

King's Billabong Floodplain Management Unit Environmental Water Management Plan

Mallee Catchment Management Authority



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EXECUTIVE SUMMARY

Environmental water management plans have been developed for key sites in the Mallee region by the Mallee Catchment Management Authority in partnership with the Victorian Department of Sustainability and Environment. These plans are based on floodplain management units (FMU's) of the Murray River floodplain and have been developed to guide future environmental water events at these sites.

The King's Billabong FMU is 10 km south east of Mildura. It is an important conservation area due to its environmental and recreation values. The main Billabong is also used for storage and transfer of irrigation water.

Key environmental values for the King's Billabong FMU include flora and fauna species listed under state, national and international treaties, conventions, Acts and initiatives such as the Growling Grass Frog and Umbrella Wattle. The area contains a number of depleted and vulnerable ecological vegetation classes and regionally important wetlands. The FMU has significant social values for the local community and the local indigenous community has strong connections to the area.

The environmental water management plan outlines ecological objectives in line with the Victorian Strategy for Healthy Rivers, Estuaries and Wetlands (VSHREW).

The ecological objectives for the King's Billabong FMU are to:

- Increase diversity of macrophytes, especially emergent macrophytes
- Reduce the abundance or dominance of *Vallisneria*
- Increase abundance and diversity of zooplankton and macro- invertebrates
- Increase breeding opportunities for frogs, including *Litoria raniformis* (Growling Grass Frog)
- Increase abundance and diversity of small bodied native fish
- Maintain self-sustaining population structure of *Tandanus tandanus* (Freshwater catfish) and increase abundance.
- Increase foraging habitat for shore birds
- Maintain aquatic refuge for water dependent birds
- Maintain a variety of habitat types for waterbird species diversity

To achieve these objectives, a long term watering regime with a minimum expectation of Kings Billabong being drawn down each year and Ducksfoot Lagoon disconnected and allowed to dry every second year has been developed.

The constraints on the current ability to manage the water regime of the King's Billabong FMU and proposed infrastructure to allow the billabong to be drawn down are outlined in the plan. It is anticipated that an improvement in wetland health and biodiversity could be achieved with the installation of a regulator on the billabong channel to allow the water level in to be varied.

A full cultural heritage management plan and detailed designs for the proposed works are the top two knowledge gaps and recommendations for the site.

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ABBREVIATIONS AND ACRONYMS

CAMBA	China-Australia Migratory Bird Agreement
CMAs	Catchment Management Authorities
DEH	Department of Environment and Heritage
DSE	Department of Sustainability and Environment
EVC	Ecological Vegetation Class
EWaMP	Environmental Water Management Plan
EWH	Environmental Water Holder
FSL	Full Supply Level
G-MW	Goulburn-Murray Water
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
Ramsar	Global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RRG	River Red Gum
TLM	The Living Murray Initiative
TSL	Targeted Supply Level

1. INTRODUCTION

1.1. Background

Environmental water management in Victoria is entering a new phase as ongoing water recovery sees significant volumes of water being returned to the environment. The increasing environmental water availability is providing new opportunities to protect, restore and reinstate high value ecosystems throughout northern Victoria. The spatial coverage of environmental watering has expanded considerably in recent years and this trend will continue into the future.

Environmental watering in Victoria has historically been supported by management plans which document key information such as the watering requirements of a site, predicted ecological responses and water delivery arrangements. State and Commonwealth environmental watering programs now have the potential to extend beyond those sites which have been watered in the past. Therefore, new plans are required to provide a transparent and informed approach to environmental water delivery across new environmental watering sites.

1.2. Purpose

The Victorian catchment management authorities (CMAs) and Department of Sustainability and Environment (DSE) are working together to develop new Environmental Water Management Plans for both current and future environmental watering sites throughout northern Victoria. The primary purpose of the plans is to provide a consistent set of documents that support the Seasonal Watering Proposals to be submitted by CMAs to the Victorian Environmental Water Holder (VEWH) each year. The supporting information will include:

- water dependent environmental, social and economic values;
- water dependent environmental condition, threats and objectives;
- long-term water regime requirements to meet environmental objectives, under a range of climatic conditions;
- environmental watering management responsibilities;
- recent records of water delivery;
- opportunities for improved efficiency or capacity through structural works or other measures; and
- scientific knowledge gaps and recommendations for future work.

This document is the Environmental Water Management Plan for the King's Billabong Floodplain Management Unit in the Mallee Catchment Management Authority region. It is a live document which is based on the best available information at the time of writing and will be updated as new information comes to hand.

1.3. Site location

The Mallee CMA is situated in the north west of Victoria. The area of responsibility is close to 43,000km² (3.9 million Ha), with a regional population estimated to be 65,000. Population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein.

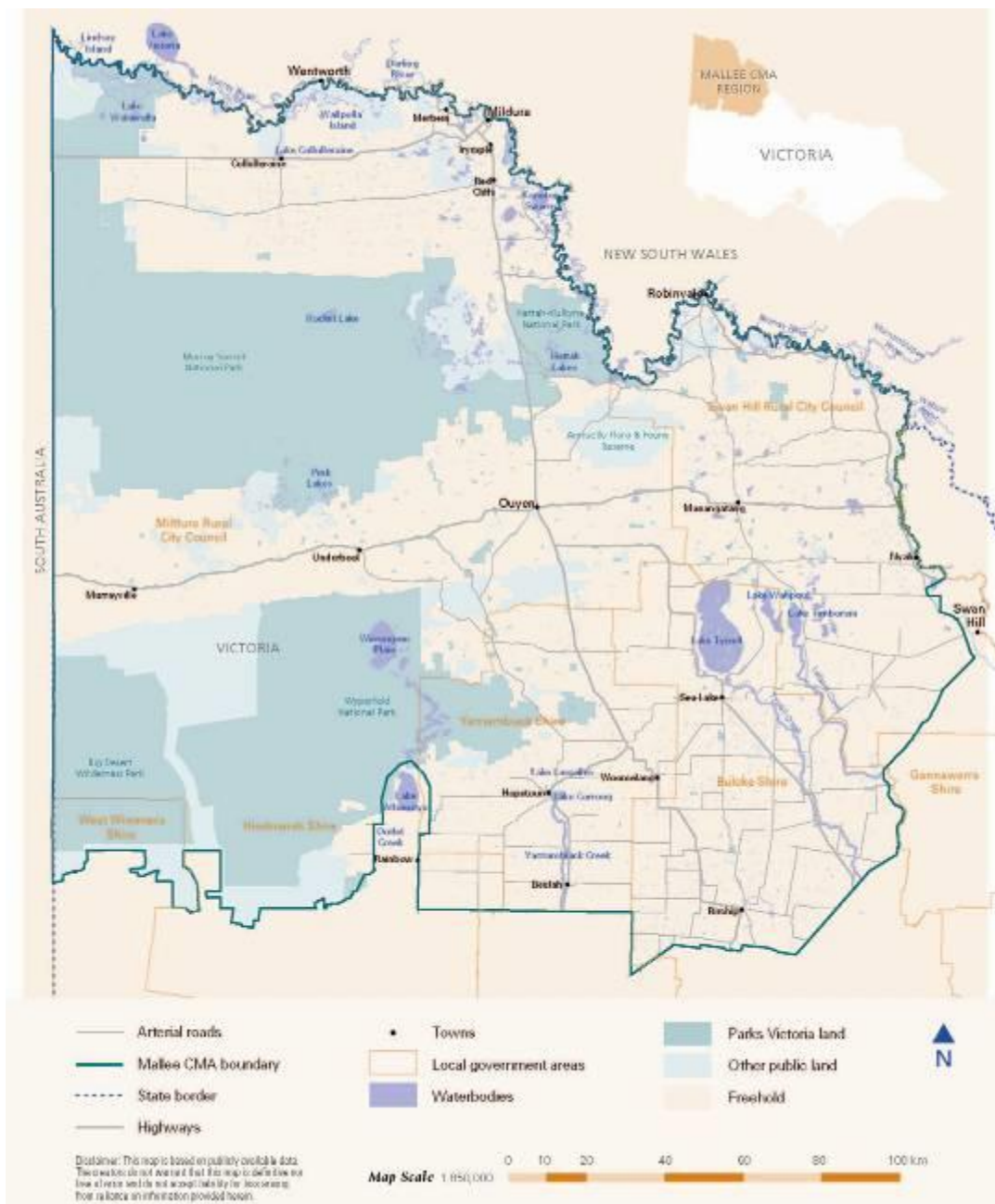
The boundaries of the Mallee CMA region cover almost one fifth of Victoria, making it the largest area managed by a Catchment Management Authority in the state.

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of National Parks, reserves, wilderness areas and large tracts of riverine and dryland forests. The other 60% is predominantly dryland cropping by area, but there is

also a significant investment in irrigation of grapes, citrus, almonds, olives, and vegetables along the Murray River corridor which contributes over 40% of the value of agricultural production for the region.

In 2006 the Mallee CMA engaged consultants, Ecological Associates, to investigate water management options for the Murray River floodplain from Nyah to Wallpolla Island. One of the major outcomes of these investigations (EA, 2006) was the development of a system of floodplain management units (FMUs) which divided the wetland and floodplain areas in which water regimes are able to be managed independently of each other but which have relatively consistent ecological values and land uses. The Mallee CMA environmental water management plans are based on these FMU's to assist with more effective management of hydraulically connected systems.

Figure 1. Map of the CMA region



1.4. Consultation

This plan was developed in collaboration with key stakeholders including Parks Victoria, the Department of Sustainability and Environment, Lower Murray Water, local interest groups and the local community.

1.5. Information sources

Information used in the development of this Plan was compiled from various sources (listed in the references at the end of the document) including river health and catchment strategies, consultant reports, scientific papers and wetland and park management plans. In addition a number of statewide data sets and digital mapping layers were used including the:

- Flora Information System of Victoria (DSE 2005a);
- Atlas of Victorian Wildlife (DSE 2007);
- Bioregional Conservation Status of Ecological Vegetation Classes;
- Wetland Environments and Extent up to 1994; and
- Aerial photography
- Digital Elevation and LiDAR modelling
- Local knowledge

This information was supplemented by discussions with people with an intimate knowledge of the study area, its environmental values and the management and operation of the King's Billabong FMU.

1.6. Limitations

The information sources used in the development of this report have a number of limitations. These limitations include the data contained in the Flora Information System and the Atlas of Victorian Wildlife comes from a combination of incidental records and systematic surveys. The data varies in accuracy and reliability due to the distribution and intensity of survey efforts. In addition, the lack of knowledge about the distribution and characteristics of invertebrates and non-vascular plant species means the data is weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrates. This report also draws on material collated from management plans, research documents and published literature. These sources vary in their age and hence the degree to which they reflect the current situation. However, the Plan is intended to be a live document and will be amended as new information becomes available.

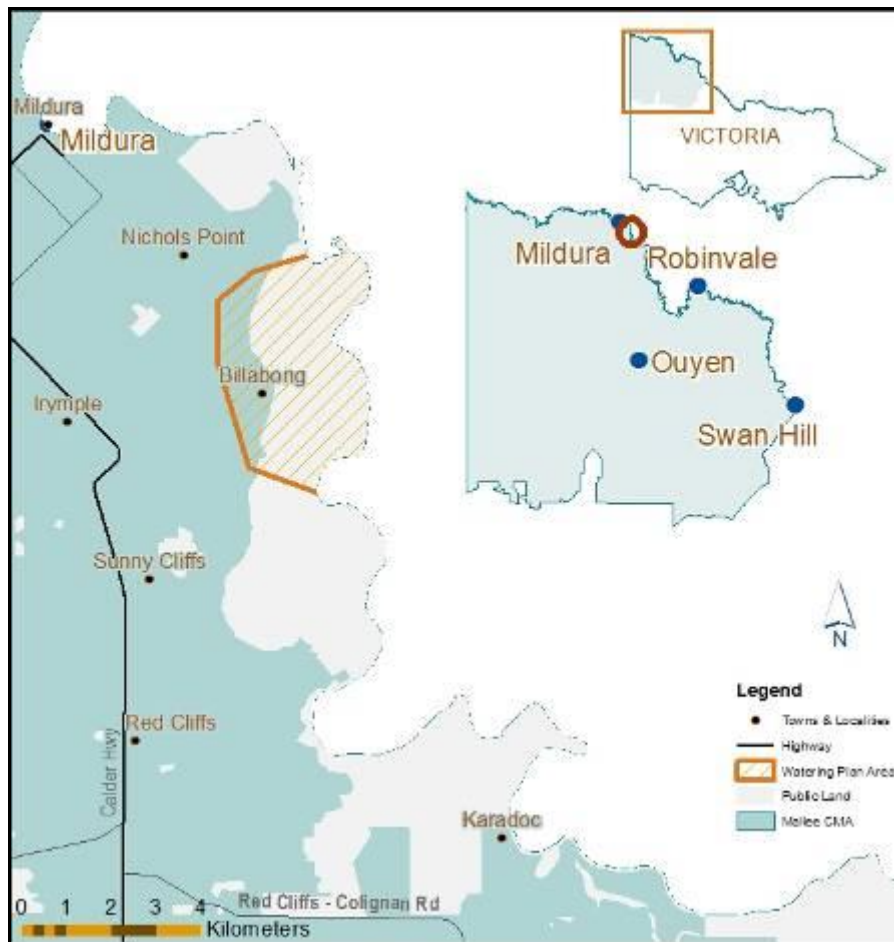
2. SITE OVERVIEW

2.1. Catchment setting

The Kings Billabong floodplain management unit (FMU) is a 1867 Ha floodplain-wetland complex located in the Kings Billabong Park approximately 10 km south east of Mildura within the Robinvale Plains bioregion of the Mallee. It is an important conservation area due to its environmental and recreation values. The main Billabong is also used for storage and transfer of irrigation water.

The wetlands in the reserve provide a range of wetland habitats including River Red Gum forest, Black Box-chenopod woodland and reed beds. The area supports a high number of native flora and fauna species. Of these 46 animal and 67 plant species are considered threatened in Victoria and a number are listed under the *Flora and Fauna Guarantee Act* 1988 and listed under the international JAMBA and CAMBA treaties. The wetlands are located in the Murray River Forest Area which is listed on the Register of the National Estate as a result of its high botanical and zoological significance. (SKM, 2002)

Figure 2. Map of Kings Billabong Floodplain Management Unit



2.2. Land status and management

Kings Billabong was a Wildlife Reserve until it was declared the Kings Billabong Park in the Victorian Environmental Assessment Council River Red Gum Forests Investigation (2008). The change in land status does not effect the land management as Parks Victoria continues to manage the area. Lower Murray Water manages the irrigation water resources and infrastructure within the park.

2.3. Wetland characteristics

Table 1. Summary of site characteristics

Characteristics	Description
Name	Kings Billabong Floodplain management Unit
Mapping ID	Includes Kings Billabong: #7329130105
Area of FMU	1867 Ha
Bioregion	Murray Fans
Conservation status	Mallee Regional River Health Strategy Priority
Land status	Kings Billabong Park
Land manager	Parks Victoria,
Surrounding land use	Irrigated horticulture, rural townships
Water supply	Pumped inflows from Murray river for irrigation purposes Ducksfoot lagoon under influence of Lock 11 weirpool
1788 wetland category	Permanent Open freshwater (6), Freshwater Meadow (1)
1994 wetland category and sub-category	Openwater shallow (6), Meadow Blackbox (1)
Wetland capacity	Kings billabong 178.75 Ha, Ducksfoot lagoon (10.43 Ha), Meadow (36.1 Ha)
Wetland depth at capacity	2-5m

2.4. Environmental water

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The Reserve can include minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements can be called out of storage when needed and delivered to wetlands or streams to protect their environmental values and health.

The Minister for Environment, who delegates management to the Department of Sustainability and Environment (DSE), holds environmental entitlements. Environmental Water for the study site may be sourced from the water entitlements and their agencies listed in Table 2 and further explained in Appendix 1.

Table 2. Summary of environmental water sources available to King's Billabong FMU

Water Entitlement	Responsible Agency
River Murray Unregulated Flows	Murray Darling Basin Authority
Murray River Surplus Flows	
Victorian River Murray Flora and Fauna Bulk Entitlement	Department of Sustainability and Environment
Commonwealth water	Commonwealth Environmental water Holder
Donated Water	Mallee CMA

* Other sources of water may become available through water trading
Explanations of these water sources can be found in Appendix 1

2.5. Legislative Policy Framework

There is a range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that direct management of the site. Those with particular relevance to the site and the management of its environmental and cultural values are listed in Table 3. For the functions and major elements of each refer to Appendix 2.

Table 3. Legislation, agreements, convention and listings relevant to the site

Legislation, Agreement or Convention	Jurisdiction	Listed
Ramsar	International	×
JAMBA	International	×
CAMBA	International	×
ROKAMBA	International	×
Bonn	International	×
EPBC	National	✓
FFG	State	✓
DSE advisory lists	State	✓

2.6. Related Plans and Activities

Parks Victoria in conjunction with the Mallee CMA have invested significant resources into the area in recent years in both environmental watering, environmental regulator installation and other on ground works such as track upgrading, pest plant and animal control, and improved signage to decrease recreational pressures on the floodplain. The Kings Billabong FMU is within the area covered by the Mallee CMA Frontage Action Plan (MCMA 2003) and has the potential to attract future funding and works through that project.

3 WATER DEPENDENT VALUES

3.1 Environmental

3.1.1 Listings and significance

Wetlands and waterways on the floodplain are a vital component of the landscape which support a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system and as the area cycles through natural variations such as wetting and drying phases. Other ecological functions include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

The Kings Billabong FMU consists of floodplain flats, floodplain creeks and wetlands which contain significant flora and fauna communities listed in various legislation, agreements or conventions as outlined in Table 4.

The Kings Billabong FMU was previously classified as a Wildlife Reserve and is recognised as a significant conservation area. The list of species recorded at Kings Billabong includes 5 species of frogs including the EPBC listed Growling Grass Frog (*Litoria raniformis*) as well as seventeen reptile species including all three species of turtles that occur in the region. (SKM 2002)

Table 4. Significant fauna species recorded, or considered likely to occur, at the site

Common Name	Scientific Name	Type	International Agreements	EPBC presence	EPBC status	FFG	DSE status
Australasian Shoveler	Anas rhynchos	B		K			V
Baillon's Crake	Porzana pusilla	B		K		L	V
Black-eared Cuckoo	Chrysococcyx osculans	B		K			N
Blue-billed Duck	Oxyura australis	B		K		L	EN
Brown Treecreeper (south-eastern ssp.)	Climacteris picumnus victoriae	B		K			N
Carpet Python	Morelia spilota metcalfei	R		K		L	EN
Caspian Tern	Hydroprogne caspia	B		K		L	N
Crimson-spotted Rainbowfish	Melanotaenia fluviatilis	F		K		L	D
Eastern Great Egret	Ardea modesta	B		K		L	V
Freckled Duck	Stictonetta naevosa	B		K		L	EN
Freshwater Catfish	Tandanus tandanus	F		K		L	EN
Growling Grass Frog	Litoria raniformis	A		K	V	L	EN
Hardhead	Aythya australis	B		K			V
Hooded Robin	Melanodryas cucullata	B		K		L	N
Intermediate Egret	Ardea intermedia	B		K		L	CR
Little Egret	Egretta garzetta	B		K		L	EN
Musk Duck	Biziura lobata	B		K			V
Nankeen Night Heron	Nycticorax caledonicus	B		K			N
Painted Honeyeater	Grantiella picta	B		K		L	V
Pied Cormorant	Phalacrocorax varius	B		K			N
Regent Parrot	Polytelis anthopeplus	B		K	V	L	V
Royal Spoonbill	Platalea regia	B		K			V
Silver Perch	Bidyanus bidyanus	F		K		L	CR
Unspecked Hardyhead	Craterocephalus stercusmuscarum fulvus	F		K		L	D
Whiskered Tern	Chlidonias hybridus	B		K			N

EPBC status: EXtingent, CRitically endangered, ENdangered, VUlnerable, COnservation DEpendent, NListed
EPBC presence: Known to occur, Likely to occur, May occur, NListed
FFG status: Listed as threatened, Nominated, DElisted, NListed, Ineligible for listing
DSE status: presumed EXtingent, REgionally EXtingent, EXtingent in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, NThreatened, DData DEficient, PKnown, NListed

3.1.2 Flora

Vegetation communities

Within the wetlands within the Kings Billabong FMU there are a variety of submerged aquatic macrophytes, emergent macrophytes and aquatic herbland plants with limited extent. River Red Gum Woodlands (EVC 813) and Black Box Woodland (EVC 103) occupy the floodplain areas surrounding the wetlands. For further detail see Appendix 4.

Table 5. Ecological vegetation classes recorded at the site

EVC no.	EVC name	Bioregional Conservation Status
		Robinvale Plains Bioregion
158	Chenopod Mallee	Vulnerable
106	Grassy Riverine Forest	Depleted
813	Intermittent Swampy Woodland	Depleted
808	Lignum Shrubland	Least concern
104	Lignum Swamp	Vulnerable
823	Lignum Swampy Woodland	Depleted
102	Low Chenopod Shrubland	Depleted
103	Riverine Chenopod Woodland	Depleted
98	Semi-arid Chenopod Woodland	Vulnerable
97	Semi-arid Woodland	Vulnerable
821	Tall Marsh	Depleted

Flora species

The significant flora species listed in the various acts and agreements which have been recorded in the Kings Billabong FMU are listed in Table 6. A full list of flora recorded at the site can be found in Appendix 3.

Table 6. Significant flora species recorded at the site

Common Name	Scientific Name	EPBC status	EPBC presence	FFG status	DSE status
Umbrella Wattle	<i>Acacia oswaldii</i>	NL	NL		V
Buloke	<i>Allocasuarina luehmannii</i>	NL	NL	L	
Jerry-jerry	<i>Ammannia multiflora</i>	NL	NL		V
Spreading Saltbush	<i>Atriplex limbata</i>	NL	NL	L	V
Dwarf Old-man Saltbush	<i>Atriplex nummularia</i> subsp. <i>omissa</i>	NL	NL		R
Coral Saltbush	<i>Atriplex papillata</i>	NL	NL		R
Silver Saltbush	<i>Atriplex rhagodioides</i>	NL	NL	L	V
Spiny-fruit Saltbush	<i>Atriplex spinibractea</i>	NL	NL		EN
Small Water-fire	<i>Bergia trimera</i>	NL	NL		V
Billabong Daisy	<i>Brachyscome</i> aff. <i>gracilis</i> (Kings Billabong)	NL	NL	L	V
Blue Burr-daisy	<i>Calotis cuneifolia</i>	NL	NL		R
Yellow Burr-daisy	<i>Calotis lappulacea</i>	NL	NL		R
Hornwort	<i>Ceratophyllum demersum</i>	NL	NL		PK
Native Scurf-pea	<i>Cullen australasicum</i>	NL	NL	L	EN
Hoary Scurf-pea	<i>Cullen cinereum</i>	NL	NL	L	EN
Grey Scurf-pea	<i>Cullen discolor</i>	NL	NL	L	EN
Woolly Scurf-pea	<i>Cullen pallidum</i>	NL	NL	L	EN
Tough Scurf-pea	<i>Cullen tenax</i>	NL	NL	L	EN
Native Couch	<i>Cynodon dactylon</i> var. <i>pulchellus</i>	NL	NL		PK
Lax Flat-sedge	<i>Cyperus flaccidus</i>	NL	NL		V

Curly Flat-sedge	<i>Cyperus rigidellus</i>	NL	NL	L	EN
Bearded Flat-sedge	<i>Cyperus squarrosus</i>	NL	NL		V
Yelka	<i>Cyperus victoriensis</i>	NL	NL		PK
Riverine Flax-lily	<i>Dianella porracea</i>	NL	NL		V
Silky Umbrella-grass	<i>Digitaria ammophila</i>	NL	NL		V
Twin-flower Saltbush	<i>Dissocarpus biflorus</i> var. <i>biflorus</i>	NL	NL		R
Small Elachanth	<i>Elachanthus pusillus</i>	NL	NL		R
Pale Spike-sedge	<i>Eleocharis pallens</i>	NL	NL		PK
Tall Nut-heads	<i>Epaltes cunninghamii</i>	NL	NL		V
Cane Grass	<i>Eragrostis australasica</i>	NL	NL		V
Purple Love-grass	<i>Eragrostis lacunaria</i>	NL	NL		V
Bristly Love-grass	<i>Eragrostis setifolia</i>	NL	NL		V
Spreading Emu-bush	<i>Eremophila divaricata</i> subsp. <i>divaricata</i>	NL	NL		R
Spotted Emu-bush	<i>Eremophila maculata</i> var. <i>maculata</i>	NL	NL		R
Summer Fringe-sedge	<i>Fimbristylis aestivalis</i>	NL	NL		PK
Veiled Fringe-sedge	<i>Fimbristylis velata</i>	NL	NL		R
Hydrilla	<i>Hydrilla verticillata</i>	NL	NL		R
Inland Club-sedge	<i>Isolepis australiensis</i>	NL	NL		PK
Warty Peppercross	<i>Lepidium papillosum</i>	NL	NL		PK
Veined Peppercross	<i>Lepidium phlebopetalum</i>	NL	NL		EN
Native Peppercross	<i>Lepidium pseudohyssopifolium</i>	NL	NL		PK
Brown Beetle-grass	<i>Leptochloa fusca</i> subsp. <i>fusca</i>	NL	NL		R
Button Rush	<i>Lipocarpa microcephala</i>	NL	NL		V
Goat Head	<i>Malacocera tricornis</i>	NL	NL		R
Bush Minuria	<i>Minuria cunninghamii</i>	NL	NL		R
Smooth Minuria	<i>Minuria integerrima</i>	NL	NL		R
Water Nymph	<i>Najas tenuifolia</i>	NL	NL		R
Upright Adder's-tongue	<i>Ophioglossum polyphyllum</i>	NL	NL		V
Sandhill Spurge	<i>Phyllanthus lacunellus</i>	NL	NL		R
Perfoliate Pondweed	<i>Potamogeton perfoliatus</i> s.l.	NL	NL		PK
Yellow Tails	<i>Ptilotus nobilis</i> var. <i>nobilis</i>	NL	NL		EN
Long Tails	<i>Ptilotus polystachyus</i> var. <i>polystachyus</i>	NL	NL		EN
Crimson Tails	<i>Ptilotus sessilifolius</i> var. <i>sessilifolius</i>	NL	NL		PK
Sarcozona	<i>Sarcozona praecox</i>	NL	NL		R
Spear-fruit Copperburr	<i>Sclerolaena patenticuspis</i>	NL	NL		V
Pin Sida	<i>Sida fibulifera</i>	NL	NL		V
Twiggy Sida	<i>Sida intricata</i>	NL	NL		V
Small-leaf Swainson-pea	<i>Swainsona microphylla</i>	NL	NL		R
Dwarf Swainson-pea	<i>Swainsona phacoides</i>	NL	NL	L	EN
Silky Swainson-pea	<i>Swainsona sericea</i>	NL	NL	L	V
Annual Spinach	<i>Tetragonia moorei</i>	NL	NL		PK
Needle Grass	<i>Triraphis mollis</i>	NL	NL		R
Scrambling Twin-leaf	<i>Zygophyllum angustifolium</i>	NL	NL		R

EPBC status: EXtinct, CRitically endangered, ENdangered, Vulnerable, Conservation Dependent, Not Listed
EPBC presence: Known to occur, Likely to occur, May occur, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DSE status: presumed EXtinct, Regionally EXtinct, EXtinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

Weeds

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. Agricultural weeds such as scotch thistle and cape weed were introduced when agricultural development occurred in the area and malourish when water is applied. A list of exotic flora species identified in the Kings Billabong FMU are listed in Appendix 3.

3.1.3 Wetland depletion and rarity

Victoria's wetlands are currently mapped and are contained within a state wetland database, using an accepted statewide wetland classification system, developed by Andrew Corrick¹ from the Arthur Rylah Institute. Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field checking. This database is commonly known as the 1994 wetland layer and contains the following information:

- categories (primary) based on water regime and
- subcategories based on dominant vegetation

None of the post-1994 wetland mapping is contained within this State wetland database.

At the same time, an attempt was made to categorise and map wetland areas occupied prior to European settlement. This was largely interpretive work and uses only the primary category, based on water regime. This is known as the 1788 layer.

It has been possible to determine the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers.

Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (ANCA 1996).

Across the state, the greatest losses of original wetland area have been in the freshwater meadow (43 per cent lost), shallow freshwater marsh (60 per cent lost) and deep freshwater marsh (70 per cent lost) categories (NRE 1997).

The King's Billabong FMU contains seven registered wetlands. These wetlands have been classified using the Corrick-Norman wetland classification system as either permanent open freshwater or freshwater meadow (see Table 7 for details). Both types of wetlands have decreased in area in Victoria and the Mallee CMA region since 1788 with deep freshwater marsh and shallow freshwater marsh being the third and fifth most depleted categories respectively in the Mallee CMA region (Mallee Wetland Strategy p12). The wetlands occupy an area of 285.96 Ha within the FMU which has a total area of 1867 Ha. The wetlands are naturally ephemeral but have not experienced regular wetting and drying due to river regulation and recent dry climactic conditions.

¹ Arthur Rylah Institute, Department of Sustainability and Environment, Victoria

Table 7. Current area of the site's Corrick classification in the region

Category	No of Wetlands in FMU	Total area in FMU (Ha)	Depletion in wetland area from 1788 to 1994		
			% change in area in Victoria	%change in area In Mallee CMA	% change in Robinvale Plains Bioregion
Permanent Open Freshwater	6	249.86	-6	+5	-1
Freshwater meadow	1	36.1	-43	-80	-1

Source: DSE Biodiversity interactive maps, Mallee Wetland Strategy

3.1.4 Ecosystem functions

The Kings Billabong FMU is a floodplain wetland complex. Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These ecosystem functions include:

- enhancing water quality through filtering sediments and re-using nutrients;
- absorbing and releasing floodwaters;
- providing organic material to rivers to maintain riverine food chains; and
- providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds and fish.

3.2 Social

3.2.2 Cultural heritage

Kings Billabong FMU contains important cultural sites for the local indigenous people and there are numerous middens, scatters and scarred trees throughout the park.

European heritage reflects the pioneering history of the area. These forests have had many uses since European settlement including grazing, forestry and local firewood collection. The area is popular for bird watching and water related activities such as camping, fishing and picnics.

The Friends of Kings Billabong are an active group who to promote and enhance the cultural and environmental values of the forests and to encourage community participation.

3.2.3 Recreation

Kings Billabong FMU is close to the Mildura township and has easy access making it popular for camping, fishing, boating, four wheel driving, trail bike riding, horse riding and walking.

3.3 Economic

The reserve was logged until the 1950s to supply fuel for steam-powered paddleboats and pumps. There was also cattle grazing, cultivation and dried fruit rack sites in the reserve until 1989 (Parks Victoria website). The storage and transfer of irrigation water and tourism (including commercial houseboat moorings in the marina in the north of the park) are the economic interests which remain.

4 HYDROLOGY AND SYSTEM OPERATIONS

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DSE 2005). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 2000 in DSE 2005). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers.

4.1 Water management and delivery

4.1.2 Pre-regulation

Prior to river regulation the ephemeral wetlands of the floodplain experienced inundation during high flow periods punctuated with drying phases on a regular basis. The inundation allowed for recruitment and preservation of the floodplain species.

4.1.3 Post-regulation

A reduction in the frequency and duration of flooding due to river regulation and recent dry climactic conditions is causing the decline of older (up to 200 years) River Red Gums fringing the wetlands on the floodplain.

Kings Billabong has been used to supply irrigation water since 1896 (Environment Australia, 2001) and for disposal of irrigation drainage water (since 1936). The wetland is maintained at a relatively constant level (37 m AHD) to facilitate the supply of irrigation water. The constant water level is achieved through the use of regulators, a levee and the pumping of water from the River Murray. (SKM 2002)

Ducksfoot Lagoon within the Kings Billabong FMU has been permanently inundated by the influence of Lock 11 weir pool. In 2010 Mallee CMA working in conjunction with Parks Victoria installed two regulators to allow the lagoon and Butler's Creek system to be disconnected from the river to allow management of a more natural wetting and drying cycle.

Appendix 5 has a summary of recent watering events

5 THREATS AND CONDITION

5.1 Water dependent threats

Threats described in the AVIRA database which may have an impact on the King's Billabong FMU include:

- Changed water regime
- Reduced wetland area
- Introduction/increase of exotic flora and fauna
- Loss or reduction of wetland connectivity

5.2 Current condition

The condition of six of the seven wetlands within the King's Billabong FMU was assessed in December 2009 using a method developed by DSE called the Index of Wetland Condition (IWC). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions.

The IWC has five sub-indices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota. Each sub-index is given a score between 0 and 20 based on the assessment of a number of measures. The overall IWC score is not a simple summation of the sub-index scores. A formula is used that weights each sub-index according to the contribution it makes to the overall condition of the wetland. The wetland hydrology sub-index for example contributes more to the overall score than the soils sub-index. Further information on the IWC scoring is provided in Appendix 6.

The overall IWC score for the wetlands assessed in this FMU in December 2009 varied from poor to moderate (Table 8).. Hydrology was considered to be very poor in all of the wetlands due to the significant impact the regulation of the Murray River has on the natural wetting and drying cycle of wetlands of the floodplain. The regulation of Murray River in turn has significantly modified the wetland vegetation. The River Red Gum Swamp EVC that once dominated the study area has been largely displaced by vegetation communities adapted to prolonged flooding. However, the recent environmental watering aims to increase the abundance, distribution and diversity of native wetland species in the study area.

Table 8. IWC sub-index and overall scores

Wetland Name	Kings Billabong Backswamp		Kings Billabong		Butlers Creek Lagoon		Baggs Lagoon		Ducksfoot Lagoon		Ducksfoot extension		Kings Billabong extension	
Wetland #	7329120125		7329130105		7329130105		7329137136		7329139116		7329141106		7329142135	
IWC sub index	Score /20	Category	Score /20	Category	Score /20	Category	Score /20	Category	Score /20	Category	Score /20	Category	Score /20	Category
Wetland catchment	14	Excellent	20	Excellent	16	Good	12.5	Good	20	Excellent	20	Excellent	17.5	Excellent
Physical form	20	Excellent	20	Excellent	20	Excellent	20	Excellent	20	Excellent	20	Excellent	20	Excellent
Hydrology	0	Very poor	0	Poor	0	Poor	0	Poor	0	Poor	0	Poor	0	Poor
Water properties	17	Excellent	17	Excellent	15	Good	17	Excellent	10.33	Moderate	10.33	Moderate	17	Excellent
Soils	19.15	Excellent	19.9	Excellent	19.65	Excellent	18.58	Excellent	18.85	Excellent	15.75	Good	19.3	Excellent
Biota	1.48	Very Poor	15.38	Moderate	13.75	Moderate	16.62	Good	15.98	Moderate	5.07	Very Poor	17.61	Good
Overall IWC score	4	Moderate	7	Good	6	Moderate	7	Good	6	Moderate	4	Poor	7	Good

5.3 Condition trajectory

Environmental water management intervention has already begun in the King's Billabong FMU. In 2010 the Mallee CMA working in conjunction with Parks Victoria installed two regulators to allow the Ducksfoot Lagoon and Butler's Creek system to be disconnected from the river to enable the re introduction and management of a wetting and drying cycle to mimic a more natural water regime.

Figure 3: Existing regulators on Ducksfoot Lagoon section of FMU.



Recent environmental watering events are outlined in see Appendix 5.

If this intervention is not continued the benefits from these watering events and investment may not be realised and the FMU will continue to be subjected to permanent inundation in some areas and reduced frequency of flood events due to river regulation and changed climactic conditions in other areas.

A program will need to be developed to monitor the condition of the FMU into the future.

6 MANAGEMENT OBJECTIVES

6.1 Seasonally adaptive approach

Victoria has adopted an adaptive and integrated management approach to environmental management. A key component of this approach for environmental watering is the 'seasonally adaptive' approach, developed through the Northern Region Sustainable Water Strategy and incorporated into the Victorian Strategy for Healthy Rivers, Estuaries and Wetlands.

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year. It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts. The approach is outlined in Table 9.

The seasonally adaptive approach has been used to guide the watering regime under various climatic scenarios. In drier periods, restricted water resource availability will potentially limit the number of ecological objectives which can realistically be provided through environmental water management. However, these ecological objectives can be achieved in wetter periods as water resource availability increases.

Table 9. The seasonally adaptive approach to river and wetland management (DSE, 2009)

	Drought	Dry	Average	Wet to very wet
Long-term ecological objectives	Long-term objectives to move towards ecologically healthy rivers - set through regional river health strategies and sustainable water strategies and reviewed through the 15-year resource review			
Short-term ecological objectives	<ul style="list-style-type: none"> Priority sites have avoided irreversible losses and have capacity for recovery 	<ul style="list-style-type: none"> Priority river reaches and wetlands have maintained their basic functions 	<ul style="list-style-type: none"> The ecological health of priority river reaches and wetlands has been maintained or improved 	<ul style="list-style-type: none"> The health and resilience of priority river reaches and wetlands has been improved
Annual management objectives	<ul style="list-style-type: none"> Avoid critical loss Maintain key refuges Avoid catastrophic events 	<ul style="list-style-type: none"> Maintain river functioning with reduced reproductive capacity Maintain key functions of high priority wetlands Manage within dry-spell tolerances 	<ul style="list-style-type: none"> Improve ecological health and resilience 	<ul style="list-style-type: none"> Maximise recruitment opportunities for key river and wetland species Minimise impacts of flooding on human communities Restore key floodplain linkages
Environmental water reserve	<ul style="list-style-type: none"> Water critical refuges Undertake emergency watering to avoid catastrophic events Provide carryover (for critical environmental needs the following year) If necessary, use the market to sell or purchase water 	<ul style="list-style-type: none"> In priority river reaches provide summer and winter baseflows Water high priority wetlands Provide river flushes where required to break critical dry spells Provide carryover (for critical environmental needs the following year) If necessary, use the market to sell or purchase water 	<ul style="list-style-type: none"> Provide all aspects of the flow regime Provide sufficient flows to promote breeding and recovery Provide carryover to accrue water for large watering events If necessary, use the market to sell or purchase water 	<ul style="list-style-type: none"> Provide overbank flows Provide flows needed to promote breeding and recovery If necessary, use the market to sell or purchase water
River and wetland catchment activities	<ul style="list-style-type: none"> Protect refuges (including stock exclusion) Increase awareness of the importance of refuges Enhanced monitoring of high risk areas and contingency plans in place Investigate feasibility of translocations Environmental emergency management plans in place Protect high priority river reaches and wetlands through fencing; pest, plant and animal management; and water quality improvement works Implement post-bushfire river recovery plans 	<ul style="list-style-type: none"> Protect refuges Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works Environmental emergency management plans in place Improve connectivity Implement post-bushfire river recovery plans 	<ul style="list-style-type: none"> Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works Monitor and survey river and wetland condition Improve connectivity between rivers and floodplain wetlands 	<ul style="list-style-type: none"> Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works Monitor and survey river and wetland condition Improve connectivity between rivers and floodplain wetlands Emergency flood management plans in place Implementation of post-flood river restoration programs

6.2 Management goal

The overall goal proposed for Kings Billabong FMU is derived from a variety of sources, including historic management goals, local expertise and knowledge, and current climate predictions. The goal considers the values the wetland supports and the potential risk factors that need to be managed. This includes consideration of the values the wetland has historically supported and the likely values it could support into the future considering climate change.

Kings Billabong floodplain management unit management goal

To provide a watering regime that supports a mosaic of aquatic and semi emergent wetland vegetation communities within the FMU to provide key habitat and food sources for a diverse range of fauna.

6.3 Ecological and hydrological objectives

6.3.1 Ecological objectives

Ecological objectives represent the desired ecological outcomes of the site. In line with the draft policy Victorian Strategy for Healthy Rivers, Estuaries and Wetlands (VSHREW), the ecological objectives are based on the key values of the site (outlined section 3). The ecological objectives are expressed as the target condition or functionality for each key value. The ecological objectives involve establishing one of the following trajectories of each key value, which is related to the present condition or functionality of the value:

- maintain
- improve
- protect
- re-instate

The ecological objectives for the site are described in Table 10. The ecological objectives were developed and reviewed by the King's Billabong Scientific Advisory Group which includes Iain Ellis (Murray Darling Freshwater Research Centre (MDFRC), Clayton Sharpe (MDFRC), Cherie Campbell (MDFRC), Jane Roberts (Independent Consultant), Kate Brandis (University NSW), Louise Searle (Mallee CMA), Peter Kelly (Mallee CMA).

Table 10. Ecological objectives for the site

Ecological objective	Justification (value based)
Increase diversity of macrophytes, especially emergent macrophytes	Raising and lowering of the billabong will provide opportunity for species such as Potamogeton (pondweeds), Myriophyllum (water milfoil) to re establish in the billabong
Reduce the abundance or dominance of <i>Vallisneria</i>	<i>Vallisneria (Ribbon Weed)</i> is currently dominant in the billabong. Decreasing its abundance will allow for other aquatic species to re establish.
Increase abundance and diversity of zooplankton and macro- invertebrates	To provide a food source for the fish, frogs and birds of the billabong ecosystem.
Increase breeding opportunities for frogs, including <i>Litoria raniformis</i> (Growling Grass Frog)	<i>Litoria raniformis</i> (Growling Grass Frogs) is a listed species recorded within the FMU
Increase abundance and diversity of small bodied native fish	To provide a food source for the larger fish and birds of the billabong ecosystem.

Maintain self-sustaining population structure of *Tandanus tandanus* (Freshwater catfish) and increase abundance.

Tandanus tandanus (Freshwater catfish) are a listed species recorded within the FMU

Increase foraging habitat for shore birds

Maintain aquatic refuge for water dependent birds

To provide opportunity for listed species which have been recorded in the FMU such as *Anas rhynchos* (Australasian Shoveler), *Porzana pusilla* (Baillon's Crake), *Oxyura australis* (Blue-billed Duck)

Maintain a variety of habitat types for waterbird species diversity

6.3.2 Hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The hydrological objectives are derived from an understanding of the local hydrology, using a “landscape logic” for the site. The landscape logic identifies the relationship between vegetation communities, ecological objectives, position in the landscape and hydrological objectives (i.e. flow requirements).

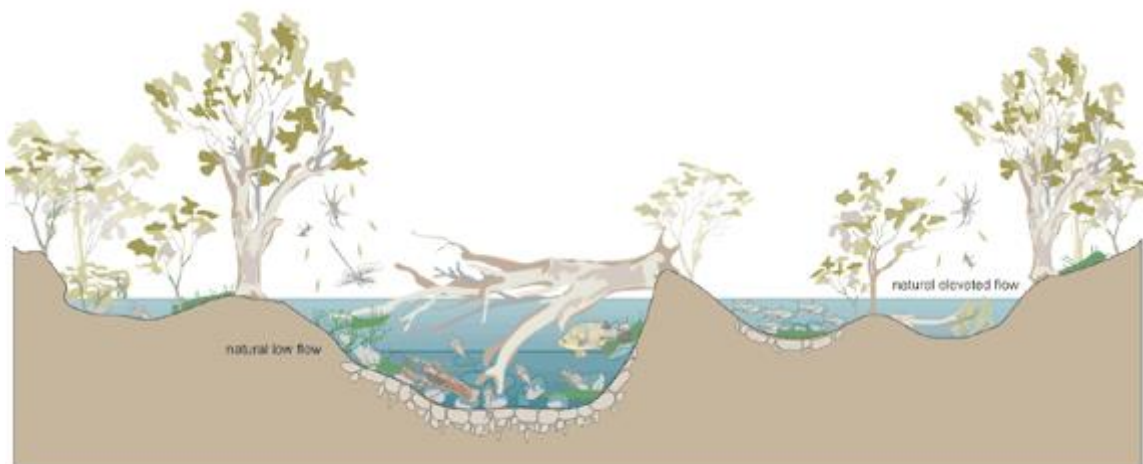


Figure 4. Schematic representation of the landscape of an Australian River

Source: Australian Catchment River and Estuary Assessment 2002, National Land and Water Resource Audit, 2002

The Mallee CMA floodplain management units incorporate components such as floodplains, anabranches, billabongs, wetlands, creeks, deflation basins and lakes. These FMUs support a range of flora and fauna communities some of which are listed under state, federal or international acts and agreements. The hydrology of the area has been altered substantially through river regulation and water diversion which has decreased the frequency of high flows which in turn has placed pressure on these ecological communities.

The hydrological objectives corresponding to each ecological objective and water management area are outlined in Table 11. As for the ecological objectives, these have been developed and reviewed by various experts and stakeholders.

Table 11. Hydrological objectives for Kings Billabong FMU

Ecological objective	Water management area	Hydrological objectives									Preferred timing of inflows	Target supply level (m)	Volume to fill to TSL ¹ (ML)	Volume to maintain at TSL ² (ML)	Total volume per event ³ (ML)	
		Mean frequency of events (number per 10 years)			Tolerable interval between events (years)		Median duration of ponding (months)									
		Min	Opt	Max	Min	Max	Min	Opt	Max							
Increase diversity of macrophytes, especially emergent macrophytes	Billabong/Lagoon system															
Reduce the abundance or dominance of <i>Vallisneria</i>	Billabong/Lagoon system															
Increase abundance and diversity of zooplankton and macrovertebrates	Billabong/Lagoon system															
Enhance breeding opportunities for frogs, including <i>Litoria raniformis</i>	Billabong/Lagoon system															
Increase abundance and diversity of small bodied native fish	Billabong/Lagoon system	8	10	10	1	4	3	6	12	Spring		Kings Billabong: Draw down up to 1m below FSL				
Maintain self-sustaining population structure of <i>Tandanus tandanus</i> and increase abundance	Billabong/Lagoon system											Ducksfoot lagoon: dry completely				
Provide foraging habitat for shore birds	Billabong/Lagoon system															
Maintain aquatic refuge for water dependent birds	Billabong/Lagoon system															
Maintain a variety of habitat types for waterbird species diversity	Billabong/Lagoon system															

¹ Estimate based on filling from empty to the target supply level (TSL), assuming no inflows (refer to water balance in Appendix 7)

² Estimate based on maintaining at target supply level (TSL) for optimum duration of ponding, assuming no inflows (refer to water balance in Appendix 7)

³ Sum of 1 and 2

6.3.3 Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is likely to be provided in drought or dry years, the optimum watering regime in average conditions and the maximum watering regime in wet or flood years.

The optimal, minimum and maximum watering regimes are described below. These volumes are based on the surface water balance in Appendix 7. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

Minimum watering regime

Draw down Kings Billabong by 1 m to mimic a minor drying phase one in two years. Depending on the volume of evaporation, seepage and natural inflows, return billabong to normal operating levels during peak irrigation period over summer. Disconnect Ducksfoot Lagoon system to allow complete drying phase one in every two years.

Optimal watering regime

Draw down Kings Billabong by 1 m to mimic a minor drying phase every year. Depending on the volume of evaporation, seepage and natural inflows, return billabong to normal operating levels during peak irrigation period over summer. Disconnect Ducksfoot Lagoon system to allow complete drying phase every year.

Maximum watering regime

Draw down Kings Billabong by 1 m to mimic a minor drying phase every year. Depending on the volume of evaporation, seepage and natural inflows, return billabong to normal operating levels during peak irrigation period over summer. Disconnect Ducksfoot Lagoon system to allow complete drying phase every year.

7 POTENTIAL RISKS OF AND MITIGATION MEASURES FOR ENVIRONMENTAL WATERING

A table of potential risks and means for mitigating these is used as the basis of assessing the risk of environmental water delivery at this site. The terms for values that may be impacted come from the Aquatic Value Identification and Risk Assessment (AVIRA) Report (DSE, 2009).

The table identifies potential risks, events that could cause such risks, the outcomes of such risks, and the actual values that could subsequently be impacted by each risk. Mitigation strategies for each event are also identified.

Table 12 Potential risks associated with environmental water delivery

#	Risk	Description	Potential Impacts							Mitigation
			Environmental					Social	Economic	
			Fish Water regime does not support breeding and feeding requirements	Birds Water regime does not support breeding and feeding requirements	Amphibians Water regime does not support breeding and feeding requirements	Invertebrate Water regime does not support breeding and feeding requirements	Native aquatic flora Watering requirement does not support establishment and growth.	Reduced public access and use	Degradation of cultural heritage sites	
1	Required watering regime not met	Flood duration too long or short	✓	✓	✓		✓	✓		<p>Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events</p> <p>Monitor flood duration to inform environmental water delivery</p> <p>Monitor the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Flood timing too late or early	✓	✓	✓		✓	✓		<p>Liaise with Goulburn-Murray Water to seek optimum timing of water delivery</p> <p>Monitor flood timing to inform environmental water delivery</p> <p>Monitor the ecological response of the wetland to flooding</p>
		Flooding depth too shallow or deep	✓	✓			✓	✓	✓	<p>Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events</p> <p>Monitor flood depth to inform environmental water delivery</p> <p>Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues</p> <p>Add or drawdown water where appropriate or practical</p>
		Flood frequency too long or short	✓	✓	✓	✓	✓	✓		<p>Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history</p> <p>Monitor the condition of the wetland</p> <p>Monitor the ecological response of the wetland to flooding</p>

2	Poor water quality	Low dissolved oxygen	✓	✓			✓			<p>Monitor dissolved oxygen levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		High turbidity	✓				✓			<p>Monitor turbidity levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		High water temperature	✓				✓			<p>Monitor water temperature and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased salinity levels	✓		✓	✓	✓			<p>Monitor salinity levels and the ecological response of the wetland to flooding</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased nutrient levels								<p>Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding</p> <p>Place public warning signs at the wetland if BGA levels are a public health risk</p> <p>Add or drawdown water where appropriate or practical</p>
		Increased organic matter	✓				✓			Implement the required water regime
3	Pest aquatic plant and animal invasion	Introduction of pest fish	✓		✓	✓	✓			<p>Monitor the ecological response of the wetland to flooding</p> <p>Install a carp screen</p> <p>Implement an appropriate drying regime</p>
		Growth and establishment of aquatic pest plants	✓	✓	✓	✓	✓			<p>Monitor the abundance of native and pest aquatic plants</p> <p>Control pest plants in connected waterways</p> <p>Spray or mechanically remove pest plants</p> <p>Implement an appropriate drying regime</p>

8 ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

a. Constraints

The existing arrangements (which were described in 4.1) allow the management of water in the Ducksfoot Lagoon and Butler's Creek system but pose constraints to the ability to manage the water levels in King's Billabong. There is currently no infrastructure in place to allow the water level to be lowered to re introduce variability in to the billabong system to mimic the more natural wetting and drying phases.

b. Irrigation modernisation

The Mallee CMA is working with Lower Murray Water who manage the irrigation infrastructure within the King's Billabong FMU to ensure that future irrigation modernisation will incorporate consideration of the environmental values of the area.

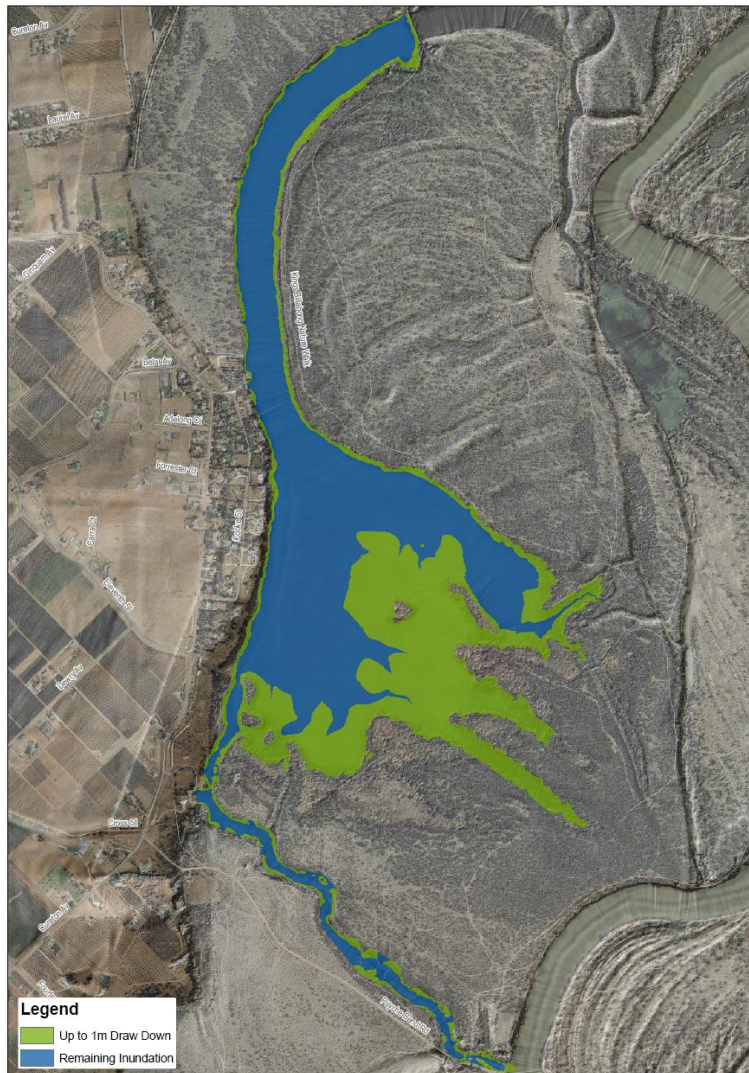
c. Infrastructure recommendations

It is proposed to construct a levee across Psyche channel leading into Kings Billabong to allow for the drawdown of the main billabong by up to 1 m. The location of this structure can be seen in Figure 5 and the extent of the drawdown can be seen in Figure 6. This will allow water management which will mimic a more natural drying phase in the shallow reaches of the billabong. It is anticipated that this management intervention will lead to improved wetland and riparian biodiversity and health.

Figure 5: Existing and proposed works in Kings Billabong FMU



Figure 6: Drawdown extent of King's billabong with proposed regulator in place.



A future management option is to raise the Ducksfoot lagoon system. The maximum level able to be contained by the regulators at Baggs and Jennings bridges is 700 mm above FSL. This would require 300ML of water and road raising works to be necessary to maintain access throughout the FMU. This would allow inundation of the fringing riparian vegetation around the lagoon and creek system.

9 KNOWLEDGE GAPS AND RECOMMENDATIONS

Table 13: Key knowledge and data gaps and recommend actions.

Knowledge and data gaps	Action recommended	Priority level	Responsibility
Full extent of cultural Heritage values	Cultural heritage management plan of FMU	1	Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA
Conceptual and detail designs for the management works	Engage consultants to carry out investigations and designs	2	
Impacts of nearby irrigation on wetland health	Investigation of surface water, groundwater and irrigation water interaction	3	
Role of wetland on fish breeding and population	Monitoring of fish population	4	
Accurate depth and volumes for the wetland	Install depth gauges and bathymetric survey	5	
Flora and fauna surveys	Data collection and monitoring	6	
Impacts of climate variability	Data collection and monitoring	7	

10 REFERENCES

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River Red Gum Investigation

APPENDIX 1: ENVIRONMENTAL WATER SOURCES

Sources of environmental water potentially available for this site under current arrangements and in the future.

Commonwealth Environmental Water Holder (CEWH)

Under *Water for the Future* the Commonwealth Government committed \$3.1 billion to purchase water in the Murray-Darling Basin over 10 years. The Commonwealth Environmental Water Holder will manage their environmental water.

The Commonwealth Water Act 2007 identified that “the Commonwealth Environmental Water Holder must perform its functions for the purpose of protecting or restoring environmental assets so as to give effect to relevant international agreements”. Wetlands listed as of International Importance (Ramsar) are considered priority environmental assets for use of the commonwealth environmental water (DEWHA 2008).

Victorian Environmental Water Holder (VEWH)

The VEWH (when established in June 2011) will be responsible for holding and managing Victorian environmental water entitlements and allocations and deciding upon their best use throughout the State. The environmental entitlements held by the VEWH that could potentially be made available to this site include:

- the Victorian River Murray Flora and Fauna Bulk Entitlement; and
- future Northern Victoria Irrigation Renewal Project Environmental Entitlement.

In 1987 an annual allocation of 27,600 ML of high security water was committed to flora and fauna conservation in Victorian Murray wetlands. In 1999, this became a defined entitlement for the environment called the Victorian River Murray Flora and Fauna Bulk Entitlement.

The Northern Victoria Irrigation Renewal Project (NVIRP) water savings are predicted to provide up to 75 GL as a statutory environmental entitlement, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria (DSE, 2008). The entitlement will have properties which enable the water to be used at multiple locations as the water travels downstream (provided losses and water quality issues are accounted for); meaning that the water can be called out of storage at desired times to meet specific environmental needs.

Donations

People who hold water entitlements sometimes donate water to their local catchment management authority for environmental use. Additionally, people have donated money to non-governmental organisations to buy temporary water allocation for environmental use. While the scale of donated water is generally small relative to other water sources, it can provide a valuable contribution, especially in times of critical needs.

River Murray Unregulated Flow (RMUF)

Unregulated flows in the River Murray system are defined as water that cannot be captured in Lake Victoria and is, or will be, in excess of the required flow to South Australia. If there is a likelihood of unregulated flow event in the River Murray system, the Authority provides this advice to jurisdictions. The Upper States then advise the Authority on altered diversion rates and environmental releases within their existing rights to unregulated flows.

Based on the information received from Jurisdictions, the Authority reassesses the event and, if necessary, limits Upper States' access to ensure that the unregulated flow event is

not over committed. The Authority then issues formal unregulated flow advice to jurisdictions including any limits to States access.

Depending on the volume of water remaining, the Authority advises EWG and the Water Liaison Working Group (WLWG) on the availability and volume of RMUF. Whilst there is a range of measures that can be undertaken by Upper States as part of their 'prior rights' during unregulated flows, RMUF events are prioritised solely for the environment.

APPENDIX 2: LEGISLATIVE FRAMEWORK

International agreements and conventions

Ramsar Convention on Wetlands (Ramsar)

The Australian Government is a Contracting Party to the convention, which is an inter-governmental treaty whose mission is “the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world”.

Bilateral migratory bird agreements

Australia is a signatory to the following international bilateral migratory bird agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

These agreements require that the parties protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn)

This convention (known as the Bonn Convention or CMS) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. The Convention was signed in 1979 in Bonn, Germany, and entered into force in 1983.

Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

This is the key piece of legislation pertaining to biodiversity conservation within Australia. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places - defined in the EPBC Act as matters of national environmental significance.

Water Act 2007 (Commonwealth Water Act)

This establishes the Murray-Darling Basin Authority (MDBA) with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

This aims to preserve and protect areas and objects in Australia and Australian waters that are of particular significance to indigenous people from injury or desecration.

State legislation and listings

Flora and Fauna Guarantee Act 1988 (FFG)

This is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes.

Advisory lists of rare or threatened species in Victoria (DSE)

Three advisory lists are maintained by DSE for use in a range of planning process and in setting priorities for actions to conserve biodiversity. Unlike other threatened species lists, there are no legal requirements or consequences that flow from inclusion of a species on an advisory list. The advisory lists comprise:

- Advisory List of Rare or Threatened Plants In Victoria – 2005
- Advisory List of Threatened Vertebrate Fauna in Victoria - 2007
- Advisory List of Threatened Invertebrate Fauna in Victoria - 2009

Environmental Effects Act 1978

Potential environmental impacts of a proposed development are subject to assessment and approval under this Act. A structural works program and any associated environmental impacts would be subject to assessment and approval under the Act.

Planning and Environment Act 1987

This controls the removal or disturbance to native vegetation within Victoria by implementation of a three-step process of avoidance, minimisation and offsetting.

Water Act 1989 (Victorian Water Act)

This is the key piece of legislation that governs the way water entitlements are issued and allocated in Victoria. The Act also identifies water that is to be kept for the environment under the Environmental Water Reserve. The Act provides a framework for defining and managing Victoria's water resources.

Aboriginal Heritage Act 2006

All Aboriginal places, objects and human remains in Victoria are protected under this Act.

Other relevant legislation

The preceding legislation operates in conjunction with the following other Victorian legislation to influence the management and conservation of Victoria's natural resources as well as outline obligations with respect to obtaining approvals for structural works:

- Environment Protection Act 1970
- Catchment and Land Protection Act 1994
- Heritage Act 1995
- Conservation, Forests and Lands Act 1987
- Land Act 1958
- Heritage Rivers Act 1992
- Wildlife Act 1975
- Murray Darling Basin Act 1993
- National Parks Act 1975
- Parks Victoria Act 1998
- Forests Act 1958

APPENDIX 3: FLORA AND FAUNA SPECIES LIST

Flora – Native

Common Name	Scientific Name	Records
Small Cooba	<i>Acacia ligulata</i>	1
Mallee Wattle	<i>Acacia montana</i>	1
Spine Bush	<i>Acacia nyssophylla</i>	3
Umbrella Wattle	<i>Acacia oswaldii</i>	1
Willow Wattle	<i>Acacia salicina</i>	1
Eumong	<i>Acacia stenophylla</i>	8
Cattle Bush	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>	4
Buloke	<i>Allocasuarina luehmannii</i>	1
Lesser Joyweed	<i>Alternanthera denticulata</i> s.l.	3
Lesser Joyweed	<i>Alternanthera denticulata</i> s.s.	2
Jerry-jerry	<i>Ammannia multiflora</i>	1
Box Mistletoe	<i>Amyema miquelii</i>	2
Nodding Chocolate-lily	<i>Arthropodium fimbriatum</i>	1
Common Woodruff	<i>Asperula conferta</i>	2
Small Saltbush	<i>Atriplex eardleyae</i>	2
Slender-fruit Saltbush	<i>Atriplex leptocarpa</i>	5
Spreading Saltbush	<i>Atriplex limbata</i>	1
Flat-top Saltbush	<i>Atriplex lindleyi</i>	13
Corky Saltbush	<i>Atriplex lindleyi</i> subsp. <i>inflata</i>	3
Old-man Saltbush	<i>Atriplex nummularia</i>	1
Dwarf Old-man Saltbush	<i>Atriplex nummularia</i> subsp. <i>omissa</i>	1
Coral Saltbush	<i>Atriplex papillata</i>	6
Mat Saltbush	<i>Atriplex pumilio</i>	1
Silver Saltbush	<i>Atriplex rhagodioides</i>	1
Berry Saltbush	<i>Atriplex semibaccata</i>	7
Spiny-fruit Saltbush	<i>Atriplex spinibractea</i>	4
Saltbush	<i>Atriplex</i> spp.	1
Sprawling Saltbush	<i>Atriplex suberecta</i>	8
Common Wallaby-grass	<i>Austrodanthonia caespitosa</i>	1
Bristly Wallaby-grass	<i>Austrodanthonia setacea</i>	3
Graceful Spear-grass	<i>Austrostipa acrociliata</i>	1
Plump Spear-grass	<i>Austrostipa aristiglumis</i>	1
Balcarra Spear-Grass	<i>Austrostipa nitida</i>	1
Knotty Spear-grass	<i>Austrostipa nodosa</i>	2
Rough Spear-grass	<i>Austrostipa scabra</i> subsp. <i>falcata</i>	2
Spear Grass	<i>Austrostipa</i> spp.	1
Pacific Azolla	<i>Azolla filiculoides</i>	2
Ferny Azolla	<i>Azolla pinnata</i>	1
Small Water-fire	<i>Bergia trimera</i>	1
Marsh Club-sedge	<i>Bolboschoenus medianus</i>	4
Billabong Daisy	<i>Brachyscome</i> aff. <i>gracilis</i> (Kings Billabong)	4
Woodland Swamp-daisy	<i>Brachyscome basaltica</i> var. <i>gracilis</i>	1
Variable Daisy	<i>Brachyscome ciliaris</i>	3
Variable Daisy	<i>Brachyscome ciliaris</i> var. <i>lanuginosa</i>	1
Lobe-seed Daisy	<i>Brachyscome dentata</i>	4
Hard-head Daisy	<i>Brachyscome lineariloba</i>	16
Leek Lily	<i>Bulbine semibarbata</i>	1
Small Purslane	<i>Calandrinia eremaea</i>	7
Slender Cypress-pine	<i>Callitris gracilis</i> subsp. <i>murrayensis</i>	2
Pale Beauty-heads	<i>Calocephalus sonderi</i>	11
Blue Burr-daisy	<i>Calotis cuneifolia</i>	4
Hairy Burr-daisy	<i>Calotis hispidula</i>	11

Yellow Burr-daisy	<i>Calotis lappulacea</i>	1
Rough Burr-daisy	<i>Calotis scabiosifolia</i>	1
Tufted Burr-daisy	<i>Calotis scapigera</i>	1
Plains Sedge	<i>Carex bichenoviana</i>	3
Spiked Centaury	<i>Centaureum spicatum</i>	1
Hornwort	<i>Ceratophyllum demersum</i>	1
Flat Spurge	<i>Chamaesyce drummondii</i>	3
Crested Goosefoot	<i>Chenopodium cristatum</i>	1
Small-leaf Goosefoot	<i>Chenopodium desertorum</i> subsp. <i>microphyllum</i>	1
Nitre Goosefoot	<i>Chenopodium nitrariaceum</i>	6
Windmill Grass	<i>Chloris</i> spp.	1
Windmill Grass	<i>Chloris truncata</i>	1
Pink Bindweed	<i>Convolvulus erubescens</i> spp. agg.	1
Common Cotula	<i>Cotula australis</i>	3
Cotula	<i>Cotula</i> spp.	2
Dense Crassula	<i>Crassula colorata</i>	8
Swamp Crassula	<i>Crassula helmsii</i>	1
Purple Crassula	<i>Crassula peduncularis</i>	2
Sieber Crassula	<i>Crassula sieberiana</i> s.l.	7
Rosinweed	<i>Cressa australis</i>	1
Native Scurf-pea	<i>Cullen australasicum</i>	1
Hoary Scurf-pea	<i>Cullen cinereum</i>	3
Grey Scurf-pea	<i>Cullen discolor</i>	1
Woolly Scurf-pea	<i>Cullen pallidum</i>	1
Tough Scurf-pea	<i>Cullen tenax</i>	3
Golden Dodder	<i>Cuscuta tasmanica</i>	1
Couch	<i>Cynodon dactylon</i>	2
Native Couch	<i>Cynodon dactylon</i> var. <i>pulchellus</i>	2
Variable Flat-sedge	<i>Cyperus difformis</i>	3
Tall Flat-sedge	<i>Cyperus exaltatus</i>	2
Lax Flat-sedge	<i>Cyperus flaccidus</i>	1
Flecked Flat-sedge	<i>Cyperus gunnii</i> subsp. <i>gunnii</i>	4
Spiny Flat-sedge	<i>Cyperus gymnocaulos</i>	4
Curly Flat-sedge	<i>Cyperus rigidellus</i>	2
Bearded Flat-sedge	<i>Cyperus squarrosus</i>	1
Yelka	<i>Cyperus victoriensis</i>	2
Star Fruit	<i>Damasonium minus</i>	1
Wallaby Grass	<i>Danthonia</i> s.l. spp.	1
Pale Flax-lily	<i>Dianella longifolia</i> s.l.	1
Riverine Flax-lily	<i>Dianella porracea</i>	4
Silky Umbrella-grass	<i>Digitaria ammophila</i>	3
Rounded Noon-flower	<i>Disphyma crassifolium</i> subsp. <i>clavellatum</i>	5
Twin-flower Saltbush	<i>Dissocarpus biflorus</i> var. <i>biflorus</i>	1
Slender Hop-bush	<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>	1
Globular Pigweed	<i>Dysphania glomulifera</i> ssp. <i>glomulifera</i>	1
Yellow Twin-heads	<i>Eclipta platyglossa</i>	2
Nodding Saltbush	<i>Einadia nutans</i> subsp. <i>nutans</i>	12
Small Elachanth	<i>Elachanthus pusillus</i>	1
Waterwort	<i>Elatine gratioloides</i>	1
Common Spike-sedge	<i>Eleocharis acuta</i>	2
Pale Spike-sedge	<i>Eleocharis pallens</i>	1
Small Spike-sedge	<i>Eleocharis pusilla</i>	1
Common Wheat-grass	<i>Elymus scaber</i> var. <i>scaber</i>	1
Ruby Saltbush	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	10
Common Bottle-washers	<i>Enneapogon avenaceus</i>	1
Spider Grass	<i>Enteropogon acicularis</i>	8
Tall Nut-heads	<i>Epaltes cunninghamii</i>	7
Cane Grass	<i>Eragrostis australasica</i>	1

Common Love-grass	<i>Eragrostis brownii</i>	1
Close-headed Love-grass	<i>Eragrostis diandra</i>	1
Mallee Love-grass	<i>Eragrostis dielsii</i>	5
Southern Cane-grass	<i>Eragrostis infecunda</i>	4
Purple Love-grass	<i>Eragrostis lacunaria</i>	3
Weeping Love-grass	<i>Eragrostis parviflora</i>	1
Bristly Love-grass	<i>Eragrostis setifolia</i>	2
Love Grass	<i>Eragrostis</i> spp.	1
Spreading Emu-bush	<i>Eremophila divaricata</i> subsp. <i>divaricata</i>	22
Common Emu-bush	<i>Eremophila glabra</i>	1
Spotted Emu-bush	<i>Eremophila maculata</i> var. <i>maculata</i>	4
Woolly-fruit Bluebush	<i>Eriochiton sclerolaenoides</i>	1
Blue Heron's-bill	<i>Erodium crinitum</i>	1
River Red-gum	<i>Eucalyptus camaldulensis</i>	9
Black Box	<i>Eucalyptus largiflorens</i>	13
Grey Mallee	<i>Eucalyptus socialis</i> subsp. <i>socialis</i>	1
Annual Cudweed	<i>Euchiton sphaericus</i>	7
Leafless Ballart	<i>Exocarpos aphyllus</i>	1
Pale-fruit Ballart	<i>Exocarpos strictus</i>	1
Summer Fringe-sedge	<i>Fimbristylis aestivalis</i>	1
Veiled Fringe-sedge	<i>Fimbristylis velata</i>	1
Sea Heath	<i>Frankenia</i> spp.	1
Hairy Carpet-weed	<i>Glinus lotoides</i>	1
Slender Carpet-weed	<i>Glinus oppositifolius</i>	1
Indian Cudweed	<i>Gnaphalium polycaulon</i>	1
Silky Goodenia	<i>Goodenia fascicularis</i>	1
Pale Goodenia	<i>Goodenia glauca</i>	1
Spreading Goodenia	<i>Goodenia heteromera</i>	1
Cut-leaf Goodenia	<i>Goodenia pinnatifida</i>	1
Small-flower Goodenia	<i>Goodenia pusilliflora</i>	1
Goodenia	<i>Goodenia</i> spp.	2
Comb Grevillea	<i>Grevillea huegelii</i>	3
Silver Needlewood	<i>Hakea leucoptera</i> subsp. <i>leucoptera</i>	1
Hooked Needlewood	<i>Hakea tephrosperma</i>	1
Rough Raspwort	<i>Haloragis aspera</i>	4
Toothed Raspwort	<i>Haloragis odontocarpa</i>	1
May Smocks	<i>Harmsiodoxa blennodioides</i>	1
Short Cress	<i>Harmsiodoxa brevipes</i> var. <i>brevipes</i>	1
Common Heliotrope	<i>Heliotropium europaeum</i>	1
Hydrilla	<i>Hydrilla verticillata</i>	1
Grass Cushion	<i>Isoetopsis graminifolia</i>	3
Inland Club-sedge	<i>Isolepis australiensis</i>	1
Broad-fruit Club-sedge	<i>Isolepis cernua</i> var. <i>platycarpa</i>	1
Tussock Rush	<i>Juncus aridicola</i>	3
Toad Rush	<i>Juncus bufonius</i>	2
Gold Rush	<i>Juncus flavidus</i>	4
Common Blown-grass	<i>Lachnagrostis filiformis</i>	1
Common Blown-grass	<i>Lachnagrostis filiformis</i> var. 1	3
Thin Duckweed	<i>Landoltia punctata</i>	1
Stalked Plover-daisy	<i>Leiocarpa websteri</i>	2
Warty Peppergrass	<i>Lepidium papillosum</i>	7
Veined Peppergrass	<i>Lepidium phlebopetalum</i>	1
Native Peppergrass	<i>Lepidium pseudohyssopifolium</i>	2
Peppergrass	<i>Lepidium</i> spp.	4
Brown Beetle-grass	<i>Leptochloa fusca</i> subsp. <i>fusca</i>	3
Button Rush	<i>Lipocarpha microcephala</i>	1
Red Bird's-foot Trefoil	<i>Lotus cruentus</i>	1
Clove-strip	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	2

Box Thorn	<i>Lycium</i> spp.	1
Harlequin Mistletoe	<i>Lysiana exocarpi</i>	1
Grey Bluebush	<i>Maireana appressa</i>	1
Short-leaf Bluebush	<i>Maireana brevifolia</i>	2
Black Cotton-bush	<i>Maireana decalvans</i>	8
Hairy Bluebush	<i>Maireana pentagona</i>	11
Goat Head	<i>Malacocera tricornis</i>	1
Narrow-leaf Nardoo	<i>Marsilea costulifera</i>	3
Common Nardoo	<i>Marsilea drummondii</i>	6
Nardoo	<i>Marsilea</i> spp.	3
Moonah	<i>Melaleuca lanceolata</i> subsp. <i>lanceolata</i>	1
Bush Minuria	<i>Minuria cunninghamii</i>	1
Smooth Minuria	<i>Minuria integerrima</i>	8
Blue Rod	<i>Morgania glabra</i> spp. agg.	1
Tangled Lignum	<i>Muehlenbeckia florulenta</i>	10
Creeping Myoporum	<i>Myoporum parvifolium</i>	1
Mousetail	<i>Myosurus australis</i>	1
Coarse Water-milfoil	<i>Myriophyllum caput-medusae</i>	1
Robust Water-milfoil	<i>Myriophyllum papillosum</i>	1
Water-milfoil	<i>Myriophyllum</i> spp.	3
Red Water-milfoil	<i>Myriophyllum verrucosum</i>	1
Water Nymph	<i>Najas tenuifolia</i>	1
Pimelea Daisy-bush	<i>Olearia pimeleoides</i>	1
Austral Adder's-tongue	<i>Ophioglossum lusitanicum</i>	1
Upright Adder's-tongue	<i>Ophioglossum polyphyllum</i>	3
Babbagia	<i>Osteocarpum acropterum</i> var. <i>deminutum</i>	1
Bonefruit	<i>Osteocarpum salsuginosum</i>	1
Swamp Lily	<i>Ottelia ovalifolia</i> subsp. <i>ovalifolia</i>	1
Grassland Wood-sorrel	<i>Oxalis perennans</i>	2
Wood Sorrel	<i>Oxalis</i> spp.	1
Hairy Panic	<i>Panicum effusum</i>	2
Knobbybutt Grass	<i>Paspalidium constrictum</i>	1
Warrego Summer-grass	<i>Paspalidium jubiflorum</i>	5
Slender Knotweed	<i>Persicaria decipiens</i>	2
Common Reed	<i>Phragmites australis</i>	1
Sandhill Spurge	<i>Phyllanthus lacunellus</i>	1
Earth Moss	<i>Physcomitrella patens</i> subsp. <i>readeri</i>	1
Austral Pillwort	<i>Pilularia novae-hollandiae</i>	1
Weeping Pittosporum	<i>Pittosporum angustifolium</i>	2
Clay Plantain	<i>Plantago cunninghamii</i>	2
Plantain	<i>Plantago</i> spp.	1
Crowned Plantain	<i>Plantago turrifera</i>	2
Forde Poa	<i>Poa fordeana</i>	2
Poached-eggs Daisy	<i>Polycalymma stuartii</i>	1
Curly Pondweed	<i>Potamogeton crispus</i>	1
Blunt Pondweed	<i>Potamogeton ochreateus</i>	1
Fennel Pondweed	<i>Potamogeton pectinatus</i>	1
Perfoliate Pondweed	<i>Potamogeton perfoliatus</i> s.l.	1
Floating Pondweed	<i>Potamogeton tricarlinatus</i> s.l.	2
Jersey Cudweed	<i>Pseudognaphalium luteoalbum</i>	6
Spiny Mud-grass	<i>Pseudoraphis spinescens</i>	1
Yellow Tails	<i>Ptilotus nobilis</i> var. <i>nobilis</i>	2
Long Tails	<i>Ptilotus polystachyus</i> var. <i>polystachyus</i>	1
Crimson Tails	<i>Ptilotus sessilifolius</i> var. <i>sessilifolius</i>	1
Inland Buttercup	<i>Ranunculus pentandrus</i> var. <i>platycarpus</i>	1
Hedge Saltbush	<i>Rhagodia spinescens</i>	2
Paper Sunray	<i>Rhodanthe corymbiflora</i>	1
Slender Dock	<i>Rumex brownii</i>	2

Narrow-leaf Dock	<i>Rumex tenax</i>	1
Prickly Saltwort	<i>Salsola tragus</i>	1
Prickly Saltwort	<i>Salsola tragus</i> subsp. <i>tragus</i>	3
Beaded Glasswort	<i>Sarcocornia quinqueflora</i>	1
Sarcozona	<i>Sarcozona praecox</i>	1
Prickly Fan-flower	<i>Scaevola spinescens</i>	1
River Club-sedge	<i>Schoenoplectus tabernaemontani</i>	3
Short-wing Saltbush	<i>Sclerochlamys brachyptera</i>	9
Grey Copperburr	<i>Sclerolaena diacantha</i>	3
Black Roly-poly	<i>Sclerolaena muricata</i>	2
Spear-fruit Copperburr	<i>Sclerolaena patenticuspis</i>	1
Streaked Copperburr	<i>Sclerolaena tricuspis</i>	5
Slender Groundsel	<i>Senecio glossanthus</i> s.l.	10
Cotton Fireweed	<i>Senecio quadridentatus</i>	1
Desert Cassia	<i>Senna artemisioides</i> spp. agg.	1
Variable Sida	<i>Sida corrugata</i>	1
Pin Sida	<i>Sida fibulifera</i>	1
Twiggy Sida	<i>Sida intricata</i>	1
Sida	<i>Sida</i> spp.	1
Narrow-leaf Sida	<i>Sida trichopoda</i>	1
Quena	<i>Solanum esuriale</i>	1
Lesser Sea-spurrey	<i>Spergularia marina</i> s.s.	1
Salt Sea-spurrey	<i>Spergularia</i> sp. 3	2
Spreading Nut-heads	<i>Sphaeromorphaea australis</i>	1
Rat-tail Couch	<i>Sporobolus mitchellii</i>	21
Star Bluebush	<i>Stelligera endecaspinis</i>	4
Small-leaf Swainson-pea	<i>Swainsona microphylla</i>	1
Dwarf Swainson-pea	<i>Swainsona phacoides</i>	1
Silky Swainson-pea	<i>Swainsona sericea</i>	1
Desert Spinach	<i>Tetragonia eremaea</i> s.l.	1
Annual Spinach	<i>Tetragonia moorei</i>	1
Grey Germander	<i>Teucrium racemosum</i> s.l.	3
Grey Germander	<i>Teucrium racemosum</i> s.s.	1
Caltrop	<i>Tribulus terrestris</i>	1
Spurred Arrowgrass	<i>Triglochin calcitrapa</i> s.l.	1
Porcupine Grass	<i>Triodia scariosa</i>	1
Needle Grass	<i>Triraphis mollis</i>	1
Narrow-leaf Cumbungi	<i>Typha domingensis</i>	1
Bulrush	<i>Typha</i> spp.	1
Eel Grass	<i>Vallisneria americana</i> var. <i>americana</i>	2
Common Verbena	<i>Verbena officinalis</i> s.l.	1
Annual New Holland Daisy	<i>Vittadinia cervicalis</i>	1
Annual New Holland Daisy	<i>Vittadinia cervicalis</i> var. <i>subcervicalis</i>	1
Fuzzy New Holland Daisy	<i>Vittadinia cuneata</i>	1
Dissected New Holland Daisy	<i>Vittadinia dissecta</i> s.l.	2
New Holland Daisy	<i>Vittadinia</i> spp.	1
River Bluebell	<i>Wahlenbergia fluminalis</i>	4
Annual Bluebell	<i>Wahlenbergia gracilentia</i> s.l.	1
Bluebell	<i>Wahlenbergia</i> spp.	1
Green-tufted Stubble-moss	<i>Weissia controversa</i>	1
Common Early Nancy	<i>Wurmbea dioica</i>	1
Sand Twin-leaf	<i>Zygophyllum ammophilum</i>	2
Scrambling Twin-leaf	<i>Zygophyllum angustifolium</i>	1
Pointed Twin-leaf	<i>Zygophyllum apiculatum</i>	3
Pale Twin-leaf	<i>Zygophyllum glaucum</i>	3
Twin-leaf	<i>Zygophyllum</i> spp.	4

Flora - Exotic

Common Name	Scientific Name	Records
Orange Fox-tail	<i>Alopecurus aequalis</i>	1
Bridal Creeper	<i>Asparagus asparagoides</i>	1
Asparagus	<i>Asparagus officinalis</i>	2
Onion Weed	<i>Asphodelus fistulosus</i>	2
Aster-weed	<i>Aster subulatus</i>	9
Hastate Orache	<i>Atriplex prostrata</i>	1
Bearded Oat	<i>Avena barbata</i>	2
Oat	<i>Avena</i> spp.	2
Mediterranean Turnip	<i>Brassica tournefortii</i>	1
Lesser Quaking-grass	<i>Briza minor</i>	1
Great Brome	<i>Bromus diandrus</i>	2
Red Brome	<i>Bromus rubens</i>	7
Ward's Weed	<i>Carrichtera annua</i>	1
Malta Thistle	<i>Centaurea melitensis</i>	1
Rhodes Grass	<i>Chloris gayana</i>	1
Spear Thistle	<i>Cirsium vulgare</i>	2
Camel Melon	<i>Citrullus lanatus</i>	1
Water Buttons	<i>Cotula coronopifolia</i>	2
Paddy Melon	<i>Cucumis myriocarpus</i> subsp. <i>leptodermis</i>	1
Couch	<i>Cynodon dactylon</i> var. <i>dactylon</i>	1
Drain Flat-sedge	<i>Cyperus eragrostis</i>	1
Curry Flat-sedge	<i>Cyperus hamulosus</i>	1
Nutgrass	<i>Cyperus rotundus</i>	1
Stinkwort	<i>Dittrichia graveolens</i>	1
Barnyard Grass	<i>Echinochloa crus-galli</i>	1
Water Hyacinth	<i>Eichhornia crassipes</i>	1
Spiny Emex	<i>Emex australis</i>	1
Stink Grass	<i>Eragrostis cilianensis</i>	1
Fumitory	<i>Fumaria</i> spp.	1
Northern Barley-grass	<i>Hordeum glaucum</i>	4
Barley-grass	<i>Hordeum leporinum</i>	1
Barley-grass	<i>Hordeum murinum</i> s.l.	1
Smooth Cat's-ear	<i>Hypochoeris glabra</i>	14
Flatweed	<i>Hypochoeris radicata</i>	1
Spiny Rush	<i>Juncus acutus</i> subsp. <i>acutus</i>	1
Willow-leaf Lettuce	<i>Lactuca saligna</i>	1
Prickly Lettuce	<i>Lactuca serriola</i>	4
Golden-top	<i>Lamarckia aurea</i>	2
Common Peppergrass	<i>Lepidium africanum</i>	1
Hoary Cress	<i>Lepidium draba</i>	4
Wimmera Rye-grass	<i>Lolium rigidum</i>	3
Horehound	<i>Marrubium vulgare</i>	1
Little Medic	<i>Medicago minima</i>	3
Burr Medic	<i>Medicago polymorpha</i>	4
Lucerne	<i>Medicago sativa</i> subsp. <i>sativa</i>	1
Bokhara Clover	<i>Melilotus albus</i>	1
Sweet Melilot	<i>Melilotus indicus</i>	1
Melilot	<i>Melilotus</i> spp.	1
Common Ice-plant	<i>Mesembryanthemum crystallinum</i>	2
Small Ice-plant	<i>Mesembryanthemum nodiflorum</i>	1
Common Evening-primrose	<i>Oenothera stricta</i> subsp. <i>stricta</i>	1
Soursob	<i>Oxalis pes-caprae</i>	1

Coast Barb-grass	<i>Parapholis incurva</i>	1
Paspalum	<i>Paspalum dilatatum</i>	1
Water Couch	<i>Paspalum distichum</i>	5
Fog-fruit	<i>Phyla canescens</i>	15
Rice Millet	<i>Piptatherum miliaceum</i>	2
Ribwort	<i>Plantago lanceolata</i>	1
Prostrate Knotweed	<i>Polygonum aviculare</i> s.l.	1
Annual Beard-grass	<i>Polypogon monspeliensis</i>	1
Wiry Noon-flower	<i>Psilocaulon granulicaule</i>	2
False Sow-thistle	<i>Reichardia tingitana</i>	4
Tiny Bristle-grass	<i>Rostraria pumila</i>	6
Wild Sage	<i>Salvia verbenaca</i>	2
Arabian Grass	<i>Schismus barbatus</i>	4
Whorled Pigeon-grass	<i>Setaria verticillata</i>	1
Mallee Catchfly	<i>Silene apetala</i> var. <i>apetala</i>	4
Smooth Mustard	<i>Sisymbrium erysimoides</i>	3
London Rocket	<i>Sisymbrium irio</i>	1
Rough Sow-thistle	<i>Sonchus asper</i> s.l.	3
Common Sow-thistle	<i>Sonchus oleraceus</i>	16
Lesser Sand-spurrey	<i>Spergularia diandra</i>	2
Red Sand-spurrey	<i>Spergularia rubra</i> s.l.	2
Cluster Clover	<i>Trifolium glomeratum</i>	1
Woolly Clover	<i>Trifolium tomentosum</i> var. <i>tomentosum</i>	3
Arrowleaf Clover	<i>Trifolium vesiculosum</i> var. <i>vesiculosum</i>	2
Small Nettle	<i>Urtica urens</i>	1
Common Vetch	<i>Vicia sativa</i>	1
Rat's-tail Fescue	<i>Vulpia myuros</i>	4
Rat's-tail Fescue	<i>Vulpia myuros</i> f. <i>myuros</i>	3
Bathurst Burr	<i>Xanthium spinosum</i>	1
Noogoora Burr species aggregate	<i>Xanthium strumarium</i> spp. agg.	1

Fauna – Native

Common Name	Scientific Name	Type	Records
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	B	9
Australasian Shoveler	<i>Anas rhynchos</i>	B	3
Australian Hobby	<i>Falco longipennis</i>	B	2
Australian Magpie	<i>Gymnorhina tibicen</i>	B	19
Australian Pelican	<i>Pelecanus conspicillatus</i>	B	34
Australian Raven	<i>Corvus coronoides</i>	B	11
Australian Shelduck	<i>Tadorna tadornoides</i>	B	29
Australian Spotted Crane	<i>Porzana fluminea</i>	B	1
Australian White Ibis	<i>Threskiornis molucca</i>	B	14
Australian Wood Duck	<i>Chenonetta jubata</i>	B	32
Baillon's Crane	<i>Porzana pusilla</i>	B	2
Barking Marsh Frog	<i>Limnodynastes fletcheri</i>	F	3
Black Kite	<i>Milvus migrans</i>	B	8
Black Swan	<i>Cygnus atratus</i>	B	39
Black-eared Cuckoo	<i>Chrysococcyx osculans</i>	B	1
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	B	12
Black-fronted Dotterel	<i>Elsayornis melanops</i>	B	8
Black-tailed Native-hen	<i>Gallinula ventralis</i>	B	3
Black-winged Stilt	<i>Himantopus himantopus</i>	B	2
Blue-billed Duck	<i>Oxyura australis</i>	B	1
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>	B	9
Brown Goshawk	<i>Accipiter fasciatus</i>	B	3

Brown Treecreeper (south-eastern ssp.)	<i>Climacteris picumnus victoriae</i>	B	15
Carpet Python	<i>Morelia spilota metcalfei</i>	R	1
Caspian Tern	<i>Hydroprogne caspia</i>	B	8
Chestnut Teal	<i>Anas castanea</i>	B	1
Chestnut-crowned Babbler	<i>Pomatostomus ruficeps</i>	B	1
Chestnut-rumped Thornbill	<i>Acanthiza uropygialis</i>	B	5
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	B	14
Common Bronzewing	<i>Phaps chalcoptera</i>	B	12
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	M	3
Common Greenshank	<i>Tringa nebularia</i>	B	1
Crested Pigeon	<i>Ocyphaps lophotes</i>	B	18
Crested Shrike-tit	<i>Falcunculus frontatus</i>	B	1
Crimson Rosella	<i>Platycercus elegans elegans</i>	B	25
Crimson-spotted Rainbowfish	<i>Melanotaenia fluviatilis</i>	F	1
Curlew Sandpiper	<i>Calidris ferruginea</i>	B	1
Darter	<i>Anhinga novaehollandiae</i>	B	20
Dusky Moorhen	<i>Gallinula tenebrosa</i>	B	10
Dusky Woodswallow	<i>Artamus cyanopterus</i>	B	8
Eastern Great Egret	<i>Ardea modesta</i>	B	20
Eurasian Coot	<i>Fulica atra</i>	B	23
Fairy Martin	<i>Hirundo ariel</i>	B	1
Freckled Duck	<i>Stictonetta naevosa</i>	B	1
Freshwater Catfish	<i>Tandanus tandanus</i>	F	2
Galah	<i>Eolophus roseicapilla</i>	B	8
Great Cormorant	<i>Phalacrocorax carbo</i>	B	15
Grey Fantail	<i>Rhipidura albiscarpa</i>	B	2
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	B	19
Grey Teal	<i>Anas gracilis</i>	B	41
Growling Grass Frog	<i>Litoria raniformis</i>	A	1
Hardhead	<i>Aythya australis</i>	B	3
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>	B	9
Hooded Robin	<i>Melanodryas cucullata</i>	B	6
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalus</i>	B	1
Intermediate Egret	<i>Ardea intermedia</i>	B	1
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	B	15
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	B	18
Little Corella	<i>Cacatua sanguinea</i>	B	3
Little Eagle	<i>Hieraaetus morphnoides</i>	B	3
Little Egret	<i>Egretta garzetta</i>	B	1
Little Friarbird	<i>Philemon citreogularis</i>	B	13
Little Grassbird	<i>Megalurus gramineus</i>	B	2
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	B	19
Magpie-lark	<i>Grallina cyanoleuca</i>	B	22
Marsh Sandpiper	<i>Tringa stagnatilis</i>	B	1
Masked Lapwing	<i>Vanellus miles</i>	B	14
Masked Woodswallow	<i>Artamus personatus</i>	B	2
Mistletoebird	<i>Dicaeum hirundinaceum</i>	B	6
Musk Duck	<i>Biziura lobata</i>	B	2
Nankeen Kestrel	<i>Falco cenchroides</i>	B	6
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	B	1
Noisy Friarbird	<i>Philemon corniculatus</i>	B	1
Noisy Miner	<i>Manorina melanocephala</i>	B	22
Pacific Black Duck	<i>Anas superciliosa</i>	B	54
Painted Honeyeater	<i>Grantiella picta</i>	B	1
Pallid Cuckoo	<i>Cuculus pallidus</i>	B	4
Peaceful Dove	<i>Geopelia striata</i>	B	12
Peregrine Falcon	<i>Falco peregrinus</i>	B	1
Pied Butcherbird	<i>Cracticus nigrogularis</i>	B	10

Pied Cormorant	Phalacrocorax varius	B	8
Pink-eared Duck	Malacorhynchus membranaceus	B	1
Plains Froglet	Crinia parinsignifera	A	7
Plumed Whistling-Duck	Dendrocygna eytoni	B	1
Purple Swamphen	Porphyrio porphyrio	B	10
Rainbow Bee-eater	Merops ornatus	B	1
Red Wattlebird	Anthochaera carunculata	B	6
Red-capped Plover	Charadrius ruficapillus	B	2
Red-capped Robin	Petroica goodenovii	B	7
Red-kneed Dotterel	Erythronyx cinctus	B	1
Red-necked Avocet	Recurvirostra novaehollandiae	B	2
Red-rumped Parrot	Psephotus haematonotus	B	23
Regent Parrot	Polytelis anthopeplus	B	2
Restless Flycatcher	Myiagra inquieta	B	1
Royal Spoonbill	Platalea regia	B	1
Rufous Whistler	Pachycephala rufiventris	B	15
Sacred Kingfisher	Todiramphus sanctus	B	11
Sharp-tailed Sandpiper	Calidris acuminata	B	1
Silver Gull	Chroicocephalus novaehollandiae	B	8
Silver Perch	Bidyanus bidyanus	B	1
Silvereye	Zosterops lateralis	B	1
Singing Honeyeater	Lichenostomus virescens	B	2
Southern Bullfrog	Limnodynastes dumerilii	A	2
Southern Whiteface	Aphelocephala leucopsis	B	1
Spiny-cheeked Honeyeater	Acanthagenys rufogularis	B	3
Spotted Marsh Frog	Limnodynastes tasmaniensis	A	8
Spotted Pardalote	Pardalotus punctatus	B	1
Straw-necked Ibis	Threskiornis spinicollis	B	5
Striated Pardalote	Pardalotus striatus	B	10
Sulphur-crested Cockatoo	Cacatua galerita	B	2
Superb Fairy-wren	Malurus cyaneus	B	8
Swamp Harrier	Circus approximans	B	12
Tawny Frogmouth	Podargus strigoides	B	1
Tiger Snake	Notechis scutatus	R	2
Tree Martin	Hirundo nigricans	B	7
Unspecked Hardyhead	Craterocephalus stercusmuscarum fulvus	F	2
Variiegated Fairy-wren	Malurus lamberti	B	7
Water Rat	Hydromys chrysogaster	M	2
Wedge-tailed Eagle	Aquila audax	B	1
Weebill	Smicronis brevirostris	B	11
Welcome Swallow	Hirundo neoxena	B	20
Western Gerygone	Gerygone fusca	B	1
Western Grey Kangaroo	Macropus fuliginosus	M	1
Western Ringneck	Barnardius zonarius zonarius	B	1
Whiskered Tern	Chlidonias hybridus	B	3
Whistling Kite	Haliastur sphenurus	B	20
White-bellied Cuckoo-shrike	Coracina papuensis	B	1
White-breasted Woodswallow	Artamus leucorhynchus	B	3
White-browed Babbler	Pomatostomus superciliosus	B	1
White-browed Woodswallow	Artamus superciliosus	B	3
White-faced Heron	Egretta novaehollandiae	B	20
White-necked Heron	Ardea pacifica	B	6
White-plumed Honeyeater	Lichenostomus penicillatus	B	24
White-winged Chough	Corcorax melanorhamphos	B	5
White-winged Triller	Lalage sueurii	B	2
Willie Wagtail	Rhipidura leucophrys	B	25
Yellow Rosella	Platycercus elegans flaveolus	B	5
Yellow Thornbill	Acanthiza nana	B	3

Yellow-billed Spoonbill	Platalea flavipes	B	12
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	B	3
Zebra Finch	Taeniopygia guttata	B	1

Legend

Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

Fauna – Exotic

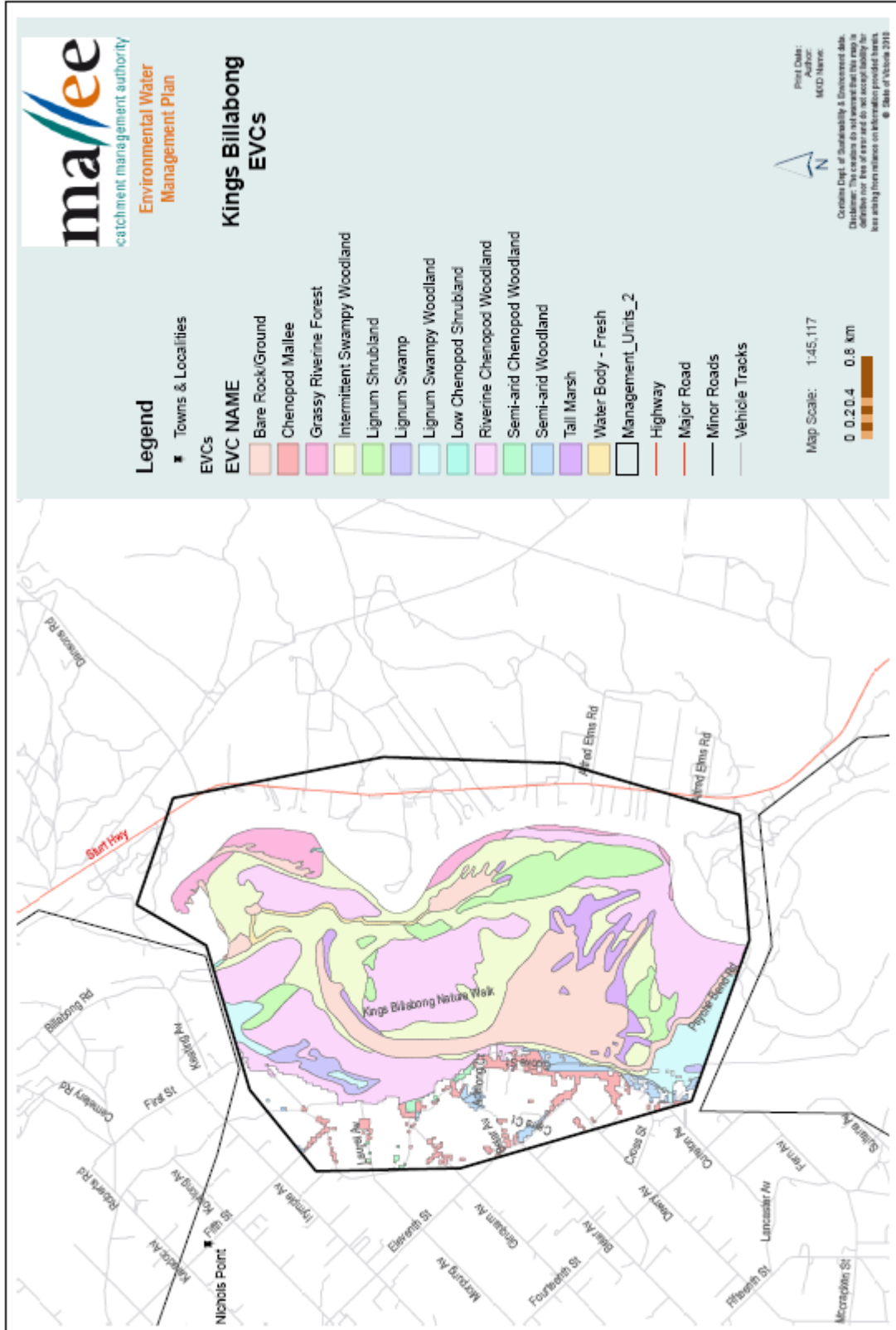
Common Name	Scientific Name	Type	rECORDS
Common Blackbird	Turdus merula	B	8
Common Starling	Sturnus vulgaris	B	19
House Sparrow	Passer domesticus	B	6
Rock Dove	Columba livia	B	8

Legend

Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

APPENDIX 4: ECOLOGICAL VEGETATION CLASSES

EVC mapping and description of each EVC for King's Billabong FMU



EVC no.	EVC name	Bioregional Conservation Status Robinvale Plains Bioregion	Description
158	Chenopod Mallee	Vulnerable	Open to very open mallee woodland to 12 m tall (almost invariably dominated by <i>Eucalyptus gracilis</i>) supported by thin Woorinen deposits typically overlying gypsiferous and sodic clays. Characterised by the dominance of saltbushes and semi succulent understorey shrubs.
106	Grassy Riverine Forest	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are infrequent, on deposited silts and sands, forming fertile alluvial soils. River Red Gum forest to 25 m tall with a groundlayer dominated by tussock-forming graminoids. Occasional tall shrubs present.
813	Intermittent Swampy Woodland	Depleted	Eucalypt woodland to 15 m tall with a variously shrubby and rhizomatous sedgy - turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear of point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow transitional bands). Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.
808	Lignum Shrubland	Least concern	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignumshrubs. Occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.
104	Lignum Swamp	Vulnerable	Typically treeless shrubland to 4 m tall, with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall areas on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.
823	Lignum Swampy Woodland	Depleted	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.
102	Low Chenopod Shrubland	Depleted	Chenopod shrubland to 1.5 m tall occupying broad, flat alluvial terraces occur along the Murray River, west from Mildura to the border. The ground layer is characterized by succulents and a suite of annual herbs.
103	Riverine Chenopod Woodland	Depleted	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey

98	Semi-arid Chenopod Woodland	Vulnerable	<p>occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.</p> <p>Sparse, low non-eucalypt woodland to 12 m tall of the arid zone with a tall open chenopod shrub-dominated understorey or a treeless, tall chenopod shrubland to 3 m tall. This EVC may occur as either a woodland (typically with a very open structure but tree cover >10%) or a shrubland (tree cover <10%) with trees as an occasional emergent. Woodland only components (ignore when assessing shrubland areas and standardise final score as appropriate)</p>
97	Semi-arid Woodland	Vulnerable	<p>Non-eucalypt woodland or open forest to 12 m tall, of low rainfall areas. Occurs in a range of somewhat elevated positions not subject to flooding or inundation. The surface soils are typically light textured loamy sands or sandy loams.</p>
821	Tall Marsh	Depleted	<p>Wetland dominated by tall emergent graminoids (rushes, sedges, reeds), typically in thick species-poor swards. Competitive exclusion in core wetland habitat - of optimum growing conditions for species tolerant of sustained shallow inundation. Occupies wetlands usually associated with anabranch creeks. Soils are almost permanently moist. Dominant species are tolerant of relatively deep and sustained inundation, but not total immersion for any sustained period.</p>

APPENDIX 5: RECENT WATERING HISTORY

The water management in the Kings Billabong FMU is currently focussed on returning a drying phase to the permanently inundated wetlands. There is no entitlement required for full supply level (FSL) in the wetlands. .

Recent water management in the Kings Billabong FMU has been restricted to the Ducksfoot Lagoon section. The regulators were installed in 2010 and the lagoon was disconnected from the Murray River to allow a drying phase. Heavy spring and summer rains prevented completed a complete drying out. The regulators will remain closed to allow the water level to fall again throughout 2011.

This appendix will be updated seasonally

Baggs Bridge regulator installation June 2010



Ducksfoot Lagoon drying in August 2010



APPENDIX 6: INDEX OF WETLAND CONDITION METHOD

Sub-indices

The table below shows what is measured for each of the six sub-indices and how each sub-index is scored. The sections below describe this in greater detail. Further information can be found on the IWC website (www.dse.vic.gov.au/iwc).

IWC sub-indices and measures

Sub-index	What is measured	How it is scored
Wetland catchment	The intensity of the land use within 250 metres of the wetland	The more intensive the land use the lower the score
	The width of the native vegetation surrounding the wetland and whether it is a continuous zone or fragmented	The wider the zone and more continuous the zone, the higher the score
Physical form	Whether the size of the wetland has been reduced from its estimated pre-European settlement size	A reduction in area results in a lowering of the score
	The percentage of the wetland bed which has been excavated or filled	The greater the percentage of wetland bed modified, the lower the score
Hydrology	Whether the wetland's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	The more severe the impacts on the water regime, the lower the score
Water properties	Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the wetland are present	The more activities present, the lower the score
	Whether the wetland has become more saline or in the case of a naturally salty wetland, whether it has become more fresh	An increase in salinity for a fresh wetland lowers the score or a decrease in salinity of a naturally salty wetland lowers the score
Soils	The percentage and severity of wetland soil disturbance from human, feral animals or stock activities	The more soil disturbance and the more severe it is, the lower the score
Biota	The diversity, health and weediness of the native wetland vegetation	The lower the diversity and poorer health of native wetland vegetation, the lower the score
		The increased degree of weediness in the native wetland vegetation, the lower the score

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures as outline above. Weightings are then applied to the scores as tabulated below. The maximum possible total score for a wetland is 38.4. For ease of reporting, all scores are normalised to an integer score out of 10 (i.e. divide the total score by 38.4, multiply by 10 and round to the nearest whole number).

IWC sub-index	Weight
Biota	0.73
Wetland catchment	0.26
Water properties	0.47
Hydrology	0.31
Physical form	0.08
Soils	0.07

Five wetland condition categories have been assigned to the sub-index scores and total IWC scores as tabulated over page. The five category approach is consistent with the number of categories used in other condition indices such as the Index of Stream Condition. Biota sub-index score categories were determined by expert opinion and differ to those of the other sub-indices.

Non-biota sub-index score range	Biota sub-index score range	Total score range	Wetland condition category
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0-4	0-8	0-2	Very poor
5-8	9-13	3-4	Poor
9-12	14-16	5-6	Moderate
13-16	17-18	7-8	Good
16-20	19-20	9-10	Excellent
N/A	N/A	N/A	Insufficient data

APPENDIX 7: WATER BALANCE

The maximum and minimum volumes required to fill the wetland to the targeted supply level (TSL) from empty have been calculated using the following equations:

Maximum fill volume (ML) =

Wetland capacity + Infiltration_F + Evaporation_F + Infiltration_{TSL} + Evaporation_{TSL}

Minimum fill volume (ML) =

Wetland capacity + Infiltration_F + Evaporation_F + Infiltration_{TSL} + Evaporation_{TSL}
– Surfacewater_{F + TSL} – Groundwater_{F + TSL}

Wetland capacity = volume of the wetland at TSL

Infiltration_F = volume required to fill the underlying soil profile during filling, but not including ongoing infiltration after TSL is reached

Evaporation_F = volume evaporated from the wetland during filling, but not including ongoing evaporation after TSL is reached

Infiltration_{TSL} = volume infiltrated into the underlying soil profile during the entire TSL operating phase (often assumed to be zero)

Evaporation_{TSL} = volume evaporated during the entire TSL operating phase

Surfacewater_{F + TSL} = volume of surface run-off and rainfall falling directly onto the wetland during filling and the TSL operating phase

Groundwater_{F + TSL} inflows = volume of groundwater entering the wetland during filling and the TSL operating phase

These equations are used to guide the estimated volumes required for the environmental watering regime (section).