Pound Bend Environmental Water Management Plan

mallee catchment management authority

Department of Environment, Land, Water & Planning

State Government Victoria

DOCUMENT CONTROL

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CONTENTS

EXECUTIVE SUMMARY

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) covers 216 identified waterways which have been grouped into planning units according to hydrological interconnectedness and commonality of threats impacting on the waterways values; resulting in 23 Waterway Management Units. This Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of Pound Bend. It is an important part of the Victorian Environmental Water Planning Framework and provides the long-term management intentions, based on scientific information and stakeholder consultation that can be used by the respective agencies; Mallee Catchment Management Authority (CMA), Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH); for both short and longer-term environmental water planning.

This EWMP is not a holistic management plan for the Pound Bend area, but is focused on environmental water management. A regional context document has been prepared to complement the Mallee CMA EWMPs and should be read in conjunction with this document (North, 2014).

Pound Bend WMU sub – unit (Pound Bend) is located in the Robinvale Plains bioregion in the Murray River Reserve (river km 1066 to 1081), five kilometres north of Wemen, and covers 1365ha . It encompasses a diverse range of floodplain and terrestrial ecosystems, most of which are in poor condition. The target area for this plan covers 202 ha within Pound Bend and is the area that can potentially be inundated through the proposed environmental watering activities.

Pound Bend is a valuable asset of the region. The site has a high diversity of terrestrial and floodplain landforms and inundation regimes, which support a diverse range of water- dependent flora and fauna species. A number of these species are listed under state, national and international treaties, conventions, Acts and initiatives, including the Regent Parrot (*Polytelis anthopeplus monarchoides*), the Great Egret (Eastern) (*Ardea modesta*) and the Spreading Emu-bush (*Eremophila divaricata ssp. divaricate*). In addition to this, the area could potentially provide habitat for the threatened Carpet Python (*Morelia spilota metcalfie*). The area also contains a number of vulnerable or depleted Ecological Vegetation Classes (EVCs) including Lignum Swamp, Shallow Freshwater Marsh, Riverine Grassy Woodland, Floodway Pond Herbland, Sub-saline Depression Shrubland and Lignum Swampy Woodland.

The site currently receives some natural flooding which promotes vegetation growth. However, the frequency and duration of these flood events are notably less compared to a more natural regime (Gippel 2014). This changed hydrological regime has impacted on River Red Gum condition, with vegetation health degrading with distance from the river bank (Cunningham et al. 2006).

Recreational impacts at the site are low. While irrigation occurs immediately adjacent to Pound Bend, and while some vegetation health issues may be attributable to the effects of irrigation drainage, the impacts are comparatively modest compared to other floodplain sites in the Mallee region. Assessment of groundwater salinity data suggests that the in-river salinity impacts from any future environmental watering event is likely to be relatively small.

The floodplains and wetlands will continue to receive less than their optimal ‘natural’ frequency of flooding without intervention. This will lead to a continued reduction in floodplain diversity and vegetation health. The declining floodplain vegetation health, diversity of habitat types, presence of water-dependent endangered species, and low salinity impact characteristics suggest the site would respond well to environmental watering.

The long term management goal of the Pound Bend EWMP is to provide a water regime that reflects natural inundation seasonality and duration that will maintain and promote the mosaic of available habitats through the Pound Bend target area.

To achieve this, ecological and hydrological objectives, have been designed and include two inundation stages. These have been developed to sustain the various ecological components of five targeted wetlands and have been incorporated into minimum, optimal and maximum long-term watering regimes.

The specific ecological objectives for this system are to:

- Protect and improve the diversity of native wetland flora species consistent with Shallow Freshwater Marsh, Floodway Pond Herbland, and Shrubby Riverine Woodland, by increasing the understorey species diversity in Un-named 1 and Tammit Wetlands.
- Protect and improve the diversity of native wetland flora species consistent with Lignum Swampy Woodland and Lignum Swamps, by increasing density of Lignum in Eastern Wetlands.
- Maintain the health of fringing River Red Gums, and facilitate longevity and improvement or River Red Gum population, as evidenced by canopy health and germination and recruitment rates.

The following minimum, optimal and maximum watering regimes have been developed to sustain and improve the ecological components of Pound Bend.

Minimum watering regime

Inundate Western and Tammit Wetlands five times in 10 years with a maximum 13 months between events once wetland is dry. Allow ponding for three to four months. Inundate Eastern Wetlands at least once every 10 years and allow ponding for at least two months, to maintain the health of Lignum present. Preferred timing for watering event is in spring or early summer.

Optimal watering regime

Inundate Western and Tammit Wetlands eight times in 10 years and allow ponding for three to four months. Inundate Eastern Wetlands four times in 10 years and allow ponding for up to six months. Preferred timing for watering event is in spring or early summer.

Maximum watering regime

Inundate Western and Tammit Wetlands every year and allow ponding for three to four months. Inundate Eastern Wetlands once every two years with a minimum of 12 months between events and allow ponding up to seven months. Preferred timing for watering event is in spring or early summer.

The delivery of environmental water necessary for these water regimes will require the installation of infrastructure, outlined in this plan. The proposed infrastructure requires further investigation and design.

ACKNOWLEDGEMENTS

This EWMP was produced by The Mallee Catchment Management Authority, with funding from the Victorian Government. The valuable contributions of Parks Victoria, Jane Roberts, Terry Hillman, other agencies and community members are also acknowledged.

1. INTRODUCTION

This EWMP has been prepared to establish the long-term management goals of the wetlands.

The key purposes of the EWMP are to:

- Identify the key issues, long-term objectives and water requirements for each wetland, identified as a high priority by the CMA;
- Provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetlands;
- Inform the development of seasonal watering proposals and seasonal watering plans;
- Inform long-term watering plans that will be developed under Basin Plan requirements.

A context document has been created to complement the Mallee CMA EWMPs and should be read in conjunction with this document (North 2014).

2. SITE OVERVIEW

2.1 Site Location

The Mallee CMA region is located in the north-west of Victoria and is the largest catchment in the state. Its area of responsibility covers approximately 39,000 km² with an estimated regional population of 65,000. The catchment runs along the Murray River from Nyah to the South Australian border, and as far south as Birchip and Rainbow (MCMA 2014). Major towns include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The region has a semi-arid climate, with an annual mean rainfall of around 250mm and average daily temperatures (at Mildura) ranging from 32°C in summer to 15°C in winter (MCMA 2006).

The Mallee CMA region consists of 38% of public land, which is mainly comprised of national parks, reserves and large reaches of riverine and dryland state forest. The remainder of the region is important for dryland farming of sheep and cereals, and irrigated horticulture (MCMA 2006).

In 2006, the Mallee CMA engaged consultants Ecological Associates (EA) to investigate water management options for the Murray River floodplain from Robinvale to Wallpolla Island. One of the major outcomes of these investigations was the development of Floodplain Management Units (FMUs). These divide the floodplain into management units whereby water regimes can be managed for a particular FMU independent of any another FMU. FMUs are relatively consistent in their ecological values and land uses. The Mallee CMA has used FMUs to inform planning and development of environmental water management plans to achieve more effective management of hydrologically connected systems. In addition to this, the Mallee CMA has also used individual FMUs or groupings of FMUs to form Waterway Management Units (WMU) for planning within its Mallee Waterway Strategy (MCMA 2014).

The site for this plan is Pound Bend WMU sub- unit located between river km 1066 and river km 1081, 5 km north of Wemen (Figure 1). Pound Bend falls within the WMU Happy Valley. Happy Valley covers a series of unconnected subunits from Liparoo to Gasdens Bend.

Pound Bend consists largely of public lands, with a small proportion of private land used for agricultural activities. This EWMP focuses on the areas that can be inundated through environmental watering, referred to as the target area, not encompassing any private land.

The target area of Pound Bend covers five wetlands that can be managed in three groups: Eastern Wetlands (7328244531 & 7328340500); Western Wetlands (Un-named 1 & 732822550); and Tammit Wetland (7428511553) (Figure 1). One of the Eastern Wetlands 7328244531 is locally known as Brown Swamp. Wetlands 7328225500 and 7328340500 will be referred to individually as smaller Western and Eastern Wetlands respectively. Wetlands identified with numbers have been categorised according to the Corrick numbering system in the state-wide wetlands 1994 database.

The proposed watering regimes in this document have been designed to better reflect natural (pre-regulation) inundation frequency, seasonality and duration in order to improve the quality of vegetation in and surrounding these wetlands and to provide better habitat to support both rare and common species found at Pound Bend.

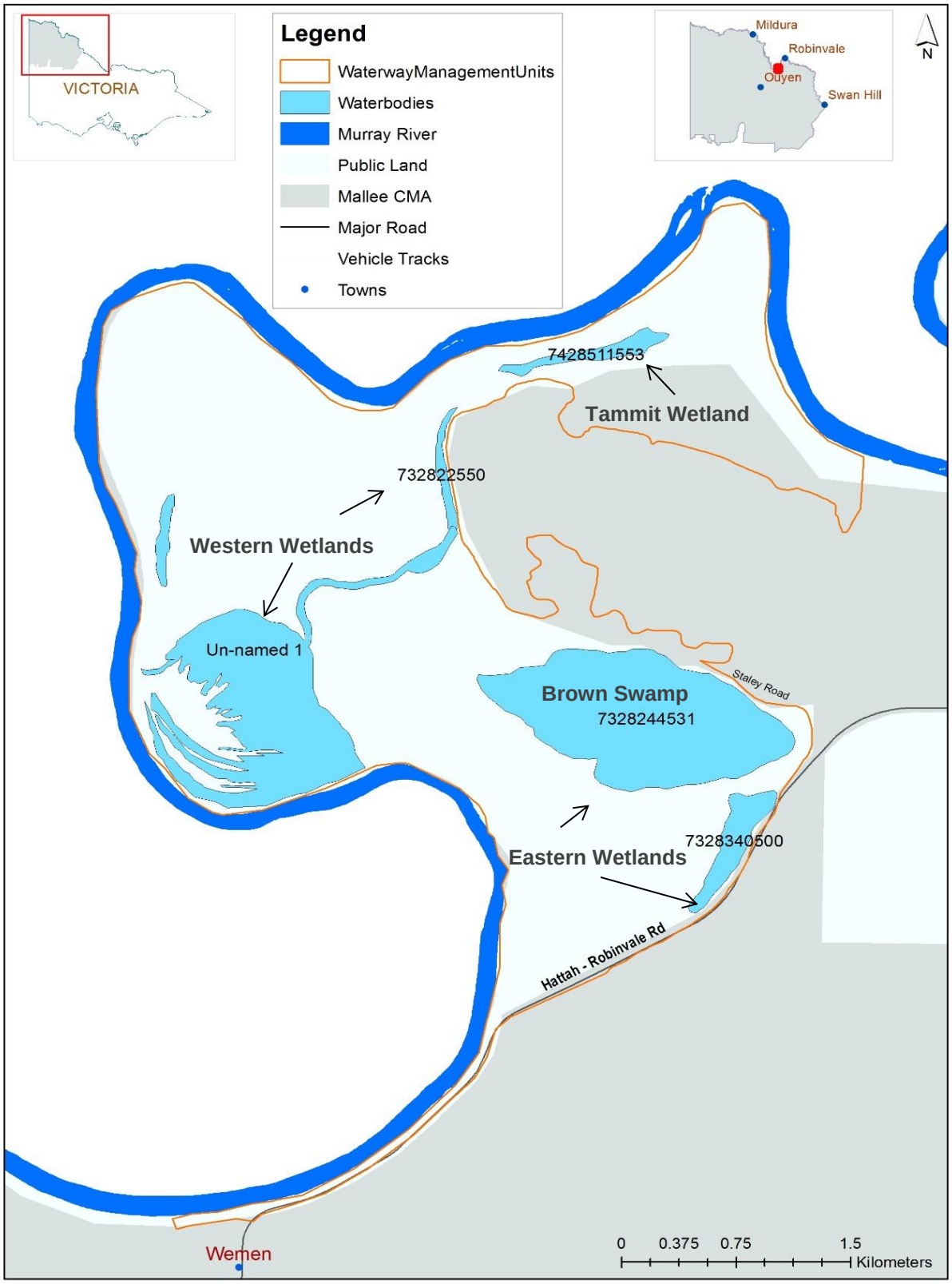

Figure 1: Pound Bend WMU Sub-Unit.

2.2 Conceptualisation of the Site

The key ecological, hydrogeological and hydrological processes and components of the Pound Bend sub-unit are presented in the conceptual diagram below, Figure 2. This provides a visual representation of the site's processes and components that are discussed throughout the document.

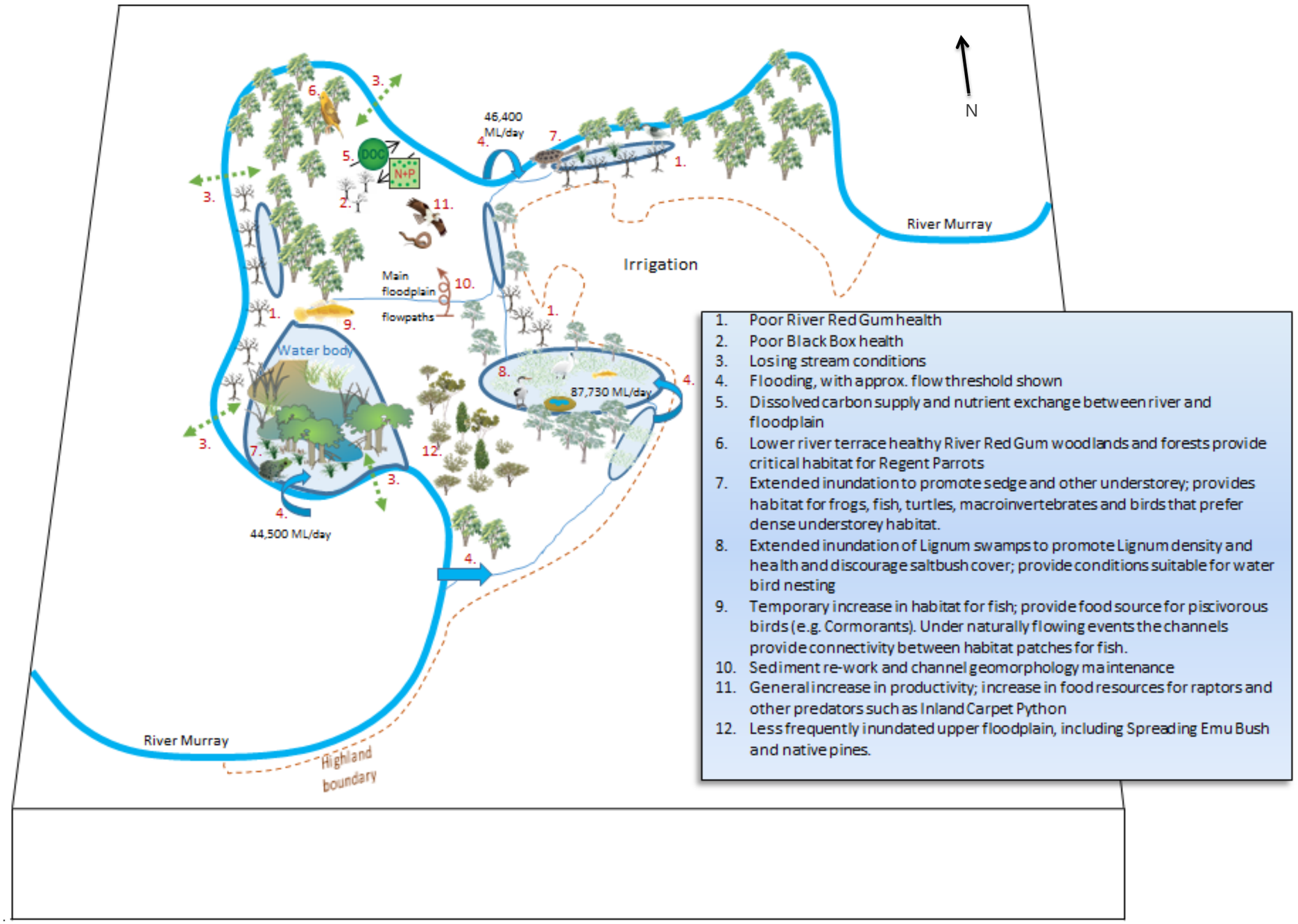

Figure 2: Conceptual diagram of Pound Bend. (This diagram is not to scale.)

2.3 Catchment Setting

Pound Bend is located in the Robinvale Plains bioregion within the Mallee CMA region. The entire floodplain is within the Murray River Reserve and adjacent to the Wemen Flora and Fauna Reserve to the east (EA 2007).

The bioregion has many periodically flooded wetlands, which makes it generally unsuitable for development. Consequently, much of the native vegetation within the bioregion still remains, mostly as public land in state forest, the Murray River Reserve and the Hattah-Kulkyne National Park (EA 2007).

Floodplains are dynamic landscapes formed by fluvial processes operating at a range of temporal scales. Floodplains are highly biodiverse ecosystems, as they are the interface between terrestrial and aquatic habitats. Flooding provides for exchange of sediment and nutrients between the floodplain, wetlands and the river. It disperses plant propagules and supports different life stages of fauna species. The composition of species that occur on the floodplain and within the wetland basins vary over time with recent and longer term inundation history. More complex geomorphology on floodplains, including associated wetland basins and creeks, produces a more variable hydrological regime, creating more diverse habitat niches for plants and animals.Pound Bend is particularly diverse in landform and vegetation communities.

Hydrogeological setting

The Robinvale Plains bioregion is characterised by a narrow gorge confined by the cliffs along the Murray River, which is entrenched within older up-faulted Cainozoic sedimentary rocks (MCMA 2003). The regional Wemen Fault is inferred to run north-south beneath the western edge of the floodplain, displacing the Tertiary sediments by some 20m, downthrown side to the west. The Wemen Trough lies to the west and the Robinvale Ridge to the East.

The floodplain is underlain by sediments of the Coonambidgal Formation, which are generally silty clays at the surface grading to medium to coarse sands at 3-5m depth. The surficial sediments have been modified by previous fluvial (river flow) processes, and, in Pound Bend, a wide range of the prior landforms have expression.

The site is mapped (Figure 3, Cullen et al. 2008) as containing an alluvial (loose sediment) terrace (correlated with the Rufus Formation which is a western correlative of the Shepparton Formation) at the western extent of the floodplain, and beneath and to the east of the irrigated dunes. The terrace clays tend to be slightly to moderately saline.

Cullen et al. (2008) also mapped three distinct floodplain meander belts (i.e. the oldest, intermediate and youngest floodplain meander belts) (Figure 3). The river channel in Pound Bend is located mainly within the youngest floodplain meander belt, flanked by intermediate or older belts. The surface materials on the oldest meander belt are noted as silty clays, while the intermediate and youngest meander belts are noted as being fine to medium sand (Cullen et al. 2008). The meander belt clays are mostly slightly to moderately saline. Loamy sands of relic dunes (Woorinen Formation) overlay the central part of the floodplain on the terrace deposits and form arcuate (bow- shaped) dunes on the oldest floodplain meander belt to the west of the central dunes (Figure 3, and Cullen et al. 2008).

The clays at Pound Bend are generally smectitic (swell and shrink, crack, and sodic (in comparison, clays can form a seal, can swell and are high in sodium). These clays are highly dispersive and form an impermeable seal after minor rain (Cullen et al. 2008).

Alluvium deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Dermosols (structured soils), Vertosols (clay-rich soils), Chromosols (soils with abrupt increase in clay content) and Sodosols (soils high in sodium and with an abrupt increase in clay content) found at Pound Bend today.

Floodplain Salinity

The Robinvale Basin is essentially a closed system with little or no opportunity for discharge to the sea, other basins or aquifer systems. The major mechanism of salt discharge is through the Murray River valley, including its floodplain and the river itself. Salt accumulation within the regional aquifers has occurred over thousands of years so that many of the regional aquifers are saline. Saline groundwater inflows are responsible for much of the salt additions to the Murray River (Brown and Stephenson 1991, AWE 2011). Floodplain salinity does not appear to be a major concern at Pound Bend (Figure 4).

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Figure 3: Landforms (Cullen et al. 2008).

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Figure 4: AEM slice (below the tilted floodplain) (Cullen et al. 2008)

The Aerial Electromagnetic slices (AEM) maps (Figure 4) and vertical profiles from the Robinvale-Liparoo AEM Atlas (Cullen et al. 2008) show a large extent of freshwater underneath the floodplain. These quite extensive freshwater lenses are a feature of the river between Pound Bend and Robinvale. Cartwright et al. (2010) have researched the provenance of these lenses and conclude they are formed by lateral recharge from the river during floods. Vertical infiltration through the floodplain soils being only a minor source of recharge to the lenses.

The AEM data (Figure 4) also shows that the floodplain under the clay-pan and under the oldest floodplain meander belt is relatively conductive. The Cullen et al. (2008) mapping infers the presence of Blanchetown Clay under this area, which could give rise to the conductive AEM signal. However, the Blanchetown Clay interpretation as presented contains some anomalies, so some minor questions remain as to the underlying hydrogeology and the source of the conductive AEM signal (i.e. saline groundwater, or clay, or a combination of both).

The in-river NanoTEM data (Figure 5, Telfer et al. 2006) shows that river bed resistivity varied within a range of 10-25 Ωm. This suggests that the river circumscribing Pound Bend is a losing stream, in which the river loses freshwater into the floodplain, creating freshwater lenses along the river bank and further inland.

During an investigative site visit in September 2014, no evidence of saline seepage was evident around the edges of the irrigation district. The clay pan (Yamba Formation) or salt lake (Figure 3) mapped in the south-east of Pound Bend also showed little evidence of high salinity associated with the clay pan/wetland area.

Assessment of groundwater salinity data and the site visit suggests that the in-river salinity impacts of any watering event are likely to be relatively small.

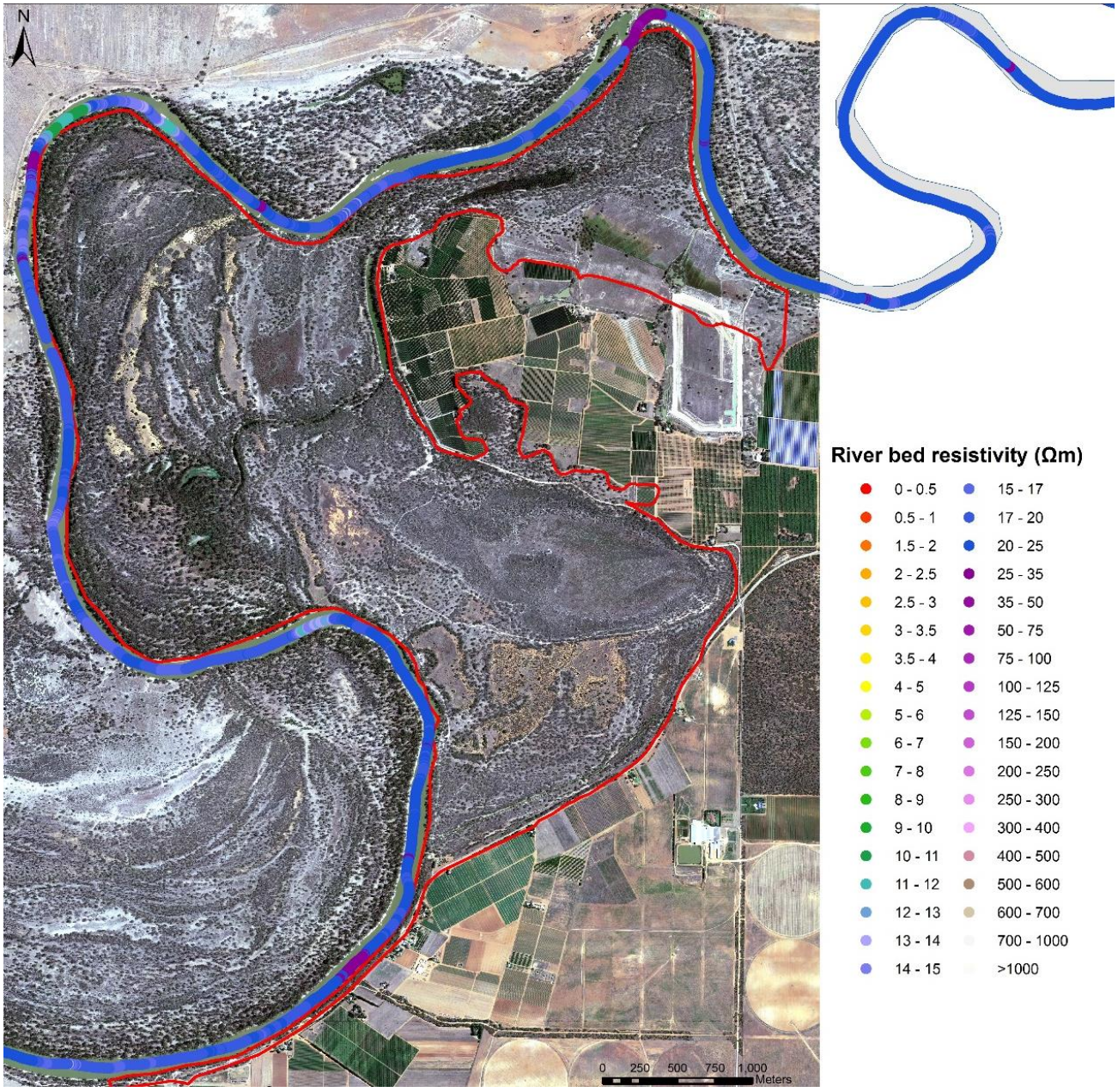

Figure 5: River NanoTEM (Telfer et al. 2006)

2.4 Land Status and Management

The river frontage at Pound Bend is reserved for public use (MCMA 2003). The areas proposed to be inundated by the watering activities lie within the Murray River Reserve; however, small sections of Pound Bend floodplain are privately owned (Figure 6). These areas of privately owned land are not included in the environmental watering target areas.

Pound Bend is directly or indirectly managed or used by a range of stakeholders (Table 1). The listed stakeholders have been identified as having a vested interest in the site; however this is not an exhaustive list. For more information on community engagement. Refer to section 10.

Table 1: Stakeholders for Pound Bend

Group	Role
Parks Victoria	Land Manager
Mallee Catchment Management Authority (MCMA)	Regional environmental management
The Department of Environment, Land, Water and Planning (DELWP)	State level environmental management
Lower Murray Water	Water delivery agency
Swan Hill Rural City Council (SHRCC)	Local Government
Aboriginal Stakeholders	Aboriginal Stakeholders. Provides assistance in planning and implementation of programs.
Murray Darling Basin Authority (MDBA)	Murray River operations
Local Landholders	Land user, provides assistance in planning and implementation of programs
Recreational users	Land user
General community (Wemen and Robinvale)	Land user, provides assistance in planning and implementation of programs

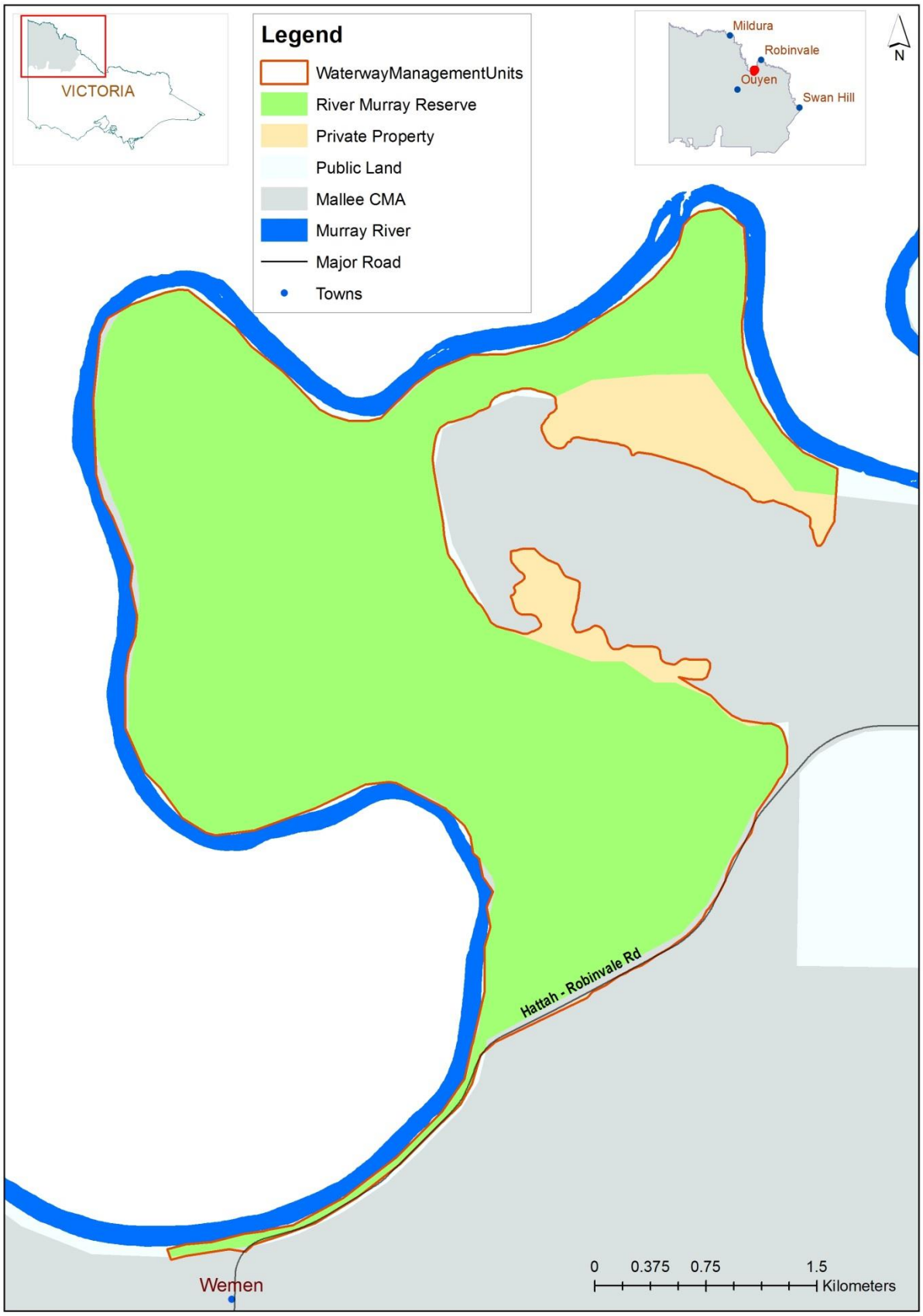

Figure 6. Land management boundaries in Pound Bend

2.5 Wetland Characteristics

Locations of wetlands within the target area of Pound Bend are presented in Figure 2.

Brown Swamp is classified as a shallow freshwater marsh (wetland number 7328-244531[1]). It covers an area of 120.48 ha. The mapped EVC for this basin indicates a sub-saline shrubland, though on-ground there was significant Lignum present, indicating a possible error with the modelled EVC classification. There are three other shallow freshwater marsh basins within the target area; Tammit, Smaller Eastern and un-named 1 Wetlands).

Un-named, the south-western inundated river flat/shallow freshwater marsh is 116 ha in area (Un-named 1), and is unmapped, and therefore unclassified, in the 1994 wetland inventory layer. River Red Gum health is generally good in these areas, but the understorey vegetation is lacking in species diversity. The red gums on these lower elevations are likely to be sustained by a freshwater lens, whereas the understorey is likely affected by reduced flooding (Figure7).

The Smaller Western Wetland is classified as permanent open freshwater. This wetland supports a Floodway Pond Herbland EVC. This linear water body is maintained as near permanent water by pumping from the river to supply irrigation on the terrace above. It acts as a holding basin from which irrigators can pump. The existing pump is on rails and may need to be raised during the environmental watering event. Ongoing consultation and monitoring will be undertaken with the landholder regarding this.

There is also a channel that can connect Tammit Wetland to the south-western river flat and Un-named 1 Wetland.

A brief overview of the main characteristics of the wetland system in the target area is given in Table 2.

Figure 7: Vegetation condition on lower elevation

[1] Wetland numbers taken from Victorian Wetland Environments and Extent - up to 2013 wetland spatial layer, better known as WETLAND_CURRENT. These numbers are based of the 1994 Wetland layer available on the on-line Biodiversity Map. The classifications of wetland type differ significantly between the two spatial wetland layers (1994 and 2013). The 1994 wetland layer was found from field visits to be most appropriate to classify each wetland.

Table 2: Summary of target area characteristics

Characteristics	Description
Name	Pound Bend Waterway Management Unit target area
Mapping ID within area	#7328-244531, #7328-22550, #7428-511553, #7328-340500, and Un-named 1.
Area	WMU sub-unit =1364.68 ha and Target area = 202 ha
Bioregion	Robinvale Plains
Conservation status	EVCs listed as Vulnerable and Depleted (Riverine Grassy Woodland, Floodway Pond Herbland, Sub-saline Depression Shrubland and Lignum Swampy Woodland)
Land status	Murray River Reserve
Land manager	Parks Victoria
Surrounding land use	Agriculture, Industry (the Wemen Mineral Sands Mine), Reserve (Wemen Flora and Fauna Reserve)
Water supply	Natural inflows from Murray River. Some areas used as irrigation channels
1788 wetland category	Not classified in 1788 mapping
1994 wetland category and sub-category	Shallow freshwater marsh, freshwater meadow, permanent open freshwater
Wetland depth at capacity	Range between approximately 1 metre and 2 metres

2.6 Management Scale

Ideal watering regimes would involve delivery of water to the wetlands to inundate 202ha, and will be managed as two separate events. Tammit and Western wetlands are to receive water on a more frequent basis, to imitate a more natural flooding regime. The Eastern Wetlands are to receive environmental water less frequently than Tammit and Western wetlands. The Eastern wetlands are found on a higher elevation, hence their less frequent watering regime.

There is currently no infrastructure in place to inundate wetlands at Pound Bend. Infrastructure would be required to water these wetlands. Infrastructure recommendations are discussed fully in the Environmental Water Delivery Infrastructure section of this document.

2.7 Environmental Water Sources

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

The Victorian Minister for Environment and Climate Change has appointed Commissioners to Victoria's first independent body for holding and managing environmental water, the Victorian Environmental Water Holder (VEWH). Commissioners are responsible for holding and managing Victoria's environmental water entitlements, and making decisions on their use.

Environmental water for the site may be sourced from the water entitlements and their agencies listed in the table below. Detailed descriptions of these sources can be found in the Mallee CMA 'Regional Context Document For Environmental Water Management Plans' (North 2014).

Table 3: Summary of environmental water sources available to Pound Bend

Water Entitlement	Responsible Agency
Murray River Unregulated Flows	Murray Darling Basin Authority
Murray River Surplus Flow	
Bulk Entitlement (Murray River - Flora and Fauna) Conversion order 1999	Victorian Environmental Water Holder
Commonwealth Environmental Water Holdings	Commonwealth Environmental Water Holder
Donated Water	VEWH

* Other sources of water may become available through water trading or changes in water entitlements.

2.8 Related Agreements, Policy, Plans and Activities

Pound Bend is located on the Victorian floodplain of the Murray River which has been assessed as part of several previous investigations. These include salinity management plans, flow studies and Land Conservation Council reviews. There has also been an investigation into River Red Gum health by the Victorian Environmental Assessment Council (VEAC 2008).

In 2007, the 'River Murray Corridor (RMC) Salinity Mapping Project' was carried out with Australian Government funding to provide information in relation to salinity management issues along the Murray River.

In 2006, EA carried out an investigation of water management options for the Murray River floodplain from Robinvale to Wallpolla Island for the Mallee CMA (EA 2007). There have been studies on the ecological values of the site, e.g. Regent Parrot (Ogyris 2007) and Carpet Python (Robertson 2006).

In 2009, pest species control of Prickly Pear at Pound Bend was initiated as a part of the Murray River Frontage Action Plan (MCMA & Parks Victoria, 2009). Prickly Pear was found to be abundant across the 1,100 ha floodplain, resulting in 3,197 plants directly injected with poison, with an effective mortality rate of 90%. There has not been any follow up in the area for pest species control.

3. HYDROLOGY AND SYSTEM OPERATIONS

3.1 Floodplain Hydrology, Water Management and Delivery

Pre-regulation (Natural)

Under natural conditions, flow is understood to have been strongly seasonal, with median daily discharge highest in spring and lowest in autumn (EA 2007). According to EA (2007), prior to river regulation, floodplain inundation would have occurred more frequently than under currently regulated conditions. In order to inundate low areas of floodplain and many wetlands, the flows would need to be 20,000 to 60,000 ML/d. These flow levels would have occurred more often and with longer duration than under the current baseline conditions (EA 2007). This is supported by the recent spells analysis by Gippel (2014) for natural and baseline flows downstream of Euston (Figure 8).

Post-regulation (Baseline)

With the effects of major storages and river regulation on the Murray River, the frequency, duration and magnitude of most flood events have decreased significantly compared to natural conditions. Since 1922, 13 weirs and locks across the Murray River have been constructed. River regulation and increased consumptive water use have reduced overbank flows important for water-dependent flora and fauna (Sunraysia Environmental 2008).

The hydrology of the Murray River at Euston under natural and current conditions was analysed by Gippel (2014) (Figure 8).

Their analysis shows that the flood events most affected are those generated by flows above approximately 15,000 ML/day, which now occur less (Figure 8; Gippel 2014). Floods generated by flows less than 90,000 ML/day are now also of shorter duration (Figure 8; Gippel 2014).

A comparison of daily discharge by month for the natural and baseline conditions is reproduced from EA (2007) in Figure 9. In addition to river regulation, a decade of drought has put extensive pressure on the system, leading to a decline in river and floodplain health (Sunraysia Environmental 2008). The flooding regime has also been affected by local works such as changes to anabranches and wetland sills, which prevent or reduce inflows to flood-dependent ecosystems (EA 2007).

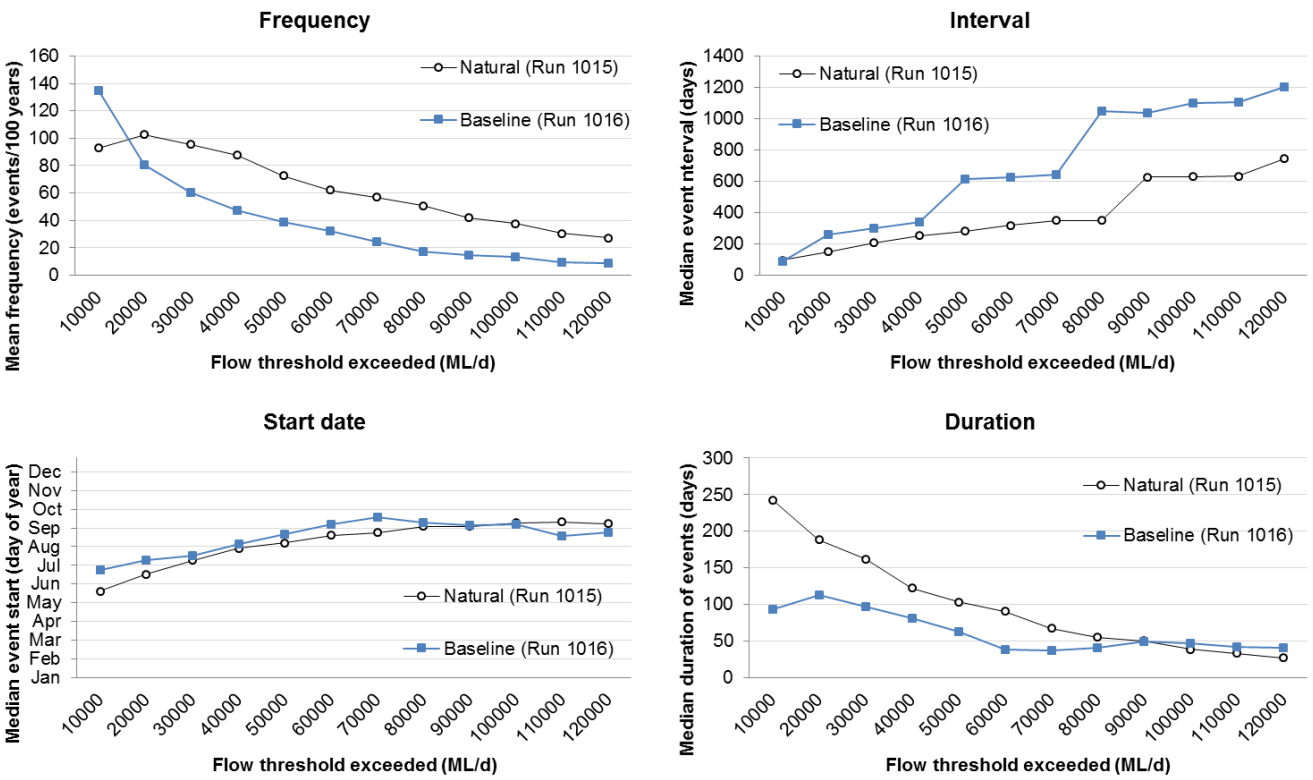

Figure 8. Comparison of Natural and Baseline Modelled Flow Scenarios for Euston Downstream (Gippel 2014).

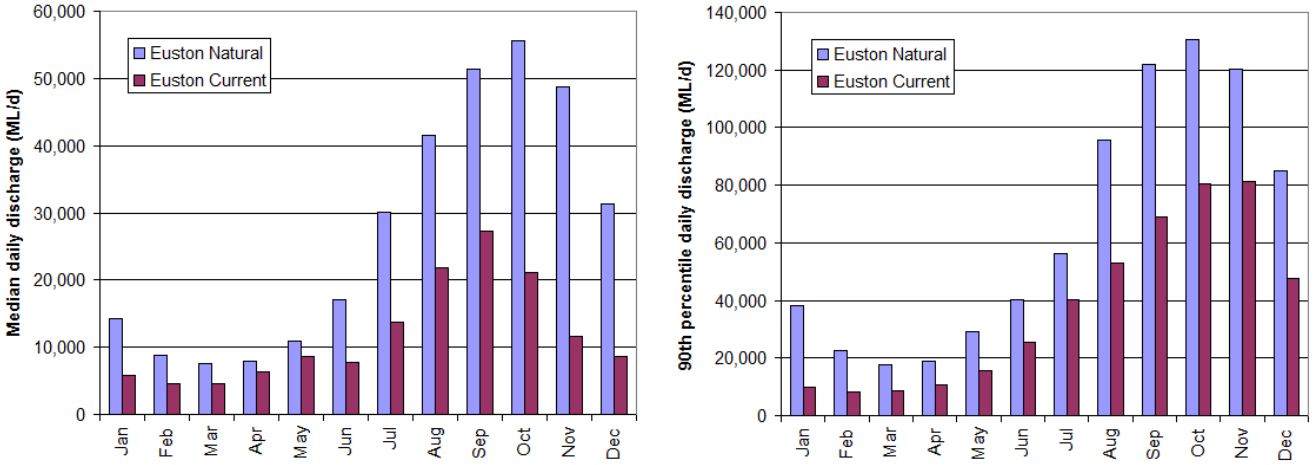

Figure 9: Distribution of median flows and 90th percentile flows for each month at Euston Weir for natural and current (baseline) conditions. Source: derived from MDBC MSM Bigmod 109 year data (EA 2007).

Commence to flow elevations were determined using a digital elevation model of the site. Elevations were then related to river stage height to determine flows required to inundate each of the main basins (Table 4).

Table 4. River thresholds required to inundate wetlands.

Wetland	Chainage from mouth (km)	Elevation threshold (m AHD)	River threshold (ML/day)
Tammit	1075	45.68	46,404
Brown Swamp	1070	47.41	87,731
Un-named 1	1070	45.21	44,514

Spells analysis undertaken by Gippel (2014) was used to model natural and baseline flows downstream of Euston. Based on the discharge thresholds presented in Table 4; flow thresholds 45,000 ML/d and 90,000 ML/d were selected to be presented in Table 5. The thresholds from natural to baseline flows show a notable reduction in the frequency and duration of flood events for the three wetlands.

Table 5. Modelled natural and baseline flow thresholds of 45,000 and 90,000 ML/d downstream of Euston.

Natural (N)/ Baseline (B)	Threshold ML/d	Frequency Mean (/10yrs)	Median Interval (50% of events are less than)	Median Duration (50% of events are shorter than)	Median event start date	Percentage of years with event
N	45,000	8.25	272	105	12th Aug	82%
B	45,000	4.12	572	77	20th Aug	39%
N	90,000	4.21	626	50	9th Sep	38%
B	90,000	1.49	1039	50	11th Sep	12%

Previous Environmental Watering

No environmental watering activities have been undertaken at the target site to date.

4. WATER DEPENDENT VALUES

4.1 Environmental Values

Wetlands and waterways on the floodplain are a vital component of the landscape and support a vast array of flora and fauna species, which may vary greatly according to the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water-dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

Listings and Significance

Fauna

A limited number of biological surveys have been undertaken at Pound Bend. The system potentially provides suitable habitat for a wide range of fauna; however, given the paucity of systematic surveys the full extent of the fauna that may use the site is unknown. Of special interest and responsibility are the six water-dependent species listed in legislation, agreements or conventions, as detailed in Table 6. A full list of all fauna previously recorded at Pound Bend is provided in Appendix 2.

Table 6: Listed fauna recorded at Pound Bend

Common name	Scientific name	Type	International agreements	EPBC status	FFG status	DELWP status
Regent Parrot*	*Polytelis anthopeplus monarchoides*	B	-	VU	L	V
Nankeen Night Heron	*Nycticorax caledonicus hillii*	B	-			NT
Royal Spoonbill	*Platalea regia*	B	-			NT
Great Egret (Eastern)	*Ardea modesta*	B	CAMBA, JAMBA		L	V
Pied Cormorant	*Phalacrocorax varius*	B	-			NT

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

*Species are included as water dependent due to habitat requirements.

The five bird species are considered water-dependent because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list includes the Regent Parrot, (*Polytelis anthopeplus monarchoides)* which is indirectly dependent on water as it requires riparian trees for nesting habitat.

Species of national conservation significance

There are numerous records of sightings of Regent Parrots within Pound Bend. The current status of nesting within the system is not known; however, Pound Bend is located within the core breeding area of the species distribution (see Baker-Gabb & Hurley 2011).

Regent Parrots nest in River Red Gum (*Eucalyptus camaldulensis*) hollows adjacent to the Murray River and use vegetated corridors as flight paths to feeding grounds (Mallee woodlands) up to 20km from nesting sites (Ogyris 2007).

Nest trees are healthy, and average 160 cm diameter at breast height, and 28 meters tall, near water. The age of suitable nest trees is thought to be at least 160 years to allow for suitable hollow development (Baker-Gabb & Hurley 2011). The nesting hollows average 18 meters above ground (Baker-Gabb & Hurley 2011).

Therefore, on-going viability of River Red Gum woodlands is critical to the Regent Parrot population. A wetland watering regime that supports River Red Gum woodlands will help improve habitat for Regent Parrots.

Species of Victorian conservation significance

The importance of Pound Bend as habitat for bird species of conservation significance is not well known. Recorded observations indicate the potential for these species to utilise the site, but whether this occurs regularly and whether the site is critical to their populations cannot be deduced from the few observations. A brief summary of habitat and requirements for wetland inundation for each of the four bird species listed in Victoria (Table 6) is provided below:

- Nankeen Night Herons utilise shallow water for foraging and breed in colonies building stick nests over water (Pizzey and Knight 2007). They are nomadic in response to rainfall and flooding of suitable habitat. Breeding usually occurs from September to February. Nankeen Night Herons have a minimum lag time to breeding of 3 months from flood, and breeding success is significantly enhanced by longer durations of inundation, up to 12 months (Rogers & Ralph, 2011).
- Royal Spoonbills also breed in colonies (including mixed species colonies) and nest on stick platforms over water, built in trees or Lignum (Pizzey & Knight 2007). They have a preference for freshwater wetlands that are vegetated. Foraging occurs in the areas of wetland edge that are less than 40 cm deep (Rogers & Ralph 2011). Fish are a significant part of the diet, as well as crustacea, molluscs and plant seeds. Breeding occurs between October and March, and is stimulated by flood (Rogers & Ralph 2011). The minimum flood duration to support successful breeding is assumed to be four to five months (Rogers & Ralph 2011).
- Great Egrets also breed on a stick platform built over water, usually between November and February (Pizzey & Knight 2007). They have a preference for permanent water sites, and forage in water up to 30 cm deep (Rogers & Ralph 2011). Fish are a significant part of their diet (Rogers & Ralph 2011). Nests are built in the forks of trees over water, in colonies (which can be of mixed species). Long lag times for breeding have been recorded, though this may vary depending on whether flooding occurs during the optimal breeding season of November to May or whether it occurs outside of the main breeding season (in which case the lag period is longer) (Rogers & Ralph 2011). Minimum flood duration needs to be six to seven months to support breeding (Rogers & Ralph 2011).
- Pied Cormorants are associated with large permanent fresh water bodies inland, but are more commonly associated with coastal sites which are their main breeding habitat. They can breed opportunistically at inland sites, are colonial nesters (mixed), exhibit a preference for permanent sites with a stable water level and build nests in trees standing in lakes and swamps (Rogers & Ralph 2011). Their diet is primarily fish and crustacea.

Appropriate watering regimes designed to support good quality vegetation (i.e. Lignum and River Red Gum communities) within the target area and provide appropriate watering events in spring/summer, will support the habitat requirements for the water-dependant bird species listed above (Scott, 1997).

Species of conservation significance with a potential to occur at Pound Bend

Seven additional water-dependant species of conservation significance have been selected as potentially inhabiting Pound Bend (Table 7). These species have not been recorded on site; however, it was considered worth noting the potential for these species to benefit from environmental watering activities at Pound Bend. The listed species (Table 7) were selected because Pound Bend supports suitable habitat for them to utilise and/or the species have been recorded at sites close to Pound Bend.

Table 7: Listed species potentially found at Pound Bend

Common name	Scientific name	Type	International agreements	EPBC status	FFG Status	Advisory List
Australasian Bittern	*Botaurus poiciloptilus*	B		E	L	EN
Australian Painted Snipe	*Rostratula australis*	B		E	L	CR
Carpet Python	Morelia spilota metcalfei	R			L	EN
Growling Grass Frog	Litoria ranformis	A		VU	L	EN
Silver Perch	*Bidyanus bidyanus*	F		CR	L	VU
South-eastern Long-eared Bat	*Nyctophilus corbeni*	M		VU	L	EN
White-bellied Sea Eagle	*Haliaeetus leucogaster*	B	CAMBA	VU	L	VU

Legend

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

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

A hydrological regime designed to support good quality vegetation, enhance floodplain biodiversity, and improve floodplain productivity will benefit the species listed in Table 7. The floodplain vegetation (e.g. Lignum) and shallow freshwater marsh wetlands, (e.g. Brown Swamp), present on Pound Bend could provide valuable habitat for water-dependent species such as the Painted Snipe, Australasian Bitterns and Growling Grass Frog. The River Red Gum and Black Box communities present on Pound Bend could also provide valuable habitat for the Carpet Python, South-eastern Long-eared Bat and White-bellied Sea Eagle. The species in Table 7 rely on suitable habitat which may be protected or improved through this EWMP. Brief notes on the habitat preferences of these species are provided below.

- Australian Painted Snipe prefer habitat in shallow and well-vegetated wetland edges, and disperse to areas with suitable habitat.
- Australasian Bitterns require complex and well-vegetated wetland habitat.
- The Growling Grass Frog is usually found amongst well vegetated permanent or ephemeral waterbodies, and these habitats are found in Pound Bend. Breeding is triggered by flooding or a significant rise in water levels in late winter/ spring (SKM, 2009). It is likely that Pound Bend could support Growling Grass Frog populations.
- The Carpet Python rely on habitat provided by River Red Gum forests and Black Box woodlands along major watercourses. Hollow-bearing trees and logs, or large rock outcrops, plus thick litter or shrub cover, are essential to the existence of Inland Carpet Pythons (DSE, 2003).
- Forests lining waterways in the Murray Darling Basin are one of a number of different habitat types favoured by South-eastern Long-eared Bats. If present, an environmental watering regime that supports River Red Gum stands and contributes to general wetland productivity (including insect productivity) would support this, and other bat species.
- White-bellied Sea Eagles nest in tall, live trees near water, and take prey from the water's surface. A watering regime that supports the longevity of large trees such as River Red Gum, will provide nesting sites into the future.
- Silver Perch spawns in response to rising floodwaters and can utilise inundated floodplains for breeding (but are not limited to floodplain habitat for recruitment), with the main spawning season being November to January (Rogers & Ralph 2011). They require high water quality and coarse substrate (Rogers & Ralph 2011).
- Water quality, levels (and rate of change in water level) and temperature interact to produce breeding cues for fish of the Murray Darling Basin. Inundation of complex habitat, which includes large woody debris, substrate variation, macrophytes, and variable flow velocities across floodplains are important factors that support recruitment of both threatened and other non-threatened fish species. Watering events that pump water onto Pound Bend won't provide opportunities for fish breeding. Watering events that do not return water to the river provide for local breeding of small-bodied fish as part of a local increase in wetland productivity.

In order to provide breeding opportunities for many fauna species, habitat elements within Pound Bend, such as temporary wetlands and River Red Gum and Black Box communities, must be maintained in good condition. The benefits associated with environmental watering, such as improved vegetation, River Red Gum recruitment and floodplain health, will facilitate listed and many other species to utilise the floodplain, improving its value in the wider landscape.

Vegetation Communities

One of the values of the Pound Bend is the high diversity of EVCs present. The key EVCs mapped in association with the wetland water bodies, or in their immediate surrounds are listed in Table 8.

EVC descriptions are provided in Appendix 1, and a map is provided in Figure 10.

Table 8: Conservation status of key EVCs in the target area

EVC no.	EVC name	Structurally dominant species	Bioregional Conservation Status
			Robinvale Plains Bioregion
104	Lignum Swamp	Lignum	Vulnerable
200	Shallow Freshwater Marsh	Sedges, rushes	Vulnerable
295	Riverine Grassy Woodland	Either or both River Red Gum and Black Box (but dominated by River Red Gum at this site)	Depleted
810	Floodway Pond Herbland	Sedges, rushes, grasses and low herbs	Depleted
818	Shrubby Riverine Woodland	Either or both River Red Gum and Black Box	Least Concern
820	Sub-saline Depression* Shrubland	Lignum	Depleted
823	Lignum Swampy Woodland	Lignum	Depleted

*The classification of Sub-saline Depression Shrubland in Brown Swamp may need revision. Sub-saline Depression Shrubland is characterised by a dominance of chenopods and succulents: however, Lignum was observed to be the dominant species. Further investigation into the EVC at Brown Swamp needs to be conducted.

Other EVCs present, within the target area, are:

- Semi arid woodland (EVC 97);
- Semi-arid Chenopod woodland (EVC 98);
- Riverine Chenopod woodland (EVC 103).

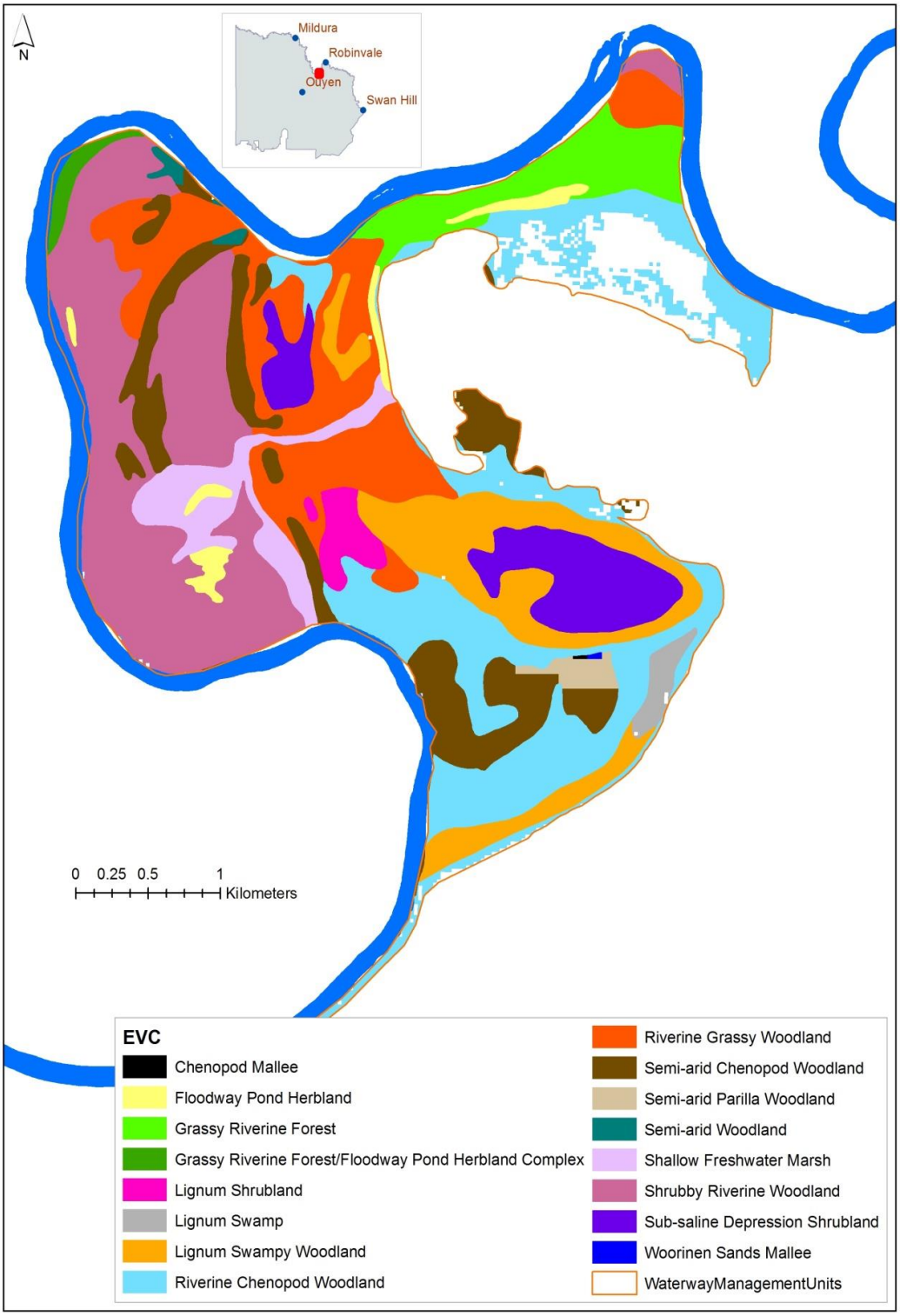

Figure 10: Ecological Vegetation Classes (EVCs) present in the target area

River Red Gum and Lignum communities are both located in areas that would benefit from a more frequent watering regime.

River Red Gums and Lignum are well represented at Pound Bend. EVC Riverine Grassy Woodland is dominated by River Red Gums. EVC Shrubby River Woodland is also dominated by River Red Gums and some Black Box. Lignum is a dominant species in EVCs Lignum Swamp, and Lignum Swampy Woodland.

Lignum-dominated communities become an extensive aquatic habitat for fish and macro-invertebrates when inundated (Ecological Associates, 2007). Lignum swamps and shrublands are also used as a nesting site by waterbirds, and as a feeding area by raptors, owls, and predatory reptiles (Ecological Associates, 2007).

River Red Gum provides extensive habitat for a range of waterbirds and other fauna such as the listed Regent Parrot, which use these trees for nesting. However, trees in poor condition make little contribution to the function and productivity of the ecosystem and the quality of woodland habitat is greatly reduced (Roberts & Marston 2011). Healthy River Red Gums contribute to the wetland ecosystem by depositing organic material, and submerged fallen trees provide structural habitat features (Roberts & Marston 2011) for wetland fauna such as perching sites for waterbirds, basking sites for turtles and snags for fish (EA 2007b).

River Red Gum communities were observed in the field to range from being in generally good health to degraded. River Red Gums on lower terraces were generally healthier as they are likely to have access to a freshwater lens. The River Red Gums on higher terraces, further away from the river were generally in poorer health (degraded) (Cunningham et al. 2010). These River Red Gums on higher terraces would most likely benefit from a more natural flooding regime.

Black Box also provides essential habitat and foraging opportunities for a range of species including mammals and reptiles and supports a high proportion of ground foraging and hollow-nesting species, such as Carpet Python and the Regent Parrot. Healthy Black Box also provide important vegetative corridors to other areas above the floodplain for a range of transient native fauna. Black Box can tolerate a range of conditions (Roberts & Marston 2011); however, under extended dry periods trees will suffer a decline in health and eventual death (EA 2007a).

The 'natural' flooding regime considered to support the values of these EVCs is as described below in Table 9 (from VEAC 2008).

Table 9: EVC ideal watering regime

EVC no.	EVC name	Natural Flood Frequency (yrs)	Critical Interval (yrs)	Minimum Duration (months)
104	Lignum Swamp	1 in 2 - 8	15	2 – 6
200	Shallow Freshwater Marsh	2 – 3 in 3	3	4 – 9
295	Riverine Grassy Woodland	2 – 3 in 10	7	<1
810	Floodway Pond Herbland	6 – 9 in 10	3	4 – 10
818	Shrubby Riverine Woodland	1 – 3 in 5	7	<1
820	Sub-saline Depression Shrubland	1 in 10 – 15	25	2 – 3
823	Lignum Swampy Woodland	1 in 2 – 8	15	2 – 4

These timeframes are estimates and should be modified based on the current condition status of EVCs and the desired trajectory of change or stabilisation, as appropriate, to inform proposed environmental watering.

Flora

Limited flora surveys have been carried out at Pound Bend. The only systematic flora survey was conducted in 1986, and covered limited areas of the floodplain, rather than the wetlands. A complete species listing from the VBA for the site is provided in Appendix 2. Of particular interest are wetland species such as aquatic and semi-aquatic flood-responder species. They provide valuable food, shelter and spawning habitat for many wetland-dependent species such as frogs. A flooding regime that supports these species will protect and enhance biodiversity in the floodplain.

The only species of conservation significance to be recorded at Pound Bend is the Spreading Emu-bush (Table 10). Spreading Emu-bush is a floodplain species not considered to be tolerant of regular or long duration of flooding, although it may recruit following inundation.

Table 10: Listed water dependent flora species recorded at the site

Common name	Scientific name	EPBC status	FFG status	DELWP status	EVC Listing species
Spreading Emu-bush	*Eremophila divaricata ssp. divaricata*	NL	NL	R	103

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

Wetland Depletion and Rarity

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

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

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

During this mapping, an attempt was made to categorise and map wetland areas present 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 therefore been possible to estimate the depletion of wetland types across the state by 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. Impacts are severe, with approximately one-third of the state's wetlands being lost since European settlement. Many of those remaining are threatened by continued degradation by salinity, drainage and agricultural practices (ANCA, 1996).

Across the state, the greatest decreases in original wetland area have been in the freshwater meadow (43 per cent decrease), shallow freshwater marsh (60 per cent decrease) and deep freshwater marsh (70 per cent decrease) categories (DNRE, 1997).

Pound Bend contains five wetlands which have been classified using the Corrick-Norman wetland classification system (Table 11). With the exception of the Smaller Western Wetland, classified as Permanent Open Freshwater, all of the other wetlands have been classified as Shallow Freshwater marsh.

While shallow freshwater marshes have undergone a significant area reduction in Victoria (-60%), this is not reflected in the Mallee CMA region or Robinvale Plains Bioregion (Table 10). Permanent open

freshwater wetlands have experienced minimal changes in area and increased by 5% in the Mallee CMA region.

A summary of the Corrick classification of the wetlands at Pound Bend, and the change in their distribution at multiple spatial scales is provide below in Table 11.

Table 11: Current area of the site by Corrick classification, and regional historical statistics.

Category	No. of wetlands in target area	Total area (ha)	Decrease in wetland area from 1788 to 1994		
			Change in area in Victoria (%)	Change in area in Mallee CMA	Change in area Robinvale Plains Bioregion
Permanent open freshwater	1	4.5	-6	+5	-1
Shallow freshwater marsh	4	273.4	-60	-6	-4

Ecosystem Functions

Greater appreciation of the ecological functions of the site will be possible with further intensive surveys.

Based on limited survey records and a brief site inspection, it is possible to identify the following key ecosystem functions:

- *Vital Habitat:* Pound Bend supports mature River Red Gums within the core nesting area of Regent Parrots, and opportunities to water the floodplain will support the health, longevity and recruitment of River Red Gums;
- *Dilution of carbon and nutrients from the floodplain to the river system:* Flooding of the floodplain and wetland basins will provide for nutrient and sediment exchange with the river;
- *Diversity of important feeding, breeding and nursery sites for native water-dependent biota and lateral connections for off-stream primary production:* Flooding of the floodplain and wetland basins will support general biological productivity, with opportunities for expression of flood responder plant species (which may remain dormant or be present only in the seed bank without any flooding) and increased food resources and habitat to support water-dependent fauna, including their breeding.
- *Connections across floodplains, adjacent wetlands and billabongs (lateral):* Waterbird groups access a variety of habitat types which only become available following inundation. Many species will nest only in trees or shrubs surrounded by floodwaters. The movement of species of fish, invertebrates and amphibians is driven by floodplain and wetland connectivity. The site may also be important for specific dispersal and connectivity functions or in the life-cycle of particular other water-dependent species that have not yet been recorded on site.

4.2 Social Values

Cultural Values

The Mallee has been occupied for thousands of generations by Indigenous people, with human activity dated as far back as 23,400 years ago. The region's rich and diverse Indigenous heritage has been formed through the historical and spiritual significance of sites associated with this habitation; together with the strong connection Traditional Owners continue to have with the Mallee's natural landscapes.

Given the semi-arid climate of the region, ready access to more permanent water has been a major determinant of human habitation, and, as such, the highest density of identified Indigenous cultural heritage sites are located around or close to areas of fresh water sources.

Within the Mallee CMA region, the Murray River and its associated waterways were important habitation areas for multiple Indigenous groups, containing many places of spiritual significance. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria, for both concentration and diversity. They include large numbers of burial, middens and hunting sites.

Waterways also play a large role in the region's more recent non-Indigenous heritage due to the historical infrastructure (e.g. buildings, irrigation and river navigation structures) they often contain. These places provide links to early industries and settlements and play a key part in the region's identity.

Cultural Heritage

Pound Bend is of significant cultural value to Indigenous and non-Indigenous people, with the area popular for fishing, camping, hunting and as a meeting place.

In regard to Indigenous cultural values, some cultural sites have been documented through various archaeological investigations, but the true extent of the number and types of sites present is still unknown.

Surveyed sites within the Mallee region include middens, earth features, scarred trees, oven mounds, surface scatters, stone quarries and places of burial.

Aboriginal people continue to have a connection to this country. Latji Latji and Tati Tati are indigenous groups that have a vested interest in this area; however, other groups/community members may have an interest in this area. Aboriginal community continues to value this country through traditional laws and customs.

Frontages to the Murray River from Robinvale to Merbein hold important European heritage value, which is reflected through homesteads, grave sites and historic markers from the early settlement of the region. The area was first explored by Major Thomas Mitchell and Captain William Sturt in the 1830s with much of it developed for large grazing runs. Closer settlement was established after the success of the Mildura Irrigation Colony in the early 1900s and the Red Cliffs and Robinvale Soldier Settlement Scheme of the 1920s and 1940s (MCMA 2003).

Recreation

Pound Bend is a popular area for recreational activities such as camping, fishing, swimming, bush walking, canoeing and kayaking. It has a boat ramp facility to launch small boats.

4.3 Economic Values

Adjacent irrigators have pump and channel infrastructure located on the floodplain. Watering events should not impact irrigator pumping requirements.

4.4 Significance

The Pound Bend floodplain is significant for its provision of vital habitat to the nationally vulnerable Regent Parrot.

Further, the floodplain has high potential habitat value for a diverse range of species, due to its underlying diversity of landform and hydrology. The fact that the key structural overstorey species of the component EVCs are in moderate health, and that the wetlands receive some 'natural' flows (discussed above in Environmental Watering Section), mean that Pound Bend is a prime target for protection of biodiversity values through supplementary flows. It has great capacity for biodiversity enhancement in understorey composition, through modest intervention to provide top-up flows.

5. ECOLOGICAL CONDITION AND THREATS

5.1 Current Condition

Index of Wetland Condition assessments have not been undertaken for wetlands within the target area. The condition assessment described below is based on brief field observations taken by Australian Watering Environments (AWE) during September 2014 and limited existing literature. It should be considered high priority to undertake a more up to date condition assessment.

AWE described the floodplain trees to be generally in moderate to good health, judged from canopy cover, with reductions of health in large old Red Gums along the north-eastern margins of the southern wetland and the southern margin of the northern wetland. It was noted that the northern wetland contains two areas where the regeneration of Red Gum appears, with some death of an older regeneration (Photo 7). Reductions in younger Red Gum health were also observed at the inland extremity of Red Gum extent in a mixed Red Gum/Black Box cohort along the river at the western edge of Pound Bend (Photo 3). Black Box was generally in good health except for what appears to be competition-based natural selection in dense black-box communities on the oldest and clayey soils of the north-western alluvial terrace. The southern wetland, which is described in the EVC map (Figure 10) as Sub-Saline Depression Shrubland, reveals that it is mostly lignum swamp with an understorey of *Atriplex lindleyi* ssp. *inflata* and other herbs. (Photo 1). It was also noted that there was potentially some impacts to understorey along the river frontage, where camping occurs.

While there was no obvious evidence of irrigation-induced decline in health, the mature River Red Gums in poor to dead condition occur between the irrigated area and the wetland/channel features.

To fully understand the current ecological condition of the wetland would require a flora assessment of the floodplain.

Along the Murray River, surveys of River Red Gum forest have shown a substantial decline in tree condition over the past twenty years. For example, in the late 1980s the health of tree canopies declined dramatically below the Wakool Junction in the Mallee. Survey of River Red Gum condition in 2006 indicated 70% of these forests across the Victorian Murray River floodplain were in a stressed condition (Cunningham et al. 2010). Stressed trees are usually found away from the banks of the Murray River and permanently inundated anabranches on the floodplain (Cunningham et al. 2006).

Cunningham et al. (2006) indicates that the condition of River Red Gum stands at Pound Bend is generally degraded or declining, with the majority of trees in the area in poor condition (Figure 11). River Red Gum condition gradually degrades as distance from the river bank increases. Patterns of decline may be related to competition pressure among the younger River Red Gums in some locations, and possible senescence among the older River Red Gums, although lack of flooding during the millennium drought (1997-2010) may have exacerbated declines in health.

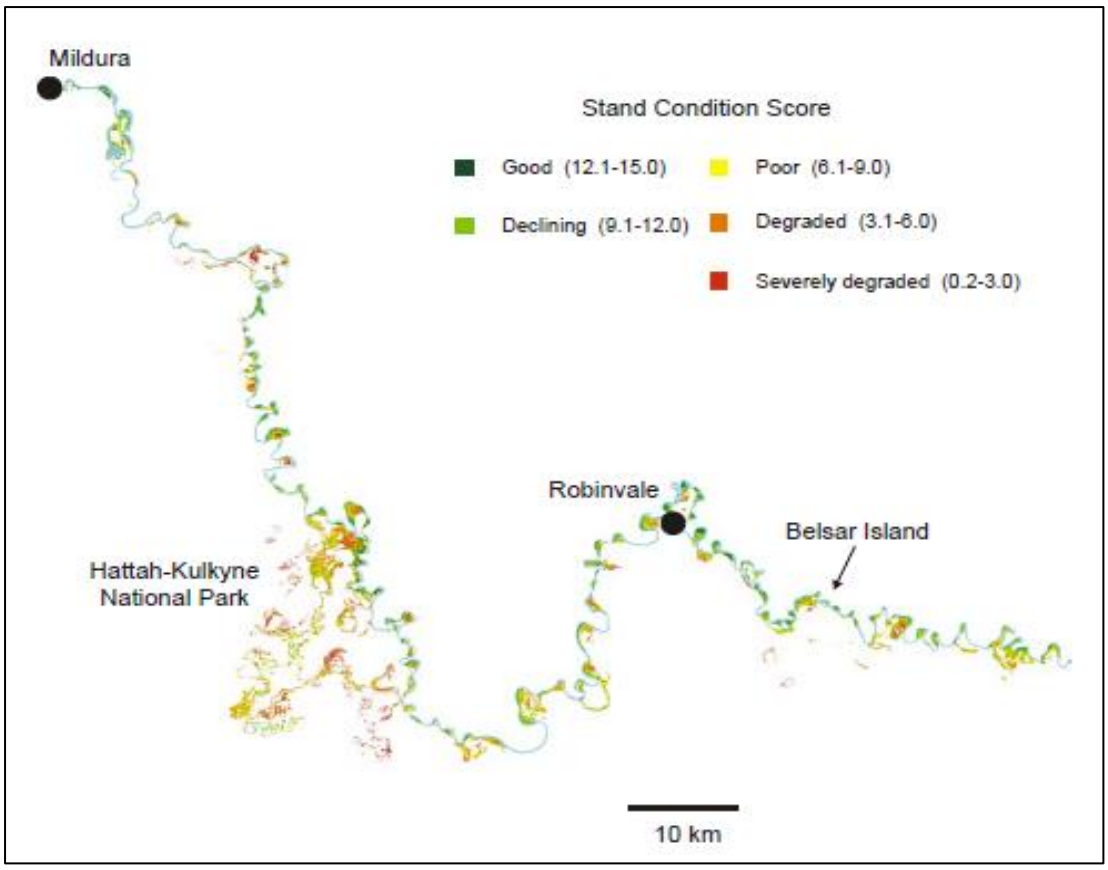

Figure 11: Condition of River Red Gum stands predicted by the PVL model (r2 = 0.78) from remotely-sensed data for the Murray Scroll Belt (Cunningham et al. 2006).

Site inspection of the Brown Swamp which is described in the EVC map (Figure 10) as Sub-Saline Depression Shrubland, found that it is mostly Lignum swamp with an understorey of *Atriplex lindleyi ssp. inflata* and other herbs. (Photo 1). Photos 1 to 7 below show the general health of key sites at Pound Bend.

Photo 1: Vegetation in Brown Swamp. Photo: AWE, Sept 2014.

Photo 2: View north across sub-saline depression, Brown Swamp, showing dominance of Lignum. Photo: AWE, Sept 2014.

Photo 3: Poor health and mortality of River Red Gum at inner margin of Red Gum extent at western margin of floodplain. Photo: AWE, Sept 2014.

Photo 4: Channel to western wetland area. Photo: AWE, Sept 2014.

Photo 5: Power, pump and very large old River Red Gum at proposed northern pumping location. Photo: AWE, Sept 2014.

Photo 6: Poor health and dead mature River Red Gum at southern edge of Tammit Wetland. Note topographic control and likely germination from a "wrack-line". Photo: AWE, Sept 2014.

Photo 7: Dieback of young River Red Gums in Tammit Wetland. Dead mature River Red Gums off-photo to right (see Photo 6). Note new River Red Gum regeneration (red circle). Regent Parrot pair sighted here. Photo: AWE, Sept 2014.

5.2 Condition Trajectory

A comparison of the characterisation of current flood regime (Table 12) with the ideal watering regime for the component EVCs (provided earlier in Table 9) shows that there is a reasonable approximation of *frequency* of event to suit River Red Gum woodland with a terrestrial understorey (e.g. EVCs 818 Shrubby Riverine Woodland and 295 Riverine Grassy Woodland) which occur on the lower terraces and the fringe of the Un-named 1 and Tammit Wetlands. The River Red Gum Community is made up of drought tolerant and flood responsive species. So it is not enough to have a watering regime that will only benefit the drought tolerant species.

The flood responsive part of the community may not always be present (should be in the seed bank) but will still require flooding. The duration of flooding is not sufficient to maintain aquatic and semi-aquatic vegetation at the lower elevations of the basins (e.g. 810 Floodway Pond Herbland and 200 Shallow Freshwater Marsh).

A loss of biodiversity would be expected over time, where the viability of seed and tubers of aquatic and semi-aquatic plant species is lost over extended dry periods. These species do not then regenerate in response to the next flood, and are lost from the vegetation community, unless they re-establish by colonising from other sites. Aquatic macrophytes in particular are highly valuable habitat for fish and frogs, and some waterbirds, such as crakes and rails.

Similarly, it appears that the frequency of inundation of the two Lignum basins (Eastern Wetlands) meets the upper bounds of the ideal watering regime for Lignum EVCs (823 Lignum Swampy Woodland, 104 Lignum Swamp). However, again, the duration of inundation is not met, leading to the basins tending towards EVC 820 Sub-saline Depression Shrubland, with higher cover of terrestrial species, such as *Atriplex lindleyi ssp. inflata*.

Table12, summarises the comparison for the two largest wetlands, which are Un-named 1 wetland and Brown Swamp.

Table 12: Comparison of ideal EVC watering regime and approximate current conditions at wetlands Un-named 1 and Brown Swamp

Dominant wetland EVCs	Natural Flood Frequency (yrs) to support EVC values	Minimum Duration (months) to support EVC values	Approximate current frequency wetland is inundated* (yrs)	Median duration of flow event that inundates wetland** (days)
Un-named 1 Wetland, lower river terrace				
200 Shallow Freshwater Marsh	2 – 3 in 3	4 – 9	1 in 2 – 3	77
810 Floodway Pond Herbland	6 – 9 in 10	4 – 10		
295 Riverine Grassy Woodland	2 – 3 in 10	<1		
818 Shrubby Riverine Woodland	1 – 3 in 5	<1		
Brown Swamp				
823 Lignum Swampy Woodland	1 in 2 – 8	2 – 4	1 in 6-7	50
104 Lignum Swamp	1 in 2 - 8	2 – 6		
820 Sub-saline Depression Shrubland	1 in 10 – 15	2 – 3		

These are based on commence to flow values and do not represent each wetland filling to their full extent, which would occur less frequently (Gippel 2014). This figure derived from the Spells analysis, Gippel (2014), describes the duration of a flood event where flows are sustained at the level that inundates each wetland. Particularly the wetlands underlain by clay may obviously hold ponded water for a longer period of time once flow ceases.*

An appropriate watering regime could enhance species diversity, improve floodplain productivity and ensure the long term viability of floodplain species. The watering regime outlined in this EWMP is designed to achieve this. Without an improved hydrological regime, floodplain health will continue to decline with an expected loss of species diversity, change of EVC present and reduced floodplain productivity.

5.3 Water Related Threats

Altered river flow regime – The floodplains and wetlands will continue to receive less than their optimal 'natural' frequency of flooding without intervention. This will lead to a continued reduction in floodplain diversity and vegetation health.

Seepage from irrigation district – Saline seepage was not observed at the margins of the irrigation district on the floodplain. Trees in localised areas are in decline, and this tends to fit a spatial distribution that indicates some interaction with an adjoining land use of irrigation. However, on brief inspection this correlation is not as strong as that observed on other floodplains with high irrigation impacts. While seepage from the irrigation district does not appear to be a threat,further investigation would be required to fully understand any and all impacts from irrigation seepage.

Poor surface water quality – There is no evidence of existing problems, such as evaporative concentration or stagnation; water pumped up onto the floodplain does not stand for long periods of time due to losing floodplain conditions.

Introduced species – Watering may provide opportunities for pest fish breeding, and for colonising weed species to expand their distribution on the floodplain. Environmental water delivery undertaken by the Mallee CMA has recently been implemented at Hattah Lakes to address pest problems and proven to be a success through monitoring.

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. These may pose a threat when water is applied as increased water availability can cause weeds to thrive and displace native vegetation. A list of exotic flora species identified at Pound Bend is given in Appendix 1.The majority of these weeds are described as having high invasive potential and high impact in the EVC descriptions for the Robinvale Plains area (DSE 2004). The following species are of note:

- Prickly Lettuce (*Lactuca serriola)* and Mediterranean Turnip (*Brassica tournefortii)* are particularly liable to reproduce prolifically on drying wetland beds, providing serious competition to native species that recruit in this environment following flood recession.
- Horehound (*Marrubium vulgare*) is a declared noxious weed in Victoria.
- Prickly pear species (*Opuntia* spp. other than *O. ficus-indica*) have been actively controlled in the past at Pound Bend (MCMA & Parks Victoria 2009).

6. MANAGEMENT OBJECTIVES

6.1 Management Goals

Pound Bend has been recognised as a priority site for habitat for Regent Parrots. River Red Gums along the lower terraces, that provide critical habitat for Regent Parrots are (from general observation) in relatively good health probably sustained by significant freshwater lenses. They are, however, susceptible to decline under low flow conditions brought on by drought. Promoting the expansion of the more drought tolerant sedges (such as *Cyperus gymnocaulos* and *Eleocharis spp*.) would provide significant habitat enhancement for frogs and fish, when they gain access to floodplain basins.

Aquatic and semi-aquatic flood-responder plant species remain dormant during dry periods, with seeds stored in the seedbank or tubers or turions surviving dormant in the substrate. These species are at risk from dying out from the vegetation community if long dry periods are experienced, leading to the viability of stored seed and other propagules being lost between floods. Maintaining a flooding regime that promotes the expression of these flood responding species in the understorey protects and enhances biodiversity of the floodplain.

There is evidence from site visits, and from the vegetation mapping discrepancies over time, that the Lignum basins of the Eastern wetlands (Brown Swamp, Smaller Easternern Wetland) have developed a significant cover of low, saline-tolerant, terrestrial shrubs and herbs. The management objective for these wetlands is to increase flooding frequency and duration to favour Lignum over terrestrial species. Lignum has high habitat value, and the development of a high cover of terrestrial species means that the wetland is under higher risk of experiencing poor water quality when it is inundated, as a result of rotting terrestrial vegetation.

Additionally, achieving a longer duration of inundation, up to 6 months, at least several times over a 10 year planning cycle, has the potential to support waterbird breeding.

The overarching management goals are to:

- Protect and maintain the health of good quality floodplain vegetation;
- Enhance floodplain biodiversity by re-instating a hydrological regime which supports a wider range of flora and fauna species;
- Provide for general floodplain productivity.

These are supported by specific ecological objectives outlined below.

6.2 Ecological Objectives

The ecological objectives are summarised in the table below.

Table 13: Ecological objectives for Pound Bend

Ecological Objective	Justification (Value based)
Protect and improve the diversity of native wetland flora species consistent with Shallow Freshwater Marsh, Floodway Pond Herbland, and Shrubby Riverine Woodland, by increasing the understorey species diversity in Un-named 1 and Tammit Wetlands.	Increase / preserve habitat and food sources for native fauna, and particularly increase the representation of aquatic and semi-aquatic vegetation which has high habitat value. Increase / preserve biodiversity
Protect and improve the diversity of native wetland flora species consistent with Lignum Swampy Woodland and Lignum Swamps, by increasing density of Lignum in Eastern Wetlands.	Increase / preserve habitat and food sources for native fauna. Increase / preserve biodiversity. Prevent terrestrialisation of higher elevation wetlands by flooding more frequently (maintains higher habitat values and reduces risks associated with accumulation of high biomass on wetland substrate). Provide opportunities for waterbird foraging and, in some years, nesting.
Maintain the health of fringing River Red Gums and facilitate longevity of River Red Gum population, as evidenced by canopy health and germination and recruitment rates.	Protect critical habitat for Regent Parrots and secure self-sustaining future habitat for Regent Parrots

6.3 Hydrological Objectives

Hydrological objectives are set out below. These are based not only on recommended watering regimes for particular EVCs, but also considers a desired trajectory of change as described in the ecological objectives and their justifications (i.e. reduce build-up of terrestrial vegetation in the Lignum wetlands on the higher terrace, promote aquatic and semi-aquatic understorey in the lower Red Gum terraces). The recommended timings are therefore based on the current mix of dominant species and their flooding and drying tolerances, as well as requirements to promote health and increase cover of other suites of understorey plants. The sources of information used are Roberts & Marsten (2011), Rogers and Ralph (2011) and VEAC (2008).

The first two rows lines of Table 12, below, describe watering options for the wetlands; the first being those wetlands that would be expected to support some aquatic and semi-aquatic herbs and macrophytes, the second being those wetlands for which Lignum is the key species to be promoted. The third row relates to the objective to inundate the fringing Red Gum woodlands of Un-named 1 Wetland, (and to a lesser extent, Brown Swamp on a less frequent basis, which would be achieved by surcharging the wetland above the levels at the observation points shown in Figures 12-14 (watering options maps), resulting in shallow flows across lower floodplain areas.

In addition to the guidelines presented below, there are adaptive management principles that should be applied in response to 'natural' floods and that should be considered in the context of mid-range timeframes (i.e. longer than annual planning cycles). Indications are that each wetland receives 'natural' flows, though these are likely to be less frequent than in the past and almost certainly of less duration. Therefore, the objectives set out below can potentially be facilitated by delivering piggyback late spring and summer flows into wetlands that have received a winter/spring flow, to extend the duration of the event and/or to achieve a surcharge of the wetlands to achieve shallow inundation of surrounding woodland vegetation communities.

Additionally, in recognition of the high value of Red Gum woodlands in this area to Regent Parrots, Pound Bend should be prioritised to receive at least minimum flow requirements in the lower Un-named 1 Wetland in drought conditions, to ensure that Red Gums do not decline to an irreversible condition. Ideally in drought conditions a refuge would be provided by ensuring there is a watering event at least one wetland within Pound Bend.

Table 14: Hydrological objectives for Pound Bend

Ecological Objectives	Water management area(s)	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			
Protect and improve the diversity of native wetland flora species consistent with Shallow Freshwater Marsh, Floodway Pond Herbland, and Shrubby Riverine Woodland	Basins: Western Wetlands, & Tammit Wetland.	5	8	10	2	4	13	4	8	10	Spring – early Summer	1,200	600-1000
Protect and improve the diversity of native wetland flora species consistent with Lignum Swampy Woodland and Lignum Swamps	Basins: Eastern Wetlands.	2	4 – 5	5	4	6	42	12	6*	18	Spring – early Summer	450	1000
Maintain the health of fringing River Red Gums and facilitate longevity of River Red Gum population.	Riparian and low floodplain fringing woodland of Un-named 1 wetland and Brown Swamp.	2	4	7	6	30	66	0	2	3	Spring – early Summer	1,200	50 – 500

*Duration is set to allow breeding cycle of waterbirds to complete; meeting an inundation duration of this length would be desirable in at least some years, as shorter periods can result in abandonment of nests.

6.4 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.

Minimum watering regime

Inundate Western and Tammit Wetlands five times in 10 years with a maximum 13 months between events once wetland is dry. Allow ponding for three to four months. Inundate Eastern Wetlands at least twice every 10 years and allow ponding for at least two months, to maintain the health of Lignum present. Preferred timing for watering event is in spring or early summer.

Optimal watering regime

Inundate Western and Tammit Wetlands eight times in 10 years and allow ponding for eight months. Inundate Eastern Wetlands four times in 10 years and allow ponding for up to six months. Preferred timing for watering event is in spring or early summer.

Maximum watering regime

Inundate Western and Tammit Wetlands every year and allow ponding for three to four months. Inundate Eastern Wetlands once every two years with a minimum of 12 months between events and allow ponding up to seven months. Preferred timing for watering event is in spring or early summer.

7. MANAGING RISKS TO ACHIEVING OBJECTIVES

The table below identifies the risks to the ecological objectives and watering requirements of the target area by identifying threats. Risks are classified as high, medium or low dependent on the likelihood and consequence of occurring.

Table 15. Assessment of risks to achieving the objectives of the Pound Bend EWMP

Threat	Likelihood	Consequence	Risk – H, M, L(likelihood x consequence)	Management Measure	Residual Risk
Impacts to private irrigator – access to infrastructure and interaction with ponded areas	Possible	Moderate	M	Capacity to meet both irrigator and environmental needs must be determined and additional infrastructure installed to protect irrigator interests.	L
Sediment transport / erosion – potential to disturb cultural heritage sites	Unlikely	High	M	Site should be monitored for any exposure of culturally significant deposits. Protocols outlined in Appendix 5 to be activated if required.	L
Access restrictions, general public	Possible	Low	L	Watering will not occur in an uncontrolled or unexpected manner. Any risks should be managed by ensuring communications are in place so that visitors know that areas will be flooded.	L
Culvert / track access to private pumping infrastructure.	Possible	Moderate	M	Feasibility assessment must include any necessary upgrades to ensure no disruption to access for private irrigator infrastructure.	L
Failure to meet ecological objectives	Possible	High	H	Monitoring program in place. Adaptive management approach.	L
Species/communities or ecological processes have been overlooked in water regime due to lack of data	Unlikely	High	L	N/A	

Threat	Likelihood	Consequence	Risk – H, M, L(likelihood x consequence)	Management Measure	Residual Risk
Flood duration too long or too short	Possible	High	M	Monitoring program in place. Adaptive approach as additional baseline and monitoring outcome data is available.	L
Water regime enhances habitat for exotic species of flora and fauna	Possible	Moderate	L	N/A	
Groundwater recharge associated with wetting Pound Bend impacts ecological values or water users	Possible	Moderate	L	N/A	
Environmental watering program negatively affects cultural heritage sites	Unlikely	High	L	N/A	
Return flows to the Murray River have significant salinity impact	Possible	High	H	It is not proposed to return environmental water to the Murray River	L
Infrastructure constructed or retrofitted to assist with implementation of hydrological regime impact environment e.g. creation of additional barriers	Unlikely	High	L	Appropriate designs in place and construction regimes in place	L
Monitoring program is unable to detect improvements in short to medium term (Engagement risk)	Possible	High	M	Appropriate engagement with stakeholders confirming expected outcomes and timeframes	L

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 Constraints

No infrastructure has been installed specifically for environmental watering purposes at Pound Bend. There are existing irrigation supply channels from the northern river side and along the southern side of Pound Bend. There is a ford crossing that allows for placement of a regulating structure (eg stop logs or similar), which could be used to achieve impoundment of water in Tammit Wetland.

The Smaller Western Wetland is currently used as a holding basin for irrigators to pump from. Any watering activities should not interfere with irrigator pumping requirements.

The environmental activities are aimed at five wetlands in Pound Bend; options for achieving watering are presented in Figures 12 to 14.

8.2 Infrastructure or complementary works recommendations

Options for infrastructure to deliver environmental watering have been presented in Figures 12 to 14.

At least two new pumps will be required. Electricity is available at the site of the existing irrigator pump; a pump located to water the Eastern Wetland will need to run on diesel. A regulator structure will need to be installed at the downstream, western end of Tammit Wetland. Localised earthworks may be required to achieve the watering options (as shown on Figures 12-14).

Western Wetlands

The Western Wetlands are proposed to be watered by pumping from the site of the existing irrigation pump located at river km 1076 (Figure 12). Water is currently pumped by private landholders to the Smaller Western Wetland via a flood runner. This wetland would be filled and overtopped, allowing the water to flow down the east-west channel into Un-named 1 Wetland. If allowed, water would continue to flow through Unnamed 1 Wetland back into the river. Two easily accessible locations have been selected, as shown in Figure 12, as daily observation points. Once the water reaches these observation points pumping would cease, filling the Western Wetland to a level of 45.2mAHD. This obviates the need for regulating structures at the southern edge of the watering target area.

Eastern Wetlands

The Eastern Wetlands are proposed to be inundated by pumping from an existing irrigation pump site located near river km 1066 (Figure 12). An existing channel that runs adjacent to the southern boundary of the Pound Bend will not be used to deliver water to the wetlands. This will be achieved by piping the water to fill the Smaller Eastern Wetland then Brown Swamp to a the level of 47.1m AHD (see Figure 12).

Tammit Wetlands

There are two proposals to water Tammit Wetlands. The first option, shown in Figure 13, uses the pump site for watering Western Wetlands. The flood runner that is used to fill the Western wetlands currently travels through a road culvert under the road seen in Figure 13. This culvert could be modified into a regulator structure using stop logs or like, to back the water up into Tammit Wetland to a height of 45.75 mAHD.

The second option is to pump water from a site closest to the eastern end of the wetland (and with lowest elevation over the pumped pathway) (Figure 14). A raised track would be used stop the water from running down into the Western Wetlands, filling Tammit to a height of 45.75 mAHD.

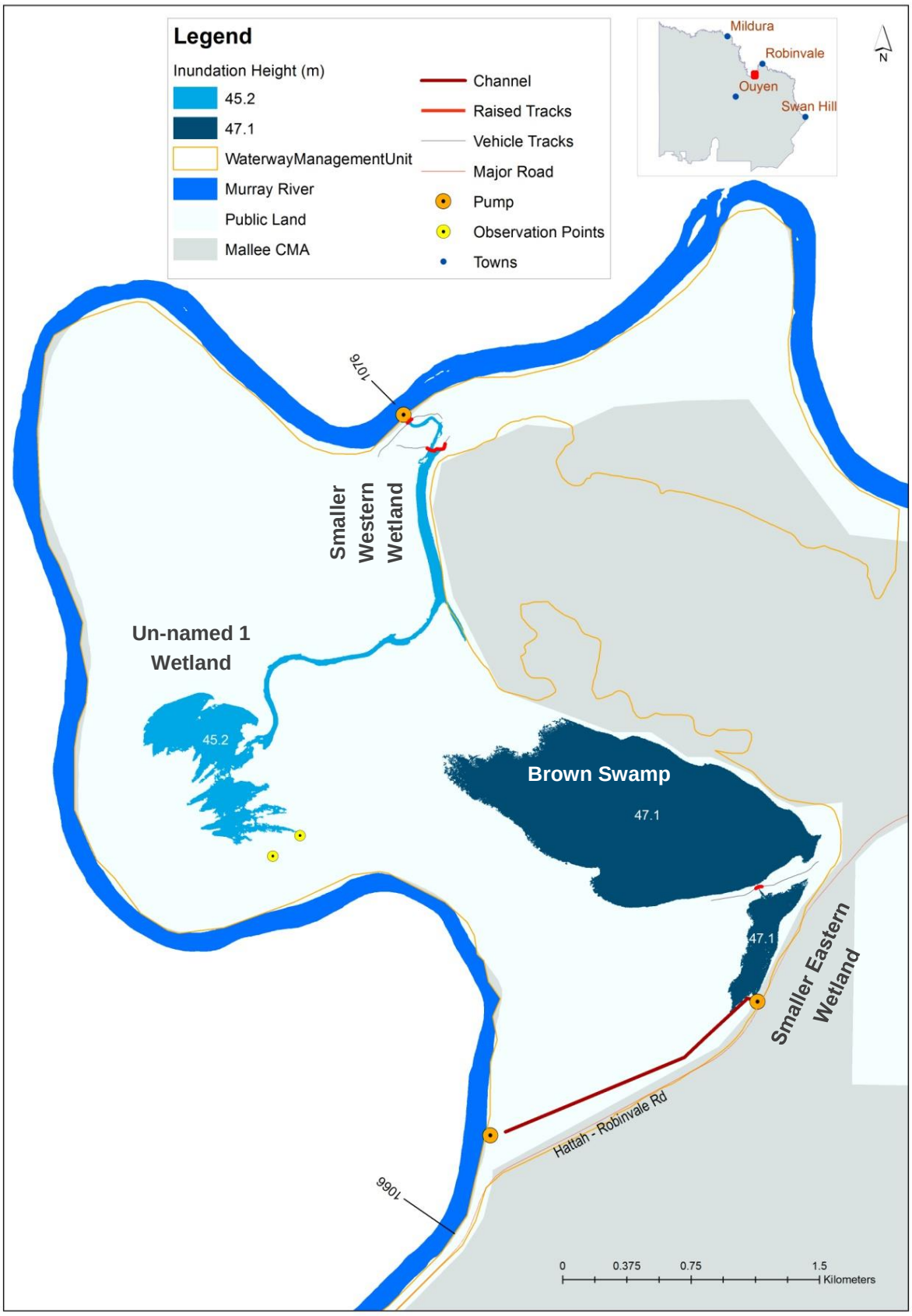

Figure 12: Pound Bend watering Western and Eastern Wetlands.

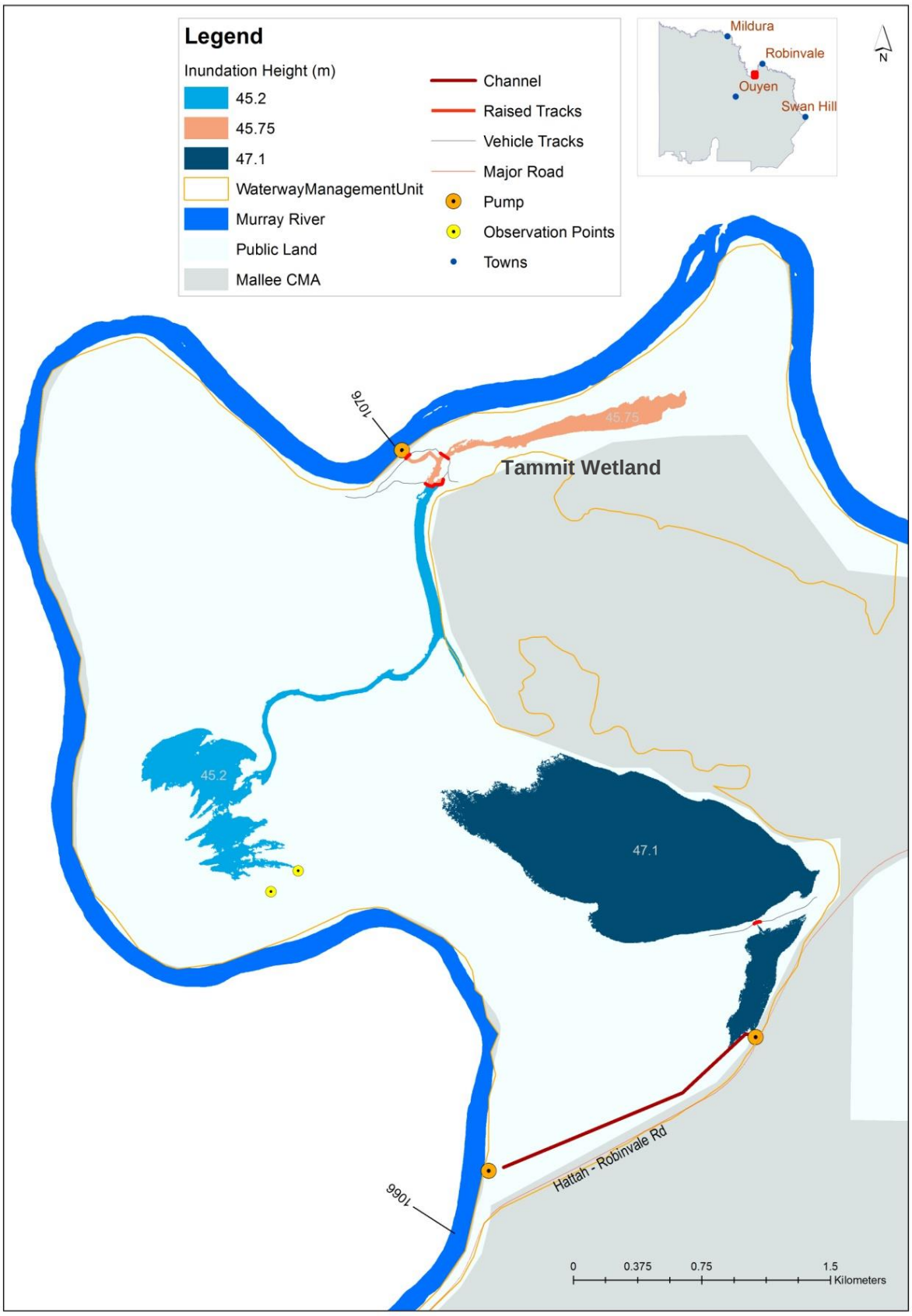

Figure 13: Pound Bend watering Tammit Wetland from existing irrigation pump at river km 1076

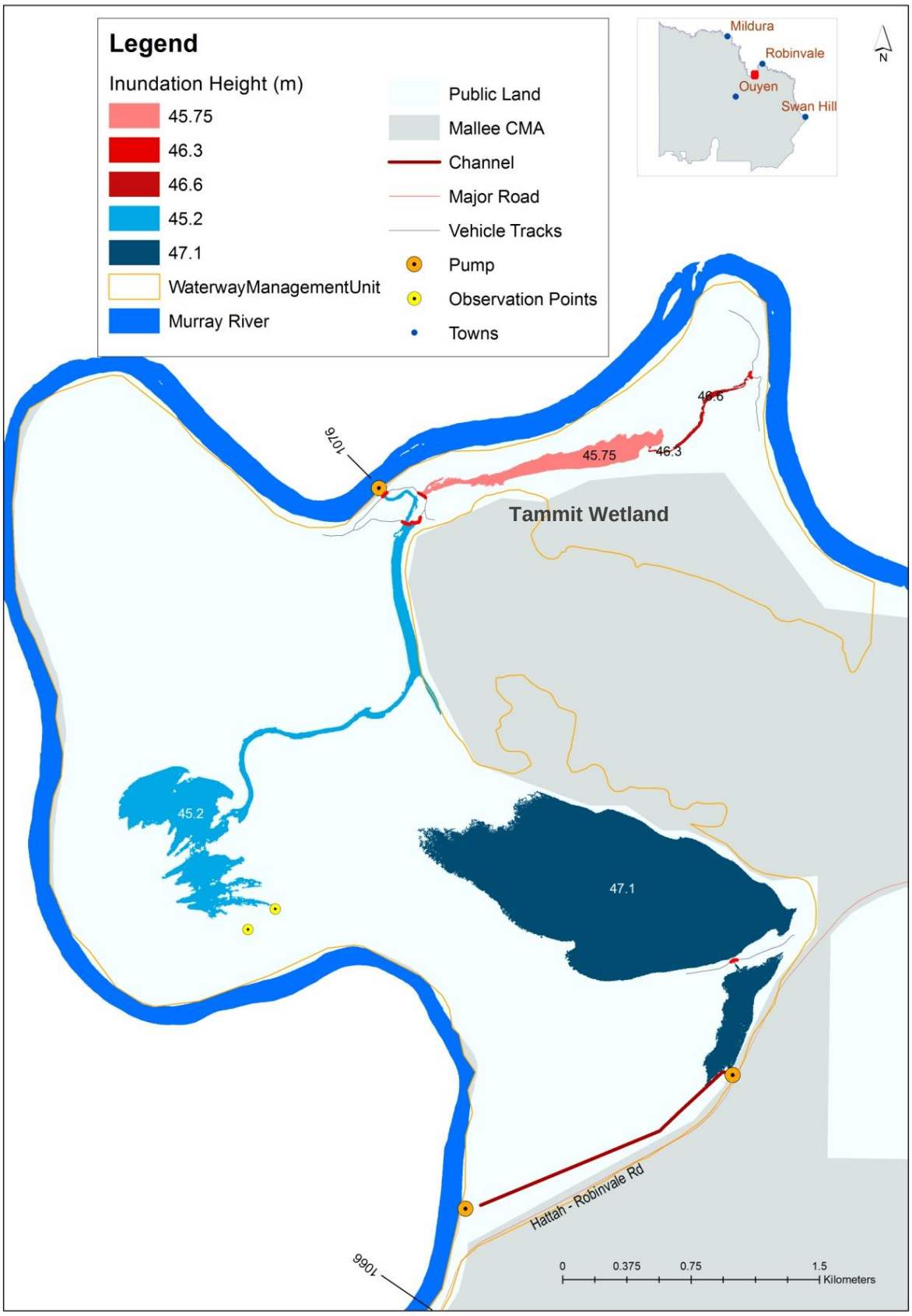

Figure 14: Pound Bend watering Tammit Wetland from new pump on the eastern end of the wetland at 1076 river km

9. DEMONSTRATING OUTCOMES

9.1 Monitoring Priorities at the Site

The following monitoring is recommended.

Monitoring of objectives:

- Tree (canopy) health assessed on lower river terraces (primary Regent Parrot habitat);
- Quadrats to assess germination rates and age structure of River Red Gum stands;
- Flora quadrats and/ or transects; to detect increases in diversity and change of composition in understorey, at all watered wetlands.

Monitoring of key dependent values:

- Regent Parrots – baseline survey of nesting trees, on-going nesting activity;
- Waterbirds, breeding activity at Lignum swamps.

Monitoring to manage watering event and inform future watering events:

- Water quality during the watering event, for risk management and adaptive management purposes;
- Soil salinity before and after watering event, in particular comparisons between the lower terrace river flat and the sub-saline wetland;
- Ongoing monitoring of cultural heritage to minimise harm to sites of cultural significance (refer to Appendix 5 for cultural heritage contingency plan).

Monitoring of Pest Species

- Pest Animal (rabbit, fox, cat, pig and goat) and Plant (Prickly Pear and Horehound) distribution and abundance.

10. CONSULTATION

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, DELWP, a local interest group and nearby residents (Table 16). Parts of Pound Bend are freehold and consultation with local landholders was required regarding the management of all wetlands and associated waterways.

Community feedback on Pound Bend EWMP raised the following points:

- The site is popular with campers and the community.
- There are concerns a watering event may cause problems with mosquitoes.
- There are concerns a watering event at Brown Swamp may cause an issue with smell.
- Effort should be made to ensure, during water events, there is access to roads, pumps and camp sites.
- Ensure information concerning the timing and level of any future watering events be communicated to relevant irrigators.

Other issues raised included:

- Campers are very good at depositing waste at the designated collection point, however during peak holiday periods, waste collection could occur more frequently.
- Consideration needs to made around complimentary pest and weed management activities.

Table 16. Consultation undertaken as part of the development of the EWMP

Meeting Date	Stakeholders	Details
9 Feb 2015	Parks Victoria	Discussion to introduce concept of plan
8 and 9 April 2015	Local residents/Wemen Community	House calls to residents to discuss plan
TBA	Indigenous groups	Face to face discussions\on-Country visits
2 March 2015	Aboriginal Reference Group	Presentation of plan
26 February 2015	Land and water Advisory Committee	Presentation of plan
13 April 2015	Wemen Progress Society	Presentation of plan

11. KNOWLEDGE GAPS AND RECOMMENDATIONS

Limited flora and fauna survey work has been carried out at Pound Bend, leading to a lack of knowledge of the full range of ecological values that may be present. The influence of the adjacent irrigation area, and the underlying hydrogeology, are poorly known. The following recommendations are made to assist to fill knowledge gaps:

- Flora (in particular wetland species) and fauna survey, to provide a more detailed understanding of site values;
- Ground truth EVC Sub-saline Depression Shrubland;
- Review of bore hole data to provide information about the presence or absence of Blanchtown clay under the southern part of Pound Bend. This will assist to determine processes of accumulation and export of salt, and will also inform investigations on mixed tree health across the floodplain;
- Tree health and soil salinity sampling across the floodplain, to be correlated with potential causes of decline.

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13. ABBREVIATIONS AND ACRONYMS

CMAs	Catchment Management Authorities
EA	Ecological Associates
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
FFG	Flora Fauna Guarantee Act
GDE	Groundwater Dependent Ecosystem
MCMA	Mallee Catchment Management Authority
MDBA	Murray Darling Basin Authority (formally Murray Darling Basin Commission, MDBC)
VEWH	Victorian Environmental Water Holder
WMU	Waterway Management Unit

APPENDIX 1. ECOLOGICAL VEGETATION CLASSES (EVCS)

EVC Name	Area (hectares)
Chenopod Mallee	0.24763068086
Floodway Pond Herbland	22.34663999510
Grassy Riverine Forest	72.08003921910
Grassy Riverine Forest/Floodway Pond Herbland Complex	9.91473645903
Lignum Shrubland	20.43088257070
Lignum Swamp	11.80669922570
Lignum Swampy Woodland	128.86126420200
Riverine Chenopod Woodland	264.83038268000
Riverine Grassy Woodland	185.74078957400
Semi-arid Chenopod Woodland	135.41364279100
Semi-arid Parilla Woodland	10.63234705360
Semi-arid Woodland	5.05315064550
Shallow Freshwater Marsh	55.23068718770
Shrubby Riverine Woodland	282.06322529300
Sub-saline Depression Shrubland	82.26859150580
Woorinen Sands Mallee	0.37838946401

APPENDIX 2. FAUNA SPECIES LIST

Fauna – Native

Common Name	Scientific Name	Type	Record
Australian Magpie	Gymnorhina tibicen	B	3
Australian Pelican	Pelecanus conspicillatus	B	2
Australian Raven	Corvus coronoides	B	4
Australian White Ibis	Threskiornis molucca	B	1
Australian Wood Duck	Chenonetta jubata	B	2
Barking Marsh Frog	Limnodynastes fletcheri	A	2
Black-faced Cuckoo-shrike	Coracina novaehollandiae	B	3
Black-fronted Dotterel	Elseyornis melanops	B	1
Blue-faced Honeyeater	Entomyzon cyanotis	B	1
Boulenger's Skink	Morethia boulengeri	R	6
Brown Goshawk	Accipiter fasciatus	B	1
Brown Treecreeper (south-eastern ssp.)	Climacteris picumnus victoriae	B	5
Buff-rumped Thornbill	Acanthiza reguloides	B	1
Carnaby's Wall Skink	Cryptoblepharus pannosus	R	3
Central Bearded Dragon	Pogona vitticeps	R	1
Common Bronzewing	Phaps chalcoptera	B	1
Crested Pigeon	Ocyphaps lophotes	B	1
Crimson Rosella	Platycercus elegans	B	2
Dusky Woodswallow	Artamus cyanopterus	B	1

Common Name	Scientific Name	Type	Record
Eastern Great Egret	Ardea modesta	B	1
Fairy Martin	Petrochelidon ariel	B	1
Galah	Eolophus roseicapilla	B	6
Great Cormorant	Phalacrocorax carbo	B	4
Grey Butcherbird	Cracticus torquatus	B	1
Grey Fantail	Rhipidura albiscarpa	B	1
Grey Shrike-thrush	Colluricincla harmonica	B	5
Grey Teal	Anas gracilis	B	3
Inland Thornbill	Acanthiza apicalis	B	1
Laughing Kookaburra	Dacelo novaeguineae	B	5
Little Black Cormorant	Phalacrocorax sulcirostris	B	2
Little Corella	Cacatua sanguinea	B	1
Little Friarbird	Philemon citreogularis	B	2
Little Pied Cormorant	Microcarbo melanoleucos	B	2
Magpie-lark	Grallina cyanoleuca	B	5
Mallee Ringneck	Barnardius zonarius barnardi	B	2
Mallee Spadefoot Toad	Neobatrachus pictus	A	1
Marbled Gecko	Christinus marmoratus	R	1
Masked Lapwing	Vanellus miles	B	2
Nankeen Night Heron	Nycticorax caledonicus hillii	B	1
Noisy Miner	Manorina melanocephala	B	5

Common Name	Scientific Name	Type	Record
Pacific Black Duck	Anas superciliosa	B	4
Pallid Cuckoo	Cuculus pallidus	B	1
Peaceful Dove	Geopelia striata	B	2
Peregrine Falcon	Falco peregrinus	B	1
Pied Cormorant	Phalacrocorax varius	B	1
Pink-eared Duck	Malacorhynchus membranaceus	B	1
Rainbow Bee-eater	Merops ornatus	B	1
Red Wattlebird	Anthochaera carunculata	B	1
Red-rumped Parrot	Psephotus haematonotus	B	4
Regent Parrot	Polytelis anthopeplus monarchoides	B	3
Restless Flycatcher	Myiagra inquieta	B	2
Royal Spoonbill	Platalea regia	B	1
Rufous Songlark	Cincloramphus mathewsi	B	1
Rufous Whistler	Pachycephala rufiventris	B	2
Sacred Kingfisher	Todiramphus sanctus	B	1
Splendid Fairy-wren	Malurus splendens	B	1
Spotted Burrowing Skink	Lerista punctatovittata	R	1
Spotted Marsh Frog (race unknown)	Limnodynastes tasmaniensis	A	1
Straw-necked Ibis	Threskiornis spinicollis	B	1
Striated Pardalote	Pardalotus striatus	B	3
Stumpy-tailed Lizard	Tiliqua rugosa	R	1

Common Name	Scientific Name	Type	Record
Sulphur-crested Cockatoo	Cacatua galerita	B	5
Tessellated Gecko	Diplodactylus tessellatus	R	1
Tree Dtella	Gehyra variegata	R	4
Tree Martin	Petrochelidon nigricans	B	3
Weebill	Smicrornis brevirostris	B	3
Welcome Swallow	Petrochelidon neoxena	B	2
Western Grey Kangaroo	Macropus fuliginosus	M	1
Whistling Kite	Haliastur sphenurus	B	5
White-browed Babbler	Pomatostomus superciliosus	B	1
White-faced Heron	Egretta novaehollandiae	B	2
White-necked Heron	Ardea pacifica	B	1
White-plumed Honeyeater	Lichenostomus penicillatus	B	5
White-winged Chough	Corcorax melanorhamphos	B	2
Willie Wagtail	Rhipidura leucophrys	B	2
Yellow Rosella	Platycercus elegans flaveolus	B	3
Yellow Thornbill	Acanthiza nana	B	1
Yellow-billed Spoonbill	Platalea flavipes	B	1
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	B	2

Legend - Type: Invertebrate (I), Fish (F), Amphibian (A), Reptile (R), Bird (B), Mammal (M)

Fauna – Introduced

Common Name	Scientific Name	Type	Record
Common Starling	Sturnus vulgaris	B	1
European Rabbit	Oryctolagus cuniculus	M	3
House Mouse	Mus musculus	M	1

Legend - Type: Invertebrate (I), Fish (F), Amphibian (A), Reptile (R), Bird (B), Mammal (M)

APPENDIX 3. FLORA SPECIES LIST

Flora - Native

Common Name	Scientific Name	Number of Records	Highest Cover / Abundance Rating
Eumong	Acacia stenophylla	1	+
Umbrella Wattle	Acacia oswaldii	1	+
Slender-fruit Saltbush	Atriplex leptocarpa	2	2
Flat-top Saltbush	Atriplex lindleyi	1	1
Variable Spear-grass	Austrostipa scabra/nitida/nodosa spp. agg.	1	2
Hard-head Daisy	Brachyscome lineariloba	2	1
Belah	Casuarina pauper	1	+
Tangled Lignum	Muehlenbeckia florulenta	1	2
Nodding Saltbush	Einadia nutans	1	+
Ruby Saltbush	Enchylaena tomentosa var. tomentosa	1	1
Spreading Emu-bush	Eremophila divaricata subsp. divaricata	1	+
Black Box	Eucalyptus largiflorens	2	2
River Red Gum	Eucalyptus camaldulensis	1	NA
Annual Cudweed	Euchiton sphaericus	1	+

Common Name	Scientific Name	Number of Records	Highest Cover / Abundance Rating
Short-leaf Bluebush	Maireana brevifolia	1	+
Hairy Bluebush	Maireana pentagona	1	+
Clay Plantain	Plantago cunninghamii	1	1
Stiff Cup-flower	Pogonolepis muelleriana	1	1
Poached-eggs Daisy	Polycalymma stuartii	1	+
Common Wallaby-grass	Rytidosperma caespitosum	2	2
Prickly Saltwort	Salsola tragus subsp. tragus	1	1
Short-wing Saltbush	Sclerochlamys brachyptera	2	2
Black Roly-poly	Sclerolaena muricata	2	1
Streaked Copperburr	Sclerolaena tricuspis	1	2
Variable Sida	Sida corrugata	1	1
Sida	Sida spp.	1	+
Quena	Solanum esuriale	1	+
Star Bluebush	Stelligera endecaspinis	1	+
Grey Germander	Teucrium racemosum s.l.	1	+
Dissected New Holland Daisy	Vittadinia dissecta s.l.	1	+
Annual Bluebell	Wahlenbergia gracilenta s.l.	1	1

Flora – Exotic

Common Name	Scientific Name	Number of Records	Highest Cover / Abundance Rating
Mediterranean Turnip	Brassica tournefortii	1	+
Red Brome	Bromus rubens	2	1
Malta Thistle	Centaurea melitensis	1	+

Common Name	Scientific Name	Number of Records	Highest Cover / Abundance Rating
Northern Barley-grass	Hordeum glaucum	1	2
Smooth Cat's-ear	Hypochaeris glabra	2	2
Prickly Lettuce	Lactuca serriola	1	+
Common Peppercress	Lepidium africanum	1	+
Horehound	Marrubium vulgare	1	+
Little Medic	Medicago minima	1	1
False Hair-grass	Pentameris airoides subsp. airoides	1	+
Mallee Catchfly	Silene apetala var. apetala	2	1
Common Sow-thistle	Sonchus oleraceus	1	+
Hare's-foot Clover	Trifolium arvense var. arvense	1	+
Squirrel-tail Fescue	Vulpia bromoides	1	3
Prickly Pear	(Opuntia spp. other than O. ficus-indica)	1	NA

APPENDIX 4. CULTURAL HERITAGE CONTINGENCY PLAN

CONTINGENCY PLANS

In the event that Aboriginal cultural heritage is found during the conduct of the activity, contingency measures are set out below. The contingency measures set out the sponsor's requirements in the event that Aboriginal cultural heritage is identified during the conduct of the activity.

1. Management of aboriginal cultural heritage found during the activity

In the event that new Aboriginal cultural heritage is found during the conduct of the activity, then the following must occur:

- The person who discovers Aboriginal cultural heritage during the activity will immediately notify the person in charge of the activity;
- The person in charge of the activity must then suspend any relevant works at the location of the discovery and within 5m of the relevant place extent;
- In order to prevent any further disturbance, the location will be isolated by safety webbing or an equivalent barrier and works may recommence outside the area of exclusion;
- The person in charge of the activity must contact the and the Mallee CMA Indigenous Facilitator
- Within a period not exceeding 1 working days a decision/ recommendation will be made by the Mallee CMA Indigenous Facilitator and the Aboriginal stakeholder;
- As to the process to be followed to manage the Aboriginal cultural heritage in a culturally appropriate manner, and how to proceed with the works;

Separate contingency plan has been developed in the event that suspected human remains are discovered during the conduct of the activity.

2. Notification of the discovery of skeletal remains during the carrying out of the activity

1. Discovery:

- If suspected human remains are discovered, all activity in the vicinity must stop to ensure minimal damage is caused to the remains, and,
- The remains must be left in place, and protected from harm or damage.

2. Notification:

- Once suspected human skeletal remains have been found, Victoria Police (use the local number) and the Coroner's Office (1300 309 519) must be notified immediately;
- If there is reasonable grounds to believe that the remains could be Aboriginal, the DSE Emergency Co-ordination Centre must be immediately notified on 1300 888 544; and

- All details of the location and nature of the human remains must be provided to the relevant authorities.
- If it is confirmed by these authorities that the discovered remains are Aboriginal skeletal remains, the person responsible for the activity must report the existence of the human remains to the Secretary, DPCD in accordance with s.17 of the Act.

3. Impact Mitigation or Salvage:

- The Secretary, after taking reasonable steps to consult with any Aboriginal person or body with an interest in the Aboriginal human remains, will determine the appropriate course of action as required by s.18(2)(b) of the Act.
- An appropriate impact mitigation or salvage strategy as determined by the Secretary must be implemented.

4. Curation and Further Analysis:

- The treatment of salvaged Aboriginal human remains must be in accordance with the direction of the Secretary.

5. Reburial:

- Any reburial site(s) must be fully documented by an experienced and qualified archaeologist, clearly marked and all details provide to AAV;

Appropriate management measures must be implemented to ensure that the remains

are not disturbed in the future