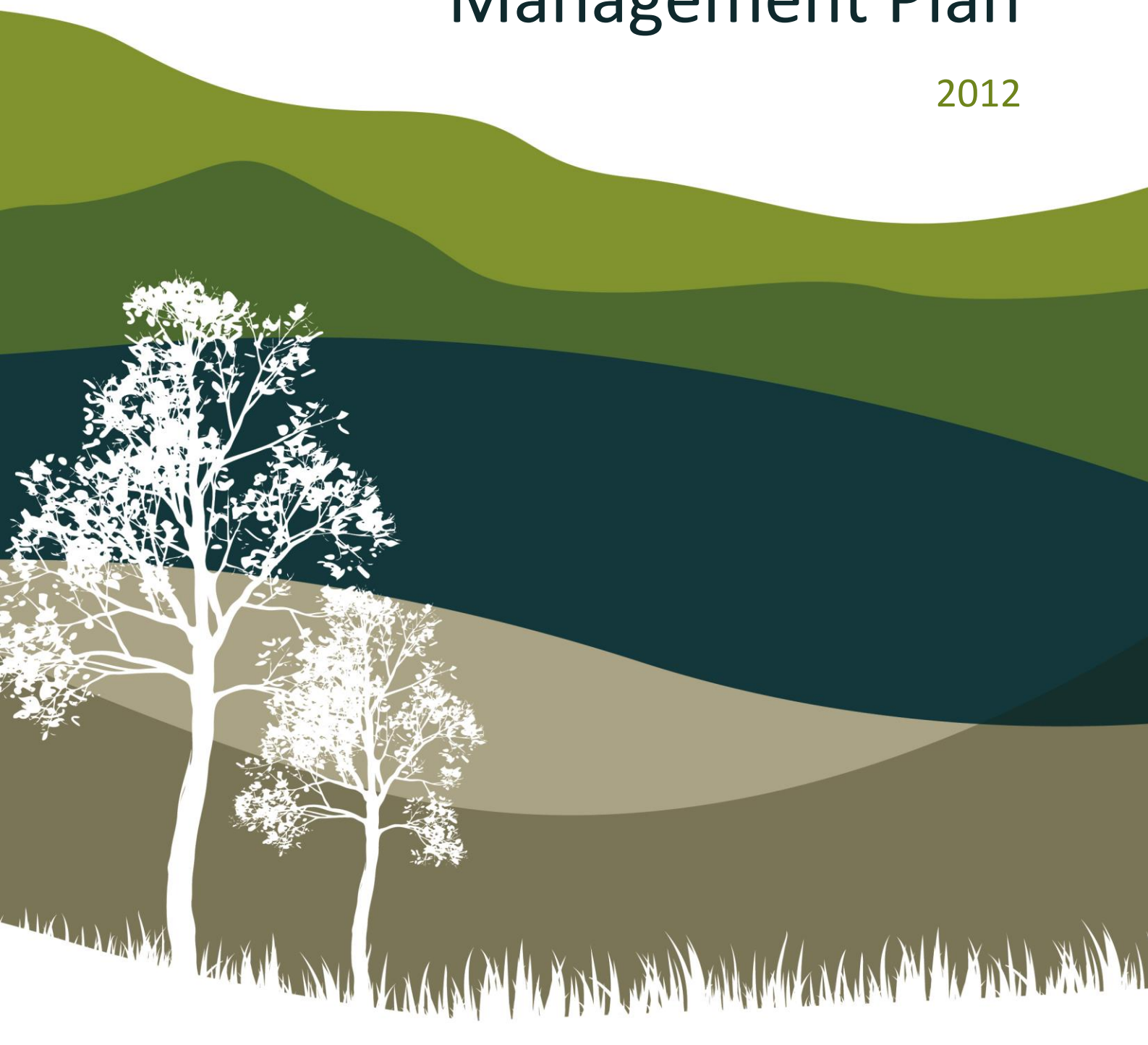
GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Kanyapella Basin Environmental Water Management Plan

2012



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Contents

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ABBREVIATIONS

BE	Bulk Entitlement
CEWH	Commonwealth Environmental Water Holder
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EPA	Environment Protection Authority
EVC	Ecological Vegetation Class
EWaMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
GB CMA	Goulburn Broken Catchment Management Authority
GL	Gigalitre (one billion litres)
G-MW	Goulburn-Murray Water
IVT	Inter-valley transfer
IWC	Index of wetland condition
kl	Kilolitre (one thousand litres)
km	Kilometre
MDBA	Murray-Darling Basin Authority
ML	Megalitre (one million litres)
NVIRP	Northern Victoria Irrigation Renewal Project
SWMS	Surface Water Management System
VEWH	Victorian Environmental Water Holder

Chapter One:

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 that 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), Department of Sustainability and Environment (DSE) and the Victorian Environmental Water Holder (VEWH) 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 Seasonal Watering Proposals to be submitted by CMAs to the Victorian Environmental Water Holder annually (section 6.3 – Implementation: Seasonally Adaptive Approach). The supporting information will include:

- lead management agencies and their management responsibilities;
- the water dependant environmental, social and economic values of the site;
- the sites environmental conditions and threats;
- hydrological and ecological objectives;
- opportunities for improved water delivery, 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 Kanyapella Basin in the Goulburn Broken Catchment Management region. This watering plan is not a holistic management plan for the site it is limited to issues related to the management of water dependent values and environmental water.

1.3 Region

The Goulburn Broken Catchment comprises the catchments of the Goulburn and Broken River. The catchment covers a total of 2,391,544 hectares or 10.5 per cent of Victorias total land area (Figure 1) and approximately two per cent of the Murray Darling Basins total land area (DNRE, 2002). Despite its small contribution to the total land area of the Murray Darling Basin, it generates 11 per cent of the basins water resources. Within the Goulburn Broken Catchment approximately 2,000 natural wetlands have been recorded including a number of wetlands formally recognised for their conservation significance. These include the internationally significant Barmah Forest Ramsar site, ten wetlands of national significance listed in *A Directory of Important Wetlands in Australia* (EA, 2001) and 111 wetlands of bioregional significance identified for the *National Land and Water Resource Audit* (CoA, 2002). In addition, a large number of wetlands support state and nationally threatened biota communities and birds listed on international agreements and conventions.

Kanyapella Basin is a 2,950 hectare shallow freshwater marsh depression within the larger Goulburn Broken Catchment (Figure 1). The Basin is situated on the floodplain of the Lower Goulburn and Murray Rivers (section 2.1 – Catchment history and setting) and is situated eleven kilometres east of Echuca (Figure 2). The Basin is a distinct depression situated within a large ancestral Lake basin previously occupied by Lake Kanyapella. Lake Kanyapella was approximately 20 kilometres in diameter and formed 20,000 years ago following the uplift in the region caused by the Cadell Fault (DPI, 2007). Kanyapella Basin is currently managed by the Department of Sustainability and Environment, Goulburn-Murray Water and Parks Victoria. In 1985, the Land Conservation Council recommended that a 2,452 hectare portion of Kanyapella Basin be deemed as a Wildlife Management Co-operative Area that be used for the conservation of wildlife, water management and provision of forest products, grazing, apiculture and recreational activities (LCC, 1985). This environmental watering plan discussed the management of this 2,452 hectare portion of the Basin only.

Prior to European settlement, Kanyapella Basin was a seasonal shallow freshwater marsh filling during Lower Goulburn River flooding events. High water levels in the river caused water to back up Warrigal Creek and Yambuna Creek and inundate Kanyapella Basin (Figure 3). The Goulburn River usually flooded during winter and spring (Cottingham et al., 2003). Post European settlement saw sections of Kanyapella Basin cleared for farming but was generally unsuitable due to regular flooding and poor drainage (DPI, 2007).

During 1967-68 all freehold land in Kanyapella Basin was purchased by State Rivers Water Supply Commission (now Goulburn-Murray Water) for the Crown. This was to facilitate the establishment of a flood retardation basin and provided the opportunity for the establishment of a Wildlife Management Co-operative Area in 1970.

In the 1970s, two irrigation outfall drains were constructed to pass through Kanyapella Basin. These drains were constructed so local drainage water can be stored in the Basin during high flow events in the Goulburn River (DPI, 2007).

Figure 1: Location of Kanyapella Basin within the Goulburn Broken Catchment

1.4 Consultation

This plan was prepared by the Goulburn Broken Catchment Management Authority with input from a Scientific Technical Committee. The Scientific Technical Committee developed ecological and hydrological goals for Kanyapella Basin at a workshop based on the local history of the swamp, knowledge of past and present watering regimes, the water requirements to support existing ecological values and the current condition of the swamp (Appendix 1). Members of the Scientific Technical Committee included Sam Green (Goulburn-Murray Water), Damien Cook (Australian Ecosystems), Doug Frood (Pathways Bushland and Environment), Keith Ward, Timothy Barlow, Jo Wood and Simon Casanelia (Goulburn Broken CMA). Draft plans of this report were submitted to members of the Goulburn Broken Wetland Management Group and the Kanyapella Basin Stakeholders Committee for comment. In addition, Jane Roberts and Terry Hillman provided a scientific review of the draft plan.

1.5 Information sources

Information used in the development of this Plan was compiled from various sources including:

- Goulburn Broken Regional River Health Strategy (GBCMA, 2005).
- Kanyapella Basin Environmental Management Plan (DPI, 2007).
- Kanyapella Basin Rehabilitation, Near Echuca, North East Victoria. Complex Cultural Heritage Management Plan (SMK, 2008)

This information was supplemented by discussions with people with an intimate knowledge of the swamp area, its environmental values, and the management and operation of Kanyapella Basin.
In addition, a number of state-wide data sets and digital mapping layers were used including:

- Flora Information System of Victoria (DSE, 2005a);
- Atlas of Victorian Wildlife (DSE, 2007a);
- Bioregional Conservation Status of Ecological Vegetation Classes;
- Wetland environments and extent up to 1994; and
- Campaspe Shire Aerial photography (1999-2000 layers).

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. The water regime for Kanyapella Basin discussed in this Plan was developed using local knowledge, technical experts, field observations and scientific literature on the water requirements of relevant aquatic flora and fauna where available.

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 intends to be a live document and will be amended as new information becomes available.

Chapter Two:

Site Overview

2.1 Catchment history

Kanyapella Basin is situated in the Murray Fans bioregion which 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). The vegetation is a mosaic of Plains Grassy Woodland, Pine Box Woodland, Riverine Plains Grassy Woodland and Riverine Grassy Woodland ecosystems (www.dse.vic.gov.au).

Kanyapella Basin is a depression situated within an ancestral Lake Kanyapella (Bowler, 1978, DPI, 2007). Lake Kanyapella (Figure 2) formed during the uplift of the Cadell Fault causing the Goulburn River to dam, thus resulting in the formation of the Lake. Lake Kanyapella stretched from Echuca to the Barma sandhills in the east, which were formed on the shore of the Lake by prevailing westerly winds (SMK, 2008). During this time, the Murray River also changed course, causing to run in a southerly direction. Over hundreds of years the river coursed along the edge of the Barma Sandhills, eventually cutting through them, causing Lake Kanyapella to drain (Figure 2). Kanyapella Basin formed as a shallow residual bowl inset into the bed of the Lake which remains connected to the Goulburn River via the Warrigal and Yambuna Creeks (DPI, 2007, SMK, 2008). Kanyapella Basin contains lake and swamp deposits of Holocene age at its center and alluvial deposits towards its fringes, with a lunette at its eastern edge dating from the Pleistocene (SMK, 2008).

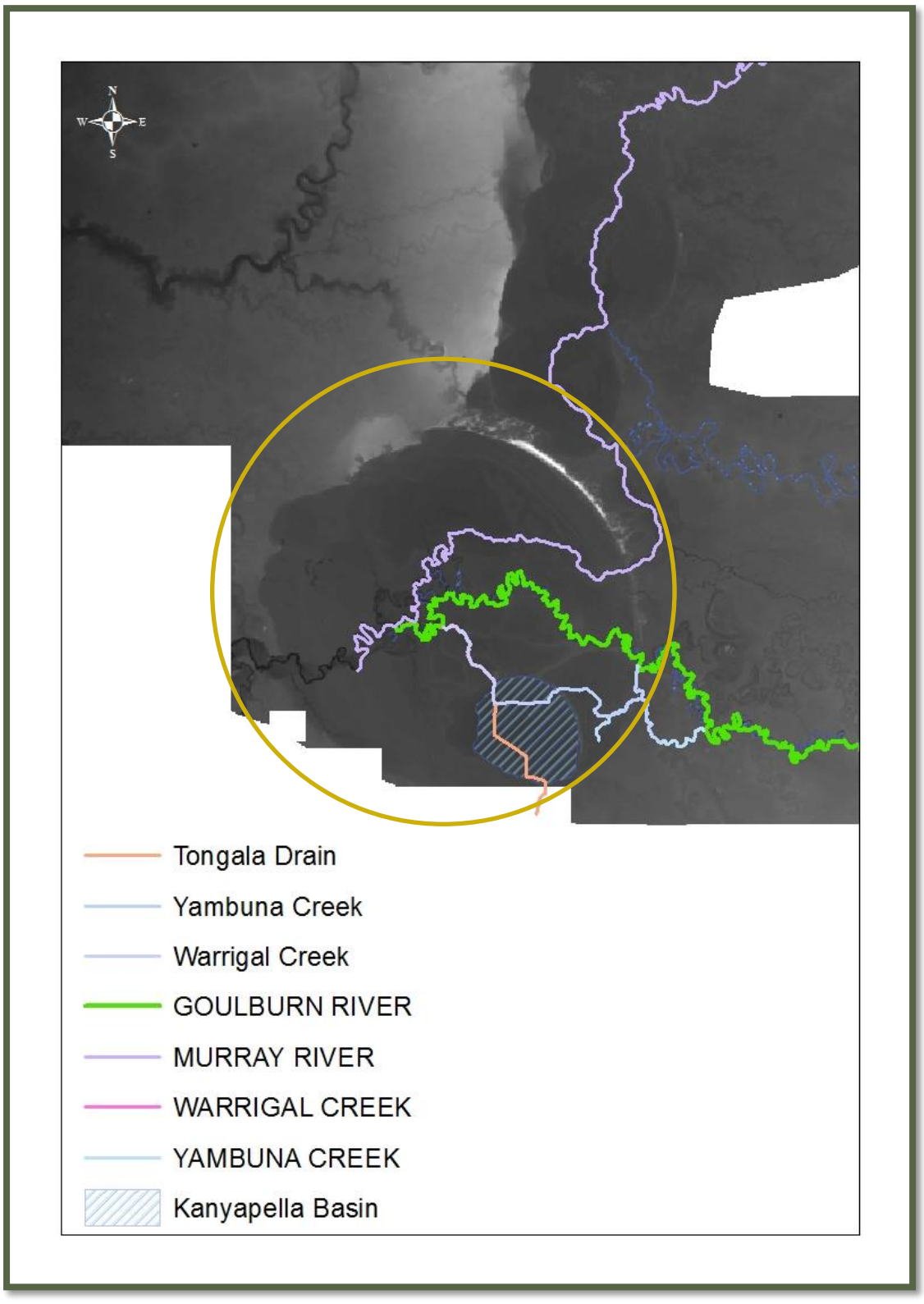

Figure 2: Kanyapella Basin (Blue hatch) situated within the former larger Lake Kanyapella (yellow circle).

2.2 Land status and management

Kanyapella Basin is managed by Goulburn-Murray Water, Department of Sustainability and Environment and Parks Victoria (section 2.3 – Wetland Characteristics, Figure 3). A range of management agencies are also responsible for ensuring that management of the study area complies with a broad range of legislative requirements. Lead management agencies and their key responsibilities are summarised in Table 1. The broader community including adjacent landholders, Yorta Yorta Peoples (section 3.4.1 - Cultural heritage values), Koyuga-Kanyapella Landcare and recreational users such as the Echuca Bird Observers Club also have an interest and role in the management of the planning area. The successful management of the study area therefore relies on effective cooperation and partnership between the government agencies and the broader community.

Table 1: Lead government agencies and their key study area responsibilities

Agency	Responsibility
Aboriginal Affairs Victoria	Promote knowledge and understanding within the wider community of the study area's Aboriginal people and their history. Administer legislation protecting Aboriginal heritage sites within the study area (*State Aboriginal Heritage Act 2006* and Part IIA of the Commonwealth *Aboriginal Torres Strait Islander Heritage Protection Act 1984*).
Department of Primary Industries	Provide technical and extension support for the sustainable management of fisheries, agriculture, minerals and petroleum.
Department of Sustainability and Environment	Provide financial, policy and strategic support for the management of public and private land. Management of flora and fauna and State Forest. Management of hunting and domestic stock licensing on public land. Currently manage 471 hectares of the Basin (461 being State Forest and 10 being Water Reserve).
Environmental Protection Authority	Protect, restore and enhance air, land and water quality and control of unwanted noise.
Goulburn Broken Catchment Management Authority	Implementation of the Goulburn Broken Regional Catchment Strategy. Works on waterways, regional drainage and floodplain management, and co-ordinating Commonwealth and State natural resource management investment. Determining the environmental water requirements of swamps and streams, developing and submitting annual water proposals to DSE for consideration, and managing the delivery of environmental water in accordance with DSE's watering plan.
Goulburn-Murray Water	Manage the majority of land within the Basin of 2,464 hectares freehold land. Have upgraded Surface Water Management Systems and implemented on ground works to allow Environmental Water delivery to the Swamp.
Kanyapella Basin Stakeholders Committee	Assist with the implementation of Management Actions that have arisen from the Kanyapella Basin Environmental Management Plan.
Murray-Darling Basin Authority	The Murray-Darling Basin Authority's principal aim is to manage the Basin's water resources in the national interest.
Parks Victoria	Currently manage a 15 hectare plot within the Basin. A Victorian Environmental Assessment Council (VEAC) recommendation has determined that Parks Victoria Manage the whole 2,950 hectare Basin in the near future (Doller, 2012).
Victorian Environmental Water Holder	Management of environmental water entitlements on behalf of the Minister for Environment as of July 2011.

2.3 Wetland Characteristics

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman (1980, Appendix 2) which includes information on water depth, permanency and salinity (Corrick and Norman, 1980). Wetlands through Victoria were mapped and classified between 1975 and 1994 and developed into spatial layers (DSE, 2007b).

Kanyapella Basin is classified as a shallow freshwater marsh in the Department of Sustainability and Environment wetland 1994 layer. Kanyapella Basin has a mean depth of 0.5m and has a calculated capacity of approximately 20,000ML. However, Goulburn-Murray Water has stipulated that the volume of water held in Kanyapella Basin as a guide for winter storage due to possible flooding of the Goulburn River should not exceed 1,500ML east of the Tongala outfall drain or 1000ML west of the Tongala outfall drain (Archard, 2005).

The wetland is located within the Murray Fans bioregion within the ancestral Lake Kanyapella area. 471 hectares is managed by Department of Sustainability and Environment, 2364 hectares is managed by Goulburn-Murray Water and 15 hectares is managed by Parks Victoria (Figure xx). Kanyapella Basin is surrounded by Irrigated and Dryland agriculture.

Environmental water could possibly be delivered via the Tongala Main Drain into the designated wildlife bays on the western side of the Basin (upgrades of the wildlife bay doors will be needed) or via the Yambuna Creek at the north-eastern end of the swamp (Figure 3). 1,500 ML is the maximum capacity that can currently be delivered the eastern side of the Basin and 1,000ML to the western side of the Basin as a guide to winter storage due to possible flooding of the Goulburn River (DPI, 2007). Due to the size of Kanyapella it would be best to deliver an Environmental Water Allocation accompanying a river flood event or a high drainage flow event (Green, 2012). Kanyapella remains connected to the Goulburn River system via the Warrigal and Yambuna Creeks (Figure 3).

Table 2: Summary of site characteristics

Characteristics	Description
Name	Kanyapella Basin
Mapping Id	7825119977
Area (ha)	2,950
Bioregion	Murray Fans
Conservation Status	Nationally Significant*
Land Status	Public
Land Manager	Goulburn-Murray Water, Department of Sustainability and Environment, Parks Victoria
Surrounding Land Use	Irrigated Agriculture and Dryland Agriculture
Water Supply	Flooding from the Goulburn River via Warrigal and Yambuna Creeks Overflow from the Tongala Main Drain Inflows from Coram Creek to the South-east of the Basin
1788 Wetland Category	Shallow Freshwater Marsh
1994 Wetland Category	Shallow Marsh
Wetland Capacity (ML)	2,500ML (advised capacity)
Mean wetland depth at Capacity (m)	0.5m^

*Kanyapella Basin recognised as Nationally Significant within the Directory of Important Wetlands (EA, 2001).

^Note: filling sections Kanyapella Basin to 0.5m will not occur during every environmental watering event. Filling the wetland to variable depths will promote an increased plant species community and drawing down the wetland slowly will allow the habitat to change in its natural state, resulting in different vegetation communities establishing within the wetland body.

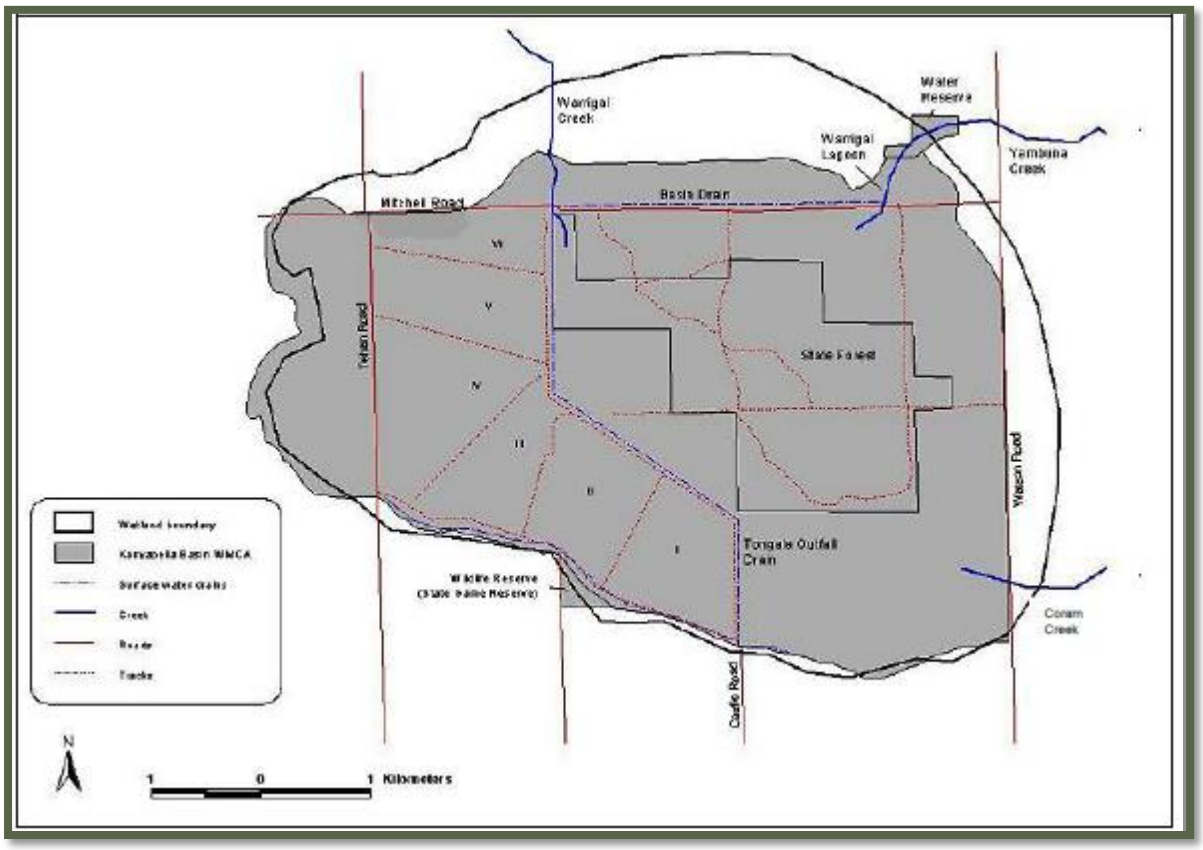

Figure 3: Kanyapella Basin Management Areas

2.4 Environmental Water Sources

The Environmental Water Reserve is the legally recognised amount of water set aside to meet environmental needs. The reserve includes minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements are held in storage and if available and required can be delivered to wetlands or streams to protect their environmental values and health. Environmental entitlements are held by the Victorian Environmental Water Holder.

Environmental water for Kanyapella Basin can be sourced from the Victorian River Murray Flora and Fauna Bulk Entitlement. This bulk entitlement has a source volume of 27,600ML and is managed by the Victorian Environmental Water Holder.

Future water reserves that may also be used in Kanyapella Basin include water savings from the Northern Victoria Irrigation Renewal Project (NVIRP – now Goulburn-Murray Water Connections Program) and environmental water held by the Commonwealth Environmental Water Holder (CEWH) (Appendix 3).

2.5 Legislative and policy framework

There is a range of international treaties, conventions and initiatives, as well as National and State Legislation, policies and strategies that direct management of Kanyapella Basin. Those with particular relevance to Kanyapella Basin and the management of its environmental and cultural values are listed below. For the functions and major elements of each refer to Appendix 4.

International treaties, conventions and initiatives:

- Japan Australia Migratory Birds Agreement (JAMBA) 1974.
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.
- China Australia Migratory Birds Agreement (CAMBA) 1986.
- Republic of Korea Australia Migratory Birds Agreement (ROKAMBA) 2002.

Commonwealth legislation and policy:

- *Australian Heritage Commission Act* 1975 (Register of the National Estate).
- *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984 (Part IIA).
- *Native Title Act* 1993.
- Wetlands Policy of the Commonwealth Government of Australia 1997.
- *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).
- *Water Act* 2007.
- A Framework for Determining Commonwealth Environmental Watering Actions 2009.

Victorian legislation:

- *Flora and Fauna Guarantee Act* 1988.
- *Water Act* 1989.
- *Catchment and Land Protection Act* 1994.
- State Environment Protection Policy (Waters of Victoria) 2003.
- *Aboriginal Heritage Act* 2006.

Victorian policy, codes of practice, charters and strategies:

- Goulburn Broken Catchment Regional Catchment Strategy (GBCMA, 2003).
- Our Water Our Future (DSE, 2004).
- Northern Region Sustainable Water Strategy (DSE, 2009b).
- Biodiversity Strategy for the Goulburn Broken Catchment, Victoria 2010-2015 (Miles et al., 2010).

2.6 Related Plans and Activities

Two key management documents have been written that directly or indirectly assist with management of the site. These include:

1. Kanyapella Basin Environmental Management Plan (DPI, 2007). This management plan presents the geo-morphological, biological, utilisation history, management history and current stakeholder's requirements. It focuses on the values as a breeding and feeding site for significant species, as a public amenity and a flood retarding and nutrient assimilating wetland.
2. Kanyapella Basin Rehabilitation, Near Echuca, Northeast Victoria. Complex Cultural Heritage Management Plan (SMK, 2008). This plan was prepared to ensure that during construction of Kanyapella rehabilitation works that reasonable measures were taken to mitigate damage to any cultural heritage potentially present. It gives descriptions of cultural heritage sites within the basin and the appropriate activities to preserve these areas when conducting works within the Basin.

These plans make a number of recommendations, some of which have been implemented and have assisted with the protection and enhancement of Kanyapella Basin natural values including:

1. Revegetation of degraded areas in the Basin and surrounding terrestrial zone.
2. Pest plant and animal control.
3. Preservation and protection of cultural heritage sites.
4. Upgrades to the Warrigal and Yambuna Creek inlets/ outlets.
5. Fencing upgrades and replacements around the Basin boundary to control stock and vehicle access.
6. Upgrading of cattle grids at the entrances of the Basin.
7. Upgrades of signage and promotional information to promote tourism and deter disturbance of native fauna and flora.

Chapter Three:

Water Dependent Values

3.1 Environmental - Fauna

3.1.1 Fauna listings and significance

Kanyapella Basin provides habitat for a wide variety of water dependent and terrestrial fauna species. To date 190 species have been recorded at the swamp (Appendix 5). These include168 bird species (114 non-wetland species and 54 wetland species), eleven mammals, two amphibians, five reptiles and three fish (all exotic). Of these, one is listed under the *Environmental Protection Biodiversity Act* (EPBC 1999), eleven are listed under the *Flora and Fauna Guarantee Act* (FFG 1988), 25 are considered critically endangered, endangered, vulnerable, near threatened or data deficient on the *DSE Advisory list of threatened vertebrate fauna in Victoria* (2007) (Table 3 for wetland species and Appendix 5 for all species). Two birds are listed under the China Australia Migratory Bird Agreement (CAMBA) and one is listed under the Japan Australia Migratory Bird Agreement (JAMBA) and the *Convention on the Conservation of Migratory Species* (Bonn).

Historic information from local sources indicates that Kanyapella Basin was a large Ibis and Spoonbill rookery in the 1950's – 60's (Farrell, 2012). This was again observed in the large flood event of 1993 when "hundreds of Ibis, Herons and Cormorants were breeding in the wetland" (Robertson and McGee, 2003).

Table 3: Conservation status of fauna species recorded at Kanyapella Basin

Common Name	Scientific Name	Type	International agreements	FFG	DSE Status
Australasian Shoveler	*Anas rhynchotis*	B			Vul
Azure Kingfisher	*Alcedo azurea*	B			NT
Brolga	*Grus rubicunda*	B		L	Vul
Eastern Great Egret	*Ardea modesta*	B	J,C,B	L	Vul
Hardhead	*Aythya australis*	B			Vul
Intermediate Egret	*Ardea intermedia*	B		L	CEn
Little Egret	*Egretta garzetta nigripes*	B		L	End
Musk Duck	*Biziura lobata*	B			Vul
Nankeen Night Heron	*Nycticorax caledonicus*	B			NT
Pied Cormorant	*Phalacrocorax varius*	B			NT
Royal Spoonbill	*Platalea regia*	B			Vul
Whiskered Tern	*Childonias hybridus*	B			NT
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	C	L	Vul

Legend
Type: (Bird (B)
International: CAMBA (C), JAMBA (J), ROKAMBA (R), Bonn (B)
EPBC Status: Vulnerable (Vu)
FFG Status: Listed as threatened (L)
DSE Status: Critically Endangered (CEn), Endangered (End), Vulnerable (Vul), Near Threatened (NT)

3.2 Flora - Vegetation Communities

A hierarchical system of classification of vegetation classes has been developed in Victoria over the past decade in order to classify vegetation into units that are both ecologically meaningful and useful for vegetation managers. The classification that has been adopted in Victoria is Ecological Vegetation Classes (EVCs), which are defined by a combination of floristics, life form, position in the landscape and an inferred fidelity to particular environments. Each EVC includes a collection of floristic communities that occur across a biogeographic range and although differing in species, have similar habitat and ecological processes operating. Approximately 300 EVCs have been described for Victoria.

Kanyapella Basin is largely dominated by a mosaic of Riverine Swamp Forest and Sedgy Riverine Forest/Riverine Swamp Forest Complex (EVC #814/817), Riverine Swampy Woodland (EVC #815) and a mosaic of Riverine Grassy Woodland and Plains Woodland (EVC #295/803).

Smaller occurrences of Drainage Line Aggregate (EVC #168), Floodplain Wetland Aggregate (EVC # 172), Plains Woodland – Black Box Dominated (EVC #803) and Sedgy Riverine Forest (EVC #816) and Spike-sedge Wetland (EVC #819) also occur within the Basin (Figure 4).

Table 4: Conservation status of water-dependent Ecological Vegetation classes recorded at Wallenjoe Swamp

EVC number	EVC Name	Bioregional Conservation Status
168	Drainage Line Aggregate	Vu
172	Floodplain Wetland Aggregate	De
295/803	Riverine Grassy Woodland and Plains Woodland	En
803	Plains Woodland (Black Box dominated)	En
814/817	Riverine Swamp Forest and Sedgy Riverine Forest/Riverine Swamp Forest Complex	De
815	Riverine Swampy Woodland	Vu
816	Sedgy Riverine Forest	De
819	Spike-sedge Wetland	Vu

Legend (Wierzbowski et al., 2002)
En = Endangered. Meaning the EVC is on the verge of extinction with 90% or more cleared since European settlement (1750).
Vu = Vulnerable. Meaning the EVC is moving towards extinction with 70% or more of these areas having been cleared since European settlement (1750).
De = Depleted. Meaning the EVC is likely to become threatened if clearing or threatening processes continue and that 50-70% of this EVC has already been cleared since European settlement (1750).

A detailed description of EVCs by Frood and Cook (Frood and Cook, 2012) was undertaken during field surveys in October 2012 and can be seen in Appendix 6.

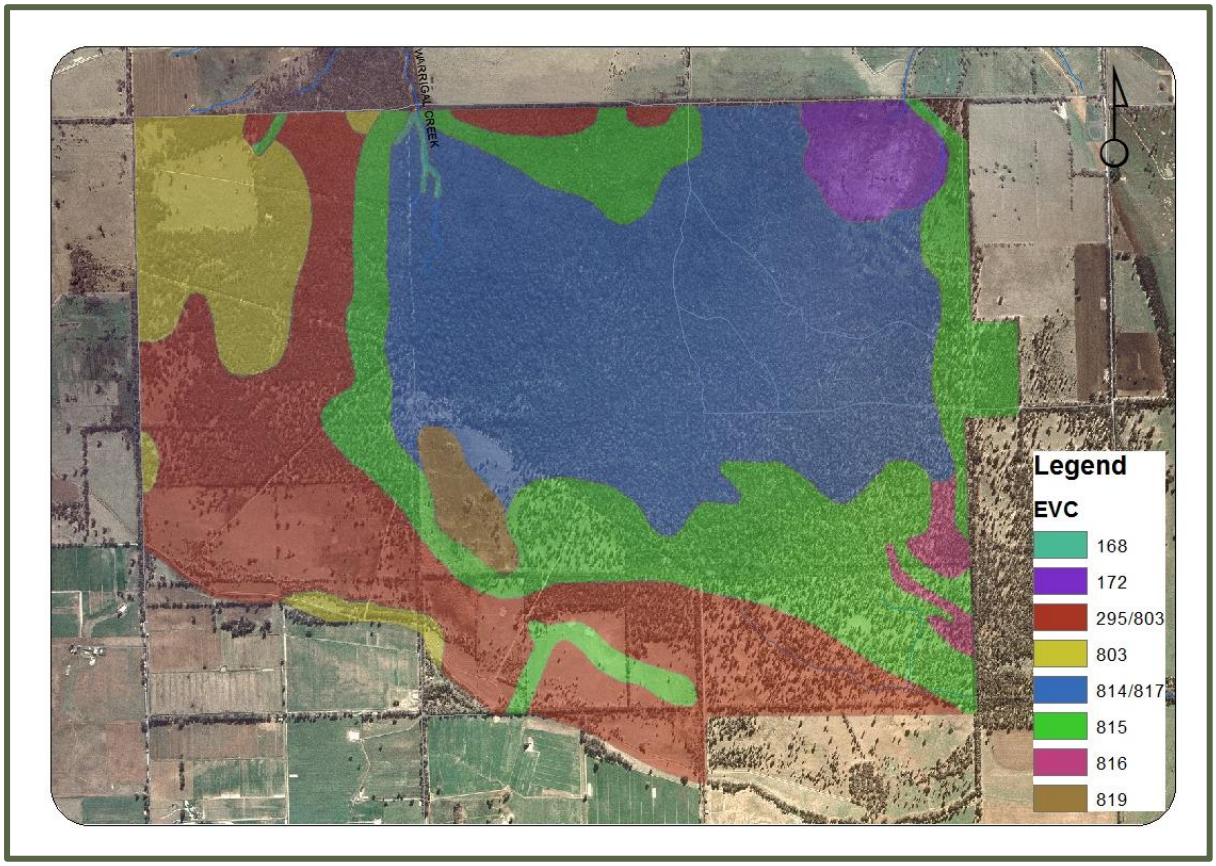

Figure 4: Distribution of EVCs in Kanyapella Basin

3.2.1 Flora – Species listing and significance

A total of 245 native flora species have been recorded at including 114 water dependent species (Appendix 7). Of these four species are listed under the *Environmental Protection Biodiversity Act* (1999) and three species are listed under the *Flora and Fauna Guarantee Act* (1988). Thirteen species are considered rare, endangered or poorly known in Victoria (Table 5, Appendix 7).

Table 5: Listed water-dependent flora species recorded at Kanyapella Basin

Common Name	Scientific Name	EPBC Status	FFG Status	DSE Status
River Swamp Wallaby-grass	*Amphibromus fluitans*	V		
Winged Water-starwort	*Callitriche umbonata*			r
Riverina Bitter-cress	*Cardamine moirensis*			r
Annual Bitter-cress	*Cardamine paucijuga s.s (type form)*			e
Pale Spike-sedge	*Eleocharis pallens*			k
Long Eryngium	*Eryngium paludosum*			v
Dwarf Brooklime	*Gratiola pumilo*			r
Rigid Water-milfoil	*Myriophyllum porcatum*	V	L	v
Annual Buttercup	*Ranunculus sessiliflorus*			v
Swamp Buttercup	*Ranunculus undosus*			v
Floodplain Fireweed	*Senecio camplyocarpus*			r
Slender Darling-pea	*Swainsona murryana*	V	L	e
Red Swainson-pea	*Swainsona plagiotropis*	V	L	e
Swamp Early Nancy	*Wurmbea dioica subsp.lacunaria*			k

Legend: EPBC Status: Vulnerable (V)**;** FFG Status: Listed as threatened (L)**:** DSE Status: Endangered (en), Vulnerable (v), Rare (r), Poorly Known (k)

3.2.2 Flora - Significance

Four nationally significant species are listed for Kanyapella Basin. Each species should be recognised for its importance at the wetland.

River Swamp Wallaby Grass inhabits both natural and man-made water-bodies. It flowers mainly between November and March and fruits later than other grasses with which it grows (Jacobs and Lapinpuro, 1986, Walsh, 1994).

Red Swainson-pea is a small, prostrate perennial herb that flowers during September and October. It is highly responsive to seasonal moisture conditions with large numbers appearing in years with high rainfall. It is found within the 350-450mm average rainfall band in open native grassland vegetation on seasonally waterlogged red-brown clay and clay loam soils (Tonkinson and Roberston, 2010).

Slender Darling-pea is an erect perennial forb which flowers from spring to early summer. It is found in grasslands, herblands and open Black-box woodlands often in depressions. It prefers heavy clay or loam soils (CoA, 2008).

Myriophyllum porcatum (rigid water-milfoil) is an annual aquatic herb that occurs in shallow, ephemeral wetlands. Little is known about the ecology of this species other than that it is found in ephemeral and seasonal wetlands and seed apparently persist in sediment when the wetland dries out. Plants have been observed flowering in September to October and fruiting from October to November (Orchard, 1985). Its habitat has been significantly reduced as a result of hydrological alteration such as wetland drainage and channelisation, increased nutrient loads from rural and urban catchments and the introduction of exotic species (DSE, 2005b, Bunn et al., 1997, Murphy, 2006).

3.3 Wetland depletion and rarity

Victoria's wetlands are currently mapped and are contained in a state wetland database, using an accepted statewide wetland classification system, developed by Andrew Corrick 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.

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 (EA, 2001). Across the state, the greatest losses of original wetland area have been in the freshwater meadow (43%), shallow freshwater marsh (60%) and deep freshwater marsh (70%) categories (DNRE, 1997).

Kanyapella Basin is classified as a shallow freshwater marsh. Within the Goulburn Broken Catchment shallow freshwater marshes have declined by 40% in area since settlement (GBCMA, 2006). The conservation and protection of these areas is imperative for the flora and fauna that rely on them as breeding, feeding and roosting sites.

3.3.1 Ecosystem functions

Wetlands are considered ecologically important due to their role in maintaining biological diversity, promoting biochemical transformation and storage and decomposition of organic materials (DSE, 2007b).

Kanyapella Basin is an ancestral depression within the floodplain. These depressions perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These 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.

However, the capacity of floodplain wetlands to perform the ecological functions outlined above will depend on their condition (section 5 – Threats and Condition) and on connectedness back to the river.

3.4 Social Values

3.4.1 Cultural heritage

Kanyapella Basin and the surrounding catchment have a long history of traditional owner occupation by the Yorta Yorta Peoples and are an important part of their cultural and spiritual heritage (Figure 5).

Kanyapella Basin would have provided the Yorta Yorta Peoples with a rich and diverse supply of plant and animal resources for food, medicines, shelter, clothing and tools (Appendix 7). Evidence of past traditional owner occupation includes earthen mounds and artefact scatters recorded. Due to land clearing many large trees were removed from the Basin with the possibility of some of these being scarred trees.

Kanyapella Basin being situated within the large Lake Kanyapella is significant to the history of the Yorta Yorta people as the Barma sand hills to the east of the ancestral Lake prevented the Great Spirit, Dhungala from continuing its journey. The waters began to rise and became deeper and deeper until the water was as high as the trees, the Yorta Yorta people began to dig through the sandhills and released Dhungala to be able to continue its journey to replenish the land. The environment land and water of the Yorta Yorta country are of natural interest and inherently linked to the Yorta Yorta nation as the Traditional Owners of this region. Kanyapella is of significance associated physical and spiritual linkage to the Yorta Yorta experience over many thousands of years of continuous connect to the laws, customs, beliefs, practices and rights of the Yorta Yorta people to the present day. The Yorta Yorta Nation Aboriginal Corporation (YYNAC) is the organisation that represents and protects the interests of the Yorta Yorta Nation of people and continues to work and develop partnerships with all sectors of community to create a great appreciation and awareness of the value Yorta Yorta people and their interests hold in protecting the natural

The Yorta Yorta Cooperative Management Agreement was signed in 2004. The agreement establishes a formal role for the Yorta Yorta Peoples in the management of land and water in their traditional country. The Yorta Yorta Nations in their draft Greater Regional Natural Resource Management Plan set out a number of objectives to protect the regions native ecosystems and biodiversity including:

- to restore, maintain and protect all native ecosystems; and
- to ensure the long term viability of populations and species considered rare and endangered, threatened or of special concern.

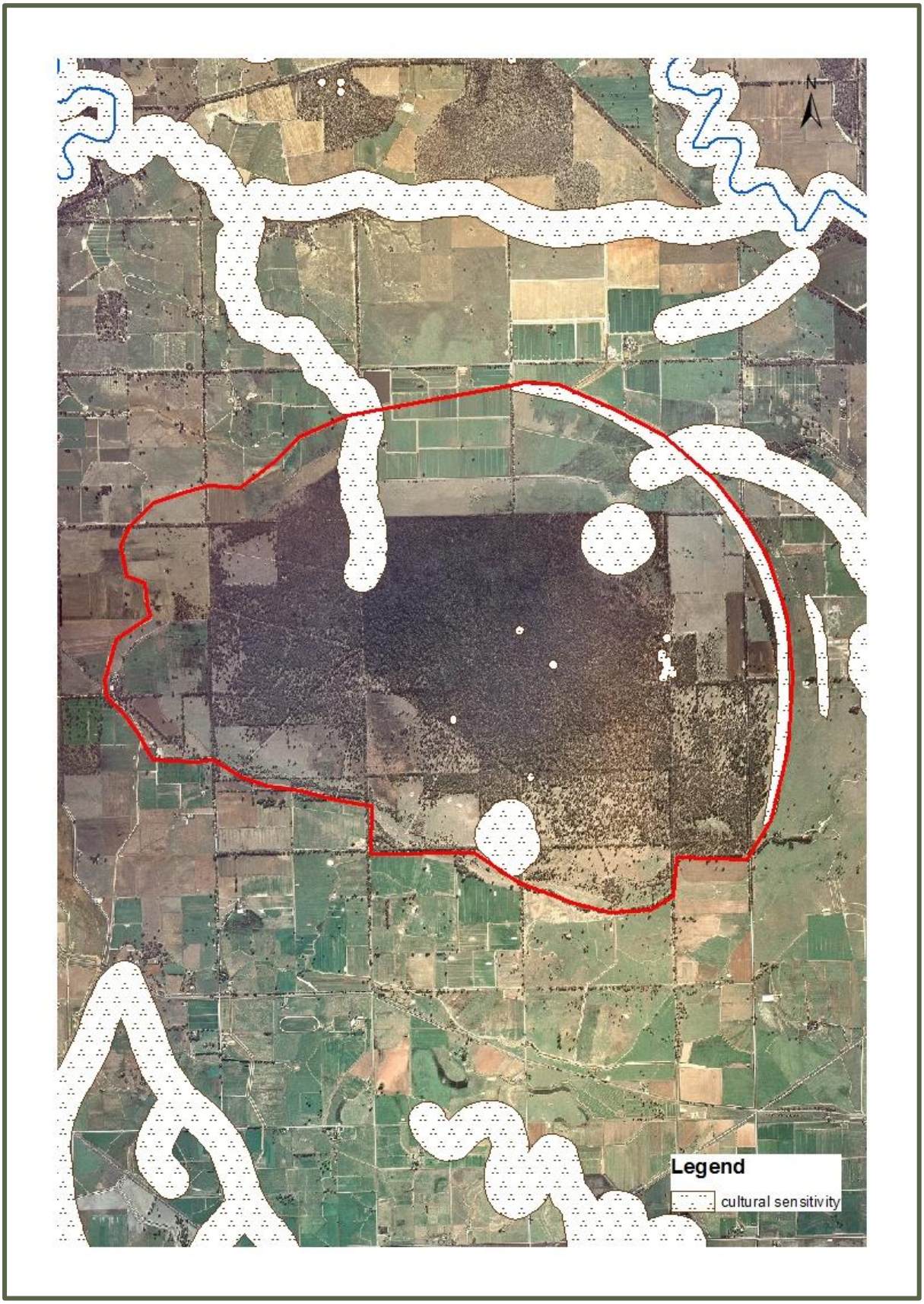

Figure 5: Culturally sensitive areas within and around Kanyapella Basin (outlined in red)

3.4.2 Recreation

Activities enjoyed by visitors to Kanyapella Basin include bird watching, picnicking, bike riding and walking. None of these activities are directly dependent on wetland flooding. However, wetland flooding can enhance the enjoyment of visitor's activities by providing more diverse habitat and fauna experiences.

3.5 Economic

Wetlands provide both direct and indirect economic values to Goulburn Broken Catchment (Cork et al., 2001) . The direct economic values that Kanyapella Basin provides to the Goulburn Broken Catchment include non-consumptive uses such as tourism and recreation. Indirect economic values that Kanyapella Basin provides to the Goulburn Broken Catchment include water filtration, flood protection, water storage, groundwater recharge, nutrient discharge, carbon storage and habitat for threatened flora and fauna species.

Chapter Four:

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, 2007b). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (DSE, 2007b). Duration, frequency and seasonality (timing) are the main components of a wetland's hydrological regime.

4.1 Pre-regulation

Under natural conditions Kanyapella Basin would have flooded during Lower Goulburn River flood events on an annual basis. Flooding would have occurred during winter – spring and often in association with Murray River Flood events (DPI, 2007). Flood events would have varied in size and duration inundating the wetland via the Yambuna and Warrigal Creeks. Under natural conditions a 1 in 10 year average return interval in the Lower Goulburn River would have almost completely inundated Kanyapella Basin (Figure 6).

4.2 Post-regulation

The current water regime in Kanyapella Basin is still based on high flows in the Lower Goulburn River. However, the construction of the Tongala, Coram and Wyuna surface water management systems has also influenced the water regime at the Basin. The drainage outfall water from the Tongala catchment passes through Kanyapella Basin on its way to outfall into the Lower Goulburn River via the Warrigal Creek (Figure 3). When water in the Goulburn River exceeds the water level in the Warrigal Creek water backs up the creek and flows into the Basin (DPI, 2007).

4.3 Wetland Volume

The total water holding capacity of Kanyapella Basin where environmental water can be delivered is approximately 20,000ML. However, Goulburn-Murray Water has stipulated that the volume of water held in Kanyapella Basin as a guide for winter storage due to possible flooding of the Goulburn River should not exceed 1,500ML east and 1,000Ml west of the Tongala surface water management system.

4.4 Environmental Water Delivery

Environmental water has not been delivered to Kanyapella Basin. In the mid-1970s supplies "controlled water" to artificial wildlife bays created west of the Tongala surface water management system (Figure 3). Water was supplied via this route to supply channels and regulators between bays which allowed water to be controlled independently. The first controlled water delivery entered Bay 1 in 1977 and was considered a success. However, the supply channel had a smaller holding capacity than the drain could deliver and a large portion of available water flowed past the wetland bays. Water was directed through Bays 1 and 2 to supplement the remaining bays, but this was to the detriment of the health of trees in these bays. In addition, some landholders reported flooding on their properties. Environmental water could be delivered via the Tongala surface water management system or the Warrigal or Yambuna Creeks during high flow events in the Lower Goulburn River.

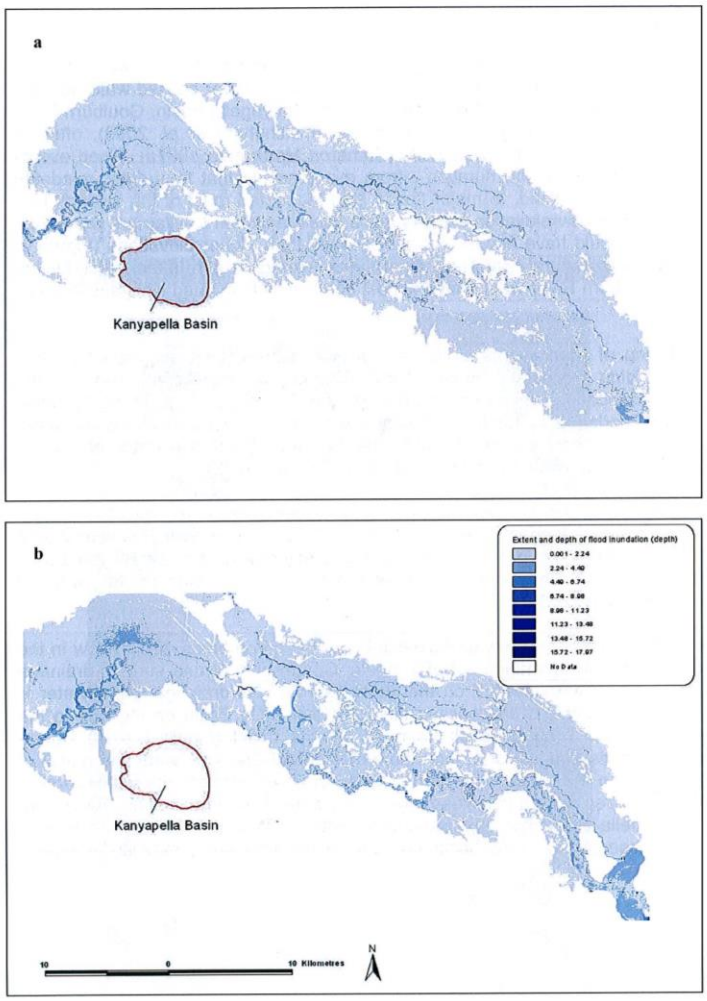

Figure 6: Extent of flood inundation (a) prior to river regulation and (b) under current conditions for Kanyapella Basin for a 1:10 year average return interval flood event in the Lower Goulburn River (DPI, 2007, Technology, 2004).

Chapter Five:

Threats and Condition

5.1 Water dependent threats

The key threats to the values of Kanyapella Basin are outlined below. These threats result from activities in the wetland, on adjoining land and in the surrounding catchment. To address these threats and the impacts an integrated approach is therefore required.

Altered water regime – Hydrology is the most important component of wetland ecosystems. It drives the physical and chemical properties of a wetland, and the biota it supports. As described in section 4 – Hydrology, the natural hydrological regime of Kanyapella Basin has been significantly altered by the introduction of irrigated agriculture post World War II causing changes to the hydrological regime of the Goulburn River, and in the 1970s when drainage construction occurred within Kanyapella Basin. However, a more natural hydrological regime will be reinstated through the delivery and management of environmental water.

Altered physical form – Physical form means the area and bathymetry of a wetland. The area of Kanyapella Basin has been reduced by drainage and excavation beginning in the 1970s with the construction of Tongala Main Drain and wildlife bays within the Basin. Future impacts on the physical form of the swamp are unlikely to occur due to the protection provided by its current landholders.

Poor water quality – Poor water quality including low dissolved oxygen may reduce habitat available for native aquatic biota, reducing its diversity and abundance. The water quality in Kanyapella Basin may be impacted by:

- Run-off containing high nutrient loads entering Kanyapella Basin from surrounding agricultural land.
- Pollutants entering Tongala Main Drain from irrigation and dryland drainage.

Degraded habitats (Soil disturbance) –Wetland soils provide the physical substrate which aquatic vegetation requires to establish, and provides habitat for benthic invertebrates and microorganisms (DSE 2009). Threatening processes that can lead to poor wetland soils within Kanyapella Basin include:

- Human visitation (walking off designated tracks into the wetland body)

Exotic flora and fauna – The invasion of native vegetation by pest plants is listed as a potentially threatening process under schedule 3 of Victoria's *Flora and Fauna Guarantee Act* (1988) and is considered to be one of the major threats to the conservation of biological diversity in Victoria (PV, 2003). The growth of pest plants can be sufficiently vigorous to reduce or prevent the regeneration or establishment of native plant species, altering the composition and structure of native communities. Modifications to the composition and structure of native vegetation as a result of pest plant invasion can modify the abundance of native fauna, geomorphological process, the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV, 2003).

A total of 69 environmental weeds have been recorded at the site comprising nine wetland species (Jolly and Osler, 2011). Of these species, Aster- weed (*Aster subulatus*) listed on the *DSE advisory list of Environmental Weeds* (DSE, 2009a) and Thread Water-starwort (*Callitriche stagnalis*) pose the greatest risk to the site due to their ability to outcompete native flora species.

Pest animals threaten the ecological values of wetlands by predating native species, transmitting diseases, and competing for food and habitat and feeding on native fauna. Pest animals recorded at Kanyapella Basin include:

- Foxes (*Vulpes vulpes*) - Fox predation is listed as a threatening process under the *Environmental Protection Biodiversity Conservation Act* (1999) and Schedule 3 of the *Flora and Fauna Guarantee Act* (1988).

5.2 Current condition

The condition of Kanyapella Basin was assessed in December 2009 using a method developed by DSE called the Index of Wetland Condition (IWC). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (DSE, 2007b).

The IWC has six subindices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota (Appendix 8). Each subindex is given a score between 0 and 20 based on the assessment of a number of measures (Appendix 8). The overall IWC score is not a simple summation of the subindex scores. A formula is used that weights each subindex according to the contribution it makes to the overall condition of the wetland. The wetland hydrology subindex for example contributes more to the overall score than the soils subindex. Further information on the method can be found on the IWC website: **www.dse.vic.gov.au/iwc**

The overall IWC score for Kanyapella Basin in December 2009 was five out of ten, which is considered to be moderate (Table 6). Of note, the subindices wetland catchment, Physical form and Hydrology were considered to be in very poor condition respectively. Wetland catchment was considered very poor as 100 per cent of the land surrounding Kanyapella Basin is used for medium intensity land uses such as irrigated agriculture. Physical form was considered very poor due to a 50-75% reduction in wetland area and wetland bathymetry has been significantly changed due to the basin being surrounded by channels and drains that affect water entry and flows. Hydrology was considered very poor due to activities that have changed the flow regime of the water source, obstruction/ regulation of the natural water inlets and outlets and drainage of water from the wetland.

Table 6: Kanyapella Basin IWC subindex score, overall score and associated condition categories

IWC subindex	Score	Condition category
Wetland catchment	4.5/20	Very Poor
Physical form	4/20	Very Poor
Hydrology	0/20	Very poor
Water properties	15/20	Good
Soils	9/20	Poor
Biota	14/20	Moderate
Overall IWC Score	**5/10**	**Moderate**

5.3 Condition trajectory

Ongoing management including the delivery of environmental water and continued monitoring of Kanyapella Basin is critical to protecting the ecological values at Kanyapella Basin. If no intervention occurs, Kanyapella Basin will only receive water via the Tongala Main Drain or Warrigal and Yambuna Creek Inlets which, with an increasingly dry climate, may occur less frequently than suits the swamp vegetation and dependent aquatic fauna. Shifts in climate such as an increase in summer storm events may also impact the wetland. This may increase flooding duration over summer and possibly cause loss of species diversity and terrestrialisation of vegetation within the wetland area.

Chapter Six:

Management Objectives and Adaptive Approaches

6.1 Management Goal

The water management goal of Kanyapella Basin is derived from sources including information from the Kanyapella Basin Environmental Wetland Management Plan (DPI, 2007) and the likely aquatic dependent values it could support into the future considering climate change.

Kanyapella Basin water management goal

"To provide a more natural hydrological regime that supports a mosaic of EVCs and habitat for significant waterbird and flora species"

The goal for Kanyapella Basin is to deliver a hydrological regime that is closer to natural than it has been.

6.2 Ecological and Hydrological Objectives

6.2.1 Ecological Objectives

Ecological objectives are 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 (section 3 – Water Dependent Values). The ecological objectives are expressed as the target condition or functionality for each key value and are expressed as one of the following trajectories for each key value:

- Protect – retain the value at an existing stage of succession.
- Improve – improve the condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.
- Maintain – maintain the current condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.
- Reinstate – reintroduce natural values that can no longer be found in the area.

The ecological objectives for Kanyapella Basin are based on values that the Basin provides for the larger catchment area and on a local scale for its ability to support flora and/or fauna species listed under the *Environmental Protection Biodiversity Conservation Act* (1999) and *Flora and Fauna Guarantee Act* (1988).

The ecological objectives for Kanyapella Basin are:

- Protect and enhance the diversity of native wetland flora species consistent with the relevant EVC.
- Reduce the cover and diversity of exotic species and /or highly invasive native flora species within the Basin area.
- Provide opportunities for waterbird breeding especially Royal spoonbills and Ibis on the back of natural flood events.

Justification for these ecological requirements is given in Table 7 and Appendix 5, 9 and 10.

Table 7: Ecological requirements for Kanyapella Basin

Ecological Objective	Justification (Value based)
Protect and enhance the diversity of native wetland flora species consistent with the relevant EVC.	Increase habitat and food sources for native fauna. Increase biodiversity.
Reduce the cover and diversity of exotic and/ or highly invasive native flora species within the Basin area.	Exotic plant species present at Kanyapella Basin notably Aster Weed and Thread water-starwort, are believed to be outcompeting native wetland plants.
Provide opportunities for waterbird breeding especially Royal Spoonbills and Ibis.	Kanyapella Basin has supported large breeding populations of Royal Spoonbills Ibis.

6.2.2 Hydrological Objectives

The watering regime for Kanyapella Basin is for flooding to occur on an annual basis. Flooding would occur in winter-spring with a possible duration of 1-6 months ponding (Table 8). In the long term, reinstating a more natural hydrological regime will encourage the restoration of native flora and reduce the abundance of weeds. Monitoring of this flooding in the Basin should be monitored. Constraints on the amount of water that can be delivered to the Basin has to be considered and environmental water should only be used to extend a breeding event or encourage growth of native plants within the Basin. Environmental water delivery to the Basin will be determined by natural flooding events. For this document an annual watering event will be discussed.

Table 8: Hydrological and ecological requirements for Kanyapella Basin

Ecological Objectives	Water management area	Hydrological Objectives											
		Recommended number of events in 10 years			Tolerable interval between events once wetland is dry (months)			Duration of ponding (months)			Preferred timing of inflows	Volume to fill to target supply level (ML)	Depth (mm)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
Improve the diversity of native wetland flora species to be consistent with EVCs #.	Wetland body and riparian zone	7	10	10	3	6	36	1	4	6	Winter – Spring	1,500ML east 1,000 Ml west	Variable to 300mm
Provide opportunities for waterbird breeding especially Royal Spoonbills and Ibisduring flood events.	Wetland body	3	10	10	6	9	12	6	8	NA	Spring [1]	1,500 east[2] 1000ML west	Maximum of 300mm[3]

1. Filling wetland based on monitoring of past environmental water deliveries to Kanyapella Basin.
2. Water depth should be kept fairly constant if waterbirds are nesting/ breeding to avoid nests being abandoned (Young 2003).
3. This is estimation only as research on frog survival in dry wetlands for extended periods is limited.

6.2.3 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; however the duration of watering may vary between these hydrological regimes. 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

Provide two seven flooding events in ten years. Fill wetland to variable depths to provide EVCs with minimum water requirements to allow survival of existing vegetation.

Optimum watering regime

Provide ten flooding events in ten years. Fill wetland to variable depths to provide EVCs with appropriate watering requirement, allow regeneration and recruitment of species within the wetland body and encourage breeding opportunities for aquatic biota.

Maximum watering regime

Provide ten flooding events in ten years. Fill wetland to variable depths to encourage growth of EVCs vegetation or encourage breeding opportunities for aquatic biota.

Filling the wetland to full supply level is not always desired. Flooding Kanyapella Basin using environmental water is not possible and will only be used to top up occurring natural flooding events. Flooding of the basin to variable depths will promote increased plant diversity and drawing down the wetland slowly will allow the habitat to change, resulting in different vegetation communities establishing within the wetland body. This will assist in meeting the EVC benchmarks required to restore Kanyapella Basin. Wherever possible, this managed hydrological regime should be aligned with local climatic conditions. The little that is known of the water requirements for the two milfoil species is consistent with the optimum watering regime described above.

6.3 Implementation: seasonally adaptive approach

Each year CMAs prepare **seasonal watering proposals** for wetlands and rivers. The proposals identify the environmental water requirements of wetlands and rivers in the Goulburn Broken Catchment in the coming year. The proposals are informed by the Environmental Water Management Plans, scientific studies and reports that identify the flood or flow regimes required to meet the ecological objectives of each site or system. **Seasonal Watering Proposals** are developed using the "seasonally adaptive" approach, originally developed through the Northern Regional Sustainable Water Strategy and now incorporated in 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 or prevailing climatic conditions. It is a flexible way to deal with short-term climatic variability and helps guide annual priorities and manage drought. This approach is outlined in Table 9.

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

The proposals are prepared in consultation with key stakeholders and partners and are approved by CMA boards. The proposals are submitted to the Victorian Environmental Water Holder (VEWH) for consideration. The VEWH then prepares **seasonal watering plans** based on the CMAs seasonal watering proposals. The plans describe the desired environmental water use for rivers and wetlands across Victoria in the coming year. To help facilitate the desired environmental water use outlined in these plans, the VEWH negotiates access to environmental water managed by the Commonwealth Environmental Water Holder (CEWH) and the Murray Darling Basin Authority (MDBA). The VEWH then prepares **seasonal watering statements** that authorise CMAs to undertake the agreed watering activities, including the use of CEWH and MDBA water. As more environmental water becomes available during the season the VEWH may prepare additional seasonal watering statements. Where possible, the VEWH, CEWH and the MDBA seek to coordinate the delivery and management of environmental water to maximise ecological benefits (Figure 14).

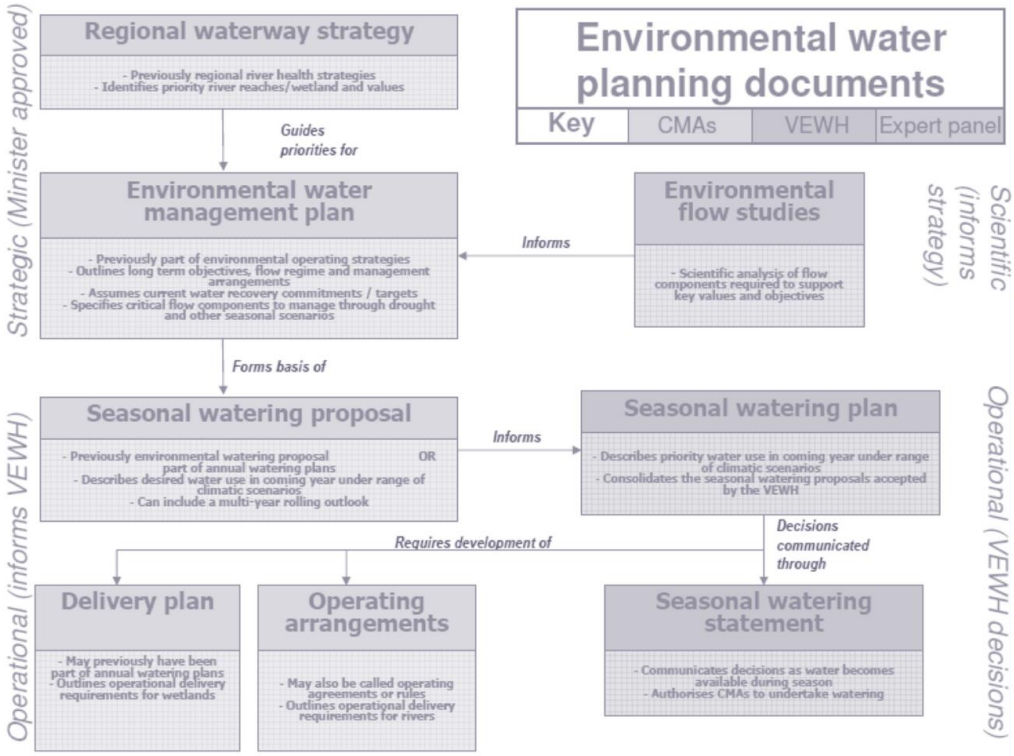

Figure 7: Flow chart for Environmental water planning

Table 9: The seasonally adaptive approach to river and wetland management

	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 rivers 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 works Monitor and survey 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 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

Chapter Seven:

Potential Risks and Mitigation Measures

Potential risks associated with impacts from the application of environmental water to Kanyapella Basin are listed in Table 10. In addition, a detailed risk assessment process will be developed prior to delivering environmental water in any give season and will be provided in the site watering proposal. Mitigation measures will also occur during environmental water delivery and thereafter to assist with lessening any potential risks.

Potential risks of environmental water delivery to Kanyapella Basin include:

- Flood duration is too long or short. If duration is too short, waterbirds may abandon nests, frogs may not complete all stages in life-cycle and aquatic flora may not set-seed. If duration is too long, vegetation composition may be lost or become less diverse due to waterlogging.
- Flood timing is too late or early. Environmental water can only be delivered during the irrigation season when there is capacity in the channel system and the Tongala Main Drain (surface water management system) which may not coincide with the desired timing.
- Flood depth is too shallow or deep. Shallow flooding may occur if environmental water allocations cannot be achieved due to delivery constraints, or deep flooding may occur if a high rainfall event occurs after delivery.
- Flood frequency is too frequent or infrequent. This may occur if a significant rainfall event occurs after an environmental water delivery, or water cannot be delivered within a sufficient time frame.
- Poor water quality. Water in the Tongala Main Drain or the channel system may have low dissolved oxygen, high turbidity, increased salinity and nutrient levels when adding environmental water to Kanyapella Basin. Flooding wetlands that have accumulated large amounts of organic material can also lead to low dissolved oxygen.
- Pest plant and animal invasion. Aquatic pest plants such as Arrowhead and pest animals such as Carp can be introduced via environmental water delivery. Flooding can also stimulate the growth of pest plants and animals if it is the wrong time or duration.
- Impacts to social and economic values such as reduced public access if flooding is too high, or the accidental degradation of cultural heritage sites.

Table 10: Potential risks associated with environmental water delivery to Kanyapella Basin

#	Risk	Description	Potential Impacts								Mitigation
			Environmental					Social		Economic	
			Fish *Water regime does not support breeding and feeding requirements*	**Birds** *Water regime does not support breeding and feeding requirements*	**Amphibians** *Water regime does not support breeding and feeding requirements*	**Invertebrate** *Water regime does not support breeding and feeding requirements*	**Native aquatic flora** *Watering requirement does not support establishment and growth.*	Reduced public access and use	Degradation of cultural heritage sites	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

		Flood frequency		✓	✓	✓	✓	✓			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
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
		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
		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
		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

Chapter Eight:

Environmental Water Delivery Infrastructure

8.1 Constraints

Kanyapella Basin is classified as a flood retardation basin. The Basin is designed to mitigate large flood events from the Lower Goulburn and Murray Rivers. Delivery on environmental water is restricted to small parcels of water including 1,000ML to the west and 1,500ML to the east of the basin. Environmental water would be best delivered once flood waters begin to recede and may assist with an extension of a bird breeding event. Warrigal and Yambuna Creeks downstream of Kanyapella Basin have some constrictions and small regulators in place. Upgrading these systems would assist with more efficient delivery of water to the Basin.

8.2 Irrigation Modernisation

The Northern Victoria Irrigation Renewal Project (NVIRP) is a $2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn-Murray Irrigation District and to save water lost through leakage, evaporation and system inefficiencies. Works will include lining and automating channels, building pipelines and installing new, modern metering technology. No works are currently required for Kanyapella Basin.

8.3 Infrastructure recommendations

The Warrigal and Yambuna regulators were upgraded in 2010 at Kanyapella Basin (Figure 8). However, waterway works on the Warrigal and Yambuna Creeks downstream of Kanyapella Basin may assist with more regular and regulated flows into Kanyapella Basin during times of flood. A scoping study of these two creeks and the ability to deliver water should be considered.

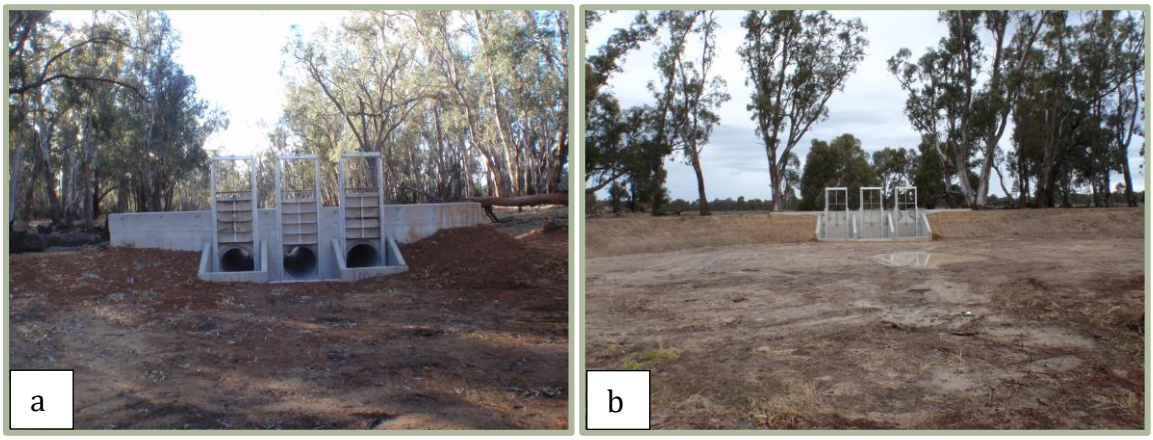

Figure 8: Warrigal regulator upgrade (a) and Yambuna regulator upgrade (b) in 2010.

Chapter Nine:

Knowledge Gaps and Recommendations

There are currently a number of knowledge gaps in relation to environmental water management at Kanyapella Basin. While most of these do not impact the ability to provide water to the wetland and generate ecological benefit, addressing these would significantly improve the accuracy of environmental water bidding, and provide long-term ecological understanding to the site.

The following list describes recognised knowledge gaps and/or recommendations that may assist with more efficient environmental water delivery to Kanyapella Basin.

- Monitor the sites environmental conditions and issues that may pose threats. This includes monitoring of exotic pest species on a long-term basis to ensure control and possible eradication.
- Simulating the natural hydrological regime to provide ecological benefits by delivering environmental water annually if possible.
- Undertake a risk management matrix before delivering environmental water to Kanyapella Basin.
- Undertake scoping study of possible works required along Warrigal and Yambuna Creeks to increase flow passage to Basin from the Goulburn River.
- Undertake scoping study of abandoned wildlife bays and determine a more efficient way to deliver environmental water to this western side of the Basin.

Chapter Ten:

Glossary

Alluvium - Detrital material which is transported by a river and deposited – usually temporarily – at points along the floodplain of a river. Commonly composed of sands and gravels.

Anastomosing Stream – Branching and re-joining irregularly to produce a net-like pattern.

Cainozoic – The division of geological time which succeeds the Mesozoic and ends at the Quaternary. The duration is approximately 63 m.y. from 65 m.y to 2 m.y. It is commonly used as a synonym for Tertiary.

Chromosol - Have a strong texture contrast between the A and B horizons, are not strongly acidic in their upper B horizons. These soils may have favourable physical and chemical properties favourable for agriculture although hard-setting surface layers with structural degradation may be caused by long-term cultivation.

Dermosols - Are diverse and have a moderate to strong structured B2 (subsoil) horizon and a lack of a strong texture contrast between the A and B horizons. These soils are not high in free iron (less than 5% Fe), nor are they calcareous throughout the profile. Increase in clay content with depth.

Holocene – Post-glacial deposits within the Quaternary Period.

Kurosols - Very acidic soils that have unusual subsoil chemical features such as high exchangeable magnesium, sodium and aluminium and very low calcium.

Lunette – Crescent-shaped, fixed dunes along the eastern sides of Lakes. Lunettes in the Echuca region are suggested to be the result of deposition by the wind, usually formed from fine-grained silt. These lunettes form by trapping atmospheric dust by the moist air being blown from lake basins at times when water was present, the trapped dust becomes deposited on the eastern margin of the lake being carried by westerly winds.

Palaeo-channels – Ancient channels

Pleistocene – local accumulations of glacial deposits which continue without change of fauna within the Quaternary Period.

Quaternary – The latest period of time in the stratigraphic column 0-2m.y.

Sodosols - Sodic soil with a clear or abrupt textural B horizon that is not strongly acid and has an exchangeable sodium percentage of 6 or greater in its upper part (an ESP of 6 is the critical limit for the sodicity to have an adverse effect on productivity of the soil). The B horizons are usually clayey with restricted hydraulic conductivity caused by the dispersive nature of the sodic clay.

Chapter Eleven:

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Chapter 12:

Appendices

Appendix 1: Workshop Notes

Participants were given a booklet with the wetland characteristics, maps and site information to discuss (all found in relevant sections of this plan). Ecological and hydrological requirements were determined by J. Wood and S. Casanelia before the Scientific Committee met and were discussed and changed where relevant. From this workshop Kanyapella Basins floristic characteristics were also revised by D. Cook and D. Frood during a three day field survey.

Appendix 2: Corrick and Norman Classification of wetland categories

A system of wetland classification developed by Corrick and Norman (1980) is used to describe wetlands in Victoria. Under this system six naturally occurring wetland types are described based upon water depth, frequency of inundation, salinity and dominant vegetation.

Freshwater meadow

These include shallow (up to 0.3m) and temporary (less than four months duration) surface water, although soils are generally waterlogged throughout winter.

Shallow freshwater marsh

Wetlands that are usually dry by mid-summer and fill again with the onset of winter rains. Soils are waterlogged throughout the year and surface water up to 0.5m deep may be present for as long as eight months.

Deep freshwater marsh

Wetlands that are generally inundated to a depth of 1-2m throughout the year.

Permanent open freshwater

Wetlands that are usually more than 1m deep. They can be natural or artificial. Wetlands are described as permanent if they retain water for longer than 12 months, however they can have periods of drying.

Semi-permanent saline

These wetlands may be inundated to a depth of 2m for as long as eight months each year. Saline wetlands are those in which salinity exceeds 3,000mg/L throughout the whole year.

Permanent saline

These wetlands include coastal wetlands and part of intertidal zones. Saline wetlands are those in which salinity exceeds 3,000mg/L throughout the whole year.

Appendix 3: Environmental Water Sources

Victorian River Murray Flora and Fauna Bulk Entitlement – Deployed along the length of the Murray River in Victoria. This has been used in the past to supply water to Barmah Forest and wetlands connected to the supply networks of the Goulburn River and lower Broken Creek Systems.

Victorian Environmental Water Holder (VEWH) – The Victorian Environmental Water Holder (VEWH) is to be established in June 2011. VEWH 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 VEWH that could potentially be made available to this site include:

- The Victorian River Murray Flora and Fauna Bulk Entitlement; and
- Future Northern Victorian Irrigation Renewal Project (NVIRP) Environmental Entitlement.

In 1987 an annual allocation of 27,600ML 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.

Future NVRIP Environmental Water Entitlements - One third of water savings from Stage 1 of the NVIRP project will be used for the environment, some of which will be stored in Lake Eildon. This water will be released into stressed rivers and streams when required. The NVIRP water savings are predicted to provide up to 75GL 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 priorities 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.

The environment's share of water savings will be over and above The Living Murray and Snowy commitments and will primarily target the use of environmental water for priority Victorian wetlands and tributaries.

This will also have flow on benefits when the water enters the River Murray, which can then be reused to meet the needs of the Murray and its floodplains and wetlands, including Kerang Lakes, Barmah Forest, Gunbower Forest, Hattah Lakes, Lindsay-Wallpolla Island and various other sites along the River Murray.

Stage 2 is expected to deliver a further 200 billion litres of water savings a year, which will be shared equally between irrigators and the environment.

Commonwealth Environmental Water Holder (CEWH) – The *Water Act 2007* established the Commonwealth Environmental Water Holder to manage the water entitlements that the Commonwealth acquires. These water entitlements will be used to protect or restore environmental assets such as wetlands and streams.

69 GL of environmental water will be available for the Lower Goulburn between February and July 2011. Commonwealth environmental water is available to avoid the critical loss of threatened species. It is also available to avoid irretrievable damage or catastrophic events and to maintain key refuges to allow re-colonisation when conditions improve.

Appendix 4: Legislative Framework

Acts, 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

Japan Australia Migratory Bird Agreement 1974 - Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment.

China Australia Migratory Bird Agreement 1986 - Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment.

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 of Migratory Species (Bonn Convention) 1979 - The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) 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. Since the Convention's entry into force, its membership has grown steadily to include 114 (as of 1 October 2010) Parties from Africa, Central and South America, Asia, Europe and Oceania.

Republic of Korea Australia Migratory Bird Agreement 2009 – Agreement between the Government of Australia and the Government of the Republic of Korea on the protection of Migratory birds.

ACTS (NATIONAL)

***Australian Heritage Commission Act* 1975** - An Act to establish an Australian Heritage Commission.

***Aboriginal and Torres Strait Islander Heritage Protection Act* 1984** - An Act to preserve and protect places, areas and objects of particular significance to Aboriginals, and for related purposes.

***Native Title Act* 1993** – Legislation to protect any native title that has survived 200 years of colonisation.

***Environment Protection Biodiversity Conservation Act* 1999** - The Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance.

***Water Act* 2007** - An Act to make provision for the management of the water resources of the Murray-Darling Basin, and to make provision for other matters of national interest in relation to water and water information, and for related purposes.

***Water Amendment Act* 2008** - An Act to amend the Water Act 2007, and for related purposes.

ACTS (VICTORIA)

***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 this Act.

***Planning and Environment Act* 1987** – Controls the removal or disturbance to native vegetation within Victoria by implementation of a three-step process of avoidance, minimisation and offsetting.

***Flora and Fauna Guarantee Act* 1988** - The key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes.

***Water Act* 1989 (Victorian)** - The legislation that governs the way water entitlements are issued and allocated in Victoria. It defines water entitlements and establishes the mechanisms for managing Victoria's water resources.

***Catchment and Land Protection Act* 1994** - has an objective of establishing a framework for the integrated and coordinated management of catchments which will;

- maintain and enhance long-term land productivity while also conserving the environment, and
- aim to ensure that the quality of the State's land and water resources and their associated plant and animal life are maintained and enhanced.

The Act established ten Catchment and Land Protection Boards, nine of which have since expanded their roles to become Catchment Management Authorities. The *Catchment and Land Protection Act* (1994) provides for the development of Regional Catchment Strategies which, among other things, must assess the nature, causes, extent and severity of land degradation of the catchments in the region and identify areas for priority attention. Local Planning schemes must have regard for the Regional Catchment Strategies.

***Aboriginal Heritage Act* 2006** - The main purpose of this Act is to provide for the protection of Aboriginal cultural heritage in Victoria. The objectives of this Act are-

(a) to recognise, protect and conserve Aboriginal cultural heritage in Victoria in ways that are based on respect for Aboriginal knowledge and cultural and traditional practices;

(b) to recognise Aboriginal people as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage;

(c) to accord appropriate status to Aboriginal people with traditional o familial links with Aboriginal cultural heritage in protecting that heritage;

(d) to promote the management of Aboriginal cultural heritage as an integral part of land and natural resource management;

(e) to promote public awareness and understanding of Aboriginal cultural heritage in Victoria;

(f) to establish an Aboriginal cultural heritage register to record Aboriginal cultural heritage;

(g) to establish processes for the timely and efficient assessment of activities that have the potential to harm Aboriginal cultural heritage;

(h) to promote the use of agreements that provide for the management and protection of Aboriginal cultural heritage;

(i) to establish mechanisms that enable the resolution of dispute relating to the protection of Aboriginal cultural heritage;

(j) to provide appropriate sanctions and penalties to prevent harm to Aboriginal cultural heritage.

Advisory lists of rare and threatened species in Victoria (DSE) – Three advisory lists are maintained by DSE for use in a range of planning processes 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 list comprises:

- Advisory list of Rare and Threatened Plants in Victoria – 2005
- Advisory list of Threatened Vertebrate Fauna in Victoria – 2007
- Advisory list of Threatened Invertebrate Fauna in Victoria - 2009

Policy and Frameworks

Wetland Policy of the Commonwealth Government of Australia 1997 - On 2 February 1997, the inaugural World Wetlands Day, the Commonwealth Government released the Wetlands Policy of the Commonwealth Government of Australia. The Wetlands Policy aims to promote the conservation, repair, and wise use of wetlands and - within the broader context of environmental management - incorporate the conservation of wetlands into the daily business of the Commonwealth Government.

Framework for Determining Commonwealth Environmental Watering Actions 2009 - The purpose of this paper is to outline a framework for determining Commonwealth environmental watering actions in the Murray-Darling Basin. The framework will be developed and implemented over the period 2009-2011, prior to the development of the Environmental Watering Plan (EWP) by the Murray Darling Basin Authority, and be adapted in accordance with the EWP once that is available.

Policy and Frameworks (Victoria)

The State Environment Protection Policy (Waters of Victoria) 2003 - Sets the framework for government agencies, businesses and the community to work together, to protect and rehabilitate Victoria's surface water environments.

Northern Region Sustainable Water Strategy 2009 - The Northern Region Sustainable Water Strategy has been released by the Victorian Government to secure the water future for urban, industrial, agricultural and environmental water users for the next 50 years.

Reports Applicable to the Environmental Watering Plan

Goulburn Broken Catchment Regional Catchment Strategy 2003 – A strategy that sets the framework for Natural Resource Management and the context for sub-strategies and action plans within the Goulburn Broken Catchment.

Our Water Our Future 2004 - Sets out 110 actions for sustainable water management aimed at every sector of the community, seeking to secure water supplies and sustain growth over the next 50 years.
The 110 actions aim to:

- Repair rivers and groundwater systems – the natural source of all our fresh water – by giving them legal water rights and conducting restoration works;
- Price water to encourage people to use it more wisely;
- Permanently save water in our towns and cities, through common sense water saving and recycling measures;
- Secure water for farms through pioneering water allocation and trading systems; and

- Manage water allocation to find the right balance between economic, environmental and social values.

Biodiversity strategy for Goulburn Broken Catchment 2009 - This Strategy follows implementation of Goulburn Broken CMAs Native Vegetation Management Strategy (developed in 2000) and from the Fringe to mainstream – a Strategic Plan for Integrating Native Biodiversity (developed in 2004). The Strategy provides a regional perspective for implementing Victoria's White Paper for Land and Biodiversity at a time of Climate Change (released December 2009).

Appendix 5: Fauna Species List

Fauna list of Kanyapella Basin – taken from Victorian Fauna Database 2010, D. Wyatt 1990's – 2011, K. Stockwell and Echuca Bird Observers Club 2011-12.

E – Listed as endangered under the *Environmental Protection Biodiversity Conservation Act (1999)*

L = listed as threatened under the *Flora and Fauna Guarantee Act (1988)*

vu = Listed as vulnerable on the DSE Advisory list of threatened vertebrate fauna (2007)

en = Listed as endangered on the DSE Advisory list of threatened vertebrate fauna (2007)

nt = Listed as near threatened on the DSE Advisory list of threatened vertebrate fauna (2007)

dd = Listed as data deficient on the DSE Advisory list of threatened vertebrate fauna (2007)

cr = Listed as critically endangered on the DSE Advisory list of threatened vertebrate fauna (2007)

w Water dependant species or Waterbirds

b Observed breeding at the Swamp

Common Name	Scientific Name	EPBC	FFG	VROTS	Origin and guild
BIRDS					
Australasian Grebe	*Tachybaptus novaehollandiae*				w
Australasian Pipit	*Anthus novaeseelandiae*				
Australasian Shoveler	*Anas rhynchotis*			vu	w
Australian Hobby	*Falco longipennis*				
Australian Magpie	*Gymnorhina tibicen*				
Australian Owlet-nightjar	*Aegotheles cristatus*				
Australian Pelican	*Pelecanus conspicillatus*				w
Australian Raven	*Corvus coronoides*				
Australian Reed-Warbler	*Acrocephalus stentoreus*				w
Australian Shelduck	*Tadorna tadornoides*				w
Australian Spotted Crake	*Porzana fluminea*				w
Australian White Ibis	*Threskiornis molucca*				w
Australian Wood Duck	*Chenonetta jubata*				w
Azure Kingfisher	*Alcedo azurea*			nt	w
Barking Owl	*Ninox connivens*		L	en	
Black Falcon	*Falco subniger*			vu	
Black Kite	*Milvus migrans*				
Black Swan	*Cygnus atratus*				w
Black-chinned Honeyeater	*Melithreptus gularis*			nt	
Black-eared Cuckoo	*Chrysococcyx osculans*			nt	

Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				
Black-fronted Dotterel	*Elseyornis melanops*				w
Black-shouldered Kite	*Elanus axillaris*				
Black-tailed Native-hen	*Gallinula ventralis*				w
Blue-faced Honeyeater	*Entomyzon cyanotis*				
Brolga	*Grus rubicunda*		L	vu	w
Brown Falcon	*Falco berigora*				
Brown Goshawk	*Accipiter fasciatus*				
Brown Songlark	*Cincloramphus cruralis*				
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*			nt	
Brown-headed Honeyeater	*Melithreptus brevirostris*				
Budgerigar	*Melopsittacus undulates*				
Buff-rumped Thornbill	*Acanthiza reguloides*				
Bush-stone Curlew	*Burhinus grallarius*		L	en	
Chestnut Teal	*Anas castanea*				w
Chestnut-rumped Thornbill	*Acanthiza reguloides*				
Collared Sparrowhawk	*Accipiter cirrhocephalus*				
Common Bronzewing	*Phaps chalcoptera*				
Crested Pigeon	*Ocyphaps lophotes*				
Crested Shrike-tit	*Falcunculus frontatus*				
Crimson Rosella	*Platycercus elegans*				
Crimson Rosella (Yellow form)	*Platycercus elegans flaveolus*				
Diamond Dove	*Geopelia cuneata*			nt	
Diamond Firetail	*Stagonopleura guttata*		L	vu	
Dollarbird	*Eurystomus orientalis*				
Dusky Moorhen	*Gallinula tenebrosa*				w
Dusky Woodswallow	*Artamus cyanopterus*				
Eastern Barn Owl	*Tyto alba*				
Eastern Great Egret	*Ardea modesta*		L	vu	w
Eastern Rosella	*Platycercus eximius*				
Eastern Spinebill	*Acanthor*				
Emu	*Dromaius novaehollandiae*				
Eurasian Coot	*Fulica atra*				w
Fairy Martin	*Hirundo ariel*				

Fan-tailed Cuckoo	*Cacomantis flabelliformis*				
Flame Robin	*Petroica phoenicea*				
Fork-tailed Swift	*Apus pacificus*				w
Galah	*Eolophus roseicapilla*				
Golden Whistler	*Pachycephala pectoralis*				
Golden-headed Cisticola	*Cisticola exilis*				
Great Cormorant	*Phalacrocorax carbo*				w
Great Crested Grebe	*Podiceps cristatus*				w
Grey Currawong	*Strepera versicolour*				
Grey Fantail	*Rhipidura albiscarpa*				
Grey Shrike-thrush	*Colluricincla harmonica*				
Grey Teal	*Anas gracilis*				w
Grey-crowned Babbler	*Pomatostomus temporalis*		L	en	
Hardhead	*Aythya australis*			vu	w
Hoary-headed Grebe	*Poliocephalus poliocephalus*				w
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*				
Intermediate Egret	*Ardea intermedia*		L	cr	w
Jacky Winter	*Microeca fascinans*				
Laughing Kookaburra	*Dacelo novaeguineae*				
Leaden Flycatcher	*Myiagra rubecula*				
Little Black Cormorant	*Phalacrocorax sulcirostris*				w
Little Corella	*Cacatua sanguinea*				
Little Eagle	*Hieraaetus morphnoides*				
Little Egret	*Egretta garzetta nigripes*		L	en	w
Little Friarbird	*Philemon citreogularis*				
Little Grassbird	*Megalurus gramineus*				w
Little Lorikeet	*Glossopsitta pusilla*				
Little Pied Cormorant	*Microcarbo melanoleucos*				w
Little Raven	*Corvus mellori*				
Long-billed Corella	*Cacatua tenuirostris*				
Magpie-lark	*Grallina cyanoleuca*				
Masked Lapwing	*Vanellus miles*				w
Masked Woodswallow	*Artamus personatus*				
Musk Duck	*Bizura lobata*			vu	w

Musk Lorikeet	*Glossopsitta concinna*				
Nankeen Kestrel	*Falco cenchroides*				
Nankeen Night Heron	*Nycticorax caledonicus*			nt	w
Noisy Friarbird	*Philemon corniculatus*				
Noisy Miner	*Manorina melanocephala*				
Olive-backed Oriole	*Oriolus sagittatus*				
Pacific Black Duck	*Anas superciliosa*				w
Painted Button-quail	*Turnix varia*				
Painted Snipe	*Rostratula benghalensis*				w
Pallid Cuckoo	*Cuculus pallidus*				
Peaceful Dove	*Geopelia striata*				
Peregrine Falcon	*Falco peregrinus*				
Pied Butcherbird	*Cracticus nigrogularis*				
Pied Cormorant	*Phalacrocorax varius*			nt	w
Pied Currawong	*Strepera graculina*				
Pink-eared Duck	*Malacorhynchus membranaceus*				w
Plumed Whistling-Duck	*Dendrocygna eytoni*				w
Purple Swamphen	*Porphyrio porphyrio*				w
Rainbow Bee-eater	*Merops ornatus*				
Red Wattlebird	*Anthochaera carunculata*				
Red-browed Finch	*Neochima temporalis*				
Red-capped Robin	*Petroica goodenovii*				
Red-rumped Parrot	*Psephotus haematonotus*				
Restless Flycatcher	*Myiagra inquieta*				
Royal Spoonbill	*Platalea regia*			vu	w
Rufous Songlark	*Cincloramphus mathewsi*				
Rufous Whistler	*Pachycephala rufiventris*				
Sacred Kingfisher	*Todiramphus sanctus*				
Scarlet Robin	*Petroica boodang*				
Shining Bronze-cuckoo	*Chrysococcyx lucidus*				
Silver Gull	*Chroicocephalus novaehollandiae*				w
Silvereye	*Zosterops laterlis*				
Singing Honeyeater	*Lichenostomus virescens*				
Southern Boobook	*Ninox novaeseelandiae*				

Southern Whiteface	*Aphelocephala leucopsis*				
Spotless Crake	*Porzana tabuensis*				w
Spotted Pardelote	*Pardalotus punctatus*				
Straw-necked Ibis	*Threskiornis spinicollis*				w
Striated Pardalote	*Pardalotus striatus*				
Striated Thornbill	*Acanthiza lineata*				
Stubble Quail	*Coturnix pectoralis*				
Sulphur-crested Cockatoo	*Cacatua galerita*				
Superb Fairy-wren	*Malurus cyaneus*				w
Superb Parrot	*Polytelis swainsonii*	Vul	L	en	
Swamp Harrier	*Circus approximans*				w
Tawny Frogmouth	*Podargus strigoides*				
Tree Martin	*Hirundo nigricans*				
Varied Sittella	*Daphoenositta chrysoptera*				
Wedge-tailed Eagle	*Aquila audax*				
Weebill	*Smicrornis brevirostris*				
Welcome Swallow	*Hirundo neoxena*				w
Western Gerygone	*Gerygone fusca*				
Whiskered Tern	*Childonias hybridus*			nt	w
Whistling Kite	*Haliastur sphenurus*				
White-backed Swallow	*Cheramoeca leucosternus*				
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		L	vu	w
White-breasted Woodswallow	*Artamus leucorynchus*				
White-browed Babbler	*Pomatostomus supeciliosus*				
White-browed Scrubwren	*Sericornis frontalis*				
White-browed Woodswallow	*Artamus superciliosus*				
White-faced Heron	*Egretta novaehollandiae*				w
White-fronted Chat	*Epthianura albifrons*				
White-napped Honeyeater	*Melithreptus lunatus*				
White-necked Heron	*Ardea pacifica*				w
White-plumed Honeyeater	*Lichenostomus penicillatus*				
White-throated Gerygone	*Gerygone olivacea*				
White-throated Treecreeper	*Cormobates leucophaea*				
White-winged Chough	*Corcorax melanorhamphos*				

White-winged Fairy Wren	*Malurus leucopyerus*				
White-winged Triller	*Lalage sueurii*				
Willie Wagtail	*Rhipidura leucophrys*				
Yellow Thornbill	*Acanthiza nana*				
Yellow-billed Spoonbill	*Platalea flavipes*				w
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*				
Zebra Finch	*Taeniopygia guttata*				
FROGS					
Common Froglet	*Crinia signifera*				Moist depressions
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				Common in farm dams and wetlands
MAMMALS					
Common Brushtail Possum	*Trichosurus vulpecular*				
Eastern Grey Kangaroo	*Macropus gigantus*				
Koala	*Phascolarctos cinereus*				
Water Rat	*Hydromys chrysogaster*				
Yellow-footed Antechinus	*Antechinus flavipes flavipes*				
REPTILES					
Eastern Bearded Dragon	*Pogona barbata*			dd	
Eastern Brown Snake	*Pseudonaja textilis*				
Eastern Snake-necked Turtle	*Chelodina longicollis*				
Tiger Snake	*Notechis scutatus*				
Lace Monitor	*Varanus varius*			vu	
Marbled Gecko	*Phyllodactylus marmoratus*				
INTRODUCED SPECIES					
Black Rat	*Rattus rattus*				
Brown Hare	*Lepus capensis*				
Common Blackbird	*Turdus merula*				
Common Starling	*Sturnus vulgaris*				
Common Myna	*Sturnus tristis*				
Domestic Pig	*Sus scofra*				
European Carp	*Cyprinus carpio*				w
European Goldfinch	*Carduelis carduelis*				
European Greenfinch	*Carduelis chloris*				
Gambusia (Mosquito Fish)	*Gambusia affinus*				w

Goldfish	*Carassius aurakus*				w
House Mouse	*Mus musculus*				
House Sparrow	*Passer domesticus*				
Rabbit	*Oryctolagus cuniculus*				
Red Fox	*Vulpes vulpes*				
Rock Dove	*Columba livia*				
Spotted Dove	*Streptopelia chinensis*				
Wild Dog	*Cannis lupus*				

Appendix 6: Ecological Vegetation Classes

The following information is taken from the Index of Wetland Condition Assessment of Wetland Vegetation Update-March 2006. Victoria's Framework for the Native Vegetation Management (DNRE 2002) utilises the notion of Ecological Vegetation Classes (EVCs). The Framework defines an EVC as follows: "An EVC is a type of native vegetation classification that is described through a combination of floristic, life form and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Each EVC includes a collection of floristic communities (ie: a lower level in the classification that is based solely on groups of the same species) that occur across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating".

Below is a description of the EVCs found within and surrounding Kanyapella Basin (Frood and Cook, 2012).

Drainage Line Aggregate (EVC #168)

A small section of drainage-line flowing out of the north-western corner of the basin into Warrigal Creek was considered of sufficient scale to be mapped as Drainage-line Aggregate. This EVC provides a collective label for the communities found along drainage lines in lower rainfall areas of the Riverina. The range of indigenous species associated with the channel and banks of this section of drainage-line included River Red-gum (*Eucalyptus camaldulensis*), Silver Wattle (*Acacia dealbata*), Pale-fruit Ballart (*Exocarpos strictus*), Common Spike-sedge (*Eleocharis acuta*), Tussock Rush (*Juncus aridicola*), Common Duckweed (*Lemna disperma*), Water Pepper (*Persicaria hydropiper*), Common Reed (*Phragmites australis*) and Narrow-leaf Cumbungi (*Typha domingensis*).

Figure 9: Drainage-line Aggregate in the north-western corner of Kanyapella Basin

Floodplain Wetland Aggregate (EVC #172)

The hydrology of the treeless wetland in the north-east corner of the reserve has been substantially altered through modification and regulation of the inflow channel. It is not considered possible to reliably interpret what the structure and floristics of the vegetation would have been prior to these modifications. Floodplain Wetland Aggregate mainly applies to wetland systems within Floodplain Riparian Woodland, and can include a wide range of component EVCs, often in association with fine-scale patterns of zonation within the vegetation. Given the floristic similarities to some components of the Floodplain Wetland Aggregate, this EVC label was considered the most suitable to describe the vegetation of this wetland.

Poong'ort (*Carex tereticaulis*) is conspicuous over a substantial portion of the outer zone of the wetland, with Tall Spike-sedge (*Eleocharis sphacelata*) dominant within the inlet channels and over much of the deeper portion of the wetland. Other wetland species present include Common Spike-sedge (*Eleocharis acuta*), Hollow Rush (*Juncus amabilis*), Tussock Rush (*Juncus aridicola*), Common Swamp Wallaby-grass (*Amphibromus nervosus*), Pacific Azolla (*Azolla filiculoides*), Common Duckweed (*Lemna disperma*) and Clove-strip (*Ludwigia peploides*). Conspicuous introduced species include the grasses Wimmera Rye-grass (**Lolium rigidum*) in the outer parts of the wetland, and Water Couch (**Paspalum distichum*) which forms dense patches in the central, wetter parts. Other wetland weeds include Water Plantain (**Alisma lanceolata*), Common Water-starwort (**Callitriche stagnalis*) and Celery Buttercup (**Ranunculus sceleratus*).

Figure 10: Floodplain Wetland Aggregate at Kanyapella Basin

Mosaic of Riverine Grassy Woodland and Plains Woodland (EVC # 295/803)

This unit is mapped mainly in the west and south of the reserve. It is largely dominated by River Red-gum (*Eucalyptus camaldulensis*), variously with a component of Black Box (*Eucalyptus largiflorens*) interspersed as scattered trees or small stands. It occurs in slightly more elevated habitat than Riverine Swampy Woodland and lacks the component of ground flora indicative of seasonally wet sites shared with wetland that characterizes the latter EVC. It is difficult to reliably separate the components of this mosaic due to the generally ecotonal character of the vegetation, the fine-scale of variation in the structural dominant and the extent of ecological modification to the ground-layer as a consequence of prior land-use. Indigenous species recorded from this mosaic mapping unit include Bristly Wallaby-grass (*Rytidosperma setaceum*), Plains Joyweed (*Alternanthera* sp. 1), Berry Saltbush (*Atriplex semibaccata*), Nodding Saltbush (*Einadia nutans*), Ruby Saltbush (*Enchylaena tomentosa*), Bluish Raspwort (*Haloragis glauca*), Smooth Minuria (*Minuria integerrima*), Fuzzy New Holland Daisy (*Vittadinia cuneata*), Salt Sea-spurrey (*Spergularia brevifolia*), Golden Everlasting (*Xerochrysum bracteatum*) and River Bluebell (*Wahlenbergia fluminalis*). This list includes some herbs which were noted from only very few individuals. A wide range of introduced annuals occur in this zone, as does the serious environmental weed Fog-fruit (**Phyla canescens*).

Figure 11: Mosaic of Riverine Grassy Woodland and Plains Woodland, Kanyapella Basin

Plains Woodland - Black Box dominated (EVC #803)

This unit was used to designate areas dominated by Black Box and lacking River Red-gum. These occur in the most elevated parts of the reserve close to the boundary, almost entirely in the western section and with the most extensive area occupying the north-west corner of the reserve. This vegetation was assigned to Plains Woodland on the basis of the composition of the remnant ground flora and the absence of representation of even the most resilient of the shrubby species generally indicative of Riverine Chenopod Woodland. Indigenous species recorded from this habitat include Bristly Wallaby-grass (*Rytidosperma setaceum*), Spider Grass (Enteropogon acicularis), Red-leg Grass (*Bothriochloa macra*), Windmill Grass (*Chloris truncata*), Rigid Panic (*Walwhalleya proluta*), Berry Saltbush (*Atriplex semibaccata*), Ruby Saltbush (*Enchylaena tomentosa*), Paper Sunray (*Rhodanthe corymbiflora*), Woolly New Holland Daisy (*Vittadinia gracilis*), Annual New Holland Daisy (*Vittadinia cervicularis*), Woolly Buttons (*Leiocarpa panaetioides*) and Tufted Burr-daisy (*Calotis scapigera*). Weeds present in this EVC include a range of introduced annuals.

Mosaic of Riverine Swamp Forest and Sedgy Riverine Forest/Riverine Swamp Forest Complex (EVC #814/817)

This vegetation unit is mapped for an extensive area on the floor of the basin. It is generally in poor condition as a consequence of modified inundation regimes and presumably other effects of prior land-use practices. The Riverine Swamp Forest component is easily identifiable in the lowest lying areas, being defined by River Red-gum (*Eucalyptus camaldulensis*) over a species-poor ground-layer dominated by Common Spike-sedge (*Eleocharis acuta*). Other species representative of at least drier phases of Riverine Swamp Forest which were recorded from this mosaic include Lesser Joyweed (*Alternanthera denticulata*), Common Swamp Wallaby-grass (*Amphibromus nervosus*), Narrow-leaf Nardoo (*Marsilea costulifera*), Common Blown-grass (*Lachnagrostis filiformis* s.s.), Narrow-leaf Dock (*Rumex tenax*), Slender Dock (*Rumex brownii*), Cotton Fireweed (Senecio quadridentatus), Ferny Small-flower Buttercup (*Ranunculus pumilio* var. *pumilio*), Riverina Bitter-cress (*Cardamine moirensis*). The most conspicuous weeds in this habitat included Marsh Fox-tail (**Alopecurus geniculatus*) and Ferny Cotula (**Cotula bipinnata*). More elevated patches within the mosaic are presumed to have previously supported Sedgy Riverine Forest/Riverine Swamp Forest Complex. The identity of the drier component of the mosaic is largely inferred from ecological context, with less evidence of the prior understory persisting. The understorey of this complex is considered to have been variously co-dominated by Poong'ort or Terete Culm-sedge (*Carex tereticaulis*) and Common Spike-sedge. However *C. tereticaulis* is now only very sparsely and inconsistently present, while the introduced Wimmera Rye-grass (**Lolium rigidum*) represents a major component of the understorey.

Figure 12: Riverine Swamp Forest at Kanyapella Basin

Riverine Swampy Woodland (EVC #815)

This EVC is interpreted as having occurred as a band around the periphery of the more flood-prone River Red-gum dominated forest types and associated treeless wetlands. Riverine Swampy Woodland is largely dominated by *E. camaldulensis*, but can include a minor component of Black Box (*Eucalyptus largiflorens*). This EVC was interpreted on the basis of tree stature and spacing and a variable component of representative remnant flora in the ground-layer. In relatively intact condition it is characterized by a grassy-herbaceous ground-layer including smaller sedges and variably a sparse component of more robust graminoids. Remnant species indicative of this EVC at Kanyapella include Brown-back Wallaby-grass (*Rytidosperma duttonianum*), Common Swamp Wallaby-grass (*Amphibromus nervosus*), Common Spike-sedge (*Eleocharis acuta*), Small Spike-sedge (*Eleocharis pusilla*), Knob Sedge (*Carex inversa*), Woodland Swamp-daisy (*Brachyscome basaltica* var. *gracilis*), Slender Goodenia (*Goodenia gracilis*), Tufted Burr-daisy (*Calotis scapigera*), Narrow-leaf Nardoo (*Marsilea costulifera*), Southern Cane-grass (*Eragrostis infecunda*), Poong'ort (*Carex tereticaulis*). Associated weed species include Paradoxical Canary-grass (**Phalaris paradoxa*), Marsh Fox-tail (**Alopecurus geniculatus*) and Fog-fruit (**Phyla canescens*).

Figure 13: Riverine Swampy Woodland at Kanyapella Basin

Sedgy Riverine Forest (EVC #816)

This EVC was mapped for restricted areas in the south-east of the reserve. While locally highly modified as a consequence of factors including changed hydrology, this EVC was interpreted from ecological context, the presence of some indicator species and the local performance of more robust graminoids. Within this EVC, *Carex tereticaulis* is the characteristic understorey dominant beneath *Eucalyptus camaldulensis*. However at Kanyapella, Gold Rush (*Juncus flavidus*) was the dominant robust graminoid, with *C. tereticaulis* much less common. Other indigenous species recorded from this habitat included Common Spike-sedge (*Eleocharis acuta*), Small Spike-sedge (*Eleocharis pusilla*), Common Blown-grass (*Lachnagrostis filiformis* s.s.), Knob Sedge (*Carex inversa*), Narrow-leaf Nardoo (*Marsilea costulifera*), Common Nardoo (*Marsilea drummondii*), Poison Lobelia (*Lobelia pratioides*), Swamp Starwort (*Stellaria angustifolia*), Narrow-leaf Dock (*Rumex tenax*), Australian Buttercup (*Ranunculus lappaceus*) and River Bluebell (*Wahlenbergia fluminalis*). The most conspicuous weeds in this habitat included Lesser Canary-grass (**Phalaris minor*) and Paradoxical Canary-grass (**Phalaris paradoxa*).

Figure 14: Sedgy Riverine Forest at Kanyapella Basin

EVC 819: Spike-sedge Wetland

This EVC was applied to the treeless area of at least former wetland on the south-west edge of the taller more flood-prone River Red-gum dominated forest area. The hydrology of this area is greatly modified (including by the artificial channels and levees traversing the reserve), and it appears that the site is now much drier than would previously have been the case. The vegetation is largely inferred from ecological context, given that the presumed former structural dominant Common Spike-sedge (*Eleocharis acuta*) is now reduced to extremely low numbers and much of the presumed former habitat is now dominated by introduced species. *Eucalyptus camaldulensis* is invading previously treeless areas, and many of the indigenous species now present are likely to have colonised from drier habitats around the margins of the wetland. Other native species recorded from this wetland include Lesser Joyweed (*Alternanthera denticulata*), Tufted Burr-daisy (*Calotis scapigera*), Common Sneezeweed (*Centipeda cunninghamii*), Smooth Willow-herb (*Epilobium billardierianum* subsp. *billardierianum*), Riverina Bitter-cress (*Cardamine moirensis*), Poison Pratia (*Lobelia concolor*), Poison Lobelia (*Lobelia pratioides*), Gold Rush (*Juncus flavidus*), Ferny Small-flower Buttercup (*Ranunculus pumilio* var. *pumilio*), Swamp Starwort (Stellaria angustifolia), Annual Cudweed (*Euchiton sphaericus*), Jersey Cudweed (*Pseudognaphalium luteoalbum*) and Cotton Fireweed (*Senecio quadridentatus*). Weed species recorded include Great Brome (**Bromus diandrus*), Bearded Oat (**Avena barbata*), Fog-fruit (**Phyla canescens*), Clustered Dock (**Rumex conglomeratus*), Curled Dock (**Rumex crispus*) and Knotted Clover (**Trifolium striatum*).

Figure 15: Spike Sedge Wetland at Kanyapella Basin

Appendix 7: Flora Species List

Flora list of Kanyapella Basin – taken from Victorian Flora Database 2010, D. Cook and D. Frood 2012 survey.

Note: EVC information is recorded from D.Cook and D. Frood Surveys only.

L = Listed as threatened under the Flora and Fauna Guarantee Act (1988)

E =Listed as Endangered under the Environmental Protection Biodiversity Act (1999)

e = Endangered in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

k = Poorly known in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

v = Vulnerable in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

r = Rare in Victoria in DSE Advisory list of rare and threatened plants in Victoria (2005)

w = Wetland species

p = Planted

= Native to Victoria but grows outside natural range

Common Name	Scientific Name	EVC 295	EVC 815	EVC 814	EVC 816	EVC 172	EVC 168	EVC 819	EVC 803	EPBC	FFG	VROTS	Origin	Indigenous Use
Gold-dust Wattle	*Acacia acinacea s.l*													
Silver Wattle	*Acacia dealbata*						✓							Wood used for handles. Gums eaten or used to make water-proof paste
Silver Wattle	*Acacia dealbata subsp. dealbata*													
Hakea Wattle	*Acacia hakeoides*													
Yarran Wattle	*Acacia omalophylla*										L	e		
Weeping Myall	*Acacia pendula*										L	e	#	
Golden Wattle	*Acacia pycantha*													
Wattle	*Acacia spp*													
Water Plantain	*Alisma plantago-aquatica*												w	
Buloke	*Allocasurina luehmannii*										L			
Lesser Joyweed	*Alternanthera denticulata s.l.*			✓				✓					w	
Joyweed	*Alternanthera spp.*													
Plains Joyweed	*Alternanthera sp.1*	✓												
River Swamp Wallaby-grass	*Amphibromus fluitans*									V			w	
Common Swamp Wallaby-grass	*Amphibromus nervosus*		✓	✓		✓							w	
Swamp Wallaby-grass	*Amphibromus spp.*												w	
Box Mistletoe	*Amyema miquelii*	✓												
Common Wheat-grass	*Anthosachne scabra s.l*													
Nodding Chocolate-lily	*Arthropodium fimbriatum*													
Vanilla lily	*Arthropodium spp. (s.s)*												w	
Chocolate lily	*Arthropodium strictum s.l*													
Common Woodruff	*Asperula conferta*													
Prickly Woodruff	*Asperula scoparia subsp. scoparia*												w	
Berry Saltbush	*Atriplex semibaccata*	✓							✓					

Plump Spear-grass	*Austrostipa aristiglumis*													
Spurred Spear-grass	*Austrostipa gibbosa*													
Knotty Spear-grass	*Austrostipa nodosa*													
Rough Spear-grass	*Austrostipa scabra*													
Rough Spear-grass	*Austrostipa scabra subsp. falcata*													
Rough Spear-grass	*Austrostipa scabra subsp. scabra*													
Corkscrew Spear-grass	*Austrostipa setacea*													
Spear-grass	*Austrostipa spp.*													
Pacific Azolla	*Azolla filiculoides*					✓		✓					w	
Red-leg Grass	*Bothriochloa macra*								✓					
Woodland Swamp-daisy	*Brachyscome basaltica var.gracilis*		✓										w	
Rayless Daisy	*Brachyscome perpusilla*													
Brome	*Bromus spp.*													
Bulbine lily	*Bulbine bulbosa*													
Sweet Bursaria	*Bursaria spinosa subsp. spinosa*													
River Bottlebrush	*Callistemon sieberi*													
Winged Water-starwort	*Callitriche umbonata*			✓								r	w	
Lemon Beauty-heads	*Calocephalus citreus*													
Pale Beauty-heads	*Calocephalus sonderi*													
Cut-leaf Burr-daisy	*Calotis anthemoides*													
Tufted Burr-daisy	*Calotis scapigera*												w	
Burr Daisy	*Calotis spp.*												w	
Riverina Bitter-cress	*Cardamine moirensis*			✓	✓			✓				r	w	
Annual Bitter-cress	*Cardamine paucijuga s.s. (type form)*	✓										e	w	
Annual Bitter-cress	*Cardamine paucijuga s.l.*												w	
Tall Sedge	*Carex appressa*												w	
Fen Sedge	*Carex gaudichaudiana*												w	
Common Sedge/ Knob Sedge	*Carex inversa*		✓		✓								w	
Sedge	*Carex spp.*												w	
Poong'ort / Rush Sedge	*Carex tereticaulis*		✓	✓	✓	✓							w	
Drooping Cassinia	*Cassinia arcuata*													
Common Sneezeweed	*Centipeda cunninghamii*		✓										w	
Flat Spurge	*Chamaesyce drummondii*		✓											
Stonewort	*Characeae spp.*												w	
Frosted Goosefoot	*Chenopodium desertorum*													
Frosted Goosefoot	*Chenopodium desertorum subsp. virosum*											k		
Goosefoot	*Chenopodium spp.*													
Windmill Grass	*Chloris truncata*								✓					
Common Everlasting	*Chrysocephalum apiculatum s.l.*													
Plains Everlasting	*Chrysocephalum sp. 1*													
Pink Bindweed	*Convolvulus erubescens spp.agg*													
Grass Bindweed	*Convolvulus remotus*													
Bindweed	*Convolvulus spp.*													
Common Cotula	*Cotula australis*		✓										w	
Common Billy-buttons	*Craspedia glauca spp.agg*												w	

Swamp Billy-buttons	*Craspedia paludicola*												w	
Spreading Crassula	*Crassula decumbens var. decumbens*												w	
Swamp Crassula	*Crassula helmsii*													
Purple Crassula	*Crassula peduncularis*												w	
Sieber Crassula	*Crassula sieberiana s.l*												w	
Sieber Crassula	*Crassula sieberiana s.s*												w	
Couch	*Cynadon dactylon*												w	
Star Fruit	*Damasonium minus*			✓									w	
Globular Pigweed	*Dysphania glomulifera subsp. glomulifera*													
Clammy Goosefoot	*Dysphania pumilio*												#	
Yellow Twin-heads	*Eclipta platyglossa*												#	
Nodding Saltbush	*Einadia nutans subsp. nutans*	✓												
Waterwort	*Elatine gratioloides*			✓									w	
Common Spike-sedge	*Eleocharis acuta*		✓	✓	✓	✓	✓						w	
Pale Spike-sedge	*Eleocharis pallens*											*k*	w	
Small Spike-sedge	*Eleocharis pusilla*		✓		✓								w	
Tall Spike-sedge	*Eleocharis sphacelata*					✓							w	
Common Wheat-grass	*Elymus scaber var. scaber*					✓								
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*	✓							✓					Berries and leaves eaten
Spider Grass	*Enteropogon acicularis*								✓				w	
Smooth Willow-herb	*Epilobium billardierianum subs. billardierianum*													
Variable Willow-herb	*Epilobium billardierianum subs. cinereum*		✓					✓					w	
Hairy Willow-herb	*Epilobium hirtigerum*												w	
Blue Devil	*Eryngium ovinum*												w	
Close-headed Love-grass	*Eragrostis elongata*												w	
Southern Cane-grass	*Eragrostis infecunda*		✓										w	
Blue Heron's-bill	*Erodium crinitum*													
Blue Devil	*Eryngium ovinum*													
Long Eryngium	*Eryngium paludosum*											*v*		
Southern Mahogany	*Eucalyptus botryoides*												#	
River Red-gum	*Eucalyptus camaldulensis*	✓	✓	✓	✓		✓	✓					w	
Black Box	*Eucalyptus largiflorens*	✓	✓						✓					
Grey Box	*Eucalyptus microcarpa*													
Hybrid River Red Gum and Black Box	*Eucalyptus X oxypoma*		✓											
Common Cudweed	*Euchiton involucratus s.l*												w	
Annual Cudweed	*Euchiton sphaericus*		✓	✓	✓			✓					w	
Flat Spurge	*Euphorbia drummondii*		✓										#	
Common Eutaxia	*Eutaxia microphylla var. microphylla*													
Pale-fruit Ballarat	*Exocarpus strictus*						✓							
Soft Crane's-bill	*Geranium potentillodies var. potentilloides*													
Austral Crane's-bill	*Geranium solanderi s.l*													
Tiny Cudweed	*Gnaphalium indutum*													
Indian Cudweed	*Gnaphalium polycaulon*												w	
Silky Goodenia	*Goodenia fascicularis*													
Slender Goodenia	*Goodenia gracilis*		✓										w	

Cut-leaf Goodenia	*Goodenia pinnatifida*													
Small-flower Goodenia	*Goodenia pusilliflora*													
Dwarf Brooklime	*Gratiola pumilo*											*r*	w	
Rough Raspwort	*Haloragis aspera*												w	
Bluish Raspwort	*Haloragis glauca*	✓										k		
Varied Raspwort	*Haloragis heterophylla*													
Jersey Cudweed	*Helichrysum luteoalbum*													
Mayweed Sunray	*Hyalosperma praecox*													
Orange Sunray	*Hyalosperma semisterile*													
Grass Cushion	*Isoetopsis graminifolia*												w	
Swamp Isotome	*Isotoma fluvitalis subsp. australis*												w	
Hollow Rush	*Juncus amabilis*					✓							w	
Tussock Rush	*Juncus aridicola*					✓	✓						w	
Toad Rush	*Juncus bufonius*												w	
Gold Rush	*Juncus flavidus*				✓			✓					w	
Joint-leaf Rush	*Juncus holoschoenus*												w	
Giant Rush	*Juncus ingens*												w	
Hoary Rush	*Juncus radula*												w	
Finger Rush	*Juncus subsecundus*												w	
Billabong Rush	*Juncus usitatus*												w	
Common Blown-grass	*Lachnagrostis filiformis s.l*		✓										w	
Common Blown-grass	*Lachnagrostis filiformis s.s*			✓	✓								w	
Thin Duckweed	*Landoltia punctata*													
Woolly Buttons	*Leiocarpa panaetioides*								✓					
Common Duckweed	*Lemna disperma*					✓	✓						w	
Common Duckweed	*Lemna minor s.l*												w	
Austral Water-mat	*Lepilaena australis*												w	
Scaly Buttons	*Leptorhynchos squamatus*												w	
Scaly Buttons	*Leptorhynchos squamatus subsp. squamatus*												w	
Milk Moss	*Leucobryum candidum*													
Hairy Stylewort	*Levenhookia dubia*													
Austral Mud-mat	*Limosella australis*			✓									w	
Large Mudwort	*Limosella curdieana*												w	
Native Flax	*Linum marginale*													
Poison Pratia	*Lobelia concolor*							✓					w	
Poison Lobelia	*Lobelia pratioides*				✓			✓					w	
Scented Mat-rush	*Lomandra effusa*													
Clove-strip	*Ludwigia peploides subsp. montevidensis*					✓							w	
Small Loosestrife	*Lythrum hyssopifolia*			✓	✓								w	
Black Cotton-bush	*Maireana decalvans*													
Wingless Bluebush	*Maireana enchylaenoides*													
Bottle Bluebush	*Maireana excavata*													
Dwarf Bluebush	*Maireana humillima*													
Hairy Bluebush	*Maireana pentagona*													
Narrow-leaf Nardoo	*Marsilea costulifera*		✓	✓	✓								w	
Common Nardoo	*Marsilea drummondii*				✓								w	
Smooth Minuria	*Minuria integerrima*	✓										r		

Yam Daisy	*Microseris scapigera s.l*													
Slender Monkey-flower	*Mimulus gracilis*													
Tangled Lignum	*Muehlenbeckia florulenta*		✓										w	
Creeping Mistletoe	*Muellerina eucalyptoides*		✓											
Waterbush	*Myoporum montanum*											*r*		
Mouse-tails	*Myosurus australis*			✓									w	
Woolly-heads	*Myriocephalus rhizocephalus*													
Upright Water-milfoil	*Myriophyllum crispatum*												w	
Robust Water-milfoil	*Myriophyllum papillosum*												w	
Rigid Water-milfoil	*Myriophyllum porcatum*									*V*	*L*	*v*	w	
Stonewort	*Nitella spp*												w	
Robust Water-milfoil	*Myriophyllum papillosum*			✓									w	
Yellow Wood-sorrel	*Oxalis corniculata s.l.*													
Grassland Wood-sorrel	*Oxalis perennans*		✓					✓					w	
Slender Knotweed	*Persicaria decipiens*			✓									w	
Water Knotweed	*Persicaria hydropiper*						✓						w	
Pale Knotweed	*Persicaria lapathifolia*												w	
Creeping Knotweed	*Persicaria prostrata*	✓	✓										w	
Common Reed	*Phragmites australis*						✓						w	
Weeping Pittosporum	*Pittosporum angustifolium*													
Hairy Plantain	*Plantago hispida*													
Ribwort	*Plantago lanceolata*													
Tussock Grass	*Poa australis spp. Agg.*													
Forde Poa	*Poa fordeana*												w	
Grey Tussock-grass	*Poa sieberiana*													
Stiff Cup-flower	*Pogonolepis muelleriana*													
Small Knotweed	*Polygonum plebeium*													
Floating Pondweed	*Potamogeton tricarinatus s.l*												w	
Mulla Mulla	*Ptilotus nobilis*													
Jersey Cudweed	*Pseudognaphalium luteoalbum*							✓					w	
Drumsticks	*Pycnosorus globosus*												#	
Small River Buttercup	*Ranunculus amphitichus*												w	
River Buttercup	*Ranunculus inundatus*												w	
River Buttercup	*Ranunculus lappaceus*				✓								w	
Ferny Small-flower Buttercup	*Ranunculus pumilio*												w	
Ferny Small-flower Buttercup	*Ranunculus pumilio var. pumilio*		✓	✓				✓					w	
Annual Buttercup	*Ranunculus sessiliflorus*		✓									v	w	
Swamp Buttercup	*Ranunculus undosus*											v	w	
Paper Sunray	*Rhodanthe corymbiflora*								✓					
Pygmy Sunray	*Rhodanthe pygmaea*													
Jagged Bitter-cress	*Rorippa laciniata*													
Slender Dock	*Rumex brownii*			✓									w	
Wiry Dock	*Rumex dumosus*												w	
Narrow-leaf Dock	*Rumex tenax*			✓	✓								w	
Common Wallaby-grass	*Rytidosperma caespitosum*												w	
Brown-backed	*Rytidosperma duttonianum*		✓					✓					w	

Wallaby-grass														
Bristly Wallaby-grass	*Rytidosperma setaceum*	✓	✓						✓				w	
Prickly Saltwort	*Salsola tragus*													
Prickly Saltwort	*Salsola tragus subsp. tragus*													
Sharp Club-sedge	*Schoenoplectus pungens*													
Short-wing Saltbush	*Sclerochlamys brachyptera*													
Galvanized Burr	*Sclerolaena birchii*											k		
Grey Copperburr	*Sclerolaena diacantha*													
Black Roly-poly	*Sclerolaena muricata*													
Dark Roly-poly	*Sclerolaena muricata var. semiglabra*											k		
Turnip Copperburr	*Sclerolaena napiformis*									E	L	e		
Floodplain Fireweed	*Senecio camplyocarpus*			✓								r	w	
Branching Groundsel	*Senecio cunninghamii var cuninghamii*		✓									r		
Cotton Fireweed	*Senecio quadridentatus*		✓	✓				✓						
Tall Fireweed	*Senecio runcinifolius*			✓										
Variable Sida	*Sida corrugata*													
Quena	*Solanum esuriale*													
Sow Thistle	*Sonchus spp.*													
Sand-spurrey	*Spergularia brevifolia*	✓		✓										
Swamp Starwort	*Stellaria angustifolia*			✓	✓			✓					w	
Slender Darling-pea	*Swainsona murrayana*									V	L	e	w	
Variable Swainson-pea	*Swainsona oroboides s.l.*												w	
Red Swainson-pea	*Swainsona plagiotropis*									V	L	e	w	
Broughton Pea	*Swainsona procumbens*												w	
Silky Swainson-pea	*Swainsona sericea*										L	v		
Northern Water-ribbons	*Triglochin multifructa*			✓									w	
Water ribbons	*Triglochin procera s.l*			✓									w	
Narrow-leaf Cumbungi	*Typha domingensis*						✓						w	
Broad-leaf Cumbungi	*Typha orientalis*												w	
Annual New Holland Daisy	*Vittadina cervicularis*								✓					
Fuzzy New Holland Daisy	*Vittadinia cuneata*	✓												
Woolly New Holland Daisy	*Vittadinia gracilis*								✓					
River Bluebell	*Wahlenbergia fluminalis*	✓	✓		✓								w	
Annual Bluebell	*Wahlenbergia gracilenta s.l.*		✓											
Large-flowered Annual-bluebell	*Wahlenbergia victoriensis*													
Rigid Panic	*Walwhalleya proluta*								✓				w	Seeds ground to flour.
Common Early Nancy	*Wurmbea dioica subsp. dioica*												w	
Swamp Early Nancy	*Wurmbea dioica subsp. lacunaria*		✓									k	w	
Golden Everlasting	*Xerochrysum bracteatum*	✓												
EXOTIC SPECIES														
Golden Wreath Wattle	*Acacia saligna*													
Sheep Sorrel	*Acetosella vulgaris*													
Creeping Knapweed	*Acroptilon repens*													
Quicksilver Grass / Small Hair-grass	*Aira cupaniana*													
Delicate Hair-grass	*Aira elegantissima*													

Water Plantain	*Alisma lanceolatum*					✓								
Orange Fox-tail	*Alopecurus aequalis*	✓	✓		✓								w	
Marsh Fox-tail	*Alopecurus geniculatus*		✓	✓										
Khaki Weed	*Alternanthera pungens*													
Pimpernel	*Anagallis arvensis*		✓											
Spleen Amaranth	*Amaranthus hybridus*													
Fiddle Neck	*Amsinckia spp.*													
Cape Weed	*Arctotheca calendula*					✓								
Aster-weed	*Aster subulata*	✓	✓	✓	✓								w	
Bearded Oat	*Avena barbata*							✓						
Wild Oat	*Avena fatua*													
Oat	*Avena sp*					✓								
Sterile Oat	*Avena sterilis*													
Lesser Quaking-grass	*Briza minor*													
Mediterranean Brome	*Bromus alopecuros*													
Prairie Grass	*Bromus catharticus*													
Great Brome	*Bromus diandrus*							✓						
Soft Brome	*Bromus hordeaceus subsp. hordeaceus*													
Thread Water-starwort	*Callitriche brutia subsp. brutia*			✓									w	
Thread Water Starwort	*Callitriche hamulata*	✓	✓	✓	✓								w	
Water Starwort	*Callitriche stagnalis*					✓							w	
Shepherd's Purse	*Capsella bursa-pastoris*													
Slender Thistle	*Carduus pycnocephalus*													
Thistle	*Carduus sp*													
Winged Slender-thistle	*Carduus tenuiflorus*													
Saffron Thistle	*Carthamus lanatus*													
Kikuyu	*Cenchrus clandestinus*													
Centaury	*Centaurium tenuiflorum*													
Common Mouse-ear Chickweed	*Cerastium glomeratum s.l.*													
Sticky Mouse-ear Chickweed	*Cerastium glomeratum s.s.*													
Mouse-ear Chickweed	*Cerastium spp.*													
Fat Hen	*Chenopodium album*													
Sowbane	*Chenopodium murale*													
Skeleton Weed	*Chondrilla juncea*													
Square Cicendia	*Cicendia quadrangularis*													
Chicory	*Cichorium intybus*													
Spear Thistle	*Cirsium vulgare*													
Common Bindweed	*Convolvulus arvensis*													
Flax Fleabane	*Conyza bonariensis*													
Tall Fleabane	*Conyza sumatrensis var. sumatrensis*													
Pampas Grass	*Cartaderia selloana*													
Ferny Cotula	*Cotula bipinnata*			✓										
Water Buttons	*Cotula coronopifolia*												w	
Water Crassula	*Crassula natans var. minus*												w	
Paddy Melon	*Cucumis myriocarpus subsp. leptodermis*													
Artichoke Thistle	*Cynara cardunculus subsp. flavescens*													
Couch	*Cynodon dactylon var. dactylon*													
Umbrella Sedge	*Cyperus eragrostis*												w	

Common Thorn-apple	*Datura stramonium*													
Stinkwort	*Dittrichia graveolens*													
Mexican Tea	*Dysphania ambrosioides*													
Barn-yard Grass	*Echinochloa crus-galli*													
Paterson's Curse	*Echium plantagineum*													
Panic Veltd-grass	*Ehrharta erecta var. erecta*													
Annual Veltd-grass	*Ehrharta longifolia*													
Willow Herb	*Epilobium spp.*													
Stink Grass	*Eragrostis cilianensis*													
Big Heron's-bill	*Erodium botrys*													
Hairy-pit Heron's-bill	*Erodium brachycarpum*													
Common Heron's-bill	*Erodium cicutarium*													
Sugar Gum	*Eucalyptus cladocalyx*													
Tall Fescue	*Festuca arundinacea*													
White Fumitory	*Fumaria capreolata*													
Gazinia	*Gazinia linearis*													
Montpellier Brome	*Genista monspessulana*													
Reed Sweet-grass	*Glyceria maxima*													
Hedypnois	*Hedypnois rhagadioloides*													
Common Heliotrope	*Heliotropium europaeum*													
Ox-tongue	*Helminthotheca echioides*													
Yorkshire Fog	*Holcus lanatus*													
Mediterranean Barley-grass	*Hordeum hystrix*													
Sea Barley-grass	*Hordeum marinum*													
Barley-grass	*Hordeum murinum s.l.*													
Knotted Barley-grass	*Hordeum secalinum*													
Barley Grass	*Hordeum sp*													
St John's Wort	*Hypericum perforatum subsp. veronense*													
Smooth Cat's-ear	*Hypochoeris glabra*													
Cat's Ear	*Hypochoeris radiate*													
Awned Club-sedge	*Isolepis hystrix*													
Spiny Rush	*Juncus acutus subsp. acutus*													
Capitate Rush	*Juncus capitatus*													
Willow-leaf Lettuce	*Lactuca saligna*													
Prickly Lettuce	*Lactuca serriola*													
Lettuce	*Lactuca spp.*													
Sharp-leaved Fluellen	*Kickxia elatine ssp. crinata*													
Willow-leaf Lettuce	*Lactuca saligna*													
Prickly Lettuce	*Lactuca serriola*													
Hairy Hawkbit	*Leontodon taraxacoides subsp. taraxacoides*													
Common Peppercress	*Lepidium africanum*													
Perennial Rye-grass	*Lolium perenne*													
Wimmera Rye-grass	*Lolium rigidum*			✓										
African Box-thorn	*Lycium ferocissimum*													
Pimpernel	*Lysimachia arvensis*													
Blue Pimpernel	*Lysimachia arvensis (Blue-flowered variant)*													
Scarlet Pimpernel	*Lysimachia arvensis (Red-flowered variant)*													

Mallow of Nice	*Malva nicaeensis*													
Small-flower Mallow	*Malva parviflora*													
Alkali Sida	*Malvella leprosa*													
Horehound	*Marrubium vulgare*													
Burr Medic	*Medicago polymorpha*													
Medic	*Medicago spp.*													
Red-flowered Mallow	*Modiola caroliniana*													
Thread Iris	*Moraea setifolia*													
Brazilian Water Milfoil	*Myriophyllum aquaticum*													
Stemless Thistle	*Onopordum acaulon*													
Sweet Panic	*Panicum gilvum*													
Red Bartsia	*Parentucellia latifolia*													
Common Bartsia	*Parentucellia latifolia ssp. latifolia*													
Paspalum	*Paspalum dilatatum*													
Water Couch	*Paspalum distichum*					✓							w	
Paspalum	*Paspalum spp.*													
Toowoomba Canary-grass	*Phalaris aquatica*													
Lesser Canary-grass	*Phalaris minor*				✓									
Paradoxical Canary-grass	*Phalaris paradoxa*		✓											
Fog-fruit	*Phyla canescens*	✓	✓					✓						
Sticky Ground-cherry	*Physalis viscosa*													
Annual Meadow-grass	*Poa annua*													
Bulbous Meadow-grass	*Poa bulbosa*													
Prostate Knotweed	*Polygonum aviculare s.l*													
Hogweed	*Polygonum aviculare s.s*													
Annual Beard-grass	*Polypogon monspeliensis*													
Poplar	*Populus spp.*													
Yellow-flowered Devil's-claw	*Proboscidea lutea*													
Prunus	*Prunus spp.*													
Nepal Firethorn	*Pyracantha crenualta*													
Celery Buttercup	*Ranunculus sceleratus subsp. sceleratus*					✓								
Small-flowered Onion-grass	*Romulea minutiflora*													
Onion Grass	*Romulea rosea*													
Sweet Briar	*Rosa rubiginosa*													
Annual Cat's-tail	*Rostraria cristata*													
Clustered Dock	*Rumex conglomeratus*							✓						
Curled Dock	*Rumex crispus*							✓					w	
Sagittaria	*Sagittaria platyphylla*													
Sagittaria	*Sagittaria spp.*													
Weeping Willow	*Salix babylonica s.l.*													
Willow	*Salix spp.*													
Pepper Tree	*Schinus molle*													
Scorzonaera	*Scorzonera laciniata*													
Scorzonaera	*Scorzonera laciniata var. calcitrapifolia*													
Scorzonaera	*Scorzonera sp*													
Italian Millet	*Setaria italica*													
Variegated Thistle	*Silybum marianum*													

Smooth Mustard	*Sisymbrium erysimoides*													
Indian Hedge-mustard	*Sisymbrium orientale*													
Mustard	*Sisymbrium spp.*													
Silver-leaf Nightshade	*Solanum elaegnifolium*													
Black Nightshade	*Solanum nigrum*													
Rough Sow-thistle	*Sonchus asper s.l.*													
Common Sow-thistle	*Sonchus olercea*													
Lesser Sand-spurrey	*Spergularia diandra*													
Coast Sand-spurrey	*Spergularia media*													
Lesser Chickweed	*Stellaria pallida*													
Garden Dandelion	*Taraxacum officinale spp. agg*													
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*													
Hare's-foot Clover	*Trifolium arvense var. arvense*													
Hop Clover	*Trifolium campestre var. campestre*													
Suckling Clover	*Trifolium dubium*			✓										
Strawberry Clover	*Trifolium fragiferum var. fragiferum*													
Cluster Clover	*Trifolium glomeratum*													
Annual-white Clover	*Trifolium michelianum var. michelianum*													
Birdsfoot Clover	*Trifolium ornithopodiodes*													
White Clover	*Trifolium repens var. repens*													
Knotted Clover	*Trifolium striatum*							✓						
Subterraneum Clover	*Trifolium subterraneum*													
Woolly Clover	*Trifolium tomentosum var. tomentosum*													
Lesser Reed-mace	*Typha latifolia*													
Small Nettle	*Urtica urens*													
Wandering Speedwell	*Veronica peregrine*			✓									w	
Common Vetch	*Vicia sativa*													
Vetch	*Vicia spp.*													
Blue Periwinkle	*Vinca major*													
Squirrel-tail Fescue	*Vulpia bromoides*													
Wall Fescue	*Vulpia muralis*													
Rat's-tail Fescue	*Vulpia myuros*													
Bathurst Burr	*Xanthium spinosum*													

Appendix 8: Index of Wetland Condition Method

Table 11 below shows what is assessed for each of the six subindices and how they are scored.

Table 11: IWC subindices and measures.

IWC subindex	What is measured	How it is scored
Swamp catchment	1. The intensity of the land use within 250 metres of the swamp	• The more intensive the landuse the lower the score
	2. The width of the native vegetation surrounding the swamp and whether it is a continuous zone or fragmented	• The wider the zone and more continuous the zone, the higher the score
Physical form	3. Whether the size of the swamp has been reduced from its estimated pre-European settlement size	• A reduction in area results in a lowering of the score
	4. The percentage of the swamp bed which has been excavated or filled	• The greater the percentage of swamp bed modified, the lower the score
Hydrology	5. Whether the swamp'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	6. Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the swamp are present	• The more activities present, the lower the score
	7. Whether the swamp has become more saline or in the case of a naturally salty swamp, whether it has become more fresh	• An increase in salinity for a fresh swamp lowers the score or a decrease in salinity of a naturally salty swamp lowers the score
Soils	8. The percentage and severity of swamp soil disturbance from human, feral animals or stock activities	• The more soil disturbance and the more severe it is, the lower the score
Biota	9. The diversity, health and weediness of the native swamp vegetation	• The lower the diversity and poorer health of native swamp vegetation, the lower the score • The increased degree of weediness in the native swamp vegetation, the lower the score

Adapted from DSE letter 29 April 2010

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures. Weightings are then applied to the scores as shown in Table 12. The maximum possible total score for a wetland is 38.4, which for ease of reporting, is scaled to 10 by dividing the total score by 38.4 and multiplying by 10. The score is then rounded to the nearest whole number.

Table 12: Weights of each subindex

IWC Sub-index	Weight
Biota	0.73
Swamp Catchment	0.26
Water Properties	0.47
Hydrology	0.31
Physical Form	0.08
Soils	0.07

Six wetland condition categories have been assigned to the sun-index scores (Table 13) and total IWC scores (Table 14), to be consistent with the number of categories used in other condition indices such as the Victorian Index of Stream Condition. Biota score categories were determined by expert opinion and differ to those of other sub-indices.

Table 13: Swamp condition categories assigned to sub-index scores

Sub-index score range (all biota)	Biota sun-index score range	Swamp condition category
0-4	0-8	Very Poor
5-8	9-13	Poor
9-12	14-16	Moderate
13-16	17-18	Good
16-20	19-20	Excellent
N/A	N/A	Insufficient data

Table 14: Swamp condition categories assigned to total IWC scores

IWC total score range	Swamp category range
0-2	Very Poor
3-4	Poor
5-6	Moderate
7-8	Good
9-10	Excellent
N/A	Insufficient data

This information has been drawn from Version 9 of the IWC – methods manual, prepared by Phil Papas, Janet Holmes and Shanaugh Lyon of the Department of Sustainability and Environment, January 2010.

Appendix 9: EVC Benchmarks for Kanyapella Basin

EVC #172: Floodplain Wetland Aggregate

Herbs 2, % cover +, broad-leaved, not aquatic but moisture-requiring tolerant of shallow inundation periods. Small aquatic herbs 2, % cover + or mud colonizing. Tall graminoids 3, % cover +. Medium graminoids 3, % cover +.

EVC #814: Riverine Swamp Forest

Trees 1, substantially modified if mature specimens absent or patches of dense regeneration evident. Medium aquatic to semi-aquatic herbs 1, % cover +, substantially modified if absent. Grasses and non-tufted sedges 1, % cover 20, grasses are floating or turf-forming species.

EVC# 816: Sedgy Riverine Forest

Trees 1, substantially modified if lacking mature specimens or patches of dense regeneration evident. Medium (to small) herbs 2, % cover +, substantially modified if <2 species and < 10% cover within intertussock spaces. Tall tufted sedges 1, % cover 15. Medium to small non-tufted sedges 1, % cover +, substantially modified if <20% cover within intertussock spaces.

EVC #819: Spike-sedge Wetland

Medium herbs 1, % cover +, mainly aquatic, substantially modified if absent. Medium to small non-tufted sedges 1, % cover 5, one species, substantially modified if not regularly present within vegetation (include culms which are dead but still attached).

Appendix 10: Frog breeding events

Table extracted from Rogers and Ralph 2011.

Frog species	Preferred hydrology of breeding site (Months)			Timing of breeding				Tadpole lifespan (Months)
	< 3	3-6	Permanent	Spring	Summer	Autumn	Winter	
Common Froglet *Crinia signifera*	*	*	*	C	CM	CM	C	2-4
Plains Froglet *Crinia parasignifera*	*	*	*	C	CM	CM	C	2-4
Pobblebonk *Limnodynastes dumerili*		*	*	CT	CM	CM	C	5-6
Barking Marsh Frog *Limnodynastes fletcheri*		*	*	C	CM	M		3-4
Spotted Marsh Frog *Limnodynastes tasmaniensis*	*	*	*	C	CM	M		3-4
Perons Tree Frog *Litoria peronii*	*	*	*	C	CM	M		3-4
Growling Grass Frog *Litoria raniformis*		*	*	C	CM	M		3-5