concern
Alluvial plains semi-arid grassland (806)	Vulnerable
Semi-arid chenopod woodland (98)	Depleted
Low chenopod shrubland (102)	Depleted
Sub-saline depression (820)	Vulnerable
Disused floodway shrubby herbland (807)	Endangered
Wetland vegetation	
Lignum swamp (104)	Vulnerable
Floodplain grassy wetland (809)	Endangered
Floodway pond herbland (810)	Depleted
Aquatic herbland	Depleted
Spike rush (*Eleocharis obicis*) wetland (819)	Vulnerable
Shallow freshwater marsh (200)	Vulnerable
Lake bed herbland (107)	Vulnerable
Ecological vegetation community complex	
Grassy riverine forest/floodway pond herbland (811)	Depleted

Source: Ecological Associates (2007); Victorian Department of Sustainability and Environment (2010).

River red gums (**Figure 2.4**) occur mainly in riparian and floodplain zones along the River Murray channel and on the edges of waterways and wetlands. These trees are an important source of habitat and a food resource for many fauna, including birds, reptiles and mammals, and are critical to the successful recruitment of many species.

Figure 2.3: River red gums occur mainly in riparian and floodplain zones along the Murray River (Corey Brown © MDBA)

River red gums also provide submerged woody habitat to anabranches through limb-drop or complete topples (Water Technology 2009; Ecological Associates 2007). Submerged woody habitat is a source of food and shelter for fish and aquatic macroinvertebrates. Similarly, limb-drop is a source of organic matter used to fuel primary productivity in the aquatic system.

In the vicinity of waterways, river red gums may be sustained by relatively fresh, shallow groundwater (Ecological Associates 2007). Over much of the floodplain, however, surface-water provided by floods is needed for these trees to survive. Under natural conditions, these areas would have been flooded for two to six years out of every 10, depending on their position on the floodplain.

Black box occurs commonly throughout the floodplain. It supports both arid and riverine bird species, and productivity and recruitment is strongly linked to flooding. Lignum is dispersed similarly to black box but is largely confined to floodplain depressions where water collects and persists after floods. When inundated, it provides habitat for both birds and fish.

Typically, arid zone floodplain wetlands are sites of high biodiversity and may support both aquatic and terrestrial plant communities, depending on inundation status (Henderson *et al*. 2009). When inundated, wetlands such as Lake Wallawalla and the Mulcra Horseshoe Lagoon host aquatic flora species grown from both dormant seeds and propagules present in the lakebed, as well as those washed in (Ecological Associates 2007). As the lake dries, aquatic vegetation will give way to wetland herb communities (Ecological Associates 2007). A total of 28 threatened wetland plant species have been reported on Lindsay Island (SKM 2003).

Anabranches dissecting the Lindsay–Wallpolla floodplain provide adverse aquatic habitats, including deep and shallow sections with varied flow velocities and both steep and sloping banks. Dense stands of aquatic macrophytes are supported and significant amounts of instream woody debris are present. The diversity of habitats within anabranches has significant potential to support fish, aquatic invertebrates, frogs and birds, including some that are threatened or uncommon.

Indigenous values

Indigenous Australian occupation across the Lindsay–Wallpolla floodplain dates back thousands of years, and was sustained by the rich productivity of the floodplain woodland and wetland systems. Historically, the islands would have been an abundant source of food and water for these communities. Today, many signs of Indigenous life still remain at the islands, including diverse archaeological site-types and complexes closely associated with floodplain features (SKM 2004). The floodplain contains many registered sites of cultural heritage, within each of which may be multiple items of significance such as burial sites, shell middens, hearths, stone artefact scatters and culturally scarred trees (Bell 2010; Kelton 1996). Under the *National Parks Act 1975* (Vic.) and the Mallee Parks Management Plan 1996, Lindsay Island is listed as a special protection zone for its many of archaeological sites.

Only a very small area of the icon site has been surveyed for areas of cultural significance, largely because of its isolation. Surveys show the area was once densely populated by Indigenous peoples, who maintained spiritual, cultural and emotional links with its land, waters and traditional resources such as native species used for food and medicine (K.Stewart, pers. comm., 2010) The land and waterways are associated with cultural learning, which is still being passed on to new generations today (NSW Department of Environment, Climate Change and Water 2010).

Culturally scarred trees are often a living remnant of traditional Indigenous life and frequently occur along the edges of waterways and wetlands. Many of these trees occur on the islands, but are often stressed because of lack of flooding and likely to die without intervention.

Social and economic values

Tourism in the Mildura region generates more than $210 million annually, and is the third-largest industry in the region (Mildura Development Corporation 2009), with tourist numbers in the tens of thousands every year (B. Rogers, pers. comm., 2010). Sites such as the Murray–Sunset National Park are major attractions contributing to the tourism industry and local economy. The island floodplains are also popular recreation sites for the local communities of Millewa and Sunraysia, Victoria and the Riverland in South Australia. Camping, canoeing, bird- and wildlife-watching, photography, fishing and four-wheel driving are all popular pursuits.

3. Ecological objectives and water requirements

Based on an understanding of the Chowilla–Lindsay–Wallpolla icon site's characteristics and ecological requirements, First Step Decision interim ecological objectives were developed and approved by Murray–Darling Basin Ministerial Council in 2003. Objectives include:

- high value wetlands maintained
- current area of river red gum maintained
- at least 20% of the original area of black box vegetation maintained.

Since these objectives were approved by Ministerial Council in 2003, jurisdictional agencies have continued to review and refine the First Step interim objectives to develop refined ecological objectives for icon sites. These refined ecological objectives reflect eight years of learning's from the delivery of environmental water, monitoring, modelling and consultation activities and scientific research, and enable a clearer, more effective, evaluation of environmental responses to environmental water delivery.

In consultation with communities, the First Step Decision objectives that relate to Victorian environmental water management plans have been extended to develop overarching objectives. These overarching objectives better reflect the specific icon site values that the environmental waterings aim to protect, as well as relevant jurisdictional management plans and obligations.

The objectives for the Lindsay–Wallpolla environmental water management plan are outlined in **Table 3.1**. In addition to the overarching objectives, more detailed objectives have been developed to guide icon site management. Targets to measure progress towards these objectives are under development for this icon site.

Table 3.1: Revised ecological objectives for the Lindsay–Wallpolla icon site

Vision: *To maintain and restore a mosaic of healthy floodplain communities across Lindsay, Mulcra and Wallpolla Islands which will ensure that indigenous plant and animal species and communities survive and flourish throughout the site*		
Icon site ecological objectives		Targets
Overarching objectives	Specific objectives	
Vegetation Increase the diversity, extent and abundance of wetland vegetation	Provide a diversity of structural aquatic habitats Increase diversity and abundance of wetland aquatic vegetation Maintain and improve the populations of threatened flora and fauna that are flow-dependent Restore productivity linkages between the river and floodplain habitats.	Targets under development
Fish Increase abundance, diversity and extent of distribution of native fish	Increase abundance, diversity and extent of distribution of native fish	Targets under development
Waterbirds Provide habitat for a range of waterbirds, including migratory species and colonial nesters	Provide occasional breeding and roosting habitat for colonial waterbirds Provide habitat suitable for migratory birds, especially species listed under the JAMBA, CAMBA and RoKAMBA	Targets under development

Recognising their different values and variable water requirements, specific objectives based on water regime classes were then developed for different wetland types and vegetation communities across the island (Ecological Vegetation Classes). These are:

- semipermanent wetlands — restore habitat and community diversity
- ephemeral wetlands — restore habitat and community diversity; reinstate the communities typical of ephemeral wetlands
- lignum — improve condition and increase extent to sustain species assemblages and processes typical of lignum communities
- open grassland — maintain habitat values and flora and fauna communities
- river red gum — maintain current condition and extent of river red gum communities to sustain species assemblages and processes typical of such woodland
- black box — improve condition to sustain species assemblages and processes typical of black box woodland.

In 2006 the Murray–Darling Basin Commission noted that the specific objectives for the Lindsay–Wallpolla component of the icon site were to be further developed (MDBC 2006). Following the completion of the *Floodplain Options Investigation: Lindsay, Mulcra and Wallpolla Islands* (Ecological Associates 2007), the objective for permanent wetlands (to restore habitat and community diversity) was removed because these do not occur naturally on the islands.

Water requirements

Ecology and hydrology

Duration, depth, frequency and timing of flooding influence plant species assemblages, their relative abundance and growth habit and the fauna communities they support. As such, plant community classifications are a useful way to directly relate water regime to flora habitat, and indirectly to fauna habitat.

Water regime classes are a spatial classification of the floodplain into areas with common water regimes and ecological characteristics. Each water regime class has its own distinct ecology and hydrologic requirements, as described in Ecological Associates (2007).

Water regime classes provide a basis to establish objectives for the location, extent and condition of components of the floodplain ecosystem and therefore to set hydrologic objectives. Water regime classes were defined using existing information that describes the vegetation and aquatic habitat values of the floodplain (Ecological Associates 2007).

The hydrological environments of Lindsay–Wallpolla Islands have been classified into water regime classes according to the vegetation communities and aquatic habitat present, their water regimes prior to river regulation and by their interpreted ecological roles (Ecological Associates 2007; see also **Table** and **figures 3.1–3.3**).

All wetland ecological vegetation classes have been classified into two water regime classes, according to water regimes, plant communities and dependent fauna (Ecological Associates 2007). All anabranch ecological vegetation classes have been grouped into water regime classes with specific water requirements based on the biota they support (Ecological Associates 2007).

The relationship between water regime classes and fauna species guilds and breeding waterbirds is outlined in Appendix B.

Table 3.2: Water regime classes and component ecological vegetation classes

Water regime class	Ecological vegetation classes
Red gum forest	Grassy riverine forest (106)
	Grassy riverine forest/floodway pond herbland complex (811)
Red gum woodland	Intermittent swampy woodland (813)
	Shrubby riverine woodland (818)
	Riverine grassy woodland (295)
	Riverine swampy woodland
Black box woodland	Lignum swampy woodland (823)
	Riverine chenopod woodland (103)
Lignum shrubland	Lignum shrubland (808)
	Lignum swamp (104)
Alluvial plains	Alluvial plains semi-arid grassland (806)
	Semi-arid chenopod shrubland (98)
	Low chenopod shrubland (102)
	Sub-saline depression (820)
	Disused floodway shrubby herbland (807)
Semipermanent wetlands	Floodplain grassy wetland (809)
	Water body—fresh
Temporary wetlands	Floodway pond herbland (810)
	Spike rush wetland (819)
	Shallow freshwater marsh (200)
	Lake bed herbland (107)
Anabranches	Ecological vegetation class mapping does not cover waterways

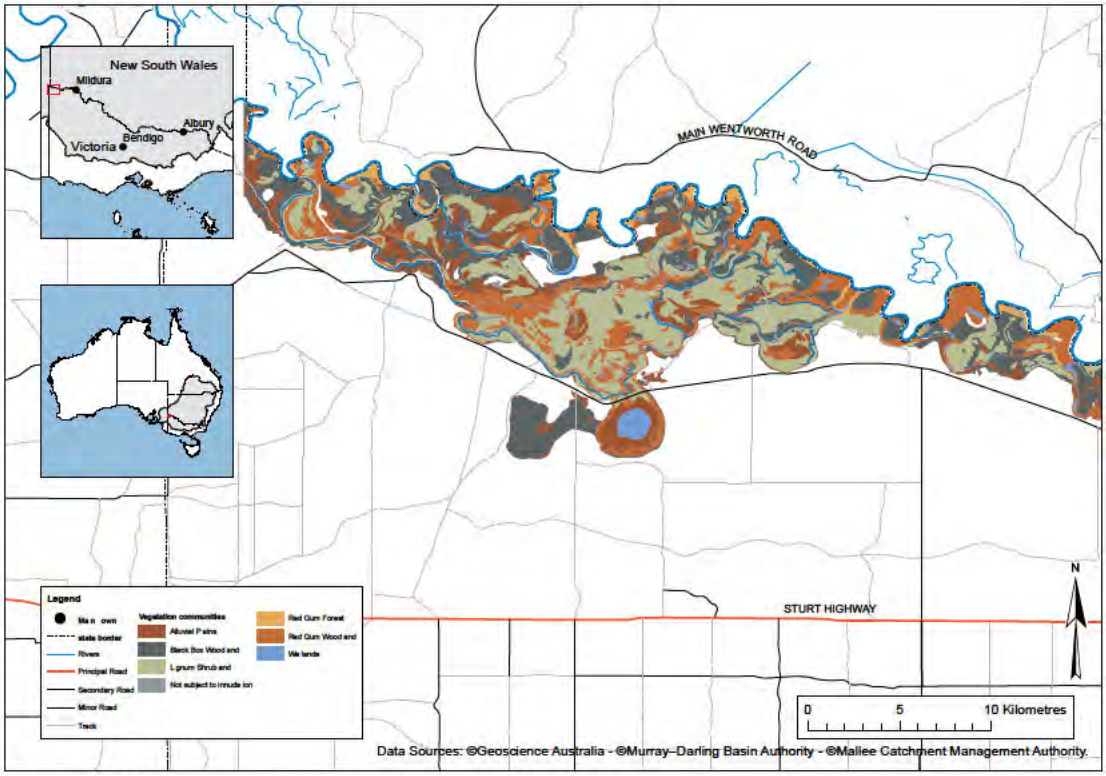

Figure 3.1: Water regime class distribution on Lindsay Island

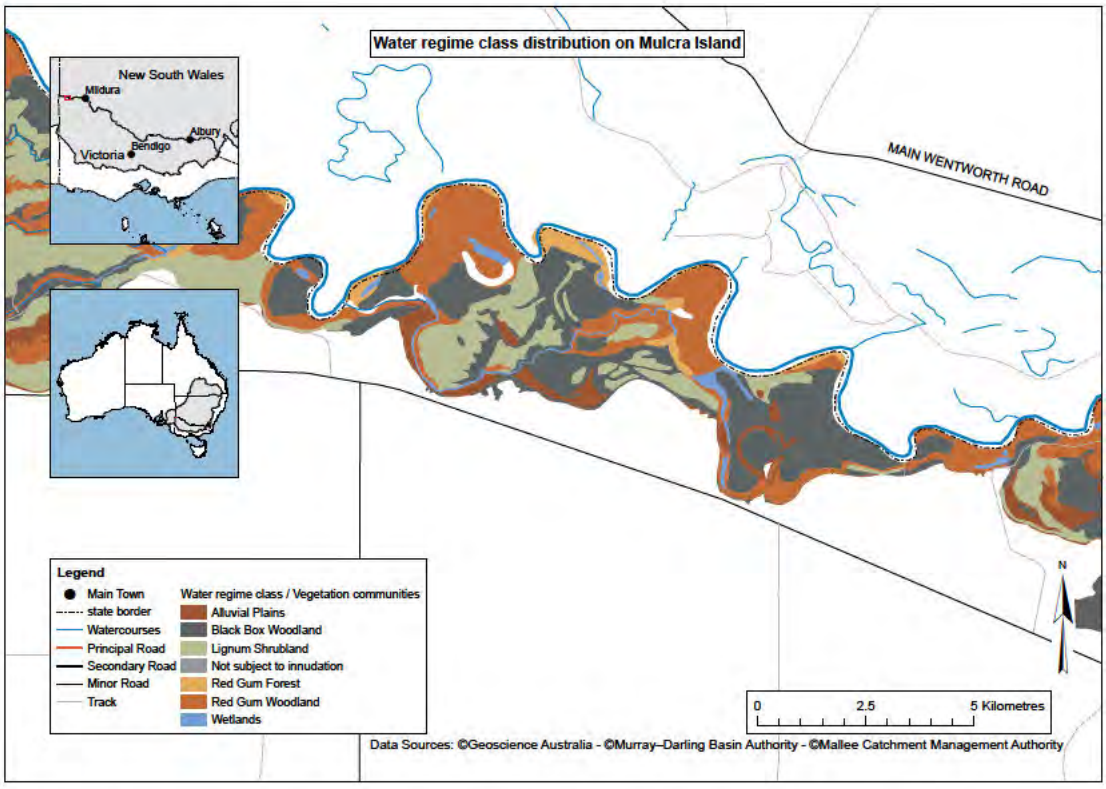

Figure 3.2: Water regime class distribution on Mulcra Island

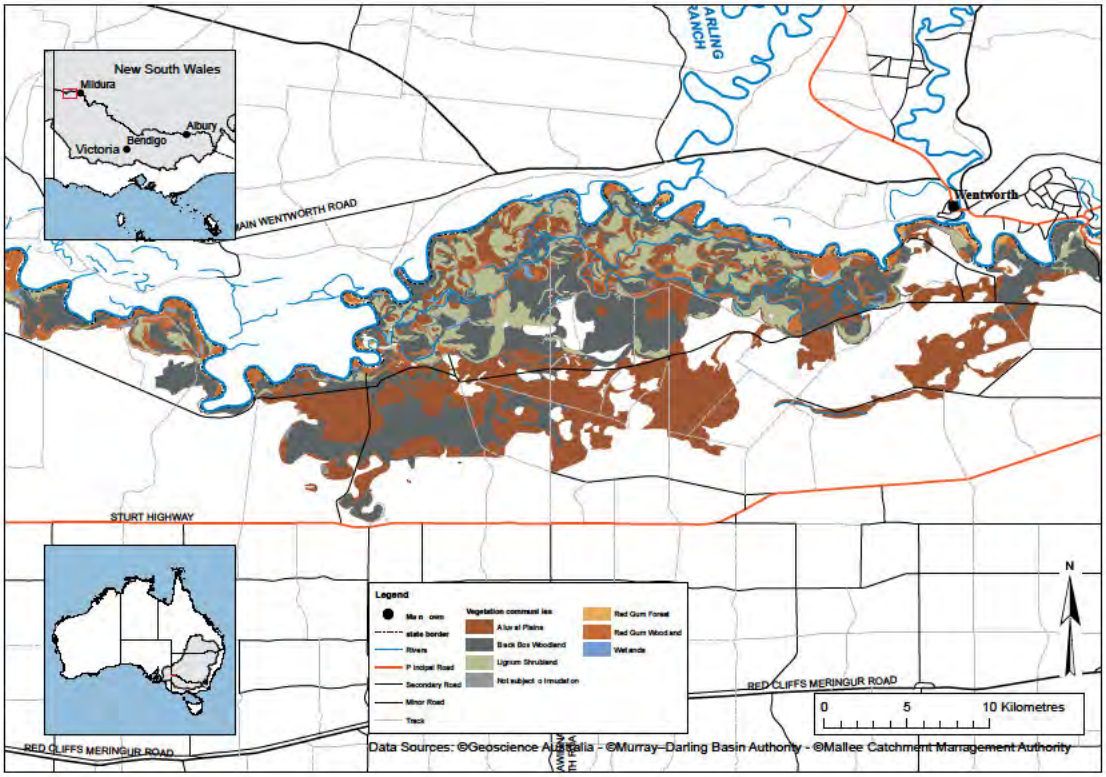

Figure 3.3: Water regime class distribution on Wallpolla Island

Table 3.3: Water requirements for the icon site environmental objectives

First Step Decision objective	Refined objectives	Vegetation community (water regime class)	River flow rate (ML/day)	Duration	Timing	Frequency (years in 10)	Maximum time between events	Works or other mechanisms to assist meeting objectives	Area flooded by works (ha)
			Required water regime						
High value wetlands maintained	Provide a diversity of structural aquatic habitats	Temporary wetlands	>30,000 ML/d	2 months	Spring	2–8	4 years	Mulcra Island works	1,286 ha across the entire icon site[b]
		Semipermanent wetlands	>60,000 ML/d	1 month				Lindsay Stage 1 works	
	Increase diversity and extent of distribution of native fish							Wetland regulators[a]	
	Increase diversity and abundance of wetland aquatic vegetation								
	Provide occasional breeding and roosting habitat for colonial water birds	Lignum shrubland	>50,000 ML/d	2 months	Spring	5	5 years	Mulcra Island works	161 ha on Mulcra Island[b]
	Maintain and improve the populations of threatened flora and fauna that are flow-dependent							Lake Wallawalla regulators	~70 ha at Lake Wallawalla
	Restore productivity linkages between the river and floodplain habitats	Anabranches	15,000 ML/d	14 days (3–4 freshes/y)	August–December	8	2 years	Mulcra Island works Lindsay stage 1 works	Flows improved over 20 km on Mulcra Island and 20 km on Lindsay Island
Current area of river red gum maintained	Provide occasional breeding and roosting habitat for colonial water birds	Red gum forest	>60,000 ML/day	4 months	Spring	7	4 years	Mulcra Island works	29 ha on Mulcra Island[b]
	Provide habitat suitable for migratory birds, especially species listed under the Japan–Australia and the China–Australia migratory bird agreements								
	Restore productivity linkages between the river and floodplain habitats	Red gum woodland	>80,000 ML/d	2 months	Spring	6	7 years	Mulcra Island works Wetland regulators Lake Wallawalla regulators	263 ha on Mulcra Island[b] Minor areas around wetlands ~250 ha at Lake Wallawalla
At least 20% of the original area of black box vegetation maintained	Provide habitat suitable for migratory birds, especially JAMBA- and CAMBA- listed species	Black box woodland	n/a	1 month	August–December	1–2	8 years	Mulcra Island works Lake Wallawalla regulators	45 ha on Mulcra Island[b] ~200 ha at Lake Wallawalla
	Restore productivity linkages between the river and floodplain habitats								

Notes
a Wetland regulators include those at Horseshoe Lagoon on Wallpolla Island, and Webster's Lagoon and Lake Wallawalla on Lindsay Island.
b Area flooded includes any areas in New South Wales inundated by raising Lock 8.

Climate and rainfall in the Murray–Darling Basin

Historically, the climate of the Murray–Darling Basin has been variable. Climate change science indicates a likely increase in this variability, resulting in more frequent and extreme floods and droughts (MDBA 2010a). Consequently, river storages and the use of environmental water will be managed according to these varying river flows.

Between 1996 and 2010, the Murray–Darling Basin was in a drought characterised by below-average rainfall in autumn and winter and few wet periods. This drought was significantly drier than the Federation Drought (mid-1890s to early 1900s) and the droughts of the World War II era (1937–1945).

Beginning in spring 2010, and continuing through the summer of 2010–11, widespread, above average rainfall across the Murray–Darling Basin broke the long standing drought. This rainfall was associated with the development, beginning in 2010, of a moderate to strong La Nina event making 2010 the wettest year on record for the Murray–Darling Basin.

Antecedent hydrologic conditions

Lindsay–Wallpolla Islands are located within the semi-arid Mallee region of Victoria. The climate is the hottest and driest in Victoria, with an average annual rainfall of 270 mm in Mildura. Average maximum temperatures are around 32°C in summer and 16°C in winter, with high evaporation rates throughout the year. As such, the River Murray represents an important source of water for the floodplain ecosystem.

The past 100 years has seen a vast increase in regulation and water extraction within the River Murray, resulting in reductions in the occurrence of high flows and extended periods of low flows, delays to the onset of floods and reduced frequencies and durations of floods (**Figure 3.4**)(Ecological Associates, 2007; SKM 2004). Flows are now captured in upstream storages and gradually released, resulting in relatively even flows all year round, transforming the River Murray into a deep habitat with low water velocities and stable water levels at low to moderate flows (Walker & Thoms 1993).

These changes to the flooding regime have affected the condition of the Lindsay–Wallpolla floodplain ecosystem. In recent years, the reduction in flooding caused by river regulation has been compounded by extended drought. These impacts are likely to increase under the predicted influence of climate change, however recent flooding in late 2010 and early 2011 will provide significant environmental benefits.

The widespread rainfall in spring 2010 has generated high flows throughout the Murray system. Flows downstream of Lock 9 began to rise in late August 2010, reaching 30,000 ML/d in October 2010. This inundated low lying wetlands along the river channel and generated flow through a number of anabranches across the islands. Flows have risen steadily since early November and exceeded 60,000 ML/d in mid-January 2011. This has generated flow into Lake Wallawalla and flooded most wetlands across the floodplain.

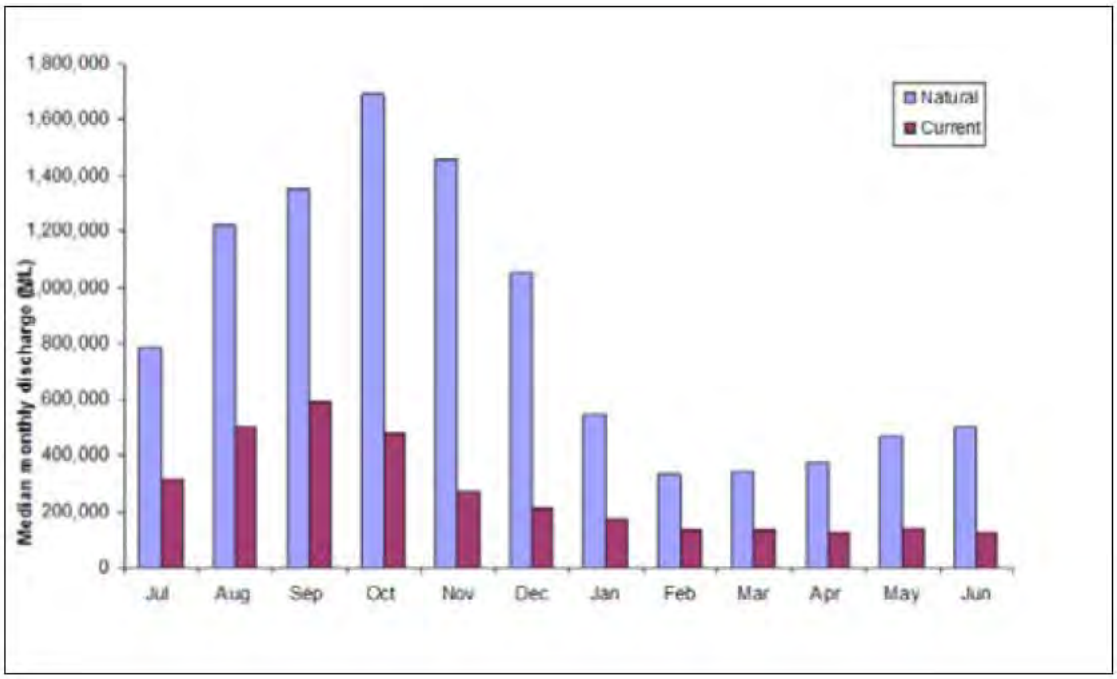

Figure 3.4: Monthly discharge at Lock 8, for modelled natural flows and modelled current system; based on 115 years of data (1894–2009) provided by MDBA

Past management actions and activities

As discussed in **Chapter 2**, Lindsay Island was made part of the Murray–Sunset National Park in 1991, with Mulcra and Wallpolla islands added in June 2010. The islands have traditionally been used for grazing, apiary, timber harvesting and water extraction, as well as broadacre and irrigated cropping.

The anabranches of Lindsay River and Wallpolla Creek are used for irrigation, stock and domestic extraction. At present, there is about 1,457 ha of irrigated horticulture at Lindsay Point, a small amount of stock and domestic extraction from Wallpolla Creek as part of Kulnine Station operations, and irrigation as part of Keera Station. Water extraction from Potterwalkagee Creek ceased when Trust for Nature purchased the adjacent property, Ned's Corner, and decommissioned the dam and channels.

4. Water delivery

Prioritisation of water requirements

The Living Murray Annual Environmental Watering Plan, developed by the Environmental Watering Group, includes a flexible decision framework to guide prioritisation of environmental watering actions. It also contains icon site environmental watering proposals, water availability forecasts and management objectives for water resource scenarios (see **Table 4.1**).

Throughout the year the Environmental Watering Group recommends environmental watering actions to the Murray–Darling Basin Authority (MDBA) for approval. These recommendations are based on the Annual Environmental Watering Plan and the volume of water available in The Living Murray's environmental water portfolio.

Local watering actions are prioritised under different water availability scenarios (see **Table 4.1**), according to the Mallee River Health Strategy (Mallee Catchment Management Authority 2006) and the Victorian Government's Northern Region Sustainable Water Strategy (Victorian Department of Sustainability and Environment 2009). Sites are chosen according to water availability and the environmental outcome achievable, as well as the ability of managers to deliver water to the site and the practicality of retaining water within the site.

Table 4.1: Objectives under different water availability scenarios

	Extreme dry	Dry	Median	Wet
Ecological watering objectives	Avoid irretrievable loss of key environmental assets	Ensure priority river reaches and wetlands have maintained their basic functions	Ecological health of priority river reaches and wetlands have been protected or improved	Improve the health and resilience of aquatic ecosystems
Management objectives	Avoid critical loss of species, communities and ecosystems Maintain key refuges Avoid irretrievable damage or catastrophic events	Maintain river functioning with reduced reproductive capacity Maintain key functions of high priority wetlands Manage within dry spell tolerances Support connectivity between sites	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 functional processes	Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna Promote higher floodplain-river connectivity Support high flow river and floodplain functional processes
Example priority locations for Lindsay–Wallpolla floodplain icon site	Base flows in Mullaroo Creek to preserve Murray cod populations	Base flows in Mullaroo Creek Base flows in Potterwalkagee Creek, Lindsay River and Wallpolla Creek Maintain priority wetlands (e.g. Webster's Lagoon)	As for Dry and: Spring pulse events in Potterwalkagee Creek and Lindsay River Inundate Mulcra floodplain Inundate Lake Wallawalla	As for Median and: Using natural flood events to inundate the broader floodplain

The Living Murray works and water modelling

Modelling

Modelling completed in 2008 found that the environmental water requirements of the floodplain icon sites (with the exception of Barmah–Millewa and the Lower Lakes, Coorong and Murray Mouth and River Murray Channel icon sites) could largely be met by a combination of the proposed TLM works, the 500 GL of recovered TLM water and 70 GL long-term Cap equivalent (LTCE) of River Murray Increased Flows.

This modelling was based on a number of assumptions including the use of unregulated flow events for environmental watering actions. It was also agreed as a modelling principle that return flows could be used to water at multiple environmental sites. There are a number of constraints to the implementation of this principle which TLM are currently working to resolve.

Further modelling is also planned to allow greater optimisation of works and measures to achieve icon site ecological objectives as we gain a greater understanding of operating scenarios.

Works

A range of water management options for Lindsay–Wallpolla Islands have been investigated under TLM. Many have been progressed to the detailed design or construction phases. Concept designs have been developed for the remaining options for further development if funding becomes available.

A brief description of priority options across Lindsay–Wallpolla Islands is provided in **Table 4.2**; see **Figure 4.1** for works locations.

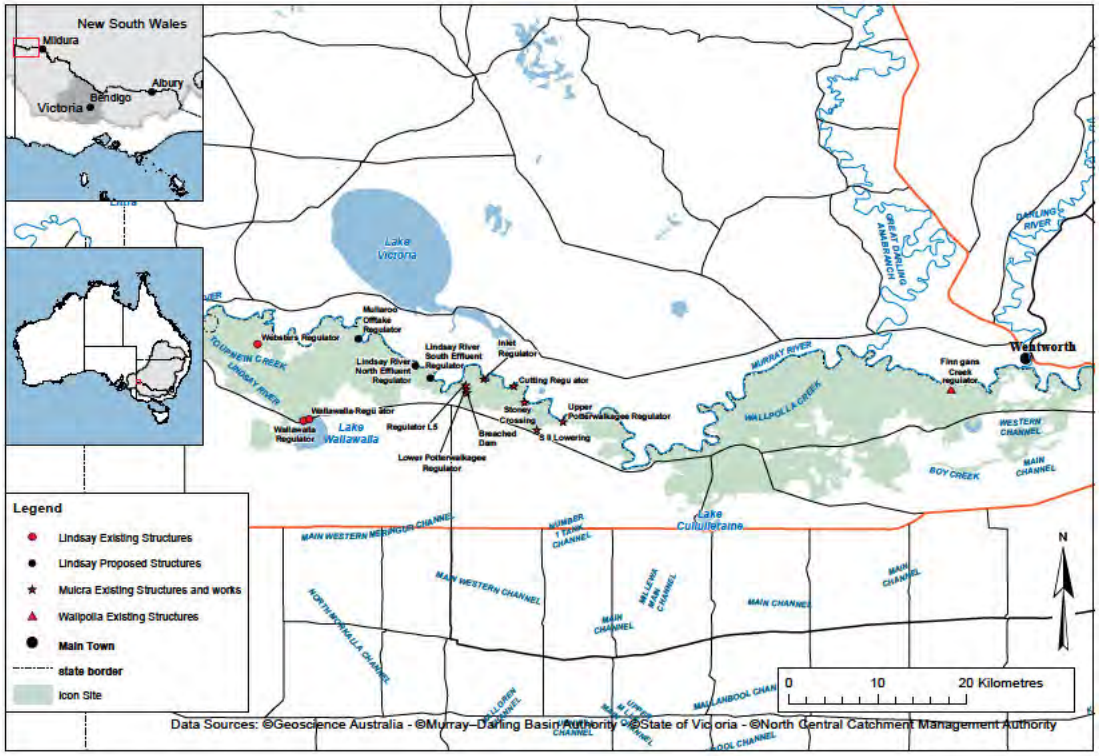

Figure 4.1: Map of existing and proposed works on Lindsay-Wallpolla Islands

Table 4.2: Completed and proposed works and their functions

Works package	Component	Function	Status
Mulcra Island	Lower Potterwalkagee regulator	Enable inundation of the Mulcra Island floodplain	Completed (2010–11)
	Lock 8 track upgrade (in Victoria and NSW)	Maintain access to Lock 8 during inundation events	
	Breached dam rehabilitation	Reinstate the natural creek alignment Remove willows and cumbungi (*Typha* species) Improve connectivity	
	'The Cutting' block bank	Prevent water draining back to the River Murray when the floodplain is inundated (maximising inundation)	
	Stoney Crossing regulator	Maximise flow capacity during inundation events and improve fish passage Enable flow management, including periodic drying of Potterwalkagee Creek	
	Upper Potterwalkagee sill lowering and regulator	Enable flow management Increase flowing habitat Improve connectivity and fish passage Inundate Snake Lagoon	
	Mulcra Horseshoe inlet regulator (L1) and L5 regulator	Enable water to be retained to desired depth and area	
	Mulcra Horseshoe pipe and channel	Deliver water from the lower Potterwalkagee Creek to the Mulcra Horseshoe wetland	
	Lock 8 track regulator (in New South Wales)	Improve connectivity between river and floodplain	
Webster's Lagoon (Lindsay Island)	Inlet regulator	Disconnect wetland from weir pool to allow for drying phase and re-instate variable water regime	Completed (2005–06)
Lake Wallawalla Regulator (Lindsay Island)	Inlet regulators (2)	Reinstate connectivity with the Lindsay River Retain inflows for desired duration Allow wetland to fully drain upon flood recession	Completed (2005–06)
	Raise Mail Road by 1 m		
Lindsay Island stage 1	Upper Lindsay River regulators (north and south inlets)	Improve flow capacity Provision of base flow to the upper Lindsay River Improve connectivity and fish passage Enable within channel spring pulse event	Detailed design (construction anticipated 2010–11)
	Mullaroo Creek regulator and fishway	Maintain fast flowing habitat for Murray cod Improve fish passage between Mullaroo Creek and River Murray	Detailed design (construction anticipated 2011–12)
Lindsay Island Stage 2	Lindsay River Weir and ancillary regulators	Enable inundation of approximately 5000 ha on Lindsay Island	Concept design
Horseshoe Lagoon (Wallpolla Island)	Inlet regulator	Disconnect wetland from weir pool to allow for drying phase and re-instate variable water regime	Completed (2005–06)
Lock 9 bypass	Bypass channel around Lock 9 and ancillary regulators	Extend and improve flowing fish habitat and connectivity Enable floodplain inundation	Concept design

Operating regimes for environmental watering actions

This section of the environmental water management plan provides a broad description of the proposed operating regimes to maximise ecological outcomes from the use of The Living Murray Water portfolio and works. To meet the proposed operating regimes a combination of unregulated and regulated environmental water may be used. While this environmental water management plan focuses on the use of environmental water from The Living Murray's Water Portfolio, there may also be other sources of environmental water available to meet the proposed regimes.

The overall aim of environmental water management across Lindsay–Wallpolla Islands is to provide a watering regime that meets the environmental water requirements of floodplain vegetation and the associated biota over the greatest area possible, taking into account recent watering events.

While the River Murray weirs (7, 8 and 9) have contributed to the changed hydrology of the islands, these structures also provide opportunities to maximise the benefits of environmental water delivery. Raising and lowering weirs can, to some extent, mimic the variable flows that would have occurred under unregulated conditions. Raising weirs under higher flows can increase the inundation of floodplain immediately upstream and also generate higher flows through upstream effluents, mimicking freshes.

The operating regimes for completed works and those in the detailed design phase (**Figure 4.2**) are outlined below, with detailed operating strategies provided in **Schedule A** (when completed). Operating strategies have not been developed for those options at concept design phase (Lindsay Island Stage 2 and Lock 9 bypass).

Opportunities exist for the coordination of operation across the Chowilla–Lindsay–Wallpolla icon site. The raising of the Lock 6 weir pool for operation of the Chowilla Floodplain TLM works potentially will require raising Lock 7, to maintain flow velocities through the Mullaroo system. This will allow operation of the Lindsay River spring pulse scenarios in conjunction with environmental watering on the Chowilla floodplain. This concept can be extended to include filling of Lake Wallawalla by pumping. Operating infrastructure to inundate Mulcra Island and Chowilla at the same time is likely to improve the ecological outcomes at both sites.

Mulcra Island

The proposed operating regime for Mulcra Island aims to maintain base flows through the system year-round, with a partial drying phase once every six to eight years to mimic natural low flow periods. Base flows are supplied under normal regulated conditions, with Lock 8 maintained at full supply level (FSL, 24.6 m Australian height datum [AHD]). This provides a permanent flow of between 50 and 100 ML/d through the new Stoney Crossing Regulator to the 10 km section of Potterwalkagee Creek downstream.

Spring freshes will be provided once every one to two years by a moderate raising of the Lock 8 weir pool (by 20 to 60 cm). Broader floodplain inundation will occur every two to three years through raising the weir pool to the top of piers (25.7 m AHD) and raising the Lower Potterwalkagee Creek regulator to pond water behind the regulator. This would mimic a 50,000 ML/d flood event and inundate about 822 ha (including 250 ha in New South Wales).

Lindsay Island — stage 1

The proposed operating strategy of the Lindsay Island stage 1 works aims to maintain existing high quality habitat for native fish, increase the extent of flowing habitat, improve fish passage and the condition of riparian vegetation. With these aims in mind, the operating regime involves provision of two key elements — low base flows and spring freshes.

Low base flows will be the normal mode of operation at the normal Lock 7 weir pool level (22.1 m AHD). At this level, the northern Lindsay regulator will be opened to allow inflows of 35 to 40 ML/d, while no flows will pass through the southern Lindsay regulator. The Mullaroo Creek regulator will be operated to pass ~700 ML/d.

Spring freshes will be provided by raising the Lock 7 weir pool to 22.6 m AHD for nine weeks, once or twice each year in years where River Murray flows of at least 17,000 ML/d have not been recorded in the previous nine months. When providing a spring fresh, both the northern and southern Lindsay regulators will be open and the Mullaroo Creek regulator will be operated to pass ~700 ML/day.

Providing spring freshes in the Lindsay River will also increase opportunities to inundate Lake Wallawalla using temporary pumps. This large wetland would normally fill via two small effluents from the middle reaches of the Lindsay River, when River Murray flows exceed 50,000 ML/d. During extended low-flow periods, as have occurred over recent years, water can be pumped from the Lindsay River into the wetland, provided that flows are high enough.

Wetland regulators

In the absence of moderate-to-high River Murray flows, regulated wetlands within the floodplain are currently prioritised and filled in accordance with the Environmental Water Group's watering criteria. These wetlands include Horseshoe Lagoon on Wallpolla Island, Lake Wallawalla and Webster's Lagoon on Lindsay Island. The specific objectives and operation of these works are outlined in **Table 4.3**.

Table 4.3: Operating regime of the regulated wetlands

Wetland (connection to River Murray)	Ecological objectives	Operation to achieve objectives
Horseshoe Lagoon–Wallpolla Island (Finnigan's Creek) Webster's Lagoon–Lindsay Island (Toupnein Creek)	Increase the area and extent vegetation in the littoral zone Provide breeding habitat for waterfowl, particularly ducks and grebes Provide habitat and promote breeding events of small fish, frogs and turtles Limit river red gum regeneration in the wet-dry littoral zone Limit cumbungi growth in the permanent pool and promote greater macrophyte diversity Reduce carp abundance	Wet the wet-dry littoral zone for 3–6 months winter/spring Filling: wetland inundated at normal weir pool levels Surcharging: regulator closed and temporary pumps used to surcharge wetland Dry the wet-dry littoral zone for 6 months summer/autumn Completely dry the permanent zone annually for 6 to 7 months Drying: regulator closed to disconnect wetland and allow drying Carp screens in operation when regulators open to allow natural inflows
Lake Wallawalla–Lindsay Island (floodrunner from Lindsay River)	Maintain lakebed herbland (supports several threatened species) Improve condition and regeneration of river red gums Provide successful waterbird breeding events Maintain populations and breeding events of small native fish Provide breeding events for golden perch (*Macquaria ambigua*) and other large floodplain fish Reduce carp abundance	Allow higher water levels to be retained in the lake and provide the opportunity to increase duration of inundation Filling: wetland filled by natural floodwaters or pumped environmental water; both regulators closed to retain water in the lake Allow complete drainage of the lake Drying: regulators fully opened Operate the structures to reduce carp access and promote movement of native fish Carp screens in operation when regulators open

Water accounting and measurement

Water accounting methodology will be developed and agreed in advance by The Living Murray Committee and the Basin Officials Committee. Consistency of water accounting methodology will be sought wherever possible. Where relevant, water accounting will be consistent with the Water Accounting Conceptual Framework and Australian Water Accounting Standards.

The best available, most appropriate and cost-effective measurement technique will be used to determine environmental water use. The appropriateness of the measurement technique is likely to differ depending on icon site and event. For example, under dry conditions, environmental water pumped into Hattah Lakes is likely to be measured using a meter while return flows are measured via a gauging station; under wet conditions, environmental water returning from Barmah–Millewa Forest will need to be modelled.

Accurate measurement of water use at Mulcra and Lindsay islands will be difficult because operating strategies involve raising locks 7 and 8. As such, modelling of the losses incurred when surcharging weir pools will be required at these sites.

Evaluation and management of risks

A number of risks are associated with using infrastructure to deliver environmental water. A risk assessment has been undertaken for the operation of the Lindsay–Wallpolla floodplain works (**Table 4.5**). Monitoring and mitigation will be carried out where possible, the results of which will be taken into consideration when implementing adaptive management principles. These risks and mitigating measures are further detailed in a detailed Risk Monitoring Plan, included at Schedule 2.

Table 4.4: Operating regimes contributing to ecological objectives

First Step Decision objectives	Vegetation community area inundated (ha)	Operating strategy	Frequency (years in 10)	Duration	Water availability scenario (range if appropriate)	Estimated volume of water required (GL)	Estimated volume of water used (GL)
Mulcra Island works							
Preferred operating scenario							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	324 ha wetlands 161 ha lignum shrubland 292 ha river red gum communities 45 ha black box woodland	Maximum floodplain inundation (including Mulcra Horseshoe)	5	4 months (full operation)	Median-wet	40	5.3
		Spring fresh	5 (3–4 per year)	14 days, 7 days between pulses	All	5.5	0.5
Minimum operating scenario							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	324 ha wetlands 161 ha lignum shrubland 292 ha river red gum communities 45 ha black box woodland	Maximum floodplain inundation (including Mulcra Horseshoe)	3	4 months (full operation)	Median-wet	40	5.3
		Spring fresh	8	14 days, 7 days between pulses	All	5.5	0.5
Regulated wetlands — Horseshoe Lagoon–Wallpolla Island; Webster's Lagoon–Lindsay Island							
Preferred operating scenario							
High value wetlands maintained Current area of river red gum maintained	120 ha wetlands Surrounding large old river red gum	Fill wetlands at regulated flows	9	3–6 months	All	2.7	2.7
		Surcharge wetlands using temporary pumps	5	3–4 weeks			
		Close regulators to dry	10	6 months			
Minimum operating scenario							
High value wetlands maintained Current area of river red gum maintained	120 ha wetlands Surrounding large old river red gum	Fill wetlands at regulated flows	5	3–6 months	All	2.7	2.7
		Surcharge wetlands using temporary pumps	3	3–4 weeks			
		Close regulators to dry	10	6 months			
Lindsay Stage 1 and Lake Wallawalla regulators[a]							
Preferred operating strategy							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	800 ha wetlands[b] 20 km of riparian vegetation watered along watercourses	Base flows (Lindsay South)	10	Year round	All	0	0
		Spring fresh	8	14 days, 7 days between pulses	All	Minor[c]	Minor[c]
		Pumping to inundate Lake Wallawalla	(3–4 per year)	4 months (full operation)	All	12	12
Minimum operating scenario							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	800 ha wetlands	Base flows (Lindsay South)	10	Year round	All	0	
		Spring fresh	5 (3–4 per year)	14 days, 7 days between pulses	All	Minor[c]	Minor[c]
		Pumping to inundate Lake Wallawalla	1	4 months (full operation)	All	12	12

Notes

a Lindsay Stage 1 works and Lake Wallawalla regulators would be operated together.

b The area of 800 ha covers fringing vegetation around Lake Wallawalla–includes river red gum woodland, black box woodland and small areas of lignum. Actual areas watered have yet to be calculated.

c Water use is yet to be calculated but is expected to be minor.

Table 4.5: Potential risks associated with TLM works on Lindsay–Wallpolla Islands

Risk	Description	Mitigation
Salinity	With any extended floodplain inundation there is a risk of mobilising salt stored within the floodplain. If operation of TLM works results in an accountable impact under the Basin Salinity Management Strategy, an entry must be made on Schedule B of the Basin Salinity Management Strategy (BSMS) Salinity Register. Victoria has conducted preliminary assessments of the impacts of proposed TLM operating strategies in line with BSMS requirements and submitted these to MDBA. These assessments suggest that salinity impacts are likely to be insignificant to minor; where accountable, provisional entries will be made on the BSMS register.	Salinity investigations and assessments guiding initial operations. Ongoing salinity monitoring. Adaptive management if necessary.
Sediment transport and erosion	Flows through waterways and into wetlands may cause erosion and contribute to sedimentation. Mobile sediment may detrimentally effect water quality and change the bed planform.	Geomorphologic investigations and assessments guiding initial operations. Ongoing geomorphologic monitoring. Adaptive management if necessary.
Water quality	Changes to water regimes risks releasing salt and nutrients from the waterway, wetland and/or groundwater, resulting in decreased water quality in the water body. They may also cause saline and black water, resulting in fish or vegetation kills. Other parameters that may affect water quality include suspended sediment loads and temperature	Water quality investigations and assessments guiding initial operations. Ongoing water quality monitoring. Adaptive management if necessary.
Pest vertebrate species	Water management actions may benefit undesirable aquatic and terrestrial pest species through provision of habitat and food resources.	Pest animal investigations and assessments guiding initial operations. Ongoing pest monitoring. Adaptive management if necessary.
Fish passage	Passing more water through anabranches and less through the main channel may reduce stimulus for fish to use the main-stem as a major migratory route.	Fish investigations and assessments guiding initial operations. Ongoing fish monitoring. Adaptive management if necessary.
Pest flora species	Increased water on the floodplains may increase the occurrence of pest plant dispersal and colonisation.	Pest plant investigations and assessments guiding initial operations. Ongoing pest plant monitoring. Adaptive management if necessary.
Cultural heritage	On-ground works may potentially disturb or damage features of cultural significance during the construction phase.	Cultural heritage investigations and assessments guiding initial operations. Ongoing cultural heritage monitoring. Adaptive management if necessary.
Further risk assessment and monitoring	Refer to Risk Management Plan (Schedule B).	–

5. Environmental monitoring

Different monitoring methods are used to assess progress toward the icon site ecological objectives. These include River Murray system-scale, icon site condition and intervention monitoring. The Living Murray (TLM) Outcomes Evaluation Framework (Murray–Darling Basin Commission 2007) outlines the rationale for these monitoring methods, which are summarised below.

River Murray system-scale monitoring

Conducted annually, River Murray system-scale monitoring and evaluation focuses on the system's ecological health, measuring improvements relating to fish, waterbirds and vegetation.

Icon site condition monitoring

Condition monitoring assesses each icon site's condition in relation to its ecological objectives. Condition monitoring is typically conducted on a medium-frequency basis (months to years), depending on the rate of change. Condition monitoring includes standard methodologies for monitoring fish, birds and vegetation, as well as icon site-specific methods for monitoring other ecological objectives (see **Schedule 3**). These monitoring activities have been classified into three categories — A, B and O.

'A' category monitoring activities are undertaken at all icon sites using agreed standardised methodologies:

- fish condition monitoring using MDBA Sustainable Rivers Audit methodology
- waterbird condition monitoring using a standard on-ground method to link with the annual aerial waterbird survey
- tree condition monitoring for river red gum and black box using on-ground assessments linked to remote-sensing data.

'B' category contains icon site-specific monitoring using locally appropriate methods. This monitoring responds to unique icon site characteristics and is less easily standardised:

- tree community distribution
- tree population structure/recruitment and relative abundance
- understorey plant assemblages, including wetland and floodplain species, and targeted surveys to assess lignum (*Muehlenbeckia florulenta*) and cumbungi (*Typha* species) condition
- additional surveys for small-bodied fish
- bush birds.

'O' category uses icon site monitoring related to objectives and is less easily linked to TLM ecological objectives.

At Chowilla–Lindsay–Wallpolla, these include threatened bird species, including regent parrot and bush stone-curlew (*Burhinus grallarius*) and frogs.

The Mallee Catchment Management Authority is responsible for all ecological monitoring under The Living Murray program at the Lindsay–Wallpolla icon site.

At present, the site specific ecological objectives for Lindsay–Wallpolla do not provide SMART (specific, measurable, achievable, realistic and time bound) targets and, as such, reporting in relation to ecological targets is generally not possible (Wallace 2009). In the interim, while site-specific ecological targets are being developed, reporting will focus on the specified ecological objectives by reporting against the variables identified in the Outcomes Evaluation Framework, e.g. species diversity; spatial distribution; relative abundance; and age structure (Wallace 2009).

More detailed monitoring may be required during the first few managed watering events following completion of the proposed works. The existing condition monitoring program should provide sufficient information about the resulting ecological outcomes, but there will also be a need for real-time monitoring of a range of parameters to identify and manage risks.

In addition, under Victoria's Native Vegetation Framework, which aims to achieve a net gain in the extent and condition of native vegetation across the state, it has been agreed that any native vegetation clearing associated with The Living Murray can be offset using the measured improvement in condition of the areas watered by the works. This policy recognises that significant biodiversity gain will occur through large-scale environmental watering, but does require implementation of a monitoring program across proposed offset sites to demonstrate the maintenance or improvement of vegetation condition.

Intervention monitoring

To improve icon site management and enhance ecological outcomes intervention monitoring investigates the links between environmental watering, infrastructure and ecological outcomes. Intervention monitoring targets environmental watering events that will inform key knowledge gaps and ecological questions. These results can be applied to other icon sites with similar ecological communities, hydrology and processes.

Groundwater monitoring

In addition to monitoring ecological outcomes and risks, groundwater and salinity monitoring will need to be undertaken, to provide information for Schedule B of the Basin Salinity Management Strategy Salinity Register. Monitoring will be undertaken according to recommendations in SKM (2009; 2010).

Risk monitoring

Risk monitoring plans have been developed (Schedule B) based on risk investigations conducted during the detail design phase of the works. These plans target monitoring efforts specifically around identified risks of the works or operations. The results from this monitoring can be used to gauge the success of the works as well as guide future management decisions.

6. Community consultation and communication

Community support for activities delivered under The Living Murray (TLM) at the Lindsay–Wallpolla icon site depends on effective engagement with a range of stakeholders.

Engagement strategies have been developed for TLM projects at Mulcra and Lindsay islands (Schedule 4), in consultation with the Icon Site Community Reference Group, the Trust for Nature and four New South Wales landholders. These groups have also provided input into the development of the Lindsay–Wallpolla Environmental Water Management Plan.

The engagement strategies focus on ensuring that the community is informed of the context, history, proposed processes, constraints and opportunities for environmental water management at the Lindsay, Mulcra and Wallpolla islands. This in turn will better enable environmental water managers to consider community values and knowledge in decision-making where possible. The Community Reference Group (see **chapter 1**), the Trust for Nature and New South Wales landholders play a key role in this process by providing advice on the most appropriate methods of engagement.

Communication and engagement activities to date have included field trips, site visits, briefings, media releases as well as events and publications for key stakeholder groups such as the Community Reference Group, local government, adjoining landholders and the local community.

Despite extended drought and low irrigation allocations, the local and wider community has been generally supportive of emergency environmental watering events at Lindsay, Mulcra and Wallpolla islands. It is understood that community opinion may shift with continued drought and that a proactive program of communication and consultation will be imperative for program success.

7. Indigenous engagement

Indigenous people have many social, cultural, customary and economic interests in the water resources of the River Murray.

The Living Murray aims to maximise ecological outcomes through the delivery of environmental water and therefore cannot provide for the commercial economic interests of any of its stakeholders. However, The Living Murray is committed to taking into account Indigenous values and objectives in its environmental water planning and management. As Indigenous communities identify objectives and strategies for achieving these Indigenous objectives they will be incorporated into environmental water management plans in the future. Indigenous consultation will be reported on in The Living Murray Annual Environmental Watering Report and The Living Murray Annual Implementation Report.

Indigenous engagement is an important aspect of managing the Lindsay–Wallpolla Islands. The Mallee Catchment Management Authority The Living Murray Indigenous Facilitator assists the project team in ensuring the local Indigenous community is fully engaged, informed and involved in the project. Involvement of the Indigenous community is critical to ensuring the success for the project, particularly as there are a number of groups involved. The Living Murray Indigenous Facilitator assists the project team in ensuring the local Indigenous community is fully informed through face-to-face and community meetings, a quarterly newsletter, fact sheets and Mallee Catchment Management Authority website updates.

The Living Murray Indigenous Partnerships Project

Murray Lower Darling River Indigenous Nations successfully negotiated the Indigenous Partnerships Project under The Living Murray Initiative. The project employs an Indigenous facilitator and establishes an Indigenous working party at each of the icon sites.

This will enable the drafting of cultural maps that will be owned by the Indigenous nations and used in the asset management plans and significant ecological asset environmental watering plans. These maps will ensure that any proposed works will not negatively impact on Indigenous sites—such as hunting sites, native fauna grazing and breeding areas, native food and medicinal plant colonies, burial sites and Dreaming or spiritual sites.

Murray Lower Darling River Indigenous Nations is a partner in this project and will assist in the establishment and support of working groups where appropriate.

8. Adaptive management and reporting

An adaptive approach is critical in managing water-dependent ecosystems because it enables land managers and policy-makers to update strategies based on the outcomes of research and watering actions. This is known as 'learning by doing' and involves designing, implementing, monitoring, reporting and evaluating our work.

Environmental water management plans are constantly refined by adaptive management, which incorporates outcomes from environmental delivery, ecological monitoring, works, modelling and community consultation.

The Living Murray Annual Environmental Watering Plan is developed at the beginning of each watering season and complements the environmental water management plan. As the season progresses, the annual water planning process responds to water availability, opportunities and environmental priorities. A flexible decision-making framework is included in the annual plan so the Environmental Watering Group can assess water priorities throughout the year according to the water resource condition.

To highlight and analyse previous activities and outcomes, the Murray–Darling Basin Authority works with icon site managers to produce an annual TLM implementation report (as required under clause 199 of The Living Murray Business Plan), which is used by the Independent Audit Group. An annual external audit is conducted to ensure TLM is implemented at an appropriate level of transparency and accountability, and to promote public confidence in the program's efforts and outcomes. The implementation report and external audit are presented to the Murray–Darling Basin Ministerial Council.

To capture key learning and changing icon site management practices, schedules appended to the environmental watering management plan are updated as required.

Adaptive management

A close relationship is required between water management and monitoring to ensure that the system is operated to optimise ecological outcomes and minimise environmental risks.

Management of environmental water will occur adaptively in line with the following process (see **Figure 8.1**).

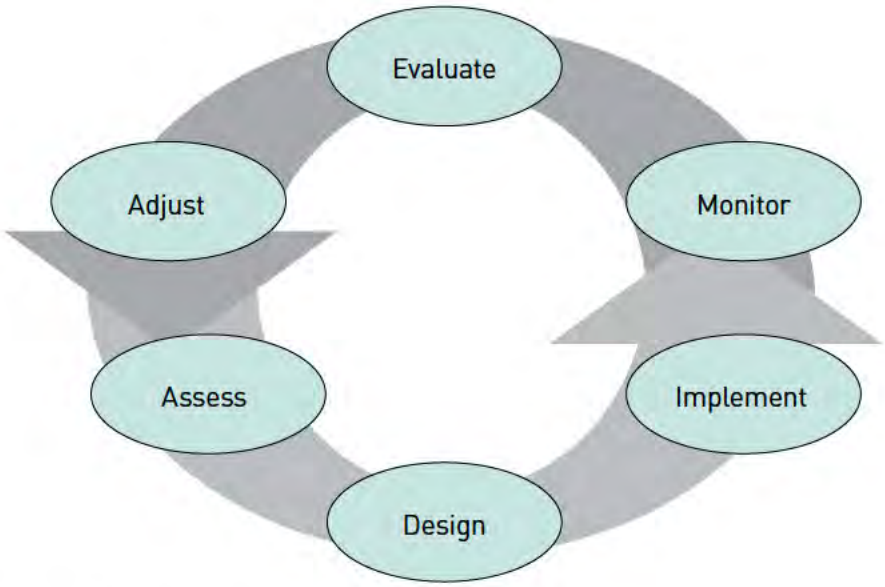

Figure 8.1: Adaptive management cycle

Assessment

The ecological issues, objectives, water requirement, priority areas and actions, and associated risks for restoring the floodplain are assessed. This stage requires community and expert input.

Design

Knowledge of the floodplain condition and its ecology are used to develop hypotheses in terms of expected responses and set objectives and targets. Interventions are designed, including a proposed package of works and operating rules.

Implementation

The recommended interventions are implemented.

Monitoring

The monitoring program will be coordinated by the Mallee Catchment Management Authority in conjunction with land managers. The different types of monitoring are discussed in **chapter 5**.

Evaluation

The monitoring results will be evaluated in light of the expected outcomes— ecological response. Triggers will be identified to inform if/how management needs to adjust (e.g. the size of flood event adopted, depending on water availability). Both short- and long-term triggers will be used. Short-term triggers include water movement into or out of structures, and whether specific biota (flora and fauna) begin to appear. Long-term triggers will include more detailed targets for ecological response.

Adjustment

The Icon Site Management Committee will consider the monitoring outcomes (and any new knowledge on the issues) to determine whether changes are required to the operating strategy and to redefine the expected outcomes from the operation (i.e. the objectives).

Assessment

Proposed changes will be assessed by the Icon Site Management Committee to consider if such changes still meet their expectations. Additional information provided through this step will be reviewed and considered.

Design

The program then moves back to the design stage where agreed changes are converted into changes to structural, operation or procedural plans.

Reporting

Improvements to actions and practices at the icon site (identified through the adaptive management process) will be reported to stakeholders through the existing governance arrangements described in **chapter 1**. This environmental water management plan will be reviewed periodically to capture the key lessons and changes in icon site management practices.

The outcomes achieved against the environmental water management plans will provide evidence of TLM progress. This information will be incorporated into the annual TLM implementation report and presented to the Murray–Darling Basin Ministerial Council. This meets the obligation to report on the annual progress of The Living Murray Initiative under clause 199 of The Living Murray Business Plan.

List of figures and tables

Figures

Tables

Appendix A: Victorian icon site governance arrangements

In Victoria, The Living Murray (TLM) Initiative is delivered by the Department of Sustainability and Environment, which provides high-level policy input and coordinates TLM delivery across all Victorian icon sites.

With the exception of the Hattah Lakes, all TLM icon sites in Victoria are multi-jurisdictional. Interstate coordination for these cross-border sites occurs through the integrated coordinating committees and icon site management committees.

Victoria has set up a TLM steering committee to oversee TLM delivery in that state (see **Figure A.1**). This high-level committee, which is chaired by the Department of Sustainability and Environment, comprises representatives from key agencies responsible for implementing TLM. Goulburn–Murray Water has also convened a state construction committee to oversee the detailed design and construction phases.

The chief executive officers of the Mallee and North Central management authorities act as regional icon site coordinators for relevant icon sites. Icon site coordinators are responsible for delivering TLM at each icon site. Accordingly, the Department for Sustainability and Environment has entered into a memorandum of understanding with the Mallee and North Central catchment management authorities that:

- establishes a collaborative working relationship between the organisations
- sets out a common understanding of intent
- commits the organisations to sub-jurisdictional arrangements for delivery of The Living Murray Business Plan.

State water authorities (Goulburn–Murray Water and SA Water) are Murray–Darling Basin Authority-delegated constructing authorities for the icon sites. As such, they are responsible for detailed design and construction under the environmental water management plan once investment proposals have been approved by the MDBA.

Specific icon site arrangements and committees for Lindsay–Wallpolla Island are set out below.

Icon Site Management Committee

The Icon Site Management Committee is composed of representatives from the Mallee Catchment Management Authority, South Australia Water, the Murray–Darling Basin Authority, the Victorian Department of Sustainability and Environment (Office of Water and State-Wide Services), Parks Victoria and NSW Office of Water.

The purpose of the committee is to:

- oversee implementation of Victoria's obligations for TLM and the Environmental Delivery program at the Lindsay–Wallpolla Islands
- provide a forum for the cooperative delivery of TLM and the Environmental Delivery program for the Lindsay–Wallpolla Islands
- advise the Icon Site Coordinator (Mallee Catchment Management Authority Chief Executive Officer) on TLM matters and the Environmental Delivery program for the Lindsay–Wallpolla Islands
- facilitate and monitor progress of TLM program delivery.

The role of the committee is to facilitate TLM implementation through their respective agencies by:

- generating support for TLM environmental works and measures and environmental delivery projects planned for the Lindsay–Wallpolla Islands within their own agencies and facilitating resolution of issues relevant to their agency
- ensuring agency commitments for TLM environmental works and measures and environmental delivery projects are fulfilled
- attending meetings with the Icon Site Management Committee and Icon Site Coordinator, as required
- disseminating information regarding long-term obligations and annual deliverables to relevant agency officers, including engaging broader staff within their organisations
- providing advice to the Icon Site Coordinator regarding implementation, policy or legislative issues, as relevant to their respective agencies, which may affect program delivery

- providing advice regarding the progress of program implementation, as required
- nominating appropriate representatives from their respective agencies to participate on project working groups, as requested
- ensuring active and timely participation of the nominated representative
- ensuring that the nominated working group representative undertakes broader engagement within their organisation, including updates to the relevant committee member.

Icon Site Construction Committee

The Icon Site Construction Committee consists of representatives from the Mallee Catchment Management Authority, South Australia Water (chair), the Victorian Department of Sustainability and Environment (Office of Water and State-Wide Services), Parks Victoria, NSW Office of Water and the MDBA.

The objective of the committee is to:

- oversee the development of detailed designs and construction of works funded under TLM at the Lindsay–Wallpolla Islands, ensuring works are consistent with the approved investment proposal and construction proposal and address any issues identified in the assessment of these documents
- foster a sharing of expertise to ensure that environmental works are designed, constructed, operated, and commissioned efficiently, and effectively to deliver the agreed environmental functionality.

The specific tasks of the committee include providing technical oversight, identifying and addressing all land management issues associated with the works, regularly reviewing project costs and timelines, reviewing risks and mitigating measures and seeking endorsement from the State Construction Committee for any project changes.

While the committee sits under the State Construction Committee, information regarding project progress is also provided to the Icon Site Management Committee.

Icon Site Community Reference Group

The Lindsay–Wallpolla Islands Community Reference Group was established in 2008 as a requirement of The Living Murray Business Plan. The Lindsay–Wallpolla Community Reference Group and Hattah Lakes Community Reference Group have merged and meet as one group. The Community Reference Group provides a platform to seek advice and a community perspective on the communication and engagement activities proposed for the project. The Community Reference Group will continue to be engaged as an advisory body for the implementation of communication tools and actions. Membership of the group includes six representatives of the local community plus the Mallee Catchment Management Authority Board chairman. The Community Reference Group reports to the Icon Site Coordinator.

Icon Site Indigenous Reference Group

An Indigenous Reference Group was planned to be established for the icon site as a mechanism for consulting with Traditional Owner groups and obtaining advice on broader Indigenous engagement.

This group has yet to be established and in the interim representatives from the Ngintait people, Wergaia/Nyeri Nyeri people and the Mildura Aboriginal Co-operative are members of the Icon Site Management Committee.

Appendix B: Fauna guilds and breeding waterbirds — water regime class relationships

Table B.1: Water regime class use by fauna guilds

Water regime classes are abbreviated as SPW Semi-permanent wetland, TW Temporary wetland, LS Lignum shrubland, RGF River gum forest, RGW River gum woodland, BBX Black box woodland, ANB Anabranches and AP Alluvial plain.

Fauna group	Guild	Number of species and species of conservation significance	Primary water regime classes	Supplementary water regime classes	Rarely used water regime classes
Waterbirds	Dabbling ducks	6 species and 2 significant	SPW and TW	LS	LS
	Deep water divers	3 species and 3 significant	SPW and TW		LS
	Grazing Water fowl	3 species and 0 significant	SPW and TW		LS
	Large waders	4 species and 1 significant	SPW and TW		LS
	Shoreline forages	7 species and 0 significant	SPW and TW		
	Piscivores	16 species and 6 significant	SPW and TW		LS
Birds of prey	Large carnivores	2 species and 1 significant	ANB and SPW		LS
	Small carnivores	18 species and 4 significant	RGF, RGW, BBX and AP		LS
Bushbirds	Insectivores	88 species and 14 significant	RGF, RGW, BBX and AP		
	Arboreal granivores	22 species and 4 significant	RGF, RGW, BBX and AP		
	Nectivores/ Omnivores	20 species and 0 significant	RGF, RGW and BBX		
	Frugivores	3 species and 1 significant	RGF, RGW, BBX and AP		
Frogs	Terrestrial frogs	5 species and 2 significant	SPW and ANB	RGF and TW	LS
	Burrowing frogs	2 species and 0 significant	RGF and RGW		
Mammals	Aquatic mammals	1 species and 0 significant	RGF and RGW		
	Arboreal herbivores	1 species and 0 significant	RGF	RGW and BBX	
	Piscivores	1 species and 0 significant	ANB and SPW	TW	LS
	Large grazers	3 species and 1 significant	RGF, RGW and BBX	AP	
Reptiles	Aquatic reptiles	4 species and 2 significant	SPW and ANB	TW	LS
	Large carnivores	7 species and 4 significant	RGF RGW and BBX		
	Small carnivores	22 species and 3 significant	RGF, RGW, BBX LS and AP		
	Omnivores	2 species and 0 significant	RGF, RGW, BBX, LS and AP		

Fauna group	Guild	Number of species and species of conservation significance	Primary water regime classes	Supplementary water regime classes	Rarely used water regime classes
Fish	Flow-dependent	2 species and 1 significant	ANB	SPW, TW and RGF	
	Large fish	3 species and 2 significant	ANB	SPW and TW	
	Small fish	2 species and 1 significant	SPW and TW	ANB	LS
	Floodplain	1 species and 0 significant	RGF and RGW	SPW and TW	BBX and LS
	Flow-dependent	1 species and 1 significant	ANB		
Aquatic invertebrates	Wetland	1 species and 0 significant	SPW and ANB	TW	

Table B.2: Water regime class use by breeding waterbirds

Water regime classes are abbreviated as SPW Semi-permanent wetland, TW Temporary wetland, LS Lignum Shrubland, RGF Red gum forest, RGW Red gum woodland, BBX Black box woodland and AP Alluvial plain.

Common name	Breeding stimulus	Nest type	Principle breeding water regime class	Supplementary breeding water regime class	Rarely used water regime classes
Red-necked avocet	Flooding, seasonal	Ground scrape in flooded reeds	SPW	TW	LS
Black-fronted dotterel	flooding	Ground scrape in flooded reeds	SPW	TW	LS
Masked lapwing	Flooding	Ground scrape in flooded reeds	SPW	TW	LS
Red-capped plover	Flooding	Ground scrape in flooded reeds	SPW	TW	LS
Black-winged stilt	Flooding	Ground scrape in flooded reeds	SPW	TW	LS
Freckled duck	Flooding, seasonal	Platform in reeds or shrubs 1m above water	SPW	TW	LS
Black swan	Flooding	Mattress of vegetation near reeds	SPW	TW	LS
Musk duck	Seasonal	Mattress of vegetation over reeds	SPW	TW	LS
Australasian grebe	Flooding	Raft of reedy vegetation over deep water	SPW	TW	LS
Buff-banded rail	Flooding, seasonal	Platform in or on flooded reeds	SPW	TW	LS
Dusky moorhen	Flooding	Platform in or on flooded reeds	SPW	TW	LS
Purple swamphen	Flooding	Platform in or flooded reeds	SPW	TW	LS
Darter	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Little egret	Flooding, seasonal	Stick nest in flooded trees	RGF and RGW		BBX
White-necked heron	Flooding, seasonal	Stick nest in flooded trees	RGF and RGW		BBX
White-faced heron	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Great cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Little black cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Pied cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX

Common name	Breeding stimulus	Nest type	Principle breeding water regime class	Supplementary breeding water regime class	Rarely used water regime classes
Little pied cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Yellow-billed spoonbill	Flooding, seasonal	Stick nest in flooded trees	RGF and RGW		BBX
Australian wood duck	Flooding	Tree hollows near water	RGF and RGW		BBX
Pink-eared duck	Flooding	Tree hollows or reedy platform	RGF and RGW		BBX
Blue-billed duck	Flooding	Tree hollows or reedy platform	RGF and RGW	TW	LS
Chestnut teal	Flooding	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS
Grey teal	Flooding	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS
Australian shelduck	Flooding, seasonal	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS
Pacific black duck	Flooding	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS

Schedules

For all schedules see ←www.mdba.gov.au/programs/tlm/icon_sites/emp.→.

Schedule 1: Operating plan for Mulcra Island and Lindsay Stage 1

Schedule 2: Risk management plan for Mulcra Island and Lindsay Stage 1

Schedule 3: Condition monitoring plan for the Chowilla–Lindsay–Wallpolla icon site

Schedule 4: Communication plan

Abbreviations and acronyms

AHD	Australian height datum
CAMBA	China–Australia Migratory Bird Agreement
GL	gigalitres
JAMBA	Japan–Australia Migratory Bird Agreement
LTCE	long-term Cap equivalent
MDBA	Murray–Darling Basin Authority
MDBC	Murray–Darling Basin Commission
ML/d	megalitres a day
RoKAMBA	Republic of Korea–Australia Migratory Bird Agreement
TLM	The Living Murray

Glossary

Aquatic ecosystem	A water environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.
Ecological objectives	An objective is a statement of the desired condition. It is not necessary to quantify an objective.
Ecological targets	A target is generated from the ecological objective and will ideally be quantitative.
Environmental water	Water that is available for the environment.
Environmental Watering Group	A jurisdictional committee that develops and implements the annual The Living Murray Environmental Watering Plan. The Environmental Watering Group recommends annual TLM watering priorities and proposals to ensure consistency between icon sites.
Environmental Water Management Plan	A plan that details the aims, objectives and management actions at an icon site that are in accord with The Living Murray. The plan complements state-based plans and processes.
Murray–Darling Basin Ministerial Council (Ministerial Council)	A ministerial council that develops and agrees to intergovernmental agreements, approves The Living Murray Business Plan and makes key decisions — for example, approval of the Murray–Darling Basin Authority's Natural Resource Management program's budget in the Corporate Plan.
Objective	Refer Ecological objectives.
Parameter	A measurable or quantifiable characteristic or feature.
Preferred operating strategy	Optimum operation of a structure to achieve a TLM ecological objective.
Ramsar Convention	A global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands.
River Management Division	A business unit of the Murray–Darling Basin Authority responsible for operating the River Murray system in accordance with the Murray–Darling Basin Intergovernmental Agreement. River Management Division manages the River Murray system to ensure that the available water is continuously accounted for and distributed to New South Wales, Victoria and South Australia in accordance with the Murray–Darling Basin Agreement.
River Murray Increased Flows (RMIF)	The component of the water recovered under the Snowy Water Inquiry Outcomes Implementation Deed (SWOID) that is returned to the River Murray system as an environmental flow.
Target	Refer Ecological target.
The Living Murray Committee	A jurisdictional committee responsible for implementing The Living Murray Business Plan.
Unregulated Flow	The volume of water surplus to regulated requirements and determined by the volume of flow in the River Murray exceeding (or predicted to exceed) the inlet channel capacity for Lake Victoria and entitlement flow for South Australia
Water requirements	Includes the flow, volume, timing, duration, velocity, depth, quality or any other attribute that is required to meet the ecological target.

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Australian Government

Australian Government

MURRAY–DARLING BASIN AUTHORITY

MURRAY-DARLING BASIN AUTHORITY

The Living Murray Program

INTERIM OPERATING PLAN 2012-13

Mulcra Island

(part of the Chowilla Floodplain and Lindsay-Wallpolla Islands Icon Site)

Note to authors and reviewers

This template has been prepared to provide a standard format for presentation of operational details for the Icon Site structures built to enable or enhance environmental watering events. The plan will form part of the Icon Site Environmental Management plans but will include sufficient detail to be a stand-alone document.

This plan will not prescribe particular watering events or if a watering event is to occur; the principal purpose of this document in the short-term is to provide guidance to assist with the commissioning of the Mulcra Island structures, prior to full operation.

It is expected that this document will be progressively updated as new information comes to light and the performance of the new structures are assessed. The long-term intent for the operational plan is to provide assistance in planning watering events. It should also provide a record of previous events and any considerations to improve subsequent operations in supporting the ecological objectives and in response to any impacts of operations to third parties.

The template has sections that need to be considered for ALL manuals. If the section is not relevant for the site please indicate as such in the manual. If the detail has been covered in another section please state "refer to section X.X for details". Please do not delete the section.

Level of detail

The level of detail will reflect the complexity of the potential operations at the site. If reasons for particular operations have origins from specific studies these should be appropriately referenced.

Version control

The Mulcra Operating Plan should be viewed as a living document, which will evolve in response to changing site conditions and ongoing knowledge development. It will be imperative to maintain appropriate document control to enable operational decisions to be based up the latest available knowledge.

Version	Date	Prepared	Reviewed	Approved
Development/Draft	2011	[redacted], MCMA	[redacted], MDBA [redacted], MDBA	N/A
1.0	Feb 2013	[redacted], MCMA		
1.1	March 2013	[redacted], MDBA		

Key Contacts

Icon Site	Mulcra Island (part of Chowilla Floodplain and Lindsay-Mulcra-Wallpolla Islands Icon Site)
Icon Site Coordinator	Mallee Catchment Management Authority [redacted] Manager River and Wetland Health [redacted] Ph: F: [redacted]
Event Coordination Team Chair	Mallee CMA [redacted] Mallee CMA TLM Coordinator. [redacted] Ph: F: [redacted]
Land Manager	Parks Victoria [redacted] Ranger In Charge – Murray-Sunset National Park [redacted] Ph F [redacted]
Operation Agency	SA Water River Operations Unit (RMOU) [redacted] Ph: F: [redacted]
River Murray Water Operations	MDBA Operations [redacted] Director River Murray Operations [redacted] Ph: F: [redacted]
NSW Liaison	[redacted] Department of Environment, Climate Change and Water NSW [redacted] Ph [redacted]
DSE involvement	Dept. Sustainability & Environment [redacted] Sustainable Water Environments, Water Group [redacted] Ph:
MDBA Project Coordinator (up to Commissioning of structures)	Murray Darling Basin Authority [redacted] EWMP Lindsay-Mulcra-Wallpolla Coordinator Assets, River Management [redacted] Ph:

Comment [redacted]: Pg 21 says its MCMA CEO

Table of Contents

Appendices:

GLOSSARY OF TERMS & ACRONYMS

ANZECC	Australian and New Zealand Environmental and Conservation Council.
Aquatic ecosystem	any water environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.
Baseline condition	an environmental quality or condition that is defined at a point in time and used as a benchmark for determining a change in the environmental quality or condition. For The Living Murray the baseline condition is 2003 when the program was announced.
BOC	Basin Officials Committee: A jurisdictional committee to coordinate the management of Basin water resources between the Commonwealth, the Authority and the Basin States.
Blackwater	Water containing a high concentration of organic matter, often accompanied by an initial depletion of oxygen.
BSMS	Basin Salinity Management Strategy
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
CRG	Community Reference Group
Commissioning	Action and requirement to ensure the structures are functioning per designs. A commissioning will be undertaken under dry and wet scenarios.
Ecological Objectives	An objective is a statement of the desired condition.
Environmental Water Management Plan (EWMP)	A document setting out the management, control and monitoring measures to be implemented during construction and/or operation of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
Environmental watering	Water entitlements legally set aside for the benefit of environmental values.
EWG	Environmental Watering Group: A jurisdictional committee that develops and implements the annual TLM Environmental Watering Plan. The EWG recommends annual TLM watering priorities and proposals to ensure consistency between icon sites.
Environmental Works and Measures Program	The EWMP funds infrastructure to deliver and manage water at the icon sites to achieve The Living Murray First Step environmental objectives. This infrastructure includes regulating structures, water delivery channels and fishways and focuses on achieving environmental outcomes at the six icon sites.
Fishway	A structure placed in or around a constructed barrier to allow migration of fish.
FSL	Full Supply Level – Operating level under normal regulated conditions
GL	Giga-Litres (1,000 Mega-Litres)
Icon Site	One of six sites identified under The Living Murray Initiative as having iconic value to the River Murray.
Managed Event	A watering event that employs the operation of the scheme's structures.

Murray Darling Basin	Comprises the catchment of the Murray and Darling Rivers and their many tributaries, extending from north of Roma in Queensland to Goolwa in South Australia.
Murray Darling Basin Authority (MDBA)	The authority responsible for managing the Murray River system in cooperation with state authorities, with the aim of ensuring reliable water supplies for all users.
River Murray	The waters of the main channel of the River Murray and its bed and banks.
Natural Event	A watering event that does not employ the use of the schemes structures.
Ramsar listing	A wetland listed under the Ramsar Convention on Wetlands; an intergovernmental treaty providing the framework for national action and international cooperation for the conservation and wise use of wetlands.
River Murray	The Murray River, the waters and the bed and banks of its tributaries and associated water bodies.
RMO	River Murray Operations – a division of the MDBA who 'operate' the river system by directing releases from storages and controlling diversions of water from the river for irrigation, urban services and environmental purposes.
RMOU	River Murray Operations Unit - a division of SA Water responsible for day to day operation and management of River Murray Structures at Lake Victoria and Downstream of Lock 10.
River Red Gum	*Eucalyptus camaldulensis* also known as Red Gum.
River regulation	Control of water flow with dams, weirs within the Murray River for irrigation and navigation purposes.
TLM	The Living Murray
Threatened species, populations and ecological communities	Species, populations and ecological communities specified in Schedules 1, 1A and 2 of the *Threatened Species Conservation Act 1995*.
Unregulated Flow	Unregulated flows are normally declared by the Murray-Darling Basin Authority when high flows are forecast to occur that are in excess of that required to meet South Australia's entitlement flow and cannot be captured and re-regulated in Murray System storages.
VEWH	Victorian Environmental Water Holder
Water year	A period from July to June, seasonally aligned and corresponding to water allocation policy in the River Murray system.

1. BACKGROUND

The Living Murray (TLM) is one of Australia's most significant river restoration programs. Established in 2002, TLM is a partnership of the NSW South Wales, Victorian, South Australian, Australian Capital Territory and the Commonwealth governments, coordinated by the Murray-Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

Through its First Step water recovery initiative, TLM has acquired a water portfolio consisting of water entitlements for environmental use. As of 2011, there is 477.8 GL long-term cap equivalent (LTCE), of water recovered for TLM[1]. The actual volume of water available against these entitlements at any given time is dependent on the water allocations announced by each state. This portfolio will be used to achieve environmental objectives at the icon sites. Regulating structures, water delivery channels and fishways, known as works and measures, will deliver and manage the environmental water at the icon sites. The success of the environmental watering against the objectives will be monitored using fish, birds and vegetation as an overall indication of the icon site's health.

TLM will seek to align itself to the requirements of the Basin Plan Environmental Watering Plan, once finalised.

The Living Murray Initiative was created to address the health concerns of the River Murray. One part of this initiative aims to improve the environmental health of six icon sites along the River Murray (Figure 1). These Icon Sites were chosen for their significant ecological, cultural, recreational, heritage and economic values.

Changes to the flow regime in the River Murray have also significantly reduced the ecological health of the island systems. This is primarily due to a reduction in the frequency and magnitude of flooding as a consequence of the long-term effects of river regulation; further compounded by the recent 10 year drought.

The Chowilla Floodplain and Lindsay-Mulcra-Wallpolla Islands Icon Site covers 43,856 ha and spans three states – South Australia, Victoria and New South Wales. The site comprises two main floodplain areas: the Chowilla Floodplain in South Australia and New South Wales, and the Lindsay-Mulcra-Wallpolla Islands in Victoria.

The Mulcra Island is approximately 2,100 ha and is situated between the Lindsay and Wallpolla Islands, approximately 70 km west of Mildura. Mulcra Island is formed by an anabranch of the River Murray, Potterwalkagee Creek (figure 2).

[1] The long term Cap equivalent is a type of average and takes into account different characteristics of water entitlements in New South Wales, Victoria and South Australia and their reliability. The measure of water recovery creates a common unit on measure, thus allowing equitable comparison of a broad range of water recovery measures.

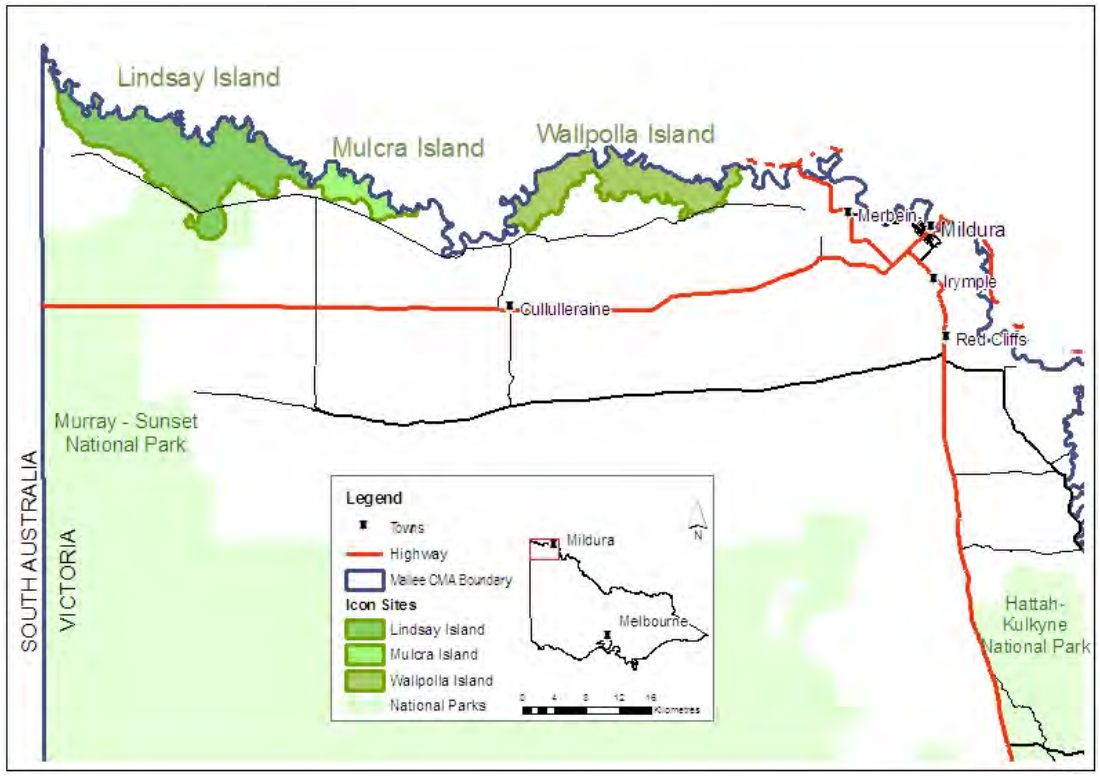

Figure 2 Icon Site boundaries and 1956 flood extent (1 in 100 year flood) at Mulcra-Lindsay-Wallpolla Islands

~~Figure 2 Icon Site boundaries and 1956 flood extent (1 in 100 year flood) at Mulcra Lindsay Wallpolla Islands~~

The Islands are situated within a semi-arid Mallee landscape and feature extensive wetland and floodplain areas supporting a mosaic of Red Gum, Black Box and Lignum communities. They are recognised nationally and internationally for their role as refuge and breeding habitat for waterbirds and for their sites of Indigenous cultural significance. The Islands are located within the Murray-Sunset National Park, Victoria.

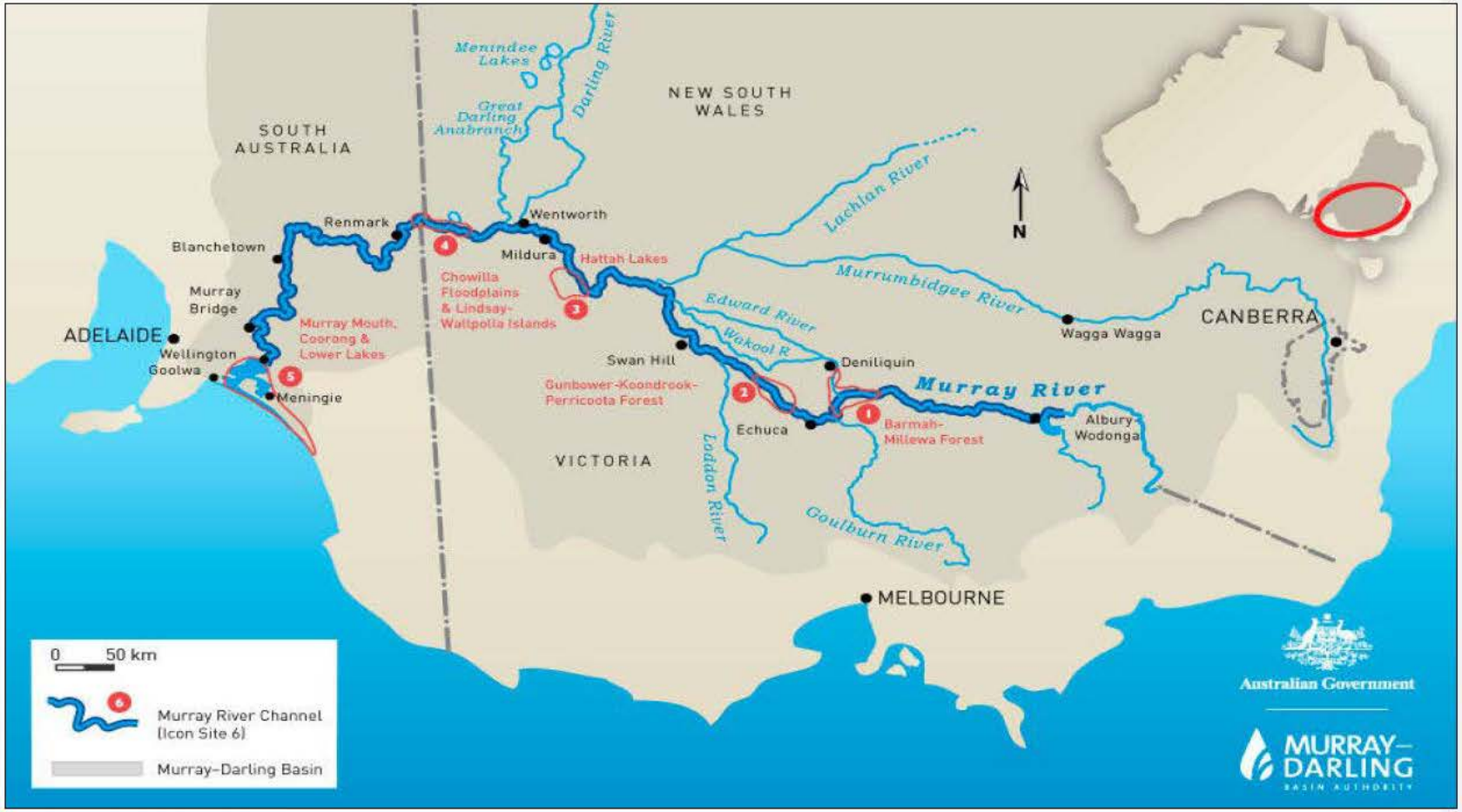

Figure 1 Map of TLM Icon Sites

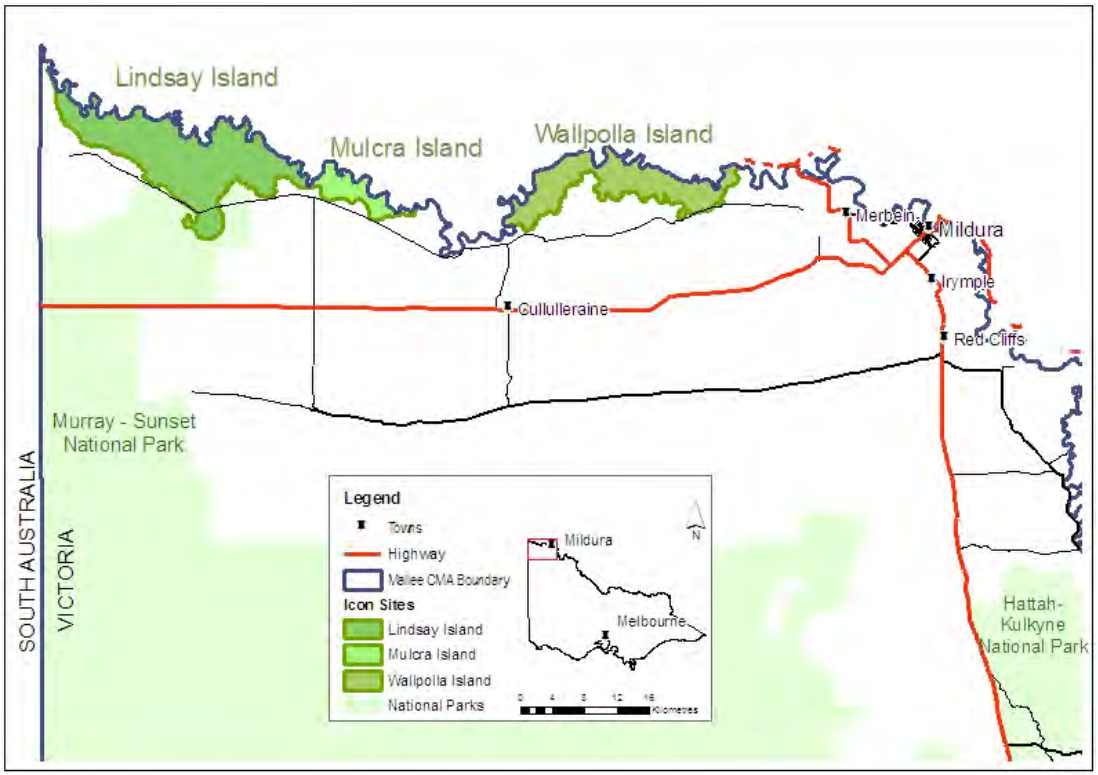

Figure 2 Icon Site boundaries and 1956 flood extent (1 in 100 year flood) at Mulcra-Lindsay-Wallpolla Islands

As part of The Living Murray program, ecological objectives were created for each Icon Site, to guide management actions. They will also provide a mechanism for evaluation and monitoring, to help determine the success of restoration projects. Five TLM ecological objectives were created for the Mulcra Island component.

The ecological objectives[2] for the Mulcra Island are:

- Maintain a diverse community of viable populations of native fish, including species dependent on fast-flowing habitat;
- Provide alternative fish passage between Lock 7 and Lock 8;
- Provide wetland habitat for frogs and turtles;
- Provide frequent breeding events for waterbirds dependent on flooded marshland and shrub land vegetation; and
- Maintain the health of 530 ha of Lignum, Red Gum Forest, Red Gum Woodland and Black Box vegetation[3].

To achieve these objectives, packages of on-ground engineering structures are being planned and constructed, designed to flexibly manage the delivery of environmental water to the creeks, wetlands and/or floodplains of the islands. These works include:

- Lower Potterwalkagee Regulator (Main Regulator), to push water onto the floodplain
- Upper Potterwalkagee Regulator, to manage flows to the Island and improve fish passage
- Stoney Crossing Regulator, to manage flows to the Island and improve fish passage
- Mulcra Horseshoe Inlet Regulators (L1 and L5), to enable water to be retained to desired depth and area
- Mulcra Horseshoe Pipe and Channel, to deliver water from the Lower Potterwalkagee Creek to the Mulcra Horseshoe wetland
- Lock 8 Wetland Regulator (NSW), to improve connectivity between river and floodplain

Non engineering works to compliment the structures mentioned above are also required to deliver environmental water. These works include:

- Lock 8 track upgrade, to maintain access to Lock 8 during inundation events
- Breached dam rehabilitation, to reinstate natural creek alignment and improve connectivity
- 'The cutting' block bank, to prevent water draining back to the River Murray.

The project has been designed to provide the flexibility to operate under a range of river conditions and can inundate over 800 ha of floodplain, wetlands and waterways, including habitat for native fish, waterbirds and turtles. The project and its operations have been designed to achieve a number of ecological objectives whilst using minimal environmental water, as described in Section 5.

[2] Refer to the Lindsay- Wallpolla Environmental Water Management Plan and the Lindsay-Mulcra-Wallpolla Island Ecological Operations Plan for further details

[3] The works will incorporate an additional 270 ha of floodplain in NSW, which will be a maximum total 800 ha of inundation.

2. Purpose of Interim Operating Plan

This interim Operating Plan will provide the framework for the operation of the Mulcra TLM structures to meet key ecological objectives within the broader context of TLM, legislative requirements and governance.

The purpose of the operating plan is to summarise the physical and organisational arrangements for environmental watering activities at the site. The method for determining the management actions is detailed in the Ecological operating plan which is a companion to this document. A brief summary of the ecological objectives and management options is included here to inform parties involved in the operation of the site but who are not involved in the ecological planning.

The operating plan also defines the obligation of the various parties to manage and operate the structures as required under the MDB agreement (S 52 – 54).

The document also contains a summary of risks and their mitigation strategies and an overview of water measurement on site.

In the short term, the specific purpose of this document is to guide the commissioning of the new structures at Mulcra Island during 2013. Guides to operating the structures at Lindsay-Wallpolla and associated structures in the vicinity will be added subsequently. As such this document is a 'living document' that will be further refined and developed over a period of time and watering events. It is expected that knowledge and information in relation to adjusting and optimising structure operations will improve with each event. Revision of the document will enable future operational decisions to be based upon the best available knowledge.

This document will be updated in preparation for the second managed watering event. It is expected that the Operating Plan will be reviewed annually by Mallee CMA in consultation with relevant stakeholders for a number of watering seasons to include key information from the operation of the works across the Lindsay-Mulcra-Wallpolla Islands Icon Site.

The wet commissioning of the structures will require a separate 'commissioning plan'. This will be developed by the State Constructing Authority and the structural, mechanical and electrical designers to ensure;

- the structures function to the designs, for example the gates are lifted easily under a managed event
- the structures are wetted at a reasonable rate of rise and fall to ensure the risk of piping failure and erosion is minimised, and
- the scheme functions to meet the TLM ecological objectives. For example the structures are built high enough to push water onto the floodplain as indicated by the models.

The first operations at Mulcra will target a level of 25.2 m AHD at the Lower Potterwalkagee Regulator, which was chosen to create overbank flooding on the Mulcra Island floodplain and to inundate the Mulcra Horseshoe wetland. This event will benefit large bodied fish, small bodied fish and riparian/floodplain vegetation.

The Operating Plan does not prescribe particular watering events or if a watering event is to occur. The intent is to provide assistance in planning watering events and to guide decision making leading up to and during events.

Table 1 summarises the intended audience of the Operating Plan and their primary requirements.

Table 1: Intended Audience for the interim Operating Plan

Audience	Key Requirements	Primary Interest		
		Ecological	Operation	Risk
Event Managers (Mallee CMA, RM Operations)	Adaptive management	✓	✓	✓
Land Manager (Parks Vic)	Adaptive management	✓		✓
Other Environmental Managers (DSE)	Adaptive management	✓		✓
Operators (SA Water RMOU & MDBA RM Operations)	Operation of structures Accountability		✓	✓
Water holder/funder (TLM-MDBA, CEWH, VEWH)	Accountability	✓	✓	✓
MDBA (BSMS)	Meet legal requirements			✓
Asset Owner (MDBA Assets)	Meet legal requirements		✓	✓

Additional Documents

This document will be supported by a number of detailed documents, each focusing on a specific area of the Lindsay-Mulcra-Wallpolla management. Table 2 outlines these documents, the agency responsible for the document and where the document resides. Figure 3 shows the main documents and their relationship with each other.

Table 2: Documents supporting ~~Hattah Lakes~~Lindsay Island Environmental Watering

Document	Purpose	Agency Responsible
Lindsay-Wallpolla Islands Environmental Water Management Plan	Long term strategic plan that outlines the site's overall management arrangements, objectives, environmental water requirements, and scope of environmental works to manage the water. Supported by detailed schedules.	MDBA
Lindsay-Wallpolla Islands Ecological Operating Plan	Provides detail on ecological objectives, water requirements and tolerances, preferred watering regime, and role of each structure in delivering water to meet the objectives. This document also encompasses the adaptive management process for achieving the site ecological objectives.	Mallee CMA
Mulcra Monitoring Plan (including risk monitoring)	Describes the monitoring activities at the site.	Mallee CMA
Mulcra Annual Communication Plan	Overview of communications roles and responsibilities.	Mallee CMA
Mulcra Island Operating Plan (this document) ↓	Schedule to Environmental Water Management Plan. It describes the environmental works, how the works relate to the ecological objectives, and defines the governance, risk management and water measurement principals for operation of the structures to deliver environmental water.	MDBA
1. Mulcra Island Operations, Maintenance and Safety Manual 2. Mulcra Island Commissioning Plan / Procedure 3. Mulcra Island Emergency Management Plan	SA Water stand-alone document for agency staff. SA Water operational procedures for commissioning structures. To be developed prior to commissioning structure(s).	SA Water

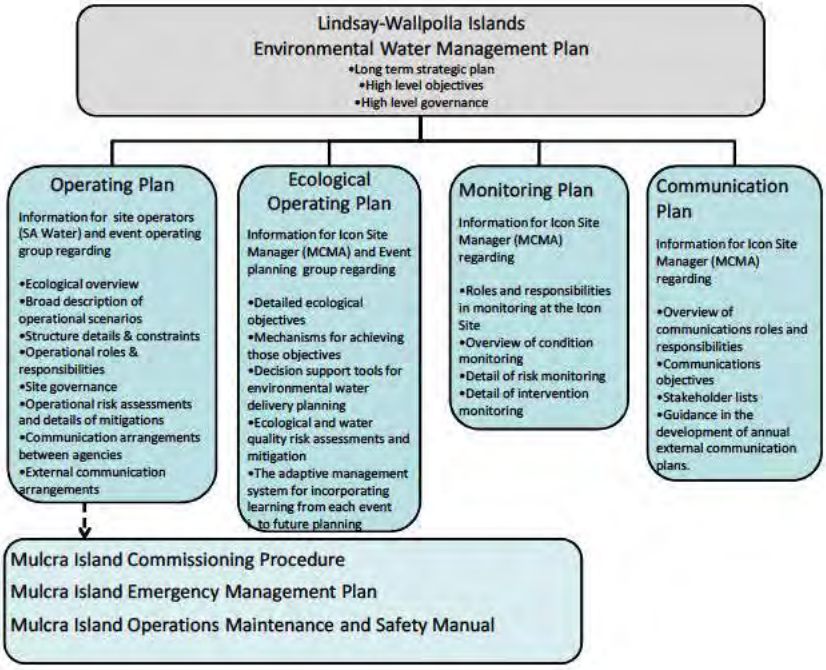

Figure 3: The key Mulcra documents

Overview of Operations

The operation of this Scheme will aim to meet the ecological objectives of the site by taking into consideration the:

- watering history,
- ecolgical condition of the site,
- current flows in the Murray, and its tributaries,
- modelled natural data[4],
- volume of water already held within the Icon Site,
- water availability for the site, and
- antecedent conditions.

Mallee CMA and Parks Victoria will guide the use of allocated water to meet the ecological objectives. The Ecological Operating Plan provides a decision support tool and adaptive management framework for decisions relating to environmental water delivery to the site.

Another source of information may be the modelled natural hydrograph, which may in the future be used to inform the operation of the site. For example the modelled data may show a hydrograph with a double peak occurring in the River Murray, which would mean two peaks entering the Mulcra Island system. Operations may be implemented to try to mimic this modelled double peak.

The rational of mimicing aspects of the natural watering regime is to restore the natural cues of bird breeding and other ecological processes along the river as the water moves through the river channel and its floodplain systems. This rationale also drives multi-site watering under TLM.

[4] Modelling natural means determining the flows and /or river heights that would have occurred pre regulation (i.e. before the weirs and dams were built).

3. INTERACTIONS WITH OTHER SYSTEMS OR STRUCTURES

This section looks at the location of other water management structures, river systems and sites, and the links between them and Mulcra Island.

Potterwalkagee Creek, which is the anabranch forming Mulcra Island is located 70km downstream of Lock 8 and sits within the Lock 7 weir pool. Majority of the floodplain and creeks are located within Victoria with a minority located within NSW (figure 2).

In this interim operating plan the volume of water flowing past the island will be influenced by;

- the River Murray and its major tributaries, upstream dams, lock and weirs,
- Operations at Lock 8, and
- Operations at Lake Victoria.

A combination of high river levels and the operations of each of the major structures on these rivers will determine the volume of water flowing past the confluence of the Potterwalkagee Creek and River Murray.

River Murray flows greater than 15,000 ML/day at Lock 8 will lead to flows commencing down Potterwalkagee Creek.

Lock 8 Operations[5] and Travel Times

Lock 8 Weir is operated to pass a range of flows under normal regulated conditions. During high unregulated flows Lock 8 will pass all flows downstream and the Lock 8 Weir structure may only be dismantled at 40,000 ML/day.

Under normal regulated river conditions, Lock 7 and 8 are the main hydrological influences on Mulcra Island. Lock 8 is located halfway along the island's northern periphery on the Murray River while Lock 7 is located downstream on the Murray off Lindsay Island. The Lock 8 weir pool provides water at Stoney Crossing into Potterwalkagee Creek, which returns 10 km later to the River Murray in the Lock 7 weir pool.

The Lock 8 Weir structure is part of the operations to raise and create a head difference to push water onto the Mulcra floodplain. Theoretically, Lock 8 weir can be raised to top of piers (25.7m AHD) to produce the floodplain watering scenario, however to date it has only been raised to 25.2m AHD.

Travel times from the Lock 8 to the Lower Potterwalkagee Creek confluence is approximately 12 hours.

Historically the volume of water entering the site has been dependent on the magnitude and duration of passing flows. Managed environmental flows will rely on varying the Lock 8 water levels.

The Lock 8 Weir is the long term measuring site which has been used as a reference for passing flows in the River Murray.

Darling River Inflow

[5] The Lock 8 Weir structure is operated by SA Water on behalf of MDBA (River Management Division). Water is released when an instruction has been given to SA Water from the MDBA River Operators. See section 4- Governance~~Governance~~

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The Darling River flow can vary its contribution to the River Murray flow and hence, can vary it's contribution into the Mulcra system. The modelling indicates that generally, the contributing Darling River flow during Summer-Autumn becomes less significant as the event continues into Winter-Spring.

The modelling also shows that the Darling flow very rarely exceeds 20,000 ML/d during Summer-Autumn under natural conditions. A typical example is shown in Figure 4 where a flood is initiated in April 1977 with a reasonable proportion of flow from the Darling River until Winter-Spring when the proportion of Darling flow reduces to 30-50%.

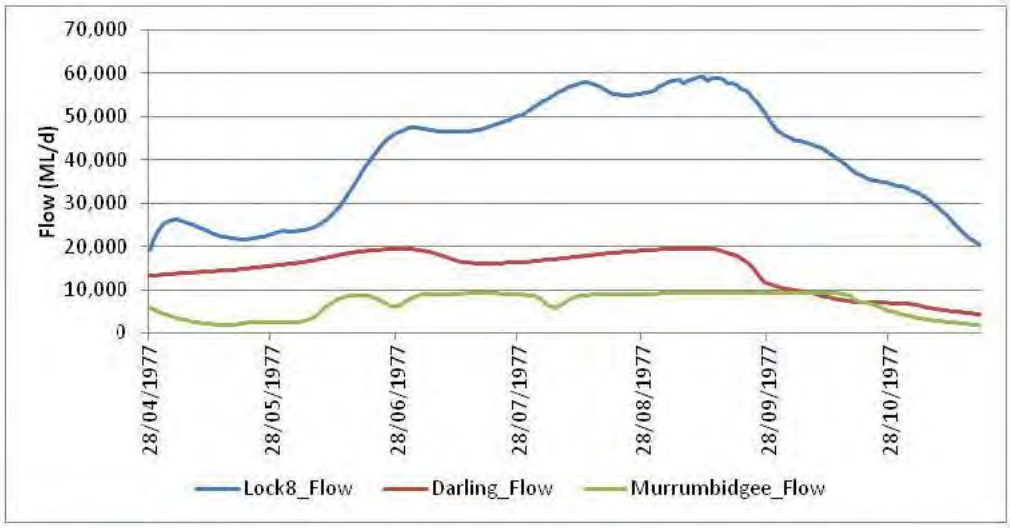

Figure 4 Example natural autumn floods at Lock 8 (mid Darling River flow)

Multi-Site Watering

Potential exists for the operation of this site, in conjunction with other icon sites and environmental watering activities, to achieve multiple benefits from a single release of environmental water from storage.

Opportunities exist to explore conducting environmental watering operations at Mulcra Island in conjunction with operations being undertaken at upstream sites. This could potentially maximise ecological benefits, particularly for fish and waterbirds, at a broader scale across the Murray-Darling Basin.

The Mulcra system is a flow-through system which means that a proportion of water is diverted from the River Murray along the Potterwalkagee Creek for 10km's before it returns to the River Murray. As such the water use at Mulcra Island will be a volume equivalent to the increased loss as a result of the watering, rather than the flow diverted from the Murray. The accounting is further described in Section 10.

Interactions within the Icon Site

Hydrological interactions

As discussed in previous sections Mulcra Island is part of the Chowilla -Lindsay-Wallpolla Icon Sites and as such this entire section will be influenced on a greater scale, specifically by the operations of Locks 10, Lock 9, Lock 8, Lock 7 and Lock 6 weir structures. The rivers/creeks converging from the River Murray are as follows; Lindsay River diverges from the River Murray upstream from Lock 7 and converges upstream of Lock 6, in the Lock 6 weir pool. The Potterwalkagee Creek diverges upstream of Lock 8 and converges upstream of Lock 7 and the Wallpolla Creek diverges and converges between Locks 10 and 9 (Figure 2).

Potterwalkagee Creek is a relatively small anabranch of the Murray and travel times through this system are short (approximately 2 days).

This information will be incorporated into the next revision of the operating plan.

Landholder interactions

Four private land holders will have land inundated by these operations. Current advice from NSW is that no work approvals (Under Section 90 of the Water Management Act 2000) or water access licence is required to conduct Mulcra Operations. NSW has requested however that a statement advising intent to conduct environmental watering operations be submitted to the NSW Office of Water prior to commencing operations. The statement shall address the following;

- Provide commencement date and duration of operation,
- Advise method to estimate water use,
- Advise area of inundation in NSW,
- Provide a basic Impact Statement of inundation to NSW.

The statement will need to be presented to allow adequate time to inform interested parties (Local Government, Landholders etc). An example of the statement shall be included with this document as an appendix following initial operations.

4. GOVERNANCE

This section describes both the high level program governance, as described in the Lindsay-Wallpolla EWMP, and governance arrangement for the initial operation of the Mulcra Island structures.

Overview of TLM governance

TLM is a joint initiative between the Australian, South Australian, New South Wales, Victorian and Australian Capital Territory governments. It is governed by:

a) *Intergovernmental Agreement (2004) on addressing water over allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2004);*

b) *Supplementary Intergovernmental Agreement (2006) on addressing water over allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2006);*

c) *Further agreement (2009) on addressing water over allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2009).*

The groups with a direct role in TLM governance are Ministerial Council, the Authority, the Basin's Officials Committee (BOC), TLM Committee (TLMC) and the Environmental Watering Group (EWG). This high level governance structure is illustrated in Table 3. Detailed Governance and Planning arrangements for use of TLM water is contained within the Mulcra Icon Site EWMP.

Table 3 Summary of planning and governance arrangements for environmental water holders

	Victorian Environmental Water	TLM water	Commonwealth Environmental Water
Water Holder	Victorian Environmental Water Holder	Partnership; MDBA, Vic, NSW and SA	Commonwealth Environmental Water
Instrument	Seasonal Watering Plan/Seasonal Water Statements	Annual TLM Environmental Water Plan	Annual Water Use Options via Seasonal Watering Plan
Governance	VEWH Commissioners	MDB Ministerial Council (with advice from BOC); MDBA (with advice from TLMC and EWG)	CEWH

While the MDBA is responsible for implementation of TLM (under Section 18H of the Water Act 2007), the management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located. The Chief Executive Officer of the Mallee CMA is the coordinator for the Mulcra Icon Site and is responsible for delivering the TLM program at the site. In addition, Parks Victoria, the MDBA, SA Water, DSE, Victorian Environmental Water Holder (VEWH) and Commonwealth Environmental Water (CEW) play key roles, which are summarised in Table 4 and briefly outlined below.

Mallee CMA

The icon site manager for Mulcra Island is the Chief Executive Officer of the Mallee CMA. Catchment Management Authorities are the caretakers of river health and responsible for the management of environmental water in Victoria, as specified in the *Water Act 1989*. The Mallee CMA is the coordinator of the delivery of the TLM program at the icon site level, where it works closely with its partner agencies, Parks Victoria and DSE and is supported by a number of site-specific committees.

Parks Victoria – Public Land Manager

Parks Victoria is the public land manager responsible for management of the Murray-Sunset National Park. Under the *Parks Victoria Act 1998*, Parks Victoria is responsible for providing services to the state and its agencies for the management of parks, reserves and other public land and is responsible for all areas reserved under the *National Parks Act 1975*.

Murray Darling Basin Authority – River Murray Operations (RMO)

The MDBA is the owner of the water delivery structures (assets) within the Lindsay-Wallpolla Icon Site as they are an important component of the River Murray System works. Appropriate arrangements for onsite control of the works (responding to RMO) will be put in place by SA Water's RMOU.

MDBA River Murray Operations staff oversees and coordinates all water deliveries along the River Murray system during the operation of any watering event.

Murray Darling Basin Authority – TLM Planning and Delivery

The MDBA – TLM Planning and Delivery Directorate is responsible for the coordination of the planning and delivery of environmental water to all icon sites. This is achieved in close consultation with the Environmental Watering Group (EWG), which is chaired by the MDBA and consists of the partner states and the Commonwealth Government. The EWG develops and implements the TLM Annual Environmental Watering Plan.

South Australian Water Corporation (SA Water)

SA Water is the MDBA-delegated constructing authority for the icon site. As such, it is responsible for the detailed design and construction activities under the EWMP.

South Australian Water Corporation - River Murray Operations Unit (RMOU)

RMOU is responsible for the operation and maintenance of all water delivery structures within the Lindsay-Mulcra-Wallpolla Icon Site that have been constructed under TLM on behalf of the MDBA. This is undertaken as part of an asset agreement between the MDBA and SA Water. Under this agreement, SA Water is responsible for "accounting for the assets, recording, reporting and auditing as well as specific high level requirements in relation to construction, maintenance and operation of assets" (MDB Agreement, Clause 55). It is anticipated that SA Water may engage local contractors to undertake some operation and maintenance activities if required. As is consistent with the operation of any River Murray asset by RMOU, all directions for the operation of the water management infrastructure at Mulcra Island will be issued by MDBA River Murray Operations. The structures will NOT be operated outside of these instructions unless there is an issue of public safety or the integrity of the structures is in jeopardy.

Department of Sustainability and Environment (DSE)

In Victoria, the overall TLM program is delivered by DSE, which provides high level policy input and coordinates the delivery of TLM across all Victorian icon sites. One of the key roles for DSE is to provide statutory and strategic guidance to the planning of Victoria. DSE is also the site owner for most Crown land in Victoria and may delegate the management of Crown land to others on its behalf, as is the case with Parks Victoria.

Victorian Environmental Water Holder (VEWH)

The VEWH was established in Victoria on the 1 July 2011. The main areas of responsibility for the VEWH are holding and managing environmental water entitlements and allocations and coordinating the delivery of Victorian environmental water allocations with those of other environmental entitlement holders to maximise benefits to the environment. The VEWH works closely with catchment management authorities and Melbourne Water to ensure that environmental water entitlements are used to maximise ecological outcomes for the water available. In terms of Lindsay, Mulcra and Wallpolla Islands, the VEWH will consider environmental watering proposals along with all others in the State to determine environmental watering priorities from a State perspective.

If one or all of the islands are determined to be an environmental priority for the year and water is made available to the site, the VEWH then authorises the use of water by Mallee CMA through a Seasonal Watering Statement.

Commonwealth Environmental Water Holder (CEWH)

Comment [redacted]: Most of this text could be moved up to the VEWH sec ion. This section should focus on the CEW annual water use documents, and the approvals by CEWH (in most but not all cases, this will be reflected in letter agreements with VEWH, and they transfer water to VEWH ABAs for use; approvals are then subject to VEWH seasonal watering statements).

As a component of Murray-Darling Basin reforms, the Australian Government has acquired a number of water entitlements with the objective to return more water to the environment. These entitlements have become a part of the Commonwealth environmental water holdings and are managed by CEWH. The volume of environmental water held by CEWH is significant and may constitute an important source of environmental water for Mulcra and other significant sites.

Environmental watering occurs through the collaboration of a range of agencies to ensure the effective delivery of water through Victorian waterways. Waterway managers play the key role of engaging with public land managers, storage operators, local landholders and communities in the development and implementation of the environmental watering program. The VEWH also works closely with other water holders, such as Commonwealth Environmental Water Office, the Murray-Darling Basin Authority and other partners in the Living Murray program to negotiate use of their water in Victorian rivers, wetlands and floodplains. These partnerships are outlined in the figure above.

Figure 5 and 6 outlines the planning process for the planning and delivery of environmental water in Victoria. Every year, the key function of the VEWH creates a seasonal watering plan that prioritises the watering activities of the entire State in an integrated way. The plan sets the scope for environmental watering activities that could occur under a range of climatic scenarios - from severe drought, right through to an extremely wet year. This plan considers the most appropriate use of environmental water entitlements held by the VEWH, as well other environmental water entitlements available for use in Victoria, such as the Living Murray entitlements and those held by the Commonwealth Environmental Water Holder.

The seasonal watering proposals identify the desired environmental water use for each system under a range of inflow scenarios. The proposals provide a clear rationale to directly inform the VEWH priorities outlined in the seasonal watering plan under the different flow scenarios. The seasonal watering proposals are informed by relevant regional river health strategies, developed in consultation with the community and other partners. In addition, scientific studies into the timing, duration and frequency of environmental flows required for each system (known as environmental flow studies), provide the scientific basis for seasonal watering proposals.

As conditions unfold, and water becomes available throughout the year, the VEWH releases seasonal watering statements to communicate decisions on environmental watering activities that are actually to be undertaken. The statements are a record of the implementation of the seasonal watering plan, and can be made at any time throughout the year.

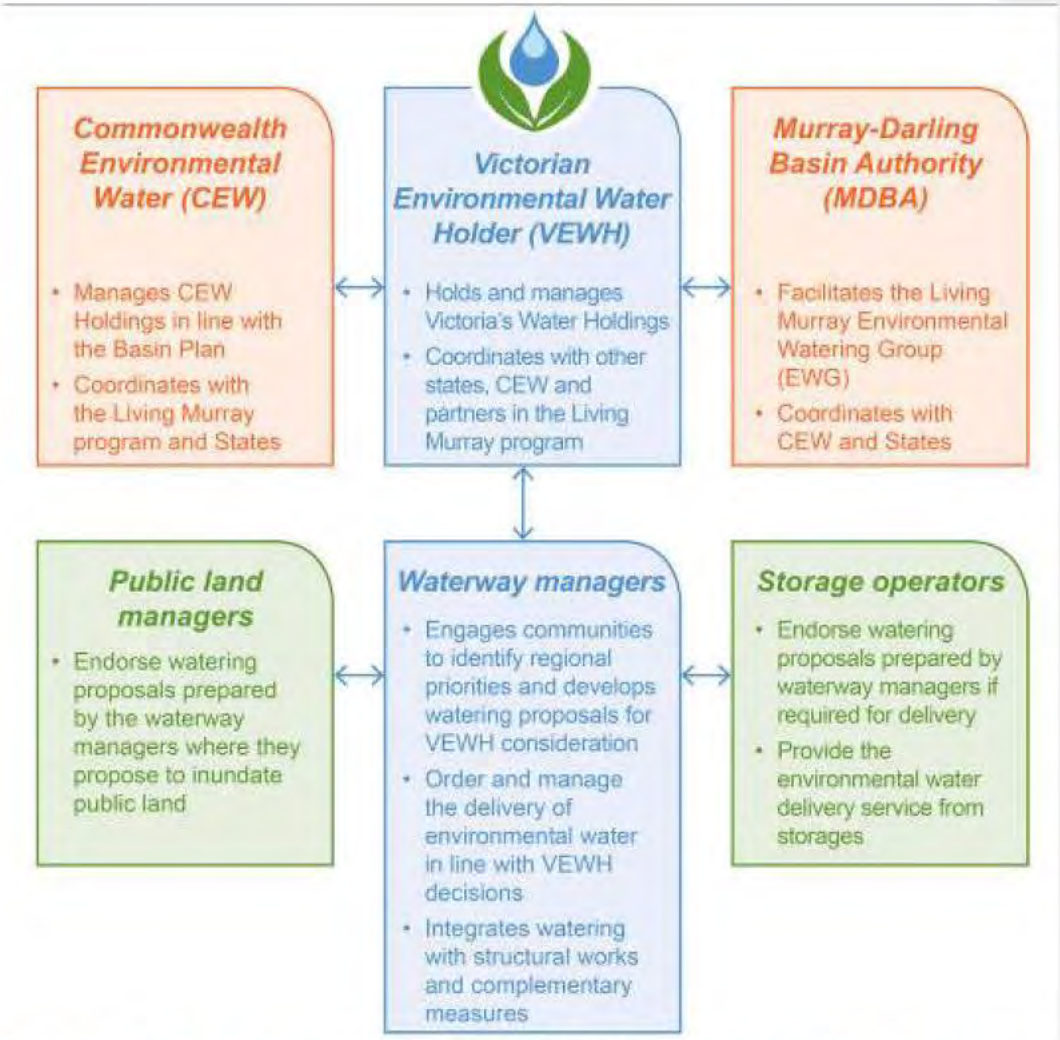

Figure 5: Victorian Environmental Water Holder (VEWH) and its relationship with other stakeholders

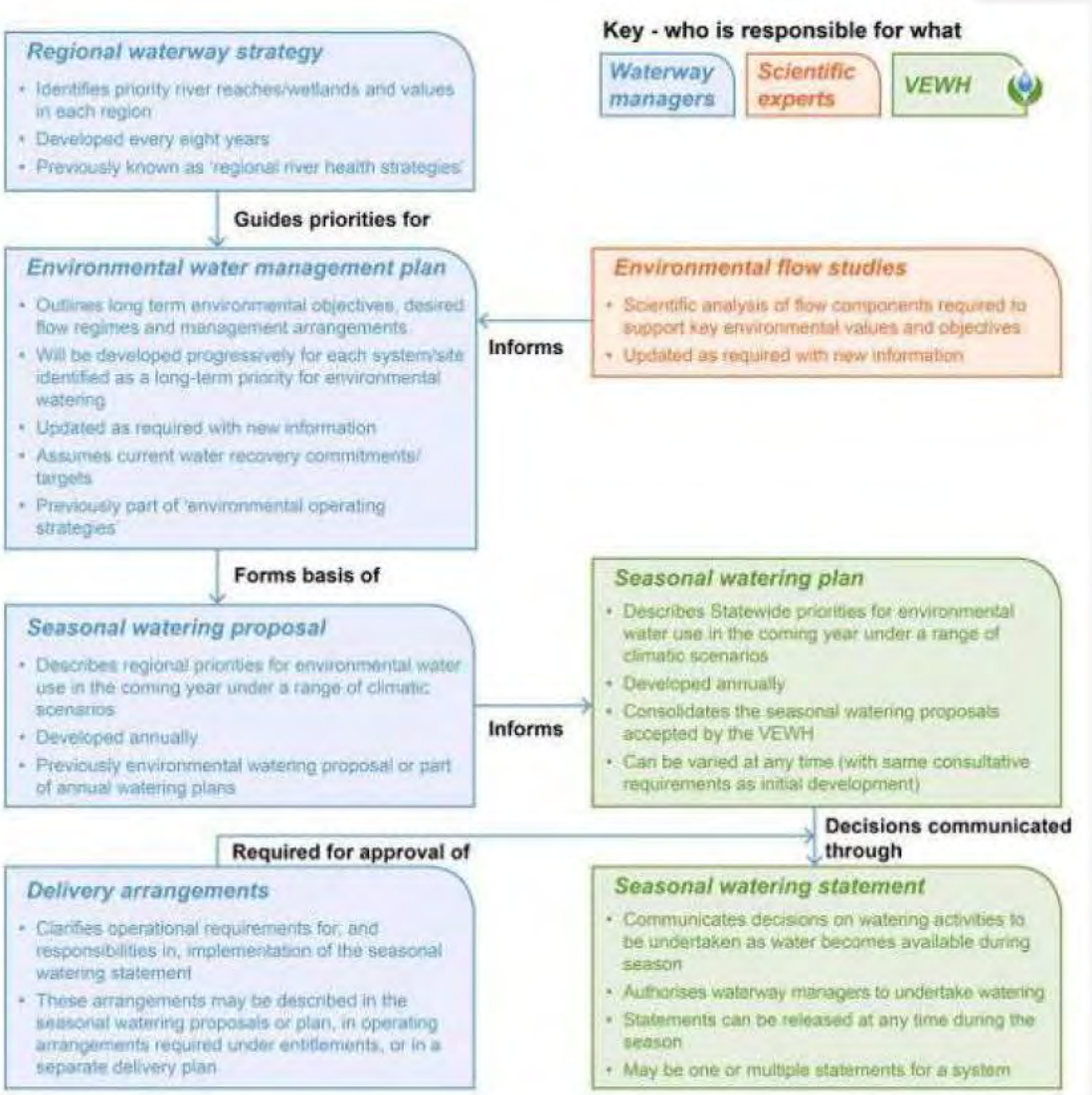

Figure 6: Responsibilities between the Victorian Environmental Water Holder (VEWH), scientific experts and the waterway mangers.

Comment [redacted]: This is more about the planning framework than responsibili ies

Mulcra Operations Group

The Mallee CMA will convene a small Operations Group, called the Lindsay-Mulcra-Wallpolla Operations Group (LMW-OG), to provide advice to the MDBA regarding event management and the day-to-day management of the structures during an event. The LMW-OG will be chaired by the Mallee CMA and membership will include jurisdictional representatives with delegated responsibilities, including those involved in day-to-day management of the structures. Representatives with delegated responsibilities include SA Water RMOU, Parks Victoria, NSW Office of Water, MCMA (Icon Site Manager), and MDBA RMO. Other agencies may be members, as deemed necessary (Figure 7).

The purpose of the group is to allow jurisdictional representatives to have input into decision making and ensure that recommendations made to MDBA RMO are sensible and practical.

This group will be replicated at each Living Murray Icon Site to advise on water use, and is expected, in the longer term, to be co-ordinated through the system-wide Operating Advisory Group (OAG) already established under the Living Murray Program.

Comment [redacted]: I think this is actually "operational"

The LMW-OG will convene weekly or as required via teleconference, to provide feedback on how the operation is going and to plan ahead for the following week.

Parks Victoria will be responsible for visitor management during the event as well as management of Park specific stakeholders; in particular liaising with neighbours and licensed business operators. The Icon Site Manager (MCMA) will be responsible for informing the wider community and managing media releases relating to the water event. MCMA will also be responsible for environmental monitoring, reporting and provision of advice to River Murray Operations.

SA Water RMOU will be required to liaise with the NSW landholders prior to any managed events occurring.

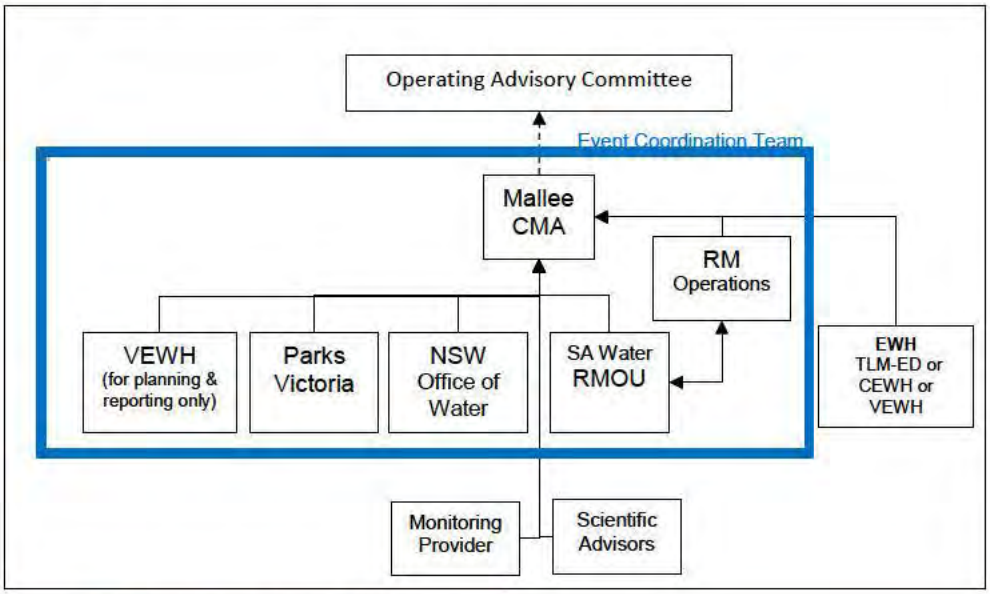

Figure 7: The Event Coordination Team structure

Comment [redacted]: This doesn't show how the LMW-OG fits in

Governance arrangement for operating the Lindsay-Mulcra-Wallpolla Island structures

The MDBA manages the assets in accordance with: the Water Act (2007); the Murray-Darling Basin Agreement (Schedule 1 to the Water Act); the MDBA's annual Corporate Plan; the Asset Agreement; and the Asset Management Plan for River Murray Operations Assets. Operation and maintenance of the assets is conducted by the MDBA River Management Division in conjunction with the relevant State Constructing Authority (in this case, SA Water). MDBA river operations staff coordinate the delivery of water (both irrigation and environmental) and manage unregulated flows throughout the River Murray System.

Management arrangements for an event:

- Following approval of environmental allocations, the LMW-OG is formed (by Mallee CMA) to discuss the events for that water year.
- This group will oversee the event, and make recommendation to MDBA River Murray Operations (RMO) regarding environmental water delivery, and the operation of structures using the environmental water order template (Appendix A).
- MDBA will consider the water order, and determine a course of action.
- MDBA will issue instructions to SA Water regarding the operation of the structures,
- SA Water will report back to RMO and the LMW-OG on execution of an order.
- Risks will be monitored as determined in the risk management strategy. Any advice regarding management of structures or delivery of water will be provided to MDBA via the LMW-OG (or direct to River Management General Manager where action is urgent)

4.1 Sourcing environmental water for a Watering Event

Environmental water for the Lindsay-Mulcra-Wallpolla Islands Icon Site may be sourced from a number of environmental water holders. These sources include The Living Murray (TLM) Program, Victorian Environmental Water Holder (VEWH) and Commonwealth Environmental Water (CEWH). There is also an unregulated flow component that is attached to some Victorian TLM entitlements.

Comment [redacted]: This is covered by the above portfolios.

Before a watering at any of the islands can commence, an environmental watering proposal must be prepared by the icon site manager and approved by the VEWH. Submissions for environmental water allocations are presented by VEWH to the relevant water holders who subsequently prioritise the watering proposals against all other watering proposals. If TLM water is proposed to be used, submissions are presented to and assessed by the EWG who then advises the MDBA on allocations of TLM Water. The CEWH also has its own process for prioritisation and approval of environmental water bids.

Comment [redacted]: This isn't quite right.

Replace with "Before the beginning of the water year, a seasonal watering proposal must be prepared and incorporated to he VEWH seasonal watering plan. During the season, before a watering at any of the islands can commence, more specific informa ion, including a delivery plan, must be prepared and endorsed by the VEWH to inform their water commitments. The VEWH will also pass on relevant information to TLM EWG and CEWH to inform their water commitments, including coordinating completion of any required templates.

Once a watering action is approved by MDBA – EWG, CEWH or VEWH, the VEWH ensure sufficient water is in the appropriate ABA. This may require a transfer of water from one ABA to another (including from MDBA or CEWH ABAs to VEWH ABAs). The VEWH will then issue a Seasonal Watering Statement to MCMA ~~allowing access to an allocation~~use of a particular volume of water in the ABA. Once the Seasonal Watering Statement is approved a water order can be placed by MCMA with SA Water, enabling a diversion to commence. The process for sourcing environmental water is depicted in more detail below (Figure 8).

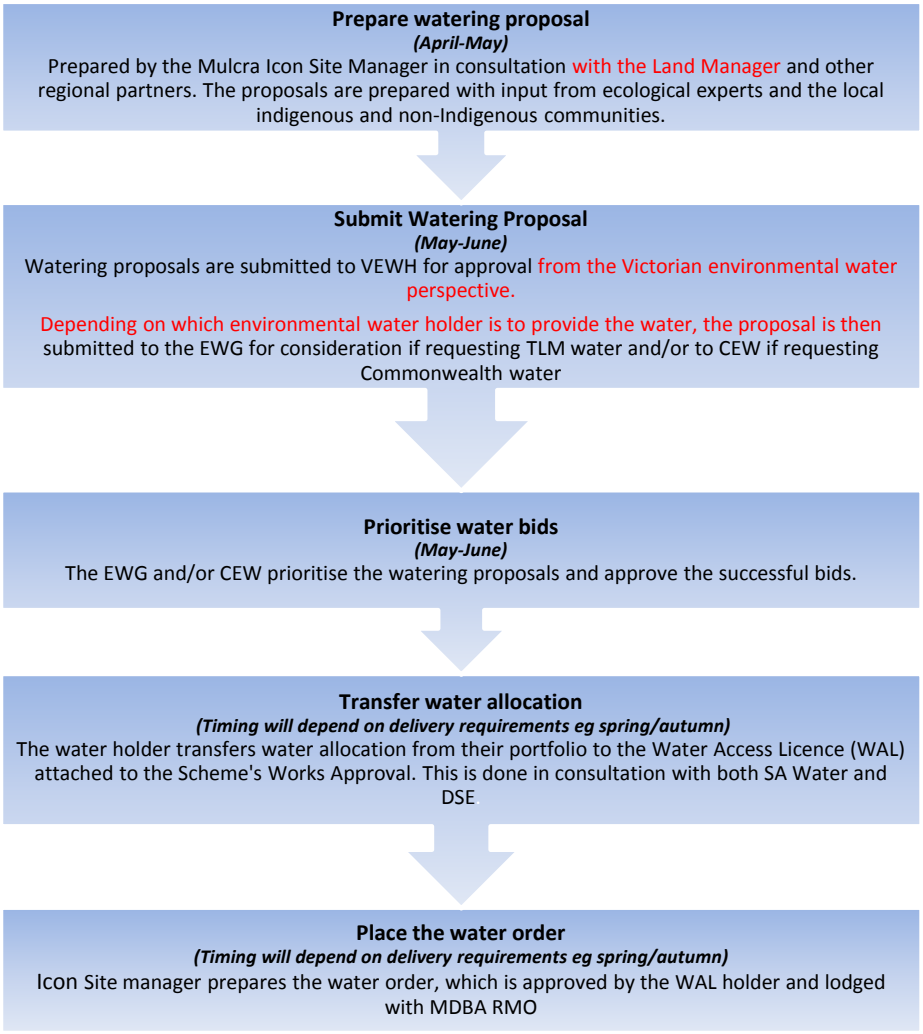

Figure 8 Sourcing environmental water for a watering event at Mulcra

4.2 Planning to conduct a watering event

A number of processes need to occur to allow for the successful planning and execution of a watering event at Mulcra. This process is outlined in Figure 9.

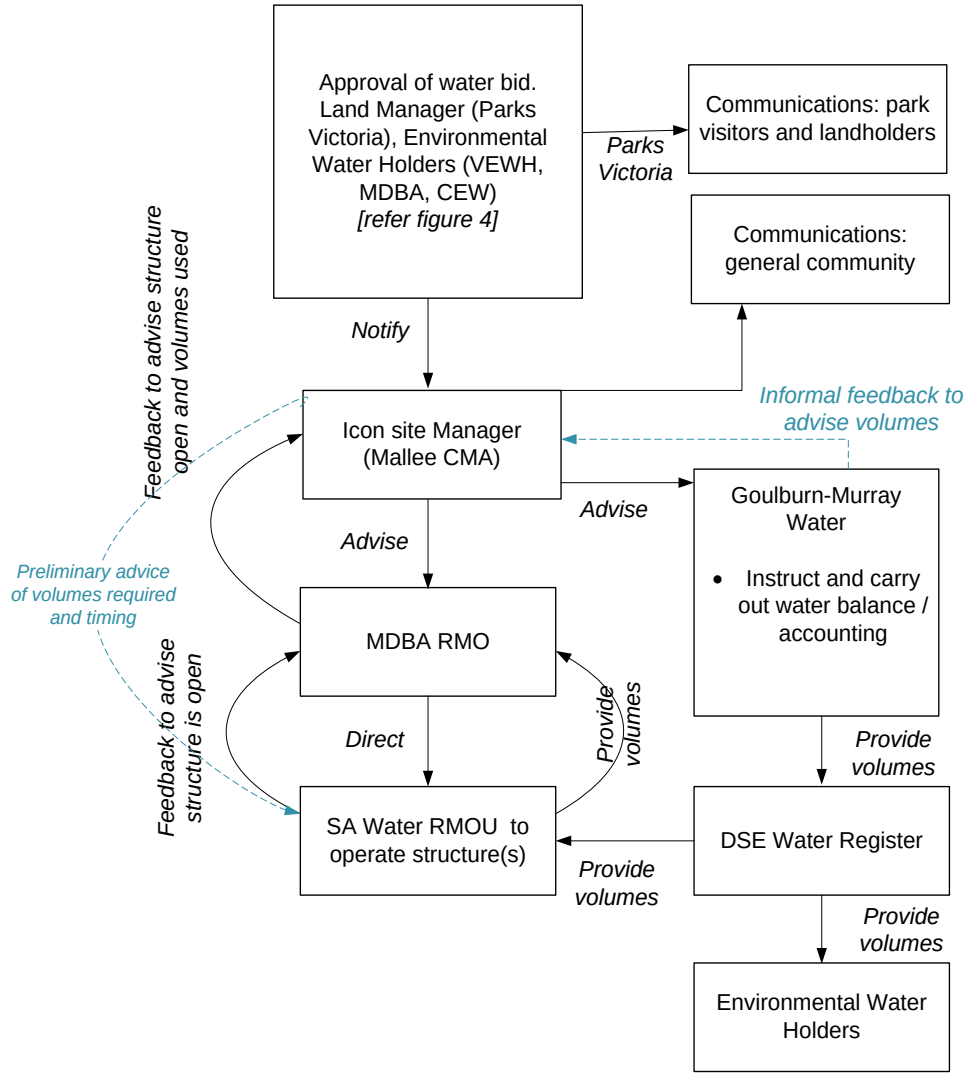

Figure 9 Process for delivery arrangements for a watering event at Mulcra

Table 4 Roles and responsibilities supporting Mulcra Island environmental watering

Organisation	Main Roles	Tasks/Responsibilities		
		Event Planning	**Event Management**	**Event Reporting**
Icon Site Manager - Mallee CMA	Event Coordination Communications Monitoring	-Convene LMW Operations Group (LMW-OG) -Ensure planning process is to annual schedule -Review and Revise Operating Plan and Risk Management Plan with other LMW-OG input -Prepare Annual Watering Plan with OC input	-Convene and coordinate weekly (or as required) meetings/teleconferences. -Coordinate event monitoring (ecology/environment/water use) -Coordinate Community Communications and Consultation	-Prepare Annual Watering Report with other stakeholder input -Compile/Collate Monitoring Results
RM Operations (MDBA)	Instruct Operations Water Delivery Water Accounting	-Provide advice on basin wide river operations and any implications	-Issue Operating Instructions (both in river and at Hattah Structures) -Provide advice on basin wide river operations and any implications -Conduct water use modelling	-Water Accounting -Provide advice on any water delivery implications encountered and future considerations
SA Water	Structure Operation & Maintenance	-Provide advice on structural or maintenance issues and any implications -Conduct maintenance	-Operate Structures to meet instructions -Provide advice on structural or maintenance issues and any implications -Water quality monitoring	-Provide details on performance of structures and any issues or future considerations -Provide details of issues associated with operational costs
Parks Victoria	Land Manager	-Provide advice on achieving ecological objectives -Advise the group regarding site ecological values or threats and any implications - Approve watering on public land	-Manage public access (during and after event) -Advise site ecological values or threats and any implications	-Provide details of site ecological responses and any future implications
NSW Office of Water				
VEWH	Water Availability (If VEWH water used) Approvals	-Approve Victorian state wide watering priorities through VEWH Seasonal Watering Plan -Approve TLM Annual Watering Plan – Victorian priorities -Co-ordinate water use with other environmental water holders, including advising on water availability for the site for all environmental water holders.	- Approves all watering activities through Seasonal Watering Statements - Provides indication on water availability for watering activities -Seek further water if required	-Assist with report compilation and review -Review volumes of environmental water used
TLM – ED (MDBA)	Water Availability (If TLM water used)	-Advise on TLM watering objectives -Advise on TLM water availability -Coordinating activities across TLM Icon Sites - Approves use of MDBA works	OBSERVER ROLE ONLY if participating -Assist with water use modelling	-Assist with water accounting -Assist with report compilation and review
CEWH	Water Availability (If Commonwealth water used)	-Advise on Commonwealth watering objectives -Advise on Commonwealth water availability -Coordinating other CEWH activities	OBSERVER ROLE ONLY if participating	-Assist with report compilation and review
MDFRC	Event Monitoring	-Provide advice on achieving ecological objectives -Identify monitoring issues and costs estimates for planned events as directed	-Undertake monitoring activities as directed -Data collection	-Report monitoring results -Advise if monitoring appropriate to assess ecological responses against objectives -Advise any monitoring issues and implications
Scientific Advisors	Specialist Advice	-Assist setting ecological objectives	-Provide specialist advice when required	NO ROLE EXPECTED
EWG	Advice	-Recommends TLM watering priorities and the implementation of events based on the TLM	NO ROLE –unless site or in river conditions lead to substantial change from planned event	-Review TLM Watering summaries provided by Icon Site Managers

		Annual Watering Plan		

5. Site Characteristics Guiding Environmental Watering

Mulcra Island has three recognised floodplain environments: Potterwalkagee Creek, Mulcra Horseshoe Lagoon and the broader floodplain (a Victorian component and a NSW component). As these three floodplain environments are inherently different it is recognised that they will contribute differently towards meeting the stated ecological objectives, as summarised in Table 5. While close ecological and hydraulic interactions exist between the three environments, they can be managed with some independence to achieve the site specific TLM ecological objectives. Figure 10 provides an indication of the areas environmental watering operations will be able to influence.

Table 5: Summary of Mulcra Island floodplain components and potential for environmental watering operations to influence the ecological objectives

Ecological Objectives	Floodplain Components		
	Potterwalkagee Creek	Mulcra Horseshoe	Floodplain
Maintain a resident population of flow-dependent fish	X		X
Provide alternate passage for native fish around Lock 8	X		
Provide frequent waterbird breeding events		X	X
Provide wetland habitat for frogs and turtles	X	X	X
Maintain floodplain and wetland vegetation	X	X	X

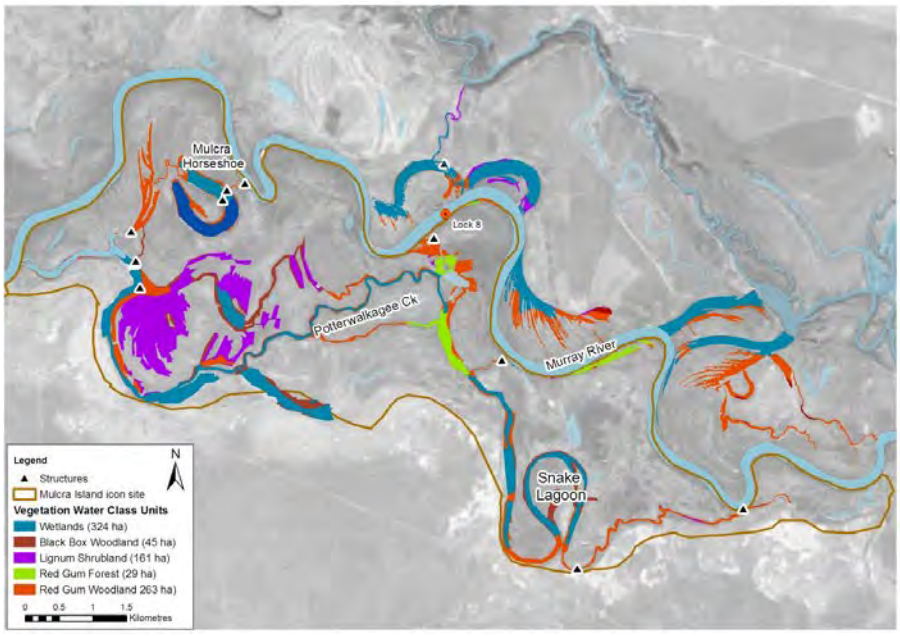

Figure 10: Floodplain areas and vegetation types that environmental watering operations can inundate (maximum extent)

Below is a summary of the ecological benefits for watering each area. Further information will be found in the Ecological Operations Plan.

Potterwalkagee Creek

Potterwalkagee Creek is valuable for native fish communities in the lower River Murray. It has historically provided habitat for three large-bodied fish (bony herring, golden perch and Murray cod) in low abundances. The creek has also supported relatively high abundances of small bodied fish (Australian smelt, carp gudgeon, unspecked hardyhead and flathead gudgeon). Small bodied fish (crimson-spotted rainbow fish and dwarf flathead gudgeon) are present but in low numbers.

It is envisaged that resident populations of fish will be maintained and enhanced by providing permanent, fast-flowing habitat together with smaller flow peaks – freshes – in winter and spring. Freshes provide cues for spawning and access to riparian habitat for juvenile fish, thereby supporting native fish communities. Freshes also maintain the health and productivity of riparian vegetation and low-lying wetlands.

Potterwalkagee Creek can provide an alternate route for fish around Lock 8 with the diverse hydraulic conditions favoured by many fish species. This improves fish migration and dispersal throughout the whole of the River Murray system, especially in areas of high juvenile recruitment and growth.

Mulcra Horseshoe Wetland

Mulcra Horseshoe Wetland and its associated flood-runners include areas of wetland herbland, lignum and red gum vegetation. Under a seasonal flooding regime, the wetland provides highly productive habitat that supports waterbird breeding and maintains a significant area of floodplain vegetation. Frequent flooding of this area will maintain the vegetation community and support high levels of productivity and food availability for waterbirds during floodplain inundation events.

Under natural conditions Mulcra Horseshoe starts to receive inflows from the River Murray when river flow downstream of Lock 8 exceeds 26,000 ML/d. The wetland is filled when flow exceeds 40,000 ML/d. Once filled to this level the wetland can take 4 to 6 months to dry out.

Mulcra Floodplain

Mulcra Island covers over 3000 ha of floodplain which supports diverse vegetation communities which in turn provide important breeding and feeding habitat for waterbirds, frogs, fish and turtles. The vegetation communities largely comprise; wetlands, River Redgum with flood dependant and flood tolerant understoreys, Lignum Shrubland and Black Box.

Floodplain inundation will support the growth and recruitment of floodplain vegetation. A flush in vegetation growth will accompany flooding and a range of floodplain plants will germinate on the flood recession. Flooded vegetation will provide breeding habitat for waterbirds, turtles, frogs and a range of other fauna. During periods of inundation fish present in Potterwalkagee Creek and the River Murray upstream of Lock 8 can access the floodplain which supports spawning, provides slackwater habitat for larvae and provides habitat for juvenile fish. Receding floodwater contributes organic matter to low-lying wetlands and Potterwalkagee Creek.

Lock 8 Floodplain

The Lock 8 Floodplain is located on the NSW side of the River Murray and consists of similar vegetation communities as on the Victorian side. The operation of the works can influence approximately 227 ha of the NSW floodplain. Regular floodplain inundation will support the growth and recruitment of vegetation such as Redgum communities.

Whilst the Lock 8 Wetland is within NSW, it will be managed as part of this operating plan as the intention is to account for water used on the NSW Lock 8 Floodplain as part of the Victorian watering action. The raising of Lock 8 for watering events will primarily be driven by conditions on Mulcra Island rather than the conditions on the NSW Lock 8 Floodplain.

6. OPERATIONAL THRESHOLDS

This section provides guidance on the ecological thresholds (which are based on the natural hydrology) that will inform the LMW-OG on the duration of watering that will be appropriate for each event.

Natural duration verses managed events[6]

Modelling to be undertaken by MDBA will in future be able to provide information on natural duration and the appropriateness of extending duration. This information will assist environmental water planning, operations and meeting the TLM ecological objectives at the site e.g. the modelling can provide information on natural duration limits. The natural duration is an indicator of the vegetation tolerances under a natural watering regime.

The major operational threshold is to ensure that watering does not go beyond the natural duration and frequency that naturally occurred historically in the area. To date the modelling has informed us that;

- the Potterwalkagee Creek would on average receive flows for about 6.5 months (200 days) every 12 months (based on natural modelled);
- the highest median flows occur through Winter-Spring (based on natural modelled);
- flood events are rarely initiated in Summer-Autumn and have long inter-flood periods (approx. 5 years for floods exceeding 40,000 ML/d under natural conditions);
- flood events have longer durations when initiated in Summer-Autumn;
- flow from the Darling River may contribute a reasonable proportion initially to floods starting in Summer-Autumn but this relative contribution reduces as the event progresses through to Winter-Spring (Darling River flow very rarely contributes more than 20,000 ML/d to events starting in Summer-Autumn).

The modelled natural durations and inter-flood periods should be taken into consideration to determine operations of the works, which will aim to provide the natural variability of flows. By restoring natural flows it is expected to restore the natural ecological variability within the system and increase the health of the in-channel and floodplain ecosystems of the Lindsay-Mulcra-Wallpolla system.

Table 6 shows Lock 8 flows and the maximum duration and frequency that this area is conditioned to ecologically. For example flows at 50,000 ML/day passing Lock 8 which are initiated in Winter-Spring on average occurs every 130 days (4.2 months) every 2.3 years. However if flows are of 50,000 ML/day are initiated in Summer-Autumn the duration averages at 179 days (5.7 months) every 5.4 years.

Table 6 also provides an appreciation on the reduction of duration and frequency has occurred under current conditions.

[6] Further information can be found in Appendix C – Spells analysis of Lock 8 flow, Technical Memo 2010/15_2, February 2013.

Table 6 Average duration in days and average inter-flood period (years) for Lock 8 flood events

	Natural Modelled		Current Modelled	
Lock 8 Flow (ML/d) Commencing at:	Winter-Spring	Summer-Autumn	Winter-Spring	Summer-Autumn
20,000	199 (1.1)	288 (3.7)	111 (1.6)	211 (5.3)
25,000	193 (1.2)	278 (3.9)	113 (1.8)	205 (5.9)
30,000	178 (1.3)	287 (4.8)	107 (2.1)	182 (5.9)
35,000	162 (1.5)	254 (4.8)	97 (2.5)	184 (7.3)
40,000	144 (1.6)	221 (4.9)	91 (3.0)	160 (7.4)
45,000	134 (2.0)	195 (5.0)	83 (3.1)	153 (8.3)
50,000	130 (2.3)	179 (5.4)	81 (6.3)	132 (8.3)

7. DETAILS OF STRUCTURES

All infrastructure has been designed for a 100-year design life and contemporary design codes have been used to ensure stability, durability and economic operation and maintenance costs. Wherever possible, provision for downstream fish passage has been considered.

The works on Mulcra Island (Figure 11) comprise a number of complementary structures to allow natural flooding events to be supplemented by either partial or fully managed events. The structures have operational flexibility and can function with minimal water availability. Environmental watering at Mulcra Island is based around varying the Lock 8 water levels. Six regulating structures and associated works enable water management at key locations across the island.

This section details the purpose of each structure and their broad design features. A summary of the main operational levels and flows for the various structures is provided in Table 7. How each structure will potentially be used is discussed in the Section 8 -Operating Regimes - and associated risks are discussed in Section 11 - Operating Risks and Mitigation Measures. Further detail on the structures can be found in the detailed design report (URS, 2009).

The works at Mulcra Island include:

- 1 large concrete regulator with aluminium stop logs and earthen stop bank to pool water on the floodplain
- 4 smaller concrete regulators with aluminium stop logs to manage inflows to the island
- A concrete pipe and channel to aid filling Horseshoe Lagoon
- Sill lowering at Snake Lagoon and the Breached Dam
- Re-habilitating the Breached Dam site
- Upgrade of the Lock 8 Track and other ancillary works
- Track upgrade and pipe culvert installation in NSW at Lock 8
- A maximum design elevation for retention of water on the island of 25.7 m AHD

The works, combined with raising Lock 8, will enable the inundation of over 800 ha of creek, wetlands and floodplain, in the absence of natural floods. This will include habitat for native fish, waterbirds, frogs and turtles while improving the condition of fringing red gum and black box communities.

The key dimensions of the regulators and block banks are summarised in Table 7 and described below. Note that the height of each structure is measured from the underside of the concrete slab or foundation stripping, to crest level.

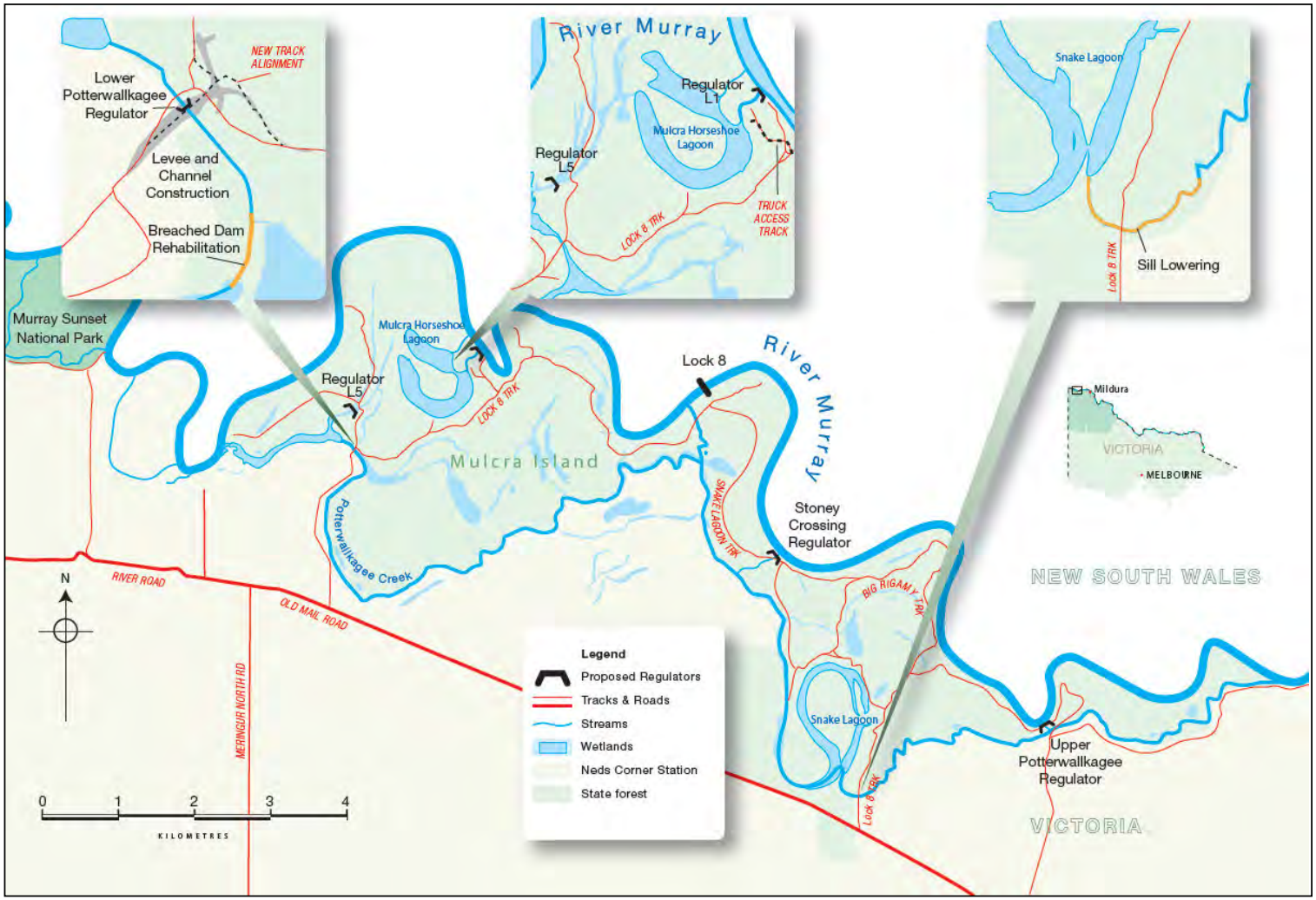

Figure 11: Map of Mulcra Island structure locations

7.1 Lower Potterwalkagee Creek regulator

The Lower Potterwalkagee Creek (LPC) Regulator is the largest of the structures built for environmental watering at Mulcra. The LPC Regulator facilitates out-of-channel flooding of low lying wetland and floodplain environments at the western end of Mulcra Island. The regulator also facilitates filling of the Mulcra Horseshoe via a connecting pipe and channel and also improves fish passage between the Potterwalkagee Creek and the River Murray.

The structure is approximately 4.4 m high, 6 m wide (at crest) and 260 m long including embankments. It primarily consists of the regulator, a road and bridge to provide access to Lock 8, a 50 m wide spillway on the southern embankment and an inlet pipe to fill the Horseshoe Wetland. The bridge is a single span 8 m long concrete structure with a 4.8 m wide dual carriageway. The regulator has three bays to pass water, each 2.0 m wide.

Water levels and flow through the regulator are controlled by the placement and removal of 0.333 m high x 2.0 m long aluminium stop logs weighing approximately 60 kg each. The stop logs are handled using a crane operated off a light truck from the carriageway and is a two person task. The regulator requires 39 stop logs to operate to full height. The design enables fish passage in both directions when the regulator is fully open. When the regulator is used to raise water levels, fish can pass in the downstream direction.

Rating tables for this structure can be found at Appendix B

7.2 Stoney Crossing regulator

Stoney Crossing historically referred to a vehicular crossing over a short man-made channel which allows permanent flow from the Lock 8 weir pool to the middle and lower sections of Potterwalkagee Creek. The Stoney Crossing (SC) Regulator provides the ability to vary flows through Potterwalkagee Creek on a seasonal basis. It enables a controlled drawdown of the creek independently of the Lock 8 weir pool level, improves fish passage through the channel and continues to provide vehicular access.

The structure is approximately 1.5 m high, 6.1 m wide (at crest) and 13.3 m long (bank to bank).The regulator consists of five parallel sets of 900 mm high x 1,200 wide mm pre-cast concrete box culverts which support the vehicular crossing. Flow through the regulator is controlled by the placement and removal of 0.2 m high x 1.2 m long aluminium stop logs. A total of 25 stop logs are required to fully close the regulator. The stop logs are handled manually which requires two persons. The design enables fish passage in both directions when the regulator is open.

Rating tables for this structure can be found at Appendix B

7.3 Upper Potterwalkagee Creek regulator

The Upper Potterwalkagee Creek (UPC) Regulator is a small structure providing the ability to deliver flows to the upper 20 km of Potterwalkagee Creek when river levels are at or exceed 24.8 m AHD (0.2 m above normal Lock 8 weir operations).

The regulator is a concrete structure approximately 0.70 m high, 6 m wide (at crest) and 8 m long (bank to bank). It has of five bays, each 1.0 m wide and separated by 0.2 m concrete piers. Flow through the regulator is controlled by the placement and removal of 0.2 m high x 1.0 m long aluminium stop logs. A total of 10 stop logs are required to fully close the regulator and they remain in place on the structure during normal river operations (when environmental watering is not taking place). The stop logs are handled manually which requires two persons. Land access to the UPC Regulator is restricted during environmental watering operations and a boat is likely to be required to install or remove stop logs during some watering events. The design enables fish passage in both directions when the regulator is open.

Rating tables for this structure can be found at Appendix B.

7.4 Mulcra Horseshoe structures

A range of structures have been developed to enable flexible water management options at the Mulcra Horseshoe Wetland, including an inlet pipe and channel from the LPC Regulator and the L5 and L1 Regulators. The structures allow for fully managed environmental watering of the wetland while not impeding on the influence of natural events. They also provide the option to utilise natural high flow events to extend the duration of inundation of the wetland.

7.5 Mulcra Horseshoe pipe and channel

A 900 mm diameter pipe (105 m long) and subsequent channel (850 m long) constructed primarily along a broad and shallow flood runner allows water ponded at the LPC Regulator to be diverted to the Mulcra Horseshoe Wetland. A hand-operated penstock gate is located at the entrance of the pipe and is accessed from the road surface of the LPC Regulator. A fish screen is fitted to the pipe at the LPC Regulator off take to prevent large fish (particularly carp) from entering the wetland. The screen must be checked regularly for obstruction and must be removed prior to flood flows occurring due to the risk of reverse flows trapping turtles against the inside of the screen.

The pipe and channel commence to flow (at very low rates) when the LPC Regulator exceeds 24.0m AHD. The pipe can deliver up to 112 ML/d when the LPC Regulator is full (25.6 m AHD) however as the head difference reduces the rate slows as the Mulcra Horseshoe gradually fills. To water the Mulcra Horseshoe Wetland requires approximately 1.5 GL. Approximately 15 days would be required to fill the wetland if the LPC Regulator was full when the pipe was opened. Most operations would allow water into wetland once the LPC Regulator exceeded 24.0 m AHD. The time taken to fill the wetland under this scenario would be considerably longer and would depend upon the rate at which the LPC Regulator is raised.

A rating table for wetland fill rates via the pipe is provided in Appendix B

7.6 L5 regulator

The L5 Regulator is on the main channel connecting the Mulcra Horseshoe Wetland to Potterwalkagee Creek (downstream of the LPC Regulator) and is only a short distance from the backwaters of the Lock 7 weir pool. The regulator pools water delivered from the inlet pipe and channel to inundate the wetland. During high flow events water backs up through the channel and floods the wetland. The L5 Regulator allows the natural high river flows into the wetland and provides the ability to close the regulator and capture water within the flooded wetland, preventing outflow to the river and thereby extending the duration of inundation.

The L5 Regulator is 2 m high, 6.1 m wide (at crest) and 80 m long (bank to bank). It consists of a single 1.5 m high x 1.8 m wide concrete box culvert to pass flows and includes a 10 m wide spillway within the embankments. Flow through the regulator is controlled by the placement and removal of 0.2 m high x 1.8 m long aluminium stop logs. A total of 9 stop logs are required to fully close the regulator. The stop logs are handled manually which requires two persons. Fish will be unable to pass when the regulator is closed. During high flows and when the regulator is open, fish will be able to pass in both directions. Carp screens have not been fitted to this structure. The use of carp screens will be reassessed following initial environmental watering operations.

The rating table for the L5 regulator is presented in Appendix F.

7.7 L1 regulator

The L1 Regulator is constructed on an effluent connecting the eastern end of the Mulcra Horseshoe to the River Murray just downstream of Lock 8. The L1 Regulator stops water from

returning to the Murray when filling the Mulcra Horseshoe via the pipe and channel. The regulator is designed to ensure that natural flood events are not restricted, allowing maximum flows through the wetland. Operating in tandem with the L5 Regulator, L1 Regulator can be closed on recession of high flow events to capture water within the flooded wetland, preventing outflow to the river and thereby extending the duration of inundation.

The L1 Regulator is 3.0 m high, 4.2 m wide (at crest) and 10 m wide (bank to bank). It consists of 3 x 1.0m bays with concrete piers to pass water and each bay is 1.0 m wide. Flow through the regulator is controlled by the placement and removal of 0.2 m high x 1.0 m long aluminium stop logs. A total of 42 stop logs are required to fully close the regulator. The stop logs are handled manually which requires two persons. Fish will be unable to pass when the regulator is closed. During high flows and when the regulator is open, fish will be able to pass in both directions. Carp screens have not been fitted to this structure. The use of carp screens will be reassessed following initial environmental watering operations.

The rating table for the L1 Regulator is presented in Appendix B.

7.8 Lock 8 wetland (NSW)

The Lock 8 wetland is located on the NSW side of the river. The Lock 8 Road crosses the downstream connection of the wetland to the river. Works include the installation of two 900 x 900 m box culverts that will be regulated with manually placed stop logs. The invert of the culverts (23.9 m AHD) will be at the same level as the creek that connects the wetland to the river. Closing the regulator will allow water to be held in the wetland at the same level as the Lock 8 weir pool up to maximum height (25.7 m AHD).

7.9 Associated works

Sill lowering

High points in the Upper Potterwalkagee Creek were lowered to 24.5 m AHD to reduce the commence-to-flow point, to improve the hydraulic capacity of the creek and provide a minimum depth of water suitable for passage of small fish during a spring fresh scenario.

Lock 8 Track upgrade

To maintain access to the gantry side of Lock 8 during managed flooding events, approximately 1500 m of track was raised to 26 m AHD (0.4-0.5 m above the maximum level of inundation).

7.10 Risks Associated with Structures

The risks associated with the structures will be described in the Risk Management Plan. This document is currently in the process of being written by SA Water.

Table 7: Summary of Mulcra Island structures, including critical operational levels and flows

Structure	Main Purpose	Key Operational Parameters	Dimension	Unit
Lock 8	Raise water level to drive flow into Potterwalkagee Creek	Full Supply Level Top of Piers Top of Fishway walls Bottom of rail beam Lock and Weir Removed	24.6 25.7 25.375 25.395 40,000	m AHD m AHD m AHD m AHD ML/d
Lower Potterwalkagee Creek (LPC)	Inundate Mulcra Island Floodplain	Max raising (structural) Max raising (water quality) Access Road (Top of Structure) Sill Level (Bottom of structure –	25.7 25.6 26 21.6	m AHD m AHD m AHD m AHD

Regulator		not including footings) Crest of spillway Commence to flow level - Horseshoe Wetland via pipe Flow to pass at maximum operating level	25.8 24 460	m AHD m AHD ML/d
Stoney Crossing (SC) Regulator	Manage Potterwalkagee Creek Inflows	Max Raising – designed to overtop during operations Access Road (Top of Structure) Sill Level (Bottom of structure – not including footings) Flow to pass with Lock 8 @ FSL Flow to pass with Lock 8 to max height (overtopped)	25.3 24 35 280	m AHD m AHD ML/d ML/d
Upper Potterwalkagee Creek (UPC) Regulator	Manage Potterwalkagee Creek Inflows	Max Raising – designed to overtop during operations Max Raising – closed regulator (dry Potterwalkagee Ck) Minimum Operating water level Top of Structure Sill Level (Bottom of structure – not including footings) Flow to pass with Lock 8 @ FSL Flow to pass with Lock 8 to max height (overtopped)	24.9 24.8 25.2 24.5 0 180	m AHD m AHD m AHD m AHD m AHD m AHD
L5 Regulator	Manage Horseshoe Wetland water levels	Max Raising – for fully managed event Top of Structure Sill Level (Bottom of structure – not including footings) Crest of spillway Invert of channel from LPC Regulator Minimum level to fill from Murray* *Corresponds to approximate flow D/S Lock 8	24.8 25.08 23.1 25?? 23.8 23.8 30,000	m AHD m AHD m AHD m AHD m AHD m AHD ML/d
L1 Regulator	Manage Horseshoe Wetland water levels	Max Raising – for fully managed event Top of Structure Sill Level (Bottom of structure – not including footings)	24.8 25 23.3	m AHD m AHD m AHD
Lock 8 Wetland Regulator	Mange flows to Lock 8 Wetland (NSW side)	Top of Structure Sill Level (Bottom of structure – not including footings)	25.7 23.9	m AHD m AHD

8. Operating Regimes

Proposed operations

The works at Mulcra Island can be operated in a number of ways to achieve TLM ecological objectives, subject to variations in water availability and operational constraints. Table 8 describes the five main watering scenarios and Table 9 summarises how each of the operations will contribute towards the TLM ecological objectives.

8.1 Long term operating regime

Watering events at Mulcra will be part of the long term TLM multi-watering operations and will be determined each year via the annual watering proposals.

The long term operating strategy for Mulcra Island is to mimic natural flow variability as close as possible. The operating regimes are very flexible; the critical operations can be conducted under normal regulated river conditions and operations do not consume large amounts of water. Therefore it is likely most planned environmental watering operations will be able to be provided under most water availability scenarios.

Each year any recent watering events will be considered against the current ecological conditions and the future potential available water to determine the preferred watering event and possible alternatives for the coming year. It is likely that in some years a combination of operating regimes could be considered as the most appropriate actions for that year. The decision regarding what events will be planned and then undertaken each year will be determined by the prevailing conditions at the site and across the Murray-Darling Basin.

Longer term environmental water planning should consider the need to actively vary water levels to reduce the risk of a constant 'tide line' of red gums developing along the perimeter of the wetlands.

8.2 Commissioning Operations

Following completion of the works, it is proposed to operate the works to its maximum height (25.6 m AHD) to commission the structures whilst the contractor is on site, which will allow an early handover from the contractor to the SA Water.

It is proposed to operate the scheme to fully inundate the Mulcra Horseshoe Lagoon for ecological purposes and to operate to full capacity on the initial event to verify the extent of watering and confirm that there are no break-outs.

Table 8: Summary of Operating Scenarios

		Operational Regime				
		Base Flow (default)	**Spring Fresh**	**Horseshoe High Flows**	**Floodplain Inundation**	**Partial Drying**
In River Conditions	Lock 8 Level	FSL (24.6 m AHD)	24.8 - 25.2 m AHD	n/a	25.2 - 25.7 m AHD	FSL (24.6 m AHD)
	Lock 8 Flow	Normal Regulated Flow (nominal >1,800 ML/d)	1,800 ML/d - 30,000 ML/d	Min 35,000 ML/d To Fill 40,000 ML/d	1,800 ML/d - 40,000 ML/d	Normal Regulated Flow
Site Structures	LPC Regulator	Fully Open	Fully Open	Fully Open	Raised min 25 m AHD - max 25.6mAHD (Must be min 0.1 m < Lock 8 level)	Fully Open
	SC Regulator	Fully Open	Fully Open	Fully Open	Fully Open	Closed
	UPC Regulator	Closed	Fully Open	Fully Open	Fully Open	Closed
	Pipe to Horseshoe	Closed	Closed	Closed	Open then close on recession	Closed
	L5 Regulator	n/a - open	n/a - open	Open then close on recession	Closed fill to max 24.8 m AHD	n/a - open
	L1 Regulator	n/a - open	n/a - open	Open then close on recession	Closed fill to max 24.8 m AHD	n/a - open
	L 8 Wetland Reg	n/a - open	Fully Open	Fully Open	Open(can vary)	n/a - open
Preferred Timing	Season	Default Operation	Winter - Spring	Winter - Spring	Winter - Spring	Spring
	Duration		Min - 21 days (+20 days↑↓Lock 8)	1-6 months (ecology dependant)	Min - 7 days @ max level (+ 90 days↑↓)	2 – 3 months
	Frequency		Annual to Biannual	When conditions allow	1 in 2-3 years	1 in 6-10 years
	Climate Conditions		Extreme Dry, Dry, Median, Wet	Wet	Dry, Median, Wet	Median, Dry
Main Outcomes	Area Inundated (Includes L 8 ↑)	n/a	265 ha (incl Snake Lagoon 28 ha)	80 ha	822 ha 532 ha Vic 290 ha NSW	n/a
	Net Water use (Includes L 8 ↑)	n/a -normal operations	1.2 GL (Preferred Duration)	1 - 1.5 GL (unregulated flows)	7 GL (Preferred Duration)	0 GL (possible savings)
	Other	Maintains Riparian zones and fish habitat	-Additional 20 kms riparian veg watered. -Additional 14 GL through system	- Maintains wetland using unregulated flows	-Floodplain veg watered -Wetlands filled -Additional 50 GL through system	-Control in channel vegetation growth

Main Risks		n/a -normal operations	High Velocities & Erosion (See Risks section)	Carp in Wetland	Water Quality (see Risks section)	Fish

Table 9: Summary of contributions of operating regimes towards site ecological objectives

Floodplain Component	Operating Regime	Contribution to Ecological Objective
Potterwalkagee Creek	Baseflow (Normal Regulated River Condition)	Maintain aquatic habitat for fish in Potterwalkagee Creek Provide permanent fast-flowing habitat in Potterwalkagee Creek Maintain upstream and downstream passage for native fish around Lock 8 Maintain instream and riparian vegetation
	Spring Fresh	Trigger native fish spawning Provide juvenile fish with access to riparian areas and low-lying wetlands Maintain the health and productivity of riparian and low-lying wetland vegetation Maintain upstream and downstream passage for fish to Lock 8 weir pool Maintain downstream passage for all fish from Potterwalkagee Creek to the Lock 7 weir pool and upstream passage for large native fish
Mulcra Horseshoe	Wetland Inundation – High Flows or Floodplain Inundation	Provide frequent waterbird breeding events Maintain floodplain and wetland vegetation
Floodplain	Floodplain Inundation	Maintain floodplain and wetland vegetation Provide conditions for waterbird, fish, turtle and frog breeding Contribute organic matter to Potterwalkagee Creek and the River Murray
Lock 8 Wetland		

For information on how each scenario meets TLM ecological objectives, refer to schedule A - The Mulcra Ecological Operations Plan.

9. External Considerations for Operations

There will be limited impact upstream or downstream at Mulcra Island during and after an environmental watering event. This is because the works function effectively under normal regulated river conditions and requires little (if any) additional water to maintain river conditions downstream of Mulcra. However, consideration will need to be made regarding the quality of water upstream.

Overall Considerations

- Reuse of net flows from upstream.
- Drainage - re use for consumption or for Environmental use.
- Dilution flows required in the advent of the release of water impacted by a blackwater event.

Upstream considerations

A risk to watering at Mulcra is the water quality entering the site from upstream. This could relate to periods of low flow in the river or blackwater events. These issues will need to be assessed on a case by case basis and appropriate actions will be taken to adjust or terminate operations accordingly.

Downstream considerations

The spring fresh operation is a flow through system which will incur very minor losses and those are mainly associated with raising the Lock 8 weir pool. The Floodplain Inundation operation does retain a considerable volume at its peak but as this is built over an extended period, the impacts to River Murray flows downstream will be negligible under all but the driest of regulated flow conditions. Under the driest conditions it is very unlikely large operations would be conducted.

Potterwalkagee Creek is a relatively small anabranch of the Murray and travel times through this system are short (approximately 2 days) which further reduces potential impacts to river operations. In the unlikely event that any minor adjustments to flow downstream were required due to Mulcra operations, they could be enacted relatively easily by increasing supply from Lake Victoria, which returns to the Murray via the Rufus River downstream of Lock 7. There are, however, key features downstream of Mulcra but upstream from Lock 7 that cannot be influenced by Lake Victoria operations (Lindsay River and Mullaroo Creek).

The Lindsay River and Mullaroo Creek system need to be maintained with a certain flow (provided by water level at Lock 7). It will be critical that during initial Mulcra operations, or if future operations approach minimum operational flows, that adequate adjustments to operations be made (such as lowering Lock 8 or LPC Regulator) to adequately accommodate for water requirements in these key areas.

Undertaking environmental watering operations at Mulcra Island in conjunction with downstream sites is a more evident and achievable proposition than with sites upstream. The current anticipated Lindsay River operations are simpler than Mulcra and the two sites could easily be operated simultaneously. Conducting Chowilla operations will take considerably more effort and coordination than either Mulcra or Lindsay and will often require significant environmental flows in addition to the normal regulated river flows. Operational and ecological gains are likely to be achieved when conducting simultaneous Mulcra, Lindsay and Chowilla operations whether they are Spring Fresh, Floodplain Inundation to full extents or a mixture of a number of operational types.

Additional considerations

Approximately 290 ha are inundated in NSW as a consequence of raising Lock 8. While there will be significant ecological outcomes for much of this area, it is important to note that four private land holders will have land inundated by these operations. Communications with NSW, both state agencies and private landholders will be of paramount importance when planning and conducting Mulcra environmental watering, as discussed in Section 3 – Interactions with other systems or structures.

An important consideration for operations at Mulcra is that raising Lock 8 by more than 0.5 m (25.1 m AHD) reduces the effectiveness of the fishway on the weir structure. Fishway walls will overtop for raisings above 0.7 m (25.3 m AHD). The peak fish migration period is between November and March and disruption to the fishway over this period has the potential to impact on regional fish populations. The impact on fish migration will be minimised by ensuring that the weir pool is restored to a level less than 0.5 m (25.1 m AHD) above the normal level for the period from November to March. Under the proposed operating regimes it can be concluded that it would be an irregular event for Lock 8 to be at this level during the nominated period.

10. Water Use

Environmental watering at Mulcra Island is operated as a flow-through system. Majority of water that is diverted through Potterwalkagee Creek will be returned to the River Murray. To achieve the ecological objectives water is consumed during these operations by evaporation, transpiration, seepage and retention in wetland areas.

For a TLM event, Mulcra Operations will be treated as a Victorian event and accounted for under a Victorian water use license. As a consequence, water used within NSW will not require NSW water unless otherwise specified.

This section provides some broad influences on water availability, details how water use is measured and an indication of the volumes consumed under the operating scenarios.

Comment [redacted]: Does his mean ability to reuse return flows? Does the accounting section need to cover off on this?

Comment [redacted]: Does his mean accounted for under a VEWH ABA? If so, state that but be clear that that requires all water required to be first transferred to a VEWH ABA…

Comment [redacted]: Not sure what this means…

10.1 Watering principles

The LMW-OG will be primarily responsible for planning and conducting the environmental watering events when water is made available by an Environmental Water Holder such as TLM. This decision will be guided by the site ecological operating plan and will consider - water availability scenarios, antecedent conditions, seasonality, site conditions, weather forecasts (temperatures), ecological values and their requirements, condition and targets and River Murray system wide operations. Each managed event will have clear documented ecological objectives, a means for measuring progress against these objectives and a mechanism for recording results/observations. The basis for this process is encapsulated in the adaptive management process described by the site ecological operating plan.

The works at Mulcra have been designed to enable the replication of key components of the natural hydrology of the Mulcra Island system, where water is stored on the floodplain and wetlands.

10.2 Structure Operation Matrix

Table 10 summarises the operation of the structures during each of the operating scenarios and the issues associated with transition from one scenario to another.

Table 10 Operating conditions and transition arrangements for Mulcra Island environmental watering works

	TO						
FROM	**Natural Flooding**	**Maximum Inundation**	**Intermediate Inundation**	**Spring Fresh Flow**	**Normal Flow**	**Partial Drying**	**Mulcra Horseshoe Inundation**
Natural Flooding (>25.7 m AHD)	General: All Regulators to be fully open allowing unrestricted flows through the system	When water levels return to Top of Piers (25.7 m AHD): · progressively insert all stop logs into LP reg using bar to force logs into position · UP reg open · SC reg open	When water levels return to required level (ie 25.7 - 25.1 m AHD): · progressively insert stop logs into LP reg using bar to force logs into position · UP reg open · SC reg open	**NOT APPLICABLE**	Wait for flood waters to recede, all regulators open	**NOT APPLICABLE**	· When Lock 8 d/s level returns to between 25 0 - 25.7 m AHD · Progressively insert stop logs into L5 & L1 regs to retain water at desired level.
Maximum Inundation	· Remove all stop logs at LP reg · UP Reg open · SC Reg open	General: · Lock 8 pool raised to top of piers (25.7 m AHD). · Progressively place all stop logs in LP reg. · LPR = 460 ML/d; 2.9m/sec (300 mm flow over top stoplogs) · SC reg open (270 ML/d) · UP reg open (180 ML/d)	· Lower Lock 8 weir pool to required level · Progressively remove stop logs in LP reg to required level · UP reg open · SC reg open	**NOT APPLICABLE**	· Lower Lock 8 weir pool to required level · Progressively remove stop logs in LP reg to required level in conjunction with weir pool adjustment · UP reg open · SC reg open	**NOT APPLICABLE**	· Maintain LP reg at 25.7 m AHD · Open pipe into connecting channel to fill wetland · L1 & L5 closed · UP reg open · SC reg open
	TO						
FROM	**Natural Flooding**	**Maximum Inundation**	**Intermediate Inundation**	**Spring Fresh Flow**	**Normal Flow**	**Partial Drying**	**Mulcra Horseshoe Inundation**
Intermediate Inundation	Remove all stop logs at LP reg	· Raise Lock 8 Weir pool to Top of Piers (25.7 m AHD) · Progressively insert all stop logs into LP reg · UP reg open · SC reg open	General: · Lock 8 pool raised to nominated intermediate level. · Required stop logs in place in LP reg · SC reg open · UP reg open	**NOT APPLICABLE**	· Lower Lock 8 weir pool to required level · Progressively remove stop logs in LP reg to required level in conjunction with weir pool adjustment · UP reg open · SC reg open	**NOT APPLICABLE**	· Maintain LP reg at 25.0 - 25.5 m AHD · Open pipe into connecting channel to fill wetland · L5 closed · Mulcra Inlet closed · UP reg open · SC reg open
Spring Fresh Flow	Lower Lock 8 pool level to normal operating level.	· Raise Lock 8 Weir pool to Top of Piers (25.7 m AHD) · Progressively insert all stop logs into LP reg · UP reg open · SC reg open	· Raise Lock 8 Weir pool to required level · Progressively insert required stop logs into LP reg · SC reg open · UP reg open	General: · Lock 8 pool raised to nominated intermediate level. · LP reg open (max. 430 ML/d; 0.43 m/sec) · SC reg open (280 ML/d) · UP reg open (150 ML/d)	Lower Lock 8 pool level to normal operating level.	**NOT APPLICABLE**	· Maintain LP reg at required level · Open pipe into connecting channel to fill wetland · L1 & L5 closed · UP reg open · SC reg open
Normal/Base Flow	**NO ACTION REQUIRED**	· Progressively insert all stop logs into LP reg · Raise Lock 8 Weir pool to Top of Piers (25.7 m AHD) · UP reg open · SC reg open	· Raise Lock 8 Weir pool to required level · Progressively insert required stop logs into LP reg · SC reg open · UP reg open	· Lock 8 pool raised to nominated intermediate level. · LP reg open · SC reg open · UP reg open	General: · Lock 8 pool at normal operating level. · All stop logs removed from LP reg (35 ML/d; 0.1 m/sec) · SC reg open (35 ML/d) · UP reg open	· Insert stop logs in UP and SC regulators	· Raise Lock 8 to 25.0 – 25. 3 m AHD · Insert stop logs at LP reg to 25.0 m AHD · Open pipe into connecting channel to fill wetland · L1 & L5 closed · UP reg open · SC reg open
Partial Drying	· Remove all stop logs SC reg · Remove all stop logs UP reg	**NOT APPLICABLE**	**NOT APPLICABLE**	**NOT APPLICABLE**	· Lock 8 pool level at normal operating level. · Remove stop logs from SC reg	General: · Lock 8 pool at normal operating level. · Sufficient stop logs installed in UP & SC regs to prevent inflows into Potterwalkagee Creek	**NOT APPLICABLE**
	TO						
FROM	**Natural Flooding**	**Maximum Inundation**	**Intermediate Inundation**	**Spring Fresh Flow**	**Normal Flow**	**Partial Drying**	**Mulcra Horseshoe Inundation**
Mulcra Horseshoe Inundation	· Remove all stop logs from LP reg · SC reg open · UP reg open · L5 & L1 regs open	· Raise Lock 8 to Top of Piers (25.7 m AHD) · Progressively insert all stop logs into LP reg · SC reg open · UP reg open · L5, & L1 regs closed · Open pipe to deliver water to channel	· Required condition to achieve flow into the pipe and channel	· Lock 8 pool raised between 25 0 - 25.7 m AHD. · Remove all stop logs from LP reg · SC reg open · UP reg open	· Lower Lock 8 pool level to normal operating level. · Close pipe to connecting channel · L5 & L1 regs closed	· Lock 8 pool at normal operating level. · Sufficient stop logs installed in UP & SC regs to prevent inflows into Potterwalkagee Creek	General: · Lock 8 pool raised between 25.0 - 25.7 m AHD. · Required stop logs placed in LP reg · Open pipe to deliver water to channel · Close L5 & L1 reg · SC reg open · UP reg open

10.3 Accounting principles

The following sections outline some general principles that need to be considered for accounting of environmental water at Mulcra Island under each operating scenario.

The water stored on the Mulcra floodplain and behind lock 8 can be considered to be an addition to the Lake Victoria storage. Given this the River Murray operators can plan and operate Lock 8 and Mulcra Island works to manage the two storages and release jointly to provide SA with entitlement flow.

As Mulcra is considered an additional part of Lake Victoria accounting is on a net use basis only.

10.4 Water Accounting Methods

Under managed events it is necessary to understand the hydraulic conditions that will apply and the volume of water that may be used, ie 5 GL is required for a full watering (800 ha for 90 days at 7mm / day actual evaporation – equates to 10mm pan evaporation).

During environmental watering the Mulcra works can be considered as three separate water bodies:

Lock 8 weir pool

Lock 8 weir pool will be raised by up to 1.1 m with inundation of fringing wetlands and floodplain on the NSW and Victorian banks. The water use is distributed along the bank between Lock 8 and Lock 9. No feasible method of direct measurement of flow into the incrementally wet up bank areas has been determined.

Given that direct measurement of water use is not feasible the most appropriate method of assessing the water use associated with the weir pool raising is to use a water balance model (eg SWET) that relates the water level at Lock 8 to the incremental area of inundation and then calculates the evaporative and seepage (wetting up and ongoing) losses using daily evaporation and rainfall data from a local station (eg Lock 8 or Lake Victoria).

Potterwalkagee creek and floodplain

Under normal weir pool operating level the flow onto the floodplain is constrained to 2 locations – Stoney crossing and Upper Potterwalkagee Creek. With a weir pool raising of 1.1 m additional points connecting the floodplain to the Lock 8 weir pool are expected to occur and the 2 main locations will become poorly defined with the Upper Potterwalkagee regulator being fully submerged. During transition from a watering event to a natural flood, as the grade on the river increases the connectivity of the upper end of the Potterwalkagee creek will increase with multiple points of connection.

In addition to the complication of upstream connectivity to the river the area inundated will be controlled by the flow released over the Lower Potterwalkagee Regulator (ie the hydraulic grade placed on the creek).

Given that the area inundated is a function of multiple variables the most appropriate method of assessing the water use associated with the weir pool raising is to use a water balance model (eg SWET) that relates the water level at Stoney crossing, Upper Potterwalkagee creek regulator and lower Potterwalkagee creek regulator to the incremental area of inundation and then calculates the evaporative and seepage (wetting up and ongoing) losses using daily evaporation and rainfall data from a local station (eg Lock 8 or Lake Victoria).

Mulcra Island Horseshoe

The water supply to the Mulcra Island Horseshoe wetland can be a combination of high water levels downstream of Lock 8, supply through the pipe from the Potterwalkagee creek, or pumping direct from the Lock 7 weir pool. The multiple sources of water, in particular the likely scenario of a management action seeking to top up the water level after a high tail water downstream of Lock 8 has partially filled the

wetlands, means that any accounting method must be able to consider the water use attributable to the action and multiple sources of water.

Options are:

- direct flow measurement at the pipe from the Potterwalkagee creek to the wetland and to develop a rating for the boards for any water released to the river on draining
- Use of a SWET model that assesses the use (seepage and evaporation).

10.5 Accounting by watering scenario

The following provides a brief summary of the proposed accounting methods to apply at Mulcra Island for environmental watering actions.

Base flow – no accounting as this represents the historical situation.

Spring freshes – apply the SWET model to Lock 8 and to the Potterwalkagee creek to assess the incremental water use. It is expected that the incremental water use will be dominated by the increased level in the Lock 8 weir pool rather than the area wet up along the Potterwalkagee creek

Intermediate inundation – apply the SWET models to Lock 8 and to the Potterwalkagee creek to assess the incremental loss

Mulcra Horseshoe inundation – apply the SWET model to Mulcra horseshoe wetland to assess the water use. If the wetland was partially filled by a natural event the use will be the incremental increase in area that is wet due to the managed addition of water to the wetland.

Maximum Floodplain inundation – apply the SWET models to Lock 8, Potterwalkagee creek and Mulcra horseshoe wetland to assess the incremental water use.

Partial drying – apply the SWET model to Potterwalkagee creek to assess the incremental water saving.

Natural flooding – no accounting as this represents the historical situation.

The MDBA has developed a Water Balance model (similar to the SWET model that has been used for calculating water use from Lock raisings previously) to determine water use at site.

The use of models for all components of the accounting allows for relatively straight forward transition between the different modes of operation. The only issue that will need to be determined operationally is when the source of environmental water changes from a regulated release to an unregulated flow and again when the flow changes from a managed event to a natural flood. These are relatively straight forward questions that can be resolved by the operators during a watering and reported as part of the end of watering accounting.

This section will be updated prior to the initial operations by the MDBA TLM Modellers and River Murray Operators, and will be updated upon information received by monitoring after each event to calibrate the model.

10.6 Water Requirements for Operating Regimes

As discussed previously, it is unlikely Mulcra Operations require additional water beyond normal regulated flows to achieve environmental watering of the site. Supplying additional water to support Mulcra operations will more likely depend upon factors external to Mulcra (upstream or downstream water supply or water quality issues) which would need to be considered by RM Operations at that time. Table 11 provides a summary of water requirements at the site for the various operating regimes.

Table 11: Summary of water requirements under the various operating regimes (based on modelled outputs)

Operating Regime	Flow			Pools		Water Used	
	Inflow Component	Peak Inflow Rate (ML/d)	Total additional flow through P-walkagee Creek (GL)	Floodplain component	Peak Volume (GL)	Floodplain component	Volume (GL)
Spring Fresh (at preferred dura ion 40 days total)	SC Regulator	280	14	Lock 8 @ 25.2 m AHD (additional above FSL)	6	Lock 8 raising (mainly NSW)	0.794
	UPC Regulator	150				Potterwalkagee Creek (Vic)	0.453
						Total	**1.247**
Floodplain Inundation (at preferred dura ion 120 days total)	SC Regulator	280	50	Lock 8 @ 25.7 m AHD (additional above FSL)	12.4	Lock 8 raising (mainly NSW) Lock 8 Wetland (NSW)	1.919 0.795
				LPC Regulator@ 25.6 m AHD	13.7	Potterwalkagee Ck and Mulcra Floodplain (Vic)	2.916
	UPC Regulator	180		Horseshoe Wetland L5 Regulator @ 24.8 m AHD	1.1	Horseshoe Wetland (Vic)	1.369
						Total	**6.999**
Mulcra Horseshoe-High Flows	Dependent upon magnitude of unregulated flow			Horseshoe Wetland L5 Regulator @ 24.8 m AHD	1.1	Dependent upon duration held	

11. Operating Risks and Mitigation Measures

The potential risks to values that may be affected by planned watering at Lindsay, Mulcra or Wallpolla Islands have been assessed by a committee consisting of Mallee CMA, Parks Victoria, MDBA, DSE, River Murray Operations and G-MW.

The scope of the assessment considered risks associated with water delivery to the wetlands and floodplains, water held within the wetlands and floodplain, and water released/spilling from the floodplain.

The scope excluded an assessment of risks associated with the actual structures. This assessment is undertaken by the operator and documented in the Mulcra Island Operations, Maintenance and Safety Manual and the Mulcra Island Commissioning Procedure.

The potential risks to environmental, social and economic values that may be affected by the planned watering of Lindsay and Mulcra Islands has been previously assessed to inform the development of the Lindsay Stage 1 Investment Proposal (Mallee CMA 2010) and the Mulcra Island Construction Proposal (2009). The potential risks were assessed for Lindsay Island by Mallee CMA and for Mulcra Island by KBR (2008) for Mallee CMA and an expert panel respectively (ecology – wetland/aquatic, geomorphology, groundwater and water quality & social/economic). Salinity risks were assessed independently for Mallee CMA for Lindsay Island (SKM 2010) and Mulcra Islands (SKM 2008).

The scope of each assessment considered risks associated with water delivery to each site for a number of different watering scenarios. The scope excluded an assessment of risks associated with the actual structures. This assessment is undertaken by the operator (SA Water) and will be documented in the Mulcra Island Operations, Maintenance and Safety Manual and Commissioning Procedure.

Each assessment used a value, threat, likelihood, consequence approach to determining the level of risks to values (ranked low to extreme) for each operating scenario for Mulcra Island and monitoring, mitigation and control actions have been identified.

A meeting was convened of the following stakeholders: Mallee CMA, SA Water River Murray Operations, MDBA, NSW Office of Water and Parks Victoria. The stakeholders reviewed the previous assessments including the methodology, identification of values, outcomes of the risk assessment and mitigation measures.

The stakeholders largely validated the assessment of risks to values at Lindsay Island. For Mulcra Island, additional values were identified and risks subsequently assessed. These included changes to pest terrestrial flora, cultural impacts, operations and maintenance activities and enforcement / compliance activities e.g. illegal fishing.

In addition, a comprehensive risk assessment is undertaken and documented in the annual seasonal watering proposal, and the event-specific delivery plan, prepared by Mallee CMA prior to delivering environmental water in any given season. This may include for example, consideration of blackwater events. Where blackwater events are considered to have a high risk to either in stream biota or water quality within the Murray River, mitigation measures and monitoring requirements are identified and implemented where required.

It is expected that the operating risks and any mitigation measures will be further fleshed out once the commissioning of the structures has been completed. In the short-term, this section will focus on the operating risks that might be associated with operation and flows for the commissioning activities. A more comprehensive risk assessment will be developed for subsequent versions of this Operating Plan.

In summary, investigations into risks have been conducted for Mulcra Island, where the negative impacts identified include a potential change to salinity and weed distribution may occur. Other minor impacts identified included potential geomorphology changes and isolated algal blooms. The minor impacts can be ameliorated by monitoring and adaptive management.

The following section outlines the short term risks associated with the early commissioning works.

11.1 Salt

There is an increased risk of salinity (low risk) in the long term due to extended floodplain watering durations resulting from the works.

In line with BSMS requirements, a salinity impact assessment was carried out for a number of watering scenarios (spring fresh, floodplain inundation and wetland retention). Impacts from the inundation and retention scenarios are potentially significant, with the upper value for impact from combined inundation and retention being 0.85 EC at Morgan for Register A. The level of analysis presented in this assessment is considered appropriate given the magnitude of the predicted salinity impacts and a monitoring program has been developed to refine the predicted salinity impacts.

Mallee CMA monitors an existing bore network within the park and will undertake a long-term salinity monitoring program to assess the impacts of environmental watering on groundwater levels and groundwater quality. Monitoring and ongoing assessment of risks will occur consistent with the basin salinity management strategy.

11.2 Water Quality

It is recognised that there may be the potential for Blue-green algae infestation and/or blackwater events to occur as a consequence of providing environmental water to achieve the maximum floodplain inundation scenario only (low to moderate risk). This has the potential to impact in stream biota and/or public health (potential human contact with waters within the park and potential impacts to downstream domestic and stock users the occurrence of either water quality issue will be considered on an individual event basis.

Routine monitoring for blue green algae within the park will be undertaken by Parks Victoria and routine water quality monitoring will be undertaken by Mallee CMA.

Mitigation actions could include the installation of signage or the cessation of watering activities. In addition Parks Victoria are responsible for Blue green algae response and communication to Park users. Mallee CMA and SA Water RMOU are responsible for communicating blackwater associated risks to Parks, SA Water customers and other stakeholders.

The proposed commissioning event will be undertaken during winter when water temperatures are typically lower, minimising the risk of Blue-green Algae and blackwater.

11.3 Fish

The potential for pest fish species is considered to be low to moderate risk for the maximum floodplain inundation scenario only. The minor impacts can be ameliorated by monitoring and adaptive management. Later treatment may include the drying of lakes to remove carp.

11.4 Weeds

The risks of promoting exotic flora are assessed as low to moderate for the maximum floodplain inundation scenario only.

Mallee CMA and Parks Victoria will monitor vegetation (exotic and native) and review /revise watering operation frequency and durations as required. Parks Victoria will continue to implement pest plant management activities within the park.

11.5 Geomorphology and Erosion

The risk of erosion is considered low for the flows expected for the commissioning activities at both Lindsay and Mulcra Islands. Regular inspections during commissioning flows will be undertaken SA Water.

11.6 Cultural, social and economic issues

The delivery of environmental water may affect social and economic values by affecting:

- Public and Parks staff management access and camping within the Park. Parks Victoria maintains their current responsibility for communicating access changes, and alternative access and camping, to Park users.
- Public amenity if blue green algae events occur. Parks Victoria maintains their current responsibility for communications including, closures, limiting access and signage as required.
- Public safety. Safety could be affected during watering operations or by access to operating infrastructure, such as regulators. MDBA, SA Water, Parks Victoria are responsible for the installation and maintenance of necessary signage and safety fencing and railings. A further risk assessment is undertaken by the operator and documented in the Operations, Maintenance and Safety Manual/s and the Commissioning Procedure/s.
- Compliance activities. There is a risk of increased illegal fishing activity due to increased boat access and fish numbers. This may lead to a need for increased compliance and enforcement activities by Parks Victoria and DSE personnel.
- Tour operators, local business and beekeepers. Parks Victoria is the primary agency currently responsible for communicating and working with tourism operators and managing tourism activities. Parks is also responsible for other commercial activities such as beekeeping. Parks is responsible for communicating with potentially affected parties, providing early warning of watering activities and identifying in advance alternative sites.

11.7 Structures

South Australian Water describes the structures in the SA Water Commissioning report. In addition SA Water undertakes a risk assessment, which is documented in the Lindsay, Mulcra and Wallpolla Islands Operations, Maintenance and Safety Manuals and Commissioning Procedures.

12. Operational Costs

Many of the costs associated with Mulcra operations will be performed by the various agencies as part of their ongoing responsibilities. Normal Mulcra operations do not involve the use of pumps and do not rely on third party infrastructure. As such most Mulcra operations incur only limited direct costs. Table 12 provides a summary of the primary cost components and where costs are initially borne. This section attempts to clarify contributions from agencies and provide any details to support their ongoing commitment and any budgetary or staffing considerations required for planning or other purposes.

Table 12: Summary of cost components for Mulcra Operations

Cost Component	Direct/Indirect	Cost borne by
Water Use	Direct	Environmental Water Holder
Monitoring	Direct	Mallee CMA
Planning and Managing Operations	Indirect	LMW –Operations Group • Mallee CMA • MDBA • SA Water • Parks Victoria • NSW Office of Water
Operation and Maintenance of Structures	Indirect	SA Water

Costs associated with water use are dependent upon a particular event and the water accounting process. The funds to provide water to conduct events is not an issue currently requiring detail in this document. An estimate of water costs per operation could be calculated using the current market value of water.

The Mallee CMA will seek an annual budget for most of the monitoring activities associated with Mulcra Operations. Details of monitoring commitments and associated costs will be set out in the Mulcra Island Risks Monitoring Plan.

Planning and managing Mulcra operations by the various agencies will be done on an in-kind basis and no specific costing or budget will apply.

12.1 Operation and Maintenance Costs

There are no major operational costs. Costs will be incorporated into the SA Water operations budget, which will be part of the O&M costs funded from the MDBA River Management Division.

Key points to note relating to operating and maintenance costs:

- The demands on SA Water in relation to Mulcra will vary considerably between years. Demands one year will be considerably less if no operation is conducted compared to years operations are executed. The type of operation will also influence demands on SA Water

- The on ground staff to operate the structures and conduct monitoring will primarily be provided by staff at Lock 8. SA Water shall determine alternative arrangements on occasions when Lock 8 staff are unavailable. There are no SA Water staff specifically allocated to Mulcra operations
- General equipment (such as the 4WD ute with Hiab Crane) will be a shared resource. SA Water will work to ensure work schedules allow adequate coverage of equipment to facilitate Mulcra operations, and
- SA Water will incur very few fixed costs in regard to operations at Mulcra

13. COMMUNICATIONS

The Living Murray Communications and Consultation Strategy and Work Plan 2010-11 includes key messages and tasks relevant to environmental watering actions, including the operations of the new structures. The Lindsay-Mulcra-Wallpolla Islands Icon Site has a communications and consultation plan specific to the site. Media issues surrounding watering actions must be in accordance with The Living Murray Communication Protocol.

The relevant TLM State Communications Coordinator is responsible for the communications activities, and will coordinate them with the relevant on-ground and executive staff. This will ensure the timely dissemination to appropriate audiences of safety and access information regarding operation periods.

13.1 Community Consultation

The Icon Site manager (Mallee CMA) is committed to establishing and maintaining strong relationships within the local community during watering operations. A vital tool in the consultation process is structured engagement with the community through engagement with key stakeholders and advisory groups.

13.2 Indigenous Engagement

To ensure the Indigenous community is provided an opportunity for input into water management, and a chance to raise and identify their cultural and spiritual links to the islands, Indigenous Stakeholders will be consulted. These stakeholders are representatives of each of the Aboriginal parties who have a vested interest in the islands.

These representatives ensure cultural heritage and values are considered and incorporated by the Icon Site manager, and the distribution of information out into the aboriginal communities. This group provides a valuable single source for Indigenous engagement, advice, input and recommendation.

13.3 Community Advisory Group

A community advisory group is currently active and informed of TLM activities in the MCMA region on a regular basis.

13.4 Communication with the community during managed events.

MCMA will lead communication activities for upcoming and ongoing watering events. Key messages will be about the timing and ecological objectives of each event.

Parks Victoria will be responsible for communicating with its stakeholders and visitors regarding any impacts on visitor experience such as road closures, access restrictions to areas of the park and water quality issues.

In the event of a broader basin scale event such as blackwater, the MDBA will take the lead on communications with support where required from local agencies.

13.5 Complaints and Enquiries

Complaints and enquiries relating to the environmental watering process shall be directed to MCMA.

Parks Victoria will be responsible for dealing with complaints and enquiries regarding visitor access to the park and water quality concerns within the park.

14. PREVIOUS EVENT RECORD

This section will contain the ongoing operations log and as such will be progressively updated as watering events occur and are examined and assessed.

15. REFERENCES

KBR, 2008. *Impact Assessment for the Operation of Water Management Structures on Mulcra Island*. Report prepared for Mallee CMA by Kellogg Brown & Root, Melbourne, Victoria.

Mallee, CMA, 2010. *Upper Lindsay Watercourse Enhancement Proposal: Lindsay Island Works Stage 1*. Report prepared by the Mallee Catchment Management Authority, Mildura, Victoria.

Mallee, CMA, 2009. *Mulcra Island Environmental Flows Project: Construction Proposal*. Report prepared by the Mallee Catchment Management Authority, Mildura, Victoria.

SKM, 2010. *Semi-quantitative Salinity Impact Assessment of Works and Measures of the Living Murray: Lindsay Island Stage 1 Works and Measures*. Report prepared for Mallee CMA by Sinclair Knight Merz, Adelaide, South Australia.

SKM, 2008. *Semi-quantitative Assessment of Living Murray Works and Measures: Salinity Impacts at Lindsay, Mulcra and Wallpolla Islands*. Report prepared for Mallee CMA by Sinclair Knight Merz, Adelaide, South Australia.

URS, 2009. *Design Report: Detailed Design and Documentation of the Mulcra Island Water Management Works*. Report prepared for SA Water by URS, Adelaide, South Australia.

APPENDIX A - The Environmental Water Order Template

ENVIRONMENTAL WATERING ORDER

Location : Mulcra Island

Order Reference No. : **Version :** **Date :**

Order From : **Order To :**

Details						
	Lower Potterwalkagee Regulator	**Upper Potterwalkagee Regulator**	**Stoney Crossing**	**Mulcra Horseshoe Inlet Reg (L1)**	**Mulcra Horseshoe Inlet Reg (L5)**	**Lock 8 Track Regulator**
Gate configuration :	Aluminium Drop Board Structure	Aluminium Drop Board Structure	Aluminium Drop Board Structure	Aluminium Drop Board Structure	Aluminium Drop Board Structure	Aluminium Drop Board Structure
Max Design Flow/day						
Flow measurement :						
Current status (ie open or shut)						
Start Date (Note 1						
Status of structure during event (ie open or shut)						
Direction of flow (Note 7)						
Required flow rate/day (Note2)(Note 3)						
Level control requirements (Note 4)						
Total volume of water to be delivered (Note 5)						
Event Duration (Note 6):						
Special requirements (Yes/No) - See Page 3						

Note 1 : A minimum of ## calendar days notice is required for all orders or revised orders. Where access to the site by boat is required then ## days' no ice is required

Note 2 : Separate/specific flow requirements to be provided for fishway/fishlock.

Note 3 : Confirm whether the flow rate is a maximum, minimum, exact or nominal figure.

Note 4 : Confirm any maximum/minimum tailwater level requirements (AHD)

Note 5 : Confirm whether the total volume of water to be delivered is a maximum, minimum, exact or nominal figure.

Note 6 : Confirm whether the event duration is a maximum, minimum, exact or nominal figure. Adopt calendar days.

Note 7 : If it is intended to change the direction of flow through the structure then this must be clearly described with details of the triggers that initiate the change.

Other Environmental Requirements/Constraints :

Eg Nominate/describe any build up or ramping down of flows

Eg Restrict use of undershot gates where likely to kill fish – ie nominate minimum tailwater depth

APPENDIX B

Rating Table for structures at Mulcra Island

Lower Potterwalkagee Creek Regulator pipe connection to Mulcra Horseshoe Wetland Rating Table (ML/d)

Water Level Mulcra Horseshoe (mAHD)	Water Level LPC Regulator (mAHD)								
	24.1	**24.3**	**24.5**	**24.7**	**24.9**	**25.1**	**25.3**	**25.5**	**25.7**
23.2	2	11	27	47	64	77	90	101	112
23.4	2	11	27	47	64	77	90	101	112
23.6	2	11	27	47	64	77	90	101	112
23.8	2	11	27	47	64	77	90	101	112
24	2	11	27	47	64	77	90	101	112
24.2	0	11	26	46	64	76	90	100	112
24.4	0	0	17	43	61	75	88	99	111
24.6	0	0	0	5	54	71	85	97	109
24.8	0	0	0	0	35	71	76	90	102

Stoney Crossing Regulator Rating Table (ML/d)

Water Level directly D/S Stoney Crossing Reg (mAHD)	Water Level U/S Stoney Crossing Regulator (m AHD)																	
	24.0	**24.1**	**24.2**	**24.3**	**24.4**	**24.5**	**24.6**	**24.7**	**24.8**	**24.9**	**25.0**	**25.1**	**25.2**	**25.3 (top of piers)**	**25.4**	**25.5**	**25.6**	**25.7**
23.7	0	20.4	40.8	67.1	97.3	134.9	172.4	222.2	274.9	335.3	403.9	478.3	559.9	650.4	767	904.2	1060.5	1243.4
24.0	0	19.3	38.6	62.7	89.3	126.1	162.9	210.1	261.8	325.8	393.3	466.2	546.6	636.9	752.3	884.1	1043.4	1219.4
24.1	0	0	35.4	58.5	85.9	123.5	161.4	207.2	256.3	316.4	383	458.6	542.4	632.2	747	879.2	1035.2	1212.7
24.2	0	0	0	46.8	79.8	118.7	159.1	205.4	254.8	313.1	376.7	447.9	528.2	620.5	741.2	873.1	1028.8	1205.9
24.3	0	0	0	0	62.8	107.1	152.1	200.7	252.5	311.4	374.9	444.3	521.8	608.1	723.9	861.2	1020.8	1191.3
24.4	0	0	0	0	0	82.7	136.2	190.1	245.8	306.4	371.4	442	519.2	604	715.9	846.2	1002.6	1176.4
24.5	0	0	0	0	0	0	104.2	170.2	232	296.1	363.8	436.8	516	601.4	711.6	839.3	990.4	1153
24.6	0	0	0	0	0	0	0	127.5	206.1	277.4	350.2	426.6	508.5	596	709	835.2	984.3	1137.3
24.7	0	0	0	0	0	0	0	0	156.9	245.6	327	409.6	495.7	585.7	702.2	830.6	978.2	1129.6
24.8	0	0	0	0	0	0	0	0	0	186.7	288.9	381.4	473.8	570.6	691.2	820.1	971.2	1123.2

24.9	0	0	0	0	0	0	0	0	0	0	218	335.6	440.2	546	668.9	803.4	958.6	1112.9
25.0	0	0	0	0	0	0	0	0	0	0	0	257.5	386.4	503.4	638	777.6	937.6	1094.4
Water Level directly D/S Stoney Crossing Reg (mAHD)	**Water Level U/S Stoney Crossing Regulator (m AHD)**																	
	24.0	**24.1**	**24.2**	**24.3**	**24.4**	**24.5**	**24.6**	**24.7**	**24.8**	**24.9**	**25.0**	**25.1**	**25.2**	**25.3 (top of piers)**	**25.4**	**25.5**	**25.6**	**25.7**
25.1	0	0	0	0	0	0	0	0	0	0	0	0	293 4	442.4	590.2	742.7	908.9	1067.8
25.2	0	0	0	0	0	0	0	0	0	0	0	0	0	335.3	518.4	689.4	860.7	1028.3
25.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	391.2	601	790.5	972
25.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	447.2	682.3	890.1
25.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	503	765.6
25.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	564.9

Upper Potterwalkagee Creek Regulator Rating Table (ML/d)

Water Level directly D/S UPC Reg (mAHD)	Water Level U/S UPC Regulator (mAHD)												
	24.5	**24.6**	**24.7**	**24.8**	**24.9**	**25.0**	**25.1**	**25.2 (top of piers)**	**25.3**	**25.4**	**25.5**	**25.6**	**25.7**
24	0	24.5	53.3	97.5	150.1	208.7	273.5	344.9	441.2	560.3	697.1	849.6	994.2
24.5	0	24.5	53.3	97.5	150.1	208.7	273.5	344.9	441.2	560.3	697.1	849.6	994.2
24.6	0	0	50.2	97.9	150.3	208.7	273.5	344.9	441.1	559.7	695.7	849.9	994.2
24.7	0	0	0	93.1	148.8	208.7	273.5	344.9	441.1	559.7	695.7	849.9	994.2
24.8	0	0	0	0	136.5	209.1	273.5	344.9	441.2	560.3	695.7	849.9	994.2
24.9	0	0	0	0	0	192.1	273.5	344.9	442.2	560.3	695.7	849.6	994.2
25.0	0	0	0	0	0	0	253.2	344.7	441.2	560.3	695.7	849.9	994.2
25.1	0	0	0	0	0	0	0	312.4	441.2	560.3	695.7	849.9	994.2
25.2	0	0	0	0	0	0	0	0	394.3	563.4	695.7	849.6	994.2
25.3	0	0	0	0	0	0	0	0	0	453	671.1	849.6	994.2
25.4	0	0	0	0	0	0	0	0	0	0	518.4	753.2	964.8
25.5	0	0	0	0	0	0	0	0	0	0	0	596.8	844.8
25.6	0	0	0	0	0	0	0	0	0	0	0	0	681.9

L1 Regulator Rating Tables (ML/d)

Water Level Directly D/S L1 Regulator (Mulcra Horseshoe) (mAHD)	Water Level U/S L1 Regulator (Potterwalkagee Ck) (m AHD)								
	24.4	**24.5**	**24.6**	**24.7**	**24.8**	**24.9**	**25**	**25.1**	**25.2**
24.3	12.5	46.2	88.8	139.1	196.3	258.5	327.7	401.9	480.7
24.4	0	46.2	88.8	139.1	196.3	258.5	327.7	401.9	480.7
24.5	0	0	88.1	139.1	196.3	258.5	327.7	401.9	480.7
24.6	0	0	0	132.4	196.2	258.5	327.7	401.9	480.7
24.7	0	0	0	0	177.6	257.4	327.7	401.9	480.7
24.8	0	0	0	0	0	223.2	320.2	401.3	480.7
24.9	0	0	0	0	0	0	269	383.9	477.4
25	0	0	0	0	0	0	0	314.8	448.2
25.1	0	0	0	0	0	0	0	0	360.8

L5 Regulator Rating Tables (ML/d)

Water Level directly D/S L5 Reg (mAHD)	Water Level U/S L5 Regulator (m AHD)																			
	23.1	**23.2**	**23.3**	**23.4**	**23.5**	**23.6**	**23.7**	**23.8**	**23.9**	**24.0**	**24.1**	**24.2**	**24.3**	**24.4**	**24.5**	**24.6**	**24.7**	**24.8**	**24.9**	**25.0**
23.0	0	4.8	17.9	34.7	54.7	76.7	102.3	129.9	159.5	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.1	0	4.8	17.9	34.7	54.7	76.7	102.3	129.9	159.5	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.2	0	0	17.9	34.7	54.7	76.7	102.3	129.9	159.5	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.3	0	0	0	34.2	54.7	76.7	102.3	129.9	159.5	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.4	0	0	0	0	51.9	77.5	102.3	129.9	159.5	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.5	0	0	0	0	0	69.9	101.8	129.9	159.5	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.6	0	0	0	0	0	0	88	126.7	159.2	191	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.7	0	0	0	0	0	0	0	106.3	152.1	189.4	224.2	259.2	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.8	0	0	0	0	0	0	0	0	124.6	177.6	220.2	258.6	295	333.5	373.3	414.5	457	500.9	546.1	592.6
23.9	0	0	0	0	0	0	0	0	0	142.9	203.3	251.2	293.6	333.8	373.3	414.5	457	500.9	546.1	592.6

APPENDIX C

Spells analysis of Lock 8 flow

Australian Government

MURRAY–DARLING BASIN AUTHORITY

Spells analysis of Lock 8 flow

Technical Memo 2010/15_2

February 2013

Document Control

Version	Author	Reviewer	Date
Draft	[redacted]	[redacted]	18/02/13

Table of Contents

1 Introduction

1.1 Study Objectives and Scope

This data analysis aims to:

- Examine the seasonality of natural and current modelled flow at Lock 8;
- Provide the average duration and inter-flood period for discrete flood events (exceeding 20,000 ML/d) for the natural and current (including TLM) modelled flow at Lock 8; and
- Examine the contribution of the Darling River to high flows at Lock 8.

2 Analysis Results

2.1 Monthly Flow Pattern

The monthly total flow (GL/month) for Lock 8 is shown in Figure 3~~Figure 3~~ and Figure 4~~Figure 4~~ for modelled natural and current (including TLM) conditions respectively (box denotes 25, 50 and 75 percentile: whiskers denote 10 and 90 percentiles). It is clear from the plots that the highest median flows occur through Winter-Spring at Lock 8.

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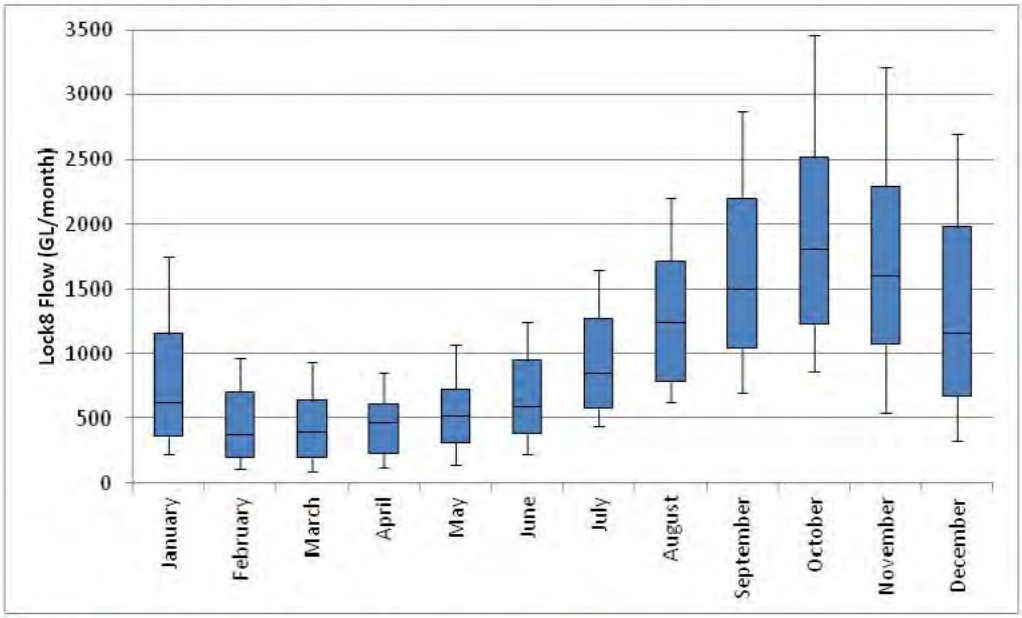

Figure 3 Monthly Lock 8 flow – modelled natural conditions

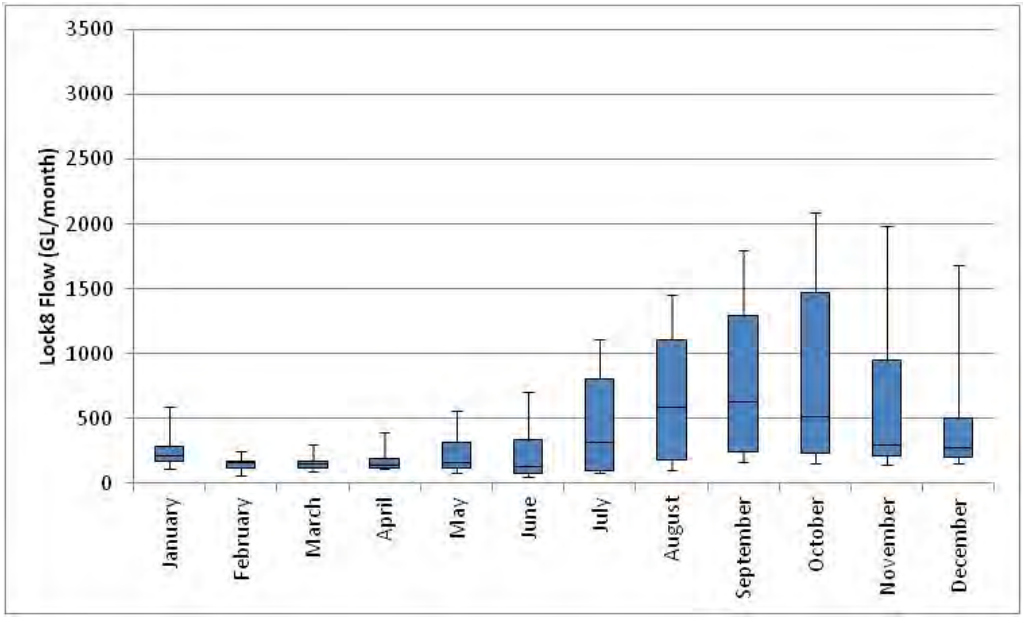

Figure 4 Monthly Lock 8 flow – modelled current conditions

2.2 Discrete Flood Events

Discrete flood events were extracted from the natural and current model runs (benchmark 1205 run numbers 2750 and 2754 respectively). Discrete events were defined as:

> *continuous flow greater than 20,000 ML/d for at least 30 days preceded by at least 30 days of continuous flow below 20,000 ML/d.*

Previous modelling indicates River Murray flows below 20,000 ML/day downstream of Lock 9 connects the River Murray with the Potterwalkagee Creek. The flows are mainly within channel and provide a small area of floodplain inundation in NSW. However, managed events will aim to target higher equivalent flows of 40,000-45,000 ML/day, which is achieved by raising Lock 8 by 0.6cm. This is an intermediate Lock 8 raising from FSL level of 24.6m AHD to 25.2m AHD. This comparison is shown in Figures 3 and 4 respectively.

These discrete flood events were separated into events starting in Winter-Spring or Summer-Autumn and each event was furthered separated into periods above higher flow thresholds to assess flow duration and inter-flood period.

The discrete flood events shows an average duration and inter-flood periods for flow ranges exceeding 20,000 ML/d are shown in Table 3~~Table 3~~. The data indicates that events starting in Summer-Autumn are rare in comparison to events starting in Winter-Spring in both the natural and current model runs. For example, a moderate flood starting in Summer-Autumn exceeding 40,000 ML/d at Lock 8 has an inter-flood period of approx. 5 years under natural conditions.

Figure 5 Modelled Lock 8 Floodplain Inundation for 20,000 ML/d (minimal floodplain inundation)

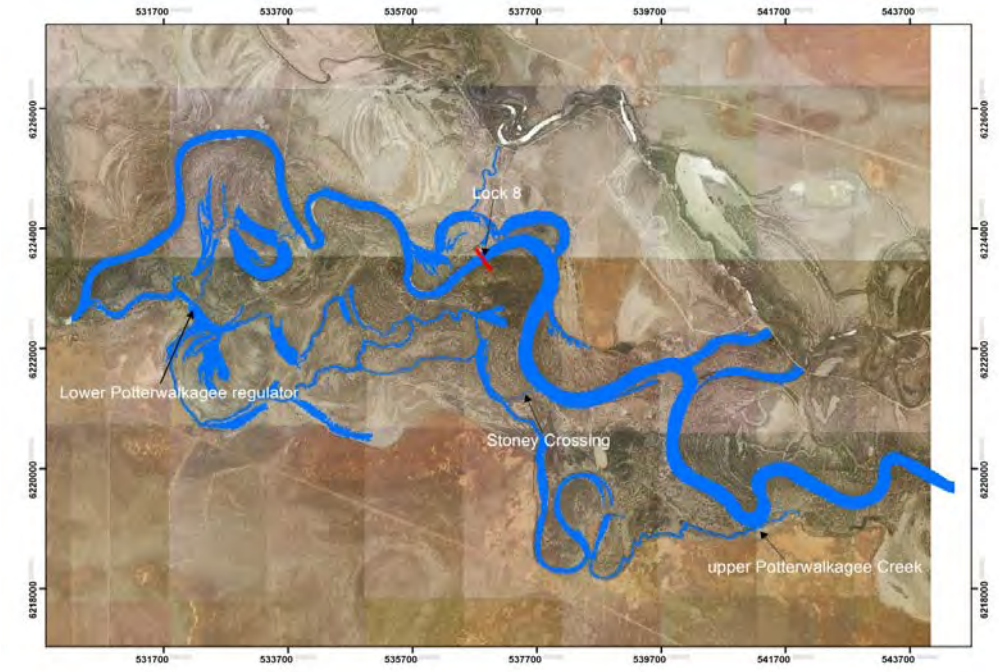

Figure 6 Modelled Lock 8 Floodplain Inundation with Lock 8 raised to 25.2m AHD (raising Lock 8 by 0.6cm which is equivalent to a flood around 40-45,000 ML/d)

2.3 Contribution of Darling River flows

Further examination of the natural flood events indicates that contributing flow from the Darling River during Summer-Autumn floods is variable. The Darling River flow can:

- contribute little flow as shown in Figure 7~~Figure 7~~ and Figure 8~~Figure 8~~;
- a reasonable proportion of the flow as shown in Figure 9~~Figure 9~~ and Figure 10~~Figure 10~~; or
- rarely contribute a large proportion to the Lock 8 flow as shown in Figure 11~~Figure 11~~.

In general, the contributing Darling River flow during Summer-Autumn becomes less significant as the event continues into Winter-Spring (the Darling flow very rarely exceeds 20,000 ML/d during Summer-Autumn under natural conditions). A typical example is shown in Figure 10~~Figure 10~~ where a flood is initiated in April 1977 with a reasonable proportion of flow from the Darling River until Winter-Spring when the proportion of Darling flow reduces to 30-50%.

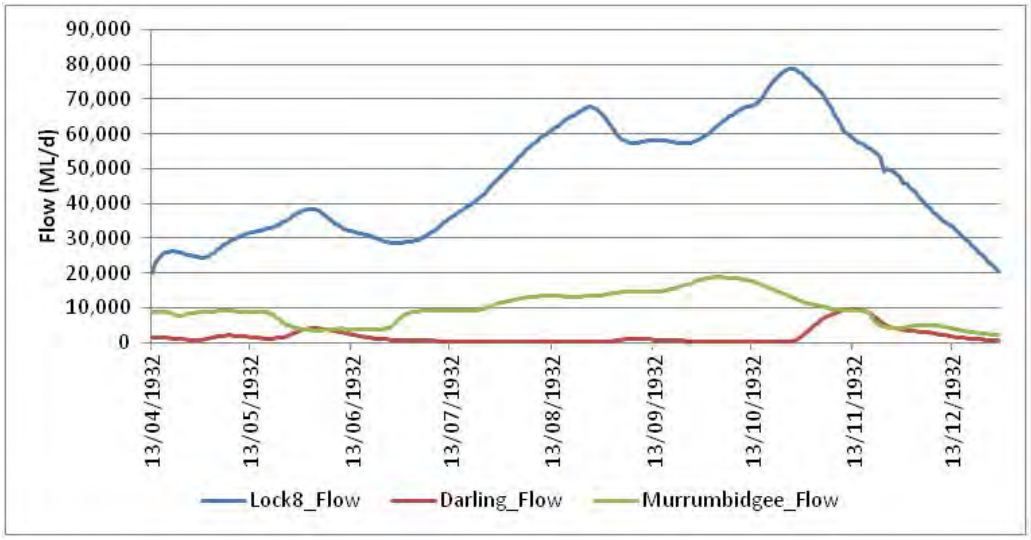

Figure 7 Example natural Autumn flood at Lock 8 (low Darling River flow)

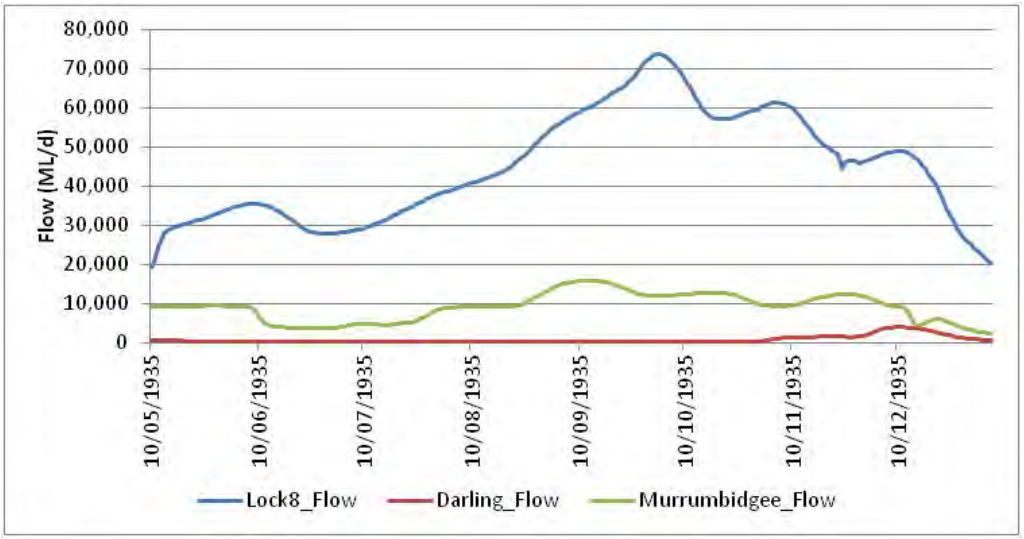

Figure 8 Example natural Autumn flood at Lock 8 (low Darling River flow)

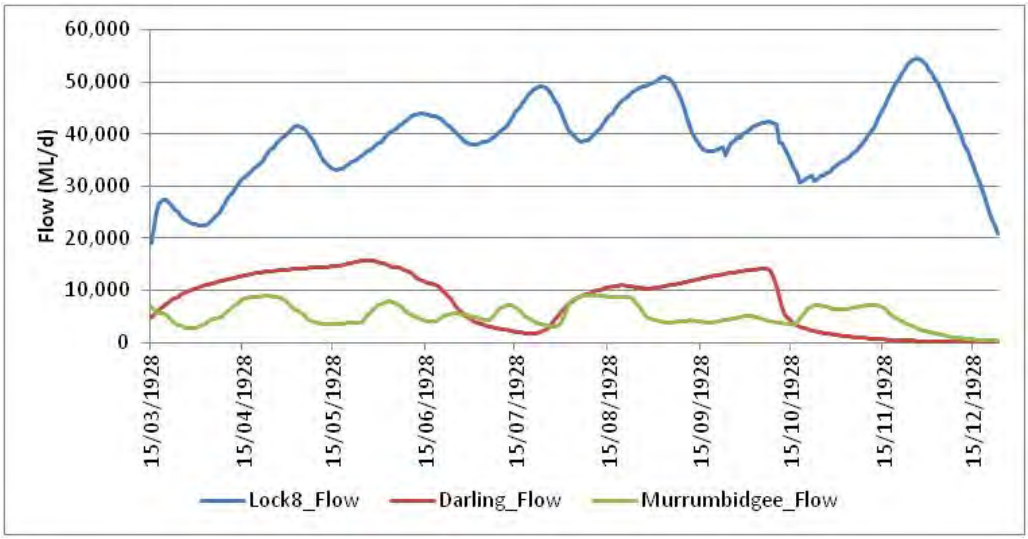

Figure 9 Example natural Autumn flood at Lock 8 (mid Darling River flow)

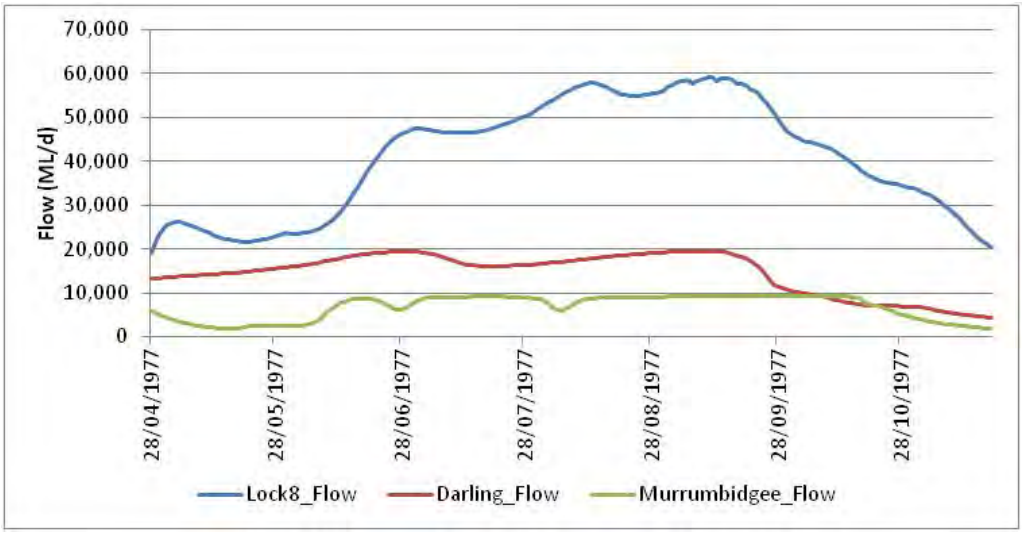

Figure 10 Example natural Autumn flood at Lock 8 (mid Darling River flow)

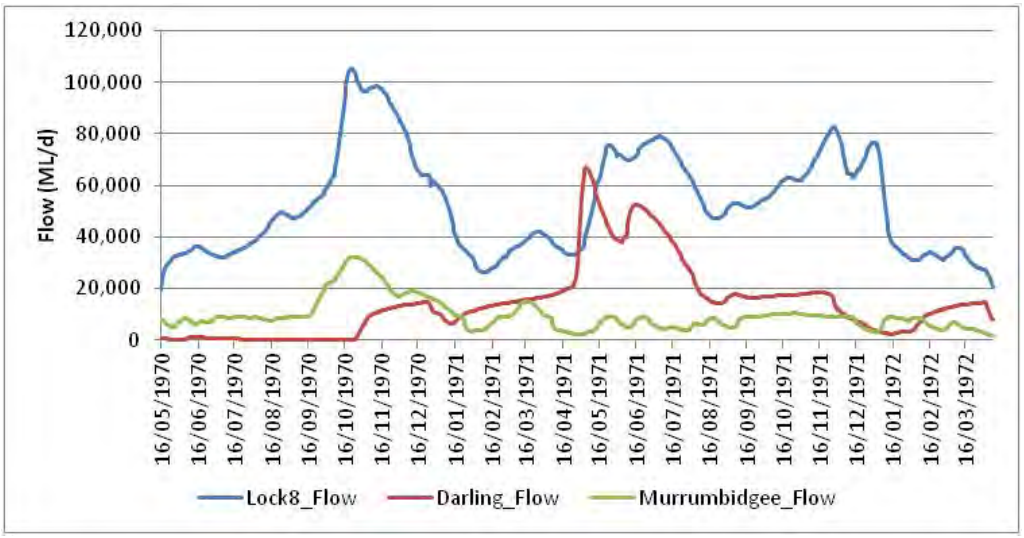

Figure 11 Example natural Autumn flood at Lock 8 (high Darling River flow in April 1971)

Plots of all flood events starting in Summer-Autumn for the natural and current model runs are included in the workbook 'Lock8_events_data xlsx' (MDBA Technical Reports Rept 2010-15).

Table 3* Average duration in days and average inter-flood period (years) for Lock 8 flood events

	Natural		Current	
Lock 8 Flow (ML/d) Commencing at:	Winter-Spring	Summer-Autumn	Winter-Spring	Summer-Autumn
20,000	199 (1.1)	288 (3.7)	111 (1.6)	211 (5.3)
25,000	193 (1.2)	278 (3.9)	113 (1.8)	205 (5.9)
30,000	178 (1.3)	287 (4.8)	107 (2.1)	182 (5.9)
35,000	162 (1.5)	254 (4.8)	97 (2.5)	184 (7.3)
40,000	144 (1.6)	221 (4.9)	91 (3.0)	160 (7.4)
45,000	134 (2.0)	195 (5.0)	83 (3.1)	153 (8.3)
50,000	130 (2.3)	179 (5.4)	81 (6.3)	132 (8.3)

* This data is based on the discrete flood events, which is described in section 2.2.

3 Conclusions

Key findings from the analysis of natural and current modelled flow at Lock 8 include:

- under modelled natural conditions the Potterwalkagee Creek would on average receive flows for about 6 months (200 days) every 12 months;
- under modelled natural conditions the highest median flows occur through Winter-Spring;
- flood events are rarely initiated in Summer-Autumn and have long inter-flood periods (approx. 5 years for floods exceeding 40,000 ML/d under natural conditions);
- flood events have longer durations when initiated in Summer-Autumn;
- flow from the Darling River may contribute a reasonable proportion initially to floods starting in Summer-Autumn but this relative contribution reduces as the event progresses through to Winter-Spring (Darling River flow very rarely contributes more than 20,000 ML/d to events starting in Summer-Autumn): and
- the modelled natural durations and inter-flood periods should be taken into consideration to determine operations of the works, which will aim to provide the natural variability of flows. By restoring natural flows it is expected to increase the health of the in-channel and floodplain ecosystems of the Lindsay-Wallpolla system.