1.0 Introduction:

1.1 Backgorund

Chinaman's Island is a nature reserve on the edge of Yarrawonga managed by a Section 86 Committee of Moira Shire – The Yarrawonga Eastern Foreshore Committee. A feature of the area is that it encompasses a shallow lagoon bordered by an area known as 'the wetland', more accurately described as a 'sedgeland'. However, this 'sedgeland' area, of approximately 1 Hectare, is now higher than the surrounding lake, and water is not fed in to the area and does not stay there after rain. It is also heavily infested with weeds.

The lagoon area, adjacent to the sedgeland, is a haven for flora and fauna. The Yarrawonga Eastern Foreshore Committee has campaigned for a 'No Boating Zone' to be declared to protect the area. In 2016 GMW/NSW Maritime designated a 'No Power Boat Zone' in the lagoon which is marked by signs and a series of buoys.

1.2 Project Scope

The Yarrawonga Eastern Foreshore Committee engaged Rakali Ecological Consulting to provide advice on:

- The current state of the 'sedgeland'
- Viable options for having some or all of the sedgeland 'wet' for some or all of the year
- Approximate estimates of the costs involved
- Description of the public benefit that could ensue
- Details of fauna and flora that could benefit from the long-term project
- Maintaining the ecological values of the lagoon area
- How the ecological values of the lagoon might be improved
- Protecting the lagoon area from potential threats.

2.0 Methods:

2.1 Wetland vegetation survey and condition assessment

The study area was surveyed on the 21st of December 2016. A list of plant species occurring in and directly adjacent the wetlands of the study area was compiled (see Appendix 1), and the Ecological Vegetation Classes (EVCs) of the area determined using "A field guide to Victorian Wetland Ecological Vegetation Classes for the Index of Wetland Condition" (DSE 2012a).

Wetland condition was assessed per the standard methodology used to determine wetland condition in Victoria; the Index of Wetland Condition (IWC) (DEPI 2013a).

2.2 Nomenclature

Nomenclature in this report follows the Flora Information System (Viridans 2013a), with consideration to the Census of Victoria Vascular Plants (Walsh and Stajsic 2007). An asterisk (*) denotes exotic species and a hash sign (#) denotes indigenous species that may occur outside of their natural range. Fauna taxonomy follows the Victorian Fauna Database (Viridans 2013b). The conservation status of threatened flora and fauna are presented as they are recognised under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Flora and Fauna Guarantee Act 1988* (FFG Act) and the Department of Sustainability and Environment rare or threatened species advisory lists (DSE 2005; DSE 2009; DSE 2013a).

2.3 Conservation Status

Throughout this report reference is made to the conservation status of indigenous flora and fauna. The following summary explains the meaning of the terms used to describe conservation status;

Table 1 Flora Conservation Status

Flora Conservation Status in Australia	
National conservation status is based on the **Environment Protection and Biodiversity Conservation Act 1999** (EPBC Act) list of taxa considered threatened in Australia. The categories for currently listed Victorian taxa are as follows:	
EX	**Extinct:** A taxon is extinct when there is no reasonable doubt that the last individual of the taxon has died.
CR	**Critically Endangered:** A taxon is critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
EN	**Endangered:** A taxon is endangered when it is not critically endangered but is facing a very high risk of extinction in the wild in the near future.
VU	**Vulnerable:** A taxon is vulnerable when it is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future.
Flora Conservation Status under the Flora and Fauna Guarantee Act 1988	
This column provides information on the listing status under the provisions of Part 3 of the **Flora and Fauna Guarantee Act 1988 (FFG Act 1988)**. A taxon may be listed as threatened if it has been nominated, assessed by the Scientific Advisory Committee and approved by the Minister for Environment. Any person may make a nomination for listing. This information is accurate as at December 2004. For the most up-to-date listings under the Act, refer to the following web site: http://www.dse.vic.gov.au	
L	Listed as threatened
N	Nominated for listing as threatened

I	Rejected for listing as threatened; taxon invalid or ineligible
D	Delisted as threatened under the FFG Act
X	Nominated but rejected.
Flora Conservation Status in Victoria – Advisory List (DSE 2005)	
Department of Sustainability and Environment (2005) Advisory List of Rare or Threatened Plants in Victoria - 2005. Victorian Department of Sustainability and Environment, East Melbourne, Victoria. This advisory list is not a statutory list of threatened taxa. There are no legal requirements or consequences that flow from inclusion of a species in this advisory list.	
x	**Presumed Extinct in Victoria:** not recorded from Victoria during the past 50 years despite field searches specifically for the plant, or, alternatively, intensive field searches (since 1950) at all previously known sites have failed to record the plant.
e	**Endangered in Victoria:** at risk of disappearing from the wild state if present land use and other causal factors continue to operate.
v	**Vulnerable in Victoria:** not presently endangered but likely to become so soon due to continued depletion; occurring mainly on sites likely to experience changes in land-use which would threaten the survival of the plant in the wild; or, taxa whose total population is so small that the likelihood of recovery from disturbance, including localised natural events such as drought, fire or landslip, is doubtful.
r	**Rare in Victoria:** rare but not considered otherwise threatened - there are relatively few known populations or the taxon is restricted to a relatively small area.
k	**Poorly Known in Victoria:** poorly known and suspected, but not definitely known, to belong to one of the above categories (x, e, v or r) within Victoria. At present, accurate distribution information is inadequate.

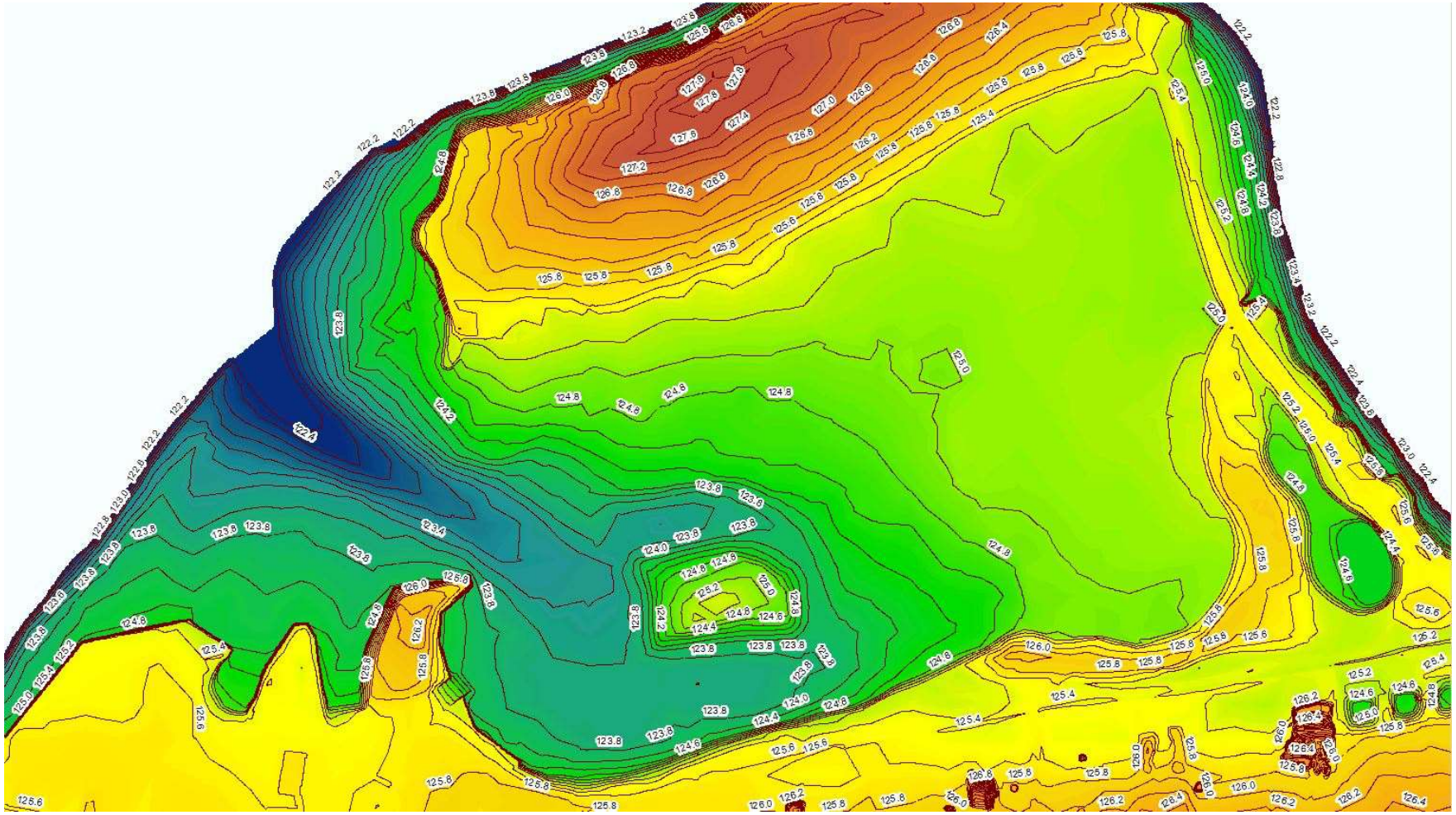
3.0 Results:

Ecological Vegetation Classes (EVCs)

In Victoria vegetation types are currently defined as EVCs. An EVC is an identifiable assemblage of plant species that grow together under a specific set of environmental conditions, such as soil type, altitude, aspect and hydrology.

The wetland EVCs present at Chinamans Island are Billabong Wetland Aggregate in the "Lagoon" area (which occurs below the level of 124.8 AHD on figure 1) and Plains Sedgy Wetland in the "Wetland" area (which occurs between 125.3 AHD and 124.8 AHD)- see figure 1.

Figure 1 The map on the following page shows the bathymetry of the area south of Chinaman's Island



3.1 Plains Sedgy Wetland (EVC 647)

This EVC is sedge dominated wetland vegetation of lowland plains, with a conspicuous and potentially diverse herbaceous component, including species characteristically associated with wet sites on fertile soils.

At Chinaman's Island this EVC is dominated by Poong'ort (*Carex tereticaulis*)- see photograph 1. The diversity and abundance of native herbaceous species within this EVC is uncharacteristically low, consisting of small, scattered patches of Upright Milfoil (*Myriophyllum crispatum*), Poison Pratia (*Lobelia concolor*), Slender Knotweed (*Persicaria decipiens*) and Shield Pennywort (*Hydrocotyle verticilata*). Native grasses of this EVC include Common Blown-grass (*Lachnagrostis filifolia* s.l) and Mat Grass (*Hemarthria uncinata*).

Photograph 1 Plains Sedgy Wetland dominated by Poong'ort (Carex tereticaulis), Chinaman's Island

Several weed species have invaded this EVC at Chinamans Island. On the drier verges the most significant weeds include Toowoomba Canary-grass (**Phalaris aquatica*) and Paspalum (**Paspalum dilatatum*)- see photograph 2. In lower-lying areas weeds including Celery Buttercup (**Ranunculus scleratus*), Drain Flat-sedge (*Cyperus eragrostis), Yellow Marsh-cress (**Rorripa palustris*) and Marsh

Ludwigia (**Ludwigia palustris*) indicate that the hydrology of this EVC has been altered by the flooding of Lake Mulwala.

*Photograph 2 Plains Sedgy Wetland invaded on drier verges by Toowoomba Canary-grass (*Phalaris aquatica) and Paspalum (*Paspalum dilatatum), Chinaman's Island*

Photograph 3 The introduced Marsh Ludwigia (Ludwigia palustris) with pointed leaves on left, compared with the indigenous Clove-strip (Ludwigia peploides subsp. montevidensis) with rounded leaves on right, Chinaman's Island

Using the IWC the Plains Sedgy Wetland at Chinaman's island scores 13/20, indicating it is in moderate condition.

Critical lifeforms Groups Score: 17.5/25- moderate

Weeds Score: 12/25- poor (high threat weeds include **Phalaris aquatica, *Paspalum dilatatum, *Cyperus eragrostis* and **Ludwigia palustris*)

Indications of Altered Processes Score: 10/25- poor (severely altered hydrology has changed species composition)

Vegetation Structure and Health Score: 25/25- excellent

3.2 Billabong Wetland Aggregate

Billabong Wetland Aggregate is a collective label for the various zones of vegetation associated with lagoons/billabongs on flood-plains. Recognizable components of Billabong Wetland Aggregate include Aquatic Herbland (EVC 653), Aquatic Sedgeland (EVC 308), Tall Marsh (EVC 821), Dwarf Floating Aquatic Herbland (EVC 949) and Floodway Pond Herbland (EVC 801).

At Chinaman's Island this aggregate is made up of Tall Marsh which is dominated by Common Reed (*Phragmites australis*), Broad-leaf Cumbungi (*Typha orientalis*), Narrow-leaf Cumbungi (*Typha domingensis*) and Marsh Club-rush (*Bolboschoenus medianus*), Aquatic Herbland which is dominated by Robust Milfoil (*Myriophyllum papillosum*), Clove-strip (*Ludwigia palustris*) and Furrowed Pondweed (*Potamogeton sulcatus*), Submerged Aquatic Herbland which is dominated by Eel Grass (*Vallisneria americana var. americana*) and a fringing Floodplain Riparian Woodland dominated by River Red Gum (*Eucalyptus camaldulensis subsp. camaldulensis*).

The most significant weeds of this EVC are the submerged Dense Waterweed (**Egeria densa*)- see photograph 5- Water Couch (**Paspalum distichum*), Willows (**Salix* sp) and Desert Ash (**Fraxinus angustifolia*).

Photograph 4 Billabong Wetland Aggregate at Chinaman's Island

Using the IWC the Billabong Wetland Aggregate at Chinaman's island scores 14.4/20, indicating it is in moderate condition.

Critical lifeforms Groups Score: 25/25- excellent

Weeds Score: 12/25- poor (high threat weeds include **Egeria densa, *Paspalum distichum, *Salix* sp and * *Pennisetum clandestinum*)

Indications of Altered Processes Score: 10/25- poor (severely altered hydrology has changed species composition)

Vegetation Structure and Health Score: 25/25- excellent

*Photograph 5 Submerged Aquatic Herbland invaded by Dense Waterweed (*Egeria densa) in lagoon at Chinaman's Island*

4.0 Discussion:

Chainman's Island occurs in what is known as the Murray Fans bioregion of Victoria (DELWP 2016). In this bioregion Billabong Wetland Aggretgate is listed as a depleted EVC, meaning that greater than 30% and up to 50% of its pre-European extent remains or greater than 50% pre-European extent remains but it is moderately degraded over most of this area.

Plains Sedgy Wetland is not listed as occurring in the Murray Fans bioregion, however it is listed as endangered in the adjacent Victorian Riverina. An endangered EVC is one that has been extensively cleared and degraded so that less than 10% of its pre-European area remains or that 10 to 30% of its pre-European extent remains but it is severely degraded over most of this area.

As well as supporting depleted and endangered EVCs the wetlands at Chinaman's Island provide significant habitat to diversity of wetland fauna including frogs, turtles and wetland birds. Platypus and over 60 species of native birds have been recorded in the area including the vulnerable Eastern Great Egret (Davidson 2006) and the secretive and disturbance-sensitive Spotless Crake (Hall 2015).

The variety of habitats in the area provides feeding and nesting sites for terrestrial woodland birds such as the Western Gerygone, Crested Shrike-tit and Red-browed Finch and all of the different

feeding guilds of wetland birds including fish-eaters (piscovores) such as Australasian Darter and great Cormorant, dabbling ducks such as Pacific Black Duck and Grey Teal, large waders such as White-faced Heron and White-necked Heron, small wades such as the Black-fronted Dotterel and herbivores such as the Black Swan, Eurasian Cook and Australian Wood Duck.

The lagoon provides one of the few areas of habitat that is relatively sheltered from wave action at the western end of Lake Mulwala, making it an important refuge for waterbirds during rough weather and allowing the growth of plants that are sensitive to extreme wave action. The Plains Sedgy Wetland area provides one of the few well vegetated shallow water habitats at the western end of Lake Mulwala, making it an important refuge for frogs and cover-dependent wetland birds such as crakes, rails and snipe.

While the wetland areas at Chinaman's Island have been highly modified by earthworks and the flooding of Lake Mulwala they are remnants of a natural wetland system (see photograph 6) and are of conservation significance, particularly given the high level of modification of the surrounding landscape.

Photograph 6 Aerial photograph of Yarrawonga in 1941, two years after the construction of Yarrawonga Wier and prior to the flooding of Lake Mulwala. The floodplain wetland that eventually became the lagoon and sedgeland at Chinaman's Island is clearly visible in the top right hand corner of this photograph

One of the requirements of the scope of works for this report was to provide advice on how to make the sedgeland 'wet' for some or all of the year. This is based on concerns that the sedgeland does

have an appropriate water regime; it does not flood frequently enough, deep enough and does not retain water for long enough. The low diversity and abundance of indigenous herbaceous species in the sedgeland is probably caused by lack of an appropriate water regime.

There have been proposals to dig ponds within the sedgeland or direct storm water into it to create an appropriate water regime. Increasing the wetness of this area during the summer months will alter the vegetation composition of the Plains Sedgy Wetland EVC, potentially increasing the area dominated by invasive plants. Under natural circumstances this EVC is usually shallowly inundated (by less than 30 cm of water) in winter and spring and is usually dry in summer. The report "Water and salinity regime and depth preferences for Victorian wetland ecological vegetation classes" (DSE 2012b) states that the usual period of inundation for this EVC is 1 to 8 months, and therefore making it permanently wet would be inappropriate.

Directing storm water into a natural wetland can have several negative impacts. Storm water often carries excess nutrients including nitrogen and phosphorous, which favours the growth of invasive and exotic plant species- see photograph 7. The hard surfaces which are associated with urban development, such as roads and roofs, increase the volume of run off that flows from a catchment. This additional run off can have significant impacts on vegetation composition, particularly because of increased summer wetness which favours the growth of certain weeds.

*Photograph 7 Example of a storm water outlet into a natural wetland at Point Cook west of Melbourne. The invasive Broad-leaf Cumbungi (Typha orientalis) has proliferated because of additional inputs of water and the drain is acting as a point source of nutrients and weeds including Drain Flat-sedge (*Cyperus eragrostis), Water Couch (*Paspalum distichum) and Water Starwort (*Callitriche stagnalis).*

It is therefore recommended storm water is not directed into the wetland. The construction of ponds within the sedgeland would necessitate the destruction of part of the sedgeland and would only have a localised affect; therefore, this action is not recommended either.

The most appropriate water to direct into the wetland is the relatively unpolluted water of Lake Mulwala. As the wetland is generally above the operating level of Lake Mulwala water would have to be pumped into it. This could be achieved with a windmill (cost of approximately $5000 to $10,000), a solar pump (cost of approximately $5000) or an electric pump (cost of approximately $2500 plus connection to existing electricity supply). Any increase in water flow into the wetland should only happen in autumn, winter or spring i.e. the pump or windmill should be disconnected during summer to allow the wetland to dry. Once the pump or windmill is installed the water regime and condition of the sedgeland should be monitored over a year. If a more appropriate water regime is re-instated the condition of the wetland should improve because indigenous wetland plant species should become more abundant and some weeds should drown out, however some active weed control is still likely to be required.

If it is found that wetland is still not retaining enough water a small levee or bund may need to be created between the sedgeland and the lagoon to a height of approximately 124.9 AHD (see figure 2), which would allow it to be filled to a depth between about 10 and 22 cm. This low bund would have to be carefully constructed when the wetland was dry in summer to minimise damage to the sedgeland.

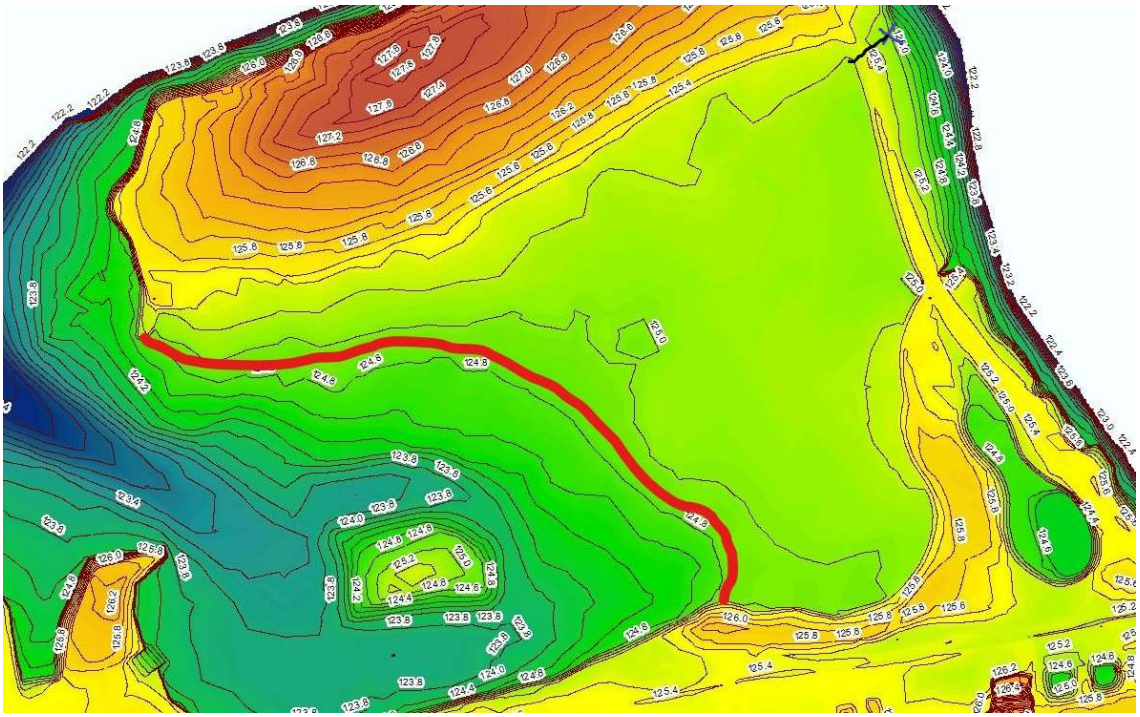


Figure 2 Suggested approximate location of bund (thick red line), pump/windmill (blue cross in top, right hand corner) and pipe from pump/windmill to sedgeland (thin black line).

Once the hydrological issues of the sedgeland have been resolved it could be planted with locally indigenous wetland species to enhance its diversity and conservation value (a list of appropriate species is provided in table 2). Returning a more appropriate water regime to the sedgeland will also benefit native wetland fauna such as frogs, crakes, rails and snipe. The public benefit of these restoration activities would be that the general public could appreciate an area of a wetland type that has been lost from the local landscape since the flooding of Lake Mulwala and local schools could study the restoration of the area and its local flora and fauna.

Table 2 Species appropriate for enrichment planting in Plains Sedgy Wetland at Chinaman's Island

BOTANICAL NAME	COMMON NAME	CONSERVATION STATUS
Amphibromus fluitans	Floating Swamp Wallaby-grass	VU
Myriophyllum crispatum	Coarse Water-milfoil	
Myriophyllum porcatum	Ridged Water-milfoil	VU L v
Nymphoides crenata	Wavy Marshwort	L v
Ottelia ovalifolia subsp. ovalifolia	Swamp Lily	
Potamogeton cheesmanii	Furrowed Pondweed	
Pseudoraphis spinescens	Spiny Mud-grass	
Cycnogeton (Triglochin) multifructa	Northern Water Ribbons	
Amphibromus nervosus	Common Swamp Wallaby-grass	

To protect and enhance the ecological values of the lagoon it is recommended that boating, the use of other recreational craft and other disturbances be excluded to encourage the use of the area by native wildlife. Woody weeds including Willows and Desert Ash should be incrementally removed from the edge of the lagoon and replaced by appropriate indigenous shrubs and small trees.

The diversity of plant species and habitat structure for native fauna could be improved by planting additional locally indigenous aquatic plant species (see table 3 for a list of appropriate species). These species may also assist the control of Dense Waterweed (**Egeria densa*) by providing competition.

Table 3 Species appropriate for enrichment planting in the lagoon at Chinaman's Island

BOTANICAL NAME	COMMON NAME	CONSERVATION STATUS
Nymphoides crenata	Wavy Marshwort	L v
Amphibromus fluitans	Floating Swamp Wallaby-grass	VU
Ottelia ovalifolia subsp. ovalifolia	Swamp Lily	
Cycnogeton (Triglochin) procerum	Water Ribbons	
Ceratophyllum demersum	Hornwort	k
Najas tenuifolia	Water Nymph	r
Potamogeton crispus	Curly Pondweed	
Potamogeton ochreatus	Blunt Pondweed	

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Appendix 1: Plant species observed in and adjacent to wetland areas at Chinaman's Island, December 2016

EPBC	FFG	DSE	Wetland Dependence	Origin	Scientific Name	Common Name	Plains Sedgy Wetland	Billabong Wetland Aggregate
			MF		*Alternanthera denticulata s.s.*	Lesser Joyweed	x	x
			AM		*Bolboschoenus medianus*	Marsh Club-sedge		x
			T	*	*Bromus hordeaceus subsp. hordeaceus*	Soft Brome	x	
		r	AM		*Callitriche umbonata*	Winged Water-starwort	x	
			AM	*	*Callitriche stagnalis*	Common Water-starwort	x	
			AM		*Calystegia sepium subsp. roseata*	Large Bindweed		x
			AM		*Carex tereticaulis*	Poong'ort	x	x
			T	*	*Cirsium vulgare*	Spear Thistle	x	
			T	*	*Cynodon dactylon var. dactylon*	Couch		x
			AM	*	*Cyperus brevifolius*	Mullumbimby Couch		x
			AM	*	*Cyperus eragrostis*	Drain Flat-sedge	x	
			T	*	*Echium plantagineum*	Paterson's Curse	x	
			OA	*	*Egeria densa*	Dense Waterweed		x
			AM		*Eleocharis acuta*	Common Spike-sedge	x	
			T/MF		*Epilobium billardierianum subsp. billardierianum*	Smooth Willow-herb	x	
			AM/GD		*Eucalyptus camaldulensis*	River Red-gum	x	x
			T	*	*Fraxinus angustifolia*	Desert Ash		x
			MF/T		*Helichrysum luteoalbum*	Jersey Cudweed		x
			AM		*Hemarthria uncinata var. uncinata*	Mat Grass	x	x
			AM		*Hydrocotyle verticillata*	Shield Pennywort	x	x
			AM		*Isolepis inundata*	Swamp Club-sedge	x	
			AM		*Juncus amabilis*	Hollow Rush	x	
			AM	*	*Juncus articulatus*	Jointed Rush	x	
			AM		*Juncus flavidus*	Gold Rush	x	
			AM		*Juncus usitatus*	Billabong Rush		x
			MF/AM		*Lachnagrostis filifolia s.l*	Common Blown-grass	x	
			AM		*Lobelia concolor*	Poison Pratia	x	
			AM	*	*Ludwigia palustris*	Marsh Ludwigia	x	x
			AM		*Ludwigia peploides subsp. montevidensis*	Clove-strip	x	x
			AM		*Lycopus australis*	Australian Gipsywort	x	x
			AM/MF		*Lythrum hyssopifolia*	Small Loosestrife	x	x
			AM		*Myriophyllum crispatum*	Upright Water-milfoil	x	

EPBC	FFG	DSE	Wetland Dependence	Origin	Scientific Name	Common Name	Plains Sedgy Wetland	Billabong Wetland Aggregate
			AM		*Myriophyllum papillosum*	Robust Water-milfoil		x
			OA		*Nitella spp.*	Stonewort		x
			T/D		*Oxalis perennans*	Grassland Wood-sorrel	x	
			AM	*	*Paspalum dilatatum*	Paspalum	x	
			AM	*	*Paspalum distichum*	Water Couch	x	x
			T	*	*Pennisetum clandestinum*	Kikuyu		x
			AM		*Persicaria decipiens*	Slender Knotweed	x	x
			MF		*Persicaria hydropiper*	Water Pepper	x	
			T/AM	*	*Phalaris aquatica*	Toowoomba Canary-grass	x	
			AM		*Phragmites australis*	Common Reed	x	x
			OA		*Potamogeton sulcatus*	Furrowed Pondweed		x
			AM	*	*Ranunculus sceleratus subsp. sceleratus*	Celery Buttercup	x	
			AM	*	*Rorippa palustris*	Marsh Yellow-cress	x	
			AM	*	*Rumex conglomeratus*	Clustered Dock	x	
			AM	*	*Rumex crispus*	Curled Dock	x	
			AM	*	*Salix babylonica s.l.*	Weeping Willow		x
			AM	*	*Salix cinerea*	Grey Sallow		x
			AM		*Typha domingensis*	Narrow-leaf Cumbungi		x
			AM		*Typha orientalis*	Broad-leaf Cumbungi	x	x
			OA		*Vallisneria americana var. americana*	Eel Grass		x
			T	*	*Vulpia bromoides*	Squirrel-tail Fescue	x	

Species shown in blue font are wetland dependant

Flora wetland dependence categories

Symbol	Functional Group	Description
OA	Obligate Aquatic	Plants that require free-standing water above the ground surface to complete their life-cycle
AM	Amphibious	Plants which are adapted to survive short to medium term inundation (greater than two weeks duration). Recruitment and periods of rapid growth and productivity of these species is often closely tied to inundation events

Symbol	Functional Group	Description
MF	Mudflat specialists	Plants that specialise in colonising the drying mud of wetlands
GD	Groundwater Dependent	Plants that while not necessarily frequently inundated by flood water would not survive on local rainfall and require access to ground water
D	Dampland	Plants that require damp or saturated, but not inundated, soil to complete their life-cycle
T	Terrestrial	Plants that survive off local rainfall. These species may survive very short term inundation but perish if soil remains inundated or waterlogged for longer than approximately two weeks