Department of
Sustainability and
Environment

Belsar and Yungera Islands Floodplain Management Unit Environmental Water Management Plan

Mallee Catchment Management Authority

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 Belsar and Yungera Island FMU is 20 km south east of Robinvale and takes in Narcooyia Creek, Bonyaricall Creek, Yungera Creek as well Lakes Powell and Carpul. Key environmental values for the FMU include flora and fauna species listed under state, national and international treaties, conventions, Acts and initiatives such as the Blue-billed Duckl and Spiny-fruit saltbush. The area contains a number of depleted and vulnerable ecological vegetation classes and 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 Belsar and Yungera Island FMU are

- To improve River Red Gum health
- To improve tree recruitment on the floodplain
- To improve understorey productivity
- To improve fish passage in Narcooyia Creek
- To improve nesting habitat in flooded trees lining the creeks and Lakes

To achieve these objectives, a long term watering regime with a minimum expectation of the FMU receiving water every five years but with an optimum goal of receiving some environmental water every year has been developed.

The constraints on the current ability to water the Belsar and Yungera Island FMU and proposed infrastructure to increase the extent of floodplain which could be watered are outlined in the plan.

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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ACKNOWLEDGEMENTS

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 Belsar and Yungera Islands 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 43,000km^2 (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.

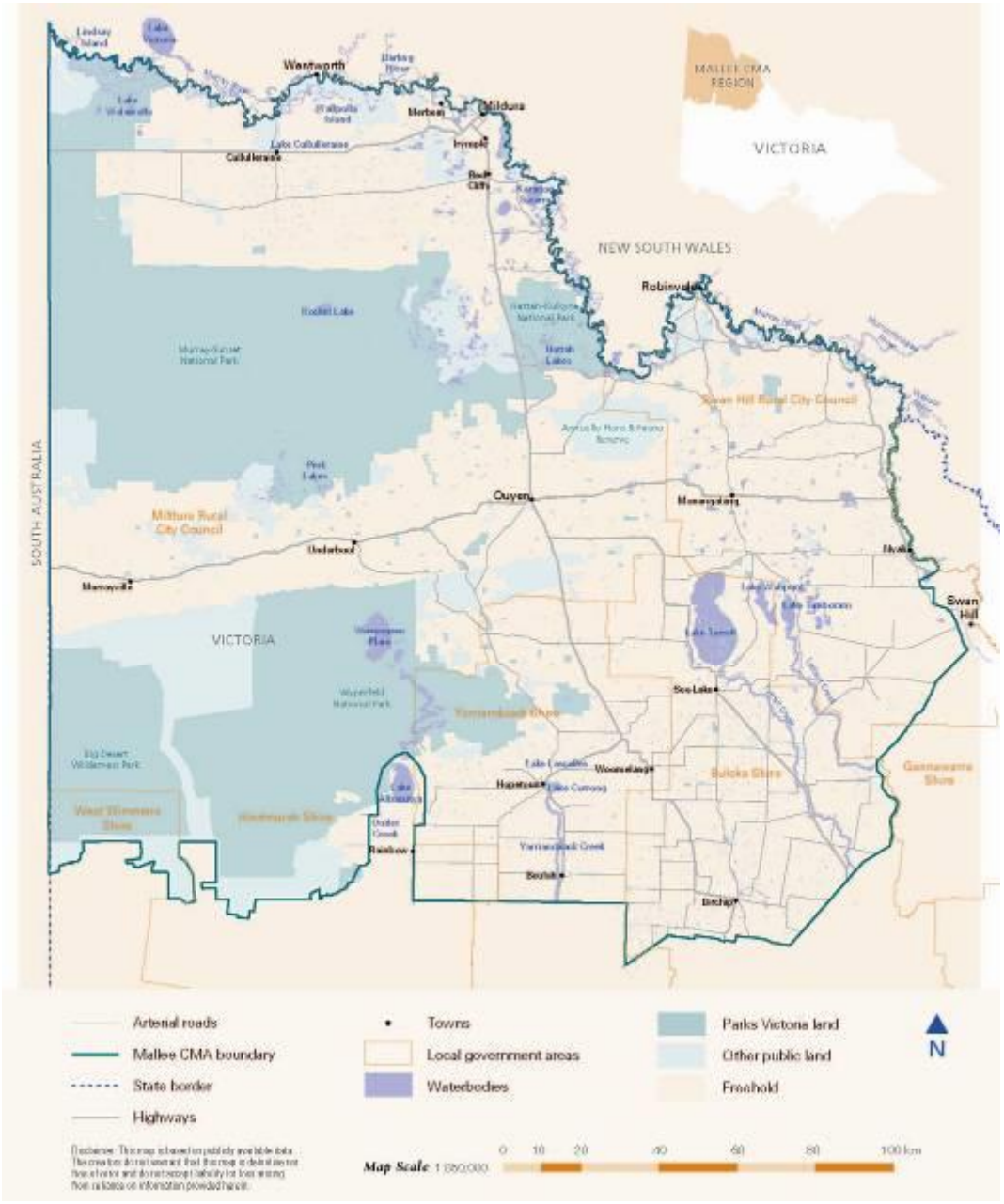
The boundaries of the Mallee CMA region cover almost one fifth of Victoria, making it the largest area managed by a Catchment Management Authority in the state.

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 and local interest groups 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 Belsar and Yungera Islands floodplain management unit.

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

Belsar and Yungera Islands form a complex floodplain management unit (FMU) largely bounded by the Murray River and the Murray Valley Highway. The FMU includes Narcooyia Creek, Bonyaricall Creek, Yungera Creek as well Lakes Powell and Carpul The area is situated approximately 20 km south east of Robinvale. The complex is on the limits of the influence of the Euston weir pool (Lock 15). Bonyaricall Creek and sections of Nargooyia Creek which are permanently inundated by the weir pool are managed with weirs and pumps as irrigation channels for private diverters.

The Belsar and Yungera Islands floodplain management unit is located in the Murray Fans bioregion within the Mallee CMA region. The Murray Fans bioregion is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels, braided old river meanders and palaeo channels and broad floodplain areas associated with major river systems and prior steams (known as braided / anastomosing streams). Alluvium deposits from the Cainozoic period gave rise to the red brown earths and texture contrast soils (Dermosols, Kurosols, Chromosols and Sodosols). (DSE website bioregions description)

Figure 2. Map of Belsar and Yungera Islands Floodplain Management Unit

2.2 Land status and management

The Belsar and Yungera Islands FMU area has historically been managed by the Department of Sustainability and Environment as State Forest but under recommendations from the Victorian Environmental Assessment Council River Red Gum Forests Investigation (VEAC 2008, p 67) the area has been declared a regional park with Parks Victoria as the land manager. This recommendation came into effect in July 2010

The area is a popular for recreation activities such as camping and fishing and has had various uses since indigenous communities first inhabited the area. More recent uses include grazing and forestry.

2.3 Wetland Characteristics

Table 1. Summary of site characteristics

Characteristics	Description
Name	Belsar and Yungera Islands Floodplain management Unit
Mapping ID	Includes wetlands:
Area of FMU and wetlmnds	820 Ha of which 343 Ha is registered wetlands
Bioregion	Murray Fans
Conservation status	Mallee Regional River Health Strategy Priority
Land status	Regional Park
Land manager	Parks Victoria,
Surrounding land use	Broadacre dryland cropping, irrigated horticulture
Water supply	Natural inflows from Murray river under high flow scenario
1788 wetland categories	Shallow freshwater marsh (5), Freshwater Meadow (4), Deep freshwater marsh (8), Permanent Open freshwater (3)
1994 wetland category and sub-category	Lake Powell and Lake Carpul -Shallow Marsh herb-dominated
Wetland capacity (estimation)	Lake Powell 2000ML, Lake Carpul 3000ML
Wetland depth at capacity	Lake Powell 1.6m , Lake Carpul 3m

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

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
Water trading	
Donated Water	Mallee CMA

*Other sources of water may become available through water trading or changes in water entitlements.
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 on ground works such as track upgrading, pest plant and animal control, and improved signage to decrease recreational pressures on the floodplain. A study completed in 2005 entitled “Assessment of Barriers to Fish Passage in the Mallee” (SKM, 2005) found that the Narcooyia Creek had the second highest priority site for removal of barriers to fish passage. The Mallee CMA engaged consultants, GHD in 2010 to carry out a scoping study of the FMU to investigate possible future infrastructure and environmental water management possibilities. A follow up feasibility study (GHD, 2011) outlines the recommendations for future works in the Belsar and Yungera Islands FMU.

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 Belsar and Yungera Islands FMU consists of sections 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 3. Further detail of these acts agreements and conventions can be found in Appendix 2.

3.1.2 Fauna

There are a large number of fauna species recorded at Belsar and Yungera Isalnd FMU. Table 4 lists the significant species recorded and the status of these species under the various agreements and acts. Refer to Appendix 3 for a complete species listing for the site.

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

Common Name	Scientific Name	Type	International agreements	EPBC status	EPBC presence	FFG status	DSE status
Australasian Shoveler	*Anas rhynchotis*	B	N		K		V
Australian Bustard	*Ardeotis australis*	B	N		K	L	CR
Blue-billed Duck	*Oxyura australis*	B	N		K	L	E
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*	B	N		K		NT
Carpet Python	*Morelia spilota metcalfei*	R	N		K	L	E
Eastern Great Egret	*Ardea modesta*	B	N		K	L	V
Freckled Duck	*Stictonetta naevosa*	B	N		K	L	E
Grey-crowned Babbler	*Pomatostomus temporalis*	B	N		K	L	E
Hardhead	*Aythya australis*	B	N		K		V
Intermediate Egret	*Ardea intermedia*	B	N		K	L	CR
Lace Goanna	*Varanus varius*	R	N		K		V
Musk Duck	*Biziura lobata*	B	N		K		V
Nankeen Night Heron	*Nycticorax caledonicus*	B	N		K		NT
Pied Cormorant	*Phalacrocorax varius*	B	N		K		NT
Regent Parrot	*Polytelis anthopeplus*	B	N	V	K	L	V
Royal Spoonbill	*Platalea regia*	B	N		K		V
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	N		K	L	V

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal
International: Camba, Jamba, Rokamba, Bonn, Not Listed
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

3.1.3 Flora

Vegetation communities

The Belsar and Yungera FMU supports a large range of EVCs. Of the nineteen EVCs supported by the floodplain complex, five are regionally depleted, and a further ten are vulnerable. There is considerable variation in the extent and distribution of individual EVCs. Lignum Swampy Woodland (# 823), Lignum Shrubland (# 808), and Riverine Chenopod Woodland (#103) occur across much of the study area, while other EVCs are more restricted in their distribution. (Cook et al 2009)

For further detail see Appendix 4.

Table 5. Ecological vegetation classes recorded at the site

EVC No	EVC name	Bioregional Conservation Status
		Murray Fans Bioregion
158	Chenopod Mallee	Vulnerable
810	Floodway Pond Herbland	Depleted
106	Grassy Riverine Forest	Depleted
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted
813	Intermittent Swampy Woodland	Depleted
107	Lake Bed Herbland	Vulnerable
808	Lignum Shrubland	Vulnerable
104	Lignum Swamp	Vulnerable
823	Lignum Swampy Woodland	Vulnerable
91	Loamy Sands Mallee	Least concern
103	Riverine Chenopod Woodland	Endangered
295	Riverine Grassy Woodland	Vulnerable
98	Semi-arid Chenopod Woodland	Endangered
97	Semi-arid Woodland	Vulnerable
200	Shallow Freshwater Marsh	Vulnerable
818	Shrubby Riverine Woodland	Least concern
819	Spike-sedge Wetland	Vulnerable
824	Woorinen Mallee	Vulnerable
86	Woorinen Sands Mallee	Depleted

Flora species

The significant flora species listed in the various acts and agreements which have been recorded in the Belsar and Yungera Islands 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 and ecological communities recorded at the site

Common Name	Scientific Name	EPBC status	EPBC presence	FFG status	DSE status
Wait-a-while	Acacia colletioides	NL	K		R
Nealie	Acacia loderi	NL	K		V
Yarran	Acacia melvillei	NL	K		V
Umbrella Wattle	Acacia oswaldii	NL	K		V
Common Joyweed	Alternanthera nodiflora	NL	K		PK
Plains Joyweed	Alternanthera sp. 1 (Plains)	NL	K		PK
Twin-leaf Bedstraw	Asperula gemella	NL	K		R
Pointed Saltbush	Atriplex acutibractea subsp. karoniensis	NL	K		R
Coral Saltbush	Atriplex papillata	NL	K		R
Mealy Saltbush	Atriplex pseudocampanulata	NL	K		R
Silver Saltbush	Atriplex rhagodioides	NL	K	L	V
Spiny-fruit Saltbush	Atriplex spinibractea	NL	K		EN
Bladder Saltbush	Atriplex vesicaria subsp. macrocystidia	NL	K		PK

Spear-grass	Austrostipa trichophylla	NL	K		R
Riverina Bitter-cress	Cardamine moirensis	NL	K		R
Compact Sneezeweed	Centipeda crateriformis subsp. compacta	NL	K		R
Cotton Sneezeweed	Centipeda nidiformis	NL	K		R
Desert Sneezeweed	Centipeda thespidioides s.l.	NL	K		R
Frosted Goosefoot	Chenopodium desertorum subsp. desertorum	NL	K		R
Hoary Scurf-pea	Cullen cinereum	NL	K	L	EN
Grey Scurf-pea	Cullen discolor	NL	K	L	EN
Woolly Scurf-pea	Cullen pallidum	NL	K	L	EN
Native Couch	Cynodon dactylon var. pulchellus	NL	K		PK
Annual Flat-sedge	Cyperus nervulosus	NL	K	L	EN
Curly Flat-sedge	Cyperus rigidellus	NL	K	L	EN
Silky Umbrella-grass	Digitaria ammophila	NL	K		V
Pale Spike-sedge	Eleocharis pallens	NL	K		PK
Purple Love-grass	Eragrostis lacunaria	NL	K		V
Bristly Love-grass	Eragrostis setifolia	NL	K		V
Spreading Emu-bush	Eremophila divaricata subsp. divaricata	NL	K		R
Spotted Emu-bush	Eremophila maculata var. maculata	NL	K		R
Bristly Sea-heath	Frankenia serpyllifolia	NL	K		R
Bluish Raspwort	Haloragis glauca f. glauca	NL	K		PK
Inland Club-sedge	Isolepis australiensis	NL	K		PK
Slender Club-sedge	Isolepis congrua	NL	K	L	V
Desert Jasmine	Jasminum didymum subsp. lineare	NL	K		V
Warty Peppercress	Lepidium papillosum	NL	K		PK
Native Peppercress	Lepidium pseudohyssopifolium	NL	K		PK
Austral Trefoil	Lotus australis var. australis	NL	K		PK
Goat Head	Malacocera tricornis	NL	K		R
Spiny Lignum	Muehlenbeckia horrida subsp. horrida	NL	K		R
Shiny Daisy-bush	Olearia passerinoides	NL	K		R
Upright Adder's-tongue	Ophioglossum polyphyllum	NL	K		V
Long Tails	Ptilotus polystachyus var. polystachyus	NL	K		EN
Crimson Tails	Ptilotus sessilifolius var. sessilifolius	NL	K		PK
Purple Pentatrope	Rhyncharrhena linearis	NL	K		V
Dwarf Bitter-cress	Rorippa eustylis	NL	K		R
Sarcozona	Sarcozona praecox	NL	K		R
Black Roly-poly	Sclerolaena muricata var. muricata	NL	K		PK
Spear-fruit Copperburr	Sclerolaena patenticuspis	NL	K		V
Pin Sida	Sida fibulifera	NL	K		V
Twiggy Sida	Sida intricata	NL	K		V
Yakka Grass	Sporobolus caroli	NL	K		R
Silky Swainson-pea	Swainsona sericea	NL	K	L	V
Desert Spinach	Tetragonia eremaea s.s.	NL	K		PK
Annual Spinach	Tetragonia moorei	NL	K		PK
Scurfy Germander	Teucrium albicaule	NL	K		PK
Sweet Fenugreek	Trigonella suavissima	NL	K		R
Needle Grass	Triraphis mollis	NL	K		R
Sticky New Holland Daisy	Vittadinia australasica var. oricola	NL	K		PK
Club-hair New Holland Daisy	Vittadinia condyloides	NL	K		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 emerged when agricultural development began in the area. These pose a potential threat when water is applied. A list of exotic flora species identified in the Belsar and Yungera Islands FMU are listed in Appendix 3.

3.1.4 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 Corrick[1] 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 Belsar and Yungera Islands FMU contains twenty registered wetlands. These wetlands have been classified using the Corrick-Norman wetland classification system as deep freshwater marsh, freshwater meadow, permanent open water or shallow freshwater marsh. All four types of wetlands have decreased in area in Victoria and all but permanent open freshwater have decreased in the Mallee CMA region since 1788 with freshwater meadow, deep freshwater marsh and shallow freshwater marsh being the top three most depleted categories respectively in the Mallee CMA region (Mallee Wetland Strategy p12). The wetlands occupy an area of approximately 343 Ha within the FMU which has a total area of 820 Ha. Some of the wetlands are ephemeral and have not experienced regular wetting due to river regulation and recent dry climactic conditions while others are permanently inundated due to the influence of the Euston weir pool

[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		
			% decrease in area in Victoria	% decrease in area In Mallee CMA	% Depletion in Murray Fans Bioregion
Deep freshwater marsh	8	121.47	70	45	6
Shallow freshwater marsh	5	176.98	60	6	10
Freshwater meadow	4	22.8	43	80	63
Permanent open freshwater	3	23.31	6	+5	0

Source: DSE Biodiversity interactive maps, Mallee Wetland Strategy

3.1.5 Ecosystem functions

The Belsar and Yungera Islands floodplain management unit 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

The floodplain of the Murray River has significant cultural heritage values for the local indigenous communities. It is well recognised as a traditional meeting place providing water, food and materials for medicines, shelter, clothing and tools. The area contains numerous scarred trees, middens, mounds, burial sites, surface scatters and other artefacts.

There is also significant early European settlement history evident across the Islands such as the remains of the Yungera Homestead.

3.2.3 Recreation

The region is popular for camping, fishing, boating, four wheel driving, trail bike riding, horse riding and walking. The Mallee CMA carried out works in 2005 to help rationalise tracks, define boundaries and better manage recreational use of the area. Large amounts of rubbish including car bodies were removed during these works.

3.3 Economic

The Belsar and Yungera Island area is a popular camping area which attracts visitors from within and outside the district who inject money into the local economy by purchasing supplies during their stay. The surrounding agricultural land is a major economic resource for the region.

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

4.1.1 Pre-regulation

The Belsar and Yungera Islands FMU is located on the Victorian floodplain of the Murray River. Prior to river regulation the floodplain experienced inundation during high flow periods on more frequent basis. This inundation allowed for recruitment and preservation of the floodplain species.

4.1.2 Post-regulation

A reduction in the frequency and duration of flooding due to river regulation and recent prolonged dry climactic conditions is causing the decline of vegetation on the floodplain.

Flow events with a threshold of 8 000ML/day and ranging up to 140 000ML/day are required to trigger commence to flow for some wetlands and higher elevation channel/flood runner areas on Belsar and Yungera Islands. These have reduced in frequency since river regulation

A review of groundwater hazards conditions found that through most of the study area (Nyah to Robinvale) groundwater levels lie below the river level and well below the floodplain surface. There is little risk of groundwater interactions under these circumstances. However, Euston weir has significant effects on the water table upstream as far as Yungera Island. The weir raises the water table so that shallow and possibly saline groundwater underlies the floodplain. Groundwater data is limited and further investigations are required to clarify this issue. (EA 2006, p 8-1)

By raising the river level, the Euston weir pool has raised the water table below low floodplain terraces, promoting the growth of Red Gum forest and woodland communities along the river bank. However elevated groundwater levels represent a threat to floodplain health at sites set back from the river bank where groundwater salinities are high. A groundwater salinity of value of 15,000 to 25,000 EC has been
reported in the central part of Belsar Island (see Ecological Associates Progress Report 2). Values of between 50,000 and 90,000 EC have been reported near Lake Powell. By raising the elevation of saline groundwater, the weir pool may expose plant roots to saline groundwater and may increase the potential for the evaporative concentration of salt in the soil profile. Temporary lowering of the Euston Weir pool
may have some benefits by promoting the discharge of saline groundwater from the floodplain (EA 2006, p 5-28)

5 CONDITION AND THREATS

5.1 Water dependent threats

Threats described in the AVIRA database which may have an impact on the Belsar and Yungera Islands 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 five of the twenty wetlands within the Belsar and Yungera Islands FMU were assessed in November 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 both wetlands assessed in this FMU in December 2009 was 6 out of 10, which is considered to be moderate (Table 8a&b). The hydrology and biota sub-indices were considered to be in very poor and poor condition respectively. Hydrology was considered to be very poor 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 for wetlands assessed in the Belsar and Yungera Islands FMU

IWC sub-index	Lake Powell		Lake Carpul		Wetland # 737612		Wetland # 745628		Wetland # 775589	
	Score /20	Category	Score /20	Category	Score /20	Category	Score /20	Category	Score /20	Category
Wetland catchment	18	Excellent	18	Excellent	20	Excellent	20	Excellent	20	Excellent
Physical form	12	Moderate	20	Excellent	20	Excellent	20	Excellent	20	Excellent
Hydrology	0	Very poor	0	Very poor	0	Very poor	0	Very poor	0	Very poor
Water properties	20	Excellent	20	Excellent	17	Excellent	17	Excellent	17	Excellent
Soils	2.9	Very poor	19.95	Excellent	19.75	Excellent	19.75	Excellent	19.75	Excellent
Biota	8.91	Poor	16.51	Good	12	Poor	12.4	Poor	12.4	Poor
Overall IWC score	**6 / 10**	**Moderate**	**8 / 10**	**Good**	**7 / 10**	**Moderate**	**7 / 10**	**Good**	**7 / 10**	**Good**

5.3 Condition trajectory

Investigation is underway in the Belsar and Yungera Islands FMU with consultants engaged by the Mallee CMA to assess and propose infrastructure recommendations to enable environmental water to be delivered and managed on the Islands.

Intervention is seen as necessary for the protection of values and to improve the condition of the FMU. If there is no intervention it is anticipated the floodplain will continue to decline in health as result of the reduced frequency of flood events due to river regulation, permanent inundation from the Euston weir pool and changed climactic conditions.

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 .

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	• Priority sites have avoided irreversible losses and have capacity for recovery	• Priority river reaches and wetlands have maintained their basic functions	• The ecological health of priority river reaches and wetlands has been maintained or improved	• The health and resilience of priority river reaches and wetlands has been improved
Annual management objectives	• Avoid critical loss • Maintain key refuges • Avoid catastrophic events	• Maintain river functioning with reduced reproductive capacity • Maintain key functions of high priority wetlands • Manage within dry-spell tolerances	• Improve ecological health and resilience	• Maximise recruitment opportunities for key river and wetland species • Minimise impacts of flooding on human communities • Restore key floodplain linkages
Environmental water reserve	• 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	• 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	• 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	• 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	• 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	• 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	• 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	• 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 Belsar and Yungera Islands floodplain management unit is derived from a variety of sources, including historic management goals, local expertise and knowledge, and current climate predictions. The goal has been developed by various experts and stakeholders. 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.

Belsar and Yungera Islands floodplain management unit management goal
To provide a watering regime that supports a mosaic of floodplain plant communities including River Red gum, Lignum/Black Box and wetland communities, which provide key habitat for a diverse range of flora and 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 various experts and stakeholders.

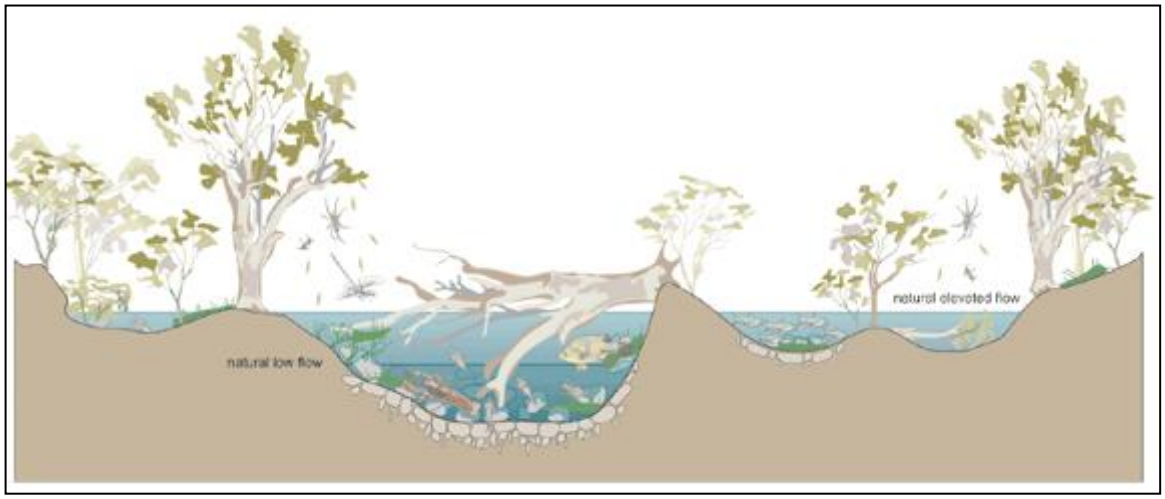
Table 10. Ecological objectives for the site

Ecological objective	Justification (value based)
Improve River Red Gum health	Healthy River Red Gum community is central to overall health and integrity of the EVCs within the FMU
Improve tree recruitment on floodplain	Allow for preservation of critical species within the FMU
Increase understorey productivity	Provide opportunity for species including: *Carex tereticaulis* (Rush sedge), *Phragmites australis* (Phragmites), *Cyperus gymnocaulos* (spiny flat sedge), *Eleocharis acuta* (common spike rush), *Paspalidium jubiflorum* (Worrego grass)
Improve fish passage in Narcooyia Creek	Provide opportunity to improve the complexity of habitat and passage for native fish populations.
Improve nesting habitat in flooded trees bordering creeks and Lakes	Provide opportunity for listed species which have been recorded in the FMU such as Blue-billed Duck (*Oxyura australis),* Eastern Great Egret (*Ardea modesta),* Freckled Duck (*Stictonetta naevosa),* Hardhead (*Aythya australis),* Intermediate Egret (*Ardea intermedia)*

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 3.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 and 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 including Parks Victoria, the Wadi Wadi people, Mallee River and Wetland Technical Advisory Committee and Dr Marcus Cooling, Ecological Associates.

Table 11. Hydrological objectives for Belsar and Yungera Islands Floodplain Management Unit

Ecological objective	Water management area	Hydrological objectives												
		Mean frequency of events (number per 10 years)			Tolerable interval between events (years)		Median duration of ponding (months)			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)
		Min	Opt	Max	Min	Max	Min	Opt	Max					
Improve River Red Gum health	Floodplain	2	10	10	0	5	3	5	5	Winter/spring	Various across floodplain And wetlands	18000	2000	20000
Promote tree recruitment on floodplain	Floodplain													
Increase understorey productivity	Floodplain													
Improve fish passage in Narcooyia Creek	Creeks													
Improve nesting habitat in flooded trees bordering creeks and Lakes	Floodplain													

[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
Inundate floodplain and fill Lake Powell once every five years. This will provide an open water assemblage. Depending on the volume of evaporation, seepage and natural inflows, provide smaller top-up volumes in the following year to maintain inundation of the creeklines.

Optimal watering regime
Inundate floodplain and fill Lakes Powell and Carpul to capacity every second year and ensure inundation period of River Red Gum areas does not exceed five months. Depending on the volume of evaporation, seepage and natural inflows, provide smaller top-up volumes in the following year to maintain inundation of the open water assemblage.

Maximum watering regime
Maintain floodplain and Lakes Powell and Carpul at capacity for five consecutive months to promote River Red Gum areas. Where possible, encourage a drying regime in summer. Allow wetland to fill with natural inflows where possible.

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. Identifying potential risks of environmental watering, and mitigation strategies

#	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*	**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	Flooding of adjacent land	
1	Required watering regime not met	Flood duration too long or short	✓	✓	✓		✓	✓			Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events Monitor flood duration to inform environmental water delivery Monitor the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Flood timing too late or early	✓	✓	✓		✓	✓			Liaise with Goulburn-Murray Water to seek optimum timing of water delivery Monitor flood timing to inform environmental water delivery Monitor the ecological response of the wetland to flooding
		Flooding depth too shallow or deep	✓	✓			✓	✓	✓	✓	Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events Monitor flood depth to inform environmental water delivery Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues Add or drawdown water where appropriate or practical
		Flood frequency too long or short	✓	✓	✓	✓	✓	✓			Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history Monitor the condition of the wetland Monitor the ecological response of the wetland to flooding

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

8 ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 Constraints

A causeway on the creek which leads to Lakes Powell and Carpul is a significant blockage to water reaching the Lakes. Blockages on Narcooyia Creek in place for irrigation water control restrict the flow of water across the floodplain of the Islands. Figure 4 shows the extent of watering possible under current conditions.

Figure 4: Current watering extent possible on Belsar and Yungera Islands

8.2 Irrigation modernisation

There are significant irrigation developments surrounding the Belsar and Yungera Islands FMU. There is the possibility that there will be further development and modernisation in these areas which will increase the demand for water supply. These developments may provide an opportunity to work with the irrigators to share infrastructure and resources to ensure environmental water considerations as well as production needs are met.

8.3 Infrastructure recommendations

Feasibility studies (GHD, 2011) recommend a tiered watering system be implemented on Belsar and Yungera Island FMU.

Two regulators would be placed along the creek systems, in a tiered watering system. The regulators would be:

- At the most downstream on Belsar Island along Bonyaricall Creek, and would be operated to provide control over a maximum inundation level of 51.8 m AHD; and
- At the middle to upstream end of Belsar Island along Narcooyia Creek, and would be operated to provide control over a maximum inundation level of 52.8 m AHD.

Figure 5 below shows the extent of containable inundation which would be experienced and the support structures required.

Figure 5: Inundation extent achievable with infrastructure in place.

The impacts of this tiered system are to target more substantially the floodplain flow along Yungera Island, both to the north and to the south of Narcooyia Creek.

With an additional environmental regulator placed at the downstream end of the system, the following watering objectives would be achieved:

- Watering of Lake Powell (and potentially Lake Carpul);
- Flow through most of Narcooyia Creek, with the ability to vary water levels within the creek along
- Belsar Island and much of Yungera Island also, providing potentially improved flow conditions and
- fish habitat;
- Floodplain (extending beyond the overbank) flow along much of Belsar Island;
- Flow in Lake Carphole, through a separate and independent regulator system.
- Floodplain (extending beyond the overbank) flow along much of Yungera Island and into some natural wetlands.

The tiered watering system would impact 2,070 ha of land in and around the main creek systems, and would require 18.3 GL (18,306,750 m3) of water (excluding evaporation, seepage and fishway losses), assuming a system operated to full capacity and a flat hydraulic gradient (“level” water) behind the key environmental regulators and throughout the creek systems feeding the regulators, once full.

9 KNOWLEDGE GAPS AND RECOMMENDATIONS

Table 13: Key knowledge and data gaps and recommend actions needed to address these, with some level or priority assigned, plus who is responsible for implementation.

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 wetlands	Install depth gauges and bathymetric survey	5	
Influence of Euston weir pool and possibility of raising weir.	Engage consultants to carry out investigations	6	
Nesting habits of birds	Data collection and monitoring	7	
Bat population in the area	Data collection and monitoring	8	
Impacts of climate variability	Data collection and monitoring	9	

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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 VEHW 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 orgnaisations 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 Straight 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
Grey Mulga	*Acacia brachybotrya*	2
Wait-a-while	*Acacia colletioides*	2
Small Cooba	*Acacia ligulata*	2
Nealie	*Acacia loderi*	1
Yarran	*Acacia melvillei*	8
Umbrella Wattle	*Acacia oswaldii*	8
Nealie	*Acacia rigens*	3
Eumong	*Acacia stenophylla*	11
Dwarf Nealie	*Acacia wilhelmiana*	5
Flannel Cudweed	*Actinobole uliginosum*	23
Mallee Bitter-bush	*Adriana urticoides var. hookeri*	1
Austral Bugle	*Ajuga australis*	5
Cattle Bush	*Alectryon oleifolius subsp. canescens*	3
Lesser Joyweed	*Alternanthera denticulata s.l.*	4
Lesser Joyweed	*Alternanthera denticulata s.s.*	10
Common Joyweed	*Alternanthera nodiflora*	1
Plains Joyweed	*Alternanthera sp. 1 (Plains)*	1
Joyweed	*Alternanthera spp.*	2
Common Swamp Wallaby-grass	*Amphibromus nervosus*	1
Long Grey-beard Grass	*Amphipogon caricinus var. caricinus*	1
Box Mistletoe	*Amyema miquelii*	4
Fleshy Mistletoe	*Amyema miraculosa subsp. boormanii*	2
Wire-leaf Mistletoe	*Amyema preissii*	3
Mistletoe	*Amyema spp.*	1
Sand Wire-grass	*Aristida contorta*	1
Twin-leaf Bedstraw	*Asperula gemella*	6
Pointed Saltbush	*Atriplex acutibractea subsp. karoniensis*	1
Small Saltbush	*Atriplex eardleyae*	5
Slender-fruit Saltbush	*Atriplex leptocarpa*	44
Flat-top Saltbush	*Atriplex lindleyi*	2
Corky Saltbush	*Atriplex lindleyi subsp. inflata*	3
Coral Saltbush	*Atriplex papillata*	14
Mealy Saltbush	*Atriplex pseudocampanulata*	5
Mat Saltbush	*Atriplex pumilio*	10
Silver Saltbush	*Atriplex rhagodioides*	1
Berry Saltbush	*Atriplex semibaccata*	15
Spiny-fruit Saltbush	*Atriplex spinibractea*	1
Saltbush	*Atriplex spp.*	3
Kidney Saltbush	*Atriplex stipitata*	3
Sprawling Saltbush	*Atriplex suberecta*	6
Bladder Saltbush	*Atriplex vesicaria subsp. macrocystidia*	1
Common Wallaby-grass	*Austrodanthonia caespitosa*	21
Bristly Wallaby-grass	*Austrodanthonia setacea*	13
Wallaby Grass	*Austrodanthonia spp.*	4
Feather Spear-grass	*Austrostipa elegantissima*	1
Desert Spear-grass	*Austrostipa eremophila*	2
Supple Spear-grass	*Austrostipa mollis*	1
Balcarra Spear-Grass	*Austrostipa nitida*	6

Rough Spear-grass	*Austrostipa scabra*	4
Rough Spear-grass	*Austrostipa scabra subsp. falcata*	28
Spear Grass	*Austrostipa spp.*	20
Spear-grass	*Austrostipa trichophylla*	3
Dark Turpentine-bush	*Beyeria opaca*	1
Tah-vine	*Boerhavia dominii*	3
Woodland Swamp-daisy	*Brachyscome basaltica var. gracilis*	4
Variable Daisy	*Brachyscome ciliaris*	7
Hard-head Daisy	*Brachyscome lineariloba*	44
Daisy	*Brachyscome spp.*	2
Leek Lily	*Bulbine semibarbata*	47
Pink Purslane	*Calandrinia calyptrata*	2
Small Purslane	*Calandrinia eremaea*	64
Matted Water-starwort	*Callitriche sonderi*	1
Slender Cypress-pine	*Callitris gracilis subsp. murrayensis*	4
Scrub Cypress-pine	*Callitris verrucosa*	6
Pale Beauty-heads	*Calocephalus sonderi*	13
Tangled Burr-daisy	*Calotis erinacea*	5
Hairy Burr-daisy	*Calotis hispidula*	36
Riverina Bitter-cress	*Cardamine moirensis*	1
Inland Pigface	*Carpobrotus modestus*	1
Belah	*Casuarina pauper*	2
Spiked Centaury	*Centaurium spicatum*	3
Compact Sneezeweed	*Centipeda crateriformis subsp. compacta*	2
Common Sneezeweed	*Centipeda cunninghamii*	15
Spreading Sneezeweed	*Centipeda minima s.l.*	3
Spreading Sneezeweed	*Centipeda minima subsp. minima s.s.*	3
Cotton Sneezeweed	*Centipeda nidiformis*	1
Desert Sneezeweed	*Centipeda thespidioides s.l.*	1
Flat Spurge	*Chamaesyce drummondii*	14
Crested Goosefoot	*Chenopodium cristatum*	2
Cottony Saltbush	*Chenopodium curvispicatum*	2
Frosted Goosefoot	*Chenopodium desertorum*	3
Frosted Goosefoot	*Chenopodium desertorum subsp. desertorum*	2
Nitre Goosefoot	*Chenopodium nitrariaceum*	18
Clammy Goosefoot	*Chenopodium pumilio*	2
Goosefoot	*Chenopodium spp.*	2
Windmill Grass	*Chloris truncata*	1
Common Everlasting	*Chrysocephalum apiculatum s.l.*	1
Groundheads	*Chthonocephalus pseudevax*	2
Small-leaved Clematis	*Clematis microphylla s.l.*	3
Bell-fruit Tree	*Codonocarpus cotinifolius*	2
Pink Bindweed	*Convolvulus erubescens spp. agg.*	3
Grass Bindweed	*Convolvulus remotus*	3
Bindweed	*Convolvulus spp.*	1
Dense Crassula	*Crassula colorata*	87
Sieber Crassula	*Crassula sieberiana s.l.*	71
Rosinweed	*Cressa australis*	2
Hoary Scurf-pea	*Cullen cinereum*	1
Grey Scurf-pea	*Cullen discolor*	1
Woolly Scurf-pea	*Cullen pallidum*	2
Couch	*Cynodon dactylon*	6
Native Couch	*Cynodon dactylon var. pulchellus*	4

Variable Flat-sedge	*Cyperus difformis*	2
Spiny Flat-sedge	*Cyperus gymnocaulos*	2
Annual Flat-sedge	*Cyperus nervulosus*	1
Curly Flat-sedge	*Cyperus rigidellus*	1
Star Fruit	*Damasonium minus*	1
Australian Carrot	*Daucus glochidiatus*	5
Mallee Bitter-pea	*Daviesia arenaria*	1
Pale Flax-lily	*Dianella longifolia s.l.*	1
Black-anther Flax-lily	*Dianella revoluta s.l.*	4
Silky Umbrella-grass	*Digitaria ammophila*	1
Rounded Noon-flower	*Disphyma crassifolium subsp. clavellatum*	1
Hard-head Saltbush	*Dissocarpus paradoxus*	3
Australian Salt-grass	*Distichlis distichophylla*	1
Slender Hop-bush	*Dodonaea viscosa subsp. angustissima*	13
Wedge-leaf Hop-bush	*Dodonaea viscosa subsp. cuneata*	1
Globular Pigweed	*Dysphania glomulifera ssp. glomulifera*	3
Yellow Twin-heads	*Eclipta platyglossa*	6
Nodding Saltbush	*Einadia nutans subsp. nutans*	100
Einadia	*Einadia spp.*	1
Waterwort	*Elatine gratioloides*	1
Common Spike-sedge	*Eleocharis acuta*	7
Pale Spike-sedge	*Eleocharis pallens*	1
Small Spike-sedge	*Eleocharis pusilla*	3
Spike Sedge	*Eleocharis spp.*	4
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*	76
Common Bottle-washers	*Enneapogon avenaceus*	4
Spider Grass	*Enteropogon acicularis*	42
Mallee Love-grass	*Eragrostis dielsii*	47
Purple Love-grass	*Eragrostis lacunaria*	18
Weeping Love-grass	*Eragrostis parviflora*	2
Bristly Love-grass	*Eragrostis setifolia*	50
Love Grass	*Eragrostis spp.*	2
Spreading Emu-bush	*Eremophila divaricata subsp. divaricata*	18
Berrigan	*Eremophila longifolia*	2
Spotted Emu-bush	*Eremophila maculata var. maculata*	1
Woolly-fruit Bluebush	*Eriochiton sclerolaenoides*	1
Blue Heron's-bill	*Erodium crinitum*	13
River Red-gum	*Eucalyptus camaldulensis*	19
Yellow Mallee	*Eucalyptus costata subsp. murrayana*	3
Dumosa Mallee	*Eucalyptus dumosa*	6
Yorrell	*Eucalyptus gracilis*	2
Black Box	*Eucalyptus largiflorens*	36
Slender-leaf Mallee	*Eucalyptus leptophylla*	6
Grey Mallee	*Eucalyptus socialis subsp. socialis*	6
Annual Cudweed	*Euchiton sphaericus*	10
Common Eutaxia	*Eutaxia microphylla*	1
Leafless Ballart	*Exocarpos aphyllus*	5
Bristly Sea-heath	*Frankenia serpyllifolia*	12
Sea Heath	*Frankenia spp.*	3
Desert Saw-sedge	*Gahnia lanigera*	1
Hairy Carpet-weed	*Glinus lotoides*	2
Slender Carpet-weed	*Glinus oppositifolius*	1
Small Mud-mat	*Glossostigma elatinoides*	1
Southern Liquorice	*Glycyrrhiza acanthocarpa*	45

Silky Goodenia	*Goodenia fascicularis*	5
Pale Goodenia	*Goodenia glauca*	6
Cut-leaf Goodenia	*Goodenia pinnatifida*	1
Small-flower Goodenia	*Goodenia pusilliflora*	4
Sticky Goodenia	*Goodenia varia*	1
Sandhill Goodenia	*Goodenia willisiana*	2
Comb Grevillea	*Grevillea huegelii*	3
Silver Needlewood	*Hakea leucoptera subsp. leucoptera*	2
Hooked Needlewood	*Hakea tephrosperma*	2
Rough Halgania	*Halgania cyanea*	4
Rough Raspwort	*Haloragis aspera*	2
Bluish Raspwort	*Haloragis glauca f. glauca*	1
Toothed Raspwort	*Haloragis odontocarpa*	1
Satin Everlasting	*Helichrysum leucopsideum*	2
Smooth Heliotrope	*Heliotropium curassavicum*	2
Common Heliotrope	*Heliotropium europaeum*	2
Grass Cushion	*Isoetopsis graminifolia*	4
Inland Club-sedge	*Isolepis australiensis*	1
Slender Club-sedge	*Isolepis congrua*	4
Desert Jasmine	*Jasminum didymum subsp. lineare*	2
Tussock Rush	*Juncus aridicola*	1
Finger Rush	*Juncus subsecundus*	3
Common Blown-grass	*Lachnagrostis filiformis*	17
Common Blown-grass	*Lachnagrostis filiformis var. 1*	3
Warty Peppercress	*Lepidium papillosum*	1
Native Peppercress	*Lepidium pseudohyssopifolium*	10
Austral Mudwort	*Limosella australis*	2
Woolly Mat-rush	*Lomandra leucocephala subsp. robusta*	4
Austral Trefoil	*Lotus australis var. australis*	1
Australian Box-thorn	*Lycium australe*	1
Harlequin Mistletoe	*Lysiana exocarpi*	3
Small Loosestrife	*Lythrum hyssopifolia*	1
Short-leaf Bluebush	*Maireana brevifolia*	19
Black Cotton-bush	*Maireana decalvans*	17
Rosy Bluebush	*Maireana erioclada*	1
Hairy Bluebush	*Maireana pentagona*	10
Erect Bluebush	*Maireana pentatropis*	1
Sago Bush	*Maireana pyramidata*	2
Bluebush	*Maireana spp.*	1
Hairy-wing Bluebush	*Maireana trichoptera*	1
Satiny Bluebush	*Maireana turbinata*	2
Goat Head	*Malacocera tricornis*	5
Australian Hollyhock	*Malva preissiana s.l.*	5
Narrow-leaf Nardoo	*Marsilea costulifera*	3
Common Nardoo	*Marsilea drummondii*	7
Nardoo	*Marsilea spp.*	1
Common Bow-flower	*Millotia muelleri*	2
Blue Rod	*Morgania glabra spp. agg.*	3
Twiggy Lignum	*Muehlenbeckia diclina*	1
Tangled Lignum	*Muehlenbeckia florulenta*	48
Spiny Lignum	*Muehlenbeckia horrida subsp. horrida*	56
Creeping Mistletoe	*Muellerina eucalyptoides*	1
Sugarwood	*Myoporum platycarpum*	1
Sugarwood	*Myoporum platycarpum subsp. perbellum*	2

Red Water-milfoil	*Myriophyllum verrucosum*	6
Velvet Tobacco	*Nicotiana velutina*	1
Nitre-bush	*Nitraria billardierei*	4
Club-moss Daisy-bush	*Olearia lepidophylla*	1
Shiny Daisy-bush	*Olearia passerinoides*	1
Pimelea Daisy-bush	*Olearia pimeleoides*	5
Upright Adder's-tongue	*Ophioglossum polyphyllum*	1
Babbagia	*Osteocarpum acropterum var. deminutum*	33
Bonefruit	*Osteocarpum salsuginosum*	2
Grassland Wood-sorrel	*Oxalis perennans*	21
Wood Sorrel	*Oxalis spp.*	3
Sand Cress	*Pachymitus cardaminoides*	1
Hairy Panic	*Panicum effusum*	1
Knottybutt Grass	*Paspalidium constrictum*	16
Warrego Summer-grass	*Paspalidium jubiflorum*	17
Panic Grass	*Paspalidium spp.*	4
Austral Stork's-bill	*Pelargonium australe*	1
Slender Knotweed	*Persicaria decipiens*	1
Pale Knotweed	*Persicaria lapathifolia*	1
Creeping Knotweed	*Persicaria prostrata*	4
Native Picris	*Picris angustifolia*	1
Mallee Rice-flower	*Pimelea microcephala subsp. microcephala*	2
Annual Rice-flower	*Pimelea trichostachya*	1
Weeping Pittosporum	*Pittosporum angustifolium*	11
Clay Plantain	*Plantago cunninghamii*	4
Plantain	*Plantago spp.*	1
Crowned Plantain	*Plantago turrifera*	1
Wiry Podolepis	*Podolepis capillaris*	2
Sticky Long-heads	*Podotheca angustifolia*	1
Stiff Cup-flower	*Pogonolepis muelleriana*	14
Poached-eggs Daisy	*Polycalymma stuartii*	9
Small Knotweed	*Polygonum plebeium*	3
Hogweed	*Polygonum spp.*	1
Small Poranthera	*Poranthera microphylla s.l.*	1
Common Purslane	*Portulaca oleracea*	1
Jersey Cudweed	*Pseudognaphalium luteoalbum*	11
Spiny Mud-grass	*Pseudoraphis spinescens*	3
Mulla Mulla	*Ptilotus exaltatus*	2
Long Tails	*Ptilotus polystachyus var. polystachyus*	7
Rabbit Tails	*Ptilotus seminudus*	3
Crimson Tails	*Ptilotus sessilifolius var. sessilifolius*	1
Pussy Tails	*Ptilotus spathulatus f. spathulatus*	1
Inland Buttercup	*Ranunculus pentandrus var. platycarpus*	1
Hedge Saltbush	*Rhagodia spinescens*	58
Paper Sunray	*Rhodanthe corymbiflora*	1
Pygmy Sunray	*Rhodanthe pygmaea*	1
Purple Pentatrope	*Rhyncharrhena linearis*	1
Chalk Crystalwort	*Riccia albida*	1
Dwarf Bitter-cress	*Rorippa eustylis*	1
Slender Dock	*Rumex brownii*	2
Glistening Dock	*Rumex crystallinus s.l.*	1
Dock	*Rumex spp.*	2
Narrow-leaf Dock	*Rumex tenax*	8
Prickly Saltwort	*Salsola tragus*	21

Prickly Saltwort	*Salsola tragus subsp. tragus*	1
Sarcozona	*Sarcozona praecox*	8
Cushion Knawel	*Scleranthus minusculus*	1
Starry Goosefoot	*Scleroblitum atriplicinum*	3
Short-wing Saltbush	*Sclerochlamys brachyptera*	35
Grey Copperburr	*Sclerolaena diacantha*	74
Black Roly-poly	*Sclerolaena muricata*	9
Black Roly-poly	*Sclerolaena muricata var. muricata*	1
Grey Roly-poly	*Sclerolaena muricata var. villosa*	6
Limestone Copperburr	*Sclerolaena obliquicuspis*	8
Mallee Copperburr	*Sclerolaena parviflora*	4
Spear-fruit Copperburr	*Sclerolaena patenticuspis*	1
Copperburr	*Sclerolaena spp.*	2
Streaked Copperburr	*Sclerolaena tricuspis*	37
Slender Groundsel	*Senecio glossanthus s.l.*	7
Cotton Fireweed	*Senecio quadridentatus*	6
Tall Fireweed	*Senecio runcinifolius*	1
Fine-leaf Desert Cassia	*Senna form taxon 'filifolia'*	1
Woody Cassia	*Senna form taxon 'petiolaris'*	2
Variable Sida	*Sida corrugata*	19
Pin Sida	*Sida fibulifera*	4
Twiggy Sida	*Sida intricata*	13
Sida	*Sida spp.*	1
Narrow-leaf Sida	*Sida trichopoda*	14
Quena	*Solanum esuriale*	13
Salt Sea-spurrey	*Spergularia sp. 3*	2
Spreading Nut-heads	*Sphaeromorphaea australis*	9
Yakka Grass	*Sporobolus caroli*	2
Rat-tail Couch	*Sporobolus mitchellii*	7
Star Bluebush	*Stelligera endecaspinis*	32
Blue Rod	*Stemodia florulenta*	34
Silky Swainson-pea	*Swainsona sericea*	1
Desert Spinach	*Tetragonia eremaea s.l.*	1
Desert Spinach	*Tetragonia eremaea s.s.*	2
Annual Spinach	*Tetragonia moorei*	4
Scurfy Germander	*Teucrium albicaule*	1
Grey Germander	*Teucrium racemosum s.l.*	17
Grey Germander	*Teucrium racemosum s.s.*	4
Germander	*Teucrium spp.*	1
Mallee Fringe-lily	*Thysanotus baueri*	4
Caltrop	*Tribulus spp.*	1
Caltrop	*Tribulus terrestris*	2
Dwarf Arrowgrass	*Triglochin nana*	1
Sweet Fenugreek	*Trigonella suavissima*	4
Porcupine Grass	*Triodia scariosa*	13
Needle Grass	*Triraphis mollis*	6
Bulrush	*Typha spp.*	1
Spur Velleia	*Velleia paradoxa*	1
Common Verbena	*Verbena officinalis s.l.*	2
Verbena	*Verbena spp.*	2
Speedwell	*Veronica spp.*	2
Sticky New Holland Daisy	*Vittadinia australasica var. oricola*	1
Annual New Holland Daisy	*Vittadinia cervicularis*	3
Annual New Holland Daisy	*Vittadinia cervicularis var. subcervicularis*	14

Club-hair New Holland Daisy	*Vittadinia condyloides*	1
Fuzzy New Holland Daisy	*Vittadinia cuneata*	11
Fuzzy New Holland Daisy	*Vittadinia cuneata var. cuneata*	1
Dissected New Holland Daisy	*Vittadinia dissecta s.l.*	15
Dissected New Holland Daisy	*Vittadinia dissecta var. hirta*	2
Woolly New Holland Daisy	*Vittadinia gracilis*	8
New Holland Daisy	*Vittadinia spp.*	10
River Bluebell	*Wahlenbergia fluminalis*	26
Annual Bluebell	*Wahlenbergia gracilenta s.l.*	2
Hairy Annual-bluebell	*Wahlenbergia gracilenta s.s.*	6
Sprawling Bluebell	*Wahlenbergia gracilis*	2
Bluebell	*Wahlenbergia spp.*	4
Rigid Panic	*Walwhalleya proluta*	6
Stiff Westringia	*Westringia rigida*	4
Golden Everlasting	*Xerochrysum bracteatum*	1
Pointed Twin-leaf	*Zygophyllum apiculatum*	6
Notched Twin-leaf	*Zygophyllum crenatum*	2
Climbing Twin-leaf	*Zygophyllum eremaeum*	3
Pale Twin-leaf	*Zygophyllum glaucum*	2

Flora - Exotic

Common Name	**Scientific Name**	**Records**
Chingma Lantern	*Abutilon theophrasti*	1
Dock	*Acetosa spp.*	2
Marsh Fox-tail	*Alopecurus geniculatus*	1
Flax-leaf Alyssum	*Alyssum linifolium*	1
Hairy Fiddle-neck	*Amsinckia calycina*	1
Asparagus	*Asparagus officinalis*	1
Onion Weed	*Asphodelus fistulosus*	2
Aster-weed	*Aster subulatus*	6
Bearded Oat	*Avena barbata*	5
Wild Oat	*Avena fatua*	2
Oat	*Avena spp.*	10
Mediterranean Turnip	*Brassica tournefortii*	53
Great Brome	*Bromus diandrus*	11
Red Brome	*Bromus rubens*	59
Saffron Thistle	*Carthamus lanatus*	3
Spiny Burr-grass	*Cenchrus longispinus*	1
Malta Thistle	*Centaurea melitensis*	6
Common Mouse-ear Chickweed	*Cerastium glomeratum s.l.*	1
Fat Hen	*Chenopodium album*	2
Sowbane	*Chenopodium murale*	1
Skeleton Weed	*Chondrilla juncea*	7
Spear Thistle	*Cirsium vulgare*	6
Camel Melon	*Citrullus lanatus*	1
Flaxleaf Fleabane	*Conyza bonariensis*	15
Fleabane	*Conyza spp.*	3
Ferny Cotula	*Cotula bipinnata*	1
Field Dodder	*Cuscuta campestris*	1
Drain Flat-sedge	*Cyperus eragrostis*	2
Stinkwort	*Dittrichia graveolens*	3
Awnless Barnyard-grass	*Echinochloa colona*	1

Barnyard Grass	*Echinochloa crus-galli*	1
Japanese Millet	*Echinochloa esculenta*	1
Paterson's Curse	*Echium plantagineum*	1
Stink Grass	*Eragrostis cilianensis*	1
Common Heron's-bill	*Erodium cicutarium*	14
Terracina Spurge	*Euphorbia terracina*	1
Chalkwort	*Gypsophila tubulosa*	1
Cretan Hedypnois	*Hedypnois cretica*	2
Creeping Heliotrope	*Heliotropium supinum*	1
Ox-tongue	*Helminthotheca echioides*	1
Hairy Rupture-wort	*Herniaria cinerea*	1
Northern Barley-grass	*Hordeum glaucum*	2
Mediterranean Barley-grass	*Hordeum hystrix*	1
Barley-grass	*Hordeum leporinum*	1
Sea Barley-grass	*Hordeum marinum*	5
Barley-grass	*Hordeum murinum s.l.*	64
Smooth Cat's-ear	*Hypochoeris glabra*	63
Prickly Lettuce	*Lactuca serriola*	20
Golden-top	*Lamarckia aurea*	1
Common Peppercress	*Lepidium africanum*	2
Wimmera Rye-grass	*Lolium rigidum*	4
African Box-thorn	*Lycium ferocissimum*	1
Small-flower Mallow	*Malva parviflora*	1
Horehound	*Marrubium vulgare*	7
Cut-leaf Medic	*Medicago laciniata var. laciniata*	13
Little Medic	*Medicago minima*	64
Burr Medic	*Medicago polymorpha*	58
Barrel Medic	*Medicago truncatula*	6
Common Ice-plant	*Mesembryanthemum crystallinum*	1
Ice Plant	*Mesembryanthemum spp.*	2
Tree Tobacco	*Nicotiana glauca*	1
Stemless Thistle	*Onopordum acaulon*	3
Prickly Pear	*Opuntia spp.*	1
Common Prickly-pear	*Opuntia stricta*	1
Tripteris	*Osteospermum clandestinum*	6
Coolah Grass	*Panicum coloratum*	1
Coast Barb-grass	*Parapholis incurva*	1
Paspalum	*Paspalum dilatatum*	2
False Hair-grass	*Pentaschistis airoides subsp. airoides*	5
Lesser Canary-grass	*Phalaris minor*	1
Fog-fruit	*Phyla canescens*	2
Wireweed	*Polygonum arenastrum*	1
Prostrate Knotweed	*Polygonum aviculare s.l.*	2
Wiry Noon-flower	*Psilocaulon granulicaule*	2
Giant Mustard	*Rapistrum rugosum*	3
False Sow-thistle	*Reichardia tingitana*	15
Annual Cat's-tail	*Rostraria cristata*	2
Wild Sage	*Salvia verbenaca*	3
Arabian Grass	*Schismus barbatus*	42
Mallee Catchfly	*Silene apetala var. apetala*	67
French Catchfly	*Silene gallica*	1
Mediterranean Catchfly	*Silene nocturna*	15
Smooth Mustard	*Sisymbrium erysimoides*	19
London Rocket	*Sisymbrium irio*	14

Black Nightshade	*Solanum nigrum sensu Willis (1972)*	3
Rough Sow-thistle	*Sonchus asper s.l.*	8
Rough Sow-thistle	*Sonchus asper subsp. asper*	2
Common Sow-thistle	*Sonchus oleraceus*	44
Lesser Sand-spurrey	*Spergularia diandra*	1
Red Sand-spurrey	*Spergularia rubra s.l.*	8
Red Sand-spurrey	*Spergularia rubra s.s.*	3
Shaftal Clover	*Trifolium resupinatum*	1
Woolly Clover	*Trifolium tomentosum var. tomentosum*	2
Wheat	*Triticum aestivum*	1
Small Nettle	*Urtica urens*	2
Common Verbena	*Verbena officinalis s.s.*	4
Trailing Verbena	*Verbena supina*	4
Squirrel-tail Fescue	*Vulpia bromoides*	2
Rat's-tail Fescue	*Vulpia myuros*	39
Rat's-tail Fescue	*Vulpia myuros f. myuros*	6
Bathurst Burr	*Xanthium spinosum*	1

Fauna – Native

Common Name	**Scientific Name**	**Type**	**Records**
Australasian Grebe	*Tachybaptus novaehollandiae*	B	11
Australasian Shoveler	*Anas rhynchotis*	B	1
Australian Bustard	*Ardeotis australis*	B	1
Australian Magpie	*Gymnorhina tibicen*	B	3
Australian Pelican	*Pelecanus conspicillatus*	B	3
Australian Raven	*Corvus coronoides*	B	5
Australian Shelduck	*Tadorna tadornoides*	B	13
Australian White Ibis	*Threskiornis molucca*	B	3
Australian Wood Duck	*Chenonetta jubata*	B	9
Barking Marsh Frog	*Limnodynastes fletcheri*	A	1
Black Swan	*Cygnus atratus*	B	3
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	B	4
Black-fronted Dotterel	*Elseyornis melanops*	B	3
Black-shouldered Kite	*Elanus axillaris*	B	1
Black-tailed Native-hen	*Gallinula ventralis*	B	2
Blue Bonnet	*Northiella haematogaster*	B	2
Blue-billed Duck	*Oxyura australis*	B	4
Blue-faced Honeyeater	*Entomyzon cyanotis*	B	1
Brown Goshawk	*Accipiter fasciatus*	B	1
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*	B	5
Brown-headed Honeyeater	*Melithreptus brevirostris*	B	2
Buff-rumped Thornbill	*Acanthiza reguloides*	B	1
Carpet Python	*Morelia spilota metcalfei*	R	2
Chestnut Teal	*Anas castanea*	B	2
Chestnut-crowned Babbler	*Pomatostomus ruficeps*	B	1
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	B	4
Clamorous Reed Warbler	*Acrocephalus stentoreus*	B	1
Common Bronzewing	*Phaps chalcoptera*	B	2
Common Froglet	*Crinia signifera*	A	1
Crested Pigeon	*Ocyphaps lophotes*	B	3
Crimson Rosella	*Platycercus elegans elegans*	B	1

Curlew Sandpiper	*Calidris ferruginea*	B	1
Darter	*Anhinga novaehollandiae*	B	8
Dusky Moorhen	*Gallinula tenebrosa*	B	3
Eastern Brown Snake	*Pseudonaja textilis*	R	1
Eastern Great Egret	*Ardea modesta*	B	1
Emu	*Dromaius novaehollandiae*	B	1
Eurasian Coot	*Fulica atra*	B	10
Freckled Duck	*Stictonetta naevosa*	B	7
Galah	*Eolophus roseicapilla*	B	20
Great Cormorant	*Phalacrocorax carbo*	B	73
Great Crested Grebe	*Podiceps cristatus*	B	7
Grey Butcherbird	*Cracticus torquatus*	B	1
Grey Shrike-thrush	*Colluricincla harmonica*	B	4
Grey Teal	*Anas gracilis*	B	29
Grey-crowned Babbler	*Pomatostomus temporalis*	B	2
Hardhead	*Aythya australis*	B	3
Hoary-headed Grebe	*Poliocephalus poliocephalus*	B	8
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	B	2
Intermediate Egret	*Ardea intermedia*	B	1
Lace Goanna	*Varanus varius*	R	1
Laughing Kookaburra	*Dacelo novaeguineae*	B	6
Little Black Cormorant	*Phalacrocorax sulcirostris*	B	10
Little Corella	*Cacatua sanguinea*	B	4
Little Eagle	*Hieraaetus morphnoides*	B	2
Little Friarbird	*Philemon citreogularis*	B	2
Little Pied Cormorant	*Microcarbo melanoleucos*	B	8
Little Raven	*Corvus mellori*	B	2
Long-billed Corella	*Cacatua tenuirostris*	B	1
Magpie-lark	*Grallina cyanoleuca*	B	5
Mallee Ringneck	*Barnardius zonarius barnardi*	B	2
Marbled Gecko	*Christinus marmoratus*	R	3
Masked Lapwing	*Vanellus miles*	B	6
Mistletoebird	*Dicaeum hirundinaceum*	B	2
Mulga Parrot	*Psephotus varius*	B	2
Musk Duck	*Biziura lobata*	B	3
Nankeen Night Heron	*Nycticorax caledonicus*	B	5
Noisy Miner	*Manorina melanocephala*	B	2
Pacific Black Duck	*Anas superciliosa*	B	41
Peaceful Dove	*Geopelia striata*	B	4
Peregrine Falcon	*Falco peregrinus*	B	1
Peron's Tree Frog	*Litoria peronii*	A	1
Pied Butcherbird	*Cracticus nigrogularis*	B	2
Pied Cormorant	*Phalacrocorax varius*	B	3
Pink-eared Duck	*Malacorhynchus membranaceus*	B	6
Plains Froglet	*Crinia parinsignifera*	A	1
Rainbow Bee-eater	*Merops ornatus*	B	1
Red Kangaroo	*Macropus rufus*	M	1
Red-capped Plover	*Charadrius ruficapillus*	B	1
Red-capped Robin	*Petroica goodenovii*	B	3
Red-rumped Parrot	*Psephotus haematonotus*	B	4
Regent Parrot	*Polytelis anthopeplus*	B	25
Royal Spoonbill	*Platalea regia*	B	2
Rufous Songlark	*Cincloramphus mathewsi*	B	3
Rufous Whistler	*Pachycephala rufiventris*	B	4

Sacred Kingfisher	*Todiramphus sanctus*	B	2
Sharp-tailed Sandpiper	*Calidris acuminata*	B	1
Silver Gull	*Chroicocephalus novaehollandiae*	B	1
Singing Honeyeater	*Lichenostomus virescens*	B	1
Southern Boobook	*Ninox novaeseelandiae*	B	2
Southern Whiteface	*Aphelocephala leucopsis*	B	4
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	B	2
Splendid Fairy-wren	*Malurus splendens*	B	3
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	A	1
Straw-necked Ibis	*Threskiornis spinicollis*	B	3
Striated Pardalote	*Pardalotus striatus*	B	4
Sulphur-crested Cockatoo	*Cacatua galerita*	B	17
Superb Fairy-wren	*Malurus cyaneus*	B	1
Swamp Harrier	*Circus approximans*	B	3
Tawny Frogmouth	*Podargus strigoides*	B	1
Tree Martin	*Hirundo nigricans*	B	4
Unidentified ibis	*Threskiornis sp.*	B	1
Unidentified small waders	*Unidentified small waders*	B	2
Unknown Raven	*Corvus sp.*	B	1
Varied Sittella	*Daphoenositta chrysoptera*	B	1
Variegated Fairy-wren	*Malurus lamberti*	B	2
Weebill	*Smicrornis brevirostris*	B	4
Welcome Swallow	*Hirundo neoxena*	B	4
Western Gerygone	*Gerygone fusca*	B	1
Western Grey Kangaroo	*Macropus fuliginosus*	M	4
Whistling Kite	*Haliastur sphenurus*	B	2
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	3
White-faced Heron	*Egretta novaehollandiae*	B	9
White-necked Heron	*Ardea pacifica*	B	6
White-plumed Honeyeater	*Lichenostomus penicillatus*	B	6
White-throated Treecreeper	*Cormobates leucophaeus*	B	1
White-winged Chough	*Corcorax melanorhamphos*	B	3
Willie Wagtail	*Rhipidura leucophrys*	B	5
Yellow Rosella	*Platycercus elegans flaveolus*	B	7
Yellow Thornbill	*Acanthiza nana*	B	1
Yellow-billed Spoonbill	*Platalea flavipes*	B	4
Yellow-rumped Pardalote	*Pardalotus punctatus xanthopygus*	B	1
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	B	5
Yellow-throated Miner	*Manorina flavigula*	B	2
Zebra Finch	*Taeniopygia guttata*	B	1

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

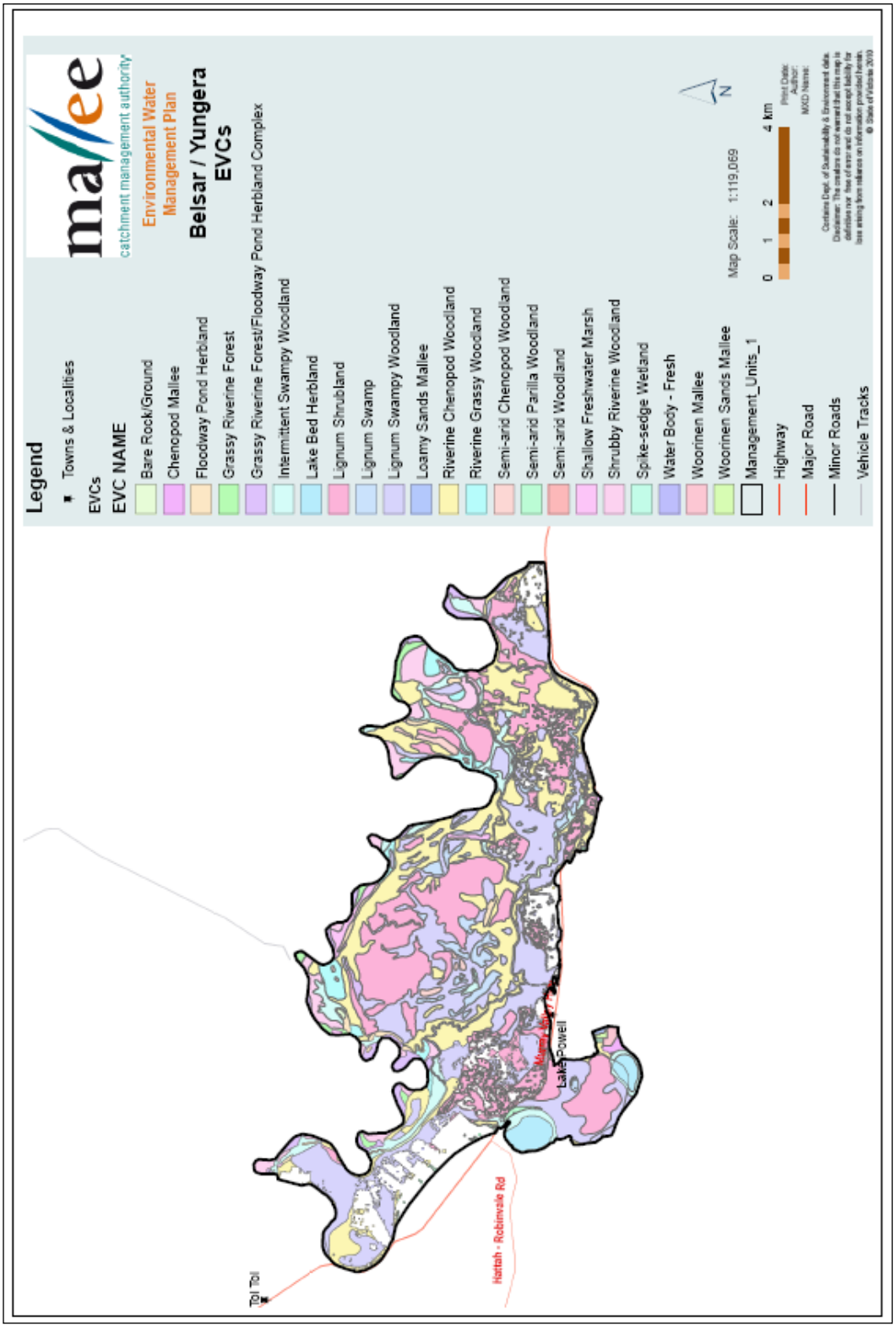
Fauna – Exotic

Common Name	Scientific Name	Type	Records
Common Starling	*Sturnus vulgaris*	B	4
European Rabbit	*Oryctolagus cuniculus*	M	4
House Sparrow	*Passer domesticus*	B	1
Red Fox	*Vulpes vulpes*	M	1

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

APPENDIX 4: ECOLOGICAL VEGETATION CLASSES

Mapping and description of each EVC within Belsar and Yungera Islands FMU



EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Fans	
158	Chenopod Mallee	Vulnerable	Open to very open mallee woodland to 12 m tall (almost invariably dominated by Eucalyptus gracilis) supported by thin Woorinen deposits typically overlying gypsiferous and sodic clays. In undisturbed remnants this EVC is characterised by the dominance of saltbushes and semi-succulent understorey shrubs.
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.
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 graminoids. Occasional tall shrubs present.
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted	EVC complex
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.
107	Lake Bed Herbland	Vulnerable	Herbland or shrubland to 0.5 m tall dominated by species adapted to drying mud within lake beds. Some evade periods of prolonged inundation as seed, others as dormant tuber-like rootstocks. Occupies drying deep-cracking mud of lakes on floodplains. Floods are intermittent but water may be retained for several seasons leading to active growth at the 'drying mud stage'.
808	Lignum Shrubland	Vulnerable	Unavailable
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	Vulnerable	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.
91	Loamy Sands Mallee	Least Concern	Semi-arid low mallee shrubland to 5 m tall, typically supporting scattered shrubs above a hummock grass field layer. Typically occurs on deep drifts of Lowan sands in the lee of ridge systems or occupying dune crests and swales in the parabolic and irregularly arranged dune in the Central Mallee and Sunset Country.
103	Riverine Chenopod Woodland	Endangered	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey 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.
295	Riverine Grassy Woodland	Vunerable	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils. River Red Gum woodland to 20 m tall with a groundlayer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.
98	Semi-arid Chenopod Woodland	Endangered	Sparse, low non-eucalypt woodland to 12 m tall of the arid zone with a tall open chenopod shrub-dominated understorey to 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.
97	Semi-arid Woodland	Vunerable	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.
200	Shallow Freshwater Marsh	Vulnerable	
818	Shrubby Riverine Woodland	Least concern	Eucalypt woodland to open forest to 15 m tall of less flood-prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often conspicuous.
819	Spike-sedge Wetland	Vunerable	Low sedgy vegetation of species-poor seasonal or intermittent wetlands, dominated by spike-sedges. Typically treeless, but sometimes with thickets of saplings or scattered more mature specimens of Eucalyptus camaldulensis. Mostly confined to a narrow ring around the upper margins of floodway ponds. Soils are typically heavy clays (e.g. mottled yellow-grey clay, grey loamy clay), occasionally silty near the surface. In some riverine sites, annual inundation is not reliable and the rhizomic rootstocks of Eleocharis acuta appear capable of surviving at least occasional periods of longer dormancy.
824	Woorinen Mallee	Vunerable	Widespread mallee woodland to 12 m tall, associated with the east-west orientated calcareous dunefields of the Woorinen Formation with a low, open chenopod dominated shrub understorey. A diverse array of sub-shrubs, herbs and grasses are also present. Typically occurs on fine textured red-brown sandy loam and clay loam soils.
86	Woorinen Sands Mallee		Mallee shrubland to 7 m tall, typically supporting a hummock grass (Triodia spp.) dominated understorey. This EVC could be considered intermediate between the heavier soil mallee woodlands and the lighter sandy soil mallee vegetation predominant on Lowan (siliceous) sand.

APPENDIX 5: RECENT WATERING HISTORY

This appendix will be updated seasonally

Recent documented watering history at Belsar and Yungera Islands FMU is summarised in the table below.

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Cost of delivery ($)	Area (Ha) Innundated	Comments
2005/06	Spring	EWR	393	393	$30 - 45/Ml*	75	
	Autumn	EWR	400	570		75	
		Donations	170				

*the cost of delivery is dependent on factors such as fuel prices, river heights, site access, type of pump required, volume to be pumped etc

Narcooyia Creek

Narcooyia Creek dry phase

Narcooyia Creek Weir

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 landuse 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

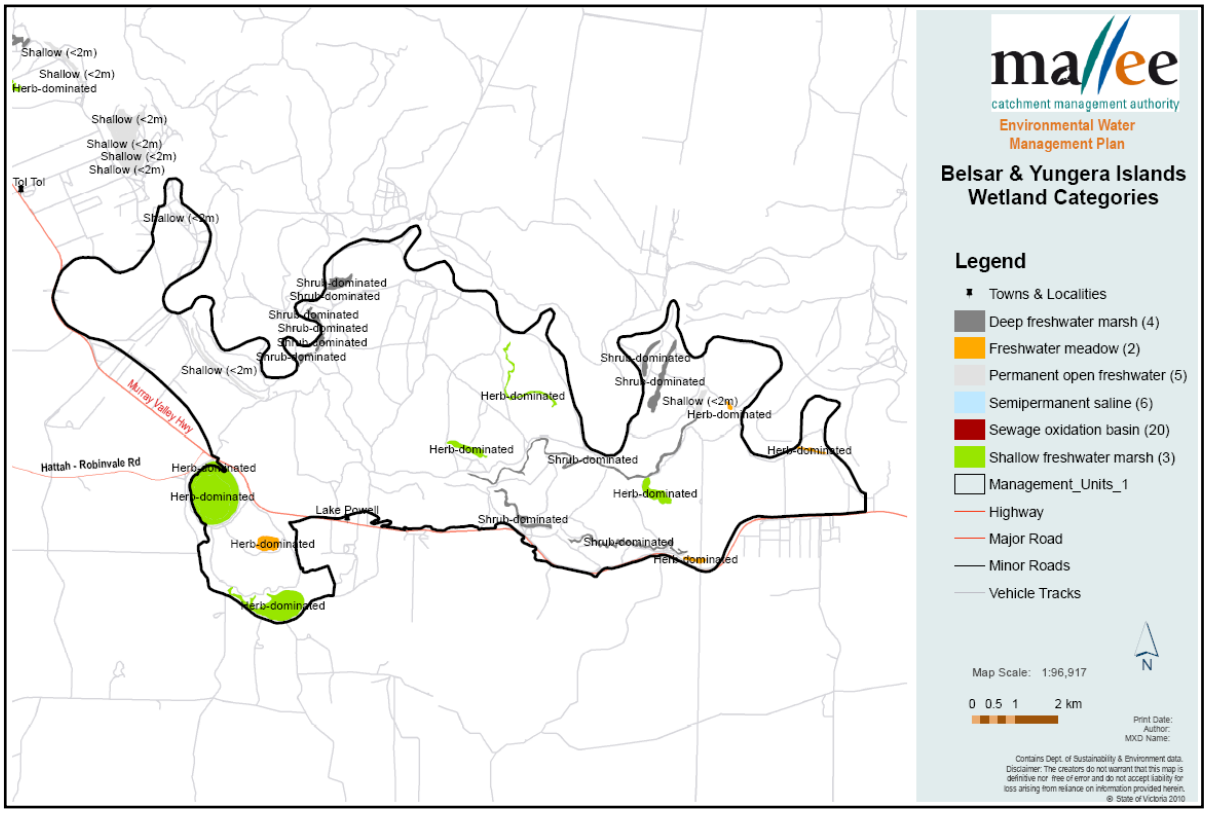
Each subindex is given a score between 0 and 20 based on the assessment of a number of measures as outline above. Weightings are then applied to the scores as tabulated below. The maximum possible total score for a wetland is 38.4. For ease of reporting, all scores are normalised to an integer score 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
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

Map of Belasr and Yungera Island Wetlands



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} + $\text{Infiltration}_{TSL}$ + Evaporation_{TSL}

Minimum fill volume (ML) =
Wetland capacity + Infiltration_{F} + Evaporation_{F} + $\text{Infiltration}_{TSL}$ + Evaporation_{TSL}
– $\text{Surfacewater}_{F + TSL}$ – $\text{Groundwater}_{F + TSL}$

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
$\text{Infiltration}_{TSL}$ = 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
$\text{Surfacewater}_{F + TSL}$ = 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).