For further information contact the Murray-Darling Basin Commission office on (02) 6279 0100

This report may be cited as: The Hattah Lakes Icon Site Environmental Management Plan 2006–2007

MDBC Publication No. 31/06

ISBN 1 921038 97 7

© Copyright Murray-Darling Basin Commission 2006
This work is copyright. Graphical and textual information in the work (with the exception of photographs and the MDBC logo) may be stored, retrieved and reproduced in whole or in part, provided the information is not sold or used for commercial benefit and its source The Hattah Lakes Icon Site Environmental Management Plan 2006–2007 is acknowledged. Such reproduction includes fair dealing for the purpose of private study, research, criticism or review as permitted under the Copyright Act 1968. Reproduction for other purposes is prohibited without prior permission of the Murray-Darling Basin Commission or the individual photographers and artists with whom copyright applies.

To the extent permitted by law, the copyright holders (including its employees and consultants) exclude all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this report (in part or in whole) and any information or material contained in it.

The development of an environmental management plan for the Hattah Lakes cannot, and is not intended to, affect or diminish any existing private rights to own or occupy land within the region covered by the plan, or the way in which such land is used in future.
# CONTENTS

1. **INTRODUCTION** ................................................................................................................. 1  
   1.1 Context – The Living Murray .......................................................................................... 1  
   1.2 Purpose of plan .................................................................................................................. 2  
   1.3 Management of risk and legal issues................................................................................. 2  
   1.4 Management roles and responsibilities............................................................................. 3  
2. **BACKGROUND** .............................................................................................................. 4  
   2.1 General Description............................................................................................................. 4  
   2.2 Values of Hattah Lakes ...................................................................................................... 7  
   2.3 Key Risks...................................................................................................................... ....... 9  
   2.4 Relevant Plans and Legislative Controls .......................................................................... 14  
3. **ENVIRONMENTAL MANAGEMENT OBJECTIVES FOR HATTAH LAKES**......................... 18  
   3.1 Vision for Hattah Lakes..................................................................................................... 18  
   3.2 Ecological Objectives for Use of Environmental Water in Hattah Lakes ..................... 18  
   3.3 Prioritisation of Water Regime Classes.......................................................................... 19  
4. **FLOW REQUIREMENTS** ................................................................................................. 20  
   4.1 Flow Requirements across the Icon Site........................................................................... 20  
   4.2 Additional Water Required to Meet Objectives .............................................................. 21  
   4.3 Current Environmental Water Allocations...................................................................... 21  
5. **OPTIONS FOR WATER MANAGEMENT FOR ENVIRONMENTAL OUTCOMES**.................... 23  
   5.1 Delivering Water to the Icon Site...................................................................................... 23  
   5.2 Water Management within the Icon Site.......................................................................... 25  
6. **OPERATION AND MANAGEMENT OF THE LIVING MURRAY WATER MANAGEMENT STRUCTURES** ......................................................................................................................... 29  
7. **COMPLEMENTARY MANAGEMENT ACTIONS** .................................................................. 29  
8. **MANAGEMENT ROLES AND RESPONSIBILITIES** ....................................................... 30  
   8.1 Arrangements for the Living Murray Icon Sites ............................................................. 30  
   8.2 General Management Arrangements ............................................................................... 30  
   8.3 Management Arrangements for Hattah Lakes.................................................................. 31  
9. **CONSULTATION** ............................................................................................................. 33  
10. **MONITORING AND ADAPTIVE MANAGEMENT** ........................................................... 34  
11. **ON GROUND ACHIEVEMENTS TO DATE USING ENVIRONMENTAL WATER** .................. 36  
12. **WORKS PROGRAM 2004 TO 2010** .............................................................................. 36  

*Environmental Works and Measures Activities*........................................................................ 36  

**REFERENCES**....................................................................................................................... 39
Appendix 1  Descriptions of Completed, Current, and Planned Investigations and Works.................................................................41

Appendix 2  Adaptive Management Cycle .....................................................44

List of Figures
Figure 1  Location of the Icon Sites .................................................................1
Figure 2.1  Location of Hattah Lakes.................................................................5
Figure 2.2  Plan of Hattah Lakes Complex.......................................................6
Figure 2.3  Comparison of inflows to Hattah lakes under natural and regulated conditions, based on monthly discharge at Euston weir .................................................12
Figure 8.3  Governance Arrangements for the Hattah Lakes Icon Site......................32

List of Tables
Table 2.1  Lakes that receive floodwaters from Chalka Creek.................................11
Table 5.1. Typical Chalka Creek characteristics - existing conditions..........................27
Table 5.2. Potential Pump station operational rules.............................................27
Table 12.1  Management Activities Undertaken to April 2006......................................37
Table 12.2  Management Activities to be Undertaken between April 2006-June 2010.........38
1. INTRODUCTION

1.1 Context – The Living Murray

In 2002, the Murray Darling Basin Ministerial Council established The Living Murray – a long-term program of collective actions aimed at returning the River Murray system to a healthy working river. The vision for The Living Murray is:

“... a healthy River Murray system, sustaining communities and preserving unique values”.

On the 25th of June 2004, the Ministers of Victoria, New South Wales, South Australia, the ACT and the Australian Government signed the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray-Darling Basin. This gives effect to their decision in August 2003 to commit $500 M to the First Step of The Living Murray, which aims to recover an average 500 gigalitres (GL) per year of ‘new water’ to improve environmental flows and achieve ecological objectives at six Icon Sites along the River Murray.

The six sites, which will benefit from the First Step, are Barmah-Millewa Forest; Gunbower Koondrook-Perricoota Forests; Hattah Lakes; Chowilla Floodplain and Lindsay-Wallpolla Islands; Lower Lakes, Coorong and Murray Mouth, and the River Murray Channel.

The arrangements for implementing the First Step are outlined in The Living Murray Business Plan (MDBC, 2004). Under the plan, water recovered through The Living Murray (TLM) will be managed through a Living Murray watering plan, which will provide the system framework for making decisions on the volume of water and the timing and frequency of water to be provided to each of the Icon Sites.

![Figure 1. Location of the Icon Sites (MDBC 2004)](image)

The business plan also requires the development of a single Icon Site Environmental Management Plan for each of the six Icon Sites. These plans will build on and refine the
ecological objectives for the icon sites outlined in the First Step, identify specific watering regimes and works required to utilise available water to meet these objectives and detail the complementary land management actions required to achieve the ecological objectives.

1.2 Purpose of plan

The plan for the Hattah Lakes Icon Site outlines:

- the environmental, cultural, economic and social values of the Hattah Lakes and processes that are currently threatening these values;
- environmental management objectives for the site;
- ecological objectives and priorities for the use of environmental water;
- environmental water requirements to meet objectives;
- options for providing environmental water including works required to make the most efficient use of water;
- works currently underway;
- complementary land management actions;
- management roles and responsibilities;
- consultation arrangements within Victoria; and
- monitoring arrangements.

It also outlines recent achievements and the work program for 2006-2010.

This plan is based on a large number of detailed, technical investigations undertaken over the past decade by the relevant management authorities coordinated by the Mallee Catchment Management Authority (CMA). It shows the significant commitment of the Victorian Government and its regional management groups to ensuring the long-term sustainability of the Hattah Lakes ecosystem.

The development of an Environmental Management Plan (EMP) for the Hattah Lakes Icon Site cannot, and is not intended to, affect or diminish any existing private rights to own or occupy land within the region covered by the plan, or the way in which such land is used in future.

1.3 Management of risk and legal issues

The Living Murray Business Plan indicates that the Living Murray Environmental Watering Plan (LMEWP) and Icon Site plans 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:

1. to the Icon Site associated with lack of action;
2. 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 EMPs necessary to achieve the environmental objectives and outcomes of TLM First Step decision for inclusion in the 2007-08 versions of the LMEWP and Icon Site EMPs.
Attention will also be given to identification of legal issues, and approaches to mitigating them, that may arise from operation of the river and its works to achieve environmental outcomes. In the first instance, the approach to management of these issues will follow that adopted by MDBC and state constructing authorities as part of normal river management.

This will involve notification of the Hattah Lakes Steering Committee, which has representatives from the Murray-Darling Basin Commission (MDBC), Parks Victoria, Department of Sustainability and Environment (DSE), the Murray Darling Freshwater Research Centre (MDFRC), and the Mallee CMA, 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 EMP’s will be reviewed and updated by the EWG for consideration of the Ministerial Council in agreeing to the 2006-07 versions of the EMPs.

Where required any necessary approvals will be obtained for any actions occurring under this plan.

1.4 Management roles and responsibilities

General Management Arrangements for Victorian Icon Sites

The Victorian Icon Sites are all floodplain sites that involve wetlands of national significance on public land. Management of Living Murray water from a Victorian perspective is therefore a complex task involving responsibilities across the Land and Water Groups of DSE, their statutory authorities eg. CMAs, Rural Water Authority (RWAs) and Parks Victoria and the DSE regions. Within Victoria, a general set of management arrangements for Victorian Icon Sites has been agreed which:

- build on existing responsibilities in policy development and investment, coordination and community consultation, service delivery and regulatory/compliance functions;
- recognise the emerging role of DSE Regional Managers to maximise integration at a local level, particularly in relation to public land management;
- establish the CMAs as managers of the environmental watering, as outlined in the White Paper;
- are consistent with the requirements of The Living Murray Business Plan; and
- recognise accountabilities of the Minister for Water and the Minister for the Environment.

They are based on the following broad roles and responsibilities.

**DSE Regions** – site owner for all public land and site owner/manager for public forests, manager of DSE approval/referrals processes, interaction with statutory planning processes.

**CMAs** – strategic regional planner for land and water management, focus for community engagement and caretaker of river health.

**Parks Victoria** – land manager for national parks and reserves.

The arrangements recognise that whilst each of these groups are involved in each of the planning, on-ground management and monitoring phases of Icon Site management, the focus and the predominant player will change depending on the stage. For example, in the planning
stage, the CMA will lead by coordinating the development of the Icon Site objectives and the development of the State Icon Site Watering Plan. For cross-border negotiation, the DSE Regional Managers have been nominated as Victoria’s Icon Site managers.

2. **BACKGROUND**

2.1 **General Description**

The Hattah Lakes Icon Site encompasses the whole of the Hattah Lakes and adjoining floodplain system, which lie within Hattah-Kulkyne National Park (HKNP), proclaimed under Schedule 2 of the *National Parks Act 1975* (Vic), and Murray-Kulkyne Regional Park (MKRP).

These parks are located in Victoria, adjacent to the River Murray, in the triangle between the towns of Mildura, Robinvale and Ouyen, and to the east of the Calder Highway (Fig 2.1). The Hattah Lakes are a system of 17 perennial and intermittent freshwater lakes, most of which are filled from the River Murray via the Chalka Creek anabranch (Fig. 2.2). The lakes only begin to fill when flows in the River Murray exceed the threshold flow rate of 36,700 megalitres/day (ML/day) at Euston Weir. Their hydrological regimes vary widely, ranging from lakes which used to hold some water almost constantly, to those with inflows averaging 1 year in 4 and with dry spells of 4 to 12 years.

The Hattah Lakes have been listed under the Directory of Important Wetlands in Australia, and 12 of the lakes have been listed under the International Ramsar Convention on Wetlands in 1982. The Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (EPBC), which came into force on 16 July 2000, identifies Ramsar sites as matters of national environmental significance for which the Australian Government has a significant responsibility. The parks were also designated as a Biosphere Reserve in 1981 under the UNESCO ‘Man and the Biosphere Program’, however this designation does not alter the legal status of the land and there are no internationally legally binding requirements regarding their management.
Figure 2.1. Location of the Hattah Kulkyne National Park
Figure 2.2. Map of the Hattah Lakes Complex
2.2 Values of Hattah Lakes

2.2.1 Environmental Values

*Natural function*

The Hattah Lakes system is a natural flood mitigation area, storing excess run-off and releasing it slowly through evapotranspiration and groundwater recharge. The wetlands act as a sink, or store, for sediments and nutrients washed in from the surrounding catchment. They also act as a source of nutrients and plant and animal propagules, which are flushed back into the River Murray during high flow events.

*Wetland representativeness*

In Victoria, wetlands are classified into eight categories. The Hattah-Kulkyne Lakes Ramsar site, which makes up the majority of the Icon Site, includes areas of two wetland types under this system – Deep Freshwater Meadow and Permanent Open Freshwater. Deep Freshwater Meadow is one of the state’s most depleted wetland habitats and is the least represented in Victoria’s protected area network.

*Flora and fauna*

More than 120 species of indigenous fauna have been recorded at Hattah Lakes. Of these, two species of fauna are considered to be nationally threatened under the Australian Government’s *Environment Protection and Biodiversity Conservation Act 1999*. A total of 39 faunal species considered to be threatened in Victoria have been recorded. Twenty seven of the species recorded are listed under the *Flora and Fauna Guarantee Act 1988*, four of these as part of the Lowland Riverine Fish Community of the Southern Murray-Darling Basin. Action Statements have been prepared for three of these species.

Vegetation communities of the Hattah Lakes system and floodplain are grouped into nine Ecological Vegetation Classes (EVCs) (White, et al. 2001 in Ecological Associates, in prep.):

EVC numbers and titles are listed below:

- 106 - Riverine Grassy Forest
- 811 - Grassy Riverine Forest;
- 813 - Intermittent Swampy Woodland
- 818 - Shrubby Riverine Woodland
- 295 - Riverine Grassy Woodland
- 823 - Lignum Swampy Woodland
- 103 - Riverine Chenopod Woodland
- 808 - Lignum Shrubland
- 104 - Lignum Wetland
- 107 - Lake Bed Herbfeld.

As defined by the State of the Parks 2000, the diversity of fauna within the parks is relatively high, with more than 208 species present (Parks Victoria, 2000). A total of six bird species listed under the Japan-Australia Migratory Birds Agreement (JAMBA) and 11 species under the China-Australia Migratory Birds Agreement (CAMBA) have been recorded at the Ramsar site. Ten species listed under the Bonn Convention on Conservation of Migratory Species of Wild Animals have also been recorded at the Ramsar site.
Waterbirds

The Hattah-Kulkyne Lakes site provides important feeding, resting and breeding habitat for more than 47 waterbird species. In terms of carrying capacity, up to 288 Hoary-headed Grebes, 101 Freckled Duck, 1,960 Pacific Black Duck, 2,550 Grey Teal, 1,280 Pink-eared Duck, 128 Black-fronted Dotterel and 1,000 Australian Pelicans have been counted at the lakes.

A total of 18 waterbird species have been recorded breeding at Hattah-Kulkyne Lakes. Of these species, 16 are threatened in Victoria, 8 are listed under the *Flora and Fauna Guarantee Act 1988*, 2 under the Bonn Convention, and one under CAMBA.

The Hattah-Kulkyne Lakes also provide drought refuge for waterbirds, reflecting the prevalence of permanent water within the wetland system.

2.2.2 Cultural / Social Values

The Hattah Lakes system has been a focus for traditional Indigenous society for thousands of years. The lakes provided reliable sources of water as well as a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools. All Indigenous cultural sites, places and artefacts are protected under the *Archaeological and Aboriginal Relics Preservation Act 1972* (Vic.) and the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Commonwealth).

Hattah Lakes lies on the border between two documented language groups or ‘tribes’ – the Latji Latji and the Nyeri Nyeri. The Latji Latji occupied the southern Murray Valley and northern Mallee, between Hattah and Wentworth, and the Nyeri Nyeri occupied the southern bank of the Murray immediately upstream (SKM, 2004).

There are nearly one thousand Indigenous archaeological sites registered with Aboriginal Affairs Victoria (AAV) for the Hattah Lakes. These sites have been recorded as a result of a number of previous cultural heritage assessments and surveys (Edmonds, 1993; Stockton, 1983, Thompson, 1983) as well as isolated recordings by DSE/Parks staff (SKM, 2004). These sites include Indigenous burial sites, scarred trees, artefact scatters, hearths and other mixed sites. Further survey is likely to reveal more archaeological sites. In addition, three places within the parks have been placed on the AAV Historic Sites and Places register (SKM, 2004).

On-going discussions need to take place with local Indigenous people in order to facilitate the management of Indigenous cultural heritage. In particular, land and water managers need to ensure that Indigenous heritage values are not adversely impacted in the course of implementing other site management strategies. Applications for Native Title Determinations lodged with the Native Title Tribunal cover the whole area including the Ramsar site.

One of the outcomes of Indigenous consultation to date is the recognition of the value Indigenous people place on the Icon Site. While the plans have been prepared to date using an ecological objective paradigm, this does not take into account the cultural heritage values Indigenous people apply to the site, for example, plant and animal species that have food, medicine or spiritual values and/or significance. Indigenous people are less likely to separate the ecological from the cultural heritage and social values.

There is currently a substantial gap in knowledge about these species, their location, extent and needs. ‘Cultural mapping’ is a concept beginning to be discussed that might address this need. This needs to be further researched, in close liaison with the relevant Indigenous people, over the next twelve months.
Non-indigenous cultural heritage

The Hattah-Kulkyne and Murray Kulkyne Parks fall within three former pastoral runs – ‘Kidds Station’, ‘Gayfield’ and the ‘Moornpoo’ run, all of which were first taken up in 1847 (SKM, 2004). By 1903, the rail line from Melbourne reached Hattah and the link to Mildura was completed the following year (SKM, 2004). By 1908, Victorian Railways had constructed a pump station and tank on the southern shore of Lake Hattah to supply steam trains at the Hattah Station west of the park. It is thought that a channel linking Lakes Lockie and Hattah was cut at the same time to augment the available supply of water (SKM, 2004).

As early as 1914, the potential of Lake Hattah for irrigation supply was investigated but found to be inadequate. In general, the lakes have been a major local water source. A bank and regulator were constructed between Lake Hattah and Little Hattah to retain water in the lake, and a dam was constructed in the park to supply the Hattah township (SKM, 2004).

Recreation and tourism

The Hattah Lakes system and adjoining River Murray and floodplains are a major focus for recreation and tourism in the parks. The parks attract over 70,000 visitors annually, many of whom partake in a wide range of activities centred on the lakes. These activities include bushwalking, camping, driving, fishing, canoeing, swimming and nature study. Game hunting is not permitted in the Ramsar site.

2.2.3 Economic Values

The Hattah-Kulkyne and Murray-Kulkyne Parks provide a variety of direct and indirect economic values to the area. The direct economic values include the use of the lakes for recreation and tourism valued at approximately $1.5 million annually. In contrast, the various regulatory ecological functions of the lakes have important indirectly measurable values that support or protect economic activities that have direct measurable values. The indirect economic values provided by Hattah Lakes include flood control for surrounding agricultural land and a potential emergency water supply for the Hattah township.

2.3 Key Risks

The key risks to the environmental values include:

- altered water regimes;
- salinity;
- nutrient pollution;
- grazing;
- pest plants and animals;
- recreation; and
- fire.

These risks result from activities in the wetlands, on adjoining land and in the surrounding catchment. Since European settlement, the structure and composition of the vegetation around the Hattah Lakes has been severely modified by domestic stock and native animal grazing, logging and the introduction of exotic flora and fauna. Protection of the site has therefore required an integrated approach. A wide variety of measures are being implemented at the Hattah Lakes to deal with these risks. They include planning, research, site works, catchment works and education.
2.3.1 Altered water regimes

The Hattah Lakes system is a series of perennial and intermittent freshwater lakes fed from the River Murray via the Chalka Creek anabranch. There have been substantial changes to the hydrological regime of the Hattah Lakes system due to the regulation and modification of flow in the River Murray and structural works and earthworks in the Chalka Creek (Cumming and Lloyd 1993).

The flows of the River Murray are regulated by a series of weirs, locks and dams along its length. Modifications to Chalka Creek include deepening and re-grading of the channel and the installation of a regulator at the inlet (Messengers) to prevent floodwater from receding. Internal modifications to the Hattah Lakes system include the construction of a channel between Lakes Lockie and Hattah, and the installation of an earthen bank and a drop-board regulator between Lakes Hattah and Little Hattah.

The effects of these changes on the Hattah Lakes system have been:

- a reduction in the flooding frequency by 57%. Instead of an average return period of 1.5 years under natural conditions, the current return period is estimated to be 3.7 years (Cumming and Lloyd, unpub. 1993);
- a reduction in the flooding duration by 65% (Cumming and Lloyd, unpub. 1993);
- a delay in the timing of flooding. Under natural conditions the most common month of flood initiation was August. Under current conditions, October has become the most common month of flood initiation (Cumming and Lloyd, unpub. 1993);
- changes to the drying regime of Lake Hattah. Since 1970 Lake Hattah has been dry for a short period in 1989, for 13 months between September 1999 and October 2000 and re-filled in November 2000. It dried again in 2001, and has remained dry since. The natural frequency of drying for Lake Hattah is estimated to be once every seven years (Cumming & Lloyd, unpub. 1993); and
- changes to the natural hydrological regime of the Hattah Lakes system have had a number of impacts upon native flora and fauna.
Table 2.1. Illustrating changes to flooding regime resulting from regulation in a series of lakes (Source: SKM, 2004).

<table>
<thead>
<tr>
<th>Lake</th>
<th>Pre-Regulation</th>
<th>Post-Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
<td>Wet Spells</td>
</tr>
<tr>
<td>Hattah</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>Bulla</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>Araluen</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>Brockie</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>Munn Lal</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>Konardin</td>
<td>2</td>
<td>8.6</td>
</tr>
<tr>
<td>Bitterang</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Marramook</td>
<td>2</td>
<td>7.1</td>
</tr>
<tr>
<td>Boichi</td>
<td>2</td>
<td>7.1</td>
</tr>
<tr>
<td>Nip Nip</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Lockie</td>
<td>2</td>
<td>12.9</td>
</tr>
<tr>
<td>Yelwell</td>
<td>3</td>
<td>17.1</td>
</tr>
<tr>
<td>Yerang</td>
<td>4</td>
<td>85.7</td>
</tr>
</tbody>
</table>

Wet Spells = the number of times the lakes are wet in a 100-year period
Years Wet = the average duration of inundation for the lakes
% Time Wet = the percentage of time the lakes were/are wet.

Figure 2.3 (below) illustrates the changes to the flooding pattern resulting from river regulation. This is drawn from modelled information over the last 100 years comparing flows which would have occurred under natural unregulated conditions and flows which would have occurred over that time under current levels of extraction. Two flow levels have been highlighted. The lower level, 1,116-1,487 GL/month, approximates the times when River Murray flows would begin entering Chalka Creek and moving through the lakes system. The higher flows of >1,487 GL/month is when the River Murray flows are high enough to start broad-scale flooding across the red gum floodplain.
<table>
<thead>
<tr>
<th>DATE</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1939</td>
<td>1366</td>
<td>2513</td>
<td>4125</td>
<td>3818</td>
<td>2249</td>
<td>1342</td>
</tr>
<tr>
<td>1940</td>
<td>419</td>
<td>510</td>
<td>606</td>
<td>565</td>
<td>369</td>
<td>217</td>
</tr>
<tr>
<td>1941</td>
<td>658</td>
<td>808</td>
<td>731</td>
<td>1000</td>
<td>769</td>
<td>384</td>
</tr>
<tr>
<td>1942</td>
<td>1795</td>
<td>2609</td>
<td>2425</td>
<td>2421</td>
<td>1612</td>
<td>939</td>
</tr>
<tr>
<td>1943</td>
<td>745</td>
<td>990</td>
<td>1296</td>
<td>1453</td>
<td>1358</td>
<td>699</td>
</tr>
<tr>
<td>1944</td>
<td>707</td>
<td>646</td>
<td>440</td>
<td>353</td>
<td>314</td>
<td>198</td>
</tr>
<tr>
<td>1945</td>
<td>414</td>
<td>924</td>
<td>1284</td>
<td>1058</td>
<td>926</td>
<td>570</td>
</tr>
<tr>
<td>1946</td>
<td>1072</td>
<td>2059</td>
<td>2248</td>
<td>1373</td>
<td>1133</td>
<td>704</td>
</tr>
<tr>
<td>1947</td>
<td>1005</td>
<td>1436</td>
<td>1704</td>
<td>2078</td>
<td>1837</td>
<td>1402</td>
</tr>
<tr>
<td>1948</td>
<td>1020</td>
<td>925</td>
<td>980</td>
<td>1131</td>
<td>1270</td>
<td>1187</td>
</tr>
<tr>
<td>1949</td>
<td>628</td>
<td>887</td>
<td>1017</td>
<td>1266</td>
<td>1896</td>
<td>1820</td>
</tr>
<tr>
<td>1950</td>
<td>1006</td>
<td>1470</td>
<td>1570</td>
<td>1420</td>
<td>2039</td>
<td>1444</td>
</tr>
<tr>
<td>1951</td>
<td>1822</td>
<td>2857</td>
<td>2927</td>
<td>2026</td>
<td>1663</td>
<td>854</td>
</tr>
<tr>
<td>1952</td>
<td>4949</td>
<td>3969</td>
<td>2958</td>
<td>3070</td>
<td>2917</td>
<td>2460</td>
</tr>
<tr>
<td>1953</td>
<td>1040</td>
<td>1704</td>
<td>2390</td>
<td>2775</td>
<td>2916</td>
<td>1942</td>
</tr>
<tr>
<td>1954</td>
<td>546</td>
<td>887</td>
<td>1076</td>
<td>939</td>
<td>949</td>
<td>1294</td>
</tr>
<tr>
<td>1955</td>
<td>1271</td>
<td>2696</td>
<td>5733</td>
<td>4849</td>
<td>5699</td>
<td>1826</td>
</tr>
<tr>
<td>1956</td>
<td>655</td>
<td>7474</td>
<td>5713</td>
<td>4482</td>
<td>3964</td>
<td>2102</td>
</tr>
<tr>
<td>1957</td>
<td>799</td>
<td>965</td>
<td>898</td>
<td>1035</td>
<td>961</td>
<td>500</td>
</tr>
<tr>
<td>1958</td>
<td>991</td>
<td>2501</td>
<td>4269</td>
<td>2765</td>
<td>2681</td>
<td>1488</td>
</tr>
<tr>
<td>1959</td>
<td>402</td>
<td>830</td>
<td>1066</td>
<td>1205</td>
<td>1562</td>
<td>781</td>
</tr>
<tr>
<td>1960</td>
<td>1465</td>
<td>2847</td>
<td>3453</td>
<td>3459</td>
<td>2320</td>
<td>1211</td>
</tr>
<tr>
<td>1961</td>
<td>864</td>
<td>1345</td>
<td>1297</td>
<td>1301</td>
<td>648</td>
<td>700</td>
</tr>
<tr>
<td>1962</td>
<td>1006</td>
<td>1114</td>
<td>1276</td>
<td>1421</td>
<td>1191</td>
<td>600</td>
</tr>
<tr>
<td>1963</td>
<td>973</td>
<td>1247</td>
<td>1524</td>
<td>1517</td>
<td>1176</td>
<td>618</td>
</tr>
<tr>
<td>1964</td>
<td>1525</td>
<td>3253</td>
<td>3009</td>
<td>3664</td>
<td>3987</td>
<td>1733</td>
</tr>
<tr>
<td>1965</td>
<td>322</td>
<td>896</td>
<td>1256</td>
<td>1287</td>
<td>752</td>
<td>547</td>
</tr>
<tr>
<td>1966</td>
<td>690</td>
<td>1117</td>
<td>1547</td>
<td>1318</td>
<td>1660</td>
<td>1716</td>
</tr>
<tr>
<td>1967</td>
<td>159</td>
<td>289</td>
<td>629</td>
<td>735</td>
<td>414</td>
<td>151</td>
</tr>
<tr>
<td>1968</td>
<td>1596</td>
<td>1427</td>
<td>2107</td>
<td>1723</td>
<td>1926</td>
<td>1354</td>
</tr>
<tr>
<td>1969</td>
<td>1355</td>
<td>1528</td>
<td>1455</td>
<td>1535</td>
<td>1148</td>
<td>1086</td>
</tr>
<tr>
<td>1970</td>
<td>1227</td>
<td>1765</td>
<td>3048</td>
<td>3608</td>
<td>2131</td>
<td>1313</td>
</tr>
<tr>
<td>1971</td>
<td>1650</td>
<td>1009</td>
<td>1227</td>
<td>1576</td>
<td>1883</td>
<td>1624</td>
</tr>
<tr>
<td>1972</td>
<td>508</td>
<td>861</td>
<td>1005</td>
<td>791</td>
<td>436</td>
<td>250</td>
</tr>
<tr>
<td>1973</td>
<td>1570</td>
<td>2597</td>
<td>3963</td>
<td>4504</td>
<td>2874</td>
<td>1669</td>
</tr>
<tr>
<td>1974</td>
<td>2299</td>
<td>4155</td>
<td>5898</td>
<td>5579</td>
<td>5951</td>
<td>2425</td>
</tr>
<tr>
<td>1975</td>
<td>1539</td>
<td>2317</td>
<td>3147</td>
<td>4577</td>
<td>5821</td>
<td>3054</td>
</tr>
<tr>
<td>1976</td>
<td>335</td>
<td>612</td>
<td>855</td>
<td>1120</td>
<td>1998</td>
<td>732</td>
</tr>
<tr>
<td>1977</td>
<td>1332</td>
<td>1244</td>
<td>1192</td>
<td>1032</td>
<td>509</td>
<td>247</td>
</tr>
<tr>
<td>1978</td>
<td>1646</td>
<td>2120</td>
<td>2692</td>
<td>2599</td>
<td>1593</td>
<td>1194</td>
</tr>
<tr>
<td>1979</td>
<td>413</td>
<td>823</td>
<td>1250</td>
<td>2427</td>
<td>2354</td>
<td>751</td>
</tr>
<tr>
<td>1980</td>
<td>812</td>
<td>1172</td>
<td>1419</td>
<td>1484</td>
<td>1026</td>
<td>593</td>
</tr>
<tr>
<td>1981</td>
<td>2408</td>
<td>5721</td>
<td>6996</td>
<td>3135</td>
<td>1532</td>
<td>642</td>
</tr>
</tbody>
</table>

**Figure 2.3. Comparison of inflows to Hattah lakes under natural and regulated conditions, based on monthly discharge at Euston weir.**
2.3.2 Other Risks

Rising groundwater is a potential risk to the vegetation within the Hattah Lakes ecosystem, with the potential to cause water logging and increased salinity in the plant root zone. By replicating natural events as best we can, adverse effects are expected to be minimal, and indeed recharging of aquifers will provide more available water for riparian vegetation and dilute salt levels in the groundwater. However, at this stage the extent of effects of adjacent irrigation and environmental flows on the water table is not known. Investigations will be undertaken to quantify the risks of rising groundwater.

Blue-green algal blooms, whilst a natural phenomenon, can affect recreational and economic values of the lakes. The Hattah Lakes complex has historically been the site of a number of blue-green algal blooms. During January of both 1991 and 1993, levels of toxic blue-green algae detected in lakes Hattah and Little Hattah were high enough to result in the closure of these lakes to recreational activities (SKM, 2004). Again, it is anticipated that this threat can be managed in the park by providing more variable water regimes.

The long legacy of stock grazing and high rabbit numbers in the area, now reserved as national park, has required an intensive program of grazing management since declaration in 1980. Following de-stocking, rabbit and kangaroo numbers increased to unsustainably high densities. Rabbit numbers have been reduced and maintained at low levels, through a combination of conventional control works and the action of Rabbit Haemorrhagic Disease Virus (RHDV).

Over-grazing by kangaroos necessitated the development of a kangaroo management plan (Restoring the Balance, DCE 1990) and institution of a kangaroo management program in 1992. Kangaroo densities have since been maintained at a level which has allowed extensive recovery of the native vegetation.

Pest fish species which occur in the lakes complex (when wet) include European Carp (*Cypinthus carpio*), Brown Trout (*Salmo trutta*), Goldfish (*Carassius auratus*), Tench (*Tinca tinca*), Redfin (*Perca fluviatilis*) and Mosquitofish (*Gambusia holbrooki*). These species are able to adapt quickly to changed environmental conditions, allowing them to establish quickly. This can lead to changes in species composition and exclusion of native species (SKM, 2004).

The uncontrolled spread of Cumbungi, an emergent macrophyte, common in wetland and littoral areas, is also viewed as a potential threat in the lakes. The maintenance and growth of this species is encouraged by static water that is enriched with nutrients, but also occurs in seasonally inundated wetlands that have a drying period (SKM, 2004). Indirect management of this threat will probably be achieved by promoting flow regimes that benefit the expansion of aquatic macrophyte assemblages (SKM, 2004).

River Red Gum and Black Box woodlands along the River Murray (and in and around the Hattah Lakes system) are frequently used by apiarists. There are over 20 licensed sites in the planning area. The most obvious environmental impact is the network of informal access tracks to the bee sites. Other likely potential impacts on native species caused by bees, such as competition for food and hollows, have not been conclusively proven (P. Kelly pers. comm.). Bees are however, a threat to the safety of campers and staff, being attracted to water sources (eg. drinking and washing water and body perspiration), especially in the campgrounds when the lakes are dry.

Inappropriate fire management practices are also seen as a threat to the parks terrestrial and aquatic biodiversity values. Whilst it is important to protect visitors and park facilities, inappropriate fire management can lead to an increase in weeds and deleterious changes in species composition (SKM, 2004).
There is significant River Red Gum sapling growth on the inner verges of many of the lakes and in the Chalka Creek. Watering these will increase their growth and health, which may throttle flows in future, unless watering continues or flooding occurs to the extent that these saplings are inundated for long enough that they drown. Extensive growth and death of saplings has occurred before, and quite large trees in the inner zone have either died from natural thinning or from extended periods of inundation in the past.

The lack of understanding of potential adverse effects of artificial flooding and reduced connectivity to the river are potential risks. For example, if water is pumped into the lakes, it could be expected that there would be lower numbers of fish, and fish of much smaller size which would make it into the lakes, as compared with natural flow. Fish are a major component of the food chain, and the ecological objectives achieved through pumping may be limited by their absence. Also, there could be the risk that particular biota will fail to complete their life cycle to replenish egg/seed banks.

The risks of doing nothing in the long-term are that biodiversity will decrease, the ecological integrity of the system will be further compromised, and, the lakes will tend towards a more terrestrial rather than flood-dependent ecosystem. Species composition will change with resultant reduction of biodiversity (SKM, 2004). In the short-term, if no water enters the system, River Red Gum decline (for example) could be expected to continue, but the magnitude and extent of adverse effects are not known.

2.4 Relevant Plans and Legislative Controls

The key land and water management plans, programs and strategies relevant to management of environmental water at the Hattah Lakes are listed below:

- The Living Murray Environmental Works and Measures Program (EWMP)
- The Living Murray Environmental Watering Plan
- The Mallee Regional Catchment Strategy (Mallee CMA, 2003)
- Mallee Waterway and Floodplain Management Strategies (Mallee CMA, 2001)
- Mallee River Health Strategy (in press)
- Mallee Parks Management Plan (DNRE, 1996)

The Living Murray Environmental Works and Measures Program

The Living Murray Environmental Works and Measures Program (EWMP) is a $150 million program to improve the health of the River Murray system by:

- making the best use of currently available water;
- optimising the benefits of any water recovered in the future; and
- adopting a principled approach to ensure investment is targeted towards the best environmental outcomes.

The EWMP is integrally linked to the successful achievement of the Living Murray First Step decision with the program focusing on maximising environmental benefits for the six Icon Sites (MDBC, 2004b). In order to help achieve the ecological objectives of the Hattah Lakes Icon Site, the program is investing in a range of operational and structural works and measures relating to wetlands and floodplain processes as well as a range of investigations to inform the further development of the Icon Site EMP. The activities will assist in mitigating the threats to the floodplain, including improving the frequency, duration and extent of flooding (MDBC,
It is envisaged that the majority of the environmental flow management activities for
the Hattah Lakes Icon Site will be funded through the EWMP.

The Living Murray Environmental Watering Plan
The Living Murray Environmental Watering Plan provides the framework for sharing
environmental water between all Living Murray Icon Sites to meet the ecological objectives. It
will be developed by the Environmental Watering Group. Annual plans will be developed until
there is more clarity around water recovery, such as conditions associated with the recovered
500 GL of Living Murray water, and water application – particularly priority sites and the
availability of structures to manage water within the site.

Environment Protection and Biodiversity Conservation Act 1999
The Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999 came into
operation in July 2000. Under the Act, an action will require approval from the Commonwealth
Environment Minister if the action has, or is likely to have a significant impact on:
1. a matter of national environmental significance (listed below);
2. the environment on Commonwealth land (if the action is taken outside Commonwealth
land), or the environment generally (if the action is taken on Commonwealth land); and
3. the environment anywhere in the world (if the action is taken by the Commonwealth or
Commonwealth agency).
The EPBC Act applies nationally and provides protection to matters of national environmental
significance. These include:
- World Heritage properties;
- National Heritage places (from 1 January 2004);
- Ramsar wetlands of international importance; nationally threatened species and
  communities which are listed under the EPBC Act (note: this may not be the
  same as those listed under state legislation);
- migratory species that are listed under the EPBC Act (protected under
  international agreements);
- nuclear actions, including uranium mining; and
- the Commonwealth marine environment (which is generally Australian waters
  beyond the 3 nautical mile limit of State waters).

The EPBC Act also applies to actions involving Commonwealth land and actions by
Commonwealth agencies. An ‘action’ includes a project, development, undertaking or any
activity or series of activities. Activities in the Icon Site plans may be actions that are subject to
the EPBC Act, including structural works and possibly actions associated with environmental
watering.

If a person proposing to take an action thinks it is likely to have a significant impact on a matter
protected by the EPBC Act they must refer the action to the Australian Government
Environment Minister for a determination on whether the action requires approval under the
EPBC Act. If the Minister determines that the action is likely to have a significant impact on a
matter protected by the EPBC Act, the action will then be subject to the environmental
assessment and approval processes, including the setting of any necessary conditions, under the
EPBC Act.

The Hattah Lakes Icon Site includes a designated Ramsar Site which comprises twelve lakes of
over 1,155 ha in area. Activities proposed under this plan may impact (positively or negatively)
on the ecological character of a Ramsar wetland or other matters of national environmental
significance, such as listed migratory and threatened species and ecological communities.

Implementation of this plan will take due account of EPBC Act requirements and, where
appropriate, will refer activities for determination on whether the action requires approval under
the EPBC Act.
The Water Act 1989
The Water Act 1989 introduced a range of water reforms, and flagged the intention to establish “bulk water entitlements” (BEs) and specific environmental responsibilities for water authorities.

The Bulk Water Entitlement orders for the River Murray also constrain the managers of water, in that, an authority cannot modify the management of wetlands and waterways, or, make water savings unless it has prepared an environmental assessment statement. The statement must be to the satisfaction of the Minister for the Environment.

The Murray-Darling Basin Salinity and Drainage Strategy (1988)
The Murray-Darling Basin Salinity and Drainage Strategy was the culmination of 20 years of discussion about how to resolve the conflicting needs of each state. South Australia wanted lower river salinity levels; Victoria and NSW wanted to drain irrigation areas.

Under the strategy, each state is fully accountable for anything it does to increase (or decrease) river salinity from 1 January 1988. The strategy is a signed agreement that binds the states and the Australian Government to jointly funding works that reduce Morgan salinity by at least 80 EC (electrical conductivity). In return for their investment, both NSW and Victoria are then entitled to increase Morgan salinity by up to 15 EC each. These entitlements are often referred to as EC credits.

In essence, Victoria contributes one quarter (20/80ths) of the costs of jointly funded works and keeps 15/80ths of the benefits. Victoria is guaranteed 15 EC credits from jointly funded works under the strategy.

Victoria is accountable to the MDB for substantiation of the EC credits generated and used.

Salinity management plans are considered to be formal statutory plans under Victoria’s planning provisions. Statutory authorities and local governments are obliged to take account of their intent and their detail. The plan focuses on enabling water trade and improved on-farm management while also protecting the environment and minimising the impact on river salinity. It also provides an accountability mechanism for the Salinity and Drainage Strategy.

Mallee Regional Catchment Strategy (Mallee CMA, 2003)
The Mallee Regional Catchment Management Strategy (RCS) and subsidiary strategies (Mallee Waterway and Floodplain Management Strategies (Mallee CMA, 2001) and the Mallee Regional River Health Strategy (Mallee CMA, in prep.) identify and prioritise natural resource management activities for the region. The RCS identifies priority actions across a range of management agencies and issues to ensure that priority actions are identified, and to facilitate identification of opportunities for achieving multiple benefits through integrating projects. Management of Hattah Lakes is a noted priority for the region.

Mallee Parks Management Plan (DNRE, 1996)
The aims of the Mallee Parks Management Plan for Hattah Kulkyne National Park directly relevant to biodiversity conservation include:
- restore, as far as possible, a more natural hydrological regime to Hattah Lakes;
- protect native plant communities in their natural condition and maintain genetic diversity;
- enhance long term survival prospects of threatened or significant plant species or communities;
- encourage degraded communities to rehabilitate by natural means;
- actively rehabilitate degraded plant communities to a level approaching pre-European settlement conditions;
• protect native animal communities and maintain genetic diversity;
• enhance long term survival prospects of threatened or significant fauna; and
• protect and enhance all landscape values.

Hattah Kulkyne Lakes Ramsar Site Strategic Management Plan (DNRE, 2003)
The objective of the Hattah-Kulkyne Lakes Ramsar Site Strategic Management Plan is to: ‘…facilitate conservation and wise use of the site so as to maintain, and where practical restore, the ecological values for which it is recognised…’. The criteria against which the Hattah-Kulkyne Lakes Ramsar site is internationally recognised include: special value for maintaining biodiversity; regularly supports greater than 20,000 waterbirds; regularly supports substantial numbers of individuals from particular groups of waterbirds; and regularly support 1% of the individuals of a population of one species or subspecies of waterbird. All Australian Ramsar sites are considered matters of National Environmental Significance under the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth). Maintenance of the ecological character of the Hattah-Kulkyne Lakes Ramsar site is achieved through implementation of the Strategic Management Plan, which has been developed to be consistent with the Australian Ramsar Management Principles established under the Environment Protection and Biodiversity Conservation Regulations 2000 (Commonwealth).

A description of the ecological character of the Hattah Lakes Ramsar site has recently been completed (DSE unpublished). An objective of the Hattah Lakes Icon Site is to maintain and where practical restore the ecological character of the Ramsar site.

The Murray River Frontage Action Plan Project was developed to address threats to the riparian land to the River Murray. The aims of the Frontage Management Plan directly relevant to water management at this icon site include:
• retain riparian vegetation and protect high value flora and fauna habitat;
• restore degraded frontages and the quality and extent of riparian and floodplain vegetation; and
• reduce sedimentation and nutrient inputs to the River Murray.

Hattah Lakes Water Management Plan (Mallee CMA in prep)
The Hattah Lakes have been the subject of extensive investigations for many years, and since 2001, under the guidance of the Hattah Lakes Steering Committee.

There are still a number of investigations to be completed before the Water Management Plan can be finalised. Ultimately, there will be an understanding of how much, when, where, and how often, the Hattah Lakes need to receive environmental water to meet the specific stated ecological objectives. A range of potential management options for the delivery of environmental water, such as installation of regulators and pumps will be considered. We will know how the water will be delivered, and have a clear set of rules to govern the operation of any structures which may be installed. The ongoing monitoring program will allow measurement of the ecological responses to management interventions. This information will be incorporated back into the management plan through annual reviews, to ensure that the management is adaptive and responsive by incorporating new information into decision making and management activities, as it becomes available.

All the information will be collated to form the basis of a final approved Hattah Lakes Water Management Plan, which will document management strategies and operational rules for structures, and prioritise and set timelines for the implementation of management actions.

Note: See Appendix 1 for more detailed descriptions of completed, current, planned investigations and actions, and indicative timelines.
Other key strategic initiatives currently under development that will guide regional management of river health outcomes for the River Murray, its anabranches, wetlands and floodplains in the Mallee, which includes the Hattah Lakes Icon Site, are the Mallee Regional River Health Strategy (Mallee CMA, in prep.) and the Mallee Wetland Prioritisation Project (Mallee CMA, in prep.).

3. **ENVIRONMENTAL MANAGEMENT OBJECTIVES FOR HATTAH LAKES**

In its decision on the First Step for The Living Murray, the Murray-Darling Basin Ministerial Council set interim ecological objectives and expected outcomes for each of the Icon Sites. For the Hattah Lakes Icon Site, the interim objectives are:

- restore healthy examples of all original wetland and floodplain communities;
- restore the aquatic vegetation zone in and around at least 50% of the lakes to increase fish and bird breeding and survival;
- increase the successful breeding events of colonial waterbirds to at least 2 years in 10 (spoonbills, bitterns, egrets and night herons); and
- increase the population size and breeding events of Murray Hardyhead, Australian Smelt, gudgeons and other wetland fish.

These interim objectives and outcomes were set for the entire Icon Site on the basis of a short review of existing information. It was always intended that they would be refined and be made more specific with more detailed analysis, local knowledge and with stakeholder and community involvement. This Icon Site plan outlines the Victorian Government’s vision for Hattah Lakes and specific ecological objectives for the use of environmental water.

3.1 **Vision for Hattah Lakes**

Taking into account the objectives of the plans outlined in section 2.4, The Living Murray vision for Hattah Lakes is to:

- preserve and where possible enhance the biodiversity values of Hattah Lakes; and
- restore healthy examples of all original wetland and floodplain communities which represents the communities which would be expected under natural flow conditions.

3.2 **Ecological Objectives for Use of Environmental Water in Hattah Lakes**

A suite of ecological objectives for use of environmental water have been developed which are in line with the vision for Hattah Lakes and with the key environmental management plans or directives for the site. These have been developed through the Hattah Lakes Water Management Program which has been established by the Mallee CMA and The Living Murray. The project is managed by a multi-agency steering committee.

**General ecological objectives:**

- restore a mosaic of hydrological regimes which represent pre-regulation conditions (to maximise biodiversity);
- maintain, and where practical, restore the ecological character of the Ramsar site with reference to the Strategic Management Plan;
- restore the macrophyte zone around at least 50% of the lakes (to increase fish and bird habitat);
improve the quality and extent of deep freshwater meadow and permanent open freshwater wetlands so that species typical of these ecosystems are represented;

• maintain habitat for Flora and Fauna Guarantee-listed Freckled Duck, Grey Falcon and White-bellied Sea Eagle in accordance with action statements;

• increase successful breeding event of colonial water birds to at least 2 years in 10 (including spoonbills, egrets, night herons and bitterns);

• provide suitable habitat for a range of migratory bird species (including Lathams Snipe, Red-necked Stint, and Sharptailed Sandpiper);

• increase distribution, number and recruitment of local wetland fish (including endangered Murray Hardyhead, smelt, and gudgeon) by providing appropriately managed habitat; and

• maximise use of floodplain habitat for recruitment of all indigenous freshwater fish.

These objectives are currently undergoing refinement as a part of the Feasibility Investigation of Options for the Hattah Lakes (Ecological Associates, in prep.). At the conclusion of these investigations, specific ecological and flow objectives will be detailed. Measurable management targets for the objectives will be defined, and methods for evaluation of ecological responses to water management will be recommended. The Murray-Darling Freshwater Research Centre (MDFRC) are in the process of developing a standard monitoring program for whole of Icon Site scale monitoring, which will be implemented across all of the MDBC Icon Sites.

3.3 Prioritisation of Water Regime Classes

The prioritisation process for delivery of appropriate water regimes to achieve ecological objectives is under development by Ecological Associates (in prep.). The approach taken has been to group the wetlands according to the natural water regime class to which they would have been subject. This has been determined based on wetland type, vegetation communities present and the elevation of terrain.

Prioritisation of water regime classes is based on the importance of delivery of a particular water regime class to achievement of the ecological objectives, and on the degree to which the water regime is threatened (Ecological Associates, in prep.).

Identification of priority sites will be based on:

• contribution to achievement of the overall ecological objectives;

• importance of conservation values present;

• degree of threat;

• feasibility of providing water in the required regime;

• predicted long-term quality of the outcome ;

• other issues which would limit the ability to meet the objectives; and

• generation or magnification of a threat resulting from environmental water management.
4. **FLOW REQUIREMENTS**

Ecological Associates (in prep.) have developed specific ecological and flow objectives for the Hattah Lakes system. The different wetland types have been grouped into water regime classes which would have been representative of the Hattah Lakes system under natural conditions, and which are required to achieve the ecological and flow objectives.

The hydraulic model will be used to run a range of scenarios to determine the range of flows required to achieve the ecological objectives designated for the site.

The next step is to investigate and evaluate water management options for delivering the appropriate range of water regimes. The feasibility of the options, in terms of costs, benefits and risks will be assessed, and recommendations made for what water management actions should be implemented, and how these can be monitored and evaluated in terms of their achievement of the flow and ecological objectives.

The pattern of water requirements, identified as a result of these investigations, will inform development of TLM Environmental Watering Plan, which will prioritise water sharing arrangements between all of TLM Icon Sites.

4.1 **Flow Requirements across the Icon Site**

Minimum flow requirements to maintain the health of the range of species and processes that occur in the Hattah Lakes system varies widely. The frequency and duration of wet and dry periods is critical.

The Hattah Lakes Water Management Program aims to ensure that at any time, a mosaic of different hydrological regimes are present across the lakes complex, providing suitable conditions for the range of flora and fauna and key ecological processes.

Preliminary flow objectives identified by SKM (2004) are:

- to increase the inundation permanence of lakes Hattah, Bulla, Arawak, Brockie, Mournpall, Marramook, Boich and Lockie;
- to increase the frequency of flooding in lakes Bulla, Arawak, Marramook and Brockie (either through increasing frequency of inflows or increasing inundation permanence);
- to decrease the duration and frequency of dry spells in lakes Hattah, Bulla, Arawak, Brockie, Mournpall, Marramook, Boich and Lockie; and
- to maintain the current frequency and duration of inundation experienced by lakes Yerang, Nip Nip, Yelwell, Konardin, and Bitterang.

These objectives and the recommended actions to meet them were developed by SKM (2004) prior to the formulation of TLM. With the additional funding made available under TLM for environmental works and measures (eg. regulators and structures), the environmental water allocations and funding available from DSE’s Flora and Fauna entitlement, and, the potential for additional water allocations to become available as a result of the water savings to be generated under TLM, many more water management options may now be considered as being potentially feasible.

For example SKM (2004) recommended the installation of four regulators between lakes Little Hattah and Hattah (upgrade the existing structure); Bulla and Arawak; Yerang and Mournpall; and Mournpall and Konardin, which could be utilised in order to manipulate water to achieve a mosaic of wetting and drying cycles within these lakes. This would have been augmented by the installation of a pumping station on the River Murray which would be used to generate flows...
into the system, or to top up high river flood events, to increase the ecological benefits of small floods to the lakes system.

These recommendations were made prior to The Living Murray First Step decision to return up to 500 GL to the river. With the extra funding and water now available, the vision is broadening to consider manipulation of water across the whole of the lake and floodplain system using regulators and pumps.

An option for consideration for example, could be the construction of a series of regulators which could be used to retain water to a pre-determined height over the whole system (if sufficient water was available), or, to manipulate regulators to push water specifically to priority areas within the system.

The following example demonstrates that large-scale watering is possible. In 2004-05, utilising water made available by DSE for emergency River Red Gum watering, 2000 ML of water, including water donated by local irrigators, was delivered by pump to the Chalka Creek. Since then, under DSE’s Environmental Water Allocation process, Hattah Lakes has received 4 GL in Spring 2005 and 6 GL in Autumn 2005. It is anticipated that 4 GL will be delivered to the lakes system in Spring 2006. Aside from saving stressed and dying River Red Gums, the watering so far has brought many ecological (and social and economic) benefits to the Hattah Lakes, and has proven that pumping water is feasible, and may assist with achieving a suite of ecological objectives at the lakes.

A more comprehensive analysis of specific flow requirements to meet specific ecological objectives are being developed by Ecological Associates (in prep.), and will be ready for inclusion in the 2007-08 plan. These investigations will also examine the extent to which the installation of regulator structures, and pump stations (for example), can enhance environmental water delivery.

4.2 Additional Water Required to Meet Objectives

A Digital Elevation Model (DEM), and hydraulic model have been completed and have proved extremely useful tools in allowing more accurate estimation of volumes of water required to achieve various objectives (eg. River Red Gum watering), in determining where water is likely to flow naturally based on the topography, and, by allowing estimation of the dimensions of any banks or structures that may be required to hold or divert water at particular points.

However, accurate estimations of how much water is required are not available at present. These will be determined at the completion of the feasibility investigations. Test scenarios will be run through the hydraulic model to determine water delivery options and water volumes required under these options, and to determine the most efficient methods of delivering environmental water to achieve the ecological and flow objectives.

4.3 Current Environmental Water Allocations

Victorian Flora and Fauna Entitlement

An allocation of 27,600 ML per year of high security water was committed for flora and fauna conservation by the Natural Resource and Environment Committee of Cabinet in 1987 (the Flora and Fauna EWA). As part of Victoria’s reform of the water industry, all existing rights to water are being converted to a Bulk Entitlement (BE) under the Water Act (1989). Through the Murray BE process, the 27,600 ML Environmental Water Allocation (EWA) has been converted to a BE. The conversion of the original allocation was signed off by the Minister for Conservation and Land Management in 1999 and has resulted in the allocation becoming a defined entitlement for the environment.
The 27,600 ML Flora and Fauna EWA cannot be carried over in storage from year to year. It is located in Hume and Dartmouth Reservoirs and is available for distribution through the River Murray system. An annual assessment is undertaken to determine its use for that year. Wetlands targeted for the allocation include Ramsar listed wetlands (those identified as wetlands of international significance due to their conservation of waterfowl habitat). It is anticipated that greater use of the EWA will be made to other River Murray wetlands when infrastructure and management constraints are addressed (DSE, 2004a). However it is unclear how this will impact on Hattah’s current water allocations.

There will be an increasing demand for use of the Flora and Fauna EWA over time. Within northern Victoria, a range of wetland planning activities has occurred which have identified the ecological requirements for individual wetlands. These include a range of wetland operational plans, wetland management plans and water management strategies. Infrastructure constraints, system constraints and management constraints may prevent water from being used within some wetlands.

The Flora and Fauna EWA is a Victorian environmental entitlement and will not be included in the environmental water managed under The Living Murray Environmental Watering Plan.

Other floodplain systems

During development of the Victorian Murray Bulk Entitlement, recommendations were made for use of environmental water on Gunbower Island and Lindsay Wallpolla floodplains (Sharing the Murray 1997). These recommendations are for use of surplus flows and are not a legal entitlement. Use of surplus flows for environmental outcomes will be managed under The Living Murray Environmental Watering Plan.

Emergency River Red Gum watering

Using water allocated from Victoria’s Flora and Fauna Environmental Bulk Entitlement and surplus flows, emergency River Red Gum watering projects were undertaken at Hattah in April to June, and September to December of 2005. This delivered a total of approximately 6 GL to Chalka Creek north and south, and lakes Lockie, and Little Hattah. During 2006, there is the potential to deliver a further 10 GL to the system, filling lakes Yerang and Mournpall.

Watering to date has resulted in a significant improvement in River Red Gum health (Oliver Scholz pers comm. 2006). Many other species have also benefited from the watering. There has been an abundance of water birds on the creek and lakes including a number of threatened species. The have been many frogs, tortoises, and invertebrates present and aquatic plants have reappeared in the creek. Fish have also been netted, proving that small fish can survive going through the pumps.

Social and economic benefits are also apparent with the pumping program having created significant interest among local people and tourists alike, and providing local contractors with employment opportunities.
5. OPTIONS FOR WATER MANAGEMENT FOR ENVIRONMENTAL OUTCOMES

The Living Murray Environmental Watering Plan (LMEWP) provides a management framework for application of environmental water across the River Murray system for achieving ecological objectives at the six Icon Sites under the Murray-Darling Basin (MDB) Ministerial Council’s The Living Murray (TLM) First Step decision.

The Living Murray Business Plan states that the purpose of the LMEWP (Clause 99) is to:

‘... apply available water in a way that enhances ecological outcomes across the six Icon Sites, protects existing high value areas or areas in good condition and realises the greatest environmental benefit from the water’.

In doing this, the LMEWP will coordinate the volume, timing, security and application of water required to meet the ecological objectives of The Living Murray First Step decision. The specific requirements of the LMEWP are outlined in Annex E of the business plan.

The relationship between the LMEWP and the Icon Site EMPs is described in the introduction to the watering and business plans. In summary, the aim of the EMPs is to inform the watering plan by describing the demand of water for each Icon Site. The Murray-Darling Basin Environmental Watering Group (EWG) was established to implement the LMEWP and in doing so, make balanced decisions on allocation of water considering all of the Icon Sites.

The Murray Darling Basin Commission MSM-BIGMOD simulation model for the River Murray system will need to be used to establish the impact of these water requirements on the overall system including deliverability and requirements for the application of water recovered under The Living Murray.

5.1 Delivering Water to the Icon Site

Delivery options for Hattah Lakes were investigated as part of the Hattah Lakes Water Management Plan – Background Report (SKM, 2004). More specific investigations into the water regime requirements for the system, and the feasibility of management options to achieve delivery of appropriate water regimes, is under development by Ecological Associates (in prep.) in light of the greater opportunities for environmental watering and works and measures which have been created under The Living Murray.

The Background Report states that the delivery of water via weir manipulation and releases from upstream storages will not be able to sufficiently deliver additional flows, to top-up existing floods, or generate smaller floods in the Hattah Lakes. It appears that the only likely way to top-up existing floods or generate floods in Hattah Lakes is through pumping from the River Murray into Chalka Creek, or the construction of a weir across the River Murray downstream of Chalka Creek.

The construction of a weir would be costly from environmental and economic perspectives, and would result in the creation of a weir pool in the only free flowing section of river from Euston to the mouth of the Murray, so this is not considered a viable option.

Manipulation of Euston Weir:

Under the current operating range, manipulation of Euston weir is of fairly limited value as there is not much flexibility to vary the flow. An increase in frequency of inflows could be achieved by boosting flows by about 20,000 ML/day for a few days to get water levels high enough to reach Chalka Creek. This would only work when flows were almost high enough to flow into Chalka Creek. The short period in which flows are raised would not allow water to...
distribute far into the lakes system. It is also possible to provide a small increase in the duration of a flood by reducing the height of the peak, and as a result, increasing the duration by a few days.

With the current limits on the operating range of Euston pool, the size and shape of the flood upstream of Euston will have a large bearing on what can be achieved downstream.

Over the next year, further modelling will be undertaken to determine whether it is possible to optimise delivery of water along the river to address water requirements of the Hattah Lakes. This will include assessment of operating constraints and opportunities at Euston weir.

**Pumping additional water into the Lakes.**

As outlined in section 4.3 (above) pumping has been used to deliver approximately 6 GL of water to the Chalka Creek and lakes Lockie and Little Hattah in 2005, for the purpose of emergency River Red Gum watering. This was undertaken in response to studies which showed that River Red Gum health was declining in many floodplain areas along the Murray, including the Chalka Creek, due to prolonged dry periods, and a lack of flooding over the past 10 years. In 2006, it is anticipated that a further 10 GL will be pumped to water River Red Gum around lakes Yerang and Mournpall.

The MDFRC are monitoring the responses of River Red Gum and fish to the pumping events, and Parks Victoria staff are monitoring waterbird response and water levels. It is anticipated that the data being collected for the pumping flow event will be compared with a high river flow event in the future, to compare ecological responses.

The pumping trials have proved that pumping is a feasible option for water delivery to the system and that positive ecological responses are achievable using this method (see section 4.3 above).

While pumping has been used to deliver water to the Hattah Lakes Icon Site, the feasibility, including cost/benefits, of pumping as a management option are under more detailed investigation. Pumping could be used as a short-term water delivery mechanism during prolonged periods of drought, and/or a more long-term option to increase the duration or peak of natural floods, and/or increase flood frequency.

**Further investigations:**

Each of the management options identified in the Hattah Lakes Water Management Plan - Background Report (SKM 2004), including regulator options within the Icon Site and long and short-term pumping from the river, are being further explored and qualified in the “Feasibility Investigation of Options for the Hattah Lakes” report which is in preparation by Ecological Associates.

This study is:

- utilising new information, including a Digital Elevation Model (DEM) and hydraulic model of the lakes complex; and

- investigating the feasibility of emergency pumping options compared to more permanent long term pumping options, in light of potential environmental water allocations through The Living Murray and use of the Victorian Flora and Fauna Environmental Water Entitlement.

Modelling scenarios will be used to develop an approach to provide and manage environmental water to provide the desired ecological outcomes. The process will be as follows:
• identify the ecological objectives and the water requirements to meet these objectives;
• identify the sites where particular ecological objectives should be met. Priorities will be set on the basis of conservation outcomes and feasibility of water management options;
• for each priority site, define the flow regime which needs to be delivered in terms of frequency, duration, seasonality and time between flows to meet the objectives;
• identify the river flow characteristics necessary to provide water to these areas;
• using DEM and hydraulic model, plus information on wetting-up requirements, seepage and evaporation, establish (as far as possible) volumes which would be retained by the lakes and what proportion of flows which would return to the river. The timing of returns will also be described; and
• using the information on required river flow characteristics and volumes retained, develop flow scenarios using the hydraulic model, models of river flow (MDBC’s MSM and/or Victoria’s REALM model) which will provide the required river height with the required frequency, duration and timing. These scenarios will investigate ways of delivering the water, which will best provide the flow regime required to meet the ecological objectives of for the Icon Site.

Environmental water provided to the Hattah Lakes is unlikely to result in much water returning to the river, at least until the lakes fill. After the lakes fill, water will return along the Chalka Creek system. The lakes will also drain to varying extents as river levels drop. As with any floodplain system, returns will also depend on how dry the floodplain system is.

5.2 Water Management within the Icon Site

5.2.1 Potential Options for Further Investigation

A series of water regulation options have been proposed in the Hattah Lakes Water Management Plan - Background Report (SKM, 2004) which would allow management of water once it has entered the Hattah Lakes system to prolong retention in some lakes. The feasibility of these and other options are being assessed, utilising the information provided by the DEM, hydraulic model, and feasibility investigations to determine effectiveness of various water management options in meeting the ecological objectives. Some potential options, specified by SKM (2004) prior to the implementation of The Living Murray include:

Pairs of Regulators

• During a flood, if the levels upstream of each of the two upstream regulators (ie. those between Hattah and Little Hattah, and between Yerang and Mournpall) exceeded the downstream water levels (ie. levels in Lakes Hattah and Bulla, and Lake Mournpall) then the upstream regulators would be opened, thus allowing floodwaters to flow into lakes Hattah, Bulla and Mournpall.
• If conditions prior to the flood were such that Lakes Arawak and Konardin were deemed to be in need of additional water (based on consideration of optimum duration of wet spells), then the downstream regulators (ie. those between Bulla and Arawak, and between Mournpall and Konardin) would also be opened, allowing floodwaters to flow into those lakes. Depending on the size of the flood, floodwaters might also then flow beyond Lake Arawak into lakes Marramook, Brockie and beyond.
• As soon as the floodwaters started to recede, the two upstream regulators would be closed, thus retaining water in lakes Hattah, Bulla and Mournpall (and if the downstream regulator had been opened, other lakes downstream of these lakes), at higher levels than would have been retained under existing conditions.
• Lakes could, if required, be drained between floods, if the duration of inundation exceeded optimum values.
It is possible that pairs of regulators will also allow some flexibility to re-distribute water between lakes, between River Murray floods. If for example, the regulators upstream and downstream of Lakes Hattah and Bulla were closed, and there was a significant volume of water in these two lakes, the downstream regulator could, if required, be opened to allow flooding of Lakes Arawak and beyond, in the absence of a River Murray flood. However, the benefits associated with this mode of operation are likely to be somewhat limited by the availability of water retained in lakes Hattah and Bulla at the time when it is required.

**Single Regulators**

If the regulators (listed above) were not used in pairs, then the mode of operation would be as described above for the upstream regulator, and there would be no downstream regulator. Under this option, there would be far less flexibility to manipulate flood levels in lakes Arawak, Konardin and other downstream lakes. This could result in these lakes becoming wetter than optimum, which may have significant negative effects on the ecology of the lakes complex.

However, there are many other locations where regulators could be used in conjunction, to maximise the ability to manipulate water to reach as much of the floodplain as possible. The DEM and hydraulic models will be used to identify the maximum height to which water can be delivered to the floodplain, for the optimum costs and benefits.

It may be for example, that regulators at either end of Chalka Creek can be constructed to the same height within the channel, and a series of regulators in between these be used to maximise the mosaic of water regimes which can be achieved.

As well as the regulators on the north and south ends of the Chalka Creek, regulators could potentially be installed at the following locations:

- Messenger’s – replace existing regulator with one which maximises the ability to retain water in the system;
- Chalka Creek north in the vicinity of Belton’s Bong built to the same height as Messenger’s;
- upstream of Lake Lockie and downstream of Boolungal Crossing to allow water to be diverted from the south arm, into the north arm of the creek;
- to the east of Lake Yelwell in the channel between Lake Yelwell and Chalka Creek north;
- to the east of Lake Bitterang in the channel between there and the Chalka Creek;
- on the Chalka Creek north and south of the channel between the main creek and Lake Cantala;
- in the channel between Lake Cantala and the River Murray and possibly between Chalka Creek and the Dry Lakes complex in the north central part of the park.

**Pump Station at the Inlet to Chalka Creek**

Installation of a permanent pump station at the inlet to Chalka Creek could potentially enable:
- amplification or extension of a natural flood; and/or
- generation of a synthetic flood.

Appropriate pump station capacities and possible modes of operation were investigated by considering:
- the peak flow capacity of Chalka Creek;
- the volume of typical flood flows along Chalka Creek; and
- the duration of typical flood flows along Chalka Creek.
Estimates of each of these parameters, for a range of floods, are presented in Table 5.1.

Table 5.1. Typical Chalka Creek Flood Characteristics – Existing Conditions

<table>
<thead>
<tr>
<th>Peak Murray flow (ML/d)</th>
<th>Peak Chalka Creek flow (ML/d)</th>
<th>Typical Chalka Creek flow volume (ML)*</th>
<th>Typical Chalka Creek flood duration (days)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>40,000</td>
<td>250</td>
<td>3,000</td>
<td>18</td>
</tr>
<tr>
<td>45,000</td>
<td>450</td>
<td>6,000</td>
<td>22</td>
</tr>
<tr>
<td>50,000</td>
<td>600</td>
<td>12,000</td>
<td>28</td>
</tr>
<tr>
<td>60,000</td>
<td>1,050</td>
<td>30,000</td>
<td>36</td>
</tr>
<tr>
<td>80,000</td>
<td>1,500</td>
<td>50,000</td>
<td>52</td>
</tr>
</tbody>
</table>

* May vary significantly between floods.

It can be seen from the table that both the peak Chalka Creek flow, and the total Chalka Creek flood volume, increase markedly with increasing Murray flow. The implications of this in determining appropriate pump station capacities are as follows:

- the peak pump station capacity and duration of operation required to simulate a Chalka Creek flood increase markedly with increasing Murray peak flow; and
- the peak pump station capacity required to boost an existing Chalka Creek flood by a given amount, also increases very significantly with increasing Murray peak flow.

SKM (2004) have proposed three pump station capacities and modes of operation for further analysis:

a) 860 ML/d capacity. This would be sufficient to generate a Chalka Creek flood equivalent to that corresponding to a Murray flow of around 55,000 ML/d, if it was operated at capacity continuously for around 30 days. It could also be operated for shorter durations to amplify and extend existing floods.

b) 220 ML/d capacity. This would be sufficient to generate a Chalka Creek flood equivalent to that corresponding to a Murray flow of around 40,000 ML/d, if operated continuously for 15 days. The pump station capacity would not be sufficient to amplify or extend larger existing floods.

c) 430 ML/d capacity. This was selected as an intermediate capacity to a) and b). It would be of sufficient capacity to both boost existing floods, and generate additional floods.

The proposed operating rules for the pump station options are outlined in Table 5.2.

Table 5.2. Potential Pump Station Operational Rules

<table>
<thead>
<tr>
<th>Pump station capacity (ML/d)</th>
<th>Generation of additional synthetic floods</th>
<th>Magnify existing events</th>
</tr>
</thead>
<tbody>
<tr>
<td>860</td>
<td>Replicate the effects of a 50,000 ML/d Murray flood, if there has been no flood for 2 successive years.</td>
<td>Boost the effects of all Murray floods between 36,700 and 45,000 ML/d, by 5,000 ML/d.</td>
</tr>
<tr>
<td>430</td>
<td>Replicate the effects of a 45,000 ML/d Murray flood, if there has been no flood for 2 successive years.</td>
<td>Boost the effects of all Murray floods between 36,700 and 40,000 ML/d, by 1,000 ML/d.</td>
</tr>
<tr>
<td>220</td>
<td>Replicate the effects of a 40,000 ML/d Murray flood, if there has been no flood for 2 successive years.</td>
<td>Not used to boost existing floods.</td>
</tr>
</tbody>
</table>
A pump station could be installed in the vicinity of the existing Messenger’s regulator, and could only be operated when the Messenger’s regulator was closed, otherwise it would pump water straight back into the river. When operated to boost an existing flood, the pump station would be operated as soon as the River Murray receded below the threshold for flooding of Chalka Creek.

The distance and area which could be covered by pumped water at any point in time would be variable, dependent on the moisture levels in the creek and/or lake beds at that time. For example, if the pump station were used to boost an existing flood, the water would flow further because the creek bed would already be wet. If, however, the pump station were used to generate an additional flood onto dry creek and lake beds, flows would not travel as far or as fast since much water would be soaked up by the dry substrate.

High capacity, low lift submersible pumps are ideally suited to this type of application. These types of pump stations are commonly used overseas, often as part of large-scale drainage and flood protection schemes. Pumps are typically suspended in large diameter (say 500 mm) vertical pipes which are, in turn, suspended from a concrete platform. Water flows in through the bottom of the pipes, is pumped vertically up through the pipes, out across the concrete platform, and on to the downstream waterway. The pumps can be powered either by electricity or diesel motors. Whilst diesel motors are noisy, it is not expected that the pumps would be operated very frequently, and the remoteness of the site will assist in minimising noise impacts. Appropriate consideration will be given to reducing noise pollution so that the landholder whose house is close to Messenger’s Regulator is not excessively affected by the noise, and adjoining landholders elsewhere if other pumping sites are preferred.

Any works would be subject to gaining the necessary approvals, and adverse impacts to the environment, cultural heritage and neighbours will be minimized.

**Combination of Measures**

Some of the measures outlined above could be sensibly combined to potentially magnify the benefits of individual measures.

Test scenarios will be run through the hydraulic model to examine the feasibility of the various options and their potential to achieve ecological objectives.

Some options considered worthy of further investigation by SKM (2004) include:

- **Option 1** – weir across the River Murray. Given the likely high cost and adverse impacts of this option, it has not been considered in combination with any other options;
- **Option 2** – regulator between lakes Hattah and Little Hattah;
- **Option 3** – regulators between lakes Hattah and Little Hattah, and between lakes Yerang and Mournpall;
- **Option 4** – regulators between lakes Hattah and Little Hattah, and between lakes Bulla and Arawak;
- **Option 5** – regulators between lakes Yerang and Mournpall, and between lakes Mournpall and Konardin;
- **Option 6** – combination of Options 4 and 5, (4 regulators);
- **Option 7** – 860 ML/d pump station at the inlet to Chalka Creek;
- **Option 8** – 430 ML/d pump station at the inlet to Chalka Creek;
- **Option 9** – 220 ML/d pump station at the inlet to Chalka Creek;
- **Option 10** – option 6 in combination with option 7;
- **Option 11** – option 6 in combination with option 8; and
- **Option 12** – option 6 in combination with option 9.

Other options, such as regulators at other locations as described above will also be considered.
6. **OPERATION AND MANAGEMENT OF THE LIVING MURRAY WATER MANAGEMENT STRUCTURES**

To date, no water management structures have been developed for the Hattah Lakes system under The Living Murray. However, the regulator between lakes Hattah and Little Hattah has been temporarily re-instated for delivering emergency River Red Gum water. Temporary levee banks have been contracted in the Chalka Creek to stop pumped water from running back into the River Murray.

7. **COMPLEMENTARY MANAGEMENT ACTIONS**

Hattah-Kulkyne National Park and Murray-Kulkyne Park are managed in accordance with the provisions of the National Parks Act (1975) and the Mallee Parks Management Plan. Natural values management is conducted within an environmental management framework based on risk management principles. In the case of Hattah-Kulkyne National Park key risks include:

- Overgrazing by kangaroos and rabbits. A state-wide risk assessment found that an area of 10,000 ha within the park was at high risk from rabbit infestation. This comprises pine-buloke woodland (depleted) and riverine woodlands. The risks from overgrazing are being addressed through coordinated kangaroo and rabbit management programs. The kangaroo program is overseen by the Victorian Kangaroo Technical Advisory Committee to ensure that it meets the highest ethical and technical standards. Regular monitoring of grazer abundance is conducted in accordance with Parks Victoria monitoring protocols.

- Introduced predators (foxes) are also considered to be a major threatening process for a range of fauna within the park, including ground-dwelling birds (eg. malleefowl), waterbirds, small mammals (eg. Common Dunnart) and reptiles (eg. Coral Snake). Foxes have also been the subject of a detailed risk assessment: ‘Assessing the Alignment of Parks Victoria’s fox control program with priorities for reducing risk to native fauna’ (Arthur Rylah Institute). Following a recommendation of this study, Parks Victoria initiated a Fox Adaptive Experimental Management (AEM) Program for the Park in 2001. This program represents a research partnership between Parks Victoria, Arthur Rylah Institute and the Mallee CMA. The effectiveness of baiting and the response by prey species within a baited zone are being contrasted with those in an unbaited zone. The lessons learnt will be applied to fox management in other National Parks and other public land within Victoria.

- Some threatened species, such as the malleefowl, are the subject of intensive monitoring by a group of volunteers (Victorian Malleefowl Recovery Group) in an on-going partnership with Parks Victoria. Data collected over more than 10 years is being periodically analysed to assess any spatial or temporal changes to the level of malleefowl breeding activity.

- Inappropriate fire regimes have been identified as a major risk to Mallee vegetation and habitats. Endemic fauna are adapted to differing seral (dry) stages following fire events and a diversity of post-fire vegetation is required to meet the habitat requirements of the full suite of species and to ensure that a particular fire event does not lead to the loss or severe depletion of a particular species or community. In response to this risk, Parks Victoria has collaborated with DSE to prepare ‘Guidelines and procedures for ecological burning on public land’ (2004). These guidelines are now being implemented to reduce the overall risk associated with inappropriate fire regimes.

Staff of Parks Victoria systematically keeps records of flora and fauna and management activities within Hattah-Kulkyne National Park. These data are stored on the corporate Environmental Information System (EIS) for ongoing analysis and interpretation.
The Mallee CMA is engaged in a range of strategic river health planning activities aimed at improving and enhancing the environmental values of the River Murray and its floodplain. This includes the River Murray Frontage Action Plan Project (FAP) (Mallee CMA, 2003), the Mallee Regional River Health Strategy (Mallee CMA, in prep.) and the Mallee Wetland Prioritisation Project (Mallee CMA, in prep.). Whilst not included in this year’s EMP, in subsequent years it is intended to undertake an assessment of the major threats to achieving the ecological objectives at the Hattah Lakes Icon Site and develop appropriate management arrangements.

For example, the Robinvale to Merbein FAP (Mallee CMA, 2003) includes the riparian and floodplain areas in Hattah-Kulkyne National Park, and identifies a number of priority aims and actions which are complementary to current and proposed water management actions. These include:

- reducing the impact of recreation;
- reducing the impact of water diversion infrastructure;
- containing and reducing the impact of weeds and pest animals;
- reducing the impact of grazing;
- restoring degraded frontages and floodplain, and the extent of riparian and floodplain vegetation;
- retaining frontage vegetation and protecting high value flora and fauna habitat;
- protecting and appropriately managing significant historic, cultural heritage and archaeological sites; and
- guiding the appropriate use and development of Crown frontages and Crown land within the River Murray floodplain.

8. MANAGEMENT ROLES AND RESPONSIBILITIES

8.1. Arrangements for the Living Murray Icon Sites

Under The Living Murray Business Plan, the state Icon Site manager will oversee the development and implementation of the Icon Site EMP and undertake appropriate consultation. Because the Hattah Lakes Icon Site area occurs wholly within Victoria, there is no requirement for the involvement of interstate agencies. However, the Department of Environment and Heritage and the Murray-Darling Basin Commission (MDBC) need to be included in an appropriate project governance structure.

8.2 General Management Arrangements

Management of TLM water is a complex task involving responsibilities across The Living Murray Partners, DSE and the statutory authorities (CMAs, RWAs and Parks Victoria) (Refer Section 1.4). The arrangements recognise that whilst each of these groups are involved in each of the planning, on-ground management and monitoring phases of Icon Site management, the focus and the predominant players will change depending on the stage. For example, in the planning stage, the CMA will lead by coordinating the development of the icon site objectives and the development of the state Icon Sites watering plan. In the management phase, DSE regions will lead by working with Parks Victoria and their forest staff to incorporate the objectives into on-ground management and implementation of the plan.

Operation of the River Murray system is directed by the MDBC’s operational arm, River Murray Water (RMW), according to the provisions of the Murray-Darling Basin Agreement and an evolving set of provisions agreed to by the MDBC. This role has its origins with the establishment of the River Murray Commission in 1917.
RMW has responsibility for directing river operations, overseeing Icon Site management and modelling to support operational decisions and policy development. The River Murray system structures include:

- 4 major storages - Dartmouth and Hume Dams, Menindee Lakes (when under MDB control) and Lake Victoria;
- Yarrawonga Weir;
- 13 weirs and locks;
- 5 barrages located near the river mouth, associated with Lakes Alexandrina and Albert; and
- a number of flow regulating structures (such as Barmah-Millewa Forest regulators).

With regard to the implementation of environmental management activities in this plan, RMW will:

- provide advice during the development of environmental flow rules and procedures to ensure their operational feasibility;
- provide the system-wide context for environmental watering through the Annual Operating Plan for the entire River Murray system (this plan is continually updated to account for changing conditions as the year progresses);
- make operational decisions for River Murray system flow control works (large and small) and issue instructions to the relevant state operating authorities – to do this RMW coordinates River Murray system water management with that of the Snowy Scheme and state-managed river systems;
- during ‘real time’ environmental events –
  - monitor river levels and flows
  - provide forecast flow patterns
  - provide advice on the availability of ‘surplus’ river flows
  - issue instructions for flow control structures for the management of flows and river levels including regulator openings in coordination with advice from each Icon Site EMP
  - keep operational water and environmental accounts;
- oversee a program by state constructing authorities to construct, operate, maintain and renew sites (infrastructure works) on its sites register.

System operation is complex, given the changing levels of consumptive use, the long travel times, location and capacity of both Icon Sites and major diverters and channel capacity constraints across the length of the system.

The Water Liaison Committee is the forum through which the partner governments share in making day-to-day decisions regarding water delivery and water accounting.

The Environmental Watering Group (EWG) has agreed to establish clearly defined roles and responsibilities for the management arrangements in this plan and other EMPs. However, pending this review, and for specific flow events affecting operation of River Murray system works at specific locations, event management groups will continue to be convened by River Murray Water in co-operation with the River Murray Environmental Management Unit. These groups bring together key representatives of natural resource agencies, catchment management organisations, constructing authorities and community interest groups as necessary to ensure a coordinated response.

### 8.3 Management Arrangements for Hattah Lakes

The nominated Icon Site manager, as per The Living Murray arrangements is Chris Halpin (DSE, Regional Director - North West Region). The nominated Icon Site manager will initiate an Integrated Coordinating Committee, including key stakeholders: the Mallee CMA, DEH,
MDBC and Parks Victoria, to provide the requisite level of project governance. The Icon Site manager will be responsible for decisions on implementation of the Icon Site plan. The existing management arrangements for the Icon Site, established to manage the Hattah Lakes environmental flow program, will be taken into account in the establishment of the governance arrangements (Figure 8.3).

Figure 8.3 Governance Arrangements for the Hattah Lakes Icon Site

Plan development

The development of the Icon Site Environmental Management Plan for Hattah Lakes has been co-ordinated by the Mallee CMA. Development has been overseen by a Steering Committee which has been established for several years to oversee the Hattah Lakes environmental flow project (currently funded through TLM Environmental Works and Measures Program. The Steering Committee is chaired by a representative of the Mallee CMA Board, and includes representatives from the Mallee CMA, Parks Victoria, DSE (regional and head office), the Murray Darling Freshwater Research Centre and the MDBC. Membership of the Steering Committee is currently being revised to include a member of the Mallee CMAs implementation
Committee and Goulburn Murray Water. Terms of reference for the steering committee, which align with the principles of TLM Governance arrangements, are currently being drafted.

**Plan Implementation**

When the required feasibility studies and concept designs have been completed, an implementation sub-committee will be formed to oversee detailed design and construction. This sub-committee is chaired by the MDBC/RMW to oversee the project management of the development of detailed designs and construction. The sub-committee includes key representatives from the Steering Committee, including Parks Victoria and the Mallee CMA.

**Monitoring**

A subset of the steering committee comprising of DSE head office, the Murray Darling Basin Commission, the Mallee CMA and the Murray Darling Freshwater Research Centre facilitates the development and implementation of the monitoring program. The Mallee CMA will be responsible for all monitoring related to the Icon Site EMP (see Section 10, below).

**9. CONSULTATION**

The State Icon Site Manager, as required by The Living Murray Business Plan (TLMBP) will establish a consultation process for the Hattah Lakes Icon Site. This will provide a basic community input process to the development and finalisation of the Icon Site EMPs. The Mallee CMA will lead this process locally through its existing Hattah Lakes Steering Committee, the Mallee CMA Board, Implementation Committees and other community and communications based functions. In line with this requirement, the Mallee CMA Hattah Lakes Steering Committee membership will be refined to ensure formalised community and other stakeholder input (eg. Goulburn Murray Water, Implementation Committee representation.) on the committee. A list of invitees to the Hattah Lakes Steering Committee has been drafted to allow involvement of additional community representatives at various stages of the project. The membership of the Steering Committee will ensure that key stakeholder interests and broader community interests are addressed.

A communication plan for the Hattah Lakes Water Management Plan has been developed, which incorporates the requirements of The Living Murray Business Plan.

It will also be the responsibility of the Icon Site manager to ensure that the consultation processes for Indigenous communities are implemented as outlined in this section, in parallel with wider community consultation, with any areas of difference between the Indigenous communities and other groups or community interests being resolved jointly, as far as possible, to achieve a shared outcome.

Implementation of the Icon Site plans will require a continued community involvement along similar lines to ensure best outcomes.

**Indigenous consultation**

Involvement of the Indigenous communities along the river will be sought for all aspects of development and implementation of the Icon Site EMP.

The principle of ‘informed consent’ will be a basic requirement for consultation with all Indigenous groups who have specific interest as traditional owners in these sites, even where there may be competing interests between groups. It will not be adequate or effective to invite nominated representatives of various Indigenous groups to attend consultation meetings and
expect them to speak or comment on behalf of others when there has been no opportunity for wider involvement, understanding and input of the people within those groups.

It will be essential to clearly identify all of the specific traditional landowner groups relevant to each of the Icon Sites and to implement consultation processes with each on the basis of their own organisational requirements. It will be the joint responsibility of the relevant Victorian agencies (DSE/Parks Victoria and CMAs) to take the Victorian EMPs to those groups for consultation and input from them.

To provide for adequate Indigenous consultation for the Icon Sites, it has been agreed that the MDBC Icon Site Indigenous Coordinator will be responsible for integrated site consultation. This will be implemented progressively. The Indigenous coordinators will provide assistance and support in establishing an understanding of the groups who will need to be consulted for each site and, where necessary, in facilitating contact and consultation processes with any of those groups.

Where there are evident differences between the input from Indigenous groups and other community organisations in relation to any of the Icon Site EMPs, then continuing discussion between the parties, facilitated by the agencies, will be required to attempt to resolve those differences before plans can be completed and approved.

During the development of the first version of the EMP, the DSE Icon Site manager on behalf of the State of Victoria initiated specific Indigenous consultation.

This consultation consisted of identifying the Indigenous groups who had an interest in one or more of the Icon Sites within Victoria, with the assistance of DSE’s Native Title Coordinators and the Indigenous Facilitators employed by DSE, Parks Victoria, and CMA’s.

Indigenous groups identified to potentially have an interest in the management of Hattah Lakes Icon Site include:
- Murray Valley Aboriginal Cooperative and Mildura Aboriginal Cooperative, which are listed in Schedule 1 of the Aboriginal and Torres Strait Islander Heritage Protection Act (1984);
- Traditional Custodians who have Native Title Determinations pending eg. the Latji Latji, Nyeri Nyeri, Tati Tati, and Wergaia peoples; and
- Other interested groups such as Aboriginal Affairs Victoria, North West Nations, and North West Cultural Program.

Each of the known groups were contacted and advised of the project, and invited to meet with agency representatives to discuss the project.

10. **MONITORING AND ADAPTIVE MANAGEMENT**

A monitoring working group has been convened by the MDBC to facilitate the development and implementation of The Living Murray monitoring program. The Mallee CMA will be responsible for all monitoring related to the Icon Site EMP.

There are three scales of monitoring which can be utilised at TLM Icon Sites:

1. **System Scale**
   - ie. The River Murray and its floodplains
2. **Icon Site Scale**
   - ie. The Hattah Lakes Icon Site
3. **Sub-Icon Site Scale**
   - ie. Chalka Creek and Lakes Yerang and Little Hattah.
The MDBC is responsible for coordinating system scale monitoring as part of The Living Murray, and provide oversight for site scale and sub-site scale monitoring to ensure that projects are integrated.

There are also different monitoring approaches which can be used, depending on the amount of scientific rigour required, the investment available and the practicality of fulfilling requirements of a method (eg. finding suitable controls). These include:

1. **Cause and Effect**
   - ie. (mBACI)

2. **Surveillance**
   - ie. (Impact, Before and After)

3. **Instantaneous Adaptive Management**
   - ie. (setting directional targets and monitoring against those → ie. 80% of waterbirds have fledged)

**Site scale monitoring**
The MDBC anticipates contracting someone to pull together the existing programs/objectives to develop guidelines for site scale monitoring by June 2006. This will provide guidance as to what to monitor, where and how at an site scale for 2006-07.

In the mean time, for the 2005-06 monitoring program, vegetation is being monitored at an Icon Site scale at the Hattah Lakes, using a ‘surveillance’ monitoring program, by utilising remote sensing. The method will be piloted at Hattah in 2006-07, and applied to the Lindsay, Mulcra, and Walpolla Islands Icon Site if deemed appropriate.

At a whole-of-site scale, vegetation ‘health’ at Hattah is being monitored by measuring ‘population sustainability’ and ‘condition’. Population sustainability is being monitoring by recording diameter at breast height for trees along floodplain transects. The frequency of occurrence of particular size trees is then plotted to analyse ‘health’ of the population, where ‘healthy’ is indicated by a good spread of tree age classes. This data is being analysed using the DEM to examine associations between recruitment/age of trees with floodplain topography.

‘Tree Condition’ is being assessed using remote sensing imagery to analyse canopy cover and vigour. This is being measured using Normalised Differential Vegetation Index, a method used worldwide to assess condition of forests.

At this stage, this monitoring and analysis will occur solely for the River Red Gum communities of the Hattah Lakes Icon Site. This can be extended to other vegetation types in future if required, pending outcomes of the MDBC direction for whole-of-site scale monitoring.

**Sub-site Scale Monitoring**
At a sub-site monitoring scale, tree and fish response to management interventions (eg. the pumping trial) is being monitored using surveillance monitoring techniques. The monitoring will be replicated in the future, and used to compare responses to a pumping event, with responses to a high river flow event.

The information generated at particular sites can be applied to other locations, and will assist with current knowledge of ecological responses likely as a result of environmental flow management interventions.

Water management options will be adaptively managed using the principles outlined below. Where a management option fails to result in the anticipated ecological response, monitoring results will help with the interpretation and development of revised operating rules.
The Adaptive Management Cycle to be utilised at the sites is outlined in Appendix 2.

11. **ON GROUND ACHIEVEMENTS TO DATE USING ENVIRONMENTAL WATER**

As part of DSE’s Environmental Water Allocation program, a process of selection and prioritisation of potential sites for River Red Gum watering between Nyah and the South Australian border was undertaken in 2004-05.

Chalka Creek north and south arms, and, lakes Lockie, Little Hattah and Yerang were selected as priority sites for the delivery of environmental water because of the high percentage of stressed River Red Gum in these locations, the amount of water available and the feasibility of delivering it. The old regulator between lakes Hattah and Little Hattah was re-commissioned, a levee bank constructed at the inlet of the Chalka Creek and between April and December 2005, approximately 6 GL was delivered to the system.

It is anticipated that a further 10 GL will be delivered in 2006, refilling the Chalka Creek south arm, refilling lakes Lockie and Little Hattah, and filling lakes Yerang and Mournpall.

Results of the monitoring of ecological response to the watering are not available at this stage, but preliminary observations indicate very high productivity in the system in response to the watering, by River Red Gum, and many species of waterbirds, invertebrates, amphibians and reptiles.

12. **WORKS PROGRAM 2004 TO 2010**

**Environmental Works and Measures Activities**

The Hattah Lakes water management planning processes have evolved significantly since this project began in 1999, and the Hattah Lakes Steering Committee was formed around the same time. An Environmental Water Officer (EWO) has been employed through The Living Murray (TLM), to manage the whole TLM program in the Mallee since 2003, and, in 2005, an EWO was employed through TLM specifically to manage the Hattah project.

When TLM came to fruition in 2002, there was a far greater focus on the Icon Sites A significant increase in funding became available for works and measures for these sites, which greatly expanded the range of potential water management options which could be considered.

Much planning and works have already been completed, while others are currently in progress, and many more are planned for the future. These sub-projects have been planned and designed to build on existing information in order to fill gaps in our knowledge of the system. In the longer-term, the results of the investigations will be consolidated into the Hattah Lakes Water Management Plan that will guide how the water regimes are managed into the future, based on rigorous scientific methodology and adaptive management.

Funds have been allocated under The Living Murray Environmental Works and Measures Program (EWMP) for the duration of the program 2004-2010; however, they are subject to review each year following more detailed examination of required activities, costing and assessment of outcomes.

From 2006-10, the EWMP will continue to evolve as investigations lead to the development of appropriate water management options and priority works, and as the outcomes of the implementation of water management arrangements are monitored and evaluated.
It is expected that environmental water, over and above DSE’s Flora and Fauna EWA, will become available for the Icon Sites as a result of water savings to be generated under The Living Murray Program. Options for delivery of this water will be reviewed as it becomes available.

Table 12.1 (below) summarises the management activities undertaken to April 2006

### Table 12.1. Management Activities Undertaken to April 2006

<table>
<thead>
<tr>
<th>Investigation / Action</th>
<th>Completion Date</th>
<th>Purpose</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft Project Management Plan V1.0</td>
<td>1999</td>
<td>Gather data, outline the rationale, aims, management structure and budget for the project</td>
<td>MCMA</td>
</tr>
<tr>
<td>Monitoring of the 2000 flood</td>
<td>2001</td>
<td>Install depth gauges, monitoring of flood levels and flood extent</td>
<td>MCMA</td>
</tr>
<tr>
<td>Draft Project Management Plan V2.0</td>
<td>2001</td>
<td>Revision of V1.0</td>
<td>MCMA</td>
</tr>
<tr>
<td>The Living Murray established</td>
<td>2002</td>
<td>A long term program of collective actions aimed at restoring the River Murray to a healthy, working river system</td>
<td>MDBMC</td>
</tr>
<tr>
<td>LIDAR / DEM</td>
<td>2004</td>
<td>LIDAR data has been captured by AAM Hatch for over 743km² of the Mallee CMA region. The data has a vertical accuracy of +/- 0.2m and a horizontal accuracy better than 0.55m, with captured point density up to 1.4m. SKM have converted the data from text file format delivered by AAM Hatch into a Digital Elevation Model (DEM).</td>
<td>Data captured by AAM Hatch and developed into a DEM by SKM</td>
</tr>
<tr>
<td>Hattah Lakes Water Management Plan – Background Report</td>
<td>December 2004</td>
<td>Details ecological, hydrological and hydrogeological values and processes, the threats to these values, proposes management objectives, assesses potential water management options and recommends preferred options.</td>
<td>SKM</td>
</tr>
<tr>
<td>Living Murray Icon Site wetlands within the Mallee CMA region: monitoring program designs and 2004-05 monitoring results</td>
<td>June 2005</td>
<td>Determine monitoring requirements for TLM Icon Sites including Hattah, and design and implement monitoring program.</td>
<td>MDFRC</td>
</tr>
<tr>
<td>Icon Site Environmental Management Plan – Hattah Lakes Significant Ecological Icon Site</td>
<td>August 2005</td>
<td>Explores the ecological objectives, the water management requirements to achieve the ecological objectives, and, to guide the management process.</td>
<td>DSE</td>
</tr>
<tr>
<td>Emergency River Red Gum Watering (ERW), and Environmental Water Allocation (EWA) pumping trial</td>
<td>August 2005 &amp; ongoing</td>
<td>Delivery of environmental water to the Chalka Creek and Lakes Lockie and Little Hattah to relieve stressed River Red Gum</td>
<td>DSE, MCMA</td>
</tr>
<tr>
<td>Monitoring ecological responses to EWA</td>
<td>August 2005 &amp; in progress</td>
<td>Monitoring of River Red Gum health, fish, birds, aquatic macrophytes, water depth and quality to compare ecological responses to an artificial flood (pumped water) versus a high river flood.</td>
<td>MDFRC, PV, MCMA</td>
</tr>
</tbody>
</table>

Table 12.2 (below) summarises management activities proposed from April 2006 to June 2010.
Table 12.2 Management Activities to be Undertaken between April 2006 – June 2010.

<table>
<thead>
<tr>
<th>Investigation / Action</th>
<th>Completion Date</th>
<th>Purpose</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic Modelling</td>
<td>March 2006 In prep.</td>
<td>Draw together existing hydrological data and derive flow relationships to create a model which can be used to simulate the effects of a range of proposed water management options on water levels in the system.</td>
<td>SKM</td>
</tr>
<tr>
<td>Feasibility Investigations</td>
<td>March 2006 In prep.</td>
<td>To define ecological objectives, water regimes required to meet these objectives, develop and prioritise management options, and recommend how water management should be monitored.</td>
<td>Ecological Associates et al.</td>
</tr>
<tr>
<td>Test Scenarios using the Hydraulic Model</td>
<td>April 2006 Not begun</td>
<td>Using the prioritised management options developed above, run management scenarios through the hydraulic model to see how well these can meet the ecological objectives</td>
<td>SKM</td>
</tr>
<tr>
<td>Salinity Investigations</td>
<td>May 2006 Not begun</td>
<td>Consolidate existing groundwater data for the site, identify knowledge gaps, recommend works to address these gaps if required, and undertake any works required.</td>
<td>Unknown</td>
</tr>
<tr>
<td>Documentary DVD</td>
<td>June 2006 In prep.</td>
<td>Document the values and threats to the Hattah Lakes system and what is being done to restore the ecological character of the site.</td>
<td>Unknown</td>
</tr>
<tr>
<td>Concept Designs</td>
<td>June 2007</td>
<td>Prepare concept designs for structures which may be installed to help restore appropriate flow regimes to the Hattah Lakes system.</td>
<td>GMW</td>
</tr>
<tr>
<td>Approvals</td>
<td>October 2006</td>
<td>Begin the process of gaining approvals to proceed to the development of detailed designs for structures.</td>
<td>GMW</td>
</tr>
<tr>
<td>Detailed designs</td>
<td>June 2008</td>
<td>Prepare detailed designs, costings and work schedules for structures to be built.</td>
<td>GMW</td>
</tr>
<tr>
<td>Construction of Structures</td>
<td>2008-2010</td>
<td>Build structures in accordance with detailed designs.</td>
<td>GMW</td>
</tr>
<tr>
<td>Adaptive management review</td>
<td>2008-2010</td>
<td>Review project and incorporate learning into revised Hattah Lakes Water Management Plan</td>
<td>MCMA</td>
</tr>
</tbody>
</table>

The actions summarised in Tables 12.1 and 12.2 (above) are described in more detail in Appendix 1.
REFERENCES


DSE (unpub) Description of the Ecological Character of the Hattah-Kulkyne Lakes Ramsar Site. DSE, Melbourne.


Mallee CMA (in prep.) Mallee Wetland Prioritisation Project. Mallee Catchment Management Authority, Irymple, Victoria.


Personal Communications

Peter Kelly, Manager Forests, DSE Northwest Region

Oliver Scholz, Murray-Darling Freshwater Research Centre, Mildura.
APPENDIX 1 – DESCRIPTIONS OF COMPLETED, CURRENT, AND PLANNED INVESTIGATIONS AND WORKS.

Works Completed

Hattah Lakes Water Management Plan – Background Report (SKM 2004). This report describes the physical and natural values and processes which characterise the Hattah Lakes system, and the potential threats to these values. It outlines broad objectives and makes recommendations for the management of the ecology, hydrology, and hydrogeology of the system, and outlines potential water management options for consideration in achievement of re-instatement of appropriate water regimes.

Digital Elevation Model
LIDAR data of the floodplain area of Hattah-Kulkyne National Park has been captured by AAM Hatch for the Mallee CMA. SKM have converted the data from text file format delivered by AAM Hatch into a Digital Elevation Model (DEM). The data has a vertical accuracy of +/- 0.15m and a horizontal accuracy of +/- 0.5m, with pixel size of 1.6m.

Icon Site Plan
The original Icon Site plan (Mallee CMA, 2005) for the Hattah Lakes Icon Site was submitted to the MDBC in 2005, in accordance with the requirements of the Living Murray Business Plan. The purpose of the Icon Site plan is to:

• outline the social, economic and environmental values of the Icon Site, the threats to these Icon Sites,
• define ecological objectives and the flow regimes required to meet these objectives;
• identify priorities and options for water delivery; and
• outline complementary land management actions; management roles and responsibilities, consultation requirements, and monitoring arrangements.

The Icon Site Plan will be revised annually to ensure the most up-to-date knowledge is adaptively incorporated into water management actions.

Works Currently Underway and / or Ongoing

Hydraulic Modelling
The DEM has been used by SKM in the development of a hydraulic model for the Hattah Lakes system. The model is almost complete, with completion expected in April 2006. The model is a combination of 2D and 1D modelling with a grid resolution of around 20 m². The objective of the modelling exercise is to compare the water regimes of the system under regulated and pre-regulated conditions, and to enable potential management options (eg. installation of a regulator at a particular point) to be evaluated by running ‘test scenarios’ through the model. This will allow changes in various components of the water regime to be evaluated and then incorporated into flow objectives for the lake.

Ecological Monitoring Program
A long-term vegetation health monitoring program for the whole of Hattah Lakes system is under development by the Murray-Darling Freshwater Research Centre (MDFRC), and will be implemented during 2006, then repeated every three years thereafter, to determine the changes in vegetation health and the causes of any change, over the long-term.

Fish, birds, and aquatic vegetation monitoring will also contribute to the monitoring program. The monitoring standards to be implemented are currently under development by MDBC. The results of the monitoring program will assist in determining the effects of water management activities. Monitoring data will be employed to inform management decisions, using an adaptive experimental approach.
**Feasibility Investigation of Options**

Ecological Associates are currently undertaking feasibility investigations of options for the Hattah Lakes system. The study will result in articulation of detailed feasibility studies at the creek and wetland scale that identify specific ecological objectives; the flow regimes required to meet ecological targets; recommendations for on-ground management actions to achieve the flow requirements and management of any associated impacts. These studies will provide clear ecological rationale for water management options and allow informed selection of structure locations to allow manipulation of water in the system, to achieve optimum environmental benefits to the system.

**Emergency River Red Gum Watering**

As well as these longer-term environmental flows investigations for Hattah Lakes, a program of emergency River Red Gum watering was carried out, in the period April-June 2005, delivering approximately 2.2 GL by pump, to water River Red Gums along the Chalka Creek. This short-term management measure was a response to wide-spread dieback of River Red Gum in lowland reaches of the River Murray. The 2.2 GL was sourced from DSE’s environmental bulk entitlement and its delivery was funded and managed by DSE. River Red Gum dieback through parts of the Mallee were surveyed and areas were prioritised to receive emergency water. River Red Gum dieback in the Hattah Lakes system was subsequently surveyed and was found to be relatively stressed (at most lakes around 70% of the riparian woodland was assessed as being stressed), so Hattah Lakes were allocated a further 3.8 GL through DSE’s Environmental Water Allocation (EWA) prioritisation process. The water was delivered to lakes Lockie and Little Hattah, in the period September-December 2005.

The delivery was funded jointly by NAP and the Victorian Governments White Paper: Our Water Our Future Initiative.

As well as providing much needed water to stressed River Red Gums, this project is being used as an experiment to monitor the differences in flora and fauna responses, and water depth and quality, to environmental water delivered by pump, as compared to a high river flow event. Monitoring will be repeated the next time there is a high river flooding event, and the results compared. Initial baseline monitoring before the watering trial was completed in September 2005, and monitoring at the completion of the first stage of the trial was completed in January 2006. The results of this monitoring will help to inform the adaptive experimental management of the system and forms part of the MDFRC’s on-going monitoring program.

An additional 10 GL is likely to be delivered to the system by the end of 2006, which will fill lakes Yerang and Mournpall.

URS are investigating the feasibility of potential pumping options for environmental water delivery at a range of Mallee sites. The results of this investigation will also influence the choice of management options which may be considered for Hattah.

**Icon Site Plan (Icon Site EMP) – Revision 2006**

Currently under revision to incorporate the most up-to-date information available as at April 2006.
**Works Planned for the Future**

**Communications and Community Consultation**
A documentary DVD about the water management program for the Hattah Lakes will be produced in 2006. This will be used as an education and communication tool to deliver key messages to stakeholders and the general public. During delivery of the EWA in December 2005, some preliminary film footage of operations was taken including footage of construction works, pumping operations, the River Murray, the Chalka Creek, some of the Hattah Lakes, and some wildlife.

A communications plan has been developed for the Hattah Lakes Water Management Plan (HLWMP). The plan outlines the objectives for communication of information about the project, identifies the target audience, articulates the key messages to be delivered and the tools used to deliver the messages, and a schedule for delivery of specific communications activities, including production of the documentary DVD by June 30 2006.

Also in 2006, a public field trip will be conducted, to explain the processes and expected outcomes of the HLWMP. Many other consultative field trips have already been held throughout the life of the project to date.

Community consultation and communication to the community will be on-going for the foreseeable future, and it is anticipated that the Documentary DVD will be updated periodically to incorporate project progress as it occurs.

**Salinity**
Investigations will be undertaken during 2006, to consolidate existing groundwater data for the site, identify knowledge gaps, recommend works to address these gaps if required and undertake any works required.

Mallee CMA will investigate current groundwater quality and trends, and the adequacy of the existing bore network and the condition of the bores. Recommendations will be made regarding the requirement for more bores, proposed locations for new bores, scheduled maintenance and monitoring of bores. Bores will be monitored to determine the effects of the EWMP and flood events on the groundwater quality.

**Structures**
When the feasibility investigations are complete around June 2006, the recommendations will be considered, and if the investigations reveal that the installation of water management structures (ie. regulators and/or pumps) is required, and the agreement of the relevant agencies is achieved, the project can then progress to development of concept designs for the structures. It is possible that further investigations may be needed before the feasibility investigations are complete.

**Approvals**
The appropriate approvals to construct the structures will then be sought from the relevant agencies. This process will be followed by preparation and costing of detailed designs for the structures.

**Construction**
Once all the approvals have been met, construction of the structures can commence, and proceed to completion according to agreed priorities.

**Adaptive Management**
Review project periodically and incorporate learning into revised Hattah Lakes Water Management Plan.
APPENDIX 2: ADAPTIVE MANAGEMENT CYCLE

Adaptive Management

Adaptive management is used to describe the approach to natural resource management that enables people to learn about systems as they manage them. The concept of adaptive management was developed by C.S. Holling and co-workers at the University of British Columbia's Institute of Resource Ecology in the late 1960s (Gunderson, 1999) and first presented in scientific literature in 1978 (Holling, 1978). The concept arose from the ecosystem management discipline as part of an attempt to address issues of scale, information gaps and the limitations of ‘reductionist’ science (Holling, 1978). Adaptive management is based upon the premise that managed ecosystems are complex and inherently unpredictable. The adaptive approach embraces the uncertainties of system responses and attempts to structure management actions as experiments from which learning is a critical product (Holling, 1978).

Although adaptive management has been defined in various ways since its development, all follow the uniting principle of dealing with the uncertainty in management of natural resources through experimentation (Holling 1978; Walters 1986). In adding to this concept, Lee and Lawrence (1986) required that adaptive management be based on the ‘best available scientific knowledge’. Further, in 1994 Bormann and Webster suggested the need to simultaneously adaptively manage at regional, provincial and watershed scales, and Gunderson et al. (1995) supported this, outlining the need for flexibility within management institutions to account for broader issues of scale (e.g. multi-jurisdictional, multi-ecosystem interactions). All of these concepts are perhaps best encapsulated by Bormann and Webster (1994). They define adaptive management as ‘learning to manage by managing to learn. It is this simple and broad concept that is being incorporated into the Hattah Lakes Water Management Plan.

One way of conceptualising the adaptive management process is through the six-step cycle developed by Nyberg (1999a) (Figure 17). The framework formed by these six steps is currently being accepted and broadly used for management globally and is intended to encourage a thoughtful, disciplined approach to management, without constraining the creativity that is vital to dealing effectively with uncertainty and change (Nyberg, 1999a).

Contemporary Adaptive Management Cycle  (Source: Nyberg, 1999a)

Steps in the Adaptive Management Cycle
The following section will outline the six steps in the adaptive management cycle and will:

• Provide a summary and key points of each step, as defined by Nyberg (1999b);
• Discuss how this step has been and/or will be incorporated into the Hattah Lakes Water Management Plan.
**Step 1: Assess**

Nyberg (1999b) states that ‘Step 1 (problem assessment) is often done in one or more facilitated workshops. Participants define the scope of the management problem, synthesize existing knowledge about the system, and explore the potential outcomes of alternative management actions. Explicit forecasts are made about outcomes, in order to assess which actions are most likely to meet management objectives. During this exploration and forecasting process, key gaps in understanding of the system (ie. those that limit the ability to predict outcomes) are identified.’

- define scope of management problem
- define measurable management objectives
- identify key indicators for each objective
- explore effects of alternative actions on indicators
- make explicit forecasts about responses of indicators to management actions
- identify and assess key gaps in understanding

Holling (1978) and Walters (1986), the proponents of the term ‘adaptive management’, both stress the importance of involving a broad range of stakeholders in all stages of project management. This has been a key focus of the Hattah Lakes Water Management Project, with the strong involvement of land and resource managers, ecologists, engineers and other agency staff throughout the process of defining ecological issues, objectives, water requirements, priority sites and actions and associated risks for restoring the floodplain. This collaboration has proved essential in ensuring realistic bounding of management problems and constraints on possible actions.

**Step 2: Design**

Nyberg (1999b) states that ‘Step 2 (design) involves designing a management plan and monitoring program that will provide reliable feedback about the effectiveness of the chosen actions. Ideally, the plan should also be designed to yield information that will fill the key gaps in understanding identified in Step 1. It is useful to evaluate one or more proposed plans or designs, on the basis of costs, risks, informativeness and ability to meet management objectives.’

- design management plan that will provide reliable feedback and fill gaps in understanding
- evaluate management options/alternative designs, and choose one to implement
- design monitoring protocol
- plan data management and analysis
- state how management actions or objectives will be adjusted
- set up system to communicate results and information

**Step 3: Implement**

Nyberg (1999b) states that ‘In Step 3 (implement), the plan is put into practice.’

- follow the plan!
- monitor implementation and document any deviations from plan
**Step 4. Monitor**

Nyberg (1999b) states that ‘In Step 4 (monitor), indicators are monitored to determine how effective actions are in meeting management objectives, and to test the hypothesised relationships that formed the basis for the forecasts.

Key points from Nyberg (1999b):

- monitor for: implementation, effectiveness, validation and surprises.
- follow the monitoring protocol designed in Step 2.

Monitoring is crucial to determining if management was successful in achieving specified objectives and to examine underlying mechanisms for the hypothesised response. The monitoring program (see sections 7.1.8, 7.2.8 & 7.3.8) for the Hattah Lakes systems will focus on formulating hypotheses, and constructing experimental comparisons to test whether the ecological and management objectives are met. The monitoring program will also quantify the hydrology of the system, determining whether or not the proposed water regime is being delivered through structural operation.

Boulton and Brock (1999) noted that management strategies for Australian wetlands must be sufficiently flexible to incorporate the seasonal, temporal and spatial variability that is a major characteristic of these systems. Natural variations in climate result in variable water regimes and ecological responses both within and between years. As a consequence the determination of environmental water delivery and ecological response for a wetland is likely to be an ongoing process requiring adaptive management. Within this framework, the outcomes from the monitoring of ecological responses and hydrology of individual systems in the Hattah Lakes system will be used to refine future management (ie. operational rules).

**Step 5. Evaluate**

Nyberg (1999b) states that “Step 5 (evaluate) involves comparing the actual outcomes to forecasts and interpreting the reasons underlying any differences.”

Key points from Nyberg (1999b)

- Compare actual outcomes to forecasts made in Step 1.
- Document results and communicate them to others facing similar management issues.

Evaluation of the monitoring data to inform management decisions is a complex process comprising statistical analysis and ecological interpretation (Tucker, 2003). The ecological response hypotheses outlined in the monitoring program will be subject to *a priori* defined analysis by the Mildura Murray Darling Freshwater Research Centre (MDFRC) on an annual basis, and the results communicated to the Mallee Catchment Management Authority (MCMA). Through a process of consultation with land and resource managers, ecologists, other agency staff and the structure owners and operators, the MCMA will facilitate the process of utilising monitoring results to define new and appropriate operational rules when developed.

**Step 6. Adjust**

Nyberg (1999b) states that ‘In Step 6 (adjust), practices, objectives, and the models used to make forecasts are adjusted to reflect new understanding. Understanding gained in the each of these six steps may lead to reassessment of the problem, new questions, and new options to try in a continual cycle of improvement.’

Key points from Nyberg (1999b)

- Identify where uncertainties have been reduced, and where they remain unresolved.
- Adjust the model used to forecast outcomes (Step 1) so that it reflects the hypothesis supported by results.
- Adjust subsequent management decisions and policies, and re-evaluate objectives, as necessary.
- Make new predictions, design new management experiments, test new options. ie., return to step 1 or 2 – repeat cycle.

The tabulated monitoring program outline (Appendix 3) has identified a series of ecological and process driven factors that might confound the observation of expected ecological responses. Some measures have been installed to mitigate these, however due to the nature of experimentation and monitoring, this is unlikely to be an exhaustive list. As such, the adjustment of the conceptual models used to predict ecological response will be an important component of the MCMA mediated ‘evaluation’ process, outlined above. Similarly, the adjustment of management decisions and re-evaluation of objectives will be the responsibility of the MCMA, in consultation with stakeholders. MDFRC will work closely with the MCMA and stakeholders to ensure that appropriate predictions and management experiments are defined before the adaptive management cycle completes a full cycle.

**Conclusion to adaptive management**

In its simplest form, adaptive management is an exercise in ‘learning to manage by managing to learn’ (Bormann and Webster, 1994). In the Hattah Lakes system it is proposed to use the formalised, structured steps within the adaptive management cycle (Figure 17) in conjunction with the best available scientific knowledge to construct an ecological response hypothesis based monitoring program. In applying such a program in a rigid and scientifically credible way, we aim to not only learn more about the system we are managing, but also to gain sufficient understanding of the underlying ecological processes to be able to extrapolate the results to other systems through formalised conceptual models.

Monitoring arrangements for the larger floodplain options, which use part of the 500 GL will be developed using the above principles. The details of floodplain monitoring will be developed once ecological and flow objectives, and management arrangements for the floodplain have been confirmed.