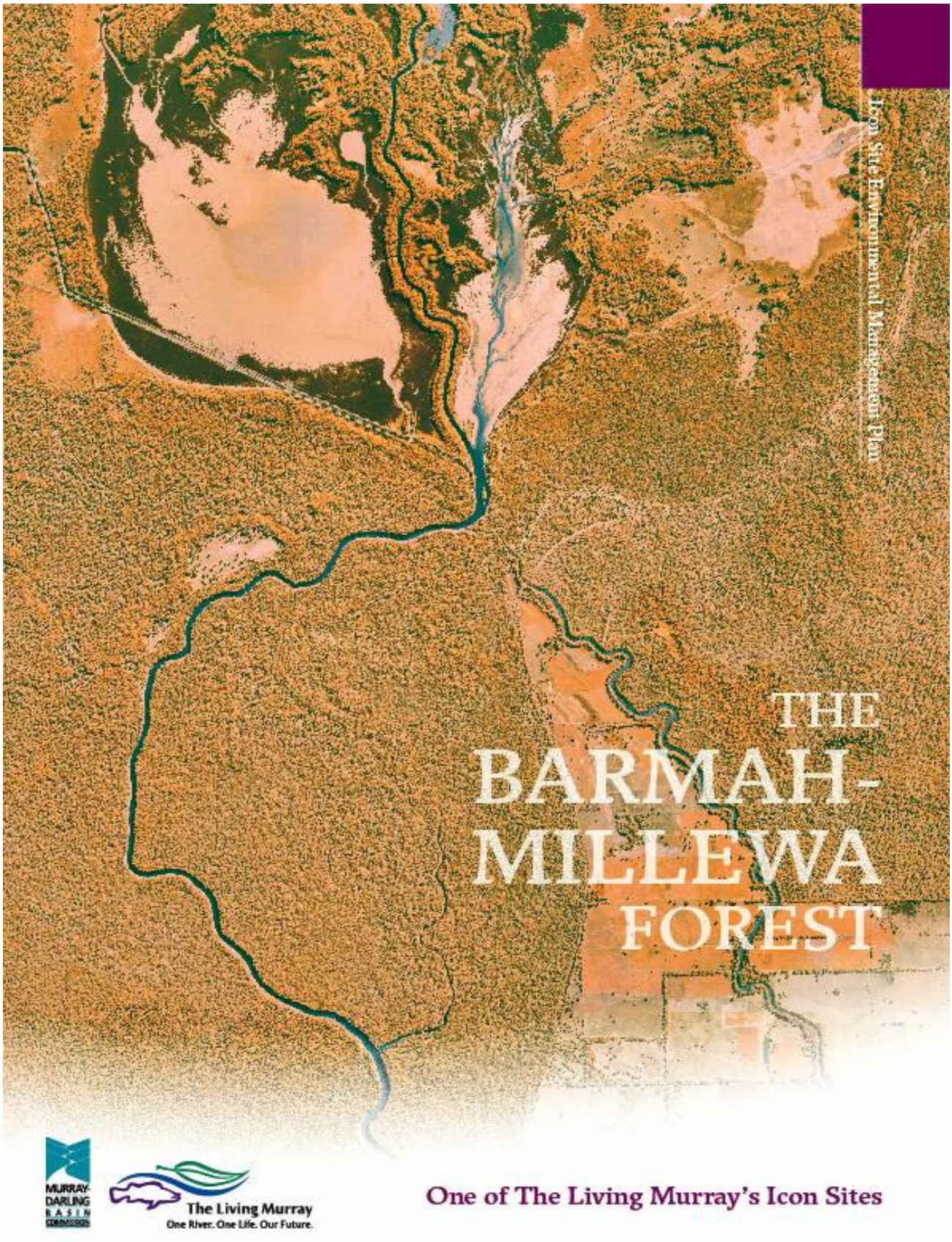

Interim Icon Site Environmental Management Plan 2007-2008

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Abbreviations and Acronyms

AEMP	Asset Environmental Management Plan, now Icon Site Environmental Management Plan
BM	Barmah-Millewa
CAMBA	China-Australia Migratory Birds Agreement
CRG	Consultation Reference Group
CC	Co-ordinating Committee
DEM	Digital Elevation Model
DSE	Department of Sustainability and Environment
EPBC	Environment Protection and Biodiversity Conservation (Act)
EWA	Environmental Water Allocation
EWMP	Environmental Works and Measures Program
FMP	Forest Management Plan
FNSW	Forests New South Wales
GBCMA	Goulburn Broken Catchment Management Authority
GIS	Geographic Information System
GL	Gigalitres (one thousand ML or one billion litres)
GMW	Goulburn-Murray Water
Ha	Hectares
Icon Site EMP	Icon Site Environmental Management Plan
JAMBA	Japan-Australia Migratory Birds Agreement
LCC	Land Conservation Council (now VEAC)
LMEWP	Living Murray Environmental Watering Plan
LIDAR	Light Detection and Ranging (= airborne laser scanning technology)
MDBC	Murray-Darling Basin Commission
ML	Megalitres (1 million litres)
MSM	Monthly Simulation Model (MDBC model of Murray River flows)
NSW	New South Wales
RCS	Regional Catchment Strategy
TAC	Technical Advisory Committee
TLM	The Living Murray
VEAC	Victorian Environmental Assessment Council

Glossary of Terms

Adaptive Management: Is a structured approach to the evaluation and solution of environmental management issues. It is also known as 'learning by doing' through carefully planned and monitored interventions that can lead to adoption of 'best practice'.

Asset Environmental Management Plan: See Icon Site Environmental Management Plan.

Benchmark condition: A starting condition from which subsequent measurements are compared or judged.

Consultation Reference Group: A group established by each Icon Site Manager and whose role is to provide the ICC with support on issues related to the development and implementation of the Icon Site EMP, to ensure that the community consultation process is open and transparent, and is based on the best information.

Control activities: Actions, procedures, operations or developments that are designed to treat an environment hazard or risk.

Control condition: Condition of an indicator from which other measurements subject to experimentation are compared or judged.

Coordinating Committee: A committee, comprising representatives from State and Commonwealth agencies, responsible for developing, implementing and improving the TLM Environmental Management Plan for each icon site.

Corrective action: A control activity that reduces the severity of an environmental problem once it is detected.

Current condition: The instantaneous status of an indicator.

Ecological character: The sum of the biological, physical and chemical components of the wetland ecosystem, and their interactions, which maintain the wetland and its products, functions and attributes.

Environmental aspects: Elements of an organisation's activities that interact, whether adversely or beneficially, with the environment.

Environmental condition indicator: An expression that provides information about the environment and, when measured periodically, demonstrates a trend.

Environmental criteria: Key values that an organisation wishes to maintain or enhance, and by which actions/aspects may be assessed. A criterion is characterised by a set of related indicators that are monitored periodically to assess change.

Environmental objective: The overall environmental goal that an organisation sets itself to achieve.

Environmental performance evaluation: Process to facilitate management decisions regarding an organisation's environmental performance by selecting indicators, collecting and analysing data, assessing information against environmental performance targets, reporting and communicating, and

periodically reviewing and improving this process.

Environmental performance target: A detailed performance requirement that needs to be set and met in order to achieve the objective set by an organisation.

Environmental water: Water that is available to the environment.

Environmental Watering Group (EWG): An advisory group that plays an important role in the governance of the icon sites. The group also prepares and keeps up to date the Living Murray Environmental Watering Plan and assesses whether the Icon Site EMPs are consistent with the watering plan. The EWG also act as the Icon Site Manager for the River Murray Channel.

Environmental Works and Measures Program: A $500 M program to complement the delivery of environmental water to icon sites and improve the health of the River Murray system.

First step decision: The initial actions outlined in the TLM initiative that aims to protect and improve the River Murray system, this includes achieving environmental objectives for six icon sites along the river.

Hypothesis testing: A method of investigation to demonstrate the truth or falseness of a theory or conceptual framework.

Icon Site (previously called a Significant Ecological Asset): A site of environmental importance in the Murray-Darling Basin where efforts to maximise environmental outcomes under the Living Murray Business Plan are being focused.

Icon Site Environmental Management Plan: A plan prepared under Section D of The Living Murray Business Plan to apply recovered environmental water, and to undertake other environmental works and measures, within an icon site in a way that maximises ecological outcomes.

Indigenous Coordinating Committee: A committee established to provide the Integrated Coordinating Committee with support on issues related to the development and implementation of the Icon Site EMP and to ensure the aspirations, interests and contributions of Indigenous people are recognised.

Inter-governmental Agreement: The Intergovernmental Agreement on Addressing Water Over allocation and Achieving Environmental Objectives in the Murray-Darling Basin between the Commonwealth of Australia and the Governments of New South Wales, Victoria, South Australia and the Australian Capital Territory, signed at the Council of Australian Governments meeting on 25 June 2004.

Jurisdictions: The Parties to the Intergovernmental Agreement, specifically the Commonwealth Government and the States, including New South Wales, Victoria, South Australia and Australian Capital Territory.

Living Murray Business Plan: The plan that describes how the actions and milestones in the Intergovernmental Agreement on Addressing Water Over allocation and Achieving Environmental Objectives in the Murray-Darling Basin are to be achieved.

Living Murray Environmental Watering Plan: A plan prepared under Section D of the Living

Murray Business Plan to apply recovered environmental water in a way that enhances ecological outcomes across six identified icon sites.

Monitoring: The periodic and systematic measurement and assessment of change of an indicator.

Montreal Process: A set of international criteria and indicators, developed from a seminar held in Montreal in 1993, which have been agreed at a National level for the sustainable management of forests.

Murray Darling Basin Agreement: The Murray-Darling Basin Initiative is a partnership between the Australian, New South Wales, Victorian, South Australian, Queensland and Australian Capital Territory governments and the community, established to give effect to the Murray-Darling Basin Agreement (MDB Agreement). The original agreement, signed by governments in 1917, was the 'River Murray Waters Agreement'. The agreement has been amended a number of times and the current agreement is the '1992 MDB Agreement'.

Murray Darling Basin Commission Office: The Office of the Murray Darling Basin Commission provides the Commission with support services necessary for administering the Murray Darling Basin Agreement and helping deliver the Commission's programs. This includes support for technical matters and policy formulation, and secretariat and administrative services to Ministerial Council, Commission, Project Boards and the various committees advising the Commission.

Murray Darling Basin Ministerial Council: Established in 1985, is the primary body responsible for providing the policy and direction needed to implement the Murray-Darling Basin Initiative. The Ministerial Council comprises the ministers responsible for land, water and environmental resources, within the contracting governments, and has the power to make decisions for the Basin as a whole. In relation to governance of the icon sites, it is the Council's responsibility to oversee the implementation of the MDB-IGA and the TLM Business Plan.

National Water Initiative: The Council of Australian Governments (COAG) in June 2004, agreed to the NWI to improve the security of water access entitlements, ensure ecosystem health, expand water trading and encourage water conservation the cities.

New e-water: Water recovered for the environment through investments made according to the Living Murray Business Plan.

Over allocation: Refers to situations where with full development of water access entitlements in a particular system, the total volume of water extracted by entitlement holders at a given time exceeds the environmentally sustainable level of extraction for that system.

Preventive action: A control activity that eliminates a serious environmental problem before it occurs.

Ramsar Convention: An international treaty dedicated to the conservation and 'wise use' of wetlands first signed in Ramsar, Iran, in 1971.

Reference condition: Condition representing a pristine or least-disturbed state from which other measurements are compared or judged.

Risk management: The ability to identify the legal constraints and risks to the implementation of the environmental management plans, along with actions to minimise these, including any assessment requirements for actions.

River Murray Water (RMW): A business unit of the Murray-Darling Basin Commission responsible for operating the River Murray system in accordance with the 1992 Murray-Darling Basin Agreement (MDB Agreement). RMW manages the River Murray system to ensure that the available water is continuously accounted for and distributed to NSW, VIC and SA in accordance with the MDB Agreement.

River regulation: Harnessing of the water resources of a river system, through a system of dams, weirs and barrages, to meet the water requirements of jurisdictions with minimum wastage.

Significant Ecological Asset: See icon site.

Statistical power: The probability that monitoring will detect important changes if they exist.

Technical Advisory Committee: A skills-based committee that provides technical advice to the Coordinating Committee with respect to the development and implementation of the Barmah-Millewa Icon Site EMP, including advice to ensure appropriate monitoring activities are co-ordinated across the site.

The Living Murray Committee: An advisory committee that will assist the Commission and its committees to implement the Living Murray initiative and the Living Murray Business Plan.

The Living Murray Initiative: One of the world's most significant river restoration programs funded by the Australian, New South Wales, Victorian, South Australian and Australian Capital Territory governments agreed to in response to evidence of the decline in the health of the River Murray system.

Trend: Trajectory that shows the direction and magnitude of change in the value of an indicator over time.

Value system: A framework that people use to assign importance and necessity to their beliefs and actions.

Acknowledgments

The Barmah-Millewa Forest Icon Site Environmental Management Plan has been prepared with the assistance from a large group of people who we would like to thank them for their valuable contribution.

The significant contribution of the Barmah-Millewa Forest Coordinating Committee and Technical Advisory Committee in directing and assisting with the production of the Icon Site Environmental Management Plan is acknowledged. The following agencies were represented on those two committees, Arthur Rylah Institute, Department of the Environment and Water Resources (formally known as Department of the Environment and Heritage), Department of Water and Energy (formally known as Department of Natural Resources), Department of Environment and Climate Change (formally known as Department of Conservation and Environment), Department of Primary Industries (incorporating Forests NSW), Department of Sustainability and Environment, Goulburn-Broken Catchment Management Authority, Goulburn Murray Water, Murray Catchment Management Authority, Murray-Darling Basin Commission and Parks Victoria.

We would also like to thank the Consultation Reference Group for their valuable feedback into the Icon Site Environmental Management Plan.

We would also like to acknowledge and thank the participants in the four workshops held to elicit views on the Icon Site Environmental Management Plan and those who put forward submissions.

Finally, the contribution of the Barmah-Millewa Forest Project Officer in collating and coordinating the production of the Icon Site Environmental Management Plan and organising the community consultation activities is acknowledged.

Executive Summary

In 2002, the Murray-Darling Basin Ministerial Council established The Living Murray program – a long-term program of collective actions aimed at returning the River Murray system to a healthy working river. The First Step decision under The Living Murray program aims to recover up to 500 GL per year (long-term average) of 'new' water over a period of five years to improve environmental flows and to achieve ecological objectives at six icons sites along the River Murray Barmah-Millewa Forest Icon Site being one of these.

The Barmah-Millewa Forest Icon Site Environmental Management Plan provides a framework for the delivery and management of environmental flows to achieve the ecological objectives. The delivery and management of environmental flows works the constraints of the current forest, river and water demands. The Barmah-Millewa Forest Icon Site EMP adopts an adaptive management approach (i.e. learning by doing). This Icon Site EMP has been developed in to ensure a consistent approach to planning and management across the icon sites and throughout the Murray Darling Basin. The management objectives that have been identified for the icon site align with the interim objectives of The Living Murray First Step decision, and the strategic delivery of available flows will be closely co-ordinated with River Murray Water management of the entire River Murray system. The Icon Site EMP complements the activities described in the land management plans implemented by the Department of Sustainability and Environment, Forests NSW and Parks Victoria (in their respective jurisdictions).

In the short term given the prediction of the continuing dry conditions, there are limited options to deliver and manage additional environmental flows for the ecological benefit of the icon site. However, there are still many activities that will be undertaken in the meantime, such as ongoing ecological monitoring, facilitating a wetland drying phase and progressing the environmental works and measures program.

This Icon Site EMP will be reviewed, reported and updated on an annual basis. It consists of three main sections:

- Part A – 'Strategic Overview' provides a summary of The Living Murray program and the governance arrangements for the icon site. It is expected that a detailed overview will be published by the Murray Darling Basin Commission outlining governance arrangements, costs, funding sources and adaptive management measures.
- Part B – 'Site Plan' is a three year rolling plan and describes the icon site, values, ecological objectives and targets, water requirements, potential threats and ameliorative measures, water

management options and community engagement.

- Part C – 'Annual Site Watering and Works Proposal' is driven by the seasonal outlook and includes an annual plan that outlines water management priorities, triggers for water application, environmental works and measures program and monitoring and reporting activities, works program and draft budget.

This Icon Site EMP is by no means finalised. It is the initial stage in an ongoing process of improvement, both in the development of the plan and in its implementation. Significant processes and procedures have been initiated, however substantially more work to develop them fully. In particular, the development of a suite of icon site-specific indicators and targets, and the means to monitor them is very much in its infancy. Similarly, the development of robust and inclusive consultation processes with the Indigenous community and the broader community at large that enable meaningful input into the planning process has only just commenced. These developments will be the focus of the effort and attention of the management committees in years to come.

Part A: Strategic Overview

1 Introduction

1.1 Overview of the Living Murray First Step Decision

In 2002, the Murray Darling Basin Ministerial Council established The Living Murray (TLM) Initiative in response to concerns about the declining health of the River Murray system. Throughout 2002 and 2003, significant work was undertaken to investigate the options for contributing to improving the health of the Murray River through the provision of additional water for the environment. This work included scientific, economic and social analysis together with consultation with communities. The initiative involves a number of collective actions to return the system to a healthy working river.

The vision of the Living Murray initiative is:

'*…a healthy River Murray system, sustaining communities and preserving unique values (March 2001).'*

On the 25th of June 2004, the Ministers of New South Wales, Victoria, South Australia, the Australian Capital Territory and the Commonwealth Governments signed the *Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray-Darling Basin* (MDB-IGA). This gave effect to their decision, made in August 2003 to commit $500M to the First Step of the Living Murray Initiative which aims to recover an average of up to 500 GL (500,000 ML) per year of 'new' water over five years. This aims to improve environmental flows and achieve ecological objectives at six icon sites along the River Murray.

The six icon sites (see Figure 1) that will benefit from the First Step are:

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

The MDB-IGA outlines each jurisdiction's roles and responsibilities for water recovery for environmental flows, and mandates the development of:

- the Living Murray Business Plan, which describes how the objectives of the Murray-Darling Basin Intergovernmental Agreement (MDB-IGA) are to be achieved, in particular the

milestones and water recovery targets, indicative volumetric targets and indicative financial commitments for each jurisdiction (provided for under Clause 13 of the MDB-IGA);

- the Living Murray Environmental Watering Plan, which provides a framework for managing environmental flows across the entire Murray Darling system;
- an Icon Site Environmental Management Plan (Icon Site EMP), identifying how environmental flows are to be delivered and managed at each icon site.

Figure 1: Location of the Icon Sites (Murray Darling Basin Commission)

2 Governance Arrangements

2.1 Overview

Each of the icon sites has in place arrangements for the management of land and water resources relevant to each site. These arrangements have been developed to meet objectives relating to regional, state, national and international programs and initiatives.

The governance arrangements specifically associated with the implementation of TLM Initiative is guided by the MDB-IGA. A double-layered governance structure works concurrently and dependently to ensure that the roles and responsibilities outlined in the MDB-IGA are achieved. This governance structure has two layers – the jurisdictional/Icon Site Manager and the Ministerial Council/MDBC.

Broader engagement and the consultation processes are required between committees and working groups. This is irrespective of whether they are jurisdictional, community-based or MDBC-led groups.

However the ultimate responsibility to ensure the icon sites are governed successfully lies with the Icon Site Managers who work in conjunction with a Coordinating Committee that is supported and guided by several committees and working groups. The members of which include jurisdictional staff, MDBC staff, community representatives, Indigenous community members and technical experts. The committees and working groups sit within a hierarchical structure, yet their primary aim is to enable the Icon Site Managers to successfully manage each icon site.

2.2 Icon Site Managers

Under the Living Murray Business Plan, each state has nominated an Icon Site Manager who will oversee the development and implementation of the Icon Site EMP, as well as undertake appropriate consultation for their state's section of the site. Where an icon site crosses state boundaries, the relevant Icon Site Managers will develop the single Icon Site EMP for the entire icon site and carry out consultation in a coordinated way.

Icon Site Managers are also responsible for carrying out community consultation in a coordinated manner and ensuring Indigenous engagement respects the jurisdiction's legislation, other agreements and related processes.

2.3 Coordinating Committee

The Coordinating Committee's (CC) main role is to oversee the development, implementation and consultation of the Icon Site EMPs. It also monitors and reports the performance of the activities carried out under the EMPs to the Environmental Watering Group. The lead Icon Site Manager is the chairperson of each CC and it is their responsibility to bring the interests of the jurisdictions to the CC for discussion.

The main functions of the Coordinating Committee include:

- advising the Icon Site Manager on issues relating to the icon site;
- assisting in the development, review and implementation of the Icon Site EMP on behalf of the lead Icon Site Manager;
- advising the lead Icon Site Manager on coordinating technical advice;
- formulation of Terms of Reference for the Technical Advisory Committee and Consultation

Reference Group;

- reviewing of interim ecological objectives;
- determining the Project Officers activities and responsibilities; and
- providing assistance to the Icon Site Managers in reporting requirements to the MDBC.

It is anticipated that the CC will meet at least twice each year to review the plan, review the performance of the previous Annual Environmental Watering Plan (EWP) and to prepare the upcoming Annual Site Watering and Works Proposal. These meetings should also provide an opportunity for site inspections and discussion about the adaptive management of the Environmental Water Allocations.

2.4 Technical Advisory Committee

The TLM Business Plan does not outline a requirement for Icon Site Managers to establish a Technical Advisory Committee (TAC), however, it does state that part of the management role includes ensuring the necessary technical advice is obtained (Clause 92). The TAC can provide technical advice to the CC with respect to the development and implementation of the coordinated Icon Site EMP, including advice to ensure appropriate monitoring activities are coordinated across the icon site.

2.5 Indigenous Reference Group

Indigenous communities have spiritual and cultural connections to their country and want to be actively involved in the conservation and management of natural resources to ensure appropriate protection and perpetuation of their cultural heritage. In the development of the Icon Site EMPs, input from Indigenous communities has been sought to ensure the aspirations, interests and contributions of Indigenous people are recognised. Consultation with Indigenous people will take an inclusive approach by giving appropriate respect to the knowledge and views of traditional owners.

Involvement of all Indigenous communities with an interest in each icon site will be sought for all aspects of development and implementation of the EMP. An Indigenous Reference Group (IRG) will be established to provide the Integrated Coordinating Committee with support on issues related to the development and implementation of the Icon Site EMP.

The formation of the IRG will include members from all interested Indigenous community groups, including Indigenous Nations and other relevant groups such as Local Aboriginal Land Councils. This

will ensure that existing arrangements and statutory responsibilities are accounted for.

2.6 Consultation Reference Group

As set out in clause 135 of the Living Murray Business Plan, Icon Site Managers will establish an inclusive Consultation Reference Group for each icon site.

The CRG will be established to provide the CC with support on issues related to the development and implementation of each Icon Site EMP to ensure that the community consultation process is open and transparent, and is based on the best information.

The main functions of the CRG are:

- to provide community advice to the CC with respect to the development and implementation of the coordinated Icon Site EMP; and
- to provide advice on consultation with regional and local groups that have an interest in the management of each site.

Membership of the CRG has been determined based on being able to demonstrate the following attributes:

- spiritual, social, economic or environmental connection to each icon site;
- involvement in community groups with an interest in each icon site;
- experiences and/or skills in leadership, negotiation, community consultation and communication; and
- knowledge or experience in water, wetland and/or forest management.

The role of Chairperson of the CRG will be alternated annually between the Murray Catchment Management Authority and the Goulburn-Broken Catchment Management Authority.

2.7 Project Officers

Project Officers are housed by, and report to, the CMAs, however their activities are directed by the Icon Site Managers. Project Officers are often ex-officio members of the CC, TAC and/or CRG and assist the Icon Site Managers with the planning and implementation of the Icon Site EMP.

Part B: Site Plan

3 Icon Site Description

3.1 Area, tenure and land management

The Barmah-Millewa Forest Icon Site is a River Red-gumRiver Red-gum (*Eucalyptus camaldulensis*) dominated floodplain covering 66,600 ha, located approximately between the townships of Tocumwal, Deniliquin and Echuca (see Figure 2). It includes Barmah Forest in Victoria and the Millewa Group of Forests in New South Wales (including Moira Forest, Gulpa Island and Millewa Forest).

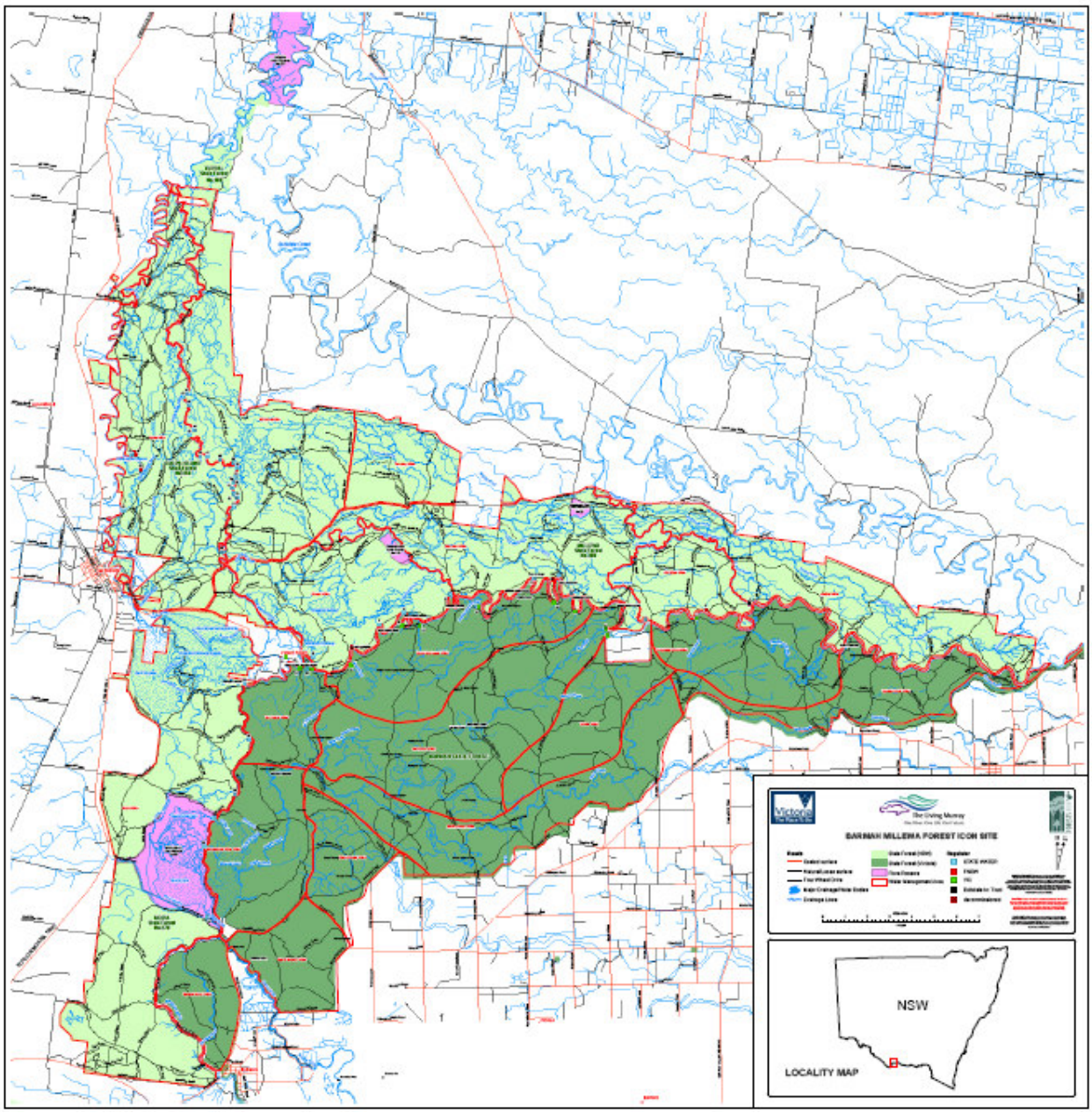


Figure 2: Barmah-Millewa Forest Icon Site with water management area boundaries

The Barmah Forest, covering approximately 28,500 ha, is predominantly state forest, managed by the Department of Sustainability and Environment under the Mid Murray Forest Management Plan (NRE 2002). There is also a significant area of state park (including two reference areas) and Murray River Reserve, managed by Parks Victoria under the provisions of the Barmah State Park and Barmah State Forest Management Plan (DCE 1992).

The Millewa group of forests covers approximately 38,100 ha and incorporate the Millewa, Moira, Gulpa Island and Tuppal State Forests. The Millewa group is managed by Forests NSW, a trading arm

of the NSW Department of Primary Industries, under the Murray Management Area Management Plan (FCNSW 1987). A number of flora and fauna reserves of varying sizes also occur across the Millewa group of forests (See Appendix A and Appendix B).

The State Forest and Barmah State Park boundaries above also represent the boundaries of the forests' respective Ramsar listings, with the exception of Ulupna Island section of the State Park.

The development of an environmental management plan for Barmah-Millewa Forest cannot and is not intended to, affect or diminish any existing private rights to own or occupy land within the region covered by the Icon Site Environmental Management Plan, or the way in which such land is used in future (MDBC 2005a).

3.2 The Cadell Tilt and Barmah Choke

Approximately 25,000 years ago, an earth movement in the southern Murray-Darling Basin resulted in the tilting of Cadell Block to the west and the eastern edge rose between 8 and 12m. This uplift of land created what is now known as the Cadell Fault. The Cadell Fault runs roughly from Deniliquin to Echuca. It eventually changed the course, pattern and character of the River Murray about 500 km (Rutherford 1990).

The newly formed Cadell Fault stopped the River Murray from flowing into the Goulburn River (north of Echuca) causing the River Murray to flow into a slight depression North East of Echuca. This abandoned riverbed is still visible and is known as Green Gully. Around 8000 years ago the River Murray turned south, breaking through the section between Picnic Point and Barmah, and took over the Goulburn channel downstream of Echuca establishing a new course to become as we know it today. The section where the Murray cut through to the Goulburn channel is today known as the Barmah Choke or The Narrows because of its limited capacity to carry flows (Rutherford 1990).

During major floods, large volumes of water are temporarily banked up behind the Barmah Choke. This reduces the height of flood peaks downstream, and floods the former lake area. The regular flooding has created a wetland now known as the Barmah-Millewa Forests, the largest area of red gum forest in Australia. These forests contain flora and fauna that would be typical of a region which receives two or three times more rainfall than it does (Rutherford 1990).

3.3 Soil Characteristics

Barmah-Millewa Forest soils are dominated by both recent and relict alluvial systems which have deposited sands, silts and clays over thousands of years. Soil types are able to be predicted based on vegetation species indicators (Davey and Wild 2005).

The floodplains and low lying areas are dominated with poorly drained grey alluvial soils which are frequently inundated. Localised wind-blown sand dunes occur sporadically through-out the forest, and are associated with better drainage and sand-dune vegetation species. On the outer edges of the floodplain, some heavier cracking clay soils occur, and these can be associated with mixed River Red-gum forest and Black-box forests (Davey and Wild 2005).

3.4 Vegetation communities and associated habitat values

Barmah-Millewa Forest vegetation communities can be broadly grouped into River Red-gum forests, Moira Grass plains, wetlands and lakes, Black Box and Grey Box forest and watercourses (see Appendix A and Appendix B for a complete of species).

River Red-gum forests generally grow on a lower elevation close to water and are characteristically 20-35m tall and closely spaced as a result of the increased flooding frequency. The understorey is comprised of herbaceous plants, including perennials, annuals (grasses) and post flooding ephemerals (Smith and Smith 1990).

Open Moira Grass plains fringed with Giant Rush and River Red-gum forests, when flooded, these are highly significant as breeding and feeding habitat for colonial breeding waterbirds like Egrets, Herons, Spoonbills and Marsh terns (Smith and Smith 1990).

Wetlands and lakes contain submerged and semi-submerged aquatic vegetation and are surrounded by Giant Rush which pond water for varying lengths of time. These areas provide suitable habitat for fish waterbirds and frogs (DSE 2005 and GBCMA 2005).

Black Box and Grey Box vegetation grows on the margins of the floodplains, with limited exposure to prolonged flooding, (growing from 5m to 20m tall). The understorey is dominated by daisies, grasses and saltbushes (Bren 1990).

Watercourses occur throughout the forest, which are important for connectivity, distribution of water, fish movement and aquatic plant growth. They also sustainlarge red gums along the banks which are utilised by birds for roosting and nesting (DSE 2005 and GBCMA 2005).

3.5 Hydrology and water management

Barmah-Millewa Forest has an intricate arrangement of inflow sources and drainage routes which is governed by flow in the River Murray (i.e. regularity, extent, duration and season of flooding). Relatively small changes in topography influence distribution and depth of flooding. Water passes over the forest floor as sheet flow in large floods and 'in creek' flow during smaller flood events. Surface flooding restores soil moisture reserves necessary for tree growth and sustains large wetland habitats.

Underground water sources also contribute to forest water demands but these systems (underlying sandy aquifers of prior stream origin) generally only influence localised areas. Their ecological significance is secondary to overland flooding.

3.6 Water Management Areas

To a degree Barmah-Millewa Forest can be managed as separate water management areas (see Figure 2). They have been differently identified by the ability to deliver water via channels and regulators. However this management technique does not provide full connectivity with the River Murray and is the used only when water is limited (DSE and GBCMA 2005). As flood magnitude increases, ability to manage the forest in this way decreases.

Water Management Areas (WMA) delineate areas of the forest where points of inflow and outflow best segregate one section of the forest from another. However, they are not discrete areas, as water usually passes from one WMA to the next via creeks and surface floods (Barmah-Millewa Forum 2004).

3.7 Water management infrastructure

In excess of 50 water management structures are currently present throughout the Barmah-Millewa Forest. Water management structures differ in purpose and design and can be broadly categorised into the following two types:

- Primary regulating structures (regulators with a discharge capacity generally >100 ML/day) occur in anabranch streams near their exit point from the River Murray, Edward River and Gulpa Creek. The main purposes of these structures are to maintain regulated flows within stream and to permit river freshes and floods passing into the forest.

- Secondary and tertiary regulating structures are commonly situated in drainage features within the interior portions of Barmah-Millewa Forest. Examples include pipes, culverts and regulators with discharge capacities generally <100 ML/day and earthen banks. The main purposes of these structures are to manipulate water distribution and depth within localised areas, and provide vehicle access. They are overtopped or outflanked during large floods.

Most of the large structures were built in the late 1930s following regulation of the Murray River (i.e. construction and operation of weirs, dams and other regulators for diversions from the river system) and to control subsequent summer wetland system flooding. Within the last decade, many smaller structures were constructed to permit flow into previously blocked flow paths or in areas where improved water management for the wetland system had been identified (DSE and GBCMA 2005).

3.8 Values

The Living Murray program aims to return the River Murray to a healthy working system. The program recognises the river and its environments as a working system currently delivering extensive environmental, social, cultural and economic benefits to the community.

Barmah-Millewa Forest, one of the icon sites, has long been recognised as having high environmental, cultural, social and economic values at a range of scales i.e. local, regional, state, Murray Darling Basin, national and international (Abel and O'Connell 2006). Failure to address ecological degradation threatens these intrinsically values and the communities that depend on them.

Recognising values helps focus decision making to ensure that:

- a working system approach is adopted;
- appropriate persons and communities are engaged, and;
- values are maintained or improved.

3.8.1 Environmental

Barmah-Millewa Forest provides habitat for numerous threatened plant and animal species (see Appendices A and B), including birds, fish and reptiles and supports waterbird colonies during appropriate breeding conditions (MDBC 2004a).

All of Barmah Forest and defined wetlands in Millewa Forests (as part of the NSW Central Murray State Forests) are listed on the Ramsar list of designated Wetlands of International Importance, which was established in response to Article 2.1 of the Convention on Wetlands (Ramsar, Iran, 1971). The Ramsar listing recognises that the Barmah-Millewa Forest (SFNSW 2002, NSW NPWS 2002 and

DSE 2003):

- contains representative, rare or unique examples of wetland types within the biogeographical region;
- supports vulnerable, endangered and critically endangered species and threatened ecological communities;
- supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions;
- vegetation corridor through the agricultural landscape;
- regularly supports 20,000 or more waterbirds; and
- important food source for fish, spawning ground, nursery and/or migration path on which fish populations (either within wetlands or creeks) depend.

A total of three bird species listed under the Japan-Australia Migratory Birds Agreement (JAMBA) and six species listed under the China-Australia Migratory Birds Agreement (CAMBA) have been recorded at Barmah-Millewa Forest (see Appendix B). Barmah-Millewa Forest contains 23 species listed under the Bonn Convention on the Conservation of Migratory Species (DSE and GBCMA 2005).

Functions of Barmah-Millewa Forest include organic carbon storage, water supply, groundwater recharge, maintenance of flow regimes and flood control. For example, Barmah Forest alone forms a natural flood retardation basin with an estimated holding capacity of 32,100 ML (DSE and GBCMA 2005).

3.8.2 Cultural and Social

Barmah-Millewa Forest is listed on the Register of the National Estate in recognition of its importance as part of Australia's heritage and outstanding natural values. There are important and significant land associations and connections to Barmah-Millewa Forest amongst Indigenous peoples and the broader community (MDBC, 2004a) and the forest consequently contains a cultural landscape that reflects both Indigenous and European activities. Evidence of Aboriginal occupation of Barmah-Millewa Forest occurs before and after European settlement. Aboriginal cultural heritage consists of spiritual sites such as specific areas that feature in dreaming stories, oral histories, events and traditions that are linked with the land.

Physical evidence of Aboriginal land use includes but not restricted to, carved trees, scarred trees, occupation sites (e.g. scatters of stone artefacts from cooking), art sites, meeting sites, ceremonial

sites, cultural places (e.g. where natural features hold a spiritual significance), sites of historic importance, burial grounds and cemeteries. The potential to improve the ecological character of the Barmah-Millewa Forest will provide opportunities for extension of Aboriginal practices such as trade between Nations.

In the past and present Baramh-Millewa Forest provides a source of plants and animals used as food, fibre, fire, ceremonial purposes, medicinal uses and men's and woman's business. Today, as in the past the Barmah-Millewa Forest provides the Aboriginal community a place to continue cultural practices performed for tens of thousands of years.

The range of non-Indigenous historic places in the forest reflects a number of different phases of European activity in the area. Relics of early European settlement are scattered around the forest, however, most of the historical value is in the events that took place and the effect they had rather than what remains (DSE and GBCMA 2005). Less tangible are the connections to the Forest of those that live near or visit the area for a multitude of reasons. People living in the area express a strong affinity for the Forest from both aesthetic and cultural perspectives. Others not directly connected to the area support its 'existence value' as part of the mosaic of environments across different scales.

Barmah-Millewa Forest is popular for recreation and tourism with the majority of visitors attracted to the river environments. Approximately 100,000 people visit Barmah Forest per year with a high proportion of these involved in tourism and recreational activities (Abel and O'Connell 2006). These activities include boating, fishing, scenic driving, 4WD driving, trail bike riding, cycling, horse riding and bushwalking are popular. Orienteering, picnicking, camping, canoeing, bait collection, duck shooting, firewood provision and hunting of feral animals in Barmah Forest (firearm restrictions apply in Millewa Forests), and nature studies are also undertaken. Bird watching is popular within Barmah-Millewa Forest and the Reed Beds Swamp bird hide provides an ideal viewing platform. Interpretive cruises of the lakes and forest highlight the abundant birdlife along with the ecology and history of the Barmah-Millewa Forest.

3.8.3 Economic

The components, functions and attributes of Barmah-Millewa Forest provide a variety of direct and indirect economic values to the area. Direct economic values derive from timber production (revenue from forest products from Barmah Forest in 2000/01 was approximately $23,2000 which is about 0.3% of the Victorian revenue from forest products), domestic stock grazing (with an average of 1,110 cattle the annual value to cattle producers in Barmah Forest is about $56,500), apiculture, and recreation and tourism (Abel and O'Connell 2006). In contrast, the natural functions of Barmah-

Millewa Forest have important indirect measurable values that support or protect economic activities that have direct measurable values. The indirect economic values provided by Barmah-Millewa Forest include flood and flow control, nutrient retention and water quality maintenance.

An Economic Evaluation of Barmah Forest Wetlands using a Contingent Valuation Method revealed that the forest's wetlands were valued by the community in 1991 at between $76.9 and $97.5 million (Stone, 1991 cited in DSE and GBCMA 2005).

4 Objectives and Targets

4.1 The Living Murray interim ecological objectives for Barmah-Millewa Icon Site

As part of The First Step decision for The Living Murray program, the Murray-Darling Basin Ministerial Council set interim ecological objectives (that is, desired results) and expected outcomes for each of the six icon sites (MDBC, 2003). For the Barmah-Millewa Icon Site, the interim ecological objective is to enhance forest, fish and wildlife values, ensuring (MDBC 2003):

- successful breeding of thousands of colonial waterbirds in at least three years in ten; and
- healthy vegetation in at least 55%[1] of the area of the forest (including virtually all of the Giant rush, Moira grass, River red gum forest, and some River red gum woodland).

Monitoring, works and flow regimes have therefore been developed so as to contribute to the ecological objectives.

4.2 Refined ecological objectives

In developing the Icon Site Environmental Management Plan, the Coordinating Committee has reviewed and refined the interim ecological objectives. The ecological objectives developed for the Barmah-Millewa Forest are complimentary to the objectives outlined in other initiatives such as the Native Fish Strategy (MDBC 2003-2013), National and State threatened species recovery plans (see Appendix F) and others.

[1] With the current availability of environmental water this target should be met. It is hoped however that as more environmental water becomes available a greater percentage could be achieved. Flooding regimes will take watering requirements of the vegation communities into account.

The International Ramsar vision, *'to maintain and, where practicable, enhance ecological character[2] of the floodplain'* is considered the pre-eminent legal obligation and over-arching objective for the Barmah-Millewa Forest Icon Site. In line with this vision, and encapsulating the importance of the Forest as a food source for fish, spawning ground, nursery and/or migration path on which fish populations (either within wetlands or creeks) depend, the refined ecological objectives for Barmah-Millewa Forest Icon Site are listed below.

- Promote healthy and diverse vegetation communities, with an emphasis on restoring natural extent and distribution of Giant Rush, Moira Grass, River Red Gum forest and River Red-gum woodland in at least 55% of the area of Barmah-Millewa Forest.

- Promote and/or sustain successful breeding events of multiple thousands of colonial and migratory waterbirds in at least three years in ten, by inundating selected floodplain and wetland areas to provide suitable nesting and feeding habitat.

- Promote successful recruitment of native fish species by improving flow variability in spring and early summer to replicate natural cues, and by inundation of floodplain and wetland areas to provide breeding and nursery habitat.

The management actions and flow regimes required to promote and/or facilitate each individual ecological objective will be considered in combination to ensure the timing of actions to achieve one ecological objective are mutually beneficial or at least do not negatively affect other objectives or other icon sites.

The strategies to achieve the objectives will be developed over the next three years. This process will be greatly facilitated by the soon to be completed hydraulic model of Barmah-Millewa Forest.

4.3 Developing and reviewing icon site ecological objectives and targets

Ecological objectives (i.e. overall goals of the Icon Site EMP) and targets (i.e. desired outcomes of specific management actions against which progress can be measured toward objectives) will be re-investigated and refined over the coming years in conjunction with adaptive management principles

[2] The "ecological character" is the structure and inter-relationships between the biological, chemical, and physical components of the wetland. These derive from the interactions of individual processes, functions, attributes and values of the ecosystem(s).

and advances in knowledge.

Additional areas identified for development of ecological objectives are listed below. These reflect interests communicated by the community and technical experts during consultation. Further work will be undertaken to formulate ecological objectives for these areas and to seek support from The Living Murray Committee for their inclusion in the Icon Site Environmental Management Plan. In the meantime, the Coordinating Committee will look at ways to synergise Living Murray activities to contribute positively to these areas, and partner organisations will be encouraged to identify alternative funding arrangements where possible. The additional aims are:

- Facilitate successful breeding and feeding opportunities for native frog species by seasonal inundation of selected floodplain and wetland areas for appropriate season and duration as required for each species.

- Facilitate healthy and diverse vegetation to provide suitable, breeding and foraging habitat for a diverse range of waterbirds and bush birds.

- Facilitate successful breeding of native turtle species by inundation of selected floodplains and wetland areas to provide suitable breeding and nursery habitat.

- Facilitate appropriate management to ensure the sustainability of Crayfish populations.

- Facilitate appropriate management measures to control the abundance and spread of invasive aquatic species.

- Facilitate appropriate geomorphology management in selected waterways.

The Technical Advisory Committee will develop targets for the icon site, and will review the objectives on an annual basis. This will be done with input from the community via the Community Reference Group and the Indigenous consultation process.

5 Water Requirements

5.1 Flooding regimes

Figure 3 shows the current average monthly flows downstream of Yarrawonga compared with what would have occurred under natural conditions between the year 1891 and 2000. This effectively illustrates recent flooding history during that period in Barmah-Millewa Forest.

A combination of natural and EWA floods have occurred during the last 10 years (2000 and 2005), there have been three long, medium-sized floods (the floods in 1996, 2000/01 and the 2005/06 EWA release lasting approximately 4 months) capable of inundating around 50% of Barmah-Millewa Forest. The flooding regimes takes into account many different factors, these include climatic conditions, seasonality, recent rainfall locally and in the catchments, irrigation requirements and water availability. These long lasting, medium-sized floods are suitable for maintenance of many sedges, rush beds and wetlands, large areas of Moira GrassMoira Grass plains and meadows and some River Red-gum forests. There have been additional instances of over bank flow during that period, however, these have not been sufficient to meet the requirements for the long, medium flood targeted by the existing Barmah-Millewa Forest EWA.

NATURAL CONDITIONS (average monthly flow, ML/day)

YEAR (June)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1891											6,200	9,900
1892	41,100	26,100	19,300	17,000	16,200	9,600	5,400	3,000	2,500	3,200	6,700	16,300
1893	18,300	17,500	31,100	31,200	41,600	14,400	5,900	3,000	3,000	3,300	5,900	32,200
1894	33,800	31,000	47,000	56,000	26,500	10,800	14,200	5,300	6,100	11,500	10,600	30,100
1895	50,400	55,100	67,600	63,100	34,700	13,900	9,000	5,800	5,000	4,700	7,200	14,000
1896	20,000	17,600	51,500	25,900	10,000	7,200	3,900	3,500	4,000	7,500	10,200	7,500
1897	16,600	8,400	21,400	18,400	9,000	6,500	10,700	7,100	4,800	3,100	2,700	4,300
1898	12,100	15,900	31,300	24,600	10,800	4,600	2,400	5,300	3,100	3,400	4,800	15,400
1899	11,100	24,400	26,300	18,600	26,100	9,000	4,900	3,300	4,100	8,900	7,300	18,400
1900	21,600	17,200	13,000	13,100	9,900	4,600	3,100	2,000	5,600	12,800	11,700	14,800
1901	28,000	27,200	38,800	26,600	13,200	6,000	3,100	1,700	1,600	1,900	3,900	7,900
1902	5,600	11,100	33,000	25,700	24,700	5,400	3,400	1,700	1,400	2,300	1,400	6,400
1903	6,600	3,000	4,900	8,700	3,000	3,700	2,200	900	1,500	3,100	5,200	8,700
1904	21,700	12,000	22,200	24,800	13,700	6,800	8,400	4,200	2,800	2,000	4,100	8,900
1905	24,800	21,400	28,300	32,000	26,200	7,300	3,300	2,000	1,300	2,100	2,600	11,500
1906	47,100	28,400	21,000	26,300	30,700	12,500	4,000	1,700	8,600	6,600	13,300	27,200
1907	52,500	46,300	51,000	67,100	27,000	22,600	8,900	4,800	3,000	3,600	6,200	8,900
1908	7,900	23,700	17,100	18,600	15,100	7,500	4,800	2,700	2,000	1,800	3,900	7,000
1909	11,500	12,800	24,200	25,300	12,400	4,400	2,100	1,700	3,200	3,100	17,400	32,900
1910	38,600	68,900	37,100	26,500	12,400	5,600	3,000	2,100	2,000	1,700	2,700	5,600
1911	15,300	11,900	42,000	29,300	19,800	14,000	8,900	14,800	15,200	8,000	7,300	26,900
1912	27,300	29,000	18,900	13,200	7,100	5,400	3,000	1,700	1,500	2,000	1,700	2,900
1913	12,100	10,300	44,300	25,800	15,400	19,900	9,000	3,400	7,700	7,500	7,400	9,700
1914	10,500	17,100	21,000	22,900	17,000	7,400	3,400	2,200	2,100	3,300	7,500	5,800
1915	7,100	6,500	7,400	4,200	1,400	2,400	1,700	800	500	700	3,800	9,000
1916	32,600	42,200	32,500	52,800	27,700	9,400	4,100	3,500	3,100	2,500	4,100	7,500
1917	40,900	38,300	50,100	55,900	52,200	41,700	14,000	7,700	7,100	8,300	19,400	84,100
1918	71,400	75,700	96,500	119,300	58,400	29,600	12,700	10,400	9,000	7,100	34,400	32,800
1919	45,300	47,000	45,500	22,600	13,600	7,100	4,100	2,900	4,300	3,700	5,900	12,300
1920	11,800	12,000	19,200	19,500	7,500	5,600	12,600	4,600	3,000	2,800	4,000	12,500
1921	43,200	48,100	55,400	30,900	18,700	9,500	7,600	4,300	4,800	5,500	4,000	20,000
1922	18,100	52,800	65,000	47,900	18,700	8,400	5,200	3,200	3,000	2,400	5,100	4,000
1923	17,200	20,300	18,500	22,500	11,100	4,100	3,200	1,700	1,000	1,100	4,900	36,300
1924	34,400	32,500	27,900	49,400	31,200	17,700	13,800	10,800	7,600	9,600	7,800	15,800
1925	11,400	23,200	52,700	44,100	42,800	20,300	15,200	11,600	7,200	5,100	6,800	9,500
1926	12,000	24,100	28,000	25,400	14,700	5,700	3,100	1,600	3,000	4,500	25,500	22,300
1927	37,200	49,000	37,500	36,500	15,600	7,400	5,800	2,700	2,200	2,000	3,800	5,500
1928	12,300	23,800	19,100	28,900	16,600	6,000	3,000	6,600	6,700	13,000	12,200	24,900
1929	20,000	14,600	16,500	41,200	19,300	6,100	2,700	2,700	2,200	5,900	6,300	13,600
1930	12,100	17,800	21,600	30,100	13,000	8,400	6,500	2,400	1,700	1,600	5,900	6,200
1931	7,900	21,400	19,300	45,700	25,400	16,900	16,300	6,300	10,600	13,100	28,900	79,200
1932	87,300	58,800	52,800	36,600	24,800	10,700	4,100	2,900	5,300	20,400	10,100	21,800
1933	31,300	22,400	61,000	25,800	16,100	6,900	3,500	2,300	1,600	2,000	3,600	7,300
1934	19,200	14,700	45,000	29,300	9,800	15,600	12,900	5,400	4,700	7,200	6,300	4,300
1935	20,800	28,000	28,100	53,000	62,900	33,400	11,500	7,600	5,000	10,400	14,900	14,200
1936	25,500	45,900	39,600	29,900	21,000	10,100	7,300	4,200	4,600	4,800	4,600	6,900
1937	24,700	59,200	44,400	21,500	14,900	14,100	9,700	5,800	4,100	3,100	4,200	4,900
1938	4,900	8,000	24,600	18,700	8,900	4,400	2,900	2,300	1,900	1,900	3,400	5,100
1939	8,400	7,600	13,800	8,400	3,500	1,500	800	800	19,600	22,100	16,900	20,900
1940	48,500	56,600	68,700	49,600	44,900	16,900	6,900	3,500	2,300	3,900	6,000	6,600
1941	6,200	8,700	11,000	8,600	4,600	3,800	10,400	5,000	5,600	4,600	3,100	5,300
1942	14,300	9,200	12,100	19,900	8,800	4,200	2,300	1,900	1,300	1,700	13,500	25,000
1943	55,600	33,700	51,300	34,900	20,200	9,900	5,500	3,100	2,200	7,200	7,900	6,900
1944	14,500	19,700	26,000	34,800	17,500	7,500	2,900	1,600	1,500	1,900	8,800	9,100
1945	10,200	7,100	5,700	6,400	4,700	2,400	1,800	2,500	1,400	1,800	1,700	4,900
1946	7,200	21,100	25,400	13,700	18,900	5,200	2,300	4,300	9,500	7,600	5,500	10,000
1947	43,000	59,500	25,700	23,900	18,800	8,300	4,800	2,800	3,300	3,600	3,700	10,200
1948	34,300	35,300	43,200	44,200	34,200	16,200	11,000	6,100	3,800	3,600	10,100	13,400
1949	10,500	14,400	19,400	21,900	39,700	10,300	5,800	2,800	4,000	3,400	4,100	6,100
1950	10,200	15,300	21,800	29,600	43,700	14,600	5,400	6,600	6,300	13,100	4,800	8,000
1951	12,400	17,400	21,500	29,200	31,800	10,400	5,500	3,000	2,600	4,300	10,500	28,500
1952	44,700	51,700	31,900	32,700	23,600	9,500	4,000	1,800	2,400	5,200	13,300	76,300
1953	61,200	34,300	61,900	39,400	52,300	36,500	12,500	7,700	3,700	3,300	5,700	8,900
1954	23,500	51,900	41,600	60,300	41,700	15,100	6,600	9,200	3,900	3,900	6,500	9,300
1955	9,700	16,600	24,700	11,300	29,500	24,000	6,800	9,200	8,600	5,400	6,800	17,000
1956	37,000	92,900	73,900	73,300	48,200	17,600	16,600	9,700	11,800	56,500	61,200	81,700
1957	108,200	77,900	63,600	69,100	46,000	21,000	8,700	5,700	5,300	4,200	5,900	6,700
1958	20,500	13,300	13,800	19,800	13,800	6,000	7,100	4,400	3,600	3,800	8,100	19,800
1959	25,100	90,100	38,400	70,700	38,200	13,200	5,800	5,100	5,900	6,800	3,800	4,400
1960	6,500	14,600	22,600	23,300	15,100	6,000	4,000	2,500	1,800	2,500	23,600	23,600
1961	31,800	65,600	40,500	52,600	23,600	14,800	6,600	3,000	3,100	5,400	5,800	7,300
1962	13,300	18,900	20,700	15,600	8,600	6,800	3,900	3,700	2,100	2,800	4,700	24,600
1963	15,000	25,800	19,700	25,800	17,100	8,200	6,400	5,200	2,000	2,300	6,100	9,500
1964	12,400	26,500	30,700	26,200	19,000	8,600	3,200	2,500	2,200	2,300	3,700	9,100
1965	68,300	47,800	49,000	80,200	31,700	13,100	5,400	2,500	1,700	1,900	2,800	3,800
1966	3,900	17,800	28,600	14,000	10,400	10,200	2,500	2,300	2,600	2,700	4,800	8,000
1967	11,400	27,900	38,400	44,400	25,900	33,300	10,000	4,000	2,500	2,700	1,700	2,000
1968	3,400	6,000	9,000	12,500	3,400	1,700	1,000	700	500	1,200	12,000	37,900
1969	13,500	37,700	34,300	48,300	32,800	12,700	6,700	3,500	4,000	7,600	7,400	14,200
1970	33,600	32,000	39,400	23,500	19,700	13,300	12,800	10,000	10,000	12,100	18,900	19,000
1971	32,900	42,700	87,200	50,500	29,100	15,500	9,200	12,500	7,900	6,900	16,800	15,900
1972	16,500	19,000	36,600	51,300	47,300	17,900	14,400	8,900	6,000	4,500	6,200	4,600
1973	12,800	17,200	22,800	11,600	6,300	3,500	1,800	9,800	6,200	9,700	32,400	27,000
1974	45,700	58,200	89,000	46,000	34,200	12,500	29,200	9,300	5,700	13,600	54,100	23,000
1975	70,700	83,100	79,900	91,100	55,400	15,200	7,100	6,500	5,500	6,700	14,100	13,400
1976	35,100	47,400	76,600	80,600	66,300	19,700	11,300	6,900	6,100	4,800	4,400	5,100
1977	5,500	10,800	13,700	36,900	14,500	9,000	6,800	4,600	5,800	6,300	5,200	11,500
1978	17,500	20,700	16,500	15,100	7,300	3,800	3,800	3,600	3,900	6,300	6,800	19,300
1979	28,200	46,000	33,500	41,000	24,400	18,400	7,300	3,300	3,200	3,900	3,400	6,000
1980	8,600	13,800	38,100	58,300	17,700	6,800	3,900	2,900	2,600	2,100	2,800	4,100
1981	13,700	26,600	32,700	24,400	18,700	12,100	5,200	4,300	3,100	2,300	2,700	15,600
1982	88,500	111,100	55,900	41,700	18,200	10,100	5,600	4,200	2,900	3,200	4,000	7,100
1983	4,700	5,300	7,900	5,300	2,200	1,500	1,100	900	2,300	6,000	10,600	17,700
1984	22,900	37,200	76,600	42,800	20,500	16,900	11,100	9,200	5,200	6,100	5,100	4,800
1985	7,200	39,600	63,100	51,200	14,800	6,000	3,600	3,000	3,600	3,600	3,700	9,500
1986	8,500	33,600	36,300	16,400	14,700	13,500	6,300	3,500	2,000	1,500	4,600	5,100
1987	51,400	49,800	34,600	52,300	43,000	17,200	8,500	4,200	4,600	4,400	7,100	17,700
1988	31,200	28,500	21,800	17,200	9,100	7,400	4,400	3,400	3,000	2,900	6,100	22,400
1989	28,500	30,500	28,500	19,000	12,900	28,200	11,600	3,800	7,400	17,900	16,500	35,900
1990	24,500	40,300	42,100	29,900	29,200	10,500	4,800	3,800	3,200	6,300	10,600	12,000
1991	75,500	79,200	46,400	40,500	25,400	7,700	6,400	4,100	2,500	3,000	2,500	6,800
1992	23,300	36,400	64,700	38,100	13,900	7,300	7,400	4,300	3,500	2,700	6,600	10,900
1993	11,900	29,400	63,100	96,200	42,000	31,600	17,100	11,400	8,900	8,600	5,600	10,200
1994	30,300	46,200	53,200	71,500	32,000	20,100	19,000	10,800	8,300	6,400	5,700	11,400
1995	13,200	11,500	10,500	12,800	13,800	7,700	6,600	7,700	4,700	3,700	14,500	40,000
1996	65,100	41,800	31,300	25,200	28,800	19,500	11,400	6,700	7,700	6,800	8,400	10,400
1997	31,600	74,500	41,900	91,800	23,200	12,400	8,700	5,100	3,500	3,100	3,800	5,800
1998	6,300	9,700	22,600	9,400	7,600	3,600	1,800	1,700	900	1,600	2,200	5,800
1999	12,700	24,800	38,400	47,600	21,500	9,100	4,600	2,700	2,600	3,400	3,000	15,300
2000	11,600	22,800	32,700	18,500	11,000	7,800	8,500	3,600	3,600	4,200		

CURRENT CONDITIONS (average monthly flow, ML/day)

YEAR (June)	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1891											3,700	3,100
1892	12,600	12,400	13,700	9,500	9,900	11,300	10,600	10,300	10,700	10,800	3,900	7,900
1893	9,000	8,200	11,100	6,500	29,900	8,300	10,700	10,600	10,600	9,700	3,900	16,300
1894	16,000	8,800	39,200	42,400	18,800	12,900	10,600	10,600	8,200	6,600	5,700	22,100
1895	42,000	52,200	62,900	57,300	27,200	12,900	8,200	10,900	10,900	10,200	3,700	6,600
1896	8,500	16,800	37,900	15,300	9,400	9,500	10,700	10,300	9,900	7,800	3,500	3,300
1897	7,500	9,700	5,900	10,300	11,200	12,400	10,500	10,200	10,600	8,800	2,700	2,200
1898	5,200	6,600	8,600	11,200	10,300	12,200	10,600	10,900	10,600	9,500	4,500	8,200
1899	5,100	8,800	8,600	10,400	11,100	8,800	9,600	10,500	9,300	9,800	3,900	10,500
1900	9,500	6,500	8,500	8,500	14,700	13,700	10,800	10,600	9,800	7,800	5,000	6,600
1901	11,300	12,800	12,900	18,700	18,800	13,700	10,900	10,600	10,600	9,400	4,400	3,000
1902	2,700	7,800	10,100	9,500	11,500	13,700	9,500	9,400	8,800	5,300	4,500	2,800
1903	3,300	11,100	7,200	7,000	10,500	5,600	10,400	6,700	5,900	5,000	3,000	4,700
1904	11,600	6,300	7,000	9,700	13,600	7,800	7,000	10,000	9,100	7,400	3,800	3,700
1905	13,100	10,100	10,100	10,300	9,700	10,100	9,100	8,700	10,600	6,900	3,600	4,900
1906	23,800	12,500	6,100	6,900	10,500	10,200	10,600	9,200	8,500	3,200	4,400	13,100
1907	23,600	19,800	34,200	50,800	15,800	12,900	10,600	10,600	10,700	8,400	4,100	4,000
1908	4,100	11,500	11,100	9,900	10,100	12,800	10,600	9,700	10,600	8,700	2,600	3,100
1909	6,200	6,900	8,100	11,500	10,600	9,800	9,100	9,000	8,800	7,200	9,100	17,700
1910	16,500	30,900	14,200	10,100	10,000	13,700	10,200	10,100	8,400	7,900	4,000	2,900
1911	9,400	5,600	21,900	16,100	16,800	13,100	10,600	11,800	10,600	10,600	5,200	14,900
1912	12,400	9,500	7,900	8,600	10,500	8,700	10,600	9,800	9,500	7,600	3,100	1,800
1913	5,900	7,600	19,300	8,800	10,100	8,400	10,600	10,800	8,200	9,700	4,200	2,700
1914	3,900	8,500	7,700	6,300	9,900	10,800	10,600	10,600	9,200	6,000	2,100	2,500
1915	3,300	11,900	7,700	8,000	13,500	11,000	10,200	10,600	8,200	7,900	3,700	5,300
1916	15,000	17,800	14,100	15,600	12,200	13,800	9,800	9,400	10,600	9,200	3,700	2,900
1917	20,400	18,600	22,900	30,600	38,800	27,600	8,400	10,400	10,800	10,500	10,800	52,300
1918	55,800	68,900	81,500	102,500	51,800	22,100	9,600	11,400	10,300	8,400	28,100	36,300
1919	41,300	43,500	39,600	13,200	9,800	10,800	10,600	9,800	9,800	7,800	3,500	4,300
1920	4,900	8,800	6,000	16,000	18,200	13,800	10,700	10,100	10,400	9,200	2,900	5,000
1921	14,800	19,000	21,900	16,100	16,700	12,900	10,000	9,200	10,800	9,500	5,400	10,400
1922	9,600	23,000	25,500	35,400	11,200	9,300	10,700	10,600	10,600	9,900	4,100	1,900
1923	7,400	5,000	4,800	7,900	10,500	9,900	10,500	10,600	10,600	9,900	2,400	15,700
1924	17,200	17,500	7,900	11,800	16,400	8,200	10,600	10,600	10,500	8,100	5,200	7,800
1925	4,900	18,500	40,800	32,400	35,900	14,500	7,800	10,400	10,700	10,800	4,900	3,300
1926	4,700	12,200	22,800	13,600	10,500	11,000	10,600	10,600	8,300	4,300	13,400	12,300
1927	14,500	35,500	33,400	26,800	9,600	9,600	10,600	10,700	10,600	10,000	4,200	1,900
1928	5,200	9,000	6,300	14,400	12,300	13,700	10,700	7,700	9,600	9,700	7,300	14,800
1929	10,400	7,700	7,400	14,500	8,700	11,300	10,600	10,700	10,000	6,700	2,800	6,300
1930	5,300	9,600	6,200	16,100	16,700	12,900	10,700	10,600	10,700	10,400	3,500	1,800
1931	2,600	7,900	10,800	14,300	8,400	5,500	10,700	10,800	9,800	6,200	20,200	44,000
1932	70,300	52,300	40,400	23,400	17,100	12,900	10,600	9,800	8,900	11,500	4,700	13,000
1933	14,000	17,300	50,800	16,600	9,600	9,500	10,200	10,600	10,700	10,000	4,600	2,700
1934	7,400	3,500	16,000	11,800	8,400	10,000	10,200	9,300	10,400	8,200	3,200	1,800
1935	8,400	9,500	8,400	47,700	51,300	26,000	8,800	10,600	10,600	6,700	4,100	7,600
1936	22,400	45,000	35,600	22,400	11,500	10,000	8,700	9,600	10,700	9,900	5,700	2,300
1937	9,200	30,400	37,900	9,900	10,000	12,300	8,600	10,900	10,700	10,300	3,800	1,800
1938	3,100	10,000	7,900	13,200	16,400	13,700	10,700	10,500	10,700	10,800	3,300	2,400
1939	4,000	5,300	8,400	9,300	16,700	11,600	8,000	9,100	11,500	15,200	8,500	11,200
1940	19,300	27,200	54,400	34,000	29,300	12,900	10,500	10,200	10,700	9,300	2,400	2,300
1941	2,500	8,900	6,900	8,800	19,400	10,400	8,200	10,600	10,700	10,600	4,600	2,200
1942	6,400	7,400	7,900	7,500	10,400	8,900	10,000	7,800	9,100	6,900	6,600	12,300
1943	24,900	14,200	17,400	10,600	10,500	9,800	9,700	9,400	10,600	9,200	4,300	2,600
1944	6,400	8,000	10,100	10,900	11,300	13,100	10,600	9,000	8,900	8,500	4,000	4,300
1945	4,200	12,000	7,100	6,900	9,800	13,200	9,000	10,600	8,400	8,000	3,800	2,400
1946	3,000	9,500	12,200	7,900	12,200	8,600	8,700	6,800	10,400	9,400	5,200	3,600
1947	19,700	20,700	9,700	9,500	10,000	13,700	10,600	10,000	10,500	8,300	4,200	4,100
1948	14,200	16,800	12,200	21,300	16,700	12,900	10,600	10,300	10,600	11,000	7,400	4,900
1949	4,900	10,300	8,800	7,200	10,900	8,200	10,600	10,500	7,700	9,600	4,000	2,500
1950	4,300	9,200	8,000	11,300	11,800	13,700	10,300	10,300	7,300	8,500	4,900	2,500
1951	3,900	8,800	5,900	6,700	8,700	10,100	10,500	9,800	10,600	8,100	4,200	11,800
1952	21,600	38,600	26,900	21,800	15,300	9,500	10,600	10,200	10,700	6,100	3,300	37,600
1953	49,900	34,800	54,500	35,600	44,900	29,700	8,500	10,300	10,700	10,200	4,700	3,800
1954	12,300	44,400	38,700	49,800	32,900	12,900	10,500	10,800	10,700	8,100	3,100	4,400
1955	4,000	10,400	8,000	7,000	10,400	21,000	9,400	9,500	11,200	9,400	3,600	8,800
1956	20,100	89,900	67,400	65,000	39,400	12,900	10,100	9,300	11,000	42,700	56,600	85,500
1957	113,700	80,500	63,100	63,500	37,500	13,600	10,500	10,000	9,700	7,400	3,300	2,700
1958	7,400	12,800	8,500	10,400	14,200	10,500	10,800	10,100	10,800	8,900	4,700	5,800
1959	9,700	50,700	38,500	60,700	31,300	12,900	10,900	11,000	11,200	10,400	3,300	1,800
1960	3,200	9,800	9,600	5,400	11,600	8,400	9,400	10,200	10,700	8,700	11,000	17,900
1961	11,400	28,900	40,600	39,200	14,500	9,900	10,400	10,600	10,200	6,500	4,300	2,400
1962	5,700	8,400	10,300	8,900	10,000	13,700	8,900	10,300	10,400	9,800	4,900	13,500
1963	7,700	10,100	8,100	10,600	9,100	9,000	8,600	10,000	10,800	8,000	3,700	5,100
1964	6,500	14,500	11,400	16,500	16,800	14,200	10,800	10,600	10,700	9,900	4,600	5,300
1965	28,100	22,700	17,200	59,200	17,900	12,900	10,700	10,700	10,600	9,800	3,600	1,800
1966	2,000	9,200	13,200	13,100	8,400	12,700	10,800	9,800	11,000	10,200	4,400	2,800
1967	5,200	13,400	19,700	17,200	16,700	14,800	10,500	10,700	10,700	10,400	4,500	2,100
1968	2,100	5,200	6,400	13,800	20,700	13,800	8,700	9,100	10,600	8,800	7,200	20,000
1969	7,100	17,600	13,500	15,000	9,700	13,700	10,700	10,100	8,900	8,700	4,100	4,100
1970	11,200	15,200	33,700	11,900	12,300	9,300	10,000	10,300	10,200	5,800	7,200	9,200
1971	13,600	41,200	75,100	32,600	18,900	12,900	11,400	10,600	11,200	8,300	6,000	7,800
1972	7,800	9,700	29,500	31,700	39,400	12,300	9,700	10,600	10,700	9,500	3,500	1,900
1973	6,100	7,300	10,700	10,300	10,400	11,100	11,000	12,600	8,500	6,700	16,400	14,800
1974	17,900	43,700	86,600	47,400	28,200	12,900	19,700	13,300	8,400	8,800	49,500	28,200
1975	48,500	82,100	82,000	86,200	49,400	13,000	10,300	10,900	9,700	7,300	5,800	4,600
1976	14,300	45,800	76,000	88,000	57,600	17,700	9,800	9,600	10,700	10,000	4,600	1,800
1977	1,900	8,000	7,700	9,300	9,100	9,200	10,900	10,500	10,500	7,900	3,900	3,900
1978	7,300	8,500	8,300	8,600	10,100	10,700	10,800	10,500	9,700	4,400	3,400	6,400
1979	13,000	19,600	8,700	27,200	16,300	12,900	10,900	10,800	10,800	8,100	3,000	2,700
1980	4,300	9,000	21,100	44,200	8,700	10,500	10,700	10,300	10,800	7,900	2,700	1,800
1981	6,800	11,000	9,700	11,000	17,500	14,100	9,600	9,300	9,600	10,600	4,900	8,100
1982	44,500	62,600	42,200	25,900	10,700	13,100	11,500	10,600	10,800	10,400	3,800	2,800
1983	3,100	11,600	9,300	11,100	18,100	13,700	10,700	8,900	6,600	9,200	4,700	7,200
1984	10,500	20,900	29,500	16,100	16,700	12,400	11,100	10,400	11,000	9,700	5,400	1,900
1985	3,100	17,300	17,600	30,700	9,400	10,400	10,700	10,600	10,900	8,700	3,400	4,200
1986	4,200	19,400	12,800	11,400	10,500	8,200	10,600	10,700	10,700	9,700	4,200	2,800
1987	28,900	19,700	12,300	18,400	24,600	8,100	10,500	10,400	10,700	8,300	3,800	10,000
1988	13,800	12,000	9,300	9,900	17,000	13,900	10,300	10,200	10,900	7,900	3,400	11,500
1989	14,100	9,800	8,900	16,100	17,400	13,300	10,200	10,900	9,500	6,800	8,400	17,400
1990	11,700	19,100	31,700	16,500	17,300	9,600	11,100	9,900	11,300	7,800	3,800	5,100
1991	41,200	55,600	41,700	29,300	20,200	12,900	9,700	10,600	10,900	9,400	2,600	2,100
1992	7,900	13,700	38,400	21,200	9,800	9,700	9,800	10,100	10,600	8,000	4,400	5,800
1993	6,500	15,100	48,100	77,100	32,400	27,100	10,400	9,800	11,600	8,500	3,900	5,100
1994	27,500	43,700	53,200	69,200	28,100	13,400	11,300	8,500	11,700	10,100	5,300	5,000
1995	5,400	9,200	11,000	16,100	17,000	13,700	9,300	9,300	10,700	6,500	5,300	18,000
1996	34,400	27,800	13,200	15,400	20,400	13,400	9,500	9,200	11,000	7,700	6,000	4,600
1997	17,900	54,300	37,600	79,100	17,200	12,900	11,100	10,800	10,800	10,200	5,400	2,000
1998	2,800	9,300	7,600	11,800	9,600	10,600	11,000	10,300	10,900	7,100	2,800	2,100
1999	5,000	8,800	23,500	16,100	16,700	12,900	10,700	10,300	10,200	10,000	4,700	6,500
2000	5,000	11,200	12,700	9,100	12,000	7,600	10,500	9,300	10,900	9,400		

- <10,600 ML/day
- 10,600 - 18,330 ML/day
- 18,330 - 25,300 ML/day
- >25,300 ML/day

Figure 3: Comparison of flood categories between natural and current conditions for downstream of Yarrawonga (109 years of modelled records)

(Murray Darling Basin Commission monthly simulation model)

5.2 Water requirements

Ecological communities within Barmah-Millewa Forest have evolved over time to a flooding regime that is dictated by the combination of natural seasonal flows and the effect of the Barmah Choke. Water requirements of Barmah-Millewa Forest can generally be described as the flooding regime that occurred under natural conditions (i.e. pre-river regulation). Water requirements comprise of temporal pattern, specific sequences of timing, depth, duration of inundation, flooding frequency and drying phase duration. These in-turn affect each of the important plant life-cycle stages including germination, establishment and growth (Roberts 2006).

Table 1 shows the flood frequencies experienced by some of the major vegetation communities at the Barmah-Millewa Forest prior to regulation and hence what could be described as there ideal flooding regime.

Table 1: Flood frequencies of the major Barmah-Millewa Forest vegetation community's pre-river regulation

Sharley and Huggan (1995), Ward (1991), Roberts and Marston (2000), Bren *et al.* (1988), Leitch (1989) and Dexter (1978) all cited in DSE and GBCMA 2005)

Vegetation community	Flood frequency[1]	Duration	Season
Giant Rush	75% – 100%	7 – 10 months	Winter – mid-Summer
Moira GrassMoira Grass	65% – 100%	5 – 9 months (no more than 10 months; minimum depth 0.5 m	Winter – mid-Summer; 2-3 months dry in late-Summer – early-Autumn
River Red-gum forest	40% – 92%	5 months	Winter – Spring
River Red-gum woodland	33% – 46%	1 – 2 months	Spring
River Red-gum/Black Box woodland	14% – 33%	1 – 4 months	Winter – Spring

[1] Percentage of years with inundation

Figure 4 indicates 'commence to flow' discharges of main vegetation associations in Barmah-Millewa Forest. 'Effective flooding' (i.e. with a minimum required depth of water) of these communities occurs at higher discharges.

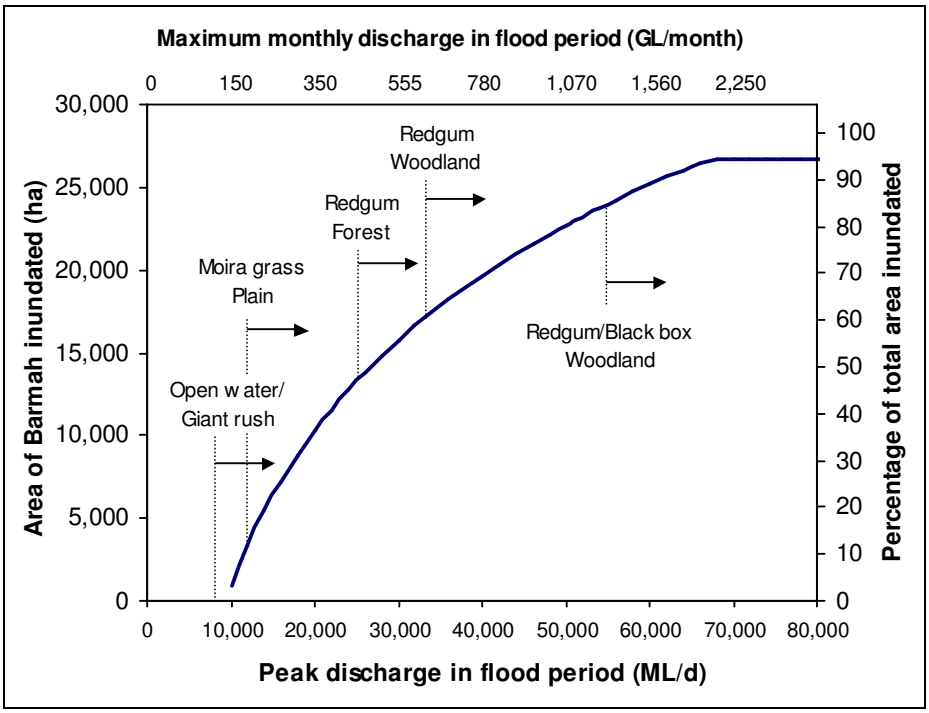


Figure 4: Area of Barmah Forest inundated as a function of River Murray flood peak and monthly peak discharge at Tocumwal (instantaneous peak discharge) and Yarrawonga (monthly total discharge). (Bren *et al*. (1987), Bren *et al*. (1988) and REG C (2003) as cited in DSE and GBCMA 2005).

In general when designing an appropriate water regime for a wetland species specific knowledge of its response at each stage of its life cycle to a flooding and drying regime for the dominate species present (Roberts 2006). Specifically, the flooding requirement of the River Red-gum has been studied at Barmah Forest (Dexter 1978). which found shallow and short duration (one month) floods are less effective than long-duration floods because they only supply water to trees close to the channel and soil moisture rapidly returns to pre-flood levels (Young 2001). The critical time in regeneration is seedling establishment, rather than germination which does not strictly depend on flooding. The best time for floods to recede is during spring-early to summer (Dexter 1978) as seedlings are able to cope with summer heat by accessing soil water.

To complete a successful colonial waterbird breeding event during the spring to early summer months a large flood between four to five months is required to ensure the breeding cycle can been completed. Nesting colonial birds have a 20km range from their nest site to the feeding area and therefore, likely that a number of wetlands (variying vegetation and in a different phase of filling or drawing down) need to be available throughout Barmah-Millewa Forest to facilitated a successful breeding event (Reid 2006).

A recent study has shown that flooding can influence the spawning and recruitment success of golden perch, silver perch, Murray cod and trout cod, however the response and mechanism is different for each species (King, Tonkin and Mahoney 2007). Golden perch and silver perch are able to spawn during flood and within channel flows (however higher spawning activity occurs during flood conditions). Spawning of Murray cod and trout cod is not influenced by flow conditions, but similarly higher recruitment occurs when the floodplain is inundated at the same time when larvae and juveniles are present (King *et al.* 2007). Finally, floods in Barmah-Millewa Forest have an important role in maintaining habitat and creating connectivity within floodplain creek and wetlands for a variety of fish species.

5.3 Water requirements to achieve objectives

Previous environmental water allocations have indicated that when 500 GL has been applied to Barmah-Millewa Forest it increased the duration as well amplifying the flood peak and therefore increasing the spread of water. Applying 500 GL in the Barmah-Millewa Forest could theoretically inundate 55% of the floodplain with a flood peak of 30 000 ML/day (see Figure 4) lasting for about a month (depending on antecedent flood conditions). This is a period long enough to facilitate bird breeding during this version of the Icon Site EMP. The Coordinating Committee and Technical Advisory Committee will develop methods and techniques to inundate a greater area of the wetlands in Barmah-Millewa Forest (hence, achieve broader ecological objectives) and to apply water to downstream wetlands and icon sites. These could be achieved by augmenting flows from Hume Dam, Ovens River, Goulburn River, utilisation of new TLM water and the acquisition of floodplain easements adjacent to the River Murray between Hume Dam and Yarrawonga.

To mitigate the associated risks and reduce the chance of error during environmental watering events the Coordinating Committee and Technical Advisory Committee rely on an effective decision and communication pathway (see Appendix C) and accurate forecasting from the Bureau of Meteorology and River Murray Water.

6 Environmental Works and Measures Program

6.1 Links between Environmental Works and Measures Program and the Icon Site Environmental Management Plan

The Living Murray Environmental Works and Measures Program is driven by the requirement to deliver environmental water efficiently to the Icon Sites and to optimise the use of recovered and other water made available to the sites. The activities and works under consideration are drawn from the need to deliver the objectives of the Icon Site EMP and in most cases are referred to within these Icon Site EMP's.

The Ministerial Council has endorsed a scheme of works and measures that may not in all cases be represented in the Icon Site EMP. In endorsing this scheme the Ministerial Council has accepted them as consistent with the overall objectives of the The Living Murray program.

Some works cross icon site boundaries or affect icon sites other than the one in which they are sited – especially those that are designed to optimise the operations of the River Murray Channel. Examples of these are those that are designed to ameliorate limitations to the provision of flows to downstream environments. The full significance of these works may not be immediately appreciated solely in the context of a particular site. The eastern Millewa regulators are a case in point, as well as providing water management opportunities for the eastern Millewa forest they will also provide the potential to relieve the entire icon site of unseasonal flows (i.e. rainfall rejections) and provide an alternative route for water around the Barmah Choke, which may benefit downstream icon sites.

6.2 Environmental Works and Measures to achieve the ecological objectives

The Living Murray Environmental Works and Measures Program (EWMP) is a $500 million program to deliver works and measures to manage environmental flows in order to improve the health of the icon site and achieve the ecological objectives (MBDC 2004):

- Making best use of the water currently available;
- Optimising the benefits of any water recovered in the future;
- Considering other priority interventions that are worthy in their own right;
- Targeting investment towards the best environmental outcomes; and
- Having input from personnel with technical and specialist expertise.

See Section 17 for a description of the proposed Environmental Works and Measures program at Barmah-Millewa Forest for the forthcoming financial year.

7 Water Management

7.1 Existing environmental water

The existing Environmental Water Allocation (EWA) for Barmah-Millewa Forest will remain a separate parcel of water, for accounting purposes, to the 500 GL/year to be recovered and applied to the six icon sites under The First Step decision.

The Revised Operating Rules for the Barmah-Millewa Forest were endorsed at the March 2007 Murray Darling Ministerial Council meeting and outline the operating rules and triggers for the Barmah-Millewa Forest Environmental Watering Account (which is independent of the Victorian irrigation allocations). The Barmah-Millewa Forest EWA is managed according to the Revised Operating Rules and triggers (see Appendix H). This will be undertaken in a manner complementary to achieving the ecological objective for this icon site.

The Barmah-Millewa Forest Environmental Water Allocation was approved in 1993. The Murray Darling Basin Ministerial Council authorised 100 GL/year as an environmental water entitlement, to be drawn equally from the States of Victoria and NSW[3], with the forest to be treated as a single unit using the single water allocation. Also, a lower security allocation of 50 GL (again to be contributed equally from Victoria and New South Wales) is to be provided in years where the irrigation water allocation in Victoria exceeds 130% (which occurs in 75-80% of years according to the model output for 'current conditions'). This water, along with the high security 100 GL/yr allocation can be accrued in an EWA storage 'kitty' up to a maximum of 700 GL (DSE and GBCMA 2005).

[3] The NSW component of the Barmah-Millewa Environmental Water Allocation (EWA) is also noted under Water Management Act 2000. The Water Sharing Plan for the Murray and Lower Darling Regulated Rivers Water Sources (Water Sharing Plan) defines the EWA rules (S. 15) and the conditions under which it may be used for the forests or, conversely, borrowed for consumptive water use. As a provision under the Water Sharing Plan, and because the EWA affects the bulk water supply of the NSW Murray River Water Source, the use and management of the EWA is subject to audit and review.
The Victorian Murray Bulk Entitlement process provided for agreement for management of the Victorian component, including an increased allocation, accrual in storage, triggers for release, and loaning in dry times.

7.2 Recovered environmental water

Water recovery is defined as 'the development of procedures for developing, assessing, accrediting and investing in water recovery measures to achieve the environmental outcomes' (MDBC 2004b). Recovered environmental water will be used to achieve the ecological objectives as stated in this Icon Site Environmental Management Plan (see Section 4). The specific quantity of recovered water available to Barmah-Millewa Forest in any given year will be determined by TLM Environmental Watering Group through The Living Murray Environmental Watering Plan.

7.3 Unseasonal Flows

Forests NSW and the Victorian Department of Sustainability and Environment have an arrangement of 'annual alternating' acceptance of any above channel flows during the unseasonal flooding period between mid-December and April (see Section 16.4.2). This co-operative arrangement allows the wetlands in each state an opportunity to dry every second year and thereby returning to a more natural flooding and drying regime.

These increased river flows usually arise because of the rejection of pre-ordered irrigation supplies due to rainfall events and typically cause River Murray flows to increase from near forest channel capacity of about 10,400 ML/day to a flow of 12,000 to 15,000 ML/day or more for a period of up to about five to seven days. Rain-rejection flows also arise from increased tributary flows.

8 Complementary Management Actions

The Barmah-Millewa Icon Site is managed under the principles of ecologically sustainable forest management, as set out in the National Forest Policy Statement (1995). These principles state that the forest be managed for the broad range of commercial and non-commercial benefits and values it can provide for present and future generations. Furthermore, as part of declared Ramsar Wetlands, the Barmah-Millewa forests are managed under the 'wise use' principles promoted by the Ramsar Convention.

In order to maximise forest values and benefits, a number of key management actions are undertaken. These include protection activities, ecological interventions, commercial production and provision of other social benefits.

Broad scale protection activities will include fire prevention and suppression, as well as pest and weed

control and carp removal. Fire management activities aim to protect fire-sensitive red gums from frequent fire. The following will be undertaken in the Barmah-Millewa forest:

- ignition prevention through enforcement of total fire ban restrictions and, in NSW, seasonal solid fuel fire bans
- broad scale control of fine-fuel loads throughout the forest through managed grazing,
- rapid response capability through early detection and readiness; and
- fire suppression.

Targeted pest and weed control activities will be undertaken in the forest in order to protect biodiversity and meet statutory responsibilities. These activities will vary across the site according to need, but may include spraying of noxious weeds in strategic locations, control of vertebrate pest animals through baiting, European carp removal, and management of widespread weeds through managed grazing. Spraying of Arrowhead (*Sagittaria sp.)* will be undertaken along watercourses and around regulators if appropriate legal permits can be obtained.

Ecological interventions include watering events, discussed elsewhere in this Icon Site EMP, but may also include ecological burning of wetlands (for example Moira Lake and Reedbeds) to promote a balance of ecological communities, and silvicultural thinning to promote River Red-gum growth.

Commercial production activities aim to deliver economic benefits to local and regional communities in an ecologically sustainable manner. A number of commercial activities will be undertaken in the Barmah-Millewa forests including harvesting of sawlogs and associated removal of residues, cattle grazing and apiary. Timber harvesting will be undertaken on a sustainable yield basis, and will be carefully managed to ensure adequate protection of site-specific values such as Aboriginal cultural heritage and species listed as threatened.

The Barmah-Millewa Forest will be managed for a range of other social benefits including recreation and provision of domestic firewood. Public access will be maintained via a network of roads and tracks, and recreation will be supported through maintenance of picnic and barbeque facilities and rubbish collection. Firewood permits will be issued to allow for domestic firewood collection.

It is important to note that within Barmah Forest, complementary land management actions are being addressed through the Victorian Environmental Assessment Council process with draft proposals recently published. Completion of this process will result in further changes to the Icon Site EMP

Complementary forest management will be carried out by the Victorian Department of Sustainability and Environment, Parks Victoria and Forests NSW in their respective jurisdictions.

9 Community Engagement

The Barmah-Millewa Forest has been long recognised as having significant environmental, cultural, social and economic values.

Registered on the National Estate, the Barmah-Millewa Forest is recognised for its important heritage and natural values. The Barmah- Millewa Forest has significance to Indigenous Australians and non-indigenous people whom have connections and associations with the Forest. It affords significant direct economic benefits such as timber production and tourism to name just two. A wide range of recreational activities undertaken in the forest highlights the value the Forest has in supporting the social framework of our communities.

Recognised as a Ramsar Wetland of International Significance, the Barmah-Millewa Forest supports a diverse habitat and listed flora and fauna species.

Community engagement in water management within the Forest needs to recognise all these values and the people that have an interest in maintaining or improving these values. More information on values can be found in (see Section 3.7)

9.1 Community Engagement Processes

A range of stakeholders (e.g. individuals, community groups, interest groups, government agencies, local councils and indigenous groups) have an interest in water management in Barmah-Millewa Forest. In order to ensure appropriate mechanisms are use to engage and allow input from such a wide range of stakeholders a Consultation Reference Group has been established to provide advice to the Coordinating Committee on how best to engage with the community in the development and implementation of the Barmah-Millewa Forest Icon Site Environmental Management Plan.

A parallel process will be developed that encourages the engagement of Indigenous people in the project (see Section 9.5 below) and respects Indigenous consultation needs.

9.1.1 Consultation Reference Group Functions

The main functions of the Consultation Reference Group are (see Appendix G for Terms of Reference):

- To provide community advice to the Coordinating Committee with respect to the development

and implementation of the coordinated Icon Site Environmental Management Plan (EMP).

- To provide advice on consultation with regional and local groups who have an interest in the management of the asset.

Advice provided by the Consultation Reference Group and Technical Advisory Committee will be used to inform the decision making of the Coordinating Committee such that both technical information, community knowledge and community concerns are taken into account. Upon advice from the CRG, the CC will facilitate targeted as well as broad community input with individuals and groups who have an interest in water management within the icon site.

9.2 Intent

Community engagement for the Barmah-Millewa Forest Icon Site will be focused around ensuring:

- The community is *informed* of the context, history, proposed processes, successes and failures, constraints and opportunities for water management in the Barmah-Millewa Forest to enable them to engage actively in debate relating to the water management in the Barmah-Millewa Forest; and,
- The community has opportunities for *involvement* and *input* in the development and implementation of the Icon Site EMP to ensure community values and knowledge are considered in decision making and accommodated within the Icon Site EMP and actions.

In this section 'community' refers to non-government stakeholders with an interest in water management within Barmah-Millewa Forest and can include organisations and individuals.

9.3 Principles for community engagement

Broad community engagement principles will be applied, these are listed below.

- Decision making processes are clearly defined and understood.
- Process maximises opportunities for involvement.
- Decision-making and consultation activities are documented.
- Engagement is inclusive but targeted to accommodate constraints and opportunities.
- Information is easily accessible, relevant, clear and timely.
- Negotiable and non-negotiable elements are clearly articulated.
- Processes appropriate to the key stakeholders interested are used.
- Facilitate use of best available information in the ongoing planning and management of the

Barmah-Millewa Forest

- Recognition of previous consultation results.
- Current networks and processes are accessed to disseminate and gather information and views.

9.4 Actions and Priorities for 2007-2010

Community engagement goals reflecting the intent of 'inform' and 'involve' are developed in Table 4, (see Section 12.1). The goals reflect what the Coordinating Committee understand the community want as a result of community meetings and discussion within the Consultation Reference Group.

Goals and priorities reflect current understanding and thinking and will be refined as the CRG builds its understanding on community needs, concerns and preferences. These goals and priorities are provided as a starting point for discussion on what is required to effectively engage the community in water management under The Living Murray program at Barmah-Millewa Forest. The Consultation Reference Group will need to undertake further work to determine how they can monitor and evaluate how well they are achieving the community engagement intent and goals.

There are a broad range of mechanisms potentially available to service the community engagement goals. For example information provision can be through frequently asked questions, community information days, forest tours, seminars, brochures, reports, presentations and media releases.

Likewise there are a broad range of mechanisms that can be used to engage the community in the development and implementation of the Barmah-Millewa Forest Icon Site EMP such as focus groups, workshops, discussion groups and surveys. The CRG will provide advice on which mechanisms are most suitable depending on the subject matter and stakeholder engagement preferences.

9.5 Indigenous Engagement processes

9.5.1 Victoria

In Victoria, the Yorta Yorta Cooperative Management Agreement between the Victorian Government and the Yorta Yorta Nations Aboriginal Corporation provides for the establishment of the Yorta Yorta Joint Body, representing the Yorta Yorta people and the Government of Victoria, to provide advice to the Minister for Environment on the management of a range of designated lands, including the Barmah Forest (DSE and GBCMA 2005).

This joint body is to ensure that there is adequate involvement of the Yorta Yorta people in any decisions as to land management and works programs in the forest, on the basis of 'informed consent' by the Yorta Yorta people.

Consultation with the Yorta Yorta people will require a process of presentation and discussion with a range of groups within the Yorta Yorta Nations Aboriginal Corporation, to ensure that all relevant family groups understand the proposals and have the opportunity to provide their views as part of the overall input by the Yorta Yorta people through the joint body.

The Yorta Yorta Cooperative Management Agreement was signed in June 2004. The appointment of Yorta Yorta Joint Body members was completed on 21 November 2005, consisting of five Yorta Yorta representatives and three Government representatives (two individuals from Victorian DSE and one from Parks Victoria). The group is now in operation.

9.5.2 New South Wales

In New South Wales, Indigenous consultation will be undertaken in an inclusive manner (i.e. consultation with the Local Aboriginal Land Councils, Traditional Owners, Clan Group, Elders and knowledge holders). Contact with the local Aboriginal community as stated in 'Operational guidelines for Aboriginal cultural heritage management' (Forests NSW and DPI Aboriginal Liaison and Cultural Heritage Unit 2006) is detailed below.

'Contact with the local Aboriginal land council, registered native title claimants and other recognised groups may be necessary to identify issues and concerns about proposed operations. The most appropriate contacts will be cultural knowledge-holders or custodians with authority to speak (by descent, historical association or entrusted knowledge) or other Aboriginal community groups that are active in heritage conservation; decisions should not be made in isolation of the land council. Protocols developed with the local Aboriginal communities will provide further advice on agreed procedures. An occasional (two-three yearly) advertisement in local media inviting Aboriginal communities to review Forests NSW regional operational plans would demonstrate commitment to inclusiveness and transparency'.

9.5.3 The Living Murray Indigenous Partnerships Project

The Living Murray Indigenous Partnerships Project Plan has been approved by The Living Murray Committee to help ensure Indigenous community knowledge, values and perspectives are taken into consideration in the Icon Site EMPs. The TLM Indigenous Partnerships Project provides the principles

and outlines the approach for Indigenous engagement with respect to the TLM. A Memorandum of Understanding (MOU) between Murray Lower Darling Rivers Indigenous Nations (MLDRIN) and the MDBC was signed during March 2006 in Albury. This MOU provides for engagement with Traditional Owners along the length of the River Murray and across state boundaries, while being inclusive of formal jurisdictional arrangements.

9.6 Intent

Until the Indigenous Reference Group is established and has opportunity to propose principles for effective engagement of Indigenous Australians in the development and implementation of the Barmah-Millewa Forest Icon Site Environmental Management Plan the Icon Site Managers and CMAs will work with Indigenous communities on an ongoing basis.

9.7 Goals and Priorities for 2007-2010

Goals and priorities reflect current understanding and will be refined once the Indigenous Reference Group (IRG) is established and builds its understanding on values, concerns and preferences. These objectives and priorities are provided as a starting point for discussion on what is required to effectively engage the Indigenous community in water management under The Living Murray Program at the Barmah-Millewa Forest Icon Site. To progress, the IRG will further develop and distribute an Indigenous Engagement Plan as a priority for the 2007/08 year.

The IRG will need to undertake further work to determine how they monitor how well they are achieving the Indigenous Engagement Intent and Goals.

Mechanisms used to achieve the objectives will need to respect the communication and engagement preferences of the Indigenous community.

10 Threats, legal risks and ameliorative measures

10.1 Management of threats, risks and legal issues

The Living Murray Business Plan indicates that The Living Murray Environmental Watering Plan (LMEWP) and Icon Site EMPs will identify legal constraints and risks to the implementation of plans along with actions to minimise these, including any assessment requirements for actions.

Risk and legal issues relate primarily to the risk of adverse consequences:

- to the icon site associated with lack of action; and
- to other river users/values associated with implementing actions at the icon site.

The Environmental Watering Group (EWG) will explore the ecological risks associated with inability to implement key actions under the Icon Site EMPs necessary to achieve the environmental objectives and outcomes of TLM First Step decisions for inclusion in the 2007-2010 version of the LMEWP and Icon Site EMPs. A further description of the process by which risk management is being progressed in provided in The Living Murray Environmental Watering Plan.

Attention will also be given to identification of legal issues and approaches to mitigating them, which may arise from operation of the river and its works to achieve environmental outcomes. In the first instance, the approach to manage these issues will follow that adopted by MDBC and state constructing authorities as part of normal river management.

This will involve notification of the Commission (or other groups as appropriate) of the level of risk involved in proposed management actions, and the appropriate method for mitigating this risk. The approach to management of risk and legal issues to support implementation of the LMEWP and Icon Site EMPs will be reviewed and updated by the EWG for consideration of the Ministerial Council in agreeing to the 2007-2010 versions of the Icon Site EMPs (necessary approvals will be obtained for actions occurring under this plan when required).

While not included in this year's Icon Site EMP, in subsequent years it is intended to attribute a level of risk to each threat based on its likelihood of occurrence and severity of consequence. This will allow the setting of priorities to ameliorate those risks.

Table 2: Potential threats to achieving The Living Murray ecological objectives and proposed ameliorative measures

	Ameliorative Measure	
Potential Threat	**New South Wales**	**Victoria**
Inappropriate water management (quantity, frequency, season and duration)	*Water Management Plan for the Millewa Forests, Water Sharing Plan for NSW Murray and Lower Darling Regulated Rivers Water Sources (2003), Barmah-Millewa Forest Icon Site EMP*, and *Barmah-Millewa Forest Water Management Strategy*.	*Barmah Forest Watering Plan* and *Barmah-Millewa Forest Icon Site EMP* and the *Victorian Bulk Entitlement process* and *Water Barmah-Millewa Forest Water Management Strategy*.
Inappropriate timber harvesting (location, season and silviculture)	*Management Plan for the Murray Management Area, Forest Management Zoning in NSW State Forests, Harvest Planning Manual*, licence conditions issued under the *Threatened Species Conservation Act 1995* and the *Native Forest Silviculture Manual*.	*Mid Murray Forest Management Plan* of the provisions of the *Forests Act 1958* and of the *Code of Forest Practices for Timber Production* (Revision No. 2, 1996).
Inappropriate grazing management (domestic stock)	*Grazing Strategy for Forest NSW Riverina Region*.	Conditions of grazing licences issued under the *Forests Act 1958* and the *Land Act 1958* and advice of the Barmah Forest Grazing Advisory Committee (established under Section 32F of the *National Parks Act 1975*).
Inappropriate fire management	*Management Plan for the Murray Management Area* and the *Fire Manual*.	Code of Practice for Fire Management on Public Land through the North East Fire Protection Plan and the *Mid Murray Forest Management Plan.*
Weeds	Implementation of the provisions of *Noxious Weeds Act 1993.*	Implementation of the provisions of the *Flora and Fauna Guarantee Act 1988* and the *Goulburn Broken Weed Action Plan.*
Introduced and/or invasive species	Implementation of the provisions of *Rural Lands Protection Act 1998*.	Implementation of the provisions of the *Flora and Fauna Guarantee Act 1988.*
Water movement barriers	Implementation of the provisions of *Murray Regional Environmental Plan No. 2*.	Implementation of the provisions of *Entitlements to the Murray - Outcomes of work to define how Victoria's River Murray water is to be shared.*
Fish movement barriers	Implementation of the provisions of the *Fisheries Management Act 1994*.	Implementation of the provisions of the *Fisheries Act 1995*.

10.2 Legal risks and ameliorative measures

Table 3 outlines legal risks and ameliorative measures to achieve the ecological objectives using water application and the Environmental Works and Measures Program.

Table 3: Legal risks and ameliorative measures

Legal Risk	Ameliorative measure
An activity proposed in the Icon Site EMP that is thought likely to have a significant impact on a matter protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). For example, a proposed activity may impact on the ecological character of a Ramsar wetland, or other matters of national environmental significance, such as listed migratory species, and listed threatened species and ecological communities.	Implementation of this plan will take due account of EPBC Act requirements and where appropriate, will refer activities to the Australian Government Environment Minister for determination on whether the action requires approval under the Act. If the Minister determines that the action is likely to have a significant impact on a matter protected by the Act, the action will then be subject to the environmental assessment and approval processes, including the setting of any necessary conditions, under the Act. See Appendix D,
An activity proposed in this Icon Site EMP that potentially breaches state legislation.	Implementation of this plan will take due account of relevant state legislation and planning instruments.
Overbank flows in the Hume to Yarrawonga reach prompting calls for compensation.	Implementation of an EWMP project to acquire easements from Hume to Yarrawonga reach.

11 Barmah-Millewa Forest adaptive management: monitoring, reporting, evaluating and improving

11.1 Adaptive Management

The Barmah-Millewa Forest Coordinating Committee has adopted an adaptive approach to management of this icon site. The 2007-2010 Icon Site EMP has been developed with significant input from all members of the Coordinating Committee, Technical Advisory Committee and Consultation Reference Group.

All water delivery to the icon site will be managed adaptively in line with the adaptive management cycle. This process will be carried out by the Icon Site Managers in consultation the Coordinating Committee, Consultation Reference Group and Technical Advisory Committee. Essentially, this process incorporates the following components (DSE and GBCMA 2005)

Monitoring, evaluating and adjusting are the basis of adaptive management focused on improving the appropriateness, effectiveness and efficiency of management.

The adoptive management cycle involves steps to:

- Assess – the issues, objectives, potential management actions, priorities and associated risks;
- Design – develop hypotheses of expected responses based on current knowledge; design proposed actions (eg. works, operating rules);
- Implement – the appropriate authority who, in each case, will implement the actions;
- Monitor – initiate and coordinate monitoring in conjunction with relevant authorities;
- Evaluate – capture key learnings and evaluate outcomes in light of expected responses from management, community and environmental perspectives, and
- Adjust – adapt future management on the basis of improved knowledge from past experience, to achieve the desired outcomes.

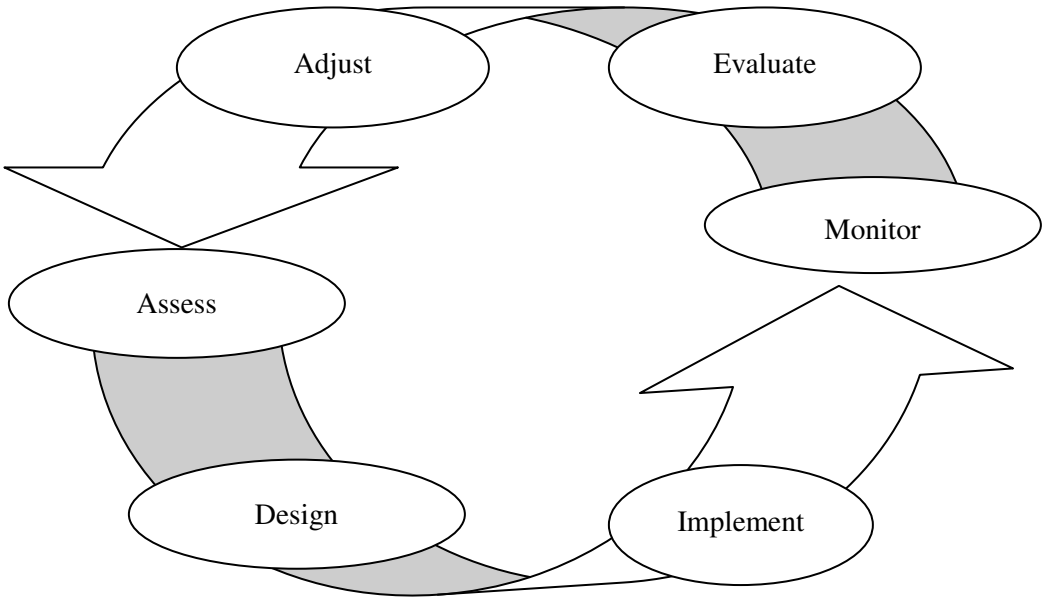


Figure 5: Adaptive Management Cycle

11.2 Monitoring

The ecological outcomes that will result from the implementation of this Icon Site Environmental Management Plan will be monitored to assess its effectiveness in achieving the ecological objectives and for use in an adaptive management context for future management.

The monitoring arrangements for TLM have been developed and agreed by the TLM Monitoring Taskforce

and are documented in the Draft TLM Outcomes Evaluation Framework. The Draft TLM Outcomes Evaluation Framework has been developed to ensure consistency in monitoring across all TLM Icon Sites. The focus of the TLM Outcomes Evaluation Framework is on fish, birds and vegetation, as these ecological indicators provide an adequate representation of the overall health of the icon site. This information can then be used to assess progress toward the objectives of the TLM First Step Decision.

The Draft TLM Outcomes Evaluation Framework sets out the arrangements necessary for the different types of monitoring required to fully inform the progress toward the objectives of the TLM First Step Decision.

The types of monitoring relevant to Barmah-Millewa Forest Icon Site are:

- Icon Site Condition Monitoring**:** To determine the change in the environmental condition of the icon site resulting from water application and implementation of works programmes under The Living Murray Programme;
- Intervention Monitoring**:** To determine the effectiveness of interventions in improving environmental condition (including key aspects of water application and works and to investigate a particular 'type' of intervention (management action such as pumping water to wetlands or flow enhancement etc);
- Compliance Monitoring**:** To determine if works and water regime have been undertaken as agreed; and
- Knowledge generation**:** To identify and address knowledge gaps and inform the management of risks posed.

At the time of writing, specific monitoring projects have been developed, in the context of the Draft TLM Outcomes Evaluation Framework, for the Barmah-Millewa Icon Site. These monitoring projects focus on Condition Monitoring and Intervention Monitoring.

An Icon Site Condition Monitoring Programme was developed for the Barmah State Forest and Barmah State Park, by the Goulburn Broken Catchment Management Authority. The Icon Site Condition Monitoring Programme for Barmah will be expanded and adapted to incorporate the NSW component of the icon site, Millewa Forest. The adapted Icon Site Condition Monitoring Plan will be logically tailored to the ecological objectives of the icon site, in order to inform the progress or otherwise toward achieving the ecological objectives. Therefore monitoring is focused initially on the ecological condition of fish, birds and vegetation at the icon site, that is, what is actually monitored is directly related to ecological objectives (see Section 4). The Icon Site Condition Monitoring Plan for Barmah-Millewa Forest Icon Site will be reviewed by the TLM Monitoring Advisory Group, to ensure it is consistent with the Draft TLM Outcomes Evaluation Framework and to ensure that the experimental designs are adequate and appropriately powerful enough to detect any

ecological outcomes that result from the implementation of this Icon Site Environmental Management Plan (see Figure 6).

A number of intervention monitoring projects have also either continued, or been implemented, on an annual basis, at the Barmah-Millewa Forest Icon Site. These Intervention Monitoring projects focus on examining specific aspects of the ecological response of fish, birds and vegetation to various interventions / watering events.

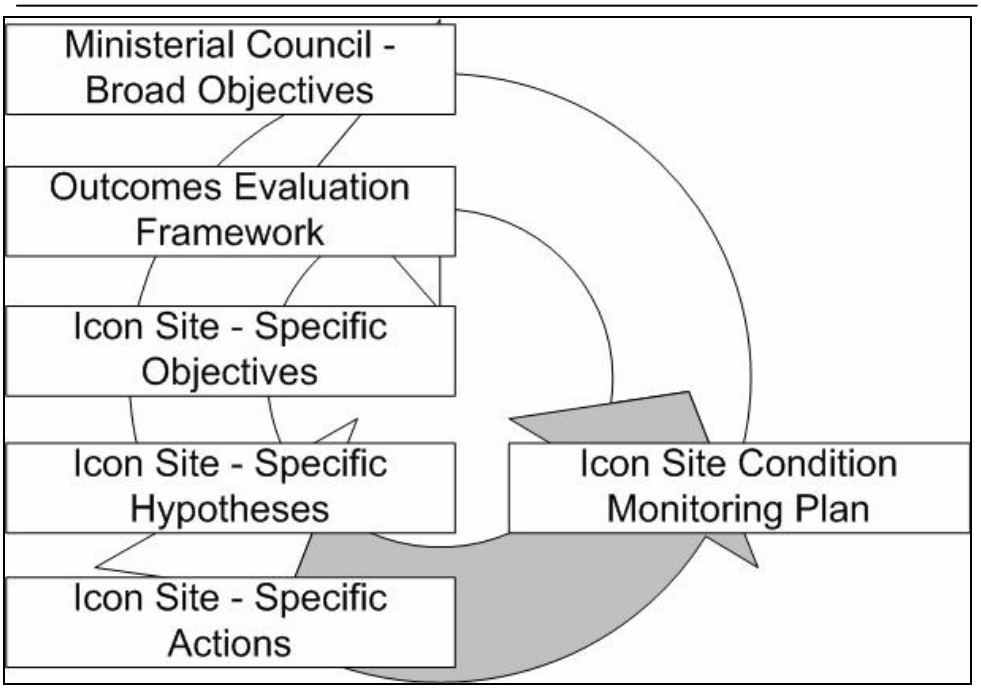


Figure 6: Baramh-Millewa Forest Condition Monitoring Plan feedback loop

Using the ecological objectives, specific hypotheses (or tests) can be formed to analyse how TLM watering will affect fish, vegetation and water regime dependent bird species. These hypotheses take the form of propositions that might be worded, for example, like; 'the provision of a flow of X ML/Day for Y days during Z months is proposed to lead to an effective Ibis breeding event at Moira Lake'. Importantly, in order to understand these hypotheses the base line conditions must be known and recorded.

The hypotheses are the basis for icon site specific actions such as opening regulators, continuing floods out of Lake Mulwala. This leads to a watering plan that includes the proposed actions as part of the tool kit to be used when water is available. Monitoring under the Icon Site Condition Monitoring Plan tests whether an action has been successful or not. A written report states to the Murray Darling Basin Ministerial Council whether the ecological objectives have been met, and whether they are useful, it also informs specific icon site actions, Icon Site EMP and the subsequent watering plan. For example, X number of days was too long or not long, and, it sets the scene for the next set of actions by making a new set of benchmarks upon which success is measured.

11.3 Reporting Requirements

Updated versions of the Icon Site EMP will be provided to the MDBC Ministerial Council each year for their approval. Annual reports on the operation of the Icon Site EMP will be prepared in accordance with the requirements of the LMEWP.

The Barmah-Millewa Forest Icon Site Annual Report will be submitted by early July each year. This will allow for its inclusion in joint reporting by the jurisdictions to the Murray Darling Basin Ministerial Council regarding overall progress of The Living Murray, due by August 31 each year. It will include, but not limited to the following:

- water management related operations undertaken at the Barmah-Millewa Forest Icon Site;
- regulator operation;
- flooding extent from both natural and managed flood events;
- status of the EWMP;
- progress and results of monitoring projects;
- the basis for decisions made regarding use, or otherwise, of available environmental water;
- volumes and timing of water application;
- progress on achieving environmental objectives for Barmah-Millewa Forest Icon Site; and
- community and indigenous consultation activities undertaken.

11.4 Evaluating

The Icon Site EMP will be reviewed annually and updated in response to information arising from monitoring, further investigations, modelling and consultation. Evaluation includes project-based and performance-based activities. Actions undertaken on the ground are compared with those proposed in the plan. A review is undertaken of each of the activities with particular consideration of the timing, milestones, targets and costs of the project compared with those proposed in the plan.

A review of the plan's objectives, strategies, performance targets, indicators and actions will assist in reviewing its progress and the effectiveness of implementation and determining whether the plan's objectives have been met. Each of the management actions will be evaluated against their respective performance indicators (targets) as provided in the plan.

The annual review provides an opportunity to alter the implementation program to better achieve the outcomes outlined in the plan, if necessary, and forms part of the adaptive management approach.

The Icon Site EMP will be further developed over the coming years to ensure that it is robust and reflects the latest information and understanding of the river and wetland systems and water delivery and recovery issues.

Monitoring activities undertaken at Barmah-Millewa Forest will be reviewed to ensure they are consistent with the Draft Outcomes Evaluation and Monitoring Framework to be supplied by MDBC to ensure consistency in monitoring across all six icon sites.

Part C: Annual Site Watering and Works Proposal

12 Community Engagement

12.1 Actions and Priorities for 2007-2008

Table 4: Community engagement goals and priorities for 2007-2010

Engagement Goals* **(not in priority order)**	Priority Activities for 2007/08 **(not in priority order)**
To know what is happening in relation to: • Decision making processes • The Living Murray program (history, objectives, sub-programs and projects). • Coordinating Committee decisions • Results of Environmental Watering Activities (positive and negative) • Barmah-Millewa Forest values • Watering requirements • Water management options • Monitoring programs • CRG activities • Water availability and triggers • Planned works • Impact of complementary land management activities on water management. • Flood heights and duration • Monitoring results • Avoiding negative impacts of environmental water delivery	1. Prepare and distribute information identifying CRG, (eg. their role and key activities). 2. Identify regional and local groups and individuals with an interest in water management within Barmah-Millewa Forest. 3. Survey current understanding and information needs and preferred mechanisms for dissemination (eg. gap analysis). 4. CRG to provide advice on methods to convey information to community (Communication Plan). 5. Provide information to the community on the 2005/06 EWA including water delivery, decision making processes, expected and unexpected outcomes. 6. Website establishment for the community to access information on Barmah-Millewa Forest (link TLM website through Goulburn Broken CMA and Murray CMA websites). 7. Icon Site tours 8. Inform community of accessibility of system updates (eg. River Murray System updates). 9. Investigate mechanisms to disclose decision making processes (eg. environmental watering events and CRG meetings). 10. Provide opportunities for all interested stakeholders to examine technical and community understandings of water management.
Negative impacts to be at least acknowledged and at best avoided	11. Host discussion on impacts of environmental watering events in Barmah-Millewa Forest. 12. Prepare documentation to the Coordinating Committee outlining concerns in relation to environmental watering events and seek solutions to these concerns.
To contribute to : • setting objectives; • development of water management options to achieve the best	13. Develop opportunities for the community to liaise with government and technical personnel to share their knowledge of the forest eg (Forest Tour to 'tap' into local knowledge). CRG to provide advice on appropriate mechanisms.

Engagement Goals* **(not in priority order)**	Priority Activities for 2007/08 **(not in priority order)**
on-ground outcomes; and, • identification of suitable performance indicators.	14. Develop opportunities for community, government and technical personnel to share understanding of values, water needs and knowledge gaps. 15. Identify opportunities to fill community research needs. 16. Seek community input to the review of ecological objectives as part of the Icon Site EMP development. . 17. Seek community advice on potential impacts, risks and opportunities of proposed projects and facilitate liaison with technical personnel.
Cross border collaboration	18. Provide opportunities for cross-border interaction on activities
Ensure land management activities within Barmah-Millewa Forest complement environmental watering efforts to improve ecological condition.	19. Provide opportunities to discuss land management activities that potentially impact on successful environmental water management.

* In relation to water management in Barmah-Millewa Forest the Coordinating Committee understands the community want.

13 Indigenous Engagement

13.1 Actions and Priorities 2007-2008

A priority for 2007-2008 is to work with Indigenous communities to develop an agreed approach to engage Indigenous peoples which respect jurisdiction's legislation, other agreements and related processes while providing an inclusive and transparent process.

14 Current condition

In October 2005, the New South Wales and Victorian Governments supported the release of the Barmah–Millewa Forest Environmental Water Allocation (EWA), according to an agreed operating plan. Between October 2005 and March 2006, 513 GL of EWA water was successfully delivered to the Forest under the auspices of The Living Murray programme. The EWA inundated 57% of the floodplain. The EWA was adaptively managed by modifying the flooding areas, water depths and durations. As a result vegetation responded with vigorous new growth, and colonial waterbirds bred, some for the first time in 40 years.

With current drought conditions persisting, large areas of Barmah-Millewa Forest are very dry at present. Some of the higher ridge areas in the Barmah-Millewa Forest have not received watering since 1996. Aerial inspections conducted during April 2007, showed clear evidence of the benefits of the 2005-06 EWA watering event, with River Red-gums in the areas watered in good health. Equally clearly, the 43% of forest area that did not receive watering is showing evidence of severe stress, with obvious decline in the health of River Red-gum and some deaths. Broad area flooding (or above average rainfall) will be required in the next 2 to 3 years in order to continue to meet the objective of 55% healthy vegetation. The long-term prognosis for the remaining vegetation is poor. It is clear that there will be landscape change as a result of the current drought and the resulting deaths of River Red-gums in this Forest.

The current dry conditions have resulted in no major waterbird breeding events since the 2005-06 EWA event when approximately 50,000 pairs of colonial waterbirds bred, including Great, Intermediate and Little Egrets, and Royal Spoonbills and Nankeen Night Herons, resulting in substantial recruitment. There have been minor breeding events of ducks and swans in isolated areas that were wet by higher than expected summer irrigation flows. Additionally, cryptic bird species such as Brolga (one pair), Crakes and Turns have been observed in areas wetted by the 2005-6 EWA.

Areas of the Forest that were previously subject to frequent, unseasonal inundation (including rain rejection events) are experiencing some welcome relief. Moira Lake is currently in a dry phase allowing carp removal and deep cracking of clays. The ecological responses that resulted from the 2005-06 EWA event highlight the sites very high value and importance in providing drought refuge areas and the significance of watering events for these responses.

Fish studies undertaken in the Barmah-Millewa region in 1999 to 2001 determined that non-native species comprised 93.7% of the total catch in the region. Although golden perch were the most abundant native fish in the region, they comprised only 2.2% of the catch. These studies indicated that numbers of drifting larval carp in the Murray River substantially increase downstream of the Barmah region suggesting that the Barmah-Millewa region was acting as a recruitment and nursery region for carp, while providing few opportunities for native fish.

More recent fish surveys indicate improved native fish numbers. Sampling undertaken by the Arthur Rylah Institute demonstrated a substantial increase in native fish spawning and recruitment during the 2005/06 EWA release. Species such as Silver Perch, Murray Cod and Golden Perch were recorded in high numbers whilst a substantial reduction in the number of adult Carp within the system was also observed. The current period of drought conditions in conjunction with the EWA and the commercial removal of 25 tonnes of Carp from Moira Lake appear to have benefited native fish recruitment whilst substantially reducing carp biomass. The establishment of a condition monitoring programme will provide a long-term dataset that can be used to determine the effectiveness of management interventions at improving fish communities within the forest.

The October 2005 EWA resulted in high levels of spawning and recruitment of Silver Perch, Golden Perch and Murray Cod. In 2006-2007 no water was available for environmental watering.

Using the approach outlined in Table 5, the environmental condition for Barmah-Millewa Forest has been given an overall rating of moderate. The results indicate that there is a stable trend for most of the condition indicators except for tree crown health which is declining. Priorities for water application occur relate to both Water Management Areas (WMAs) and specific sites (see Appendix E).

Table 5: Current condition

Key Performance Area	Condition Indicator	Target	Barmah Forest		Millewa Forest		Comment
			2007 Condition Status[2]	Condition Trend	2007 Condition Status[2]	Condition Trend	
Forest health[1]	Flood dependent ground vegetation	Opportunity for growth, reproduction and dispersal provided over 55% of forest no more than four years apart.	Declining	Stable	Good	Stable	The 2005/06 EWA resulted in a medium level flood event in Baramh-Millewa Forest (equivalent to a one in five year flood event) which resulted in 57% of the floodplain to be inundated.
	Tree crown condition	95% of dominant and co-dominant trees with a crown rating >0.8 over 55% of the forest.	Declining	Declining	Good	Stable	The 2005/06 EWA resulted in significant improvements in tree crown condition over the majority of River Red-gum vegetation. However, due low sub-surface soil moisture levels in higher levels crown condition is deteriorating through the absence of above average rainfall and/or substantial flooding.
Waterbirds[1]	Breeding success of colonial nesting waterbirds	Successful breeding of thousands of colonial waterbirds in at least three years in ten.	Good	Stable	Good	Stable	The 2005/06 EWA stimulated successful breading of approximately 50,000 colonial waterbirds in multiple colonies throughout Barmah-Millewa Forest system.
Fish[3]	Successful recruitment of native fish species	Successful recruitment of native fish species by improving flow variability in spring and early summer to replicate natural cues, and by inundation of floodplain and wetland areas.	Good	Stable	Good	Stable	The 2005/06 EWA stimulated successful recruitment of golden perch, silver perch, Murray cod and trout cod species (along with a raft of other native fish) within Barmah-Millewa Forest.

[1] Adopted definition of The Living Murray Interim Ecological Objectives

[2] Good, target condition currently satisfied, intervention unlikely to be required during the current water year. Moderate, present condition at borderline of satisfaction, intervention may be required within the next 1–2 water years. Poor, present condition unsatisfactory, intervention should be undertaken within the current water year.

[2] Adopted definition of the refined ecological objectives for Barmah-Millewa Forest Icon Site.

15 Priority Water Management Areas

Priority water management areas within Barmah-Millewa Forest are targeted for future water management activities. These sites are prioritised using two methods, firstly the difference between ideal flood frequency and antecedent observed flood frequency. Flood scores are given depending upon the degree of observed wetland system flooding, ranging from 0 (no flooding) to 3 (fully flooded), and are reported annually. Secondly, other observational trends and results from condition monitoring not detected by the prioritisation table is also used to identify priority water management areas. Specific priority sites within Water Management Areas are also highlighted at this juncture, being primarily based on vegetation health and known bird breeding sites. Aspects of fish and frog ecology are also taken into account, as are results from various monitoring projects undertaken in Barmah-Millewa Forest.

In general, priority sites tend to be areas of colonial-nesting waterbirds, Moira GrassMoira Grass plains and areas of Barmah-Millewa Forest exhibiting drought stressed River Red-gum (which occupies most of the high ground or elevated water management areas and therefore can usually only be watered from large natural flood events). Depending on the nature of the flood event and the flood requirements of species and/or wetland sites, then priorities for water management will differ though will tend to reflect more natural flood regimes to significant sites (DSE and GBCMA 2005).

Near annual flooding of Moira GrassMoira Grass plains of sufficient depth (> 0.5m) and duration (3-6 months) is a high priority for Barmah-Millewa Forest flood management. This requires preferentially diverting all seasonal flood inflows into wetland locations containing Moira Grass plains and avoidance of flooding such wetlands from unseasonal flooding, such rain-rejections events (DSE and GBCMA 2005).

Diversion of unseasonal flooding usually arising from rain-rejection events are generally managed away from Moira Grass plains and semi-permanent wetlands as frequent re-rewetting of these sites will degrade their natural values. As such, management of rain-rejection events depends upon their volume and timing and tends to be prioritised towards higher drought-stressed River Red-gum areas away from wetland basins.

An arrangement of alternating these unseasonal flows between the Barmah Forest wetlands and the Millewa Forest wetlands on a year by year basis is also employed to minimise re-wetting of wetland environments during their dry phase, (DSE and GBCMA 2005).

15.1 Priority Water Management Areas

Using the numeric scoring method set out in Appendix E, the 2007-2008 priority water management areas

are outlined in Table 6. Please note that these priority setting tools will be evaluated by the Coordinating Committee and Technical Advisory Committee over the coming 12 months.

Table 6: Priority water management areas for 2007-2008

Barmah Forest	Millewa Forest
Kynmer Creek (A), Yielima (D), Black Swamp (E), Gulf Creek (F), Boals Deadwood (G), Top Island (H1), Goose Swamp (H3), Barmah Island (H4).	Aratula Creek (J), Plantation (L), Mary Ada (M), Edward River (N), St Helena Swamp (Q), Gulpa Creek (R), Moira Lake (S).

15.2 Priority Water Management Sites

Specific sites located within individual WMAs may also be priorities for water application in a given year. Priority sites for 2007-2008 may include a combination of sites listed in Table 7.

Table 7: Priority sites for water application 2007-2008

Priority Sites	Barmah Forest	Millewa forests
Moira Grass plains and meadows	Doctors Point, Keyes Point, Harbours Lake, Top Lake, Duck Hole Plain, Little Rushy Swamp (and similar wetlands along Gowers Track), War Plain and Steamer Plain.	Algeboia and Porters Plains, Moira Lake and Reed Beds Swamp
Water-bird breeding areas	Bunyip Hole, Green Engine Lagoon, Boals Deadwoods and parts of Top Island. Occasionally, fringing areas of Gulf and Smiths Creeks and parts of Steamer and War Plains.	Gulpa Creek Reed Beds, Duck/Coppinger's Lagoon, Sheldrakes and Moira Lakes, St Helena Swamp and parts of Gulpa Island State Forest

15.3 2007-2008 Water Management Actions

Specific water management regimes proposed for Millewa Forest in 2007-2008 under various seasonal conditions are outlined in Table 8. Watering is proposed only in the event of a 'Moderate' or better season with average/above average rainfall and inflows. Watering will be concentrated on wetland areas. In the event of continuing drought or otherwise dry year, no watering is proposed.

Table 8: Millewa Forest water management actions 2007-2008

Scenario	Strategy	Action	Location[1]	Timing	Triggers	Water
Very Dry Year	Maintain water within Murray	▪ Keep Regulators Closed ▪ Operate Moira Lake in Dry Phase	All WMA's Moira WMA	All	Nil	Nil
Dry Year	Maintain water within Murray	▪ Keep regulators closed – where practicable ▪ Operate Moira Lake in Dry Phase ▪ House Creek & Pinchgut preferentially used for Unseasonal flows.	All WMA's Moira WMA Mary Ada	All Summer	Nil Unseasonal Flows 10-12000 ML	Nil
Moderate	Water for maintenance of key representative / breeding areas	▪ Watering regime for Moira Lake specifically targeting vegetation ▪ Water within Reed Beds to maintain waterbird breeding	Moira Lake Moira WMA Reed Beds Moira WMA	Winter / Spring Spring / summer	Unregulated Flow events during winter / spring (waterbird breeding)	Nil 10GL+
Wet	Water for stimulation of breeding events andmaintenance.	▪ Water delivery through forest effluent regulators – particularly Mary Ada & Gulf. ▪ Manage water delivery (750ML/day) through Gulpa Creek to stimulate & maintain waterbird breeding.	All WMA's Reed Beds	Winter / Spring / Summer	Unregulated flow events / Ovens River inflows / EWA allocation triggered	100GL+ 10GL+

[1] See Section 3.6 for information outlining the Water Management Areas within Barmah-Millewa Forest.

Specific water management regimes proposed for Barmah Forest in 2007-2008 under various seasonal conditions are outlined in Table 9. Watering is proposed only in the event of a 'Moderate' or better season with average/above average rainfall and inflows. Watering will be concentrated on wetland areas. In the event of continuing drought or otherwise dry year, no watering is proposed.

Table 9: Barmah Forest water management actions 2007-2008

Scenario	Strategy	Action	Location[1]	Timing	Triggers	Water
Very Dry Year	Maintain water within Murray	▪ Keep Regulators Closed ▪ Monitor water levels in unregulated anabranches through Barmah (primarily Little Budgie Creek – Budgee Creek system) to ensure that overbank flows do not occur on Steamer and War Plains.	All WMAs	All	Maintain Murray River below 10,300ML/d downstream of Tocumwal	Nil
Dry Year	Maintain water within Murray	▪ Keep regulators closed – where practicable ▪ Maintain Steamer and War Plains in Dry Phase. ▪ Boals Deadwoods and tertiary regulators are to be preferentially used for Unseasonal flows. Other regulators in Water Management Area G (eg Stuarts Kitchen and Bull Paddock) and Sandspit Regulator if necessary.	All WMAs WMA H2 WMA G	All Summer/Autumn	Nil Unseasonal Flows 10-12000 ML	Nil
Moderate	Water for maintenance of key representative / breeding areas	▪ Watering regime for waterways and Giant Rush wetlands and Boals Deadwoods.	All WMAs Boals Deadwoods (WMA G)	Winter / Spring Spring / summer	Unregulated flow events during Winter/Spring (fish in waterways and habitat maintenance and potential waterbird breeding in Giant Rush wetlands)	Nil 10GL+
Wet	Water for stimulation of breeding events and maintenance.	▪ Water delivery through forest effluent regulators – particularly Gulf, Boals and Top Island. ▪ Manage water delivery (35ML/d decreasing to 250ML/d) through Boals Deadwoods to simulate and maintain waterbird breeding.	All WMA's WMA F, G, H1, H2 and H4	Winter / Spring / Summer	Unregulated flow events / Ovens River inflows / EWA allocation triggered	100GL+ 10GL+

[1] See Section 3.6 for information outlining the Water Management Areas within Barmah-Millewa Forest.

16 Triggers for water application

16.1 The Living Murray 'New' water application

It is likely that there will be no 'new' environmental water available for application at Barmah-Millewa Forest in 2007-2008. In the event such water does become available, it is likely that it would be incorporated into the existing Barmah-Millea Forest EWA, should a release be triggered under its interim operating rules (see Appendix H).

16.2 Barmah-Millewa Forest Environmental Water Allocation

In 2006 New South Wales and Victoria re-borrowed the EWA for consumptive use due to the dry conditions and low to medium River Murray inflows in (including borrowing of their respective annual 50 GL contribution). The dry conditions have continued into 2007 eliminating the availability of the EWA for use in Barmah-Millewa Forest to date. In any event the EWA was used in 2005-2006 and is unlikely to be required 2007-2008 because of the following:

- the higher parts of Barmah-Millewa Forest are most in need of the water, but channel capacity constraints between Hume and Yarrawonga, combined with limited EWA availability would prevent these areas being watered under such a release; and
- only low levels of Barmah-Millewa Forest (i.e. floodplains and wetlands) could be targeted and these received watered during 2005-2006 and are not in dire need of another watering this year as some of the indented wetlands need to complete a drying phase.

If very wet conditions and high inflows do occur, then it is likely that any water borrowed by the states would be paid back into the EWA account by October 2007. Watering of the forest would most likely begin naturally through an Ovens River flood or spill from Hume Dam and part or all of the EWA may then be called on in accordance with the 'standard' triggers and rules (see Appendix H). The higher elevation parts of the forest (and high priority areas for water application) would be able to be watered using a combination of natural and EWA flows under this scenario.

The current EWA account for 2007-08 stands at **100** GL (100 GL annual allocation to be made on June 1st 2006), as summarised in Table 10.

Table 10: Summary of Barmah-Millewa Forest Environmental Water Account up to 2008[a]

Water year		2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
EWA at end of previous year	NSW	0	75	125	175	225	44
	Victoria	-50	25	75	125	175	-6
Annual EWA allocation	NSW	50	50	50	50	50	47.5
	Victoria	50[b]	50	50	50	50	47.5
Additional EWA based on Victoria reaching 30% + sales and a matching allocation from NSW	NSW	25	-	-	-	25	-
	Victoria	25	-	-	-	25	-
Potential Total	NSW	75	125	175	225	300	92
	Victoria	25	75	125	175	250	42
Total EWA available		100	200	300	400	550[d]	133[c]

[a] Accounts maintained by River Murray Water, in conjunction with Victorian Department of Sustainability and Environment; and New South Wales Department of Natural Resources.

[b] Note that Victoria's normal contribution of 50 GL for 2001-02 was advanced for use in 2000-01.

[c] Note that both Victoria and New South Wales may seek to temporarily borrow all of their respective components of the EWA if consumptive water availability remains low.

[d] Both states used 256 GL in 2005/06

16.3 Operational flows

There may be an opportunity to transfer water to Lake Victoria at rates above channel capacity through Barmah-Millewa Forest and if the Victorian component is paid back and available, there may be scope to consider possible use of part of the Victorian component of the EWA. However, as use of one jurisdiction's component of the EWA is contrary to the normal rules, it would have to be considered by the Murray-Darling Basin Commission and the Victorian Government.

16.4 Regulator operation

16.4.1 Seasonal flows

Flow triggers for regulator operation and Water Management Areas affected during seasonal flows in 2007-2008 are summarised in Table 11 and Table 12.

Table 11: Barmah Forest regulator operation for seasonal flows (June to December 2007)

River Murray Flow at Yarrawonga (ML/d)	Regulators to be opened	Water Management Areas (WMAs) affected
<12,000	Tertiary regulators plus partial Boals.	Predominately high ground in Boals WMA
12,000	Above (including all of Boals), plus Sandspit and partial Gulf	Smiths Creek and Boals Deadwood WMA
13,000	Boals, Sandspit, Bull Paddock, Stewarts Kitchen, 50% Gulf	Smiths Creeks, Boals Deadwood and Gulf Creek WMa
14,000	All 100% except for 75% Gulf WMA	All WMAs except parts of Boals Deadwood WMA
15,000 and greater	All	All

Table 12: Millewa Forest regulator operation for seasonal flows (June to December 2007)

River Murray Flow (ML/d) with duration of greater than 7 days	Regulators to be opened	Water Management Areas (WMAs) affected
11,000-12,000	Small freshes during the core flooding period can be used to assist refilling of dry wetlands.	Moira WMA
12,000 – 15,000	Mary Ada Regulator, Pinch Gut, House & Potts regulators	Mary Ada, Plantation
15,000 and greater	All regulators open	Potentially all WMAs

16.4.2 Unseasonal flows

In 2007-2008, it is the turn for Millewa Forest to accept unseasonal flows, as far as is possible (see Section 7.3). Accordingly, unseasonal Summer and Autumn flows up to 15,000 ML/d in 2007-2008 will trigger

regulator operation as (see Table 13) to allow these flows into Millewa Forest. Flows in excess of this will have to be progressively released into Barmah Forest waterways (see Table 14).

Table 13: Millewa Forest priority forest regulators for unseasonal flows (2007-2008)

River Murray Flow at Yarrawonga (ML/d)	Regulators to be opened	Water Management Areas (WMAs) affected
12,000	Tertiary Regulators at Sandspit	Predominantly high ground in WMA Smiths Creek
13,000	Tertiary Regulators at Sandspit plus Boals, Bull Paddock, Stewarts Kitchen, 50% Gulf	WMA Smiths Creek, Boals Deadwood and Gulf Creek
14,000	All 100% except for 75% Gulf	All WMAs
15,000	All	All WMAs

Table 14: Barmah Forest priority forest regulators for unseasonal flows (2007-2008)

River Murray Flow at Yarrawonga (ML/d)	Regulators to be opened	Water Management Areas (WMAs) affected
16,000	Following complete opening of Millewa Forest regulators, then Barmah tertiary regulators and Sandspit.	Predominantly waterways of WMA C (Smiths) and high ground in WMA G (Duck Hole/Boals)
17,000	Above, plus remaining regulators in WMA G (Bull Paddock, Stewarts Kitchen).	WMA Smiths Creek, Boals Deadwood and Gulf Creek
18,000	Above, plus Top Island and partial Gulf	WMA C, G, F, H1 (and by default most other WMAs)
19,000	Above, plus more of Gulf (plus likely to have to also operate Goose Swamp regulators for rainfall in Broken Creek catchment in the 'Wet' scenario)	All WMAs

17 Environmental Works and Measures Program

17.1 Environmental Works Program 2007-2010

Proposed Environmental Works and Measures Program located at Barmah-Millewa Forest Icon Site for 2007-2008 are shown below in Table 15 will manage environmental flows in order to improve the health of the icon site and achieve the ecological objectives.

Table 15: Proposed environmental works and measures 2007-2008

Project	Funding 2007-2008
Barmah Forest Tertiary Effluent Regulators upgrade/repairs ▪ This project will improve the accounting and efficiency of water regulation between the River Murray and Barmah-Millewa Forest where water management aims to achieve TLM objectives. ▪ The upgrade and repairs will enable greater flexibility, control and efficiency for the movement of environmental water within Barmah-Millewa Forest. EWMP Project I20 - Barmah Forest Water Management Plan and Works Cutting Creek Erosion Control Project – Feasibility Study & Concept design ▪ This project will continue to gather data to determine the rate of erosion of Cutting Creek and the deposition of sediments onto the northern end of the bed of Barmah Lake. ▪ The findings will formulate recommendations and options for control works and to provide a base line set of data before control works are initiated. Black Engine Creek Erosion Control Project – Feasibility Study & Concept design ▪ This project will continue to gather data to determine the rate of erosion of Black Engine Creek. ▪ The findings will formulate recommendations and options for control works and to provide a base line set of data before control works are initiated.	To be considered as part of the River Murray Water asset register. Not required.
Millewa Forest EWMP Project I06 – Rehabilitation of Tuppal Creek and Bullatale Creek systems ▪ This project is evaluating options to increase the operational flexibility of the Mid-Murray, with a primary driver of reducing unseasonal flooding of Barmah-Millewa Forest. ▪ Investigations to date have considered works required to increase the diversion capacity of the Tuppal Creek and/or Bullatale Creek systems and the ecological consequences of such actions within the receiving streams.	$530,000

Project	Funding 2007-2008
Current investigations are considering the capacity restraints of the Edward-Wakool system, and its ability to convey water to downstream areas. ▪ Investigations in 2007/2008 shall include the finalisation of options and the development of concept designs of the preferred option.	
Millewa Forest EWMP project I19 – Structural and Flow Options for Millewa Forest ▪ *Eastern Millewa regulators* Investigate opportunities to improve flooding characteristics of the Eastern Millewa forest. This area has a reduced duration and frequency of floods resulting in forest health decline. ▪ Investigations to use the forest model being developed by Goulburn Broken CMA to develop and assess opportunities to improve forest flooding in priority areas of the eastern Millewa forest. ▪ *Moira Lake Rehabilitation – Stage 3* Finalisation of concept and final designs for the construction of a drainage channel and regulating structures that will create the opportunity to drain the Moira Lake wetland system (independent of the regulated river levels). ▪ River regulation has resulted in the lake being permanently inundated which in turn has reduced the ecological values. ▪ *Fish passage to all weirs* Fish commonly become stranded behind regulators when they move from the floodplain into creeks/rivers after flood events. ▪ These investigations shall prioritise structures requiring either operational changes or structural changes to address this issue.	$935,000

Project	Funding 2007-2008
EWMP Project I53 – Edward River Fishways (Stevens Weir & Edward River Offtake Regulator) ▪ Currently Stevens Weir is a fish migration barrier from downstream to upstream habitats. The fishway will increase the available habitat and connectivity with Barmah-Millewa Forest floodpain for fish breeding and recruitment purposes. ▪ A new fish way structure will be constructed to replace the existing fish way structure at the Edward River Offtake Regulator. The existing fish way is ineffectual, and requires replacement. ▪ It is anticipated that Freshwater Catfish, Trout Cod, Silver Perch, Golden Perch, Murray Cod and many other native species will benefit from the construction of these fishways.	$378,000
Barmah-Millewa Forest Mary Ada (Millewa) and Gulf Creek Regulator (Barmah) works feasibility study ▪ This project will improve fish passage provisions at key regulator sites within Barmah and Millewa Forests and in turn enhance the fish values of the Forest and River Murray system.	Condition Monitoring Plan will confirm management alteration.
Outside of Barmah-Millewa Forest EWMP Project I52 – Optimisation of Lake Mulwala and River Murray Operational Flexibility ▪ This project will consider options that address the issue of system capacity and unseasonal flooding of the Barmah-Millewa forest. ▪ The focus of this project will be to assess the outcomes of options on a catchment scale, and how combinations of options may be used to achieve complementary outcomes.	No budget currently available.
Other (Barmah Forest) Refurbishment and renewal of strategic low-lying flood management structures has been deferred to commence in 2007-2008.* *Additional works from other funding sources.	Not an EWMP project covered by funding from River Murray Water.

18 Monitoring projects

An opportunity exists for the funding of monitoring projects during the 2007-2008 financial year. Approved monitoring projects will address the refined ecological objectives (see Section 4.2), Draft Outcomes, Evaluation Monitoring Framework and Condition Monitoring Plan (to be finalised by June 2007), and endorsed by both the Technical Advisory Committee and Coordinating Committee. When an Environmental Water Allocation is delivered water quality, bird and fish breeding and recruitment success will be monitored occur during and immediately after the event.

19 Draft Budget

The MBDC, through the Living Murray initiative, provides an annual budget to support the development and implementation of the Living Murray Icon Site EMPs. This funding is used to provide project funding to develop and implement the Icon Site EMP and to undertake consultation and monitoring.

An Environmental Works and Measures Program is also funded by the MDBC. This program undertakes activities associated with construction of operations measures at each icon site to provide for efficient delivery and management of environmental water to meet the ecological objectives of the icon site. The MDBC has advised of a draft 2007-2008 budget of $744,000 to support activities to achieve the ecological outcomes at Barmah-Millewa Forest Icon Site (see Table 16).

Table 16: Draft Barmah-Millewa Forest Icon Site operational budget 2007-2008

Task	Description	Estimated commitment as at 1 June 2007 (GST exclusive)*
Environmental Management Plan	Icon Site EMP (including Watering Plans)	$219, 000
Administration	Project management (salary and Project Officer operating costs)	$117, 000
Monitoring and Evaluation	Monitoring and evaluation projects	$312, 000
Consultation	CRG operation, consultation (including Indigenous consultation), and promotional expenses	$52, 000
Draft Total		**$744, 000**

* Please note that this budget is indicative.

References

Abel N. and O'Connell D. (2006) *Values from Barmah Forest,* in *Barmah Forest: A review of its values, management objectives and knowledge base*, Goulburn Broken Catchment Management Authority, 2006

BMF (2004) 2004-2005 *Annual Operating Plan*, Barmah-Millewa Forum, Albury.

Bren L. (1990) *Red Gum Forests,* in *The Murray*, Mackay N. and Eastburn D. (eds) pp 17-39, Murray Darling Basin Commission, Canberra

Bren, L. J., O'Neill, I.C. & Gibbs, N.L. (1987) *Flooding in the Barmah Forest and its relation to flow in the* Murray-Edward River System. Aust. For. Res., 1987, 17, 127-144.

Bren, L. J., O'Neill, I.C. & Gibbs, N.L. (1988) Use of map analysis to elucidate flooding in an Australian riparian River Red-gum forest. Water Resources Research, Vol 24, No. 7, Pages 1152-1162.

Davey M. and Wild J. (2005) *Healthy Soils Mapping Project*, Murrumbidgee Catchment Management Authority, Department of Natural Resources and Department of Primary Industry.

DSE and GBCMA (2005) *Asset Environmental Management Plan: Barmah Significant Ecological Asset – Draft 11 May 2005*. Department of Sustainability and Environment, Benalla and Goulburn Broken Catchment Management Authority, Shepparton.

DCE (1992) *Barmah Management Plan - Barmah State Park & Barmah State Forest*. Department of Conservation and Environment, Victoria. ISBN 0 7306 2248 7.

Dexter, B.D. (1978) *Silviculture of the River Red-gum forests of the central Murray floodplain*. Proceedings of the Royal Society of Victoria **90**: 175-194.

DSE (2003) *Barmah Forest Ramsar Site: Strategic Management Plan*. Department of Sustainability and Environment, Melbourne.

FCNSW (1987) *Murray Management Area Management Plan*, Forestry Commission of NSW, Sydney.
Forests NSW and DPI Aboriginal Liaison and Cultural Heritage Unit (2006) *Operational guidelines for Aboriginal cultural heritage management*

GBCMA (2003) *Regional Catchment Strategy.* Goulburn Broken Catchment Management Authority, Shepparton.

Leitch, C. (1989) *Towards a strategy for managing the flooding of Barmah Forest.* Seminar on Barmah Forest organised by the State Working Group on River Murray Wetland and Forest Management, Department of Conservation Forests and Lands, Benalla Region, Victoria.

Maunsell Pty Ltd (1992) *Barmah-Millewa Forests Water Management Plan*. Final Report to the Murray-Darling Basin Commission, January 1992. Murray Darling Basin Commission, Canberra City, ACT.

MDBC (2003) *Communiqué* – 14 November 2003, Murray-Darling Basin Commission, Canberra, ACT.

MDBC (2004a) *The Living Murray Environmental Works and Measures Program*, Murray-Darling Basin Commission, Canberra, ACT.

MDBC (2004b) *Living Murray Business Plan*, Murray-Darling Basin Commission, Canberra, ACT.

MDBC (2005) *The Living Murray Environmental Watering Plan 2004-2005 Interim Arrangement*. Murray-Darling Basin Commission, Canberra, ACT. Publication No. 08/05

MDBC (2005a) *Fact Sheet 6: The Barmah Choke*, as accessed Monday 16th May 2005 at www.mdbc.gov.au/river_murray/river_murray_system/barmah/barmah_choke.htm

MDBC (2005b) *Draft 2005-2006 Work Plan Environmental Works and Measures Program*, Murray-Darling Basin Commission, Canberra, ACT.

MDBC (2005c) *The Living Murray Foundation Report on the significant ecological assets targeted in the First Step Decision,* Murray-Darling Basin Commission, Canberra, ACT.

MDBC (2006) *Water application across the River Murray system and Icon Sites: Status Report.* Murray Darling Basin Commission, Canberra ACT. Publication No. 25/06

NRE (2002) *Forest Management Pan for the Mid-Murray Forest Management Area.* Department of Natural Resources and Environment, Victoria.

REG C (2003) *Regional Evaluation Reference Group assessment of reference point flow scenarios for Zone C of the River Murray system (Yarrawonga Weir to the Wakool junction).* Regional Evaluation Group C report as part of the Scientific Reference Panel to The Living Murray, Murray-Darling Basin Commission,

Canberra.

Reid J. (2006) *Waterbirds and water regimes* in *Barmah Forest: A review of its values management objectives and knowledge base*, Goulburn Broken Catchment Management Authority, 2006.

Roberts J. (2006) *Floodplain vegetation responses to water regime, grazing and fire,* in *Barmah Forest: A review of its values management objectives and knowledge base*, Goulburn Broken Catchment Management Authority, 2006.

Roberts, J. & Marston, F. (2000) Water regime of wetland and floodplain plants in the Murray-Darling Basin. A sourcebook of ecological knowledge. Technical Report 30-00, CSIRO Land and Water, Canberra.

Rutherford I. (1990) *Ancient River, Young Nation*, in *The Murray*, Mackay N. and Eastburn D. (eds) pp 17-39, Murray Darling Basin Commission, Canberra

Sharley, T. & Huggan, C. (eds) (1995) Chowilla resource management plan: final report, March. Prepared by the Chowilla Working Group in consultation with the Chowilla Reference Group, Murray-Darling Basin Commission, Canberra.

SFNSW and DLWC (1996) *Water Management Plan for the Millewa Forests*, State Forests of New South Wales, Deniliquin, NSW.

SFNSW & NSW NPWS (2002) *Information Sheet on Ramsar Wetlands – Central Murray Red Gum Forests.* State Forests of NSW and NSW National Parks and Wildlife Service.

Smith P. and Smith J. (1990) *Floodplain Vegetation,* in *The Murray*, Mackay N. and Eastburn D. (eds) pp 17-39, Murray Darling Basin Commission, Canberra

Stone, A. (1991) *Economic evaluation of wetlands, Wetland Conservation Report Series: Number 1*, Department of Conservation and Natural Resources, Melbourne.

Ward, K. A. (1991) *Barmah-Millewa Forests trial watering -Investigation of the Moira Grass plains in Barmah Forest, Victoria*. Report prepared for the Murray-Darling Basin Commission. NRMS Project No. M007B. Floodplain Ecology Group. Department of Conservation & Environment, Victoria.

Young, W.J. (ed.) (2001) *Rivers as Ecological Systems - the Murray-Darling Basin.* Murray-Darling Basin Commission, Canberra

Appendix A Flora species of conservation significance

Common Name	Scientific Name	Victorian FFG Act	EPBC Act	VROTS	NSW Threatened Species
Annual Bitter-cress	*Cardamine paucijuga s.s.*			v	
Austral Pillwort	*Pilularia novae-hollandiae*				e
Austral Trefoil	*Lotus australis*			k	
Bear's-ear	*Cymbonotus lawsonianus*			r	
Blue Burr-daisy	*Calotis cuneifolia*			r	
Bluish Raspwort	*Haloragis glauca f. glauca*			k	
Buloke	*Allocasuarina luehmannii*	L			
Buloke Mistletoe	*Amyema linophylla subsp. orientale*			v	
Button Rush	*Lipocarpha microcephala*			v	
Common Joyweed	*Alternanthera nodiflora*			k	
Cotton Sneezeweed	*Centipeda nidiformis*			r	
Dark Roly-poly	*Sclerolaena muricata var. semiglabra*			k	
Downs Nutgrass	*Cyperus bifax*			v	
Dwarf Bitter-cress	*Rorippa eustylis*			r	
Dwarf Brooklime	*Gratiola pumilo*			r	
Fat Spectacles	*Menkea crassa*	L		e	
Hypsela	*Hypsela tridens*			k	
Lax Flat-sedge	*Cyperus flaccidus*			v	
Mountain Swainson-pea	*Swainsona recta*	L	E	e	e
Mueller Daisy	*Brachyscome muelleroides*	L	V	e	v
Native Peppercress	*Lepidium pseudohyssopifolium*			k	
Reader's Daisy	*Brachyscome readeri*			r	
Ridged Water-milfoil	*Myriophyllum porcatum*		V		
River Swamp Wallaby Grass	*Amphibromus fluitans*		V		
Swamp Wallaby-grass	*Amphibromus fluitans*		V		v
Slender Bitter-cress	*Cardamine tenuifolia*			k	
Slender Darling-pea, Slender Swainson, Murray Swainson-pea	*Swainsona murrayana*		V		
Slender Love-grass	*Eragrostis exigua*			e	
Slender Sunray	*Rhodanthe stricta*	L		e	

Slender Tick-trefoil	*Desmodium varians*			k	
Small Scurf-pea	*Cullen parvum*	L	E	e	e
Smooth Groundsel	*Senecio glabrescens*			r	
Smooth Minuria	*Minuria integerrima*			r	
Spiny-fruit Saltbush	*Atriplex spinibractea*			e	
Squat Picris	*Picris squarrosa*			r	
Summer Fringe-sedge	*Fimbristylis aestivalis*			k	
Tricolour Diuris	*Diuris sheaffiana*		V		
Twiggy Sida	*Sida intricata*			v	
Umbrella Wattle	*Acacia oswaldii*			v	
Violet Swainson-pea	*Swainsona adenophylla*			e	e
Winged Peppercress	*Lepidium monoplocoides*	L	E	e	
Yelka	*Cyperus victoriensis*			k	
Yellow-tongue Daisy	*Brachyscome chrysoglossa*	L		v	

Source: Victorian Flora Information System (2007), Environmental Protection and Biodiversity Conservation Act 1999

EPBC Act: Listed under the Environment Protection and Biodiversity Conservation Act, 1999 (CE- critically endangered, E- endangered, V- vulnerable).

NSW Threatened Species: listed under the NSW Threatened Species Conservation Act, 1995;

VROTS: Victorian Rare or Threatened Species list. (e – endangered, v – vulnerable, r – rare, k – data deficient).

Victorian FFG: listed under the Victorian Flora and Fauna Guarantee Act, 1988, (e, endangered; v, vulnerable; r, rare; k, poorly known in Victoria; L, listed)

Appendix B Fauna species of conservation significance

Common Name	Scientific Name	Victorian FFG Act	EPBC Act	VROTS	JAMBA/ CAMBA	NSW Threatened Species
Australasian Bittern	*Botaurus poiciloptilus*	L		e		v
Australian Painted Snipe	*Rostratula australis**		V			
Azure Kingfisher	*Alcedo azurea*			n		
Barking Marsh Frog	*Limnodynastes fletcheri*			d		
Barking Owl	*Ninox connivens*	L		e		v
Black-chinned Honeyeater	*Melithreptus gularis*			n		v
Blue-billed Duck	*Oxyura australis*	L		e		v
Brush-tailed Phascogale	*Phascogale topoatafa*	L		v		v
Brolga	*Grus rubicunda*	L		v		v
Brown Toadlet	*Pseudophryne bibronii*			e		
Brown Treecreeper	*Climacteris picumnus*			n		v
Bush Stone-curlew	*Burhinus grallarius*			e		e
Cattle Egret	*Ardea ibis*		M		J, C	
Caspian Tern	*Hydropogne caspia*				C	
Carpet Python	*Morelia spilota metcalfei*	L		e		
Murray Rainbowfish	*Melanotaenia fluviatilis*	L		d		v
Diamond Dove	*Geopelia cuneata*	L		n		
Diamond Firetail	*Stagonopleura guttata*	L		v		v
Eastern Bearded Dragon	*Pogona barbata*			d		
Eastern Long-eared Bat	*Nyctophilus timoriensis (South-eastern form.*		V			
flat-headed galaxias	*Galaxias rostratus*					v
Freshwater Catfish	*Tandanus tandanus*	L		e		
Freckled Duck	*Stictonetta naevosa*	E				v
Fork-tailed Swift	Apus pacificus				J, C	
Gilberts Whistler	*Pachycephala inornata*					v
Glossy Ibis	*Plegadis falcinellus*			n	C	
Golden Perch	*Macquaria ambigua*			v		
Greenshank	*Tringa nebularia*				J. C	
Great Egret	*Ardea alba*	L		v	J, C	
Grey-crowned Babbler	*Pomatostomus temporalis*	L		e		
Hardhead	*Aythya australis*			v		
Hooded Robin	*Melanodryas cucullata*	L		n		v

Common Name	Scientific Name	Victorian FFG Act	EPBC Act	VROTS	JAMBA/ CAMBA	NSW Threatened Species
Intermediate Egret	*Ardea intermedia*	L		c		
Large-footed Myotis	*Myotis adversus*			l		v
Latham's Snipe	*Gallinago hardwickii*			n	J, C.	
Lewin's Rail	*Rallus pectoralis*	L		v		
Little Bittern	*Ixobrychus minutus*	L		e		
Little Egret	*Egretta garzetta*	L		e		
Macquarie Perch	*Macquaria australasica*	L	E	e		
Marsh Sandpiper	*Tringa stagnatilis*				C	
Masked Owl	*Tyto novaehollandiae*	L		e		v
Meuller Daizy	*Brachyscome muelleroides*		V			
Murray Cod	*Maccullochella peelii peelii*	L	V	e		e
Murray Heardyhead	*Craterocephalus fluviatilis*		V			e
Musk Duck	*Biziura lobata*			v		
Nankeen Night Heron	*Nycticorax caledonicus*			n		
Olive perchlet	*Ambassis agassizi*					e
Painted Honeyeater	*Grantiella picta*	L		v		v
Painted Snipe	*Rostratula benghalensis s. lat*		M		C	e
Pied Cormorant	*Phalacrocorax varius*			n		
Plains Wanderer	*Pedionomus torquatus*		V			
Purple-spotted Gudgeon	*Mogurnda adspersa*			e		e
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*					v
Red-capped Robin	*Petroica goodenovii*					
Red-necked Stint	*Calidris ruficollis*				J, C	
Regent Honeyeater	*Xanthomyza phrygia*		E, M			e
Royal Spoonbill	*Platalea regia*			v		
Sharp Tailed Sandpiper	*Calidris acuminata*				J, C	
Silver Perch	*Bidyanus bidyanus*	L		c		v
Southern Bell Frog, Growling Grass Frog, Warty Bell Frog, Green and Golden Frog	*Litoria raniformis*		V			
Southern Pygmy Perch	*Nannoperca australis*					v

Common Name	Scientific Name	Victorian FFG Act	EPBC Act	VROTS	JAMBA/ CAMBA	NSW Threatened Species
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll,	southeastern mainland population *Dasyurus maculatus maculatus* SE mainland population		E			
Squirrel Glider	*Petaurus norfolcensis*	L		e		v
Square-tailed Kite	*Lophoictinia isura*		R	e		v
Striped legless Lizard	*Delma impar*		V			
Swift Parrot	*Lathamus discolor*		E			e
Superb Parrot	*Polytelis swainsonii*	L	V	e		v
Tree Goanna	*Varanus varius*			v		
Tree Martin	*Hirundo nigricans*					
Trout Cod	*Maccullochella macquariensis*	L	E	c		
Turquoise Parrot	*Neophema pulchella*			l		v
Whiskered Tern	*Chlidonias hybridus*			n		
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	L		v	C	
White-throated Needletail	*Hirundapus Caudacutus*				J, C	

Source: Atlas of Victorian Wildlife DSE (2007) Barmah Forest Ramsar Site Strategic Management Plan and SFNSW & NSW NPWS (2002) and EPBC Act (www.environment.gov.au/epbc/index.html)

JAMBA-CAMBA: Listed under migratory bird agreements (J: Japan - Australia Migratory Bird Agreement; C: China - Australia Migratory Bird Agreement).

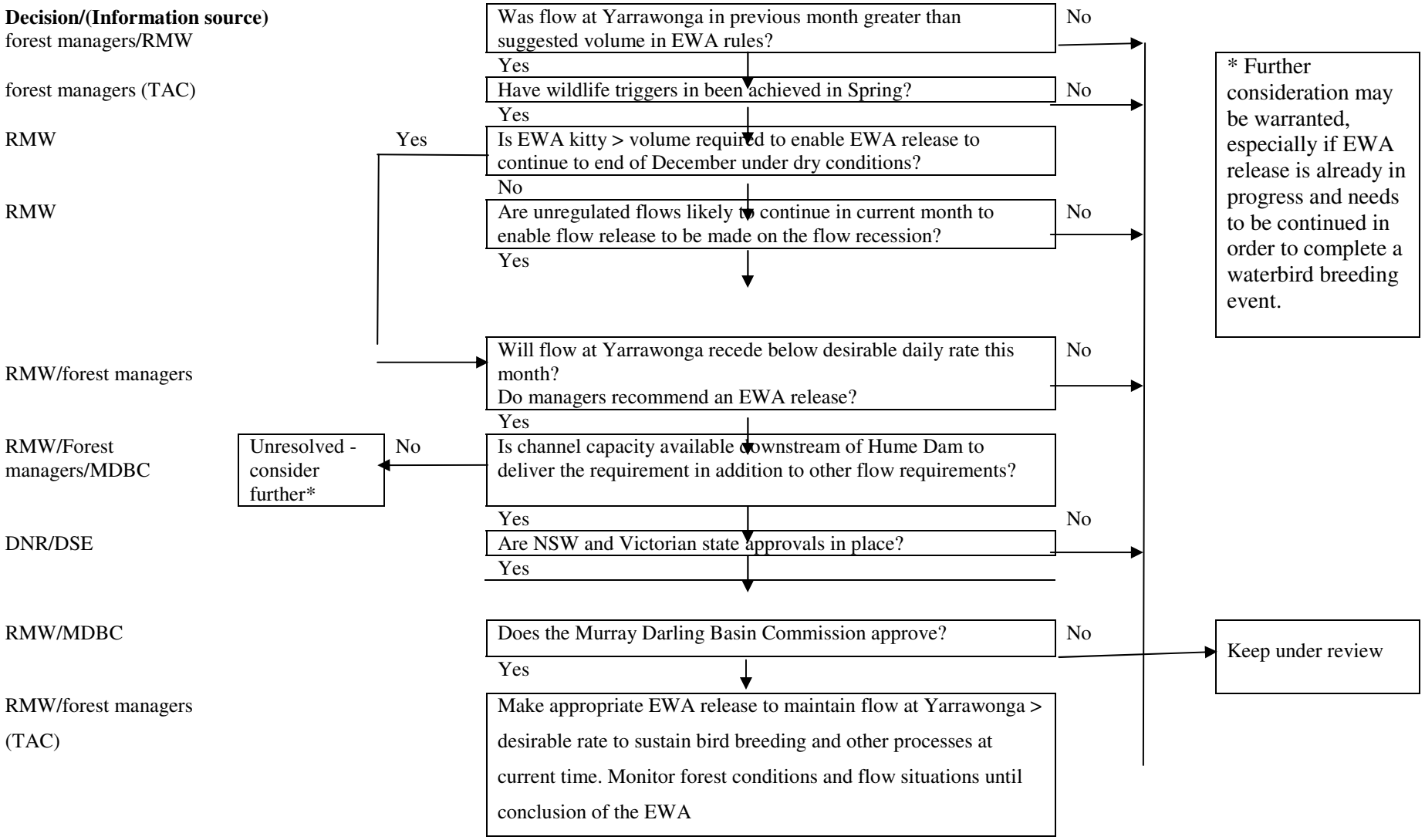
EPBC Act: listed under the Environment Protection and Biodiversity Conservation Act, 1999 (CE-critically endangered, E-endangered, V-vulnerable and M- migratory).

NSW Threatened Species: listed under the NSW Threatened Species Conservation Act, 1995; (endangered, v-vulnerable, ep-endangered population).

VROTS: Victorian Rare or Threatened Species list 2007 (e – endangered, v – vulnerable, r – rare, k – data deficient).

Victorian FFG: Listed under the Victorian Flora and Fauna Guarantee Act, 1988, (e-endangered, v-vulnerable, r-rare, k, poorly known in Victoria, L-listed)

Appendix C Barmah-Millewa Forest EWA Release Decision Pathway



Appendix D Relevant legislation and planning documents

D.1 Legislation

Numerous state and Commonwealth legislation and various planning instruments regulate activities within the Barmah-Millewa Forest. These include a large number of Acts, amendment acts and regulations, the key ones of which are listed below.

Table 17: Legislation relevant to activities within Baramh-Millewa Forest

Jurisdiction	Legislation/Planning Instrument
New South Wales	▪ Murray Shire Local Environmental Plan ▪ Murray Regional Environmental Plan No. 2 ▪ Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2003 ▪ Forestry Act 1916 ▪ National Parks and Wildlife Act 1974 ▪ Threatened Species Conservation Act 1995 ▪ Fisheries Management Act 1995 ▪ Aboriginal Land Rights Act 1983 ▪ Native Title (New South Wales) Act 1994 ▪ Water Act 2000 ▪ Protection of the Environment Operations Act 1997
Victoria	▪ Reference Areas Act 1978 ▪ Flora and Fauna Guarantee Act 1988 ▪ Forests Act 1958 ▪ National Parks Act 1975 ▪ Victorian Water Act 1989 ▪ Sustainable Forests (Timber) Act 2004 ▪ Archaeological and Aboriginal Relics Preservation Act 1972 ▪ Environment Protection Act 1970
Commonwealth	▪ Aboriginal and Torres Strait Islander Heritage Protection Act 1984 ▪ Environment Protection and Biodiversity Conservation Act 1999*

The value of the biodiversity of the Barmah-Millewa Forest has been well recognised over time, as reflected by the environmental objectives set in the various management plans that

regulate activities in the forest.

* Barmah-Millewa Forest includes parts of the Barmah Forest and New South Wales Central Murray State Forests Ramsar sites. Activities proposed under this plan may impact on the ecological character of a Ramsar wetland, or other matters of national environmental significance, such as listed migratory species, and listed threatened species and ecological communities.

Implementation of this plan will take due account of EPBC Act requirements and where appropriate and will refer activities for determination on whether the action requires approval under the EPBC Act.

D.2 Planning Instruments

Table 18: Key planning documents and agreements for Barmah-Millewa Forest

	Strategies, Plans and Agreements
National	▪ National Water Initiative (COAG) ▪ Convention on Wetlands, Ramsar, Iran 1971.
Murray Darling Basin	▪ Murray-Darling Basin Agreement ▪ Murray-Darling Basin Salinity Management Strategy ▪ River Murray Water's Annual Operating Plans ▪ The Living Murray Initiative-First Step Decision ▪ Inter-governmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the MDB (MDB-IGA) ▪ Environmental Works and Measures Program ▪ Initial Living Murray Environmental Watering Plan 04-05 Interim Arrangements ▪ Memorandum of Understanding between Murray Lower Darling Rivers Indigenous Nations and Murray Darling Basin Commission ▪ The Living Murray Indigenous Partnerships Project Business Case and Action Plan 2006
Victoria	▪ Victorian River Health Strategy ▪ Victoria's Biodiversity Strategy ▪ Report on the Murray Valley Area (Land Conservation Council) ▪ Victorian Environmental Assessment Council ▪ Ramsar Site Strategic Management Plan ▪ Victorian River Health Strategy ▪ Goulburn-Broken Regional Catchment Strategy ▪ Barmah Forest Ramsar Site Strategic Management Plan ▪ Mid Murray Forest Management Plan ▪ Barmah State Park and Barmah State Forest Management Plans ▪ Barmah-Millewa Forest Water Management Strategy
New South Wales	▪ Operational guidelines for Aboriginal cultural heritage management ▪ Water Management Plan for the Millewa Forests ▪ Murray Management Area Management Plan ▪ Grazing Strategy for the Riverina Region ▪ Barmah-Millewa Forest Water Management Strategy

Appendix E Identifying priority Water Management Areas and Sites

E.1 Priority Water Management Area identification

As occurred in the Barmah-Millewa Forum's Annual Operating Plans, which set out their advice to the MDBC regarding management of Seasonal and Unseasonal flows and potential use of the Forests' EWA, a 'numeric scoring method' proposed by Associate Professor Bren of the University of Melbourne has been used to determine priority WMAs for 2007-2008. Under this method, each WMA is assigned an 'annual flood score' based upon flood rankings from 0 for 'no flooding at all' to 3 for 'completely flooded'.

Given that Professor Bren's ideal flooding score is based on the ideal long term flooding frequency, a 7-year period has been used to analyse the present flooding history.

As is shown in the table below, the scores assigned for flood year 2000 were largely '3's' while those assigned for the dry years 1999, 2001 and 2002 are all close to 0.

Adopting a 7-year weighted score and an arbitrary cut off at –3.4, the analysis, not surprisingly given the number of recent dry years in the record, shows 13 WMA's as priority watering areas for 2007-2008.

E.2 Priority site identification

Priority sites listed in this plan are generally sites historically known to support colonial-nesting waterbirds and Moira Grass plains and meadows.

Table 19: Application of Numeric Flood Scoring

	Observed flooding score													
Water Management Area	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Ideal average annual flood score#**	**Accumulated score, Winter 1998-2006**	**Ideal score, Winter 1998-2006**	**Surplus Deficiency, Winter 1998-2006**	**Watering analysis 200 2007^**
Kynmer Creek (A)	1	1	2	0	1	0	0	1	0	1.3	6	11.7	-5.7	Priority
Tongalong Creek (B)	1	1	3	0	1	1	1	2	0	1.5	10	13.5	-3.5	
Smiths Creek (C)*	3	1	3	0	1	0	0	2	0	1.5	10	13.5	-3.5	
Yielima (D)	2	1	3	0	0	0	0	2	0	1.5	8	13.5	-5.5	Priority
Black Swamp (E)*	2	1	3	0	0	0	0	1	0	1.6	7	14.4	-7.4	Priority
Gulf Creek (F)	2	1	3	0	2	1	1	3	0	1.9	13	17.1	-4.1	Priority
Boals Deadwood (G)	2	1	2	0	1	1	1	3	0	1.9	11	17.1	-6.1	Priority
Top Island (H1)	2	1	3	0	1	1	1	3	0	1.9	12	17.1	-5.1	Priority
Steamer/War Plain (H2)	2	1	3	0	2	2	2	3	1	2.0	16	18.0	-2.0	
Goose Swamp (H3)	1	1	3	0	1	1	0	0	0	1.6	7	14.0	-7.0	Priority
Barmah Island (H4)	2	1	3	0	2	2	2	1	0	2.0	13	18.0	-5.0	Priority
Aratula Creek (J)	3	0	3	0	0	0	0	1	0	1.5	7	13.5	-6.5	Priority
Plantation (L)	2	0	3	0	0	1	0	1	0	2.0	7	18.0	-11.0	Priority
Mary Ada (M)	3	0	3	0	0	1	1	2	0	1.9	10	17.1	-7.1	Priority
Edward River (N)	3	1	3	0	0	1	1	2	0	2.3	11	20.7	-9.7	Priority
Towrong Creek (P)	3	0	3	0	0	0	1	2	0	1.4	9	12.6	-3.6	
St Helena Swamp (Q)	2	1	3	0	0	1	1	2	0	2.2	10	19.8	-9.8	Priority
Gulpa Creek (R)	2	1	3	0	0	1	2	1	0	2.2	10	19.8	-9.8	Priority
Moira Lake (S)	2	1	3	0	2	1	2	2	1	2.0	14	18.0	-4.0	Priority

Dr Leon Bren's scoring basis

0 = 'no flooding the WMA'
1 = 'some flooding the WMA'
2 = 'lot of flooding' ^
3 = 'completely flooded'

Based on the proportion of wetlands, SQI, SQII, SQIII in each WMA and desirable flooding frequencies of 10 years out of 10 for wetlands, 8 years, 5 years and 3 years out of 10 for SQI, SQII and SQIII.

Priorities are determined using arbitrary cut-off of -4.0

* Water management of Black Swamp WMA (E) is hydraulically linked to Smiths WMA (C).

H2-H4 Scoring for these WMAs was previously presented as part of H1 scores.

E.3 Future Identification of priority sites

With the advent of The Living Murray and consequent opportunities for increased environmental water allocation, a process will be developed to identify the priority sites to deliver environmental water to meet the ecological objectives.

Identification of priority sites will be based on an assessment that includes:

- contribution to meeting the ecological objectives;
- conservation value;
- area;
- degree of threat;
- feasibility of providing water in the required regime;
- predicted long-term success and quality of the outcome;
- ability to manage other issues which would limit the ability to meet the objectives; and
- generation or magnification of a threat resulting from environmental water management.

Appendix F Existing objectives from relevant documents

Asset Environmental Management Plan: Barmah Significant Ecological Asset – Draft 11 May 2005

OBJECTIVES &/OR TARGETS

General ecological objectives:

- protect the ecological character of the floodplain, as required under the Ramsar convention;
- enhance the ecological functions and diversity of the floodplain by re-instating a more natural flood regime;
- enhance breeding and recruitment of native floodplain fauna and germination and regeneration of native flora;
- provide suitable habitat conditions for native flora and fauna;
- ensure that all natural, flow related ecological functions can occur;
- protect and restore Moira Grass plains; and
- ensure breeding success of colonial waterbirds.

The overall ecological targets:

- provide successful recruitment of large colonies of colonial waterbirds at least 3 years in 10;
- increase the area and quality of Moira Grass plains;
- provide breeding opportunities for floodplain fish, frogs and tortoises;
- provide Winter-Spring floods to 50% of red gum forest; and
- provide Winter-Spring floods to a proportion of all Barmah-Millewa wetland communities.

More detailed ecological objectives and associated hydrological conditions are below:

Ecological objective	Associated hydrological conditions
• Reduce encroachment of Giant Rush and River Red-gum onto Moira Grass plains	Flow maintained <10,600 ML/day during Summer and Autumn (ie. prevent unseasonal flooding)
• Maintain health of sedges, Giant Rush and wetland communities; assist maintenance of majority of Moira Grass; maintain up to half of River Red-gum forest; provide events suitable for successful waterbird breeding o 55% of forest inundated	• 4-month flood of 400 - 550 GL/month for 4 months in 50% of years (equivalent to average daily flow of 13,135 ML/day to 18,330 ML/day) • Less than 5 years between these events
• Maintain health of majority of River Red-gum forest; maintain some River Red-gum woodland o 66% of forest inundated	760 GL/month (equivalent to average daily flow 25,300 ML/day) in 40% of years; any month Aug-Nov, duration 4 months
• Maintain up to one half of River Red-gum woodland communities o 75% of forest inundated	912 GL/month (equivalent to average daily flow 30,400 ML/day) in 30% of years; any month Aug-Nov, duration 1 – 4 months

Water Management Plan for the Millewa Forests				
Key result areas	**Objectives**	**Strategies**	**Performance Indicators**	**Target levels/dates**
Floodplain forest ecology	To maintain and where possible improve existing forest values.	Emulate natural flooding and drying regimes in terms of frequency, duration and seasonality. Develop methodology to identify variations to forest health and condition since Hume Dam construction (1936).	Maintain areas of existing River Red-gum site quality types. Report on significant variations in each Water Management Area.	7000 ha Site Quality 1 and 13 000 ha Site Quality 2 forest. Complete assessments for the St Helena, Edward, Gulpa and Moira Water Management Areas by 2006.
Wetlands	To maintain and where possible improve the abundance and diversity of wetland dependent flora and fauna.	Emulate natural flooding and drying regimes in terms of frequency, duration and seasonality.	Abundance and diversity of key waterbird and native fish populations.	Formation of new egret colonies and a Whiskered Tern colony by 2006. Evidence of native fish recruitment within Moira Lake by 2006.
Waterways management	Emulate natural flooding and drying regimes in terms of frequency, duration and seasonality.	June-December – supply water to the forests to the best possible advantage. January-May – minimise the peak flow and duration of rain rejection events to the extent possible.	Volume of water released for forest and wetland water management. Review of Hume Dam pre-release strategy. Development of a rain rejection flow impact minimisation strategy.	Subject to further evaluation.

The Barmah-Millewa Forest Water Management Strategy

OBJECTIVES &/OR TARGETS

- to manage the Barmah-Millewa Forest as a single ecosystem for the purposes of water management
- to optimise use of river flows to enhance water management of the environment
- to facilitate effective water management by refining the division of forest into areas that can be managed independently or semi- independently
- to provide, operate and maintain water management works or structures required for economic and effective operation of the Water Management Strategy
- to record and evaluate information on the forest's history and past and on-going management practices, and apply that information to water management and to assessment of the Water Management Strategy's performance
- to monitor, record and evaluate scientific information required to manage water flow operations efficiently, and to use that information in assessing the Water Management Strategy's performance and in managing adaptively
- to monitor, record and evaluate socio-economic information to assist in managing water flow operations, and to use that information in assessing the Water Management Strategy's performance and in managing adaptively
- to increase knowledge of the needs of environmental watering regimes and of water management practices, and to apply that knowledge in assessing the Water Management Strategy's performance and in managing adaptively
- develop plans to implement the Water Management Strategy with maximum effectiveness

Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2003

OBJECTIVES &/OR TARGETS

- improve opportunities for natural regeneration and breeding cycles and ecological processes reliant on seasonal patterns, in particular by reinstating more natural wetting and drying cycles
- increase the connectivity between the river and floodplain during Spring and early Summer
- contribute to the maintenance or enhancement of the physical habitats of the river system
- improve the opportunities for breeding of native fish and other native organisms by encouraging the migration of native fish and allowing access to spawning sites, food sources and improved water quality, including correct thermal conditions
- promote the recovery of threatened species, populations and ecological communities
- contribute to expansion and diversification of river bank habitat
- contribute to maintenance of bank stability
- assist in maintenance of the ecological health of anabranches and billabongs, particularly for habitat that may not be provided in the main river channel
- contribute to the maintenance or improvement of water quality to downstream water environments
- protect basic landholder rights to access water
- enhance the viability, sustainability and security of primary and secondary, recreational and tourist industries, and the communities of the Murray-Lower Darling region.

Entitlements to the Murray: Outcomes of works to define how Victoria's River Murray water is to be shared (1999)

OBJECTIVES &/OR TARGETS

The purpose of these bulk entitlements is to convert existing rights to Victoria's water from the River Murray to clearly defined entitlements in order to:

- protect the environment
- prevent erosion of existing water rights
- set rules about how water will be shared in droughts
- provide a basis for trade of entitlements to higher value uses – including incentives for efficiency improvements
- implement the cap on diversions established by the MDB Ministerial Council

Appendix G Terms of Reference for Barmah-Millewa Consultation Reference Group

Context

Barmah-Millewa Forest is one of six icon sites targeted for attention under The Living Murray. The Living Murray is a long-term program managed by the Murray Darling Basin Commission to return the River Murray system to a healthy working river. As a First Step environmental benefits will be maximised at the six icon sites.

NSW Forests and the Victorian Department of Sustainability and Environment will jointly manage the Barmah Millewa Asset with assistance from a Coordinating Committee (CC). The CC will draw upon technical expertise and community advice to develop and implement an Icon Site EMP which will outline the ecological objectives, values, water requirements, works and available budget to ensure the long term health of the forest. A Consultation Reference Group (CRG) and an Asset Technical Advisory Committee will be formed.

While a commitment has been made to form a CRG, this is not the only mechanism for consultation the CC intends. In addition, the Coordinating Committee will facilitate targeted as well as broad community input with people and groups that have an interest in water management within the site. Indigenous communities will be consulted to determine the best approach to enable inclusive engagement of Indigenous people.

Key Task of the Consultation Reference Group:

- to provide community advice to the CC with respect to the development and implementation of the coordinated Icon Site EMP; and
- to provide advice on consultation with regional and local groups who have an interest in the management of the site.

Sub-tasks

In order to fulfil the main functions outlined above, the CRG will be required to:

- identify stakeholders and people with an interest in the management of the asset;
- communicate with community members and groups to provide information and elicit views;
- provide advice on community values to assist in formulating objectives for the Icon Site EMP;
- provide advice on knowledge within the community that could contribute to the management of the icon site;
- provide advice on potential impacts, risks and opportunities of proposed projects;

- provide advice on the development, implementation and review of a Community Engagement Strategy including:
    - suitable consultation activities;
    - research and monitoring priorities to fulfil community knowledge gaps;
    - communication and information requirements; and
    - ways to monitor community participation.

Activities outside the scope of the CRG

The CRG is an advisory group. Direct management of budgets, project officers and Environmental Water Allocation is outside the scope of the group. Land tenure issues are outside the scope of The Living Murray.

Relationships

The CRG will need to communicate with the community, CC and Technical Advisory Committee and Indigenous processes.

Composition of Consultation reference group

The CRG will consist of 15 – 18 members plus people with Indigenous connections[4].

Membership of the CRG will be based on skills, knowledge and experience in a number of areas with an emphasis on the ability of members to represent community interests.

Members will be expected to demonstrate:

- a spiritual, social, economic or environmental connection to the Barmah-Millewa Forest;
- an ability to represent a range of interests in the orest;
- a capacity to contribute to the Coordinating Committees understanding of community issues (including social, spiritual, economic and environmental) as they relate to water management within the forest (experience in leadership, negotiation, consultation and communication would be desirable); and
- a knowledge of water, wetland, natural resource or forestry management (desirable but not essential).

Membership at any given time will be appointed in order to ensure key skills and knowledge and access to community networks is maintained within the group. The Project Officer will be an ex-

[4] Summary of Outcomes – Barmah-Millewa Forest Significant Ecological Asset: Community Consultation Workshop – 7/7/2005

officio member of the CRG.

Selection process

CMAs are responsible for selection and will provide membership advice to the CC, who in turn will provide membership advice to the Murray Darling Basin Commission. The Goulburn Broken CMA has recommended membership be drawn from the Shepparton Irrigation Region Implementation Committee. In addition, the Murray CMA will select up to nine members under an Expression of Interest process. Processes to seek Indigenous membership are yet to be identified in collaboration with Indigenous communities.

Expression of Interest Process:

- advertisements will be placed in local papers;
- applications from NSW or Victorian residents will be accepted;
- a selection panel consisting of a Murray CMA Board member, Murray CMA staff member and the Lead Asset Manager will review applications and select applicants based on ability to fulfil key skills, experience and knowledge requirements; and
- the selection panel will also give consideration to the collective makeup of the CRG to achieve a balance in skills and knowledge of community issues and access to community networks.

Dispute resolution:

Should an applicant have a dispute in relation to the selection process - their complaint should be addressed to the CC.

Reimbursement

Members of the CRG will be reimbursed for expenses such as travel costs and meals.

Terms of Appointment

A member is appointed:

a) for an initial period not exceeding 2 years. Members can nominate for a further term after the expiry of their initial term. A maximum of two consecutive terms is recommended; and

b) on the terms and conditions set out in the code of conduct.

Meetings

The ability to attend meetings is a key selection criteria for the CRG. It is anticipated the CRG will meet on an as-needs basis but expect two or three meetings per year.

Appendix H Barmah-Millewa Forest EWA Interim Operating Rules

Revised Operating Rules for the Barmah-Millewa Forest Environmental Water Allocation (B-MF EWA)

Reference:
MDBC Technical Report 2006/13, July 2006
Murray Darling Basin Commission
Canberra

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INTRODUCTION

Interim operating rules (*Attachment A*), initially approved by Council meeting 30 (30 March 2001) for management of Barmah-Millewa Forest Environmental Water Allocation (B-MF EWA), were extended by Council meeting 40 (19 May 2006) until 30 June 2007. However foreshadowed changes to Victoria's Sales Allocation require revised rules to be developed by that date. To develop the new rules, an inter-jurisdictional steering committee was set up and that committee has supervised substantial hydrological modelling work.

While a summary of the modelling work undertaken is provided in the MDBC technical report 2006/13, a more detailed description of the modelling can be found in the MDBC technical reports 2006/4 (*Part 1*), 2006/7 (*Part 2*), 2006/8 (*Part 3*), 2006/10 (*Part 4*), and 2006/12 (*Part 5*).

Main aim of revising the interim rules were to preserve the rights of both the forest and water users while removing reference to Victoria's sales allocation and fully defining the exceptional circumstances under which NSW will have an improved water availability and reliability, especially during long drought periods.

Followings are major changes incorporated in to the revised rules:

(a) exogenous trigger for allocation of lower security entitlement to BMF EWA,

(b) definition of the exceptional circumstances under which the NSW general security allocation limit for borrowing can be lifted from 30% to 50%,

(c) applying evaporation losses only to carried over component of BMF EWA as a proportion of total loss in Hume and Dartmouth storages,

(d) not restricting use of BMF EWA when some water has been borrowed,

(e) independent State accounts of BMF EWA with rules to balance these accounts whenever possible (B-MF EWA releases and spills no longer shared equally),

(f) allowing each State to overdraw independently whenever it has sufficient reserve,

(g) non-spillage of B-MF EWA water borrowed by States in previous years, and

(h) creation of new TLM reference condition and refinement of various other rules.

The changes made in the reference condition and in the interim rules formed the basis of the development of the revised rules, which are described below. For some clause in the revised rules that needed additional explanation, explanatory notes are provided at *Appendix 1*. The proposed revised rules were notionally endorsed by the inter-jurisdictional steering committee on 12 July 2006. It is recommended that the proposed rules be adopted for the management of the B-MF EWA when the interim rules expire on 30 June 2007.

REVISED B-MF EWA OPERATING RULES - JULY 2006

1. Allocation of Entitlement

1.1 Annual allocation

Annual allocation of entitlement to the Barmah-Millewa Forest Environmental Water Account (EWA) is supplied *half each* by New South Wales and Victoria. The annual allocation consists of two components:
(a) a 100 GL high-security allocation; and
(b) a 50 GL lower-security allocation.

1.2 High-security allocation

The high-security water has the same reliability as Victoria's water right or high reliability water share along the River Murray. High-security allocations for B-MF EWA are made throughout the season as Victorian allocations are announced.

1.3 Lower-security allocation

The lower-security water is allocated when the total natural inflow to Hume Reservoir for preceding months, which vary from 30 months on 1 July to 35 months on 1 December, exceeds the triggers in *Table 1*. (*See explanatory note 1.3*)

Table 1. Exogenous triggers for lower-security allocation

Month	1 Jul	1 Aug	1 Sep	1 Oct	1 Nov	1 Dec
Period (months)	30	31	32	33	34	35
Trigger (GL)	8650	8988	9243	9253	9267	9280
Modelled frequency (%)	49	53	61	69	75	76

1.4 Timing of lower-security allocation

Preliminary lower-security allocations are made in July to reserve water for the environment but these allocations may be reduced in August when the first formal allocation is made. Formal lower-security allocations made after July can not be reduced and allocations are not increased after December. (*See explanatory note 1.4*)

1.5 Allocation limit

Any increase in the allocation is limited to the volume that will bring each State's share of the account to 350GL. (*See explanatory note 1.5*)

2. Carryover

The unused water in the EWA will be carried over from one year to the next.

3. Overdraw

Allowance has been made for the allocation to be overdrawn by up to 100 GL (50GL from each

State) to ensure adequate water is available for forest watering, provided a State has sufficient reserves. A State can overdraw independently. (*See explanatory note 3*)

4. Evaporation loss

The B-MF EWA is reduced by evaporation. The evaporation loss applied to the EWA is determined as a fraction of the total loss from the Hume and Dartmouth Reservoirs. The fraction is calculated as the non-borrowed, carried over component of the EWA divided by the total storage in the two reservoirs. Evaporation losses will be shared pro-rata between each State's share of the non-borrowed, carried-over components of the EWA except when a State's share of the account is negative. A State's share of evaporation becomes nil when a State's share of the account is negative. (*See explanatory note 4*)

5. Borrow and Payback

5.1 Borrow and payback triggers

Each State's share of the EWA can be borrowed for consumptive use by that State, subject to the following rules:

(a) Each State can borrow that volume of water necessary to increase its allocation to its target allocation; and
(b) Water borrowed is paid back when it is no longer required to supply the target allocation.

5.2 Target allocation

The target allocation for Victoria is 100% of Water Right or High Reliability Water Share. The target allocation for New South Wales is normally 30% general security allocation but this can be increased to 50% under exceptional circumstances.

5.3 NSW exceptional circumstances

Exceptional circumstances for NSW are defined as occurring when the average November allocation (including carryover) for the four years up to and including the current year would otherwise have been less than 50%. However, exceptional circumstances cannot be declared in consecutive years. (*See explanatory note 5.3*)

5.4 Forest watering while borrowing

Release of the non-borrowed component of the EWA is allowed even though some of the EWA remains borrowed.

5.5 Borrowing in the fifth year of drought

Each State will consider, consult and justify before making a decision to borrow water in the fifth year of drought when a release might be made under *sub-clause 8.2* of these rules.

5.6 Borrowing for other environmental purposes

If the Commission agrees, water may be borrowed from the EWA for other environmental

purposes provided that:
(a) the required water has not already been borrowed for consumptive use;
(b) water is not required in that year by the B-MF; and
(c) the required water can be repaid at the start of the following year. (*See explanatory note 5.6*)

6. Spillage

6.1 Priority of spills

When Hume *physically* spills, water will first spill from the carried over component of other environmental entitlements, then from the B-MF EWA. (*See explanatory note 6.1*)

6.2 Spillage limit

A State's share of the EWA cannot spill below 100GL plus an additional volume if water was borrowed by the State in the previous year. This additional volume is equal to the maximum borrow by that State in the previous year excluding water borrowed under *sub-clause 5.6* and is limited to 100GL for each State. (*See explanatory note 6.2*)

6.3 Account imbalances

If the States' shares of the EWA are unequal when the account spills, water spills first from the State with the bigger account until the States' accounts are in balance or the spillage limit is reached.

7. Internal spills

Each State's share of the allocation is stored on their respective sides of the storages. The States' shares of the EWA will not be affected by internal spills in Hume or Dartmouth.

8. Release triggers

8.1 Trigger flows

Releases are made from the Barmah-Millewa Forest EWA under the trigger flow conditions specified in *sub-clauses 8.2* to *8.5*.

The trigger flows are the monthly flows in the River Murray downstream of the Yarrawonga Weir in the preceding months. In interpreting these triggers, the *usable component* of the EWA is defined as the total EWA allocation less twice the maximum water borrowed by either States.

8.2 October release for a five-year drought

Releases are triggered in October if four years have passed with no release or without a flow downstream of Yarrawonga of at least 500 GL/month from September to November and 400 GL/month in December.

8.3 October release following a September flow

Releases are triggered in October if the September flow exceeded 500 GL/month and the *usable component* of the account is ≥ 400 GL.

8.4 November release following a October flow

Releases are triggered in November if the October flow exceeded 500 GL/month and the *usable component* of the account is ≥ 400 GL.

8.5 December release

Releases are triggered in December if the flow exceeded 500 GL/month for both October and November.

9. Release targets

9.1 Target flows

Releases for the Barmah-Millewa Forest will attempt to achieve the target flows downstream of the Yarrawonga Weir specified in *sub-clauses 9.2* and *9.3*.

9.2 Normal target flows

The normal target flows downstream of the Yarrawonga Weir are 500 GL/month for October and November, and 400 GL/month for December.

9.3 Special target flows

Except for releases triggered under *sub-clause 8.2*, if three years pass with no flow of ≥ 660 GL/month in any one month from August to November, then the target flow is increased from 500 GL/month to 660 GL/month at Yarrawonga:

(a) for October if a release starts in October; or
(b) for November if a release starts in November. (*see explanatory note 9.3*)

9.4 Reduction of target flows for fifth year drought

The targets for releases triggered under *sub-clause 8.2* must be reduced if the flow in either October or November is less than 300 GL/month.

10. Amendment of release triggers and targets

These operating practices for making releases (*Clauses 8 and 9*) can be varied and refined from time to time to improve environmental outcomes:

(a) in a given year by agreement between the managers of the EWA in consultation with water managers in the two States, and in consultation with MDBC Officers, or
(b) as an agreed permanent change to a rule approved by the Commission after a review of the long-term impacts.

11. Accounting for releases

11.1 Accounting for releases from the B-MF EWA

Releases from the B-MF EWA are calculated as the difference between the releases from

Hume Dam to meet the target flows and the releases that would have been made to meet all other requirements other than new environmental uses agreed after 29 August 2003. (*See explanatory note 11.1*)

11.2 Sharing of releases between the States

Until one State's ability to release is exhausted, releases are shared between the States in amounts which tend most to equalise the State's remaining B-MF environmental water accounts (including water that has been borrowed). When one State's ability to release is exhausted, water can continue to be released from the other State's account.

A State's ability to release water is exhausted if:

(a) all its remaining account has been borrowed; or
(b) its account is empty and its overdraw limit has been reached. (*See explanatory note 11.2*)

12. Barmah-Millewa Forest EWA and Special Accounting

12.1 Declaration of periods of special accounting

For the purposes of declaring periods of special accounting under clause 122 of the *Murray-Darling Basin Agreement (MDBA)*, the non-borrowed component of the BMF EWA must not be considered to be part of the New South Wales or Victorian Reserves.

12.2 Special Accounts of State water use

The release by a State of the BMF EWA must not be treated as a water diversion for the purposes of special accounting under paragraph 124(a) of the *MDBA*.

Explanatory Notes

Revised Operating Rules for the B-MF EWA - July 2006 (*DRAFT*)

Additional information that some clauses of the Revised Operating Rules for the B-MF EWA needed is provided below as explanatory notes.

1.3 Lower-security allocation

Hume natural inflows are the inflow that would have occurred to Hume Reservoir but for the influence of the Dartmouth Dam and the Snowy Scheme, inflows to the Hume Reservoir are calculated by water balance and are adjusted for the net impact of the Snowy Scheme and the impoundments and losses in Dartmouth.

If the cumulative Hume natural inflows for the past 31 months at 1 August exceed 8988GL, then a lower-security allocation of 50GL is made. If the inflow is less than this trigger volume, then no allocation is made this month but it may be made in subsequent months if inflows increase and the corresponding trigger in those months is exceeded.

1.4 Timing of lower-security allocation

Allocations are made at the start of the month based on inflows for the preceding months as prescribed in *Table 1* of the operating rules. Any lower-security allocation made in July is preliminary only and is made to ensure that sufficient resources are reserved for a subsequent formal allocation. If the trigger is exceeded only in July, then no lower-security allocation is made. However, if the trigger is exceeded in any of the months from 1 August to 1 December, the allocation is made even if the trigger is exceeded in only one month.

1.5 Allocation limit

The B-MF EWA can contain a maximum of 700GL at any time. This limits each State's share of the account to a maximum of 350GL. When any new allocation is added to the account, the allocated volume is limited to the volume that will bring each State's share of the account to 350GL. Once an allocation has been made, water not allocated because of the 350GL limit is not available for topping up the B-MF EWA later in the season.

3. Overdraw

Each State can independently overdraw a maximum of 50GL irrespective of whether the other State is overdrawing. Provision of overdraw allows each State to bring their next year's allocation forward on the basis of a pro-rata share of reserve so that the EWA can be released in the current year. For this to occur, a State must have sufficient water in reserve (excluding the B-MF EWA and the mandatory reserve) for the EWA to be overdrawn without affecting the current year's or next year's allocation for

other users.

For NSW to have sufficient reserves, it must have made a general security allocation of 100%. For Victoria to have sufficient reserves for maximum overdraw, it must have made an allocation greater than 100% of Water Right or High Reliability Water Share.

4. Evaporation loss

Evaporation losses from B-MF EWA are calculated on the basis of pro-rata losses from the volume of the Hume and Dartmouth reservoirs at the end of the month.

The loss adjustment in any month will be the total net evaporation from the Hume and Dartmouth reservoirs divided by the total storage volume in Hume and Dartmouth and multiplied by "the water volume of the EWA less the water borrowed less the water allocated to the account in the current year".

For example, for a given month if Hume storage = 1600GL, Dartmouth storage = 2200GL, Hume evaporation loss = 18GL, Dartmouth evaporation loss = 12GL, B-MF EWA = 550GL (NSW = 240GL, Victoria = 310GL), Borrow from the EWA = 20GL (NSW = 13GL, Victoria = 7GL) and the current year's allocation to the EWA = 150GL (75GL from each State), then the B-MF EWA losses for that month = (550-20-150)*(18+12)/(1600+2200) = 3GL.

This is calculated as follows:

$$BM_{Loss} = \frac{(Hume_{Loss} + Dartmouth_{Loss}) \times Max(0, BM_{EWA} - BM_{Borrow} - BM_{CurrentYearAllocation})}{(Hume_{Storage} + Dartmouth_{Storage})}$$

Evaporation losses are shared pro-rata between each State's share of the non-borrowed, carried-over components of the EWA except when a State's share of the account is negative. A State's share of evaporation becomes nil when a State's share of the account is negative. For each State, pro-rata loss is calculated as follows:

$$BM_{Loss}(VIC) = BM_{Loss} \times \frac{(VIC_{EWA} - VIC_{Borrow} - VIC_{CurrentYearAllocation})}{Max(0.001, BM_{EWA} - BM_{Borrow} - BM_{CurrentYearAllocation})}$$

$$BM_{Loss}(NSW) = BM_{Loss} \times \frac{(NSW_{EWA} - NSW_{Borrow} - NSW_{CurrentYearAllocation})}{Max(0.001, BM_{EWA} - BM_{Borrow} - BM_{CurrentYearAllocation})}$$

In the above example, evaporation loss for NSW's share of the account would be 3*(240-13-75)/(550-20-150) = 3*0.40 = 1.20GL and for Victorian share of the account would be 3*(310-7-75)/(550-20-150) = 3*0.60 = 1.80GL.

5.3 NSW exceptional circumstances

For the purpose of defining *NSW exceptional circumstances*, the four-year average November allocation for NSW is calculated as the sum of the November general security allocation and the

November carryover (expressed as a percentage) for the last three years plus the carryover for current year (expressed as a percentage) and 30% general security allocation for current year, all divided by four. This can be mathematically expressed as follows:

$$\frac{\sum_{i=1}^{3}(CarryOver_{Nov} + GenSecAllocation_{Nov}) + Carryover_{Currentyear} + 30\%}{4}$$

If this four-year average November allocation is less than 50%, NSW is considered to be under exceptional circumstances for the purpose of managing the B-MF EWA.

5.6 Borrowing for other environmental purposes

Water year starts at 1 July and ends at 30 June.

6.1 Priority of spills

Hume spills are accounted in the following order:

(a) the carried-over component of environmental water other than B-MF EWA;

(b) the carried-over component of B-MF EWA; and

(c) Consumptive water.

This gives a higher priority/importance to the preservation of reliability of existing entitlements and the B-MF EWA over the new environmental water created after 29 August 2003.

6.2 Spillage limit

When B-MF EWA spills following the Hume spills, a State's share of the EWA spills down to a limit of 100 GL if that State has not borrowed any water in the previous year. If a State has borrowed in the previous year, the spillage limit for that State is increased by its borrow until it reaches 200GL.

For example, if a State has borrowed more than 100GL in the previous year, this State's B-MF account spills down to 200GL rather than 100GL. If the other State did not borrow in the previous year, its share of the account will spill down to 100GL.

9.3 Special target flows

Special target flow of 660GL applies for one month only. The special target flow is not tried in November if an attempt was already made in October to achieve the special target, irrespective of the success or failure. However if the flood is initiated in November, the special target is attempted in November.

In the fifth year of drought, special targets are often not met because of limited water resource

availability due to long dry-spell. For this reason, the special target flow of 660GL is not attempted during the fifth year flooding.

11.1 Accounting for releases from the B-MF EWA

The following example illustrates how releases from the B-MFEWA are accounted.

Assume that a total volume of 300GL was released from Hume dam to meet the target flows at Yarrawonga for Barmah-Millewa flooding including other environmental uses. If a release of 200GL was required to meet the downstream requirements for irrigators and SA supply, then releases from the B-MF EWA would be 300GL-200GL = 100GL. This is because the downstream demand of 200GL would have been released anyway even if Forest flooding had not been initiated.

11.2 Sharing of releases between States

Examples given in *Table 1* illustrate the sharing of the B-MF EWA releases between States.

Table 1. Examples of sharing of EWA releases between States

	NSW (GL)	Victoria (GL)
Initial Account	300	200
Borrowed Water	100	0
Available Overdraw	0	50
Example 1: Sharing a release of 100 GL		
Releases	100	0
Final account	200	200
Example 2: Sharing a release of 300 GL		
Releases	200	100
Final account	100	100
Example 3: Sharing a release of 400 GL		
Releases	200	200
Final account	100	0
Note: Borrowed water can not be released		
Example 4: Sharing a release of 450 GL		
Releases	200	250
Final account	100	-50
Note: States may have different overdraws		

Note: Final account = Initial account - Releases

Attachment A

Interim Operating Rules and Triggers
Barmah-Millewa Forest Environmental Watering Account
(MDBMC, Meeting 30, 30 March 2001)

No	Agreed Rule or Trigger
1.	The 100 GL of high-security water has the same security as Victoria's water right along the Murray. This will be augmented with 50 GL of lower-security water (25 GL from each State), which is not allocated until Victoria's seasonal allocations along the Murray reach 100% of water right plus 30% of "sales", and is then allocated fully. It should be allocated in 75 to 80 years out of 100. The use of Victorian allocations to define security will be replaced by the use of independent triggers as soon as these can be developed and agreed to by the two States.
2.*	**Each States' share of the allocation is stored on their respective sides of the storages.**
3.	All the water allocated is carried over if not used, with the maximum volume of the allocation being 700 GL (this could be say 150 GL allocated in the current year, plus 550 GL carried over).
4.	When Hume *physically* spills, the first water spilt is the Barmah-Millewa kitty – though up to 200 GL, if kitty contains that much, will be retained.
5.	Allowance has been made for the allocation to be overdrawn by up to 100 GL to ensure adequate water is available for forest watering, provided there is "sufficient water" in storage. It is proposed that "sufficient water" will be defined by the Commission, to ensure each State can underwrite the overdraw. Possible definitions include: more than 2,000 GL of water stored in Dartmouth, each State having more than 700 GL stored in Dartmouth, or each State having more than 50 GL in excess of the mandatory reserve for the following year.
6.*	Each State's share of the Barmah-Millewa environmental allocation can be borrowed for consumptive use by that State, subject to clearly defined borrowing and payback rules to be agreed between the States and endorsed as part of these arrangements. Any water borrowed by either of the States must be paid back... Initially, Victorian water users can borrow when allocations would otherwise be below 100% water right, only enough to get allocations to 100% water right. The water must be paid back fully as soon as borrowing is not needed for this. And NSW water users can borrow when their general security allocations would otherwise be less than 30%, only to the extent necessary to get these allocations to 30%. The water must be repaid as soon as borrowing is not needed for this. Both States agree that the above borrow and payback triggers will be adopted as

No	Agreed Rule or Trigger
	operational guidelines during the interim period. However, each State reserves its position to alter the application of these triggers in special or exceptional circumstances, and in such circumstances to consult on the matter through the Commission. The idea that water paid back can not be spilled until one year after it is paid back is to be further investigated and considered for possible adoption.
7.	In principle, credits may be allowed to the environmental allocation for water returning from the forest to the River, where this returning water is not surplus to requirements – the operational details to be agreed between the States.
8.	Releases for the Barmah-Millewa forest will be made to top up the Yarrawonga flow using target flows similar to the following: ▪ If there's a flood ≥500 GL/m from September through to November, then maintain at 400 GL in December (if sufficient volume in the allocation); ▪ If there's a flood ≥500 GL in September or October and kitty is ≥400 GL (including overdraw), keep at 500 GL/m till November & 400 GL in December; ▪ If 4 years pass with no release, & no flood of ≥500 GL in September to November & 400 in December, try for 500 GL/m in October & November & 400 GL in December; ▪ If 3 years pass with no month from August to November with ≥660 GL, then if a release starts in October or November, the target flow increases to 660 GL at Yarrawonga.
9.	The above operating practices for releases can be varied and refined from time to time, by agreement between the managers of the forest water in consultation with water managers in the two States, and with the agreement of the MDBC.

Note: * indicates that detailed modelling of this rule has been undertaken.