Neds Corner Environmental Water Management Plan

SUNRAYSIA environmental
Land, Water & Environment

mallee
catchment management authority

Document Control

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Cover photo: Environmental water delivered to Neds East during 2016.

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Acknowledgements

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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) identified 23 Waterway Management Units (WMU) from 216 targeted waterways in the Mallee. The interconnectedness and commonality of threats impacting on the waterways values were used to group them into planning units. This EWMP has been developed for the Neds Corner WMU Sub-unit. Hereafter referred to as Neds Corner. The EWMP will help to guide future environmental watering activities for this area.

Neds Corner is located in the Murray Scroll Belt Bioregion within the Mallee Catchment Management Authority (Mallee CMA) region, 7 km downstream of Lock 9 and approximately 60 km west of Mildura, on the Murray River floodplain.

Neds Corner is owned by Trust for Nature and has been managed for conservation since 2002. The site offers a strategic connection as the only private tenure among 200 km of Murray River frontage within the Murray Sunset National Park. Survey work conducted at Neds Corner has identified key ecological values including critically endangered reptiles, the De Vis' Banded Snake (*Denisonia devisi*) and Hooded Scaly-foot (*Pygopus schraderi*), and near threatened mammals including Giles' Planigale (*Planigale gilesi*) and the Fat-tailed Dunnart (*Sminthopsis crassicaudata*). The nationally vulnerable Regent Parrot is recorded at Neds Corner, and vulnerable waterbird species Hardhead (*Aythya australis*), Inland Dotterel (*Charadrius australis*) and Eastern Great Egret (*Ardea modesta*) are all recorded. A diversity of birds in general are recorded at Neds Corner, and waterbird species sighted include Cormorants, Ducks and Spoonbills and the local Indigenous community's totem species, the Pelican.

Vegetation communities present include the vulnerable Alluvial Plains Semi-arid grassland, which can be prone to invasion by terrestrial species under reduced inundation regimes. This in turn can put at risk important habitat niches for listed terrestrial fauna recorded at Neds Corner that inhabit the grey cracking soils and utilise vegetation as cover. Lignum is present in many EVCs throughout the target area and can provide important habitat for waterbirds and terrestrial fauna.

The whole 1,435 ha has a water requirement as a floodplain complex (Mallee CMA, 2014), but the focus for this plan is restricted to a target area of approximately 50 ha. The target area covers three wetlands and a floodplain depression. One wetland (Neds East) can be managed independently of the other sites. This target area is the maximum extent to which environmental water is able to be managed with the existing infrastructure in place, with a larger extent possible with additional track raising works as recommended in this EWMP.

The long-term management goal for the Neds Corner EWMP is:

> *To provide a mosaic of intermittent wetlands that provide waterbird breeding and feeding habitat set within a productive floodplain system.*

To achieve this, ecological and hydrological objectives, were designed, and these were developed to sustain the various ecological components of the three targeted wetlands and floodplain depression. These have been incorporated into minimum, optimal and maximum watering regimes. The ecological objectives for Neds Corner are:

NC1: By 2030, improve vital habitat at Neds East and Woolshed Creek, Ned's Corner by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.

NC2: By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis) to sustain communities and processes typical of such communities at Neds East and Woolshed Creek, Ned's Corner

NC3: By 2030, improve condition and maintain extent from baseline levels of Lignum (*Duma florulenta*) to sustain communities and processes reliant on Lignum communities at Neds Central, Ned's Corner.

Minimum, optimal and maximum watering regimes have been developed to sustain and improve the ecological components of the target area. Optimal regimes are provided below for the area that is able to be watered with current infrastructure.

Management Area	Inundation area, duration and frequency
Neds East	Inundate Neds East with approximately 100 ML six times in ten years with a maximum interval of four years between events. Maintain water within the wetland for four months, allowing natural recession to improve diversity of the Floodway Pond Herbland EVC.
Neds Central	Inundate Neds Central with approximately 150 ML. Deliver water five times in ten years with a maximum interval of five years between events. Maintain water within the wetlands for four months, allowing natural recession to improve condition of the Lignum communities.
Woolshed Creek	Inundate Neds East with approximately 70 ML six times in ten years with a maximum interval of four years between events. Maintain water within the wetland for four months, allowing natural recession to improve diversity of the Floodway Pond Herbland EVC.

It is recommended that additional track raising is conducted to expand the inundation extent to 171 ha, achieving inundation of Neds Corner Lagoon and additional areas of vulnerable EVCs.

Figure 1 Neds East prior to delivery of environmental water in 2016

1.0 Introduction

This Environmental Water Management Plan (EWMP) has been prepared by the Mallee CMA to establish the long-term management goals of Neds Corner.

The key purposes of the EWMP are to:

- Identify the long-term objectives and water requirements for the wetlands, recognised as high and medium priorities in the *Mallee Waterway Strategy (MWS)*;
- Provide a medium for community consultation, including for the long-term objectives and water requirements of the wetland;
- Inform the development of seasonal watering proposals and seasonal watering plans;
- Inform long-term watering plans that will be developed under Murray-Darling Basin Plan requirements.

Figure 2 Environmental water delivery to Neds Corner, 2016

2.0 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 39,000km ^{2} 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 is semi-arid with an annual 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 approximately 40% public land consisting mainly of national parks, reserves and large reaches of riverine and dryland forest. The rest of the region is important for dryland farming of sheep and cereals and irrigated horticulture (MCMA 2006).

In 2006 the Mallee CMA engaged consultants to develop a system of Floodplain Management Units (FMUs). These divide the floodplain into management units in which water regimes can be managed independently of 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 and 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 the Neds Corner FMU (or WMU sub-unit) (Figure 3), hereafter referred to as Neds Corner in this document, located on the Murray River floodplain 7 km downstream of Lock 9, and between 746 and 758 river km. The Neds Corner sub-unit represents 1,345 ha, is approximately 60 km west of the Mildura CBD and falls within the Mulcra WMU. Mulcra WMU covers an area of 4,735 ha, extending from Neds Corner to the westernmost end of Mulcra Island. For a map of the WMU, refer to the *Mallee Waterway Strategy 2014-22*.

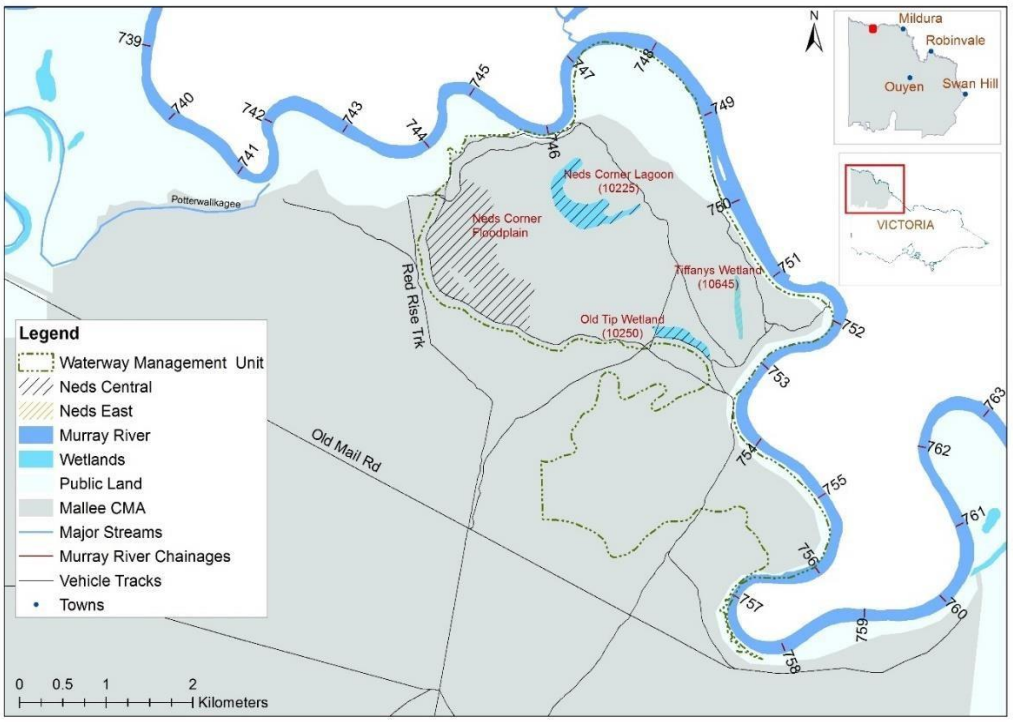

Figure 3. Map of Neds Corner WMU sub-unit

Figure 3b. Map of Woolshed Creek

2.2 Catchment Setting

Neds Corner is located in the Murray Scroll Belt Bioregion. The Murray Scroll Belt Bioregion is characterised by an entrenched river valley and associated floodplain and lake complexes of numerous oxbow lakes, billabongs, ephemeral lakes, swamps and active meander belts. Alluvium deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Dermosols, Vertosols, Chromosols and Sodosols) supporting Alluvial-Plain Shrubland, Riverine Grassy Chenopod Woodland and Riverine Grassy Forest ecosystems.

The Murray River in this location is contained within the valley section of the Lower Murray Tract. This section is characterised by a river and floodplain valley up to 10 km wide with many anabranch channels, cutoffs, billabongs and deflation basins (Thoms et al 2000, p.116).

The land surrounding Neds Corner is predominantly managed for conservation. Neds Corner is located on land owned by Trust for Nature, part of the property known as Neds Corner Station, which is the largest private conservation property in Victoria (Trust for Nature, 2011). Upstream, to the east, is Kulnine Station, now incorporated in to the Murray Sunset National Park, and downstream the Park continues as the former Mulcra Island State Forest. The national park provides an uninterrupted frontage to the Murray River from the South Australian border eastwards to an area within Wallpolla Island, with Neds Corner providing a Private Protected Area within this 200 km frontage (VEAC 2008b).

The floodplain at Neds Corner represents an important site due to its position between the Mulcra and Wallpolla Island components of Chowilla Floodplain and Lindsay-Wallpolla Islands Living Murray Icon Site. Across the Murray River in NSW, significant areas of Murray River floodplain include the former Moorna and Wangumma State Forests (now known as the Tar-Ru Lands). Neds Corner therefore provides a strategically important link between large areas of natural environment that are well recognised for their significant ecological values.

2.2.1 Neds East

Tiffanys Wetland (#10645), referred to as Neds East in this EWMP, is a natural floodplain wetland surrounded by dense floodplain vegetation. Natural connection would occur from floodrunners downstream firstly, with flow-through via the nearer upstream connection under higher flows.

2.2.2 Neds Central

Neds Central is a wetland complex comprising two wetlands: Old Tip Wetland (#10250) and Neds Corner Lagoon (#10225). Neds Corner Floodplain provides a hydrological connection between the two.

Wetland #10250 is positioned high on the floodplain, close to the elevated terrace. This wetland connects upstream via a deeply incised creek-like channel under high flows, before spilling out to the floodplain to the west. At higher flows, water would then flow to Wetland #10225. At these flow thresholds, flow-through of Neds Corner Floodplain would be achieved.

Neds Corner Lagoon (#10225) represents a wetland within an area of elevated floodplain, comprised of alluvial plains and lignum swamp areas.

Neds Corner Floodplain is a broad and shallow floodplain depression that occurs in the west of the target area. Whilst not currently mapped as a wetland in the state wetland database, this mostly treeless elevated floodplain area is comprised of areas of Lignum and grassland and is likely to hold water after a flood event. It may also receive local stormwater runoff from significant rain events, from the upper terrace to the south.

2.2.3 Woolshed Creek

Woolshed Creek is found on Trust for Nature's Neds Corner property and is a new site listed for environmental water. Environmental water delivery to Woolshed Creek will support stressed river red gum and black box communities and target a more natural inundation

frequency. The delivery of environmental water in spring 2019 will focus on the southern reach of Woolshed Creek, which has received less natural inundation than the northern reach. The southern reach of Woolshed Creek has remained dry over an extended period due to the elevated terrain, which is evident by the poor condition of fringing river red gums and black box communities.

2.3 Conceptualisation of the Site

The wetlands and floodplain at Neds Corner are presented visually in Figure 4 to provide a conceptual representation of key ecological processes, water dependent values and threats to those values. The interactions between the values and threats are further discussed throughout the document.

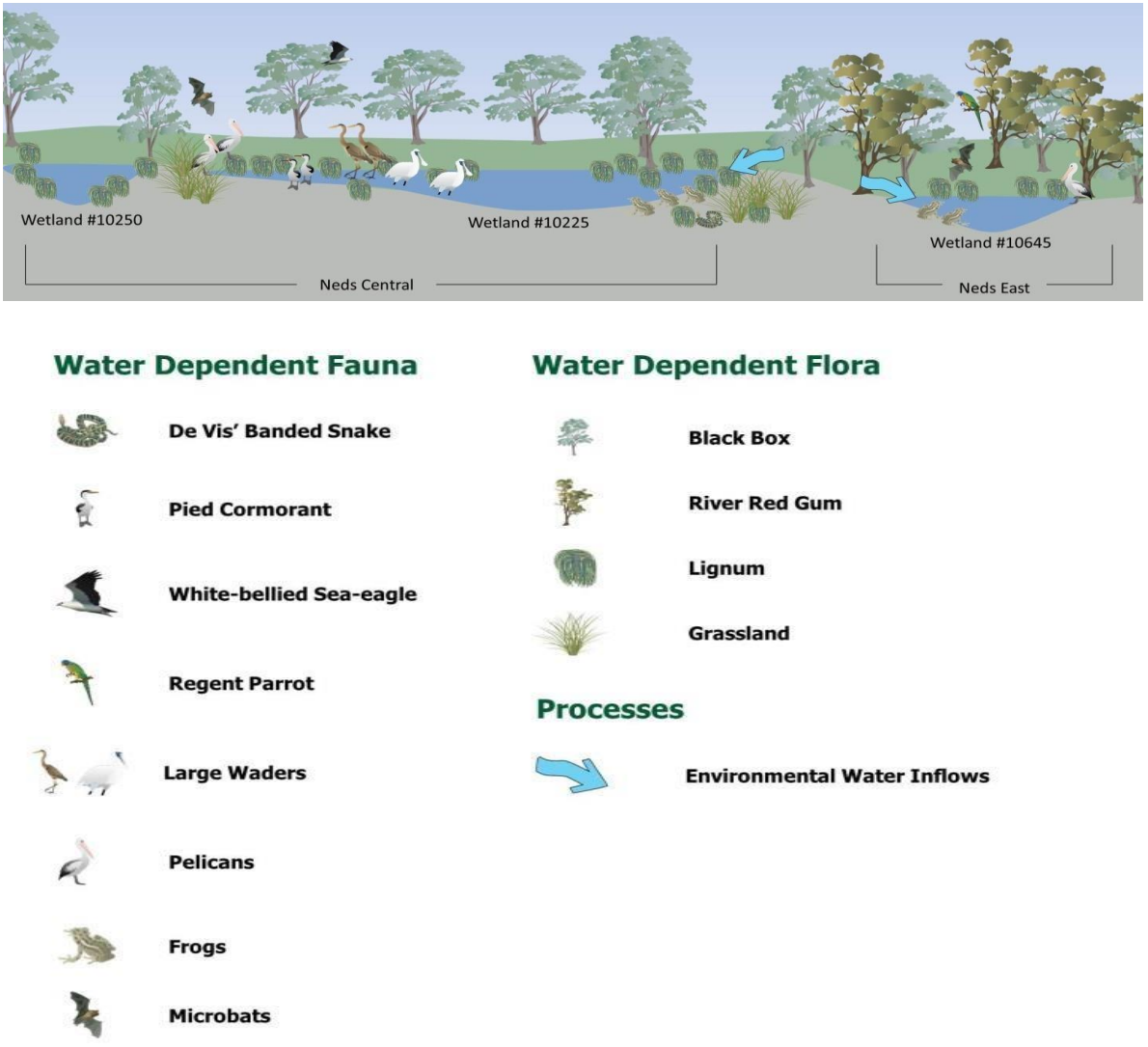

Figure 4. Conceptual model of the threats and values associated with Neds Corner

Neds East is surrounded by large old River Red Gum and Black Box but with little sign of recruitment. The large old trees offer hollows that may be utilised by hollow seeking fauna such as the Regent Parrot and several species of microbat.

Black Box and Lignum surround the Neds Central wetlands, which are situated on higher elevations on the floodplain along with shrublands and grasslands. Freshwater inflows to

the system will be delivered as environmental water by pumping from the Murray River to inundate all wetlands.

This flooding leads to the rapid release of nutrients from the soils, production of seed and egg banks, and increase in productivity that provides invertebrates as food sources for microbats  .

Frogs  are likely to take advantage of the extended wetland environment, providing enhanced foodweb opportunities and supporting the De Vis' Banded Snake  . Improving condition of Lignum  communities will enhance cover for this snake and other terrestrial fauna. Likewise, introducing a wetting and drying phase will allow the grey cracking soils to offer shelter and ambush habitat for the De Vis' Banded Snake and Giles' Planigale.

2.4 Land Status and Management

Neds Corner is comprised of private land that is owned and managed by Trust for Nature (Victoria). Public land occurs on the river frontage as part of the Murray Sunset National Park, managed by Parks Victoria. Areas of management responsibility are shown in Figure 5, where private land indicates the area under management by Trust for Nature. Table 1 lists the key stakeholders and their responsibilities in relation to Neds Corner.

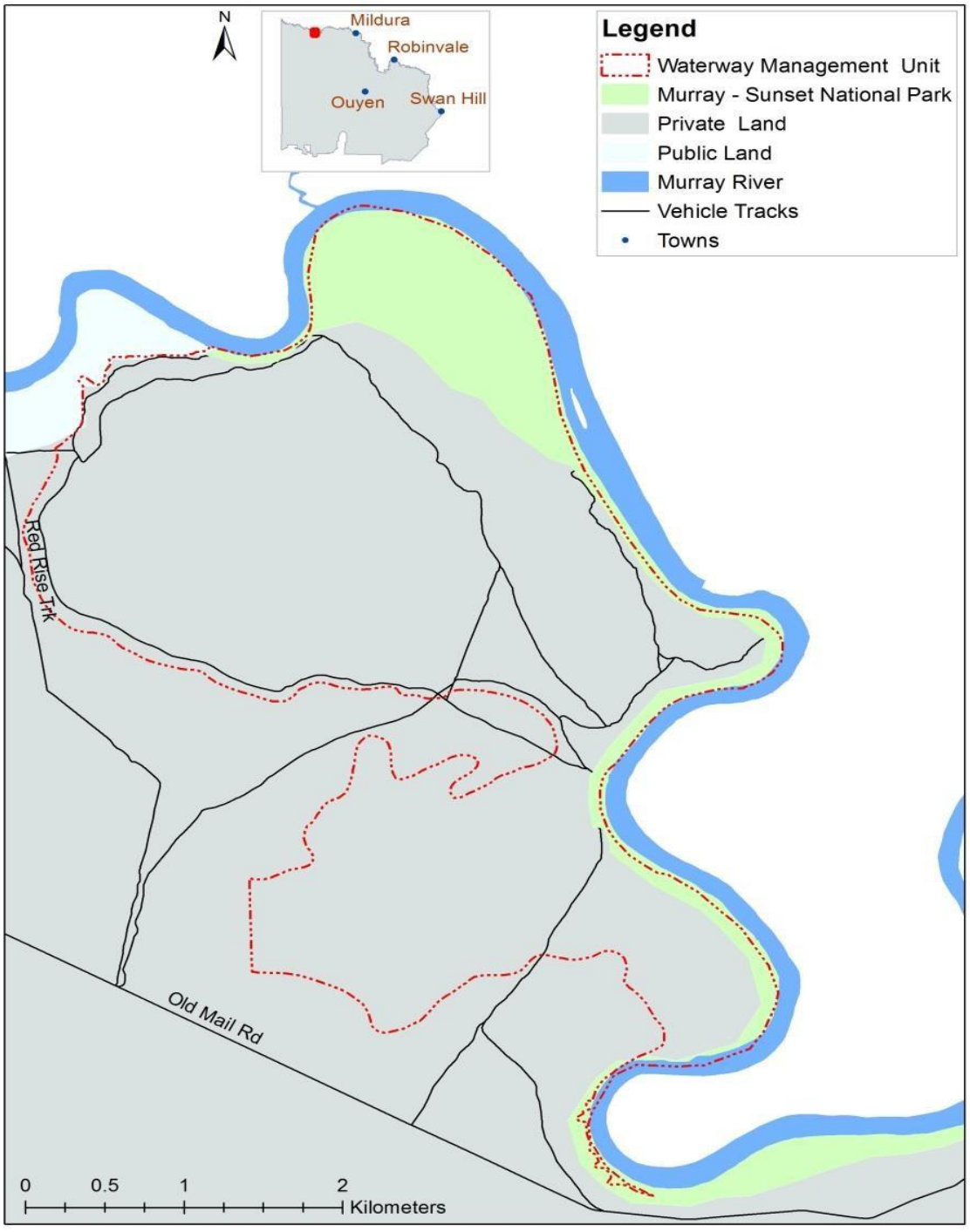

Figure 5. Neds Corner Stakeholders Map

Table 1. Stakeholders for Neds Corner

Stakeholder	Responsibilities
Trust for Nature	Land owner and land manager
Parks Victoria	Land Manager. Parks Victoria is responsible for Conserving Victoria's special places with the aim to ensure that our valued parks, and the natural assets and cultural heritage they hold, can be enjoyed now and by future generations. A section of the land adjacent to the Murray River is managed by Parks Victoria as part of the Murray Sunset National Park (VEAC 2008b).
Aboriginal Communities	Indigenous Representation
Birdlife Mildura	Bird observer group, land user
Mallee CMA	The Mallee CMA's responsibility is to ensure that natural resources in the region are managed in an integrated and ecologically sustainable way. The Mallee CMA is the Waterway manager, responsible for preparing Environmental Water Management Plans and Seasonal Watering Proposals and implementing watering actions at this site and others.
Victorian Environmental Water Holder	Determines locations and volumes for environmental water delivery.
Department of Environment, Land, Water and Planning	DELWP is responsible for state level environmental water management planning, land manager and threatened species manager

2.5 Wetland Characteristics

A brief overview of the main characteristics of wetlands at Neds Corner is provided in Table 2 and wetland types are shown in Figure 6. An indication of the hydrology of the area is provided in the LiDAR imagery (Figure 7). This image has been used to estimate wetland depths.

Table 2. Wetland characteristics at Neds Corner

Characteristics	Description				
Name	Neds Central			Neds East	Woolshed Creek
Wetland ID	#10225	Not mapped	#10250	#10645	
Total Area	Total area of WMU Sub-unit 1,435ha Total of all (mapped) wetlands 37.8 ha				
Wetland Area	24.9 ha	113 ha	8.2 ha	4.7 ha	5 ha
Bioregion	Murray Scroll Belt Bioregion				
Conservation status of EVCs	Vulnerable & Depleted			Depleted & Least Concern	
Land Status	Private Land				
Land Manager	Trust for Nature				
Surrounding land use	Conservation				
Water supply	Connected to Murray River at flows > 122,500 ML/day		Connected to Murray River at flows > 56,300 ML/day	Connected to Murray River at flows > 56,300 ML/day	
1788 wetland category	Freshwater meadow	Not mapped	Not mapped	Not mapped	
2013 wetland category and sub-category	Temporary Freshwater Swamp	Not defined	Unknown	Unknown	
Wetland depth at capacity	~1 m	~1 m	~1 m	~1.2 m	~1.5 m

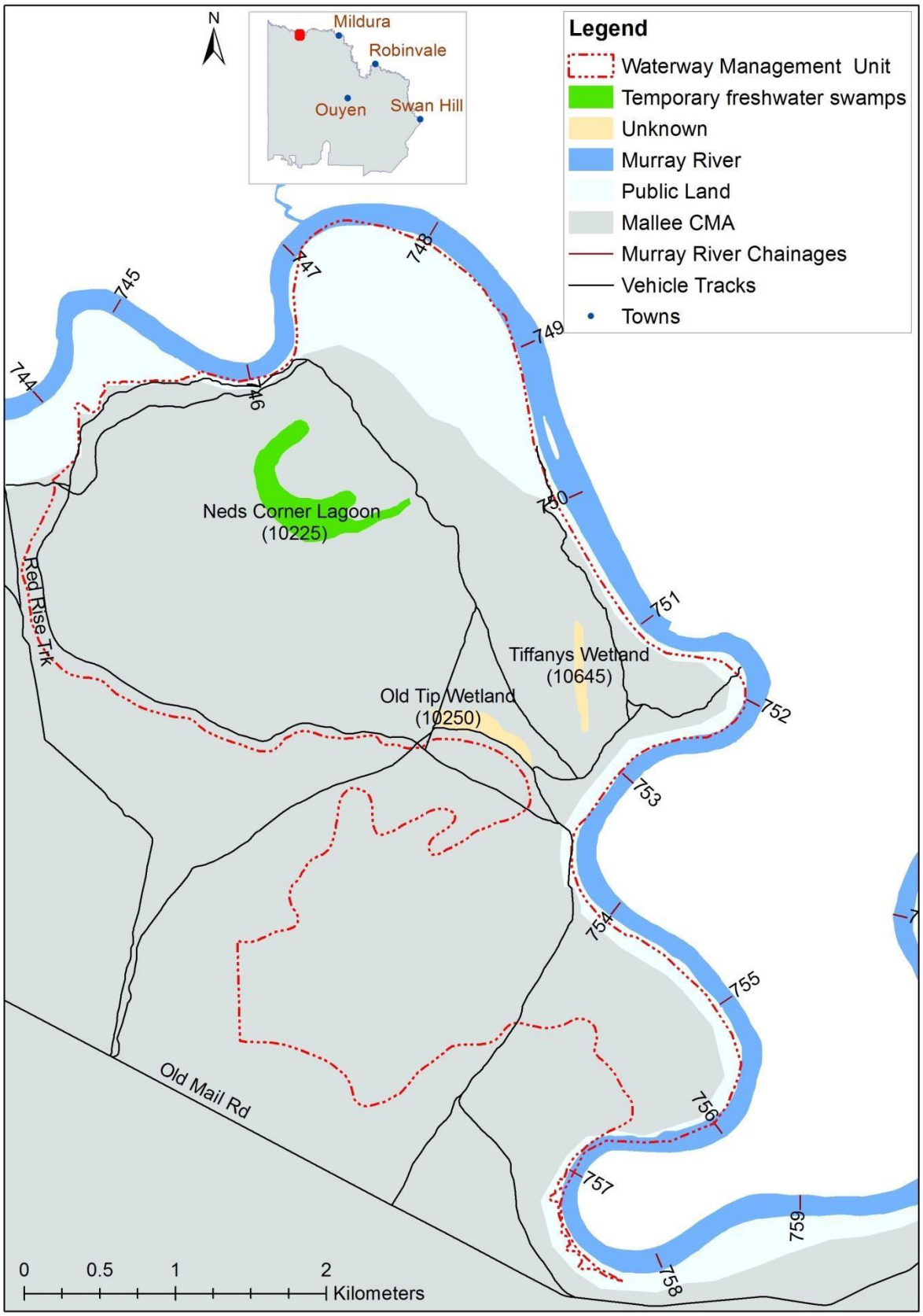

Figure 6. Neds Corner Wetlands

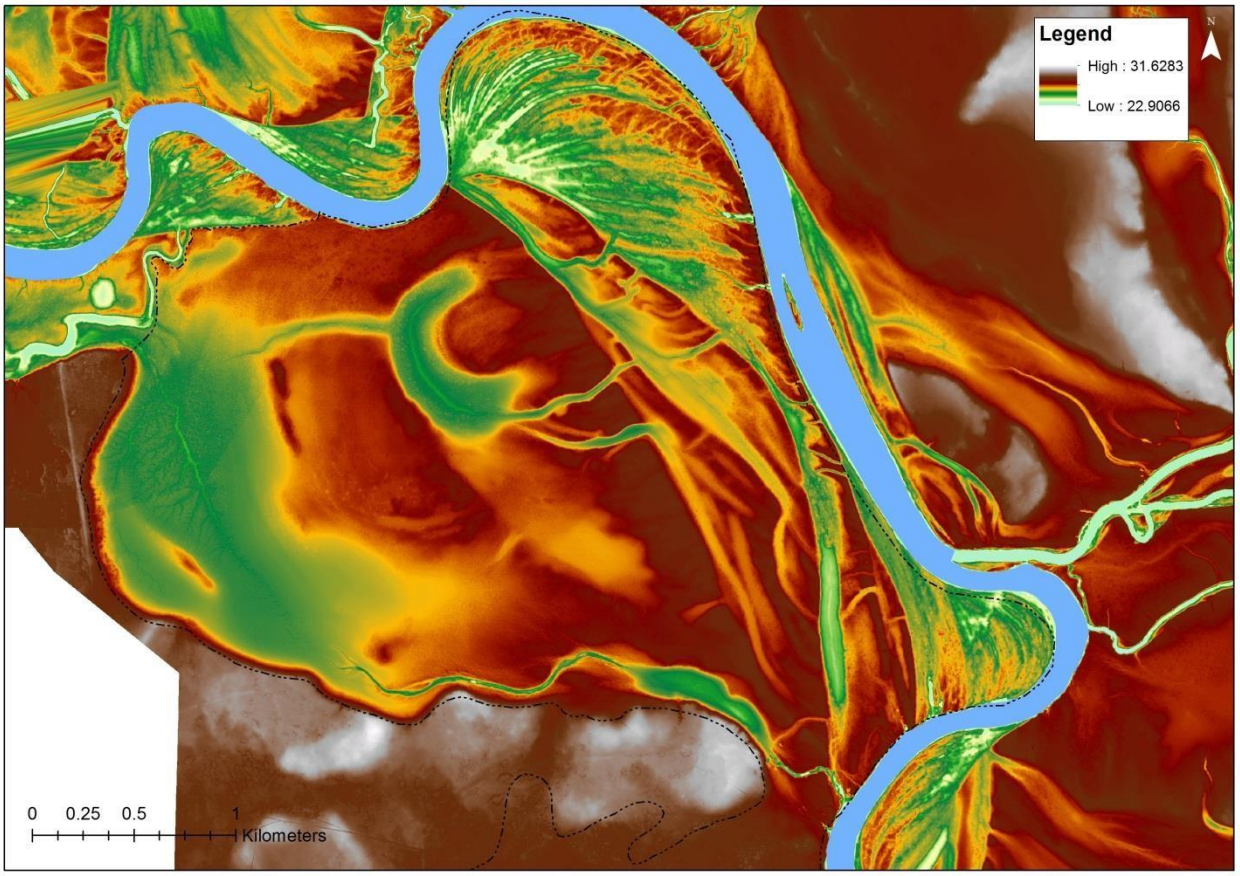

Figure 7a. Neds Corner LiDAR Imagery

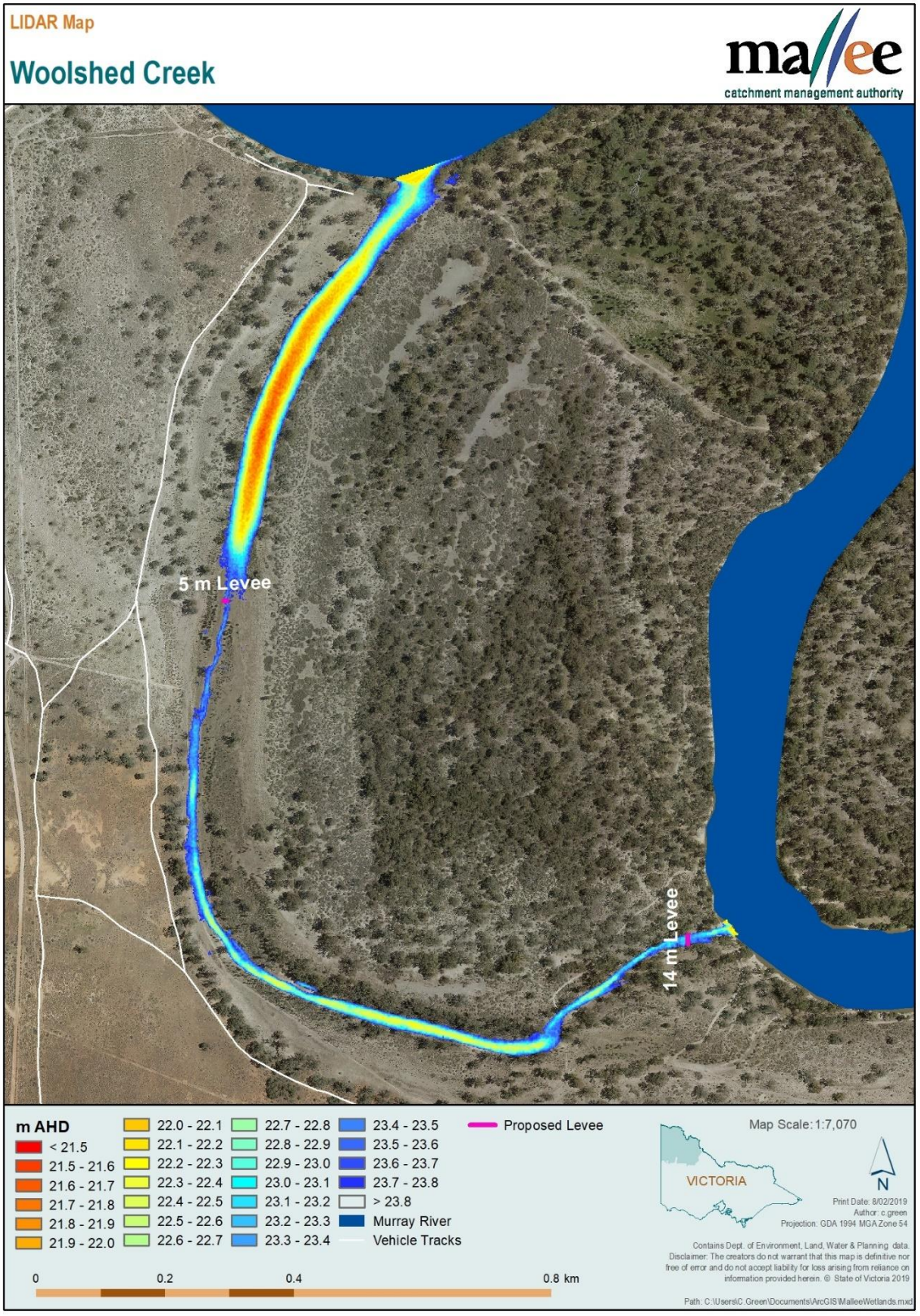

Figure 7b. Woolshed Creek LiDAR Imagery

2.6 Management Scale

The whole 1,435 ha at Neds Corner has a water requirement as a floodplain complex (Mallee CMA, 2014), but the focus for this plan is restricted to a target area of approximately 60 ha. The target area covers one wetland in Neds East, a wetland complex: Neds Central, and a one wetland Woolshed Creek. The proposed watering regime at the eastern end of the property currently has two components, because Neds East and Neds Central can be managed independently of each other. However the pumping point is the same for both areas: at approximately 753.5 river km via a natural effluent connection. Woolshed Creek is in a separate area at the far western end of the property which also requires pumped delivery via a natural connection at approximately ???? river km.

Environmental water will be pumped from the Murray River to Neds East and to Neds Central, with road raising to retain water within the wetlands. Approximately 100 ML of environmental water is proposed to be delivered to Neds East, and approximately 150 ML of water is proposed to be delivered to Neds Central. These volumes are based on experience from a previous environmental watering event during 2014/15. Delivery of environmental water is proposed to improve the Floodway Pond Herbland EVC within Neds East, and to reinstate the Lignum Swamp EVC in Neds Central. Woolshed Creek received its first environmental water delivery of 20ML in 2019.

Inundation with greater volumes of environmental water, and additional track raising would facilitate delivery to Wetland #10225 (see section 8.0).

Figure 8. Environmental water delivered in 2016 to Neds East.

2.7 Related Agreements, Policy, Plans and Activities

Neds Corner is situated on the Victorian floodplain of the Murray River. The river is the subject of a range management plans and studies including Salinity Management Plans, Flow studies and Land Conservation Council Reviews. In 2008 an investigation into River Red Gum Health by the Victorian Environmental Assessment Council (VEAC 2008b) resulted in a section of Neds Corner close to the Murray River being incorporated into the Murray Sunset National Park.

Neds Corner is within an area covered by the *Regional Riparian Action Plan* (DEWLP 2015A) and has the potential to attract future funding and works through that plan, which incorporates a range of actions to enhance the riparian habitat of Mallee waterways.

Neds Corner Station, of which Neds Corner sub-unit is part, is the largest private conservation property in Victoria (Trust for Nature, 2011). The property was formerly a sheep grazing property, and was purchased by Trust for Nature in 2002. Grazing was ceased, weed and rabbit control activities followed, along with revegetation works. Further work involved the removal of fences to facilitate wildlife movement. The property is now described as a "living university and an ongoing demonstration of conservation land management" (Trust for Nature, 2011).

The *Ned's Corner Conservation Action Plan* (Koch, 2011) identifies conservation assets at Neds Corner Station and guides future management through a process of analysing the health and threats to these assets to determine conservation objectives. The plan provides strategies and action steps to achieve the defined conservation objectives, as well as monitoring and evaluation regimes.

A Cultural Heritage Management Plan will be prepared based on an ongoing study of archaeological sites at Neds Corner Station. La Trobe University is currently operating a 'field school' to assess cultural heritage values at Neds Corner Station (Trust for Nature, 2011).

The *Mallee Waterway Strategy* (MCMA 2014) identifies Wetlands #10225 and #10250 as high and medium priority wetlands respectively within the Mulcra WMU. Long term Resource Condition Targets for the Mulcra WMU include (MCMA 2014):

- To improve the condition of riparian habitat associated with high and medium priority waterways by 2022.
- To improve the condition of aquatic habitat associated with high and medium priority waterways by 2022.
- To improve hydrology within high and medium priority waterways by 2022.
- To improve water quality within high and medium priority waterways by 2022.
- To increase the number of Cultural Heritage sites associated with priority waterways which are captured within registered management plans by 2022.
- To increase community understanding of, and participation in the management of, priority waterways by 2022

Further information on Management Activities can be found in the *Mallee Waterway Strategy 2014-22.*

Additional information on regional agreements, policies, plans and activities can be found in the *Context Document for Environmental Water Management Plans, Mallee CMA Region* (Sunraysia Environmental 2014).

3.0 Hydrology and System Operations

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

3.1 Water management and delivery

3.1.1 Pre-regulation

Prior to river regulation the wetlands and floodplain of Neds Corner were inundated under high river levels and retained water for a period of time after river levels fell, before eventually drying out. Natural flows were strongly seasonal with daily discharges highest in spring and lowest in autumn (Ecological Associates 2007b). The semi-permanent wetlands of the floodplain experienced inundation during high flow periods punctuated with drying phases on a regular basis. This inundation regime allowed for recruitment and preservation of floodplain flora and fauna species.

3.1.2 Post-regulation

In this part of the Murray River, the frequency, duration and magnitude of floods have been reduced due to effects of regulation and major storages in the Murray River and its tributaries. The mean flow volume at the South Australian border is 44% of the natural flow and periods of prolonged low flow are more frequent (Thoms et al, 2000, p 116).

Locks and Weirs were installed in this section of the river between 1926 and 1934 (Thoms et al, 2000, p.116). Neds Corner is located 7 km downstream of Lock 9. The hydrology for this reach of the Murray River can be broadly described in terms of the flow measured upstream of Lock 9 (river gauge 4260505). Flows of less than 10,000 ML/day are now more frequent in this part of the river. Flows of 55,000 ML/day, representing a magnitude sufficient to inundate Neds East and part of Neds Central now occur half as frequently as under natural conditions. Furthermore, flows large enough to reach Wetland #10225 now only occur 25% as often (Ecological Associates 2015).

The commence to flow (CTF) rates for wetlands in the target area have been identified as:

- 56,300 ML/day for Wetlands#10645 and #10250
- 122,500 ML/day for Wetland #10225

It has been approximated from LiDAR imagery that floodplain of Neds Central engages under Murray River flows of 100,000 ML/day.

3.1.3 Changes to frequency of wetland inundation at Neds Corner

Spells analysis undertaken by Gippel (2014) was consulted to better understand the frequency of inundation of the Neds Corner wetlands under post-regulation conditions (Figure 9). The percentage of years with the threshold event of 50,000 ML/day from pre-regulation to post-regulation (baseline) have significantly reduced (approximately 50 per cent), and the durations of these events are also significantly reduced. The interval between events has also increased. This is shown in Table 3.

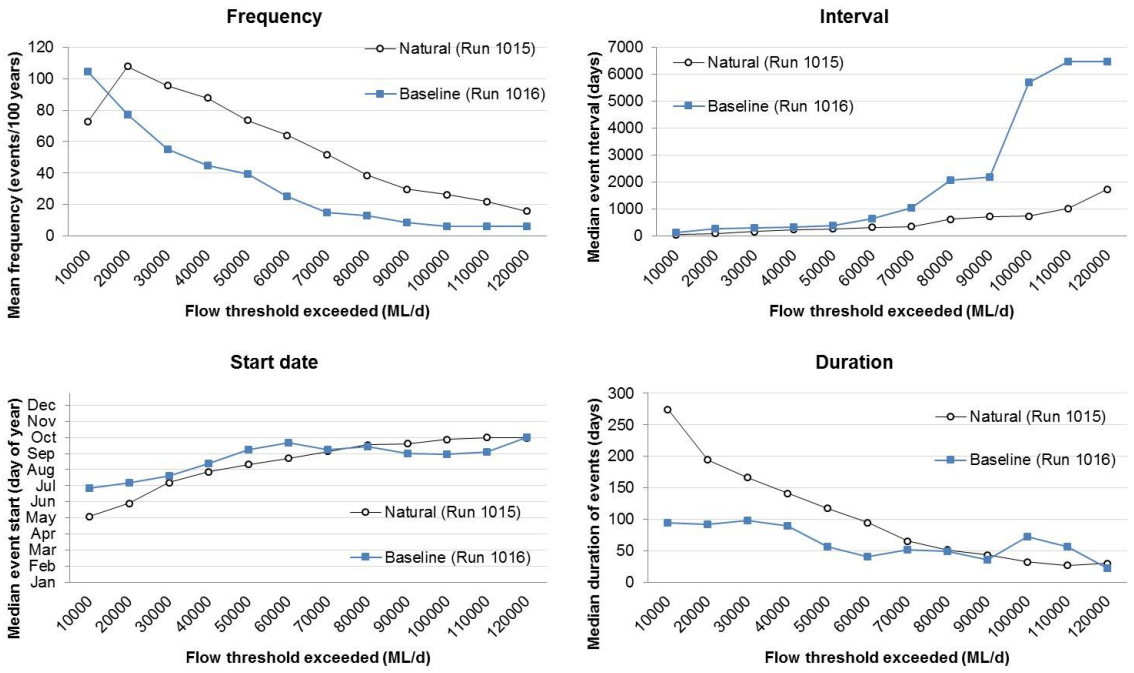

Figure 9. Comparison of Natural and Baseline Modelled Flow Scenarios for Lock 9 upstream (Gippel, 2014).

Table 3. Modelled natural and baseline flows for flow thresholds of 55,000 to 125,000 ML/d upstream of Lock 9

Natural (N)/ Baseline (B)	Threshold ML/d	Frequency Mean (events/ 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	55,000	7.11	296	104	20th Aug	74%
B	55,000	3.16	359	47	20th Sept	37%
N	125,000	1.05	1595	37	8th Sept	10%
B	125,000	0.35	4195	60	17th Oct	3%

3.1.4 Environmental watering

Neds Corner received environmental water in 2010, 2015, 2016 and 2019 (first delivery to Woolshed Creek) via a temporary pump on the Murray River located at an upstream connection point (Figure 21). The aim of these environmental watering events was to provide breeding and roosting habitat for colonial waterbirds as outlined in Table 4. Minor road raising was undertaken at several locations (Figure 21) to retain water within the target area. The target area could be expanded, with additional track raising, to a higher level and over a greater distance. The section titled Environmental Water Management Infrastructure discusses opportunities for future works.

An environmental water delivery event in 2010 was followed by a natural flood event spanning December 2010 to March 2011. Water was retained in the wetlands for more than twelve months, and had receded from the floodplain of Neds Central by May 2011.

Table 4. Previous environmental watering events at Neds Corner

Target Area	Timing	Volume (ML)	Duration
Woolshed Creek	Sep-Oct 2019	21	Allowed to recede naturally
Neds East	Sep-Oct 2019	98	Allowed to recede naturally
	Nov-Dec 2017	104	Allowed to recede naturally over approximately 4-6 months
	Autumn 2016	100	Allowed to recede naturally over approximately 4-6 months
	Autumn 2015	88	Allowed to recede naturally over approximately 4-6 months
	7 Dec 2010	171	Water remained until February 2012, supplemented by natural flood event
Neds Central	Sep-Nov 2019	149	Allowed to recede naturally
	Autumn 2016	150	Allowed to recede naturally over approximately 4-6 months
	Autumn 2015	125	Allowed to recede naturally over approximately 4-6 months
	26 Nov 2010	154	Water remained until December 2011, supplemented by natural flood event

Significant vegetation response was evident after the 2015 event, with a flourish of strong growth exhibited by Lignum located in the north of the Neds East target area (Figure 10).

Figure 10. Strong growth occurred at Neds East after the 2015 watering event. This image captured 11 April 2016.

Figure 11. A northern section of Neds East, after delivery of environmental water in Autumn 2016.

4.0 Water Dependent Values

4.1 Environmental Values

Wetlands and waterways on the floodplain are a vital component of the landscape. The habitat provided by vegetation communities around wetlands is essential to many water dependent fauna. 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.

A *Bush Blitz Species Discovery Program* was undertaken in 2011 across Neds Corner Station. Through this survey 884 species were identified, with up to 21 species constituting new to science records. Seven FFG listed fauna species and the nationally vulnerable Regent Parrot were recorded, as well as 73 threatened plant species, with the highest number recorded on sandy rises and broad depressions subject to seasonal flooding (*Bush Blitz Species Discovery Program: Neds Corner Station Victoria*, 2011). A report on the Bush Blitz program lists all species recorded. Key water dependent species are discussed in this plan.

4.2 Listings and Significance

4.2.1 Fauna

A list of native species recorded in the area was obtained by a recent search of the Victorian Biodiversity Atlas, Appendix 1, and a review of records collected by Trust for Nature (Trust for Nature, 2011). Of special interest and responsibility are the water dependent species and species that will benefit from delivery of environmental water that are listed in legislation, agreements or conventions shown in Table 5.

Table 5. Listed fauna recorded at Neds Corner

Common Name	Scientific Name	Type	International Agreements	EPBC Status	FFG Status	DEPI Status
Eastern Great Egret[#]	*Ardea modesta*	B	JAMBA	Mi, Ma	L	VU
Hardhead[#]	*Aythya australis*	B	NL	NL	NL	VU
Inland Dotterel[#]	*Charadrius australis*	B	NL	NL	NL	VU
Eastern Snake-necked Turtle	*Chelodina longicollis*	A	NL	NL	NL	DD
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*	B	NL	NL	NL	NT
De Vis' Banded Snake[#]	*Denisonia devisi*	R	NL	NL	NL	CE
Emu	*Dromaius novaehollandiae*	B	NL	NL	NL	NT
Red-naped Snake[#]	*Furina diadema*	R	NL	NL	L	VU
Diamond Dove[#]	*Geopelia cuneata*	B	NL	NL	L	NT
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	NL	Ma	L	VU

Common Name	Scientific Name	Type	International Agreements	EPBC Status	FFG Status	DEPI Status
Swift Parrot#	*Lathamus discolor*	B	NL	E	L	EN
Growling Grass Frog	*Litoria raniformis*	A	NL	V	L	EN
Rainbow Bee-eater	*Merops ornatus*	B	JAMBA	Mi	NL	NL
Southern Myotis#	*Myotis macropus*	M	NL	NL	NL	NT
River Snail#	*Notopala sublineata*	I	NL	NL	L	CE
Hanley's River Snail#	*Notopala sublineata hanleyi*	I	NL	NL	L	CE
Crested Bellbird	*Oreoica gutturalis gutturalis*	B	NL	NL	L	NT
Pied Cormorant	*Phalacrocorax varius*	B	NL	NL	NL	NT
Giles' Planigale*	*Planigale gilesi*	M	NL	NL	L	NT
Regent Parrot#	*Polytelis anthopeplus monarchoides*	B	NL	V	L	VU
Hooded Scaly-foot#	*Pygopus schraderi*	R	NL	NL	L	CE
Yellow-bellied Sheathtail-bat#	*Saccolaimus flaviventris*	M	NL	NL	L	DD
Little Broad-nosed Bat#	*Scotorepens greyii*	M	NL	NL	NL	NT
Fat-tailed Dunnart#	*Sminthopsis crassicaudata*	M	NL	NL	NL	NT
Apostle Bird#	*Struthidea cinerea*	B	NL	NL	L	NL
Lace Monitor#	*Varanus varius*	R	NL	NL	NL	EN

Legend
EPBC status: **N**ot **L**isted; **Mi**gratory; **Ma**rine, **V**ulnerable; **E**ndangered **FFG** status: **L**isted as threatened, **N**ot **L**isted
DELWP status: **EN**dangered; **VU**lnerable; **R**are; **N**ear **T**hreatened; **D**ata **D**eficient **Type**:
Mammal, **A**mphibian, **B**ird, **R**eptile, **I**nvertebrate

***Species are included as water dependent due to habitat requirements.**
 # Recorded at Neds Corner by Trust For Nature, but not listed in VBA records

These species are considered water-dependent because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list also includes the De Vis' Banded Snake (*Denisonia devisi*), the Giles' Planigale (*Planigale gilesi*) and the Hooded Scaly-foot (*Pygopus schraderi)* that are indirectly dependent on water as they live within floodplain woodlands and require vigorous groundcover

and fallen timber. These three species may benefit from enhanced vegetation condition, extent and diversity at Neds Corner.

De Vis' Banded Snake

The Dev Vis' Banded Snake (*Denisonia devisi*) is recorded in only a handful of locations in Victoria, and was first formally identified and described in the state in 2005 (Clemann, et al. 2007) from surveys conducted at Wallpolla Island and Mulcra Island. Listed as critically endangered in Victoria, this snake has been sighted at Neds Corner. An able swimmer, it is known to prey on frogs and prefers floodplain habitat, using cracks in the clay for shelter (Just 2010). Delivery of environmental water at Neds Corner may help increase the abundance of prey and improve the quality of physical habitat in the cracking clay soils.

Hooded Scaly-foot

The Hooded Scaly-foot, is a legless lizard that is critically endangered in Victoria. Neds Corner is one of only six known locations for this species recorded in Victoria (Brown & Potts 2013). Little is known about the ecology, habitat requirements or home range of this species although it appears to depend upon the burrows of large invertebrates for shelter and feeds on spiders and scorpions (Roberston & Canessa 2012). Although this species is not directly dependent on water, it does require ground cover and woody debris (MCMA 2011), making it indirectly dependent on water.

Giles' Planigale

The Giles' Planigale is a small marsupial recorded at 20 dispersed locations east of Lake Eyre. In Victoria its range may be limited to the floodplains of the Murray River downstream of the junction with the Darling River. It has been recorded in areas that have grey cracking soils in or near Black Box Woodlands, with patchy but dense understorey of Lignum (*Muehlenbeckia florulenta*), Nitre Goosefoot (*Chenopodium nitrariaceum*) or Old Man Salt Bush (*Atriplex nummularia*) (Sluiter & Robertson, cited in MCMA 2011A). The Giles' Planigale is predominantly nocturnal and preys on a range of invertebrates including spiders, cockroaches, beetles and slaters (Read, cited in DSE 2003). It is possible that the cracks in the floodplain soils are the single most important factor influencing the distribution of the Giles' Planigale in Victoria (MCMA 2011A).

Figures 12a/b. The soils in parts of Neds East exhibit significant shrink-swell characteristics, as evidenced in the top image, captured April 2016, with some cracks measuring 50 mm across. Water movement along these cracks was demonstrated, bottom image, during delivery at Neds East in Oct 2019. These soils may provide habitat for the near threatened Giles Planigale and the critically endangered De Vis' Banded Snake recorded at Neds Corner.

Microbats

At least fourteen species of bat have been detected on Neds Corner Station. Microbats are important in ecological processes such as seed dispersal and pollination (Medellin *et al.* 2000). In fact, Medellin and Gaona (1999, cited in Medellin *et al.* 2000) found that bats disperse more seeds than birds. Increased species diversity and abundance are indicators of undisturbed, or healthy, habitats (Medellin et al. 2000), as they occupy many trophic levels and have specialised diets and specific roosting and foraging habitats. Medellin et al (2000) suggests they can be a better indicator of ecological integrity than a group that occupies a single trophic level, such as vegetation or top order predators. Microbats on the Murray River floodplain can use Black Box Woodlands and roost in these hollow-bearing trees. Table 6 lists the species of bat recorded at Neds Corner Station and their roosting and foraging requirements. It is expected that delivery of environmental water to the target area at Neds Corner would improve foraging habitat and ecological productivity for bats, and, over the longer term, facilitate hollow provision by maintaining health of the Black Box overstorey within some of the target area.

Table 6. Bat species recorded on Neds Corner Station

Species	Scientific Name	Roost in Hollows?[#]	Foraging Zones[#]
Gould's Wattled Bat	*Chalinolobus gouldii*	✓	Below canopy, along edges of forests
Chocolate Wattled Bat	*Chalinolobus morio*	✓	Mostly between top of understorey and canopy
Little Pied Bat	*Chalinolobus picatus*	In trees	Chenopod shrublands, mallee, open dry forests
Inland Freetail Bat	*Mormopterus planiceps (sp. 2)*	✓	Above canopy
Inland Freetail Bat	*Mormopterus planiceps (sp. 3)*	✓	Open areas and over water
Southern Freetail Bat	*Mormopterus planiceps (sp. 4)*	✓	Ground, between trees and above canopy.
Southern Myotis	*Myotis macropus*	✓	Over water

Lesser Long-Eared Bat	*Nyctophilus geoffroyi*	✓ or under peeling bark	Ground, foliage and mid-air
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	✓	Above the canopy
Inland Broad-Nosed Bat	*Scotorepens balstoni*	✓	Up to 15 m above ground, but not above tree canopy, edge of forests
Little Broad-nosed Bat	*Scotorepens greyii*	✓	Edges of waterbodies
White-Striped Freetail Bat	*Tadarida australis*	In trees	Ground and above canopy.
Inland Forest Bat	*Vespadelus baverstocki*	✓	A wide area, woodlands, grasslands, shrublands
Southern Forest Bat	*Vespadelus regulus*	✓	Close to vegetation and understorey
Little Forest Bat	*Vespadelus vulturnus*	✓	Close to vegetation, upper levels, 3-8 m above ground, always below the canopy

(#Source: Mid Murray LAP 2009)

Waterbirds

Australia's waterbirds are often nomadic and take advantage of highly variable, and often temporary, aquatic resources. The distribution of temporary habitat patches throughout the landscape may facilitate movement and exploitation of available resources for waterbirds (Roshier et al. 2001). The provision of environmental water to wetlands is one method of creating such habitat patches for waterbirds, allowing them to move between suitable habitat to survive and reproduce (MDBA 2009).

Birdlife Australia has recorded waterbirds at Neds Corner Station including Ducks, Cormorants, Pelicans, Herons, Plovers, Swamphens and the Inland Dotterel (*Charadrius australis*). A mosaic of wetland habitats can influence waterbird diversity (Bancroft, Gawlik & Rutchey 2002). Providing environmental water to the different wetlands at Neds Corner can offer this important diversity of wetland depths and types. An important habitat component at Neds Corner is Lignum shrubland, which can be used for nesting by a range of waterbirds including Cormorants, Pelicans, and Spoonbills (Appendix 1). The vulnerable Hardhead (*Aythya australis*) is also known to utilise Lignum for nesting.

4.2.2 Vegetation Communities

Eight water dependent EVCs are identified within the target area (Table 7). Two EVCs are listed as Vulnerable within the Murray Scroll Belt bioregion. The bioregional conservation status of all water dependant EVCs in the target areas is shown in Table 7.

For a full list of EVCs within the Neds Corner area and details on each see Appendix 2. The EVCs in the target area at Neds Corner are illustrated in Figure 13.

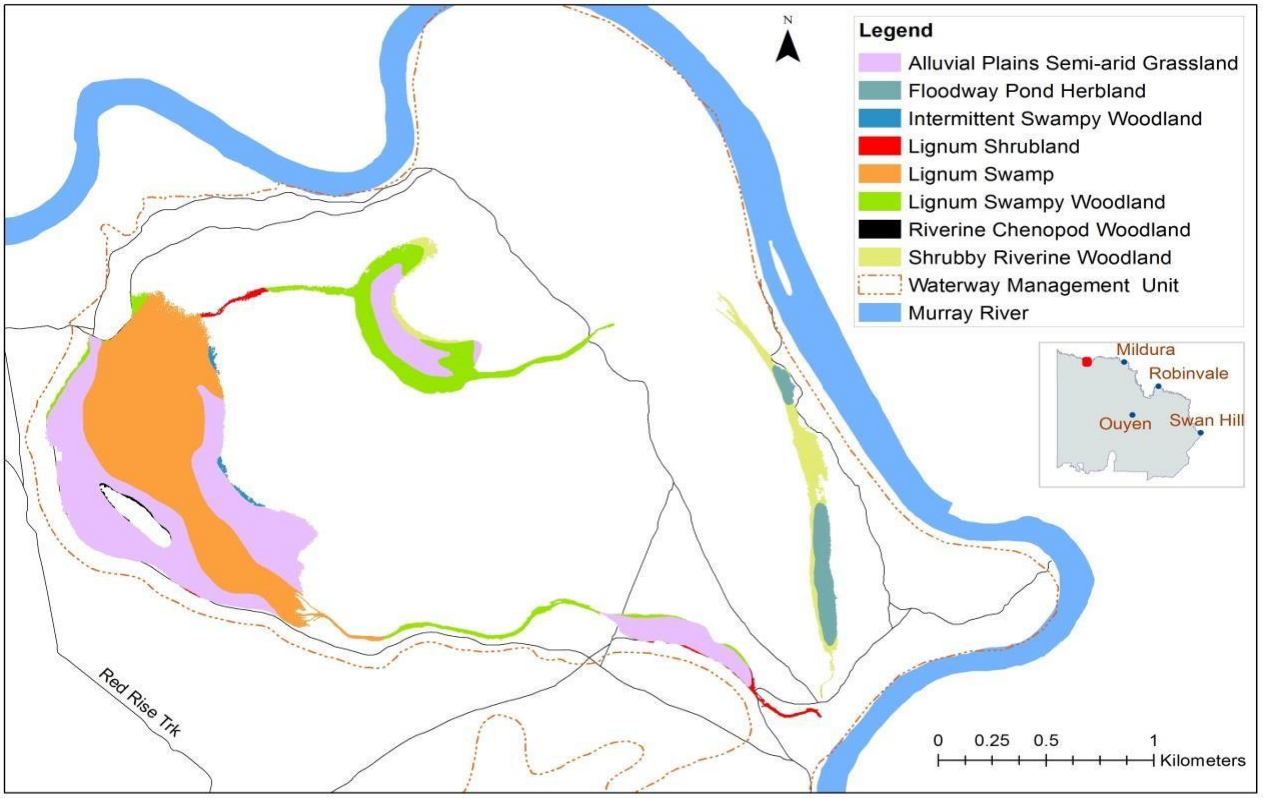

Figure 13a. Ecological Vegetation Classes (EVCs) in the target area at Neds Corner

Figure 13b. Ecological Vegetation Classes (EVCs) in the target area at Woolshed Creek

Table 7. Conservation status of water dependent EVCs at Neds Corner

EVC no.	EVC name	Bioregional Conservation Status Murray Scroll Belt Bioregion*	Area (ha)
103	Riverine Chenopod Woodland	Depleted	0.4
104	Lignum Swamp	Vulnerable	62.4
806	Alluvial Plains Semi-arid Grassland	Vulnerable	64.7
808	Lignum Shrubland	Depleted	19.2
810	Floodway Pond Herbland	Depleted	6.6
813	Intermittent Swampy Woodland	Depleted	0.8
818	Shrubby Riverine Woodland	Least Concern*	9.4
823	Lignum Swampy Woodland	Depleted	19.2

* The bioregional conservation status (BCS) of the wetland EVCs in this plan are based on expert advice but have not yet been formally approved by DELWP. In the case of Shrubby Riverine Woodland, no preliminary wetland BCS has been advised, consequently the terrestrial BCS has been applied.

Lignum Swamp covers much of the inundation area of Neds Floodplain. This typically treeless EVC is widespread in low rainfall areas that are subject to infrequent inundation (DSE, 2005). This EVC is dominated by Tangled Lignum, (*Muehlenbeckia florulenta)*, which becomes an extensive aquatic habitat for fish, reptiles and macroinvertebrates when inundated. It is also used as a nesting site by waterbirds, and as a feeding area by raptors, owls, and predatory reptiles (Ecological Associates, 2007a). The area mapped as Lignum Swamp in the target area is currently in poor health (Figure 14), although it is showing signs of recovery in response to the delivery of environmental water in 2015.

Figure 14. Lignum in the westernmost area of Lignum Swamp (Neds Central) appears to be responding well to environmental water delivery in 2015, with previous dieback exhibiting regrowth.

Also mapped in this target area is Alluvial Plains Semi-arid Grassland EVC. This EVC is defined as grassland to herbland, with only incidental shrubs including Tangled Lignum and Nitre Goosefoot. In response to flooding, opportunistic annual species occur. This EVC is generally located in lower lying areas of higher level terraces and along creek lines, and whilst it can tolerate prolonged dry periods, the composition may suffer invasion of terrestrial species without occasional flooding (DSE 2005). The natural flood frequency of this EVC is one in 2-15 years with a critical interval of 25 years and a minimum duration of 1.5-6 months (VEAC 2008a).

Lignum Swampy Woodland occurs on the fringes of the Alluvial Plains Semi-arid Grassland EVC. This EVC is dominated by Tangled Lignum, but also supports Eucalypt or Acacia woodland with River Red Gum and Black Box being the dominant tree species. This EVC would have experienced a flooding event once in 2-8 years under natural conditions, with a critical interval of 15 years between events. The recommended duration of ponding for Lignum Swampy Woodland is 2-4 months (VEAC, 2008).

Shrubby Riverine Woodland occurs in Neds East. River Red Gum dominates this EVC and older trees may provide hollows, offer nesting opportunities for Regent Parrot (*Polytelis anthopeplus*) and microbat species.

The shrub layer present in this EVC provides cover and forage habitat for reptiles and woodland birds. This EVC would have experienced frequent short inundation, with a flooding event 1-3 years in 5. The recommended ponding duration for Shrubby Riverine Woodland is less than one month (VEAC, 2008). Some very large old River Red Gum occur in the target area (Figure 15).

Figure 15. An excellent specimen, a very large old River Red Gum fringing the target area at Neds East.

Floodway Pond Herbland occurs in Neds East. This EVC is typically treeless, comprised of generally ephemeral species that germinate on drying mud, but is prone to invasion of Red Gum saplings if flood frequency and depth is inadequate (DSE 2005). Inundation 6-9 years in 10, with a critical interval of three years and ponding duration of 4-10 months is recommended (VEAC 2008a).

Lignum Shrubland is mapped in two small patches in the target area. It is comprised of sparse Tangled Lignum and/or Nitre Goosefoot with herbaceous or turf grassland rich in annual or ephemeral herbs and small chenopods. Inundation one year in four to ten, with a critical interval of 15 years and ponding of 2-4 months is recommended (VEAC 2008a).

Tangled Lignum (*Muehlenbeckia florulenta*), is considered to be the most significant floodplain shrub in mainland Australia due to its extensive distribution, local dominance and value as habitat (Roberts & Marston 2011). It is dominant or co-dominant in five EVCs mapped in the target area and has particular ecological value as a waterbird breeding habitat (Rogers & Ralph 2011). Wetland birds that breed over water, such as Egrets, use flooded Lignum shrublands (Ecological Associates 2007a) for resting and Pelicans, Cormorants and Spoonbills may use Lignum for nesting (Rogers & Ralph 2011). Furthermore, when Lignum is inundated it provides productive habitat for invertebrates, frogs and fish. During dry phases, healthy Lignum can provide shelter and forage habitat for woodland birds, reptiles such as the vulnerable Red-naped Snake (*Furina diadema*), the critically endangered De Vis' Banded Snake and

mammals such as the near threatened Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Giles' Planigale, all of which utilise cracking clay soils for shelter.

Two small areas of EVCs are mapped at the perimeter of the target area, comprising Intermittent Swampy Woodland and Riverine Chenopod Woodland. Although these EVCs appear in the map (Figure 13) they are located at higher elevations and are unlikely to be inundated by the proposed environmental watering.

Figure 16. Environmental water delivered to Wetland #10250, (Neds Central) Autumn 2016

4.2.3 Flora

Flora species listed in the various acts and agreements which have been recorded in the area at Neds Corner and may benefit from environmental water delivery are listed in Table 8. This list offers an indication of the floristic diversity within this sub-unit. A full list of flora at Neds Corner that has been recorded in the VBA is provided in Appendix 2.

Table 8. Listed flora species recorded at the site

Scientific Name	Common Name	EPBC Status	FFG Status	DELWP status
Spreading Angianthus	*Angianthus brachypappus*	NL	NL	VU
Silver Saltbush	*Atriplex rhagodioides*	NL	L	VU
Sand Brome	*Bromus arenarius*	NL	NL	R
Twining Purslane	*Calandrinia volubilis*	NL	NL	R
Riverina Bitter-cress#	*Cardamine moirensis*	NL	NL	R
Tall Sneezeweed#	*Centipeda pleiocephala*	NL	NL	EN

Desert Bindweed	*Convolvulus clementii*	NL	NL	VU
Darling Lily#	*Crinum flaccidum*	NL	L	VU
Native Couch#	*Cynodon dactylon* var. *pulchellus*	NL	NL	K
Twin-flower Saltbush	*Dissocarpus biflorus* var. *biflorus*	NL	NL	R
Bignonia Emu-bush#	*Eremophila bignoniiflora*	NL	L	VU
Bundled Peppercress	*Lepidium fasciculatum*	NL	NL	K
Native Peppercress	*Lepidium pseudohyssopifolium*	NL	NL	K
Leafless Bluebush	*Maireana aphylla*	NL	NL	K
Goat Head	*Malacocera tricornis*	NL	NL	R
Bush Minuria	*Minuria cunninghamii*	NL	NL	R
Smooth Minuria	*Minuria integerrima*	NL	NL	R
Tangled Copperburr	*Sclerolaena divaricata*	NL	NL	K
Poverty Bush	*Sclerolaena intricata*	NL	NL	VU
Black Roly-poly	*Sclerolaena muricata* var. *muricata*	NL	NL	K
Hairy Darling-pea#	*Swainsona greyana*	NL	L	EN
Desert Glasswort	*Tecticornia triandra*	NL	NL	R
Annual Spinach	*Tetragonia moorei*	NL	NL	K
Mallee Annual-bluebell	*Wahlenbergia tumidifructa*	NL	NL	R

Legend
EPBC status: **N**ot **L**isted **FFG** status: **L**isted as threatened, **N**ot **L**isted
DELWP status: **EN**dangered, **V**ulnerable, **R**are, Poorly **K**nown

*Possibly water dependent, found around lakes and watercourses, and could potentially be found around wetlands.
Recorded at Neds Corner by Trust For Nature

Several listed species in Table 8 are herbs or forbs that could be classed as water dependent in that they are floodplain species that are likely to respond to a flood event. The rare Riverina Bitter-cress (*Cardamine moirensis*) and the endangered Hairy Darling-pea (*Swainsona greyana*) are two such species recorded at Neds Corner that may germinate after inundation, possibly in the Floodway Pond Herbland EVC mapped in Neds East.

The target area is generally surrounded by an overstorey of River Red Gum (*Eucalyptus camaldulensis*) and Black Box (*Eucalyptus largiflorens*) with a mid-storey of Tangled Lignum (*Muehlenbeckia florulenta*). The close proximity of wetlands and woodlands at Neds Corner contributes to the habitat complexity and conservation significance of the site. When flooded, the woodland floor becomes an extension of the wetland habitat, thereby extending food and shelter opportunities for aquatic fauna (Ecological Associates

2006) such as frogs and waterbirds. They also provide important refuges for birds, reptiles and mammals, in the form of perches and nesting hollows.

Black Box woodland provides essential habitat and foraging opportunities for a range of species including microbats, De Vis' Banded Snake, and Red-naped Snake. Healthy Black Box vegetation helps provide important vegetative corridors to other areas above the floodplain for a range of transient native fauna such as the Regent Parrot. Black Box can tolerate a range of conditions from wet to dry (Roberts & Marston 2011), however, under extended periods of dry conditions trees will suffer a decline in health and eventually death (Ecological Associates 2007a).

Tangled Lignum, combined with other understorey species, offers shelter for a range of birdlife including nesting sites for waterbirds and cover for reptiles and small marsupials.

River Red Gums are the most widespread eucalypt tree in Australia, occupying riparian habitats along water courses and wetlands (Roberts & Marston 2011). Healthy River Red Gums contribute to the wetland ecosystem by depositing organic material, and fallen trees and branches provide structural habitat features for native fauna such as reptiles and microbats. Older trees can provide perching sites for birdlife, nesting sites for the White-bellied Sea-eagle, and hollows for the Regent Parrot and microbats. Healthy River Red Gum stands also provide flight paths for the Regent Parrot, linking to the Black Box woodlands access to higher elevation areas including mallee feeding grounds.

4.2.4 Wetland Depletion and Rarity

Neds Corner contains three wetlands. Only one of these has been classified using the Corrick-Norman wetland classification system: Neds Corner Lagoon is classified as Freshwater Meadow. This is the most significantly altered wetland type in the Mallee CMA Region since 1788 (MCMA 2006) (Table 9). Freshwater meadows are usually shallow (<0.2 m) and can have waterlogged soils for up to three months each year (Corrick & Norman 1980, p.8).

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).

Table 9. Changes in area of the wetlands in the target area by Corrick classification

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 Murray Scroll Belt
Freshwater Meadow	1	4.7	-43	-80	0

Source: DEPI Biodiversity interactive maps, Mallee Wetland Strategy (Mallee CMA 2006b)

4.2.5 Ecosystem Functions

Wetland ecosystems support distinctive communities of plants and animals and provide numerous ecosystem services to the community (DEPI 2005). Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These ecosystem functions include:

- Enhancing water quality through filtering sediments and re-using nutrients;
- Absorbing and releasing floodwaters;
- Providing organic material to rivers to maintain riverine food chains; and

- Providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds and fish.

Altered water regimes in the target area due to river regulation and sustained low flows in the Murray River have seen a decrease in the frequency of inundation in these floodplain wetlands and therefore a subsequent decrease in the ability for these wetlands to perform these valuable ecosystem functions.

4.3 Social

4.3.1 Cultural Value

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 freshwater sources.

Within the Mallee CMA region, the Murray River and its associated waterways were important habitation areas for multiple Aboriginal 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. Appendix 3 outlines the actions necessary if Aboriginal cultural heritage values are discovered during environmental water delivery activities.

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.

4.3.2 Cultural Heritage

In regard to Indigenous cultural values, Neds Corner Station has been the subject of several archaeological studies. The area and its surrounds are suggested to contain "one of the highest densities of Indigenous cultural objects and burial sites in Victoria" (Trust for Nature, 2011). In a current study extending to 2020, and funded by the Australian Research Council, researchers from La Trobe University have excavated sites at Neds Corner (Worthington 2014). Some cultural sites have been registered, and more may be identified in the future.

The broader region encompassing Wallpolla Island to the South Australian border is known to be rich in archaeological value. Bone fish hooks have been excavated on the floodplain, dating to 6,000 years ago.

Surveyed sites include middens, earth features, scarred trees, Aboriginal mounds and surface scatters. Surface scatters in this area may consist of chipped stone artefacts, animal bones, human remains/burials, shell, charcoal, hearth stones, clay balls and or ochre. Studies of hearths and middens suggest Indigenous inhabitants may fished in the river using nets, weirs, fish traps and spears tipped with bone or quartz (Trust for Nature, 2011).

Aboriginal people continue to have a connection to this country. There is no native title claim over this area but the Neds Corner region is recorded as an approximate boundary for the Latji Latji people to the east and the Ngintait westward (Tindale cited in Gange 2011), with the Yeri Yeri people also recognised in the area (Gange 2011). The local Indigenous community's totem species for this area is the Pelican.

European heritage reflects the pioneering history of the area. Captain Charles Sturt first passed through this area in the 1830s. A lease for Neds Corner Station was first registered in 1847, with the licence being transferred to pastoralist and agent Edward (Ned) Meade Bagot 1847 (Gange 2011, p.25; ANU 1969). The

run was named after a shepherd called Ned, who, it is thought, used part of the area to tend his sheep (Trust for Nature, 2011).

Between 1876 and 1920 Neds Corner was taken up by William Dundas Fisher, and James Francis Cudmore and William Barr Smith. In 1920 a consortium of returned soldiers formed the Ned's Corner Pastoral Company, which held the lease and gained freehold over some parts, until selling to the Kidman Pastoral Company in 1948 (Gange 2011, p.26). As part of the Kidman empire, irrigation was introduced to 121 hectares in 1955, and a manager's house and shearers quarters were constructed (Trust for Nature, 2011).

4.3.3 Recreation

The region is popular for fishing, picnicking, bird watching, camping, boating, barbequing and walking. Neds Corner station offers accommodation facilities for up to 30 people at any one time, offering the opportunity for members of the public to experience all that the 30,000 ha property has to offer, and providing easy access to the neighbouring Murray Sunset National Park.

4.4 Economic

The economic benefits of Neds Corner arise from the potential for conservation activities to introduce financial benefit to the local economy. Trust for Nature and its supporters conduct on ground activities and provide employment for a workforce that injects money into the local community without the need to farm the land and return an income from it. The accommodation facilities at Neds Corner station also provide economic benefits from tourism. Furthermore, with the property nestled between areas of national park, activities at Neds Corner that enhance the condition of the floodplain environment assist with connectivity between these reserved areas, enhancing the overall visitation value of the national park and potentially increasing tourism value.

4.5 Significance

The riparian and floodplain communities of the Murray River are important to the functioning of the river system and its sustainability. Neds Corner is a well-preserved and diverse floodplain system that includes important features of conservation significance.

The target area includes one of the most depleted wetland types in the Mallee CMA region, Freshwater Meadow. Significant floodplain fauna species are recorded including the Giles Planigale, Growling Grass Frog and De Vis' Banded Snake. At least fourteen bat species are known from Neds Corner, including three listed species. It is likely that these species will benefit from environmental water delivery to the target area with enhanced floodplain productivity, prey opportunities, and increased forage areas for those species known to forage over water.

Large areas of Lignum vegetation comprising vulnerable and depleted EVCs provide habitat for native fauna including waterbirds and frogs when inundated, and the Giles' Planigale when dry.

The large number of new species records gained from the Bush Blitz in 2011 indicates the potential for this site to maintain diverse flora and fauna. Its position between areas of National Park and a Living Murray Icon Site indicates its significance within the region. The conservation work implemented by Trust for Nature thus far may be enhanced by improving the health of the floodplain, increasing its potential to perform valuable ecosystem services within the wider region.

5.0 Ecological Condition and Threats

The Mallee River Health Strategy (MCMC 2006a) lists the degradation of riparian vegetation as a key threat in this area and notes the grazing that occurred in the past.

5.1 Current Condition

The waterbodies in the target area have not been assessed using the Index of Wetland Condition (IWC) developed by DELWP. This is noted as a knowledge gap to be addressed. The general condition of each of the three sites is broadly described, based on site visits in recent years.

Neds East has responded well to several years of environmental water delivery. Lignum stands have exhibited strong growth (Figure 10, page 18). Tree canopies and the wetland bed has showed signs of positive vegetative response within the woodland and herbland EVCs, with good coverage of herbs and forbs that dry off over the summer (cover image; Figure 17).

Figure 17. Tree canopies and herbland vegetation showing positive response to the 2019 watering event (photo captured 12 November 2019).

Woolshed Creek was initially viewed in November 2017 following the natural flooding in 2016. A positive vegetative response in both overstorey and understorey species was observed (Figure 18). The primary aim of the 2019 water delivery was to build on these outcomes.

Figure 18. Woolshed Creek displaying a good response in water-dependent vegetation following the natural floods of 2016, photo taken Nov. 2017.

Lignum dieback was apparent across the floodplain of Neds Central, with loss of some overstorey in 2016 (Figure 19a). This vegetation has shown marked improvement after several years of environmental water delivery and natural floods (Figure 19b). Grey cracking soils were evident in this location and herbs and forbs were also noted. Areas situated high on the floodplain continue to exhibit signs of drought impact, with nearby Black Box overstorey in very poor health.

Figure 19a/b. Lignum at Neds Central had suffered severely when observed in 2016 (left), but was exhibiting a strong evidence of growth in response to several years of environmental water delivery and natural floods (right).

5.2 Condition Trajectory

In the absence of environmental water delivery, the condition of the target area is expected to decline. Dry conditions will continue to impact already severely stressed vegetation, including key species like Lignum and Black Box. This will reduce the capacity of the target area to support important native terrestrial fauna and reduce nesting habitat for waterbird species. Furthermore, as a result of reduced frequency of inundation of the vulnerable Alluvial Plains Semi-arid Grassland EVC, invasion of terrestrial flora species is likely in this already at risk community. Loss of diversity within the Floodway Pond Herbland through reduced germination or invasion by terrestrial flora species will mean reduced cover and forage habitat for native terrestrial fauna.

However, all wetland areas initially visited in April 2016 exhibited strong potential for positive vegetative response to delivery of environmental water. Neds Central had clearly suffered from extended dry conditions, exhibiting the potential for loss of vegetation and loss of habitat for native fauna. The vegetation in these areas did however appear to be responding well to environmental watering in 2015, and are likely to benefit from future deliveries.

The reduced flooding duration and frequency in the target area will continue to impact the ecology of the wetland and creeks through:

- reduced organic matter recruitment;
- reduced suitable nesting and roosting sites for waterbird species that rely on flooded shrublands;
- lower capacity to provide nesting sites for hollow-dependent birds, reptiles, and bats;
- reduced understorey habitat and shelter for birds and reptiles; and
- limited food sources for all waterbird types, reptiles and amphibians through reduced condition and extent of floodplain vegetation

Without alterations to flow frequency and extent, the health of the ecosystem of Neds Corner is likely to suffer.

Figure 20. Neds Central, during environmental water delivery in 2016.

5.3 Water Related Threats

5.3.1 Changed water regime

The current altered water regime is considered the biggest threat for the target area and is the primary factor behind the development of this environmental water management plan.

The regulation of the Murray River has seen the water regime through Neds Corner altered. Flow events of the magnitude required to allow flows into the creeks and wetlands of the floodplain are less frequent and of shorter duration. This, combined with intermittent but extended dry periods over the last fifteen years, affects the vigour of the vegetation and places trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

5.3.2 Introduced Flora and Fauna

The Red Fox (*Vulpes vulpes)*, is a significant threat as a predator to many species of ground-nesting bird, opportunistically taking eggs from nests and preying on broods. Reptiles are preyed upon, and freshwater turtles (Thompson 1983) are threatened by nest predation. Although the fox is not a water related threat, it may have a substantial impact on water dependent ecological values at the site.

Similarly, the European Rabbit (*Oryctolagus cuniculus*) may pose a threat to biodiversity when water is applied. Rabbits can impact biodiversity through grazing on emerging vegetation and displacing native fauna through warren construction.

Feral pigs (*Sus scrofa*) are known to occur on the Murray River floodplain and may post an increased threat in the target area when water is applied. Feral pigs can uproot native vegetation and reduce capacity for recruitment due to soil disturbance. Pigs are also opportunistic feeders and have been known to predate lizards, snakes, frogs, turtles and turtle eggs (DPI NSW 2012).

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 propagules to spread and weeds to thrive and displace native vegetation. Weeds that may occur within the target area include Noogoora Burr (*Xanthium strumarium*), Bathurst Burr (*Xanthium spinosum*), African Boxthorn (*Lycium ferocissimum*) and Prickly Pear (*Opuntia* spp.). A list of exotic flora species identified at Neds Corner is provided in Appendix 1.

6.0 Management Objective

6.1 Management Goal

The overall goal for the Neds Corner target area reflects the values of the wetlands and the potential threats that need to be managed. This includes consideration of the values the wetlands have historically supported and the likely values they could support into the future.

The goal for the Neds Corner EWMP is to:

> *To provide a mosaic of intermittent wetlands that provide waterbird breeding and feeding habitat set within a productive floodplain system.*

Opportunities to protect the environmental values and improve conditions may be provided through environmental watering at this site.

6.2 Environmental Objectives

Environmental objectives represent the desired environmental outcomes of the site based on the management goal, above, as well as the key values outlined in the Water Dependent Values section. It is intended that EWMP objectives will be described in terms of the primary environmental outcomes, in most cases ecological attributes. The focus of the objectives should be on the final ecological outcomes and not the drivers per se.

During 2020, the environmental objectives (formally ecological objectives) undertook a refinement process with the intent of improving the specificity and measurability of the objectives through the development of targets, and to improve line of sight to the Basin Plan. While the process attempted to maintain the intent and integrity of the original objectives, it provided an opportunity to reassess the suitability of these objectives for the asset. The rationalisation, assessment of SMARTness, mapping to Basin Plan and update of each objective for Neds Corner can be found in Section 5.19.1 of Butcher et al. (2020).

6.2.1 Alignment to Murray-Darling Basin Plan

The primary environmental outcome of the Basin Plan is the protection and restoration of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin, with strengthened resilience to a changing climate. The MDBA is required to measure progress towards achieving the objectives of the Environmental Watering Plan (EWP) (Chapter 8 of the Basin Plan) by using the targets in Schedule 7 and having regard to the long-term average sustainable diversion limits, ecological objectives and ecological targets. These are set out in Long-Term Watering Plan's (LTWP), the Basin-wide Environmental Watering Strategy (BWS) and annual Basin environmental watering priorities.

6.2.2 Mapping of Environmental objectives to high level planning documents

As well as alignment with Basin Plan, the objectives have alignment with Basin-wide environmental Watering Strategy objectives and State level Long-term Watering Plan objectives. Table 10 maps the current EWMP objectives against these objectives to provide a line of sight.

Table 10. Table 10 - Mapping updated Neds Corner EWMP objectives to Basin Plan Environmental Watering Plan (EWP) objectives, Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) quantified environmental expected outcomes (QEEO) (MDBA 2019), and Long-term Watering Plan (LTWP) Victorian Murray objective (DELWP 2015).

EWMP objectives	Basin Plan EWP objective	Relevant Schedule 7 target	Relevant BWS QEEO	LTWP objective
NC1	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent vegetation Recruitment and populations of native water-dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species	B2.11	LTWPVM2
NC2	8.05,3(b)	Condition of priority asset - prevention of decline in native biota Condition of native water dependent vegetation	B2.8	LTWPVM5
NC3	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of water-dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - feeding, breeding, nursery	B2.10	LTWPVM8

6.2.3 Environmental objectives and targets

While every attempt has been made to make the following objectives and targets as complete as possible, there still remains gaps as critical information is not currently available. As such, baselines are not able to be set at this time. In the interests of moving forward, the objectives and targets have been written in a way (i.e. red highlighted text) that allows this information to be included at a later stage as this information becomes available.

Table 11. Updated ecological objectives for Neds Corner

Environmental objective	Target
NC1: By 2030, improve vital habitat at Neds East and Woolshed Creek, Ned's Corner by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	By 2030, increase diversity of native of macrophytes at Neds East and Woolshed Creek, Ned's Corner with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (submerged to partially emergent) (Ase) (no species recorded) • Seasonally immersed – low growing (Slg) (Native Couch *Cynodon dactylon var. pulchellus*, Rat-tail Couch *Sporobolus mitchellii*) • Seasonally inundated – emergent non woody (Sen) (Common Swamp Wallaby-grass *Amphibromus nervosus*) • Mud herbs (Muh) (Riverina Bitter-cress *Cardamine moirensis*, Tall Sneezeweed *Centipeda pleiocephala*, Large Mudwort *Limosella curdieana*, Mousetail *Myosurus australis*, Starry Goosefoot *Scleroblitum atriplicinum*,

	Annual Spinach *Tetragonia moorei*)
NC2: By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis) to sustain communities and processes typical of such communities at Neds East and Woolshed Creek, Ned's Corner	By 2030 a positive trend in the condition score of River Red Gum dominated EVC benchmarks at Neds East and Woolshed Creek, Ned's Corner asset at 80% of sites over the 10 year period OR By 2030, at stressed sites (see Wallace et al. 2020) at Neds East and Woolshed Creek, Ned's Corner: in standardised transects that span the floodplain elevation gradient and existing spatial distribution, ≥70% of viable trees will have a Tree Condition Index Score (TCI) ≥ 10
NC3: By 2030, improve condition and maintain extent from baseline levels of Lignum (*Duma florulenta*) to sustain communities and processes reliant on Lignum communities at Neds Central, Ned's Corner.	By 2030, condition in standardised transects that span the floodplain elevation gradient and existing spatial distribution at Ned's Central, Neds Corner ≥70% of Lignum plants in good condition with a Lignum Condition Score (LCI) ≥4.

6.3 Hydrological Objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives for the target area. The hydrological requirements to achieve the objectives are presented in Table 12.

The following hydrological objectives address the underlying ecological objectives for each site:

- Lignum is a dominant species in the EVCs mapped in Neds Central, Neds Corner Lagoon and Neds Floodplain. It can tolerate a wide range of wet and dry conditions. Flood requirements vary with frequencies of one to three years needed to maintain large shrubs with vigorous canopy, and flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but growth will decline and these plants do not accommodate nesting by birds. Durations of three to seven months is required to sustain vigorous canopy, but continuous flooding is detrimental. Although timing of flooding is not crucial for Lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts & Marston 2011). Natural flood timing will also promote fauna outcomes for feeding, shelter and breeding.
- The Alluvial Plains Semi-arid Grassland EVC also supports Lignum, however this EVC is dominated by grasses and is typically present at higher elevations and would have experienced inundation events less frequently than other EVCs within the target area. Flood frequencies of one in 2-15 years is recommended.
- Floodway Pond Herbland and Shrubby Riverine Woodland EVCs are found at Neds East and Woolshed Creek. Annual inundation will encourage germination, vegetative growth and/or reproduction (Rogers & Ralph 2011). It is suggested the natural duration may vary between one and eight months for Floodway Pond Herbland (DSE 2012) and less than one month for the woodland (VEAC 2008a). A variance in ponding duration is encouraged.

These water requirements have been used as a guide to develop the hydrological objectives for the Neds Corner target area. As little information exists as to the flood requirements of the various fauna species important to the target area, hydrological objectives have not been set for fauna species.

Table 12 Hydrological objectives for the Neds Corner target area

Ecological objective		Water management area	Hydrological Objectives									Average Total Volume per Event (ML)[1]
			Mean frequency of events (Number per 10 years)			Tolerable interval between events (years)		Duration of ponding (months)			Preferred timing of inflows	
			Min	Opt	Max	Min	Max	Min	Opt	Max		
With current infrastructure	**Improve** recruitment, diversity and productivity to meet EVC benchmarks in the Floodway Pond Herbland EVC (810) **Maintain** structure of Shrubby Riverine Woodland EVC (818)	**Woolshed Creek**	3	6	7	1	4	2	4	6	Spring	20
	Improve recruitment, diversity and productivity to meet EVC benchmarks in the Floodway Pond Herbland EVC (810) **Maintain** structure of Shrubby Riverine Woodland EVC (818)	**Neds East**	3	6	7	1	4	2	4	6	Spring	100
	Improve productivity of Lignum communities (EVCs 104, 808, 813, 823)	**Neds Central**	3	5	10	1	5	2	4	5	Spring	150
With proposed infrastructure	**Improve** floristic diversity to meet EVC benchmark for Alluvial Plains Semi-arid Grassland (806)	**Neds Central including Neds Corner Lagoon**	1	3	5	1	15	1.5	3	5	Spring	250

6.3.1 Water Management Regime

The wetland watering regime has been derived from the ecological and hydrological objectives. It is important to note that the target area consists of two management areas, one is a combination of Neds East and Neds Central (that can be watered independently), the second is Woolshed Creek.

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, however flexibility is encouraged in accordance with the minimum, maximum and optimal hydrological objectives in Table 12. The minimum objectives are likely to be provided during drought or dry periods, the optimum objectives during periods of average conditions and the maximum objectives during wetter periods.

The optimal, minimum and maximum watering regimes for each stage are described in the following pages. The extent of the target area inundated is also presented in Figure 21a/b. Due to the inter-annual variability of these estimates, particularly the climatic conditions, determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

It is proposed that delivery of environmental water to the target area will take place via the regime discussed below. Minor infrastructure modifications will need to be undertaken to expand the inundation area and are discussed fully in section 8. At the pump outflow point, erosion control measures are recommended (Figure 22).

Delivery under this regime would see Neds East and Woolshed Creek inundated to promote herbland diversity and help maintain the structure of the fringing woodland community. It would see water delivered to Neds Central to promote Lignum growth (Figure 21a/b).

Management Area	Water Regime	Inundation area, duration and frequency
Neds East and Woolshed Creek	**Minimum**	Inundate Neds East (100 ML) and Woolshed Creek (20ML) three times in ten years with a maximum interval of four years between events. Maintain water within the wetland for two months, allowing natural recession to maintain diversity of the Floodway Pond Herbland EVC.
	Optimal	Inundate Neds East (100 ML) and Woolshed Creek (20ML) six times in ten years with a maximum interval of four years between events. Maintain water within the wetland for four months, allowing natural recession to improve diversity of the Floodway Pond Herbland EVC.
	Maximum	Inundate Neds East (100 ML) and Woolshed Creek (20ML) seven times in ten years with a maximum interval of one year between events. Maintain water within the wetland for six months, allowing natural recession to improve diversity of the Floodway Pond Herbland EVC.
Neds Central	**Minimum**	Inundate Neds Central (150 ML). Deliver water three times in ten years with a maximum interval of five years between events. Maintain water within the wetlands for two months, allowing natural recession to maintain condition of the Lignum communities.
	Optimal	Inundate Neds Central (150 ML). Deliver water five times in ten years with a maximum interval of five years between events. Maintain water within the wetlands for four months, allowing natural recession to improve condition of the Lignum communities.
	Maximum	Inundate Neds Central (150 ML). Deliver water ten times in ten years with a maximum interval of one year between events. Maintain water within the wetlands for five months, allowing natural recession to improve condition of the Lignum communities.

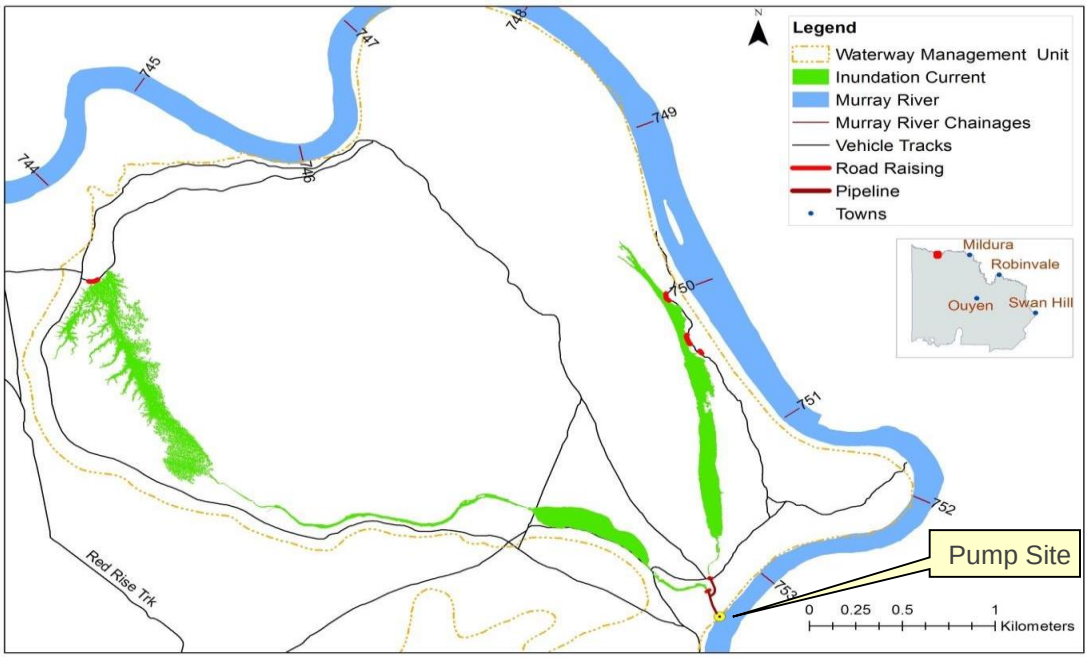

Figure 21a. Current inundation extents, Neds Central and East target areas

Figure 21b. Current inundation extent, Woolshed Creek target area

7.0 Managing Risks to Achieve Objectives

Delivery Plans will be developed for all wetland sites allocated environmental water. A broad risk assessment has been undertaken for the system to identify any major risks which would require mitigation measures; these are outlined in Table 14. The Risk Rating matrix in Table 13 has been

used to rate the risks in Table 14. Prior to delivering environmental water in any given season, these risks will be further refined as part of the Seasonal Watering Proposal and Environmental Water Delivery Plan process. These documents will provide a greater level of risk analysis and mitigation measures according to conditions observed closer to the proposed delivery (i.e. operational risks). The documents will also include detailed consideration of the impact of proposed mitigation measures on the likelihood and consequence of the risk occurring (residual risk) as this may change according to catchment conditions closer to the proposed delivery. They will clearly outline roles and responsibilities regarding risk management.

Table 13. Risk Rating

		Consequence				
Likelihood		Negligible 1	Minor 2	Moderate 3	Major 4	Extreme 5
	Almost Certain 5	Medium 5	Medium 10	High 15	High 20	High 25
	Likely 4	Low 4	Medium 8	Medium 12	High 16	High 20
	Possible 3	Low 3	Medium 6	Medium 9	Medium 12	High 15
	Unlikely 2	Low 2	Low 4	Medium 6	Medium 8	Medium 10
	Rare 1	Low 1	Low 2	Low 3	Low 4	Medium 5

Table 14: Environmental Water Delivery Risk Assessment

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	Residual Risk		
			Likelihoo	Consequen	Rating		Likelihoo	Consequen	Rating
Volume	1.0	Current recommendations on environmental flow inaccurate	Possible	Moderate	Medium	Base decisions on existing records and best available knowledge	Rare	Moderate	Low
Environment	2.1	Water fluctuation causes erosion/bank instability	Possible	Moderate	Medium	Monitor bank status at high risk locations such as the inlet channel of wetland #10250	Rare	Moderate	Low
	2.2	Water management promotes weed spread (e.g. Bathurst Burr, Noogoora Burr, African Boxthorn, Prickly Pear)	Possible	Moderate	Medium	• Liaise with land manager to control invasive weeds in vicinity • Monitor weed emergence after event	Rare	Moderate	Low
	2.3	Delivery promotes pest animal activity (pigs, foxes, rabbits)	Possible	Moderate	Medium	• Monitor pest animal activity • Liaise with landholder/land manager to control pest animal infestations • Align feral pig control with watering activities	Rare	Moderate	Low
	2.4	Red Gum saplings invade Neds East	Possible	Moderate	Medium	• Monitor germination after natural flood event • Consider and research delivery and retention of environmental water to inhibit Red Gum growth	Unlikely	Low	Low

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	Residual Risk		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Compliance	3.0	Environmental water account is overdrawn	Possible	Major	Medium	Ensure delivery contractor is aware of delivery volumes and adheres to delivery plan	Rare	Major	Low
	3.1	Environmental releases causes flooding of access tracks	Possible	Minor	Medium	• Construct track crossings above proposed maximum level of environmental watering • Consult with land manager to minimise impacts	Rare	Moderate	Low
Reputation	4.0	Unable to provide evidence in meeting ecological objective	Possible	Major	Medium	• Need to communicate ecological objectives • Ensure monitoring activities are undertaken • Establish monitoring framework	Rare	Moderate	Low
	4.1	Key stakeholders not supportive of environmental water release	Possible	Minor	Medium	Continue to engage with stakeholders and undertake communications	Rare	Moderate	Low

8.0 Environmental Water Management Infrastructure

8.1 Constraints

The existing arrangements limit the extent of area of floodplain which can be inundated by environmental watering in the Neds Corner target area to a total achievable inundation area of 50 ha. Currently at this extent water begins to break out through low points and returns to the Murray River rather than being held on the floodplain at higher levels.

8.2 Infrastructure and Complementary Works Recommendations

Extending the length and height of the existing track raising works would expand the inundation extent to a total of 171 ha (Figure 23). This area could be inundated in accordance with the hydrological objectives stated in Table 12, page 39, to promote diversity and limit the invasion of terrestrial species within the Alluvial Plains Semi-arid Grassland EVC.

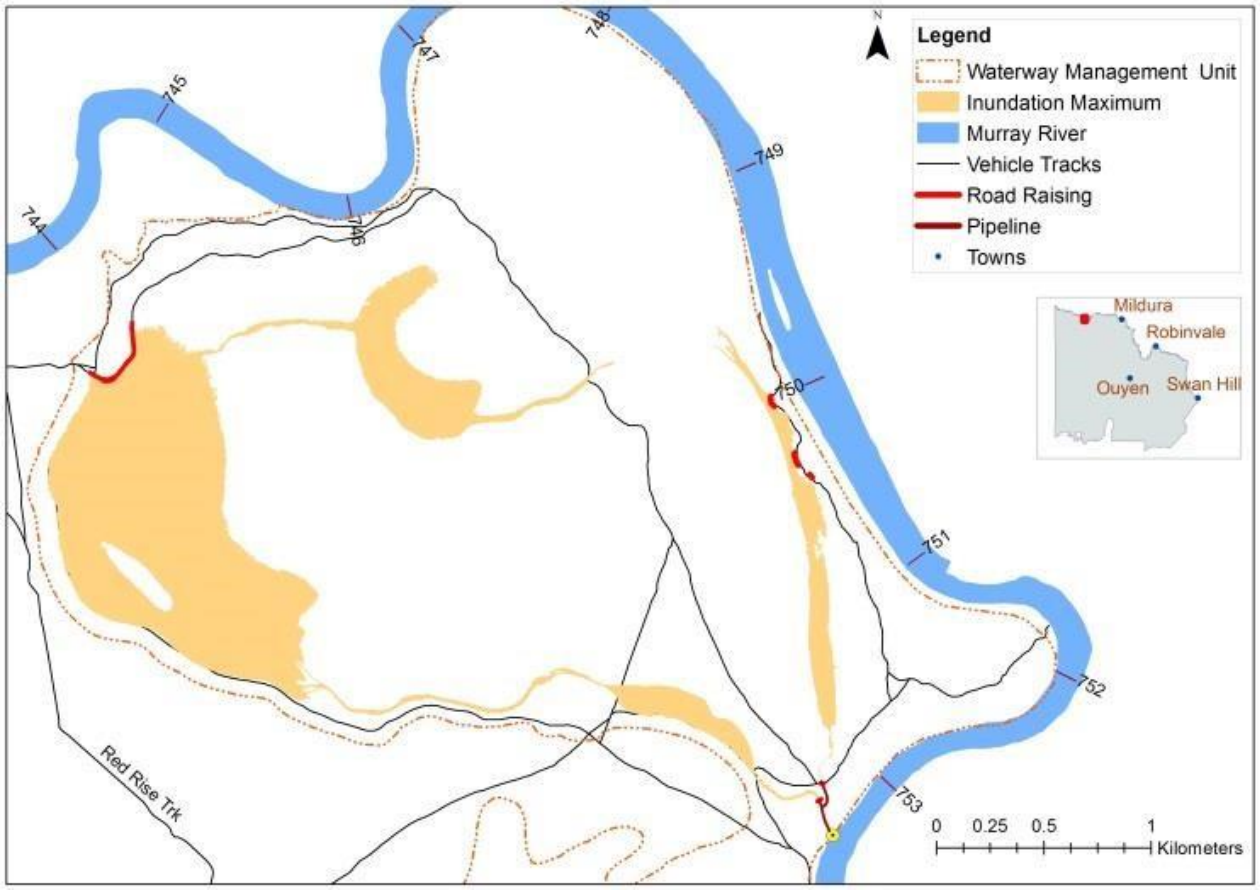

Figure 23. Maximum Inundation extent with additional track raising

9.0 Demonstrating Outcomes

9.1 Monitoring Priorities at the Site

Monitoring of the impact of water management events is proposed as outlined in Table 15. The monitoring events should include baseline and event-based monitoring.

Table 15. Proposed Monitoring for Neds Corner

Objective	Hypotheses	Indicator(s)	Frequency

Improve recruitment, diversity & productivity to meet EVC benchmarks in target area	Delivery of environmental water as per plan will improve vegetation diversity and condition	Photopoints IWC assessments	Every 2 years Every 5 years
Improve habitat value for waterbirds	Delivery of environmental water as per plan will improve aquatic and terrestrial vegetation structure and condition offering improved habitat condition and diversity for waterbird guilds	Bird Survey Vegetation Condition Monitoring	Three times each year, as per current regime Every 2 years
Improve habitat value for terrestrial fauna	Delivery of environmental water as per plan will support terrestrial fauna that is dependent on healthy shrubland vegetation as habitat	Terrestrial fauna surveys	Every 3 years

Photo point monitoring will be conducted before and after water management events at Neds Corner to measure the success of environmental watering in improving wetland and riparian vegetation communities.

Other incidental observations that may occur in the course of the monitoring methods above, such as visitation by waterbirds and other species to the wetlands during and after watering events, may be utilised.

Detailed monitoring of water management at Neds Corner would be dependent on funding from the State or Commonwealth governments.

10.0 Consultation

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, the landholder and the Department of Environment, Land, Water and Planning (DELWP). Table 16 outlines consultation undertaken in the development of this plan.

Table 16. Consultation Process for development of the Neds Corner WMU sub-unit Environmental Water Management Plan

Meeting date	Stakeholders	Details
Ongoing throughout plan development	Landholder (Trust for Nature)	Initial discussion to introduce concept of plan. Ongoing consultation regarding delivery events, monitoring and site access and plan development. Information on ecological values present.
TBA	Parks Victoria	Initial discussion to introduce concept of plan
TBA	Indigenous Groups	Face-to-face discussions/on-Country visits
TBA	Mallee CMA – Land and Water Advisory Committee	Preparation for environmental watering event

11.0 Knowledge Gaps and Recommendations

This plan is based on best information at the time of writing. In some cases this information is scarce or outdated. Further investigation and information collection will continue and the results of this further work will continue to build a better understanding of the site and add rigor to future planning. Some areas where further knowledge would be beneficial are outlined in Table 17. A cultural heritage management plan would be essential before any on ground works could be undertaken.

Table 17. Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Priority level	Responsibility
Importance of the site for waterbird breeding	Data collection and monitoring	1	Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA
Index of Wetland Condition Assessments	IWC assessments undertaken to establish baseline condition and inform future monitoring	2	

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Abbreviations and acronyms

AHD	Australian Height Datum
CAMBA	China-Australia Migratory Bird Agreement
CMAs	Catchment Management Authorities
CTF	Commence to Flow
DELWP	Department of Environment, Land, Water and Planning
EVC	Ecological Vegetation Class
EPBCA	Environment Protection and Biodiversity Conservation Act
EWMP	Environmental Water Management Plan
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray-Darling Basin Authority (formerly Murray-Darling Basin Commission, MDBC)
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement

Appendix 1: Flora and fauna species list

Flora – Native

Scientific Name	Common Name	Victorian Advisory List	Records
Acacia stenophylla	Eumong		1
Amphibromus nervosus	Common Swamp Wallaby-grass		1
Angianthus brachypappus	Spreading Angianthus	Vulnerable	1
Atriplex eardleyae	Small Saltbush		3
Atriplex leptocarpa	Slender-fruit Saltbush		7
Atriplex lindleyi	Flat-top Saltbush		5
Atriplex lindleyi subsp. *inflata*	Corky Saltbush		1
Atriplex nummularia	Old-man Saltbush		1
Atriplex rhagodioides	Silver Saltbush	Vulnerable	2
Atriplex vesicaria	Bladder Saltbush		2
Brachyscome lineariloba	Hard-head Daisy		6
Brachyscome spp.	Daisy		2
Bromus arenarius	Sand Brome	Rare	1
Bulbine semibarbata	Leek Lily		4
Calandrinia eremaea	Small Purslane		6
Calandrinia volubilis	Twining Purslane	Rare	2
Calotis hispidula	Hairy Burr-daisy		3
Centipeda thespidioides s.l.	Desert Sneezeweed		1
Chenopodium curvispicatum	Cottony Saltbush		2
Chenopodium nitrariaceum	Nitre Goosefoot		2
Convolvulus clementii	Desert Bindweed	Vulnerable	3
Crassula colorata	Dense Crassula		2
Crassula sieberiana s.l.	Sieber Crassula		2
Daucus glochidiatus	Australian Carrot		1
Disphyma crassifolium subsp. *clavellatum*	Rounded Noon-flower		2
Dissocarpus biflorus var. *biflorus*	Twin-flower Saltbush	Rare	2
Duma florulenta	Tangled Lignum		3
Einadia nutans	Nodding Saltbush		1
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush		1
Erodium crinitum	Blue Heron's-bill		2
Eucalyptus camaldulensis	River Red-gum		2
Eucalyptus largiflorens	Black Box		1
Euphorbia drummondii s.l.	Flat Spurge		2
Goodenia glauca	Pale Goodenia		8
Goodenia pusilliflora	Small-flower Goodenia		1
Hakea leucoptera subsp. *leucoptera*	Silver Needlewood		1
Harmsiodoxa blennodioides	May Smocks		1
Hyalosperma semisterile	Orange Sunray		2
Isoetopsis graminifolia	Grass Cushion		1

Lepidium fasciculatum	Bundled Peppercress	Poorly known	2
Lepidium pseudohyssopifolium	Native Peppercress	Poorly known	1

Scientific Name	Common Name	Victorian Advisory List	Records
Limosella curdieana	Large Mudwort		4
Maireana aphylla	Leafless Bluebush	Poorly known	2
Maireana appressa	Grey Bluebush		3
Maireana pyramidata	Sago Bush		2
Malacocera tricornis	Goat Head	Rare	3
Microseris sp. *3*	Yam Daisy		5
Minuria cunninghamii	Bush Minuria	Rare	1
Minuria integerrima	Smooth Minuria	Rare	1
Myosurus australis	Mousetail		3
Myriocephalus rhizocephalus	Woolly-heads		1
Nitraria billardierei	Nitre-bush		1
Osteocarpum acropterum var. *deminutum*	Babbagia		3
Osteocarpum salsuginosum	Bonefruit		1
Plagiobothrys elachanthus	Hairy Forget-me-not		3
Plagiobothrys plurisepalus	White Rochelia		3
Plantago cunninghamii	Clay Plantain		1
Plantago drummondii	Dark Plantain		2
Polycalymma stuartii	Poached-eggs Daisy		1
Ranunculus pentandrus var. *platycarpus*	Inland Buttercup		4
Rhagodia spinescens	Hedge Saltbush		1
Rhodanthe corymbiflora	Paper Sunray		1
Rhodanthe pygmaea	Pygmy Sunray		1
Scleroblitum atriplicinum	Starry Goosefoot		6
Sclerochlamys brachyptera	Short-wing Saltbush		1
Sclerolaena diacantha	Grey Copperburr		1
Sclerolaena divaricata	Tangled Copperburr	Poorly known	2
Sclerolaena intricata	Poverty Bush	Vulnerable	1
Sclerolaena muricata var. *muricata*	Black Roly-poly	Poorly known	2
Sclerolaena tricuspis	Streaked Copperburr		1
Senecio glossanthus s.l.	Slender Groundsel		4
Senecio spp.	Groundsel		2
Sida trichopoda	Narrow-leaf Sida		7
Spergularia brevifolia	Salt Sea-spurrey		7
Tecticornia tenuis	Slender Glasswort		2
Tecticornia triandra	Desert Glasswort	Rare	3
Tetragonia moorei	Annual Spinach	Poorly known	1
Teucrium racemosum s.l.	Grey Germander		4
Teucrium racemosum s.s.	Grey Germander		2

Thysanotus baueri	Mallee Fringe-lily		2
Wahlenbergia tumidifructa	Mallee Annual-bluebell	Rare	1
Wurmbea spp.	Early Nancy		1
Zygophyllum glaucum	Pale Twin-leaf		6
Zygophyllum iodocarpum	Violet Twin-leaf		1

Flora – Exotic

Scientific Name	Common Name
Alopecurus geniculatus	Marsh Fox-tail
Avena fatua	Wild Oat
Bromus rubens	Red Brome
Cotula bipinnata	Ferny Cotula
Erodium cicutarium	Common Heron's-bill
Erodium moschatum	Musky Heron's-bill
Herniaria cinerea	Hairy Rupture-wort
Lamarckia aurea	Golden-top
Mesembryanthemum nodiflorum	Small Ice-plant
Parapholis incurva	Coast Barb-grass
Pentameris airoides subsp. *airoides*	False Hair-grass
Sonchus oleraceus	Common Sow-thistle
Vulpia myuros	Rat's-tail Fescue
Hordeum murinum s.l.	Barley-grass
Silene apetala var. *apetala*	Mallee Catchfly
Silene spp.	Catchfly

Fauna – Native

Scientific Name	Common Name	Victorian Advisory List	Records
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		1
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		2
Acanthiza reguloides	Buff-rumped Thornbill		2
Acanthiza uropygialis	Chestnut-rumped Thornbill		1
Aegotheles cristatus	Australian Owlet-nightjar		1
Anas gracilis	Grey Teal		2
Anas superciliosa	Pacific Black Duck		4
Anhinga novaehollandiae	Darter		1
Anthus novaeseelandiae	Australasian Pipit		1
Aphelocephala leucopsis	Southern Whiteface		1
Barnardius zonarius barnardi	Mallee Ringneck		1
Cacatua sanguinea	Little Corella		2
Chalinolobus gouldii	Gould's Wattled Bat		1
Chenonetta jubata	Australian Wood Duck		1
Christinus marmoratus	Marbled Gecko		2

Climacteris picumnus victoriae	Brown Treecreeper (southeastern ssp.)	Near threatened	3
Colluricincla harmonica	Grey Shrike-thrush		1
Coracina novaehollandiae	Black-faced Cuckoo-shrike		3
Corcorax melanorhamphos	White-winged Chough		1
Corvus coronoides	Australian Raven		1
Cracticus torquatus	Grey Butcherbird		2
Dacelo novaeguineae	Laughing Kookaburra		2

Scientific Name	Common Name	Victorian Advisory List	Records
Dicaeum hirundinaceum	Mistletoebird		1
Diplodactylus tessellatus	Tessellated Gecko		1
Dromaius novaehollandiae	Emu	Near threatened	6
Egernia striolata	Tree Skink		1
Egretta novaehollandiae	White-faced Heron		2
Elseyornis melanops	Black-fronted Dotterel		2
Eolophus roseicapilla	Galah		2
Eulamprus quoyii	Eastern Water Skink		1
Falco peregrinus	Peregrine Falcon		1
Gehyra variegata	Tree Dtella		1
Geopelia striata	Peaceful Dove		2
Grallina cyanoleuca	Magpie-lark		1
Gymnorhina tibicen	Australian Magpie		1
Haliaeetus leucogaster	White-bellied Sea-Eagle	Vulnerable	2
Haliastur sphenurus	Whistling Kite		1
Heteronotia binoei	Bynoe's Gecko		1
Hieraaetus morphnoides	Little Eagle		1
Lichenostomus penicillatus	White-plumed Honeyeater		1
Macropus fuliginosus	Western Grey Kangaroo		1
Macropus rufus	Red Kangaroo		1
Malurus cyaneus	Superb Fairy-wren		1
Manorina flavigula	Yellow-throated Miner		1
Manorina melanocephala	Noisy Miner		1
Melithreptus brevirostris	Brown-headed Honeyeater		1
Menetia greyii	Grey's Skink		1
Merops ornatus	Rainbow Bee-eater	JAMBA	1
Milvus migrans	Black Kite		1
Morethia boulengeri	Boulenger's Skink		1
Ninox novaeseelandiae	Southern Boobook		1
Nyctophilus geoffroyi	Lesser Long-eared Bat		1

Nymphicus hollandicus	Cockatiel		1
Ocyphaps lophotes	Crested Pigeon		3
Oreoica gutturalis gutturalis	Crested Bellbird	Near threatened	1
Pachycephala rufiventris	Rufous Whistler		1
Pardalotus striatus	Striated Pardalote		2
Pelecanus conspicillatus	Australian Pelican		1
Petrochelidon neoxena	Welcome Swallow		3
Petrochelidon nigricans	Tree Martin		2
Petroica goodenovii	Red-capped Robin		2
Phalacrocorax carbo	Great Cormorant		1
Phalacrocorax sulcirostris	Little Black Cormorant		2
Scientific Name	**Common Name**	**Victorian Advisory List**	**Records**
Phalacrocorax varius	Pied Cormorant	Near threatened	9
Philemon citreogularis	Little Friarbird		1
Planigale gilesi	Gile's Planigale	Near threatened	5
Platalea flavipes	Yellow-billed Spoonbill		1
Platycercus elegans	Crimson Rosella		1
Plectorhyncha lanceolata	Striped Honeyeater		3
Podargus strigoides	Tawny Frogmouth		1
Psephotus haematonotus	Red-rumped Parrot		1
Rhipidura leucophrys	Willie Wagtail		1
Smicrornis brevirostris	Weebill		1
Sugamel niger	Black Honeyeater		1
Todiramphus sanctus	Sacred Kingfisher		1
Vespadelus regulus	Southern Forest Bat		1
Vespadelus vulturnus	Little Forest Bat		1

Fauna – Exotic

Scientific Name	Common Name
Capra hircus	Goat
Felis catus	Cat
Mus musculus	House Mouse
Oryctolagus cuniculus	European Rabbit
Passer domesticus	House Sparrow
Vulpes vulpes	Red Fox

Appendix 2: Ecological vegetation classes

Description of each EVC in the Neds Corner WMU sub-unit

EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Scroll Belt	
103	Riverine Chenopod Woodland	Depleted	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
104	Lignum Swamp	Vulnerable	Typically treeless shrubland to 4 m tall, with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall areas on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.
806	Alluvial Plains Semi-arid Grassland	Vulnerable	Grassland / herbland - variable according to seasonal conditions and site-wetness, mostly < 0.2 m. The potential dominant, *Sporobolus mitchellii,* is a species with warm season growth, with vigour and performance flood-promoted, but apparently not emergent until after flood recession.
808	Lignum Shrubland	Depleted	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.
813	Intermittent Swampy Woodland	Depleted	Eucalypt (- Acacia) woodland with (variously shrubby) rhizomatous sedgy - turf grass understorey, at best development dominated by flood-stimulated species in association with flora tolerant of inundation. The floristics are variable and often appear modified as a consequence of disturbance. Riverine floodplains of north-west and lake verges of Wimmera and southern Mallee.
818	Shrubby Riverine Woodland	Least Concern (Terrestrial BCS)	Eucalypt woodland to open forest to 15 m tall of less flood-prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often conspicuous. Dominant tree species; *Eucalyptus largiflorens Eucalyptus camaldulensis*

EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Scroll Belt	
823	Lignum Swampy Woodland	Depleted	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.

Appendix 3: 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.

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;
- A separate contingency plan has been developed in the event that suspected human remains are discovered during the conduct of the activity.

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**