

# Ecological Character Description Addendum

Kerang Wetlands Ramsar Site



## **Acknowledgements**

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# 1. Introduction

An ecological character description (ECD) for the Kerang Wetlands Ramsar Site was completed in 2011 (Kellogg Brown and Root 2011). Since that time, new information has been generated for the site, which has resulted in amendments to the ECD for the Kerang Wetlands Ramsar Site as outlined below.

- The name of one of the wetlands within the site has been corrected.
- The wetland types within the Ramsar site have been updated based on an update in 2014 to the Victorian Wetland Inventory and additional information.
- The criteria met by the site have been reviewed. The justification for meeting each criterion has been better aligned with the requirements of the Ramsar guidance. There is evidence that the site has never met criterion 1, however an additional criterion is met (criterion 4). Thus, the site meets criteria 2, 3, 4 and 5.
- A review of critical components, processes and services (CPS) has been undertaken, with two new critical CPS being identified (vegetation diversity and diversity of wetland types).
- The list of species, which meet criterion 2, has been revised with newly listed threatened species added and the removal of threatened species which are either not wetland dependent and or not regularly supported at the site. A change to the critical service of supporting threatened species has also been updated to reflect these changes.
- A review and update of Limits of Acceptable Change (LAC) for the critical CPS has been undertaken.
- Additional information on threats has been added based on a risk assessment undertaken for the recent action plan for the Kerang Wetlands Ramsar Site (NC CMA in prep.).

## 2. Update of wetland names

The original nomination document for the Kerang Wetlands Ramsar Site listed Town Swamp and Back Swamp as two of the wetlands comprising the Ramsar site (Ministry of Conservation 1982). In the 2011 ECD for the site, the two are named within one polygon as “Back / Town Swamp” (Kellogg Brown and Root 2011).

Community consultation for the action plan for the Kerang Wetlands Ramsar Site (NC CMA in prep.) revealed confusion about the names of wetlands adjacent to the town of Kerang. A recent review of mapping layers has revealed that the correct names for the wetlands (as shown in Figure 1) are:

- Town Swamp (south of the railway line and to the west of the Loddon River) and within the Ramsar site
- Town Common (south of the railway line, to the east of the Loddon River) and mostly outside the Ramsar site boundary and
- Kerang Weir Pool (the weir pool and associated marshes north of the railway line), with the western portion lying within the Ramsar site boundary. Parts of this wetland were formerly labelled as “Back Swamp”.

The name has been changed in Ramsar documentation to “Town Swamp / Kerang Weir Pool” to more accurately reflect official names.

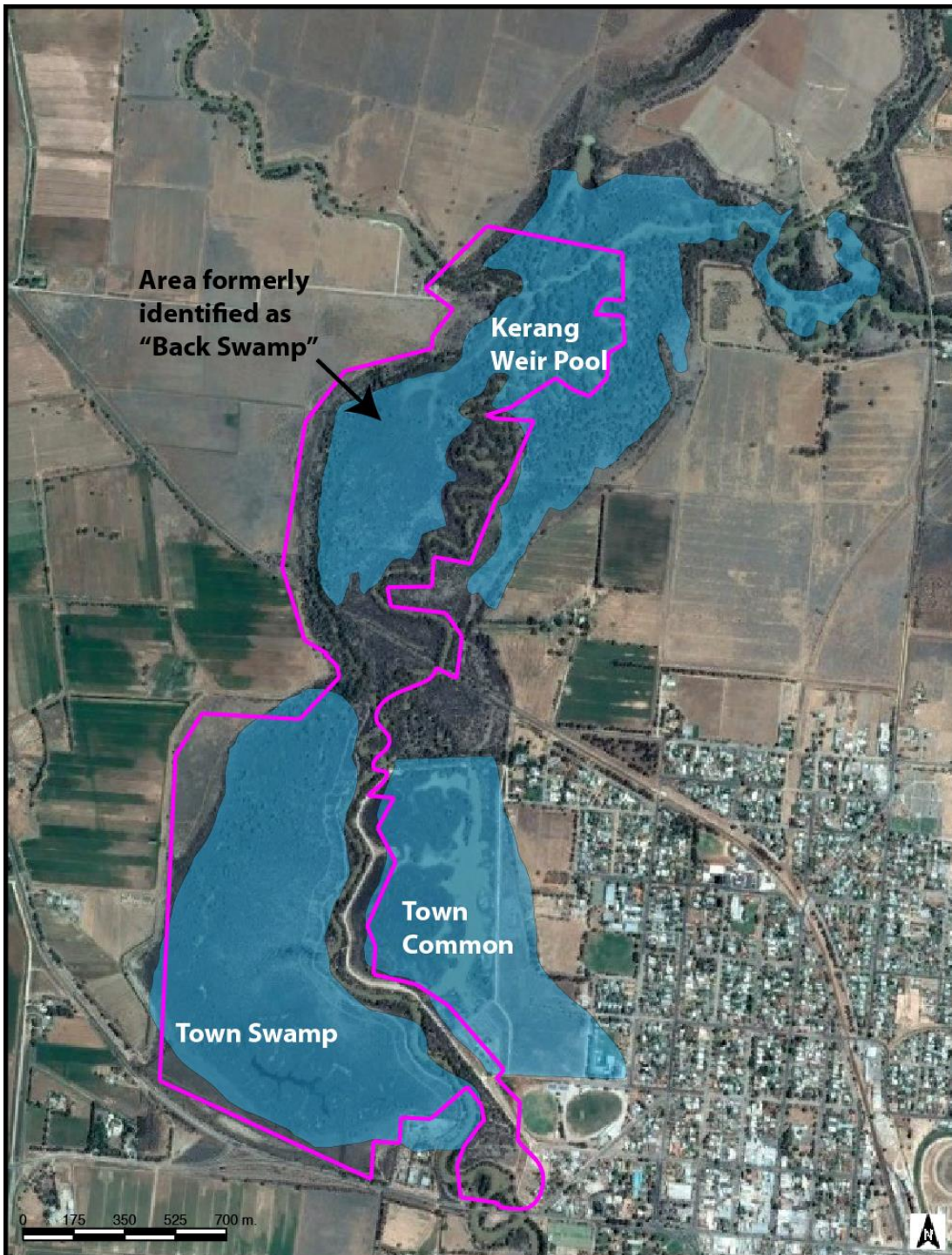


Figure 1: Wetland now correctly named “Town Swamp/ Kerang Weir Pool” within the Ramsar site boundary (pink line) and location of “Town Common”, which is largely outside the Kerang Wetlands Ramsar Site.

### 3. Update of wetland types

Recent survey information and mapping has resulted in a more robust assessment of wetland types within the Kerang Wetlands Ramsar Site. Based on this, the Kerang Wetlands Ramsar Site contains the following wetland types (in order of dominance):

- **O**: permanent freshwater lakes (over 8 ha) – 2257 hectares
- **W**: shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils and **Ts**: seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes – 2884 hectares
- **R**: seasonal/intermittent saline/brackish/alkaline lakes and flats – 1038 hectares
- **Q**: permanent saline/brackish/alkaline lakes - 976 hectares
- **P**: seasonal/intermittent freshwater lakes (over 8 ha) – 762 hectares
- **Tp**: permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season – 196 hectares
- **8**: wastewater treatment areas; sewage farms, settling ponds, oxidation basins – 6 hectares.

The occurrence of these wetland types in the 23 wetlands in the Ramsar site is set out in Table 1.

This assessment updates the information in the 1999 Ramsar Information Sheet for the Kerang Wetlands in which only four Ramsar wetland types were identified as occurring at the site (O, Tp, Ts and Q). It also updates the information in the 2011 ECD in which type Ts was removed from the 1999 Ramsar Information Sheet list and three additional types were added (R, Xf and 8), (Kellogg Brown and Root 2011).

Wetlands previously described as Xf (tree dominated) are largely dominated by the shrub lignum (*Duma* spp.) and so more correctly classified as wetland type W (shrub dominated).

It should be noted that Fosters Swamp, is a natural wetland, a small portion of which is used by Lower Murray Water for discharge of treated wastewater. As such, it is not an artificial wetland and was mistakenly assigned a wetland type of “8” in Kellogg Brown and Root (2011). Within the Ramsar boundary and within the former bed of the Fosters Swamp, but now separated from it by a bank, is an eight-hectare series of wastewater treatment ponds (wetland type 8), (

Figure 2).

**Table 1: Assessment of wetland types in the Kerang Wetlands Ramsar site. Note that Stevensons Swamp has not held water since the time of listing and its wetland type could not be determined.**

Wetland	Size (ha)	Current wetland classification (DELWP 2016a)	Dominant vegetation communities (Cook and Bayes 2014)	Ramsar wetland types(s)
Kerang Sewage Farm	6	Permanent freshwater lake	Sewage ponds, open water	8
Little Lake Charm	96	Permanent freshwater lake	Little emergent vegetation	O
Lake Charm	519	Permanent freshwater lake	Little emergent vegetation	O
Kangaroo Lake	983	Permanent freshwater lake	Little emergent vegetation, fringed with woodland	O
Racecourse Lake	232	Permanent freshwater lake	Little emergent vegetation, fringed with woodland	O

Wetland	Size (ha)	Current wetland classification (DELWP 2016a)	Dominant vegetation communities (Cook and Bayes 2014)	Ramsar wetland types(s)
Third Lake	234	Permanent freshwater lake	Open water with fringing tall marsh and swampy woodland	O
Reedy Lake	193	Permanent freshwater lake	Largely open water, fringes of emergent macrophytes and lignum	O
Middle Lake	196	Permanent freshwater swamp	Areas of open water, but significant cover of lignum and tall marsh	Tp
Lake Tutchewop	755	Permanent saline lake	Largely unvegetated, fringed with samphire	Q
Lake William	95	Permanent saline lake	Largely unvegetated, fringed with samphire	Q
Lake Kelly	76	Permanent saline lake	Largely unvegetated, fringed with samphire	Q
Little Lake Kelly	50	Permanent saline lake	Largely unvegetated, fringed with samphire	Q
First Marsh	762	Temporary freshwater lake	Largely open water, fringes of emergent macrophytes and lignum	P
Hird Swamp	344	Temporary freshwater marshes and meadows	Tall marsh fringed with lignum	Ts, W
Second Marsh	242	Temporary freshwater swamp	Intermittent swampy woodland	W
Third Marsh	1043	Temporary freshwater swamp	Intermittent swampy woodland	W
Lake Bael Bael	611	Temporary freshwater swamp	Areas of open water fringed by swampy woodland	W
Cemetery Swamp	112	Temporary freshwater swamp	Lignum swampy woodland	W
Johnson Swamp	400	Temporary freshwater swamp	Open water, with a fringe of tall marsh and lignum	Ts, W
Town Swamp	83	Temporary freshwater swamp	Lignum swampy woodland	W
Kerang Weir Pool	49	Temporary freshwater swamp	Lignum swampy woodland	W
Fosters Swamp	334	Temporary saline lake	Little emergent vegetation, largely dries out, but small area remains permanently inundated due to discharge from adjacent sewage treatment ponds	R (Q – small area)
Stevensons Swamp	78	Temporary saline lake	No wetland vegetation, has not held water in decades	R
Lake Cullen	626	Temporary saline lake	Little emergent vegetation	R



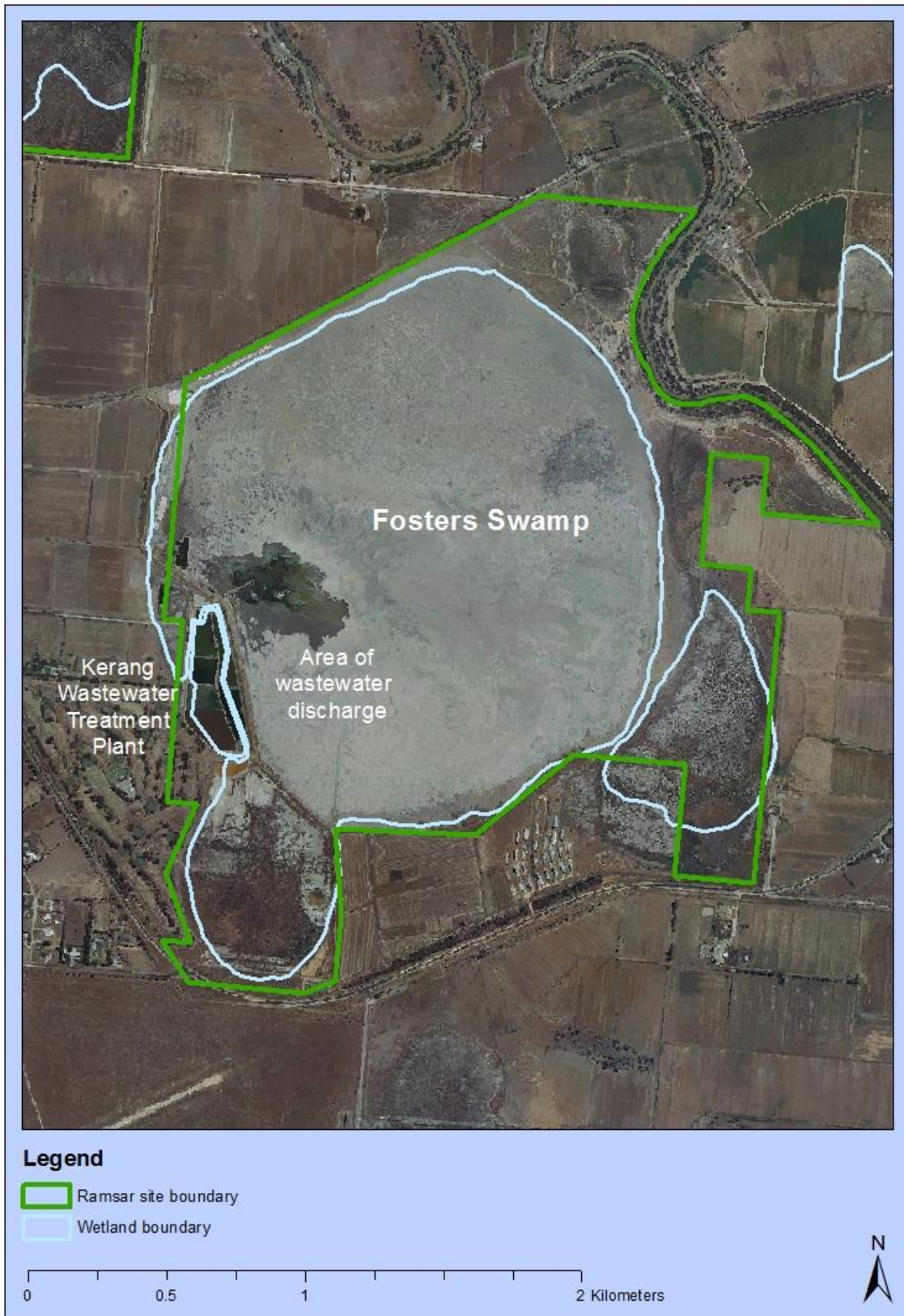


Figure 2: Fosters Swamp, showing adjacent wastewater treatment ponds and treated water discharge area.

## 4. Ramsar criteria

All criteria have been reviewed, as several inconsistencies were evident in the 2011 ECD. More rigorous application of the Ramsar Convention *Explanatory Note and Guidelines for completing the Information Sheet on Ramsar Wetlands (RIS)* has resulted in the conclusion that the site meets criteria 2, 3, 4 and 5 but has never met criteria 1 and 6.

### 4.1 Justification for the site not meeting Ramsar criteria 1 and 6

#### Criterion 1

*A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.*

The justification for criterion 1 has been reviewed. It has been determined that the original assessment that the Kerang Wetlands Ramsar Site met this criterion at listing was an error.

The appropriate bioregion for the site is the Murray-Darling drainage division (Department of the Environment, Water, Heritage and the Arts 2008). There are eight wetland types represented in the Kerang Wetlands Ramsar Site (Table 1).

Mapping and classification of the wetlands in the Murray Darling drainage division, indicates that the Kerang wetlands do not represent any “rare” or “unique” wetland types (Brooks et al. 2013). Therefore, this criterion could only be considered met on the basis of a representative wetland in the bioregion in “near natural” condition. Many of the wetlands within the Ramsar site have been modified for use as water storages or saline disposal basins and as such could not be considered to be in “near natural” condition. While the Avoca Marshes, comprising First, Second and Third Marsh, are unregulated, recent assessments in 2008 and 2014 (during and post Millennium drought) found that they were in poor condition (Cook and Bayes 2014) and cannot be considered to be good representatives of their type in the bioregion.

This criterion was erroneously assessed as being in met at nomination (Ministry of Conservation 1982) and in the 2011 ECD (Kellogg Brown and Root 2011). This criterion was not met at the time of listing and remains unmet.

#### Criterion 6

*A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.*

This criterion is only applied to wetland dependent flora and fauna that are regularly supported (in two thirds of seasons) at a Ramsar site. Assessment of this criterion must be made using the most recent official population estimates (Wetlands International 2012). The ECD states that this criterion is met for the banded stilt (*Cladorhynchus leucocephalus*) based on four occasions between 1982 and 2003 (Kellogg Brown and Root 2011). This is insufficient to meet the requirements of “regularly supports”.

Recent data indicates that the site may support 1% of the population of Australasian bittern (*Botaurus poiciloptilus*) at Johnson and Hird Swamps. The 1% population threshold for this species is five individuals (Wetlands International 2012). Data on cryptic species is lacking for the Ramsar site at the time of listing and there are few dedicated counts. The following records are derived from the Atlas of Living Australia and NC CMA unpublished:

- January 2003 – Ten
- October 2005 – Eight
- November 2006 – Ten
- November 2016 – Seven
- January 2016 – Four

Four counts above the one percent threshold in 13 years, is insufficient to meet the requirements of “regularly supports”. However, with continued dedicated monitoring, the site should be reassessed against this criterion at the next update of the Ramsar Information Sheet.

This criterion was not met at the time of listing and remains unmet.

## 4.2 Changes resulting from a review of the Ramsar criteria met

### Criterion 2

The list of species which meet criterion 2 has been revised. This includes the addition of several species present at the site which were not included in the 2011 ECD and the removal of other species.

Several species in the 2011 ECD are not considered to be regularly supported within the site. Macquarie perch (*Macquaria australasica*), Murray hardyhead (*Craterocephalus fluviatilis*), Australian painted snipe (*Rostratula australis*) and Regent Parrot (*Polytelis anthopeplus*) have had only sporadic records from within the site. Growling grass frog (*Litoria raniformis*) may no longer be present within the site as recent searches have failed to locate the species (Rakali 2014). Records at, and prior to the time of listing, for this species were for Hird and Johnson Swamps (in 1982) and from near Reedy Lake (in 1961) (Rakali 2014). Eastern curlew (*Numenius madagascariensis*) has recently been listed as critically endangered under the EPBC Act, but records for this species are limited to before listing.

Two threatened fish species Murray cod (*Maccullochella peellii*) and silver perch (*Bidyanus bidyanus*) have been recorded in the Kerang Wetlands, and the former is stocked in several of the wetlands annually (Department of Environment and Primary Industries 2014). These species, however, are river channel specialists that prefer flowing environments and infrequently use wetland habitats (Rogers and Ralph 2011) and the wetlands of the Ramsar site do not provide core habitat.

In addition, other nationally listed species identified in the 2011 ECD are not wetland dependent and therefore do not contribute to meeting this criterion: regent honeyeater (*Anthochaera (Xanthomyza) Phrygia*) and plains wanderer (*Pedionomus torquatus*).

### Criterion 3

The justification for criterion 3 has been updated, with further evidence provided supporting previous assessments, which concluded that the site met this criterion on the basis of waterbird diversity. The list of waterbirds now excludes Black kite (*Milvus migrans*), which is listed in Table 7.2 of the ECD, and is not considered to be wetland dependent (Kingsford et al. 2012). Waterbird breeding which was stated in the ECD as a justification for criterion 3 is considered to contribute to the site meeting criterion 4.

### Criteria 4 and 5

Justification has been provided for the site meeting criterion 4.

The justification for criterion 5 has been strengthened with additional data.

## 4.3 Updated justification for Ramsar criteria met

At the time of listing the Kerang Wetlands Ramsar Site would have met six of the current nine criteria and continues to do so.

### Criterion 2

*A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.*

This criterion is only applied to wetland dependent flora and fauna, and the site regularly supports two waterbird species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and / or IUCN Red List:

- Australasian bittern (*Botaurus poiciloptilus*) – Endangered (EPBC and IUCN) and
- curlew sandpiper (*Calidris ferruginea*) – Critically endangered (EPBC).

There are numerous, but patchy records of Australasian bittern from within the Ramsar site. The Atlas of Living Australia (<http://www.ala.org.au/>), together with data provided by North Central Catchment Management Authority (NC CMA) indicates the species was present in Hird and/or Johnsons Swamp in 2003, 2004, 2005, 2006, 2007, 2014, 2015 and 2016.

There are over 150 records of curlew sandpiper in the Kerang Wetlands Ramsar Site from the 1970s to 2015. Between 1980 and 2015 they were recorded in 69 percent of years (data from the Atlas of Living Australia and the Victorian Biodiversity Atlas). They have been recorded at Fosters Swamp, Kangaroo Lake and Lakes Cullen, Kelly and Tutchewop.

The Kerang Wetlands Ramsar Site met this criterion at the time of listing and continues to do so.

### **Criterion 3**

*A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region*

Guidance from the Convention indicates that this criterion should be applied to “hotspots” of biological diversity and centres of endemism within a biogeographic region. As with criterion 1, the relevant bioregion is the Murray-Darling Basin drainage division.

The Kerang Wetlands Ramsar Site supports a high diversity of waterbirds, most likely related to the diversity of habitats provided by the site (permanent and temporary, fresh and saline, vegetated and open water). The ECD indicates that a total of 75 species of waterbird have been recorded within the site, but more recently accessed data combining records from the Atlas of Living Australia, The Victorian Biodiversity Atlas, Annual Summer Waterfowl Counts (DELWP unpublished) and NC CMA unpublished data indicate that the total number of waterbird species recorded at Kerang Wetlands Ramsar Site is 86 (this list includes species that regularly occur as well as vagrants and isolated records). This represents the second most species rich Ramsar site, with respect to waterbirds, in the bioregion after the Coorong and Lakes Alexandrina and Albert Ramsar Site (118 waterbird species; Butcher and Cottingham 2011). In addition, data collected between 2010 and 2012 confirms that Kerang was among the most species rich of waterbird sites in the bioregion, ranking in the top 20 sites for each year and at number four in 2012 (Kingsford et al. 2014).

Biodiversity is not just measured in terms of species richness, but encompasses some aspects of variability between species represented (DeLong 1996). Therefore, a site may be considered more diverse if it contained the same number of species, but these species were from a larger range of families or groups. Kingsford et al. (2014) indicated that the Kerang Lakes not only supports a relatively high number of waterbird species, but that these are distributed across all defined functional groups (ducks, herbivores, large wading birds, piscivores and shorebirds); representing a higher diversity than sites that support species from only one or two functional groups.

The Kerang Wetlands Ramsar Site meets this criterion.

### **Criterion 4**

*A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their lifecycles, or provides refuge during adverse conditions.*

The basic description of this criterion implies a number of common functions/roles that wetlands provide including supporting fauna during migration, providing drought refuge, supporting breeding and moulting in waterfowl. The Kerang Wetlands Ramsar Site provides all these functions with respect to waterbirds.

Thirty-five species of waterbirds listed under international migratory agreements have been recorded within the Ramsar site. This includes species that, in Australia, are residents (e.g. eastern great egret) and 23 international migratory species. There are five species of international migratory shorebirds that are regularly recorded in the Kerang Wetlands Ramsar Site (Table 2).

The Kerang Wetlands Ramsar Site supports Australian shelduck (*Tadorna tadornoides*) and musk duck (*Biziura lobata*) during the critical life stage of moulting. These species aggregate on the open waters of the permanent lakes during moult of primary flight feathers, when the birds are vulnerable to predators (Kellogg Brown and Root 2011).

There are records of 28 species of waterbird breeding within the Ramsar site (Victorian Biodiversity Atlas, Atlas of Living Victoria). The site is particularly important for colonial nesting species, and this has been recognised as significant at the bioregion scale (Kingsford et al. 2014). The ECD states that there were 99 colonial nesting breeding events within the site between 1980 and 2005 (Kellogg Brown and Root 2011). More recent data, suggests that the site continues to support large-scale waterbird breeding. For example, >20,000 colonial nesting species, predominantly, straw-necked ibis (*Threskiornis spinicollis*) bred in the site during 2010, with smaller breeding colonies in 2011 and 2012 (Kingsford et al. 2014) and 1000s of nests in 2014 (Australian Waterbird Surveys database). In 2016, large numbers of Australian white ibis (*Threskiornis molucca*) and straw necked ibis bred at Middle Reedy Lake (NC CMA unpublished data). There are also records of wetland dependent raptors (swamp harrier; *Circus approximans*) and other wetland dependent birds (e.g. Australian reed warbler; *Acrocephalus australis*) breeding in the site (Victorian Biodiversity Atlas).

The Kerang Wetlands Ramsar Site contains several permanent wetlands that are maintained as water storages (e.g. Reedy Lakes complex, Lake Charm and Kangaroo Lake). These wetlands retain water during drought conditions when most natural wetlands in the region would dry. The permanent wetlands provide drought refuge, particularly for waterbirds. During years of below average rainfall, as many as 55 900 waterbirds have been recorded within the Ramsar site, with an average maximum annual count of > 20 000 waterbirds during dry years (Table 3).

This criterion was met at the time of listing and continues to be met.

**Table 2: International migratory waders recorded in the Ramsar site and their frequency of occurrence (percentage of years). The five species regularly supported (more than two thirds of years) are shown in bold.**

Common name	Species name	JAMBA	CAMBA	ROKAMBA	Frequency of occurrence
Australian painted snipe	<i>Rostratula australis</i>		X		6
Black-tailed godwit	<i>Limosa limosa</i>	X	X	X	14
<b>Common greenshank</b>	<b><i>Tringa nebularia</i></b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>74</b>
Common sandpiper	<i>Actitis hypoleucos</i>	X	X	X	9
<b>Curlew sandpiper</b>	<b><i>Calidris ferruginea</i></b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>69</b>
Eastern curlew	<i>Numenius madagascariensis</i>	X	X	X	6
Great knot	<i>Calidris tenuirostris</i>	X	X	X	3
Greater sand plover	<i>Charadrius leschenaultii</i>	X	X	X	3
Latham's snipe	<i>Gallinago hardwickii</i>	X	X	X	31
Long-toed stint	<i>Calidris subminuta</i>	X	X	X	6
<b>Marsh sandpiper</b>	<b><i>Tringa stagnatilis</i></b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>66</b>
Oriental plover	<i>Charadrius veredus</i>	X		X	9
Pacific golden plover	<i>Pluvialis fulva</i>	X	X	X	17
Pectoral sandpiper	<i>Calidris melanotos</i>	X		X	14
Red knot	<i>Calidris canutus</i>	X	X	X	9
Red-necked phalarope	<i>Phalaropus lobatus</i>	X	X	X	9
<b>Red-necked stint</b>	<b><i>Calidris ruficollis</i></b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>71</b>
Ruddy turnstone	<i>Arenaria interpres</i>	X	X	X	23

Common name	Species name	JAMBA	CAMBA	ROKAMBA	Frequency of occurrence
Ruff	<i>Philomachus pugnax</i>	X	X	X	11
Sanderling	<i>Calidris alba</i>	X	X	X	3
<b>Sharp-tailed sandpiper</b>	<b><i>Calidris acuminata</i></b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>77</b>
White-winged black tern	<i>Chlidonias leucopterus</i>	X	X	X	29
Wood sandpiper	<i>Tringa glareola</i>	X	X	X	23

**Table 3: Annual total maximum waterbird abundance in the Kerang Wetlands Ramsar Site for years with below average rainfall of 372 mm (data from the Atlas of Living Australia, Victorian Biodiversity Atlas, Annual Summer Waterfowl counts (DELWP unpublished) and Kingsford et al. 2014).**

Year	Rainfall	Annual maximum count
1977	256	55 900
1980	338	Insufficient data
1982	164	4307
1985	372	21 327
1990	352	53 688
1994	232	26 468
1996	359	46 148
1997	273	15 032
1998	366	14 383
2001	269	12 254
2002	176	29 568
2003	372	6316
2004	348	17 739
2006	217	6671
2008	305	Insufficient data
2009	309	Insufficient data
2012	328	65 634
2013	316	13 590
2014	345	22502
2015	227	4845
Average		24 4920

## Criterion 5

*A wetland should be considered internationally important if it regularly supports 20 000 or more waterbirds.*

The Convention provides guidance on the definition of “regularly” as follows in relation to this criterion:

“a wetland regularly supports a population of a given size if:

i) the requisite number of birds is known to have occurred in two thirds of the seasons for which adequate data are available, the total number of seasons being not less than three; or

ii) the mean of the maxima of those seasons in which the site is internationally important, taken over at least five years, amounts to the required level (means based on three or four years may be quoted in provisional assessments only).”

Complete counts of waterbirds across all wetlands within the Kerang Lake Ramsar site are rare. Despite this, there is good evidence that the site regularly supports > 20 000 waterbirds. Data pooled from all sources indicates that between 1977 and 2016, the annual maximum count exceeded 20 000 on 18 occasions (46 % of years; Figure 3). While this falls below the two thirds of seasons requirement, the average maximum abundance (1977 to 2016) is 31 600. Indicating that the site meets this criterion with respect to average annual maximum abundance, despite a lack of consistent counts across the Ramsar site.

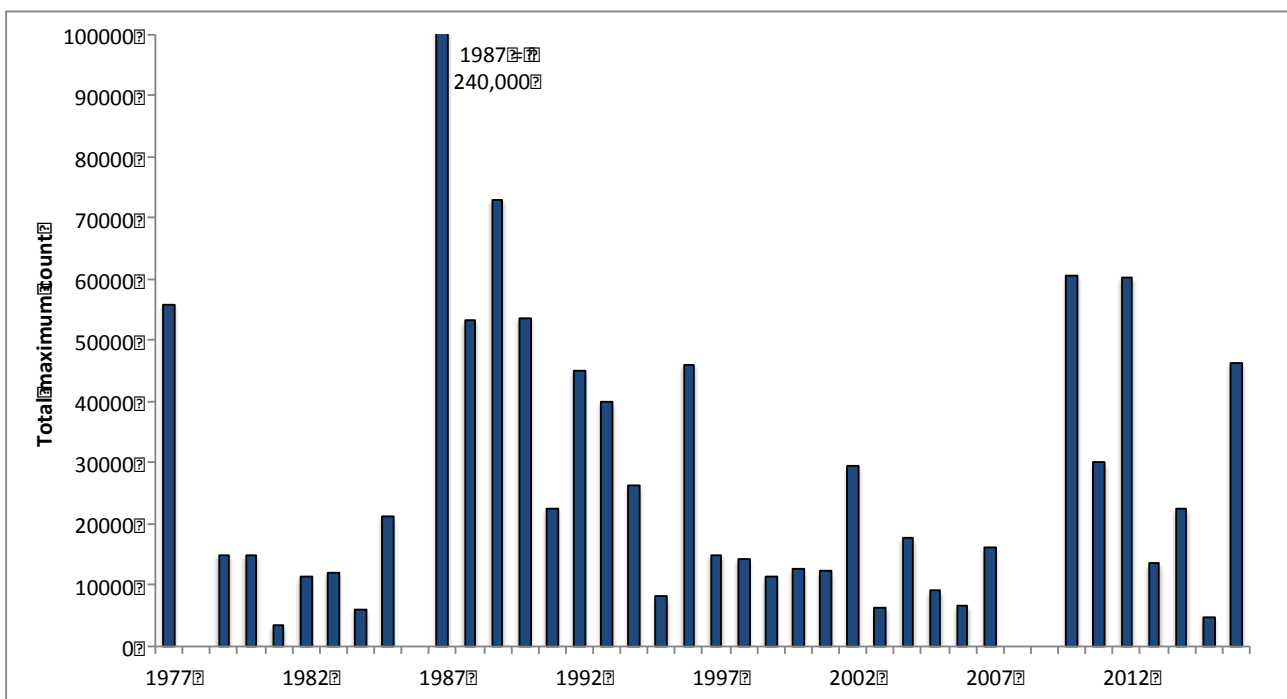


Figure 3: Annual maximum waterbird counts in the Kerang Lakes from 1977 to 2016 (data from the Atlas of Living Australia, Victorian Biodiversity Atlas, Annual Summer Waterfowl counts (DELWP unpublished) and Kingsford et al. 2014).

This criterion was met at the time of listing and continues to be met.

## 5. Critical components, processes and services

The Kerang Wetlands ECD identified three components and one process that are critical to the ecological character of the Ramsar site. Detailed descriptions of these critical CPS can be found in that ECD (Kellogg Brown and Root 2011):

- Hydrology – ECD section 3.1.1
- Salinity – ECD section 3.1.2
- Waterbird abundance – ECD section 3.1.3 (renamed waterbird diversity and abundance)

- Waterbird breeding – ECD section 3.1.4

The national framework indicates that the minimum components, processes, benefits and services, which should be included in an ECD are those (Department of the Environment, Water, Heritage and the Arts 2008):

1. that are important determinants of the sites unique character
2. that are important for supporting the Ramsar criteria under which the site was listed
3. for which change is reasonably likely to occur over short to medium time scales (less than 100 years) and
4. that will cause significant negative consequences if change occurs.

Applying these criteria resulted in an additional component and two services critical to the ecological character of the Kerang Wetlands Ramsar site:

- vegetation diversity (critical component)
- supports a diversity of wetland types (critical service) and
- supports threatened wetland species (critical service).

### 5.1 Additional critical component: vegetation diversity

The 2011 ECD describes the vegetation in the site in section 3.2.6 as a component of ecological character, but was not considered critical. Recent surveys of vegetation at each of the wetlands has provided additional information and evidence to support this component as being critical to the ecological character of the Ramsar site (Cook and Bayes 2014).

There are over 170 wetland dependent native plant species within the Kerang Wetlands Ramsar Site. This includes a broad range of species including both freshwater and saline tolerant flora. Cook and Bayes (2014) provided function groups for these species as follows:

- obligate aquatic - plants that require free-standing water above the ground surface to complete their life-cycle (11 species)
- amphibious - plants which are adapted to survive short to medium term inundation (greater than two weeks' duration). Recruitment and periods of rapid growth and productivity of these species is often closely tied to inundation events (71 species).
- mudflat specialists - plants that specialise in colonising the drying mud of wetlands (32 species)
- groundwater dependent - plants that while not necessarily frequently inundated by flood water would not survive on local rainfall and require access to ground water (7 species) and
- dampland - plants that require damp or saturated, but not inundated, soil to complete their life-cycle (52 species).

The 2005 ecological vegetation class (EVC) modelled data and mapping indicates eight wetland EVCs within the Ramsar site (DELWP unpublished). More detailed, on-ground mapping was conducted in 2008 and 2014 at 14 wetlands within the Kerang Wetlands Ramsar Site (Cook and Bayes 2014), and this provides a more accurate estimation of wetland dependent vegetation communities at these sites, as well as an indication of their condition, based on Index of Wetland Condition biotic sub-index scores (DELWP 2106b). The two data sets have been combined to provide an overall estimation of wetland dependent vegetation communities within the Ramsar site (Table 4).

The following is a summary of each of the major EVCs within the Ramsar site in 2014 (from Cook and Bayes 2014). Data from the time of listing is not available and non-woody vegetation communities will change under different water regimes (e.g. submerged aquatic communities emerge upon inundation and recede during dry phases in intermittent wetland systems). However, the description can be considered indicative of the vegetation communities that occur within the Ramsar site now and most likely at the time of listing.



## Freshwater Lake Aggregate

This is a collection of freshwater EVCs that have been mapped as a group in the 2005 EVC mapping (DELWP unpublished) and as separate EVCs (aquatic herbland, lake bed herbland and tall marsh) by Cook and Bayes (2014). These freshwater macrophyte dominated vegetation communities have a combined cover of 3278 hectares within the Ramsar site, occurring at Little Lake Charm, Lake Charm, Kangaroo Lake, Racecourse Lake, the Reedy Lake Complex, Lake Bael Bael and the Avoca Marshes, Hird Lake and Johnson Swamp. A small area occurs at Lake Cullen associated with a leaking water control structure.

The aquatic herbland at the Reedy Lakes Complex and Hird Swamp is dominated by herbaceous aquatic species such as pond weeds (*Potamogeton ochreatus*, *P. cheesemani*), waterwort (*Elatine gratioloides*), (Red Pondweed), *Ludwigia peploides subsp. montevidensis* (Clove-strip), *Myriophyllum papillosum* (Robust Milfoil) and *Myriophyllum verrucosum* (Red Milfoil). This EVC was assessed in 2014 as being in excellent condition (Cook and Bayes 2014).

Lake bed herbland is a community dominated by herbs and grasses (generally treeless) adapted to grow on the drying mud of freshwater lake beds. Within the Ramsar site it is often salt affected with invasions of the saltmarsh species blackseed glasswort (*Tecticornia pergranulata subsp. pergranulata*) and much of this vegetation was assessed in 2014 as being in poor condition (Cook and Bayes 2014).

Tall marsh is a vegetation community that comprises emergent macrophytes and within the Ramsar site typical species include: cumbungi (*Typha orientalis* and *Typha domingensis*), river club rush (*Schoenoplectus tabernaemontani*), giant rush (*Juncus ingens*) and occasionally common reed (*Phragmites australis*). In 2014, this vegetation community was assessed as being in moderate to good condition (Cook and Bayes 2014).

## Lignum dominated vegetation communities

Three lignum dominated EVCs occur within the Ramsar site (lignum shrubland, lignum swamp and lignum swampy woodland) covering 1562 hectares. Lignum is a feature at all the wetlands in the Ramsar site, except the saline lakes (Lake Tutchewop, Little Lake Kelly, Lake Kelly, Lake William and Lake Cullen). Two species of lignum occur within the Ramsar site; tangled lignum (*Duma florulenta*) and spiny lignum (*D. horrida*) and these species occur in association with cane grass (*Eragrostis australasica*) and a variety of grasses in lignum shrubland. In the lignum swampy woodland EVC, lignum occurs with black box (*Eucalyptus largiflorens*) and river red gum (*E. camaldulensis*) and/or eumong (*Acacia stenophylla*) with an understorey of aquatic species such as milfoil (*Myriophyllum papillosum*) water ribbons (*Triglochin multifructa*) and spike sedges (*Eleocharis* spp.).

In 2014, much of the lignum dominated vegetation was considered to be in poor to very poor condition with a high number of invasive species displacing the native shrubs (Cook and Bayes 2014).

## Tree dominated vegetation communities

There are three tree dominated EVCs within the Kerang Wetlands Ramsar site:

- Intermittent Swampy Woodland is a tree-dominated woodland with a shrubby and rhizomatous sedge understorey. There are large areas of this EVC in the Avoca Marshes and some in the Reedy Lake Complex dominated by river red gum, with occasional black box. Native understorey species include sedges (e.g. *Carex* spp.) and grasses (e.g. common blown grass (*Lachnagrostis filiformis*)).
- Riverine chenopod woodland occurs at many of the wetlands in the Ramsar site, with the greatest extent at Kangaroo Lake and Racecourse Lake. It is dominated by black box with a shrubby understorey with species such as tangled lignum, nitre goosefoot (*Chenopodium nitraria*), and various saltbushes (e.g. *Atriplex* spp.).
- There is a small area of riverine grassy woodland in Town Swamp and Kerang Weir Pool dominated by river red gum with a grassy understorey.

Table 4: Wetland vegetated EVCs in the Kerang Wetlands Ramsar Site (data from Cook and Baynes 2014<sup>1</sup> and DELWP unpublished<sup>2</sup>). Note that Stevensons Swamp has been omitted, as it has not held water since before listing and no longer supports wetland vegetation.

EVC	Freshwater lake aggregate	Aquatic herbland	Lake bed herbland	Tall marsh	Brackish lake bed herbland	Samphire shrubland	Lignum shrubland	Lignum swamp	Lignum swampy woodland	Intermittent swampy woodland	Riverine chenopod woodland	Grassy riverine forest
<b>Vegetation group</b>	<b>Freshwater lake aggregate</b>				<b>Saline Vegetation</b>		<b>Lignum dominated</b>			<b>Tree dominated</b>		
Lake Tutchewop <sup>1</sup>						52					20	
Lake William <sup>1</sup>						15					16	
Lake Kelly / Little Lake Kelly <sup>1</sup>						180					8	
Fosters Swamp <sup>2</sup>						40					1	
Little Lake Charm / Lake Charm <sup>2</sup>	516							117			14	
Kangaroo Lake / Racecourse Lake <sup>2</sup>	1210							29	2		46	
Reedy Lakes complex <sup>1</sup>		5		33					1	87	27	
First Marsh <sup>1</sup>			583				10			180		
Second Marsh <sup>1</sup>			11				22		118	244		
Third Marsh <sup>1</sup>			103				5		525	622		
Lake Bael Bael <sup>1</sup>			376	3				51		214		

EVIC	Freshwater lake aggregate	Aquatic herbland	Lake bed herbland	Tall marsh	Brackish lake bed herbland	Samphire shrubland	Lignum shrubland	Lignum swamp	Lignum swampy woodland	Intermittent swampy woodland	Riverine chenopod woodland	Grassy riverine forest
Cemetery Swamp <sup>2</sup>							2		222			
Hird Lake <sup>1</sup>		80		64					180	3	20	
Johnson Swamp <sup>1</sup>			170	41					105	24		
Lake Cullen <sup>1</sup>				9	594					3	24	
Town Swamp / Kerang Weir Pool <sup>2</sup>								9	164			3
<b>Total</b>	<b>1726</b>	<b>85</b>	<b>1317</b>	<b>150</b>	<b>594</b>	<b>287</b>	<b>39</b>	<b>206</b>	<b>1317</b>	<b>1377</b>	<b>177</b>	<b>3</b>
<b>Group totals</b>		<b>3278</b>			<b>881</b>			<b>1562</b>			<b>1557</b>	

### Saline vegetation communities

There are two saline vegetation communities within the Ramsar site. In 2014, Lake Cullen has a large extent of brackish lakebed herbland on the drying lakebed. In 2012 when the wetland was full of water, the vegetation was in good condition, but in 2014 when the lakebed was drying, the vegetation was assessed as “poor”. This reduction in condition was largely due to the fact that the dry lake bed did not support the expected cover and diversity of lake bed herbs and had been invaded by black-seeded glasswort (Cook and Baynes 2014).

Samphire shrubland occurs at the more saline lakes of Tutchewop, William, Kelly and Little Lake Kelly. The community is dominated by salt tolerant shrubs such as blackseed glasswort, grey glasswort (*Tecticornia halocnemoides*) and berry seablite (*Suaeda baccifera*). In 2014, this vegetation community was considered to be in good condition across all wetlands where it occurred (Cook and Baynes 2014).

## 5.2 Additional critical service: supports a diversity of wetland types

As described above, there are eight Ramsar wetland types in the Kerang Wetlands Ramsar Site. This diversity of wetland types is largely due to the combination of hydrology (see ECD section 3.1.1) and salinity (see ECD section 3.1.2). This diversity of wetland types provides a diversity of habitats for wetland dependent flora and fauna, particularly waterbirds; as well as provision of other services such as recreation. Apart from the Kerang Wastewater Treatment Plant which occupies only six hectares, wetlands can be grouped by type into five broad categories.

### Permanent freshwater lakes and swamps

Little Lake Charm, Lake Charm, Kangaroo Lake, Racecourse Lake and Third Lake, Middle Lake and Reedy Lake Complex all fall into this category and combined they cover an area of 2257 hectares within the Ramsar site. They are part of the Victorian Mid-Murray Storages and managed by Goulburn Murray Water; which maintain permanent water in these wetlands. They are largely open water, but may have fringes of emergent vegetation. Submerged aquatic macrophytes occur when the water is clear and sufficient light reaches the sediments and this was noted and mapped in 2006 at several wetlands including Little Lake Charm and Racecourse Lake. However, more recent mapping in 2013 – 2014 failed to detect submerged macrophytes at this site (Cook et al. 2013). Conditions at the time of listing are not known, but it is likely that non-woody vegetation such as emergent reeds and submerged macrophytes would vary over time in response to hydrology and water quality.

Deep, open water habitat provides habitat for diving and dabbling ducks and it is these open expanses of water that can provide refuge habitat during moult of primary flight feathers. The permanent freshwater is also important for native fish and several species are stocked within these lakes such as golden perch and Murray Cod (Department of Environment and Primary Industries 2014). Fish within these wetland systems proved valuable food resources for piscivorous waterbirds such as darters and cormorants.

### Seasonal /intermittent freshwater lakes

First Marsh is within this category of wetlands. It is dominated by open water when inundated, with a fringe of emergent vegetation. It covers 762 hectares within the Ramsar site. Upon drying, lakebed herbland colonises the drying wetland sediments (Cook and Baynes 2014). First Marsh is an unregulated system (i.e. not operated as a water storage or wastewater or salinity disposal site).

Wetting and drying cycles are important in maintaining productivity (Froend and McComb 1994). First Marsh provides important food resources for species such as large wading birds upon inundation.

### Seasonal /intermittent freshwater marshes and shrub-dominated wetlands

Second Marsh, Third Marsh, Lake Bael Bael, Cemetery Swamp, Hird Swamp, Johnson Swamp and Town Swamp / Kerang Weir Pool<sup>1</sup> are largely vegetated intermittent wetlands within the Ramsar site and cover a

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<sup>1</sup> Kerang Weir Pool has areas of permanent water, but is surrounded by larger areas of lignum swamp.

combined total of 2884 hectares. The majority of these wetlands have large areas of lignum dominated vegetation communities, many with a sparse overstorey of river red gum and/or black box. Hird and Johnson Swamps and Middle Lake also have significant areas of tall marsh, with emergent macrophytes forming dense vegetation cover (Cook and Bayes 2014). Several of these systems are regulated (Hird and Johnson Swamps and Town Swamp / Kerang Weir Pool) and have managed hydrological regimes, while others (Second and Third Marsh and Cemetery Swamp) are largely unregulated systems. These wetlands are generally shallow when inundated and retain water for only part of a year, enabling them to support long-lived woody vegetation communities.

### **Permanent saline lakes**

Lake Tutchewop, Lake William, Lake Kelly, Little Lake Kelly and a small part of Fosters Swamp are within this wetland category and cover an area of 976 hectares. All of these wetlands receive some form of water discharge. The permanently inundated part of Fosters Swamp (Figure 2) receives treated wastewater from the Kerang Wastewater Treatment Plant and the remainder receive saline water from the Barr Creek Diversion Scheme as part of the Murray-Darling Basin Authority Salt Interception Scheme. It is these water inflows that maintain the permanent and saline nature of these lakes.

The high salinity precludes freshwater vegetation, but most have margins of salt tolerant vegetation such as samphire (Cook and Bayes 2014). High salinity also results in clear water, with sediment particles flocculating under these conditions and this provides clear water for high salt tolerant algal growth, which in turn provides for an abundance of invertebrates (Khan 2003a, 2003b). These highly productive systems support high abundances of waterbirds, particularly waders. Thousands of banded stilt (*Cladorhynchus leucocephalus*), red-necked avocets (*Recurvirostra novaehollandiae*) and sharp-tailed sandpipers (*Calidris acuminata*) have been recorded in these lake systems; as have up to 8400 grey teal (*Anas gracilis*) and large numbers of other duck species known to utilise saline wetland habitats (Victorian Biodiversity Atlas).

### **Seasonal intermittent saline wetlands**

Lake Cullen and Stevenson Swamp are within this wetland group as well as most of Foster's Swamp (Figure 2). This group covers a combined area of approximately 1038 hectares. Lake Cullen and Stevenson Swamp are terminal wetlands and likely were naturally saline as salts concentrated when waters evaporated (Cook and Bayes 2014). Lake Cullen is now managed through environmental water (Cook and Bayes 2014) and there is anecdotal evidence that Stevenson Swamp has not held water for any length of time since before the time of listing in 1982. Lake Cullen is a shallow wetland that when inundated supports a saline aquatic meadow vegetation community and upon drying the lakebed is colonised by salt tolerant species such as black-seeded glasswort.

Lake Cullen periodically supports large numbers of waterbirds, particularly ducks, swans and coots (Summer Waterfowl Counts, DELWP unpublished).

## **5.3 Additional critical service: supports threatened species**

There are two threatened waterbird species that are regularly supported by the Ramsar site.

### **Curlew sandpiper**

The curlew sandpiper (*Calidris ferruginea*) is an international migratory species that spends the non-breeding season in the southern hemisphere. The birds arrive in late spring, spend the summer feeding on invertebrates in intertidal mudflats and depart for the northern hemisphere in February to March. Juveniles who arrive in Australia spend their first one or two winters here before heading to the northern hemisphere to breed. The curlew sandpiper is a small bird, with a weight of just 60 grams (Higgins and Davies 1996). The species is listed as critically endangered under the EPBC Act due to declines in the global populations, with habitat declines particularly at staging areas in the Yellow Sea recognized as the most significant impact factors (MacKinnon et al. 2012, Murray et al. 2015, Hua et al. 2015).

A small number of curlew sandpiper are regularly recorded in the Kerang Wetlands Ramsar Site, with maximum counts of around 200 in 1987 and 1990. The species is most often observed in the saline wetlands of Lake Tutchewop (60 % of records) and Lake Cullen (8% of records), with occasional sightings at Lake

Kelly, Foster Swamp Lake Bael Bael and Hird and Johnson Swamp (Victorian Biodiversity Atlas; Atlas of Living Australia).

### **Australasian bittern**

The Australasian bittern (*Botaurus poiciloptilus*) is a shy and cryptic wading species of wetland bird. Habitat preferences are for permanent, densely vegetated freshwater wetlands (Higgins and Marchant 1990). It is a diurnal forager and actively hunts prey items such as frogs and fish as well as a variety of terrestrial animals such as rodents and snakes (Menkhorst 2012).

Permanent and intermittent freshwater marshes with emergent vegetation provide habitat for this species within the Kerang Wetlands Ramsar Site. The Australasian bittern has been recorded at Hird and Johnson swamps, with single records also from Lakes Tutchewop and Cullen (Atlas of Living Australia and NC CMA unpublished). Data are too sparse to determine numbers within the Ramsar site, but there are four records of > 1 % of the population (5 individuals Wetlands International 2012):

- January 2003 – 10 in Hird Swamp
- October 2005 – 8 in Johnson Swamp
- November 2006 – 10+ in Hird Swamp
- November 2015 – 7 in Johnson Swamp.

Observations of Australasian bittern in New Zealand indicate a potentially long breeding season. Booming calls were recorded in most months but peaked between September and November. Breeding was observed from August to May, with most activity in November and December (O'Donnell 2011). The species is present in the Ramsar site during the breeding season and calls have been observed, suggesting the species possibly breeds in both Hird and Johnson Swamp.

## **6. Limits of Acceptable Change**

### **6.1 Summary of changes to LAC**

LAC for the Kerang Wetlands Ramsar Site were reviewed with site managers and relevant technical experts. LAC fell into one of three categories (Table 5).

#### **1. No change**

The salinity LAC for Kangaroo Lake, Racecourse Lake, Little Lake Charm, Reedy Lake, Middle Lake, Third Lake, Cemetery Swamp, Lake Bael Bael, Avoca Marshes, Kerang Weir Pool, Town Swamp, Johnson Swamp, and Hird Swamp remains unchanged at greater than 4000 EC when more than 75% full. The salinity LAC for these wetlands is of low confidence but insufficient additional data could be sourced to develop new LAC. The LAC should be reviewed in the future when additional quantitative data becomes available.

#### **2. New information resulted in a refinement or significant change to the following LAC**

- salinity for Lake Cullen
- hydrology
- waterbirds (abundance) and
- waterbird breeding.

#### **3. New LACs were developed for:**

- vegetation diversity
- waterbird diversity and
- threatened species.

The revised LAC are set out in the Table 5: Revised LAC for the Kerang Wetlands Ramsar Site. **Error! Reference source not found.** The complete set of LAC for the site are shown in Table 7

Confidence levels have been reviewed for new and revised LAC. These are assigned as follows:

- High – Quantitative site-specific data; good understanding linking the indicator to the ecological character of the site; LAC is objectively measurable.
- Medium – Some site-specific data or strong evidence for similar systems elsewhere derived from the scientific literature; or informed expert opinion; LAC is objectively measurable.
- Low – No site-specific data or reliable evidence from the scientific literature or expert opinion, LAC may not be objectively measurable and/or the importance of the indicator to the ecological character of the site is unknown

**Table 5: Revised LAC for the Kerang Wetlands Ramsar Site.**

Critical CPS	Existing LAC	Evidence	Revised LAC	Confidence
Hydrology – Kangaroo Lake Racecourse Lake Reedy Lake	Permanently inundated. Not to exceed the 600mm range of fluctuation in water levels two years in a row.	The operating ranges (metres AHD) for the Goulburn-Murray Water operated storages are as follows (data provided by K. Mason, Goulburn-Murray Water): – Kangaroo, Racecourse and Little Lake Charm – 73.10 to 73.93 (0.83 m) – Lake Charm – 73.00 to 73.93 (0.93 m) – Reedy and Middle Reedy Lakes – 74.47 to 74.88 (0.41 m) – Third Reedy Lake – 74.40 – 74.57 (0.17 m)	– Kangaroo Lake, Racecourse Lake, Lake Charm and Little Lake Charm: permanently inundated, water level to not be > 74.1 m AHD or < 72.9 m AHD for more than two years in a row. – Reedy Lake and Middle Reedy Lake: permanently inundated, water level to not be > 75.0 m AHD or < 74.3 m AHD for more than two years in a row. – Third Reedy Lake: permanently inundated, water level to not be > 74.8 m AHD or < 74.2 m AHD for more than two years in a row.	Low
Hydrology – Lake Charm Little Lake Charm Third Reedy Lake	Permanently inundated. Not to exceed the 1000 mm range of fluctuation in water levels two years in a row.	Exponentially Weighted Moving Averages (EWMA) are a control charting technique designed to detect sustained trends and if a system is “out of control”. EWMA of water levels in these storages are provided in Figures 4 to 7 and indicate that with the exception of Lake Charm, there has not been a sustained change in water level or variability since the mid-1980s.		
Middle Reedy Lake	Permanently inundated. Not to exceed the 400mm range of fluctuation in water levels two years in a row.	The LAC is meant to be a potential indicator of a change in character and so should be outside operating ranges and the variability in water levels at the time of listing. It also needs to account for short term responses to flood and drought. However, these systems are permanently inundated and it is permanent water that provides habitat for waterbirds during drought conditions.  LAC have been modified to reflect the conditions at the time of listing and to be outside normal operating levels, with lakes grouped according to operations of Goulburn-Murray Water.		
Hydrology – Cemetery Swamp	Not dry for 10 or more consecutive years. Not continuously wet for more than two years	LAC has been updated based on local knowledge.	Not continuously wet for 10 or more years. Not continuously dry for nine or more years.	Moderate



Critical CPS	Existing LAC	Evidence	Revised LAC	Confidence
Hydrology – Lake Bael Bael	Not dry for nine or more consecutive years.	LAC has been updated based on local knowledge to include a wet phase threshold.	Not continuously wet for five or more years. Not continuously dry for nine or more years.	Moderate
Hydrology – Avoca Marshes	First Marsh: not wet for three or more consecutive years. Not dry for more than six years in any 20-year period.  Second and Third Marshes: not wet for more than two consecutive years. Not dry for more than 17 years in any 20-year period	LAC has been updated based on local knowledge.	First Marsh: Not continuously wet for three or more years. Not continuously dry for six or more years.  Second and Third Marshes: Not continuously wet for three or more years. Not continuously dry for 10 or more years. Years.	Moderate
Hydrology – Town Swamp / Kerang Weir Pool	Not continuously wet for two or more years. Not dry for five or more consecutive years.	The water regime of these two wetlands is believed to be different with Town Swamp being drier and Kerang Weir Pool being considered almost permanent. Water levels in Kerang Weir Pool vary according to river heights and irrigation flows, whereas Town Swamp is flooded when the river floods (based on anecdotal evidence from local landholder, Goulburn Murray Water staff and statements in the 2011 ECD). There is a lack of hydrological data available for wetlands and the LAC as it currently written is not appropriate for both wetlands.	Insufficient data to determine a LAC for these two systems, however once data is available it would be expected that two separate LAC are required – one for each wetland.	n/a
Hydrology – Lake Cullen	Not dry for more than 10 years in any 20-year period.	An environmental water management plan for Lake Cullen recommends a water regime designed to maintain ecological character: two years wet and four years dry (NC CMA 2013). LAC is based on a 50% change from this recommended regime.	Not continuously wet for five or more years. Not continuously dry for eight or more years.	Moderate
Hydrology – Johnson Swamp	Not dry for five or more consecutive years. Not wet for two or more consecutive years	No significant change to LAC.	Johnson Swamp not dry for five or more consecutive years. Not wet for two or more consecutive years.	Moderate
Hydrology – Hird Swamp	Not dry for five or more consecutive years. Not wet for two or more consecutive years.	No significant change to LAC. The hydrology of the wetland has not changed other than experiencing an extended dry period during the Millennium Drought.	Hird Swamp not dry for five or more consecutive years. Not wet for two or more consecutive years.	Moderate

Critical CPS	Existing LAC	Evidence	Revised LAC	Confidence
Salinity – Lake Cullen	Salinity levels to be between 10,000 EC and 120,000 EC when lake is more than 75% full.	<p>Lake Cullen does not flood naturally as it is cut off from the floodplain. The only water that the wetland receives is fresh water from managed deliveries (environmental water or flood mitigation flows) via the regulated irrigation system.</p> <p>Salinity levels in the lake range from 4000 EC to 170000 EC depending on water level (Lugg et al. 1989). As the wetland undergoes a drying cycle it progresses from fresh to brackish to hypersaline.</p> <p>When monitored in 2016, salinity ranged between 1744 and 2038 EC (less than 10,000 EC) when water level was above 72 AHD (75% full by depth). However, there are no data for other events where the lake exceeded 72 AHD.</p> <p>Given the limited evidence on salinity levels at different levels of inundation for Lake Cullen, the LAC is not considered valid. Instead an interim LAC has been adopted based on a change in salinity category to hypersaline (&gt;85,000EC) which applies when the lake is 75% full. The LAC should be reviewed as more data becomes available</p>	The lake does not fall into the hypersaline category (exceed 85,000 EC) when $\geq 75\%$ full (by depth).	Low
Waterbirds - abundance	Where appropriate data are collected, the number of years in which >20,000 waterbirds are recorded in a rolling ten-year period is not less than three years.	<p>Data from multiple sources has now been consolidated to provide annual total maximum waterbird counts for the Ramsar site. Abundance is highly variable due to two separate factors: firstly, inconsistent counts across all wetlands within the Ramsar site; and secondly, the highly mobile nature of waterbirds, that respond to climatic and other factors.</p> <p>A plot of moving averages at five and ten-year time frames (Figure 8) illustrates this variability and the fact that a five-year average is probably too short a period of time to derive a LAC. The ten-year average is more stable and does not indicate a sustained trend in waterbird abundance at the site. Data used span both wet and dry periods and the 10-year average never falls below 10,000.</p>	The 10-year rolling average for annual maximum waterbirds is not < 10,000	High

Critical CPS	Existing LAC	Evidence	Revised LAC	Confidence
Waterbirds – colonial nesting species	<p>Middle Lake: No more than 10 consecutive years in which there is no successful breeding of Australian white ibis and straw-necked ibis.</p> <p>Avoca Marshes: No more than 10 consecutive years in which there is no breeding of royal spoonbill, darter, great cormorant, pied cormorant and yellow spoonbill.</p>	<p>Records of waterbird breeding are largely ad hoc or opportunistic, with no dedicated monitoring program designed to capture these events, even for colonial nesting species. The data in the ECD is not quantitative and does not indicate whether a single pair started to nest, or a full colony of 1000s of birds successfully fledged chicks. More recent data from aerial surveys across most of the Ramsar site indicates colonial nesting of straw-necked ibis and Australian white ibis in the Reedy Lakes system in 2010, 2011, 2012 2013, 2014 but the only breeding recorded in the Avoca Marshes was for grey teal in 2012 (<a href="https://aws.ecosystem.unsw.edu.au/publicsearch">https://aws.ecosystem.unsw.edu.au/publicsearch</a>).</p> <p>The available data do not support a LAC for colonial nesting species in the Avoca Marshes and so this has been removed. The LAC is based upon colonial nesting species breeding anywhere within the Ramsar site, noting that the Reedy Lake complex is the most likely to support this on a regular basis.</p>	<p>No more than 10 consecutive years in which there are no colonial nesting events of at least 1000 nests in the Kerang Wetlands Ramsar Site. Species may include <i>any</i> of the following:</p> <ul style="list-style-type: none"> <li>– Australasian darter (<i>Anhinga novaehollandiae</i>)</li> <li>– Australian white ibis (<i>Threskiornis molucca</i>)</li> <li>– Great cormorant (<i>Phalacrocorax carbo</i>)</li> <li>– Pied cormorant (<i>Phalacrocorax varius</i>)</li> <li>– Royal spoonbill (<i>Platalea regia</i>)</li> <li>– Straw-necked ibis (<i>Threskiornis spinicollis</i>).</li> <li>– Yellow-billed spoonbill (<i>Platalea flavipes</i>)</li> </ul>	Moderate
Waterbird diversity	None specified, not identified as critical service in ECD.	<p>The site supports a diversity of waterbirds with a total of 86 wetland dependent species recorded from the site. Annual total wetland bird species richness from 1980 to 2016 is 45. Similar to waterbird abundance, this measure suffers from a lack of complete counts across the Ramsar site each year and, prior to the mid 1980s in particular, sampling effort was low. Since the 1990s, the rolling five-year average has remained above 35 (Figure 9). LAC is set on a 50% decline in average species richness to account for the high degree of variability.</p>	Total annual species richness of wetland dependent birds shall not be less than 22.	Moderate

Critical CPS	Existing LAC	Evidence	Revised LAC	Confidence
Vegetation diversity	None specified, not identified as critical service in ECD.	<p>Recent vegetation mapping has been used to establish a benchmark, as data from the time of listing is not available. Vegetation communities have been grouped into broad types, reflecting the variability in response to annual water conditions (for example, non-woody vegetation may occur as submerged macrophytes during inundation, but transition to lakebed herbland during drying). The extent of the broad vegetation communities is as follows (Cook et al. 2013, Cook and Bayes 2014):</p> <ul style="list-style-type: none"> <li>• Freshwater herb/grass/sedge/forb – 3278 hectares</li> <li>• Brackish herb/grass/sedge/forb – 600 hectares</li> <li>• Samphire – 290 hectares</li> <li>• Lignum dominated – 1562 hectares</li> <li>• Intermittent swampy woodland – 1300 hectares</li> </ul> <p>In addition, a total of 170 native wetland dependent plant species have been recorded from the site (Cook and Bayes 2014).</p> <p>LAC is based on a 25% decline in the extent / species richness of these vegetation across the Ramsar site.</p>	<p>The total extent of the following vegetation communities will not be less than:</p> <ul style="list-style-type: none"> <li>• Freshwater herb/grass/sedge/forb – 2400 hectares</li> <li>• Brackish herb/grass/sedge/forb – 450 hectares</li> <li>• Samphire – 220 hectares</li> <li>• Lignum dominated – 1170 hectares</li> <li>• Intermittent swampy woodland – 975 hectares</li> </ul> <p>The species richness of native wetland dependent plant species will not be less than 125.</p>	Moderate
Supports a diversity of wetland types	None specified, not identified as critical service in ECD.	Wetland type is a product of hydrology, salinity and vegetation. This criteria service is covered by the LACs for those respective components and processes.	See LAC for hydrology, salinity and vegetation.	n/a
Supports threatened species - waterbirds	None specified, not identified as critical service in ECD.	<p>There is insufficient data on the two threatened waterbird species within the site to develop a quantitative LAC. The Australasian bittern occurs in Hird and Johnsons Swamps, and the Curlew Sandpiper is most often recorded in Lake Tutchewop (and other saline wetlands in the site) – with records of presence in 69% of years.</p> <p>LAC is based on presence, over a medium timeframe (10 years) to account for shorter term variability.</p>	<p>Australasian bittern (<i>Botaurus poiciloptilus</i>) present in five out of 10 years in Hird and / or Johnsons Swamp.</p> <p>Curlew sandpiper (<i>Calidris ferruginea</i>) recorded within the Ramsar site in no less than five years out of 10.</p>	Low

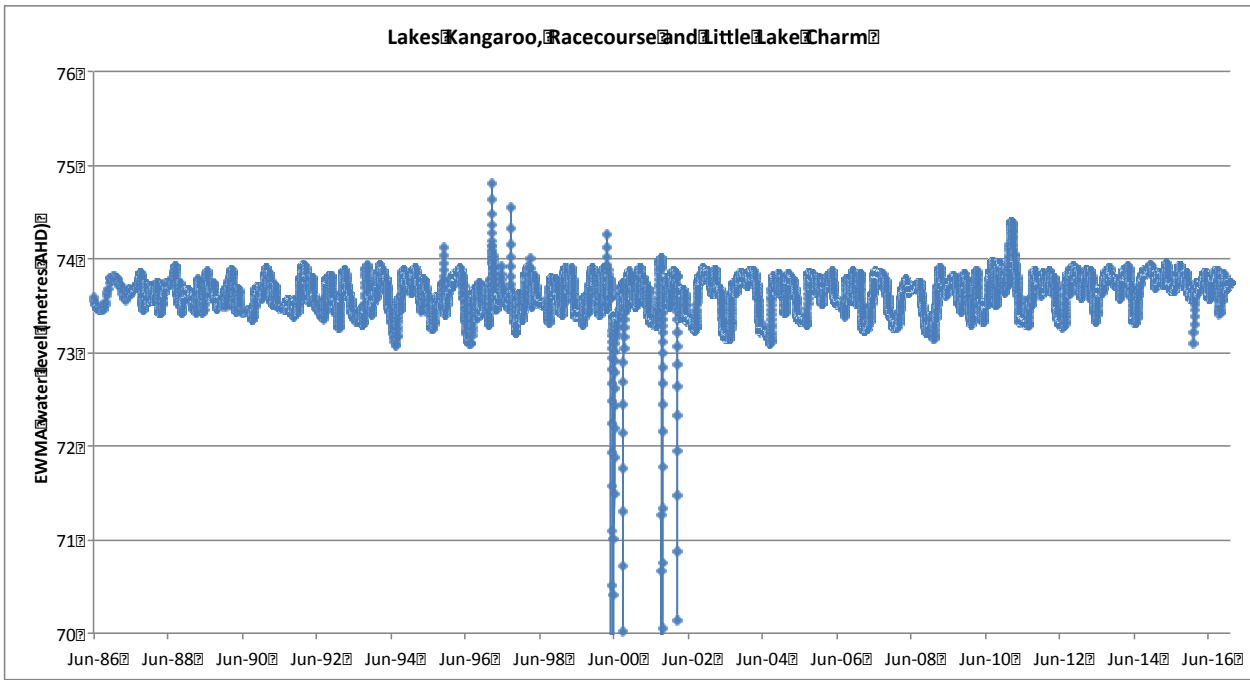


Figure 4. EWMA of water levels at gauge representing Lakes Kangaroo, Racecourse and Little Lake Charm (data provided by Goulburn-Murray Water).

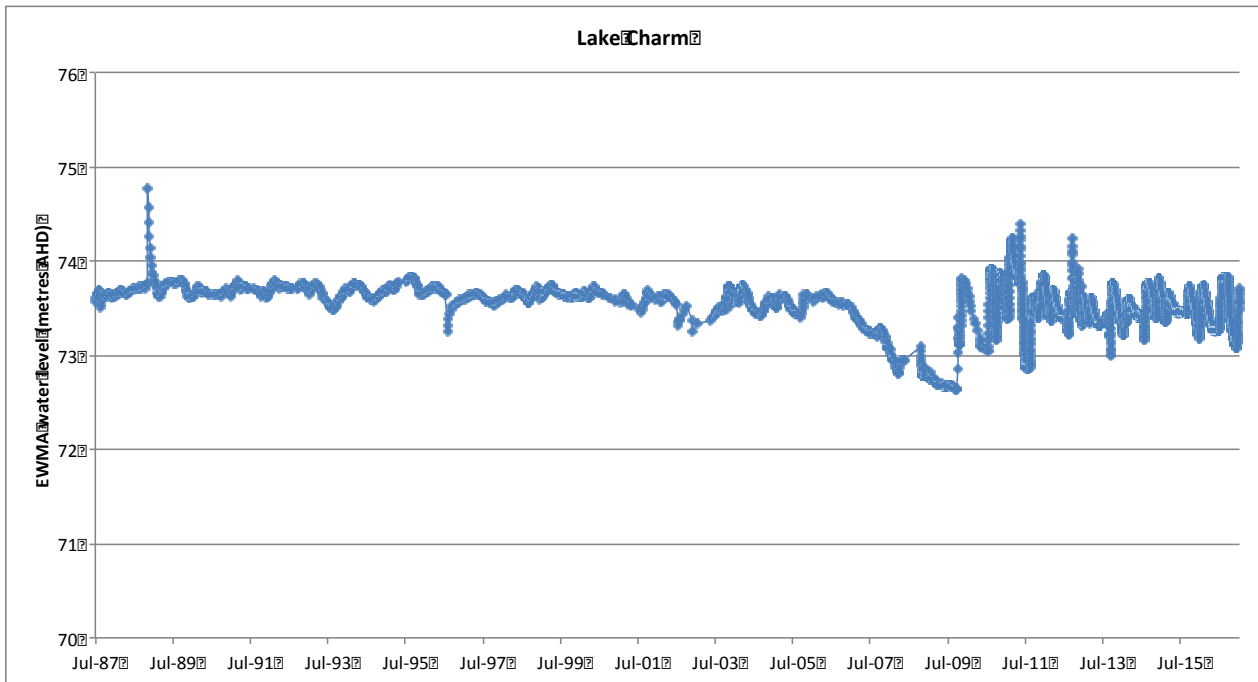


Figure 5: EWMA of water levels at Lake Charm (data provided by Goulburn-Murray Water).

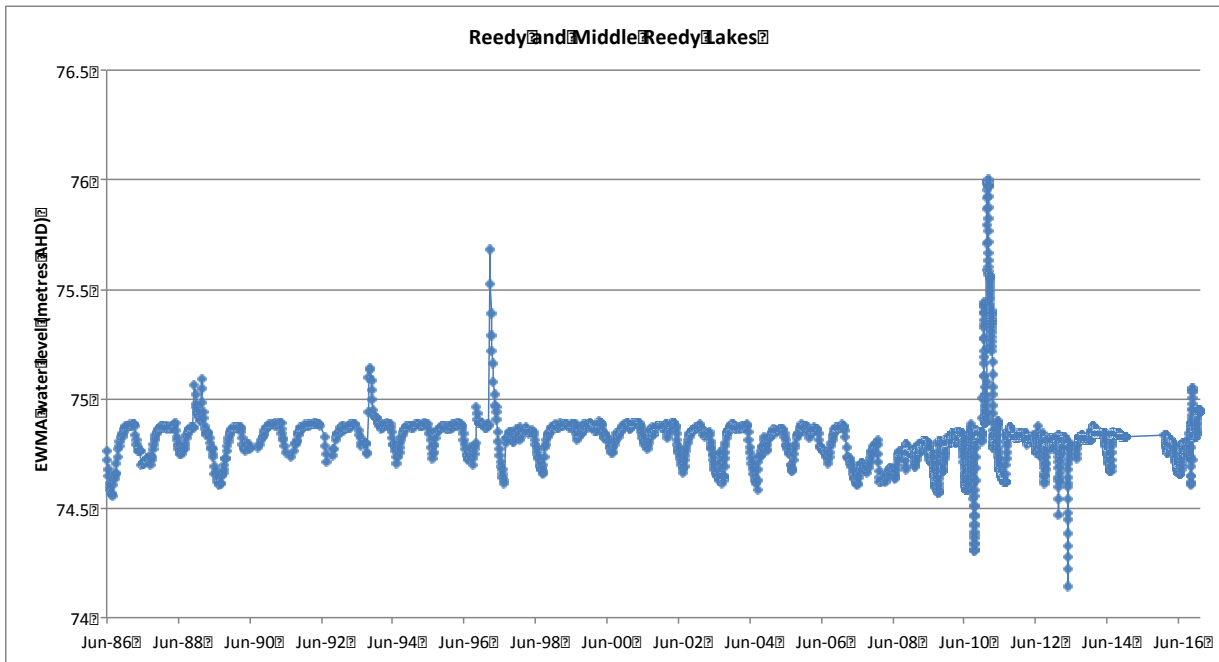


Figure 6: EWMA of water levels at gauge representing Reedy and Middle Reedy Lakes (data provided by Goulburn-Murray Water).

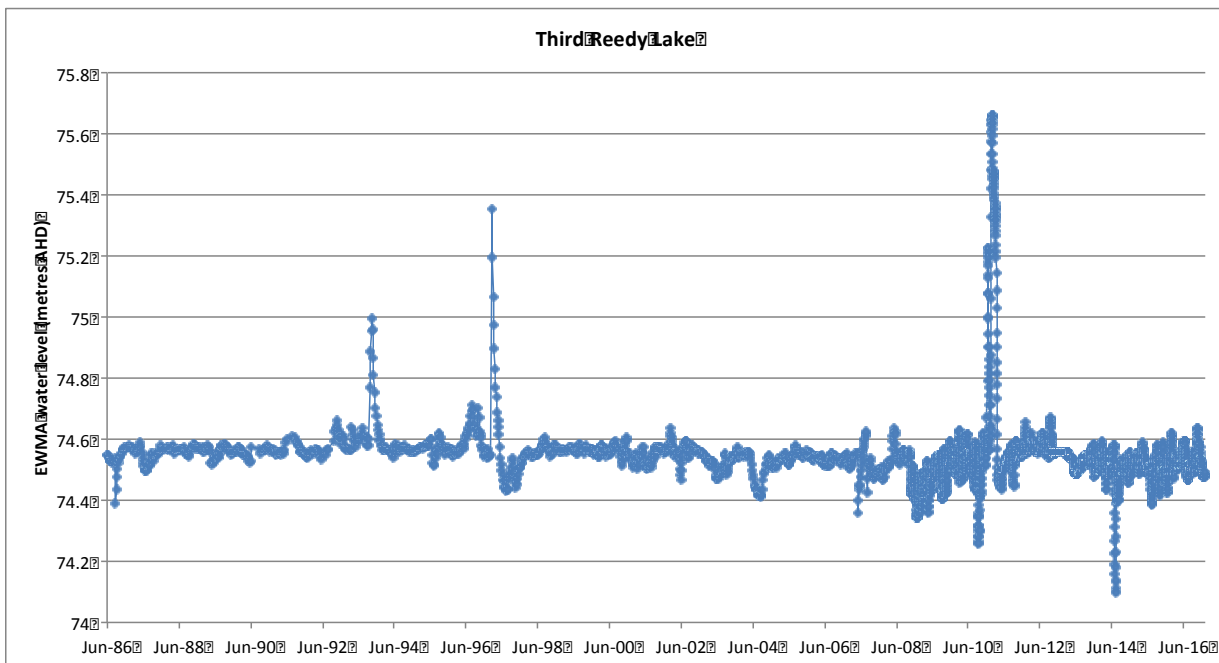


Figure 7: EWMA of water levels at Third Reedy Lake (data provided by Goulburn-Murray Water).

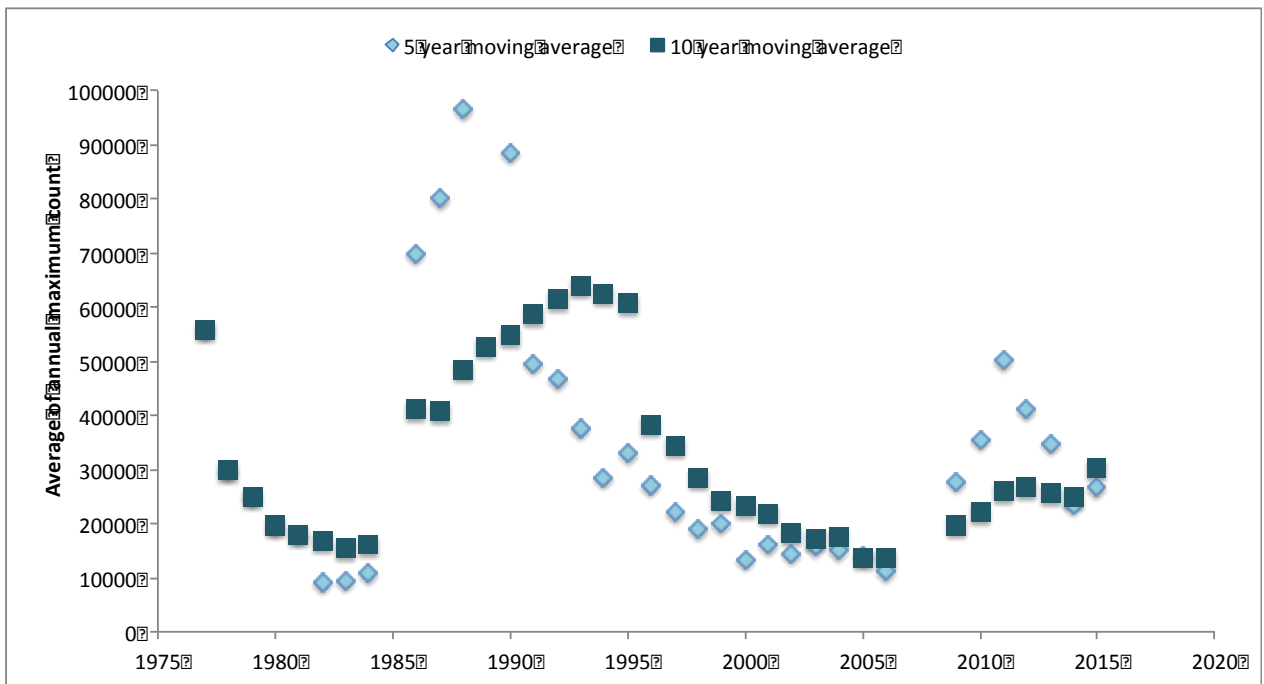


Figure 8: Moving averages (five and ten-year time frames) for annual total maximum waterbird counts in the Kerang Wetlands Ramsar Site.

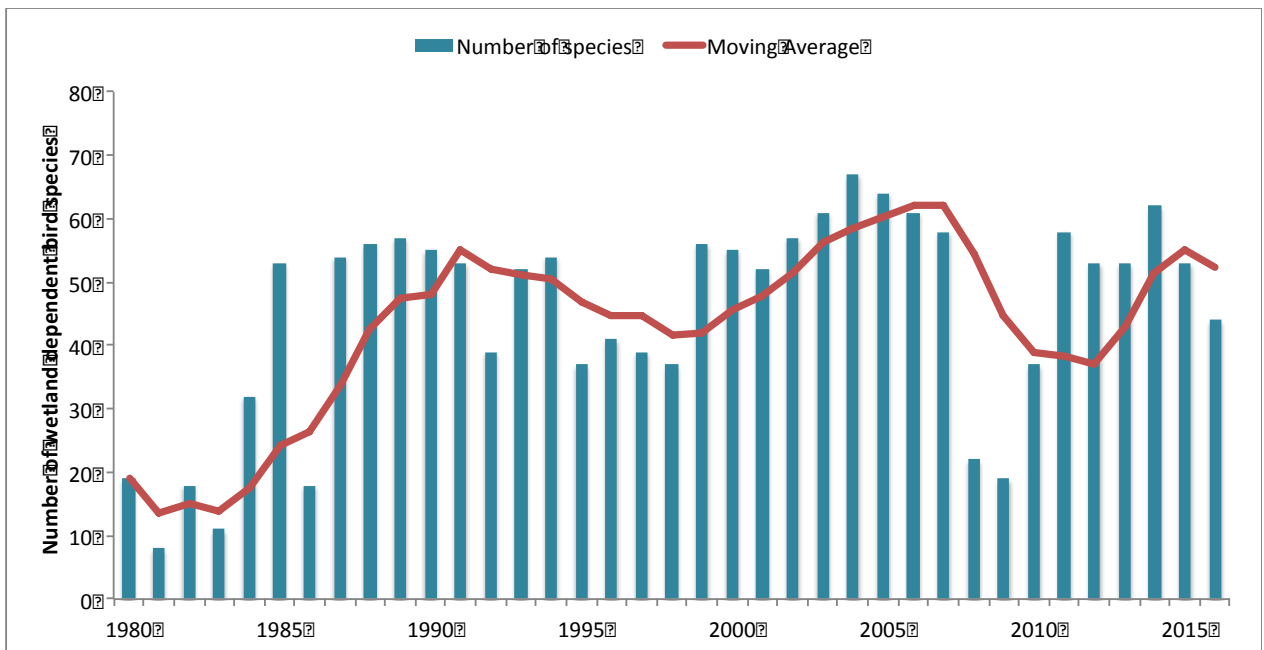


Figure 9: Total annual species richness for wetland dependent bird species in the Kerang Wetlands Ramsar Site, with five year rolling average (data from Atlas of Living Australia, Victorian Biodiversity Atlas, NC CMA unpublished).

## 7. Threats to ecological character

### 7.1 Threats

The ECD for the Ramsar site (Kellogg Brown and Root 2011) describes the following threats to the site:

- presence of pest plants and animals
- altered water regimes
- surrounding land use change
- unsustainable recreational activities
- changes to level and trend in surface water quality
- climate change and
- bed and bank erosion.

A risk assessment for an action plan for the Kerang Wetlands Ramsar Site undertook a detailed risk assessment for values in each of the four hydrological categories of wetlands:

- regulated freshwater permanent wetlands (Little Lake Charm, Lake Charm, Kangaroo Lake, Racecourse Lake, Third Lake, Reedy Lake and Middle Lake)
- regulated freshwater intermittent wetlands (Hird Swamp, Johnson Swamp, Town Swamp, Kerang Weir Pool and Lake Cullen)
- salt/sewage disposal and drainage wetlands (Lake Tutchewop, Lake William, Lake Kelly, Little Lake Kelly and Fosters Swamp) and
- unregulated freshwater intermittent wetlands (First Marsh, Second Marsh, Third Marsh, Lake Bael Bael, Cemetery Swamp and Stevensons Swamp).

The risk assessment identified the threats that pose a very high or high risk to the values in each of these hydrological categories (Table 6). The plan describes the values that are affected, the stressor and the effect on the values.

**Table 6. Threats that pose a very high or high risk to wetlands in each of four hydrological categories in the Kerang Wetlands Ramsar Site.**

Threat	Regulated freshwater permanent wetlands	Salt / sewage disposal and drainage wetlands	Regulated freshwater intermittent wetlands	Unregulated freshwater intermittent wetlands
Climate change and severe weather events - Drought		Yes	Yes	Yes
Climate change and severe weather events - Higher temperatures	Yes		Yes	Yes
Climate change and severe weather events – Unseasonal flooding			Yes	Yes
Flood mitigation	Yes			
Invasive native species - aquatic vegetation e.g. Cumbungi and Typha			Yes	
Invasive non-native species - aquatic vegetation e.g. Arrowhead	Yes			



Threat	Regulated freshwater permanent wetlands	Salt / sewage disposal and drainage wetlands	Regulated freshwater intermittent wetlands	Unregulated freshwater intermittent wetlands
Invasive non-native species - non-woody weeds e.g. creepers	Yes	Yes	Yes	Yes
Invasive non-native species - woody weeds e.g. willows, boxthorn, blackberry, briar rose	Yes	Yes	Yes	Yes
Invasive non-native species: carp and Gambusia	Yes			
Invasive non-native species: Cats, foxes, pigs, rabbits	Yes	Yes	Yes	Yes
Loss of standing timber habitat	Yes			
Recreational activities	Yes	Yes	Yes	Yes
Residential and commercial development	Yes	Yes	Yes	Yes
Resource use - grazing licenses	Yes	Yes		Yes
Resource use - Unlicensed grazing		Yes	Yes	Yes
Water resource use and regulation		Yes	Yes	Yes
Wild fire			Yes	Yes

## 8. Changes since listing

The results of a 2016 assessment of the status of the critical CPS against the updated LAC is set out in Table 7. This assessment indicates that the majority of LAC were met, with the exception of the hydrology LAC for Lake Charm and the Avoca Marshes. Water storages are managed with the aim of meeting the LAC, but periods of drought and flood, result in fluctuations in water level beyond manager's ability to control. For the Avoca Marshes the late 1996 to mid-2010 Millennium Drought (<http://www.bom.gov.au/climate/updates/articles/a010-southern-rainfall-decline.shtml>) meant the LAC was exceeded. These exceedances are **not** considered a potential change in character.

Table 7. Summary of assessment against LAC for the Kerang Wetlands Ramsar Site.

Critical CPS	Limit of Acceptable Change	2016 Assessment
Hydrology - Kangaroo Lake, Racecourse Lake, Lake Charm and Little Lake Charm	Permanently inundated, water level to not be > 74.1 m AHD or < 72.9 m AHD for more than two years in a row.	Data provided by Goulburn-Murray Water indicate that water levels in Kangaroo Lake, Racecourse Lake and Little Lake Charm were greater than 74.1 m AHD in 2011 (Figure 10). Water levels in Lake Charm exceed limits in 2011, 2012 and 2013 (Figure 11). <b>LAC is exceeded for Lake Charm</b>
Hydrology - Reedy Lake and Middle Reedy Lake	Permanently inundated, water level to not be > 75.0 m AHD or < 74.3 m AHD for more than two years in a row.	Data provided by Goulburn-Murray Water indicate that water levels exceeded limits in 2011 and 2013 and by 900 mm in 2016. No data was available for 2015 (Figure 12). <b>LAC is met</b>

Critical CPS	Limit of Acceptable Change	2016 Assessment
Hydrology - Third Reedy Lake	Permanently inundated, water level to not be > 74.8 m AHD or < 74.2 m AHD for more than two years in a row.	Data provided by Goulburn-Murray Water indicate that water levels exceed limits in 2011 and 2014 (Figure 13). <b>LAC is met</b>
Hydrology - Cemetery Swamp	Not continuously wet for 10 or more years. Not continuously dry for nine or more years.	Cemetery swamp was inundated in 2011 and 2012; but exceeded the LAC in the previous decade (Victorian annual waterfowl count DELWP unpublished). <b>LAC is met</b>
Hydrology - Lake Bael Bael and First Marsh	Not continuously wet for five or more years. Not continuously dry for nine or more years.	Lake Bael Bael was dry in 2011, inundated in 2012 and part of 2013 and dry in 2014 (Victorian annual waterfowl count DELWP unpublished). <b>LAC is met</b>
Hydrology - Avoca Marshes	First Marsh: Not continuously wet for three or more years. Not continuously dry for six or more years. Second and Third Marshes: Not continuously wet for three or more years. Not continuously dry for 10 or more years. Years.	Although the Marshes filled in 2010 and 2011 (Victorian annual waterfowl count DELWP unpublished), the LAC is exceeded due to the Millennium Drought (late 1996 to mid-2010). <b>LAC is exceeded</b>
Hydrology - Town Swamp / Kerang Weir Pool	Insufficient data to determine a LAC.	<b>Not applicable.</b>
Hydrology - Lake Cullen	Not continuously wet for five or more years. Not continuously dry for eight or more years.	Dry from 2001 to 2006/7, when received environmental water. Dry again in 2007/8 to 2010; then received environmental water in 2010/2011 and 2011/ 2012 (Jensz 2011). <b>LAC is met.</b>
Hydrology - Johnson Swamp	Johnson Swamp not dry for five or more consecutive years. Not wet for two or more consecutive years.	Wet dry cycles as follows (Jensz 2011 and unpublished data provided by NC CMA): 2005/6 – wet 2006/7 – 2009/10 – dry 2010/11 – wet 2011/12 – wet 2012/13 – dry 2013/14 – dry 2014/15 – dry 2015/16 - wet <b>LAC is met.</b>

Critical CPS	Limit of Acceptable Change	2016 Assessment
Hydrology - Hird Swamp	Hird Swamp not dry for five or more consecutive years. Not wet for two or more consecutive years.	Wet dry cycles as follows (Jensz 2011 and unpublished data provided by NC CMA): 2005/6 – dry 2006/7 – wet 2007/8 – 2009/10 – dry 2010/11 – wet 2011/12 – wet 2012/13 – 2015/16 dry (four years) <b>LAC is met.</b>
Salinity	Greater than 4000 EC when more than 75% full, at any of the following wetlands: Kangaroo Lake; Racecourse Lake; Little Lake Charm; Reedy Lake; Middle Lake; Third Lake: Cemetery Swamp; Lake Bael Bael; Avoca Marshes; Back/ Town Swamp; Johnson Swamp; Hird Swamp.	Data for past 3 years (2011 – 2014) indicates ( <a href="http://data.water.vic.gov.au/monitoring.htm">http://data.water.vic.gov.au/monitoring.htm</a> ): Kangaroo Lake < 1000 EC Lake Bael Bael < 4000 EC, when wet, higher when dry Lake Cullen = 11650 in 2007 No other data available <b>Insufficient data to assess LAC</b>
Salinity – Lake Cullen	The lake does not fall into the hypersaline category (exceed 85,000 EC) when >=75% full (by depth).	<b>Insufficient data to assess LAC</b>
Waterbirds - abundance	The 10-year rolling average for annual maximum waterbirds is not < 10,000	The ten-year rolling average 2005 to 2015 remained above 10,000 (see Figure 8) above). <b>LAC is met.</b>
Waterbirds – colonial nesting species	No more than 10 consecutive years in which there are no colonial nesting events of at least 1000 nests in the Kerang Wetlands Ramsar Site. Species may include <i>any</i> of the following: <i>Australasian darter (Anhinga novaehollandiae)</i> <i>Australian white ibis (Threskiornis molucca)</i> <i>Great cormorant (Phalacrocorax carbo)</i> <i>Pied cormorant (Phalacrocorax varius)</i> <i>Royal spoonbill (Platalea regia)</i> <i>Straw-necked ibis (Threskiornis spinicollis)</i> <i>Yellow-billed spoonbill (Platalea flavipes)</i>	Data from aerial surveys indicates breeding by colonial nesting species every year from 2010 to 2014, with > 1000 nests in 2010 (26,000 nests) and 2014 (4000 nests) ( <a href="https://aws.ecosystem.unsw.edu.au/publicsearch">https://aws.ecosystem.unsw.edu.au/publicsearch</a> ). Observations of > 1000 nests in 2016 (NC CMA unpublished). <b>LAC is met.</b>
Waterbird diversity	Total annual species richness of wetland dependent birds shall not be less than 22.	Data indicates that the rolling average 2005 to 2015 was > 38 each year (see Table 4 above). <b>LAC is met.</b>

Critical CPS	Limit of Acceptable Change	2016 Assessment
Vegetation diversity	The total extent of the following vegetation communities will not be less than: Freshwater herb/grass/sedge/forb – 2400 hectares Brackish herb/grass/sedge/forb – 450 hectares Samphire – 220 hectares Lignum dominated – 1170 hectares Intermittent swampy woodland – 975 hectares The species richness of wetland dependent plant species will not be less than 125.	Data from 2014 was used to establish the LAC and all vegetation communities were in excess of the thresholds, species richness was > 170 wetland dependent plant species (Cook et al. 2013, Cook and Bayes 2014). <b>LAC is met.</b>
Supports a diversity of wetland types	See LAC for hydrology, salinity and vegetation.	Insufficient data to assess against LAC (salinity and hydrology, see above).
Supports threatened species - waterbirds	Australasian bittern ( <i>Botaurus poiciloptilus</i> ) present in five out of 10 years in Hird and / or Johnsons Swamp. Curlew sandpiper ( <i>Calidris ferruginea</i> ) recorded within the Ramsar site in no less than five years out of 10.	Australasian bittern and curlew sandpiper recorded in five of the last 10 years. (Atlas of Living Australia ( <a href="http://www.ala.org.au/">http://www.ala.org.au/</a> )). <b>LAC is met.</b>

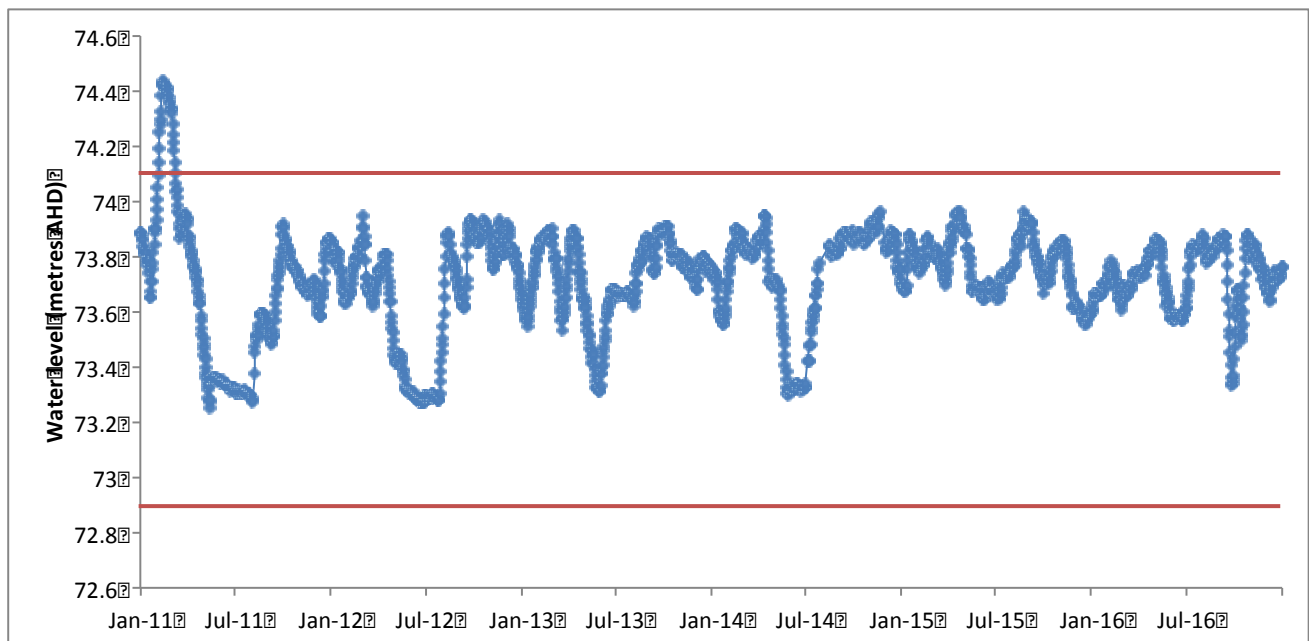


Figure 10: Water level at gauge representing Racecourse Lake, Kangaroo Lake and Little Lake Charm 2011 – 2016 (data provided by Goulburn-Murray Water), red lines indicate LAC water levels.

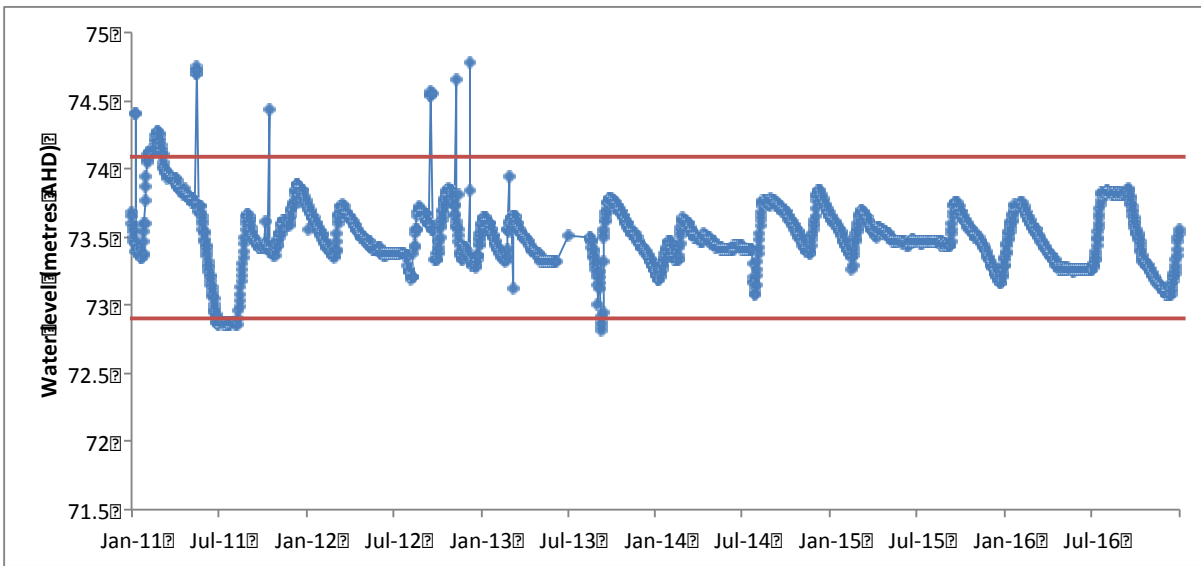


Figure 11: Water level in Lake Charm 2011 – 2016 (data provided by Goulburn-Murray Water), red lines indicate LAC water levels.

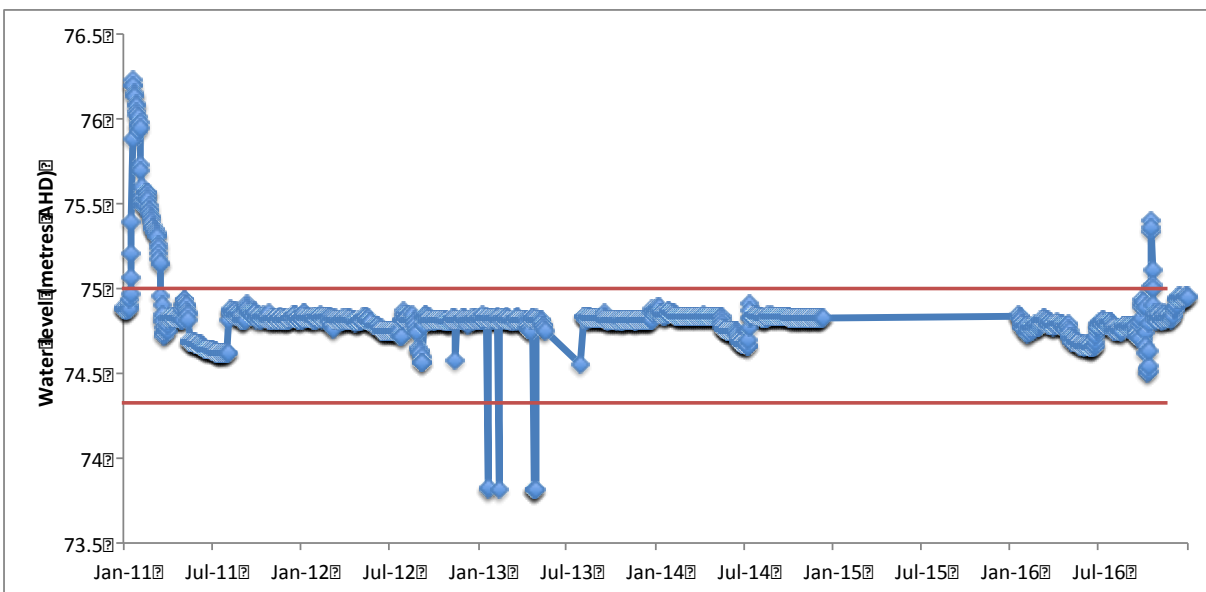


Figure 12: Water level in Reedy and Middle Reedy Lake 2011 – 2016 (data provided by Goulburn-Murray Water), red lines indicate LAC water levels.

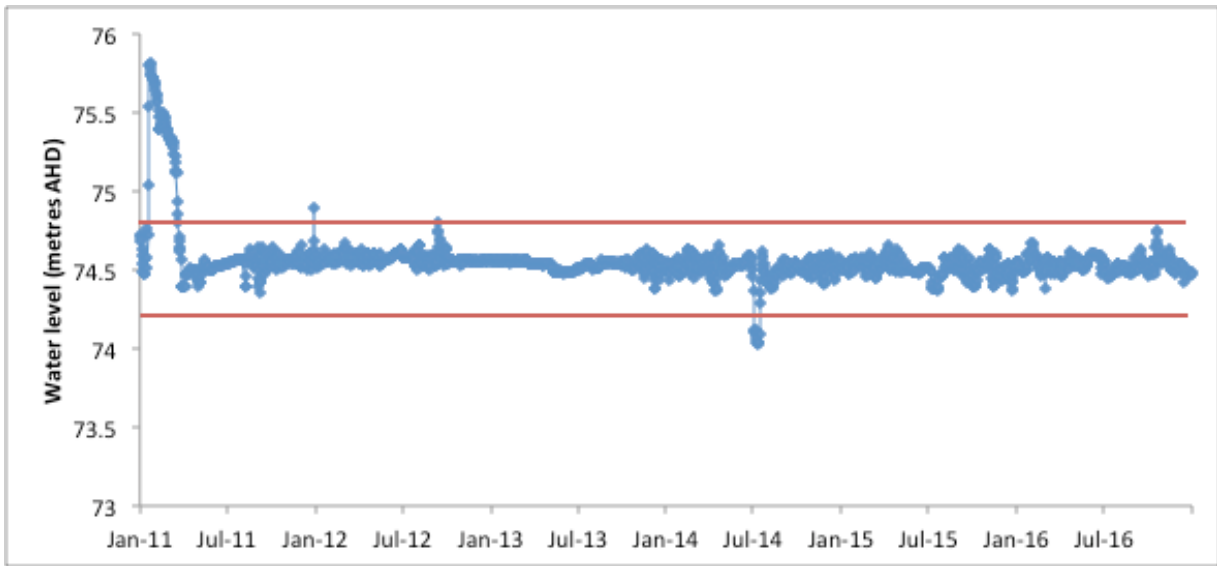


Figure 13: Water level in Third Reedy Lake 2011 – 2016 (data provided by Goulburn-Murray Water).

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