

BENCHMARKING WETLAND FLORA IN THE LOWER LATROBE WETLANDS

Report to the West Gippsland CMA, June 2015.

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[Cover photo: Alison Oates]

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1. INTRODUCTION

1.1 PROJECT TEAM

A team led by Pathways Bushland & Environment was contracted by the West Gippsland Catchment Management Authority to undertake the project 'Benchmarking Wetland Flora in the Lower Latrobe Wetlands'. The team comprised Doug Frood (Pathways Bushland and Environment), in collaboration with Paul Boon (Dodo Environmental), Alison Oates (Oates Environmental Consulting) and Jim Reside (Wildlife Unlimited), with GIS support provided by Richard Maxwell (EcoDev, Tatura).

1.2 CONTEXT FOR PROJECT

The West Gippsland CMA requires updated mapping and benchmarking of Ecological Vegetation Classes (EVCs) in the lower Latrobe wetlands, suitable data on the water quality and species present and their water/salt regime requirements. This information is required to improve understanding of how watering and other influences affect the wetlands system, including the component species, and consequently to inform future management of the wetlands.

The project brief states that this project will provide a foundation for the development of an Environmental Water Management Plan (EWMP) for the lower Latrobe wetlands. The purpose of the EWMP is to ensure the health and function of water-dependent ecological values of the wetlands is maintained over the long-term. The EMWP details ecological values, sets objectives for their quality and identifies watering requirements to achieve these objectives. Information on weed species collected during this project will also contribute to the Gippsland Lakes Weed Control Strategy being prepared by Parks Victoria.

1.3 OBJECTIVES AND OUTCOMES

The brief defines the main purpose of the project as to record the floristic components of Sale Common, Dowd Morass and Heart Morass, and the key objectives of this project as:

- To update EVC maps and flora species lists for the lower Latrobe wetlands.
- To improve understanding of how watering and other management activities have influenced vegetation changes in the lower Latrobe wetlands.
- To provide information for planning of other active interventions to improve habitat quality of the lower Latrobe wetlands, such as weed control.

The project tasks include:

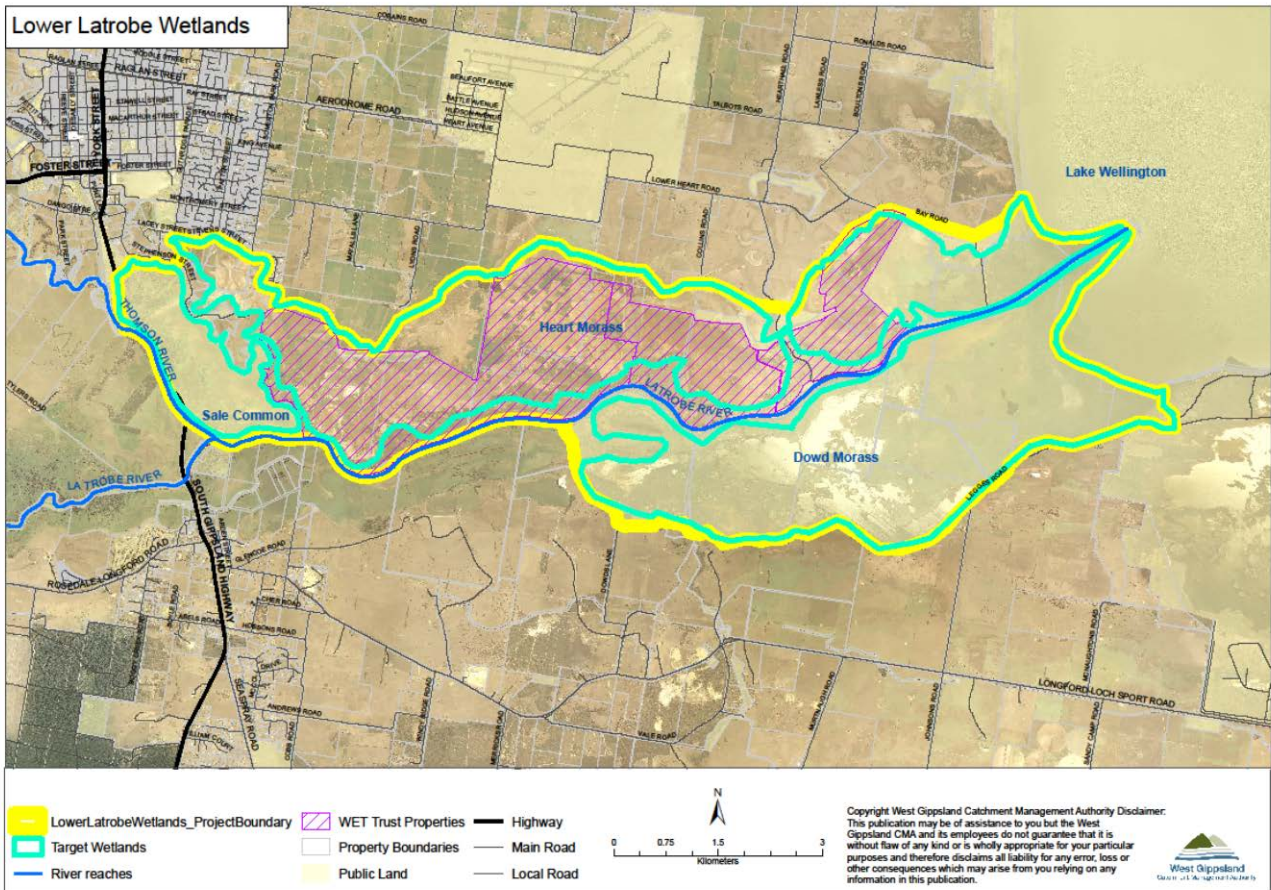
- Detailed technical review of available information relevant to the vegetation of the lower Latrobe wetlands, historical water regimes and previous works.
- Mapping of updated EVCs within the three wetlands.
- Compilation of flora species lists for each wetland.
- Establishment and sampling of permanent vegetation monitoring sites for each wetland.
- Assessments of the wetland vegetation across the wetlands using the vegetation component of the DEPI (now part of DELWP) Index of Wetland Condition.
- Collection of information on vegetation-related issues/risks, including the presence and severity of weed infestations, presence of threatened species and recommended management actions.

1.4 STUDY AREA

The project area comprises the lower Latrobe wetlands, which include Sale Common (adjacent to the Thomson River just above its confluence with the Latrobe River), and Dowd Morass and the Heart Morass (on the north and south of the Latrobe River respectively, adjacent to Lake Wellington). Their location is shown on Map 1 below. The south-eastern extremity of this mapped area includes approximately 20 ha of prior Commonwealth military range where public access is not permitted. This area was excluded from the current investigation.

The lower Latrobe wetlands have a combined area of approximately 3,600 ha. Lake Wellington forms part of the Gippsland Lakes, which comprise a listed Wetland of International Significance under the Ramsar Convention. Sale Common, the State Game Reserve in the eastern portion of Heart Morass, and most of Dowd Morass are also included

within this Ramsar site. The lower Latrobe wetlands are complementary to the lakes system, and provide important habitat for a range of flora and fauna, particularly many species of migratory water birds. The influence of increased salinity in the Gippsland Lakes, due to the permanent opening of the entrance to the ocean in 1889, has extended to the lower Latrobe wetlands, where cycling salinity levels are largely determined by the amount of freshwater flowing in from the Latrobe and Thomson Rivers.



Map 1. Location of lower Latrobe wetlands

2. REVIEW OF EXISTING INFORMATION

A detailed technical review of the available information relevant to the vegetation of the lower Latrobe wetlands, historical water regimes and previous works is included as Appendix 1.

3. DOCUMENTATION OF THE FLORA

3.1 SPECIES LIST

A species list was compiled for the study area, using existing information and observations from the current study, and annotated according to the source of records and relevant section of the study area. 378 vascular taxa were recorded, of which 224 are regarded as indigenous. These figures include a small amount of duplication due to different levels of taxonomic resolution between records from the various sources, as well as a few records which appear to be based on misidentifications. Some additional annotation is provided where the veracity of records is questioned or variation in the plant names applied is otherwise potentially confusing. This list is included as Appendix 2.

3.2 SIGNIFICANT FLORA SPECIES

Eight vascular plant species with a Victorian Rare or Threatened Status (VROT species) have been recorded from the study area. The identification of one of these (*Eucalyptus strzeleckii*) remains to some extent tentative; however if the plants from the lower Latrobe wetlands are not properly referable to this species, then they would appear likely to represent an undescribed taxon with an even higher conservation status. *Eucalyptus strzeleckii* is also considered vulnerable at the National level (VU). An additional species (*Amphibromus fluitans*) is also considered vulnerable Australia-wide, although it is not included in the Victorian listing.

The eight VROT species and their threat codes are as follows:

- v *Amphibromus sinuatus* (Wavy Swamp Wallaby-grass)
- k *Berula erecta* (Water Parsnip)
- k *Bolboschoenus fluviatilis* (Tall Club-sedge)
- k *Callitriche palustris* var. *palustris* (Starwort)
- v *Eucalyptus ?strzeleckii* (?Strzelecki Gum)
- r *Fimbristylis velata* (Veiled Fringe-sedge)
- k *Hypsela tridens* (Hypsela)
- r *Ranunculus amplus* (Feather-leaf Buttercup)

The relevant codes are defined as follows (DEPI, 2014b):

- VU Vulnerable: A taxon is considered (Nationally) 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.

- 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.

***Amphibromus fluitans* (Graceful Swamp Wallaby-grass)**

Graceful Swamp Wallaby-grass is an aquatic to semi-aquatic grass of seasonal wetland habitats. This species was listed for the western area of the Wet Trust land (Bolton's) at Heart Morass by D. Cook in 2008. It was recorded from monitoring quadrat DC-08 (corner post 55H 0510121 / 5777616) in March and October 2008, in a small grassy wetland within woodland near the Latrobe River. It was also recorded from Sale Common in quadrat SC-03 (corner post 55H 0507109 / 5780041), to the near north of the boardwalk, during the current study, in largely herbaceous aquatic to semi-aquatic vegetation with scattered *Juncus ingens* (Giant Rush).

***Amphibromus sinuatus* (Wavy Swamp Wallaby-grass)**

Wavy Swamp Wallaby-grass is an aquatic to semi-aquatic grass of seasonal wetland habitats. This species was listed for the western and central areas of the Wet Trust land (Bolton's and Frawley's respectively) at Heart Morass by D. Cook in 2008. It was recorded from

monitoring quadrat DC-08 (corner post 55H 0510121 / 5777616) in March and October 2008, and January 2013, in a small grassy wetland within woodland near the Latrobe River. .

***Berula erecta* (Water Parsnip)**

Water Parsnip is a medium sized herb of wet soils in cooler districts. During the current study, this species was observed at Heart Morass State Game Reserve in Swamp Scrub dominated by *Melaleuca ericifolia* (Swamp Paperbark), near where the central track on the levee meets the Latrobe River. It was also listed by Boon *et al.* (2007) for Dowd Morass.

***Bolboschoenus fluviatilis* (Tall Club-sedge)**

Tall Club-sedge is a medium to tall sedge of wetlands and stream banks. This species was observed at several locations on the south-west side of Sale Common, as a local dominant in patches within inundation-prone sedgeland vegetation which is otherwise dominated by *Bolboschoenus medianus* (Marsh Club-sedge). It sometimes extends into the edges of adjacent woodland.

***Callitriche palustris* var. *palustris* (Starwort)**

Starwort is a small, annual, aquatic herb which occupies open habitats on muddy shallows of wetlands. This species was listed for the western and central areas of the Wet Trust land (Bolton's and Frawley's respectively) at Heart Morass by D. Cook in 2008.

***Eucalyptus strzeleckii* (Strzelecki Gum)**

Strzelecki Gum is a medium-sized tree, mainly occurring in seepage zones on slopes and valleys in higher-rainfall hilly country to the west of the study area. This population was previously thought to be referable to *E. yarraensis* (Yarra Gum), but has instead since been tentatively identified as *E. strzeleckii* by Melbourne Herbarium. If confirmed as this species, the population at Heart Morass represents a disjunct easterly occurrence. It was listed for the western area of the Wet Trust land (Bolton's) at Heart Morass by D. Cook in 2008 (as *Eucalyptus yarraensis*). It occurs as a small population scattered along Flooding Creek and the nearby section of the Latrobe River in the western part of the Wet Trust property (Bolton's). During the current study, a single tree was observed along the banks of Flooding Creek in Sale Common, at 55H 0508372 / 5778615 (roughly opposite the veteran 'Mystery Eucalypt' in the Wet Trust property).

***Fimbristylis velata* (Veiled Fringe-sedge)**

Veiled Fringe-sedge is a small annual sedge of wet sites. This species was listed for the western area of the Wet Trust land (Bolton's) at Heart Morass by D. Cook in 2008. It was recorded from monitoring quadrat DC-06 (corner post 55H 0510008/ 5777909) in March 2008 and January 2011, in an inundation-prone area dominated by *Carex gaudichaudiana* (Fen Sedge) in woodland near the Latrobe River. During the current study, it was observed in monitoring Quadrat DC-07 (corner post 55H 0512056 / 5778564), in open rushland dominated by *Juncus ingens* (Giant Rush). It was also locally abundant in the vicinity of quadrat SC-02 (corner post 55H 0507084 / 5780011), on the floor of Sale Common near the boardwalk, in low herbland germinated on the mud following drawdown.

***Hypsela tridens* (Hypsela)**

Hypsela is a small, prostrate herb of mud on exposed wetland floors. This species was listed for the western area of the Wet Trust land (Bolton's) at Heart Morass by D. Cook in 2008. During the current study, a small patch of this plant was observed on a *Juncus* mound, near the bank on the northern edge of Freshwater Hole, at 55H 0515799 / 5779557, within or adjacent to the boundary of the eastern portion of the Wet Trust land (Guest's).

***Ranunculus amplus* (Feather-leaf Buttercup)**

Feather-leaf Buttercup is an aquatic herb. This species was listed for the central area of the Wet Trust land (Frawley's) at Heart Morass by D. Cook in 2008. It was recorded from monitoring quadrat DC-10 (corner post 55H 0514714/ 5778181) in April 2010, October 2011 and January 2013, in open rushland dominated by *Juncus ingens* (Giant Rush).

Many other species present at the wetlands are of high local to regional significance. Of particular interest is the isolated veteran specimen of the 'Mystery eucalypt' (as labelled in the D. Cook list of 2008) which occurs along Flooding Creek at Heart Morass. The herbarium has tentatively identified this as a hybrid between *E. tereticornis* subsp. *mediana* (Gippsland Red-gum) and *Eucalyptus botryoides* (Southern Mahogany). While this hybrid is recognised in the DELWP Victorian Biodiversity Atlas list of Victorian plants, it is not afforded a VROT status.

3.3 PERMANENT MONITORING SITES (QUADRAT SAMPLING)

Permanent quadrats have been previously established in the Wet Trust portion of Heart Morass and assessed over a number of years. The data from these surveys has provided valuable information regarding changes in vegetation health and water quality in the wetland over time. During the current study, twenty-eight additional permanent vegetation monitoring sites were established and sampled, in addition to the eleven existing sites in Heart Morass. Of these additional sites, three were located in Sale Common, fifteen in Dowd Morass, seven in the Heart Morass State Game Reserve and three additional sites in the Wet Trust area. The three additional sites in the Wet Trust area were located near the boundary between the eastern portion (Guest's) and the central portion (Frawley's), but presumably within the eastern portion. Quadrat sampling during the current project has collected data consistent with that already collected from these existing permanent quadrats.

Additional quadrat sites were selected to represent a range of mapping units (EVC and general condition). Efforts were made to locate these in such a manner as to aid repeated sampling, but sufficiently discreetly to avoid attracting unwanted public attention. It was initially intended to place at least several quadrats per vegetation type in each wetland, and a number of sites in ecologically informative sites such as on vegetation boundaries or where process of change was suggested, e.g. by colonization of species from adjacent EVCs. However the complexity of the vegetation had not been appreciated prior to this survey, and consequently this level of replication of sampling was not feasible.

The new quadrats were square in shape, with ten metre sides unless otherwise indicated (one terrestrial quadrat with twenty metre side was sampled), and were marked on a nominated corner with a star picket.

At each quadrat, all vascular plant species were recorded and their cover estimate provided using a modified Braun-Blanquet scale as follows:

- + Few individuals (generally less than 5), less than 1% cover.
- 1 Many individuals, less than 1% cover.
- 2 1 - <5% cover, any number of individuals.

For covers over 5%, estimates to the nearest 5% were provided.

In addition to plant species and cover, the following data was collected at each quadrat during the previous sampling at Heart Morass:

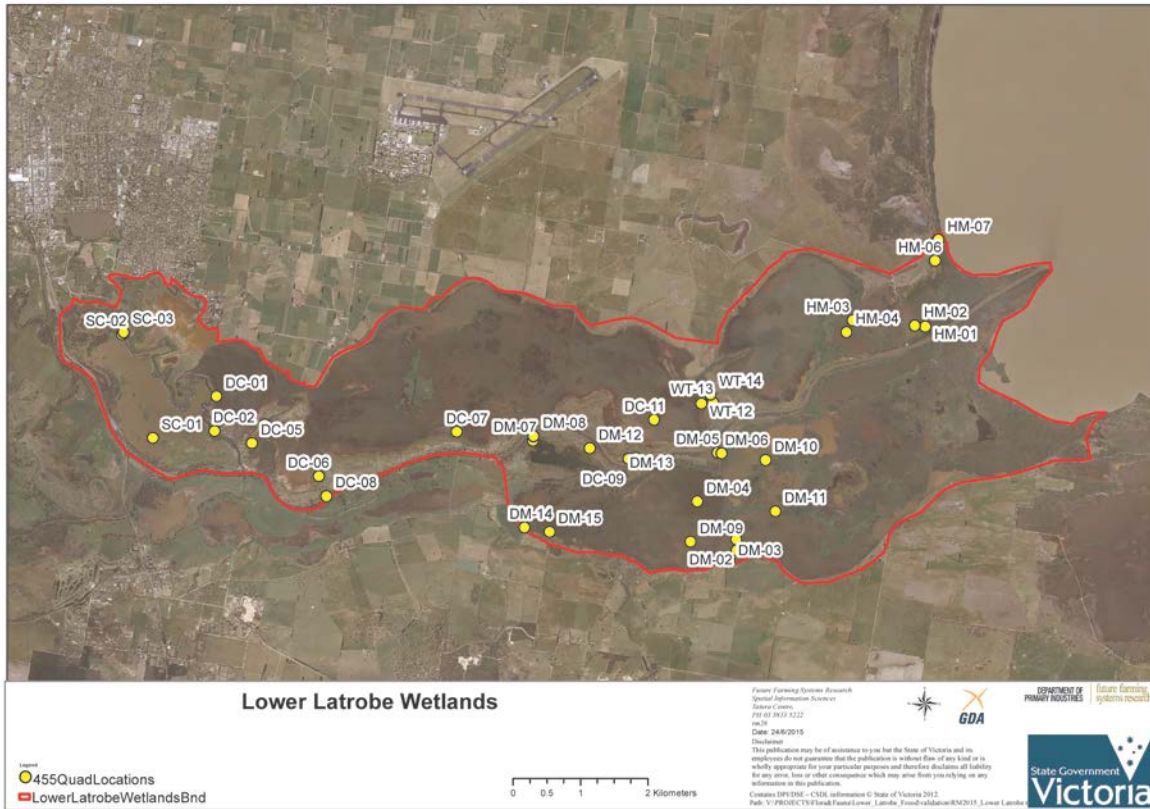
- GPS coordinates
- Site photo
- Water depth (cm) at star picket
- EC ($\mu\text{s}/\text{cm}^3$) where the quadrat was inundated at the time of the assessment.
- pH
- Water temperature ($^{\circ}\text{C}$)
- Any additional notes as relevant.

It is here considered that grams/litre is a more suitable measure of salinity in the context of the salinity levels in the lower Latrobe wetlands, and salinity data was collected using this measure rather than $\mu\text{s}/\text{cm}^3$. Otherwise, the measures used at Heart Morass were collected at all quadrat sites sampled during the vegetation assessment where relevant.

The salinity measurements were made with a TPS Model WP81 Conductivity/Salinity/pH/ORP meter, calibrated at 0 and 36 g/L with TPS salinity standards. For some of the earlier samplings during the current study, water salinity was measured both near the surface and at depth. As the extent of stratification of salinity proved to be negligible, only one sample was collected during later samplings. It was noted on the quadrat sheets whether the measure of pH applies to water (where the site was inundated) or soil (where the site was dry). The pH measurements of the water were to one-tenth of a pH unit, whereas the soil measurements were to the nearest half of a unit.

In the Heart Morass quadrats from the prior monitoring are marked with a star picket in the south-west corner and photographed from the northern side. This latter approach was repeated for the three additional sites sampled in the Wet Trust area. Otherwise photos were taken diagonally across the quadrat from the marker picket, with the orientation of the quadrat relative to this post being specified on the data sheet. If desired, the method for taking the photos could be standardised to include that used in the Wet Trust area during future sampling.

Map 2 (below) shows the location of the quadrats. The quadrat data are presented in Appendix 3.



Map 2. Location of monitoring sites.

3.4 ANALYSIS OF QUADRAT DATA

The species data from the previous monitoring and current sampling of the Wet Trust quadrats, and all quadrats from the current sampling (i.e. lacking the historic sampling of the permanent monitoring sites) are presented in separate two-way tables (as Appendix 4). These allow more direct comparison of the sites, including across time at the existing sites, and between sites in the current study. Trends in the vegetation are discussed in section 6.2.

4. VEGETATION DESCRIPTION AND MAPPING

4.1 MAPPING METHODOLOGY

The mapping was undertaken using a combination of access from fringing sites, supplemented by inspections from boat (kayak or canoe) in conjunction with interpretation of the available aerial photography which was printed at a scale of 1:10,000 for use in the field. An extensive portion of the eastern part of the study area is not practicably accessible by either of these means, and interpretation was based solely on examination of the available aerial photography. Digital aerial imagery from the 2009 Victorian Landcover Data Set was supplied by the West Gippsland Catchment Authority, with aerial imagery from October 2014 (part of the Wellington mosaic, at 15 cm resolution), also becoming available towards the completion of the field work. The initial mapping was undertaken at a scale of 1:10,000. In general the minimum size of a patch of a Map unit considered for inclusion was approximately 30 m diameter, or in the case of linear features such as levees, approximately 15 m width. However, not all patches occurring at this scale were necessarily identified and mapped. The initial line-work was converted to ArcView compatible GIS data by Richard Maxwell of the Department of Economic Development, Jobs, Transport and Resources (EcoDev), Tatura.

4.2 EVC DEFINITION

Ecological Vegetation Classes (EVCs) are the descriptive units of a type of native vegetation classification that is described through a combination of its floristic, life form, and ecological characteristics, and through an inferred fidelity to particular environmental attributes (DEPI, 2013). Each EVC includes a collection of floristic communities (i.e. a lower level in the classification that is based solely on groups of the same species) that occur across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.

A summary of prior mapping and interpretation of the EVCs represented in the lower Latrobe wetlands is included in the review of existing information (Appendix 1).

4.3 INTERPRETATION OF MAPPING UNITS AND RELEVANT EVCs

The mapping units for the current study were developed and refined during field assessment. They comprise a synthesis of variation within the relevant EVCs and generalised condition classes. Some of these units comprise fine-scale mosaics or complexes where it was not

realistic to map the components separately. A number of others are indicative of vegetation which has been substantially modified through hydrological alteration and/or invasion by dominant introduced species, and do not readily match existing EVCs other than the generalised default used to map highly disturbed or modified vegetation (EVC 999 'Unknown/unclassified').

Small areas of a native vegetation community not suitably matching any of the existing EVC descriptions were encountered during the field work. This vegetation has been referred to a new provisional EVC (A116 Wet Sedgy Herbland), which has been incorporated into the vegetation assessment guides of the Index of Wetland Condition (IWC), awaiting formal acceptance by DELWP.

Some other small areas supported vegetation which was dominated by native species but, as a consequence of modified land-use practises such as grazing and presumably altered hydrology, did not match any of the existing EVC descriptions, and it was unclear what EVC would have been present prior to these modification. In such cases, the relevant mapping units were referred to EVC 74 'Wetland Formation'; however as far as possible, use of this generalised default was avoided.

4.4 CONSTRAINTS AND LIMITATIONS

The mapping is mostly far more detailed than previously undertaken, particularly around the wetland fringes, and where practicable has been extensively ground-truthed. However, there will no doubt be errors, inaccuracies and omissions due to time and access constraints, and places where the interpretation of gradients between vegetation types at some point requires decisions with a degree of subjectivity.

Application of the Map units comprises an overall generalized assessment of an area, and at times can include small areas of vegetation which may better fit another unit - e.g. Map unit 302 refers to Floodplain Riparian Woodland with a primarily introduced understorey, whereas Map unit 301 refers to this EVC with a weedy understorey which nevertheless retains a substantial component of remnant understorey flora, notably the shrub *Melicytus dentatus*. Small areas within polygons mapped as 302 could well be interpreted as 301. Similarly, Map units 121 and 131 describe transitions between Floodplain Riparian Woodland and the wetter EVCs Tall Marsh and Swamp Scrub. Wetter patches with the Floodplain Riparian Woodland can locally approach these structures, particularly in a narrow band along the river verge, however are generally not recognised separately unless they are the dominant local theme.

Map unit 601 describes wet areas dominated by *Paspalum distichum* but retaining a component of wetland species. Map unit 611 describes damp to dryland sites dominated by introduced grasses, and may include some areas which would be better referred to unit 601, but the wetland component was obscured or otherwise not detected during the field assessment.

Clumps of *Typha* spp. are difficult to detect on the aerial photography, and it is highly probable that a number of small patches dominated by these plants have been overlooked, particularly further into the wetlands. Care is required in interpreting the aerial photography, as algal growth and accumulations of small floating aquatic species can resemble larger wetland species on the imagery. Allowing for this, it appears that the area occupied by *Phragmites australis* is quite dynamic, with substantial small-scale differences between the two sets of available aerial photography evident. It is presumed that patches of this species can expand rapidly under favourable conditions, or alternatively be suppressed by the sustained presence of deeper water.

While the Index of Wetland Condition generally requires assessment based on which EVCs the current vegetation has been derived from, this can be of little relevance to mapping the current vegetation, particularly where few clues of the extent of modification remain and the modified vegetation is readily referable to EVCs which can occur in unmodified sites elsewhere. One of the most problematic issues to resolve during the vegetation mapping was the transition between the currently brackish vegetation types Estuarine Scrub and Estuarine Reedbed, and the relevant non-saline alternatives Swamp Scrub and Tall Marsh. This is particularly difficult where this transition is occurring in areas which are for all intents and purposes inaccessible, particularly given the transition can be gradational or difficult to interpret in sites where recovery from prior saline back-flooding is still occurring. In such cases, the location of the relevant vegetation boundaries is inevitably accompanied by a high degree of uncertainty.

The mapping units are outlined below, including which (currently present) EVC they have been referred to. A general overview of the relevant EVCs is also provided. Photographs of the mapping units are provided as Appendix 5. The initial line-work was converted to GIS data by Richard Maxwell of the Department of Economic Development, Jobs, Transport and Resources (EcoDev), Tatura.

4.5 BIOREGIONAL CONSERVATION STATUS OF EVCs

The combination of EVC and bioregion is used to determine the bioregional conservation status (BCS) of an EVC. This is a measure of the current extent and quality for each EVC, when compared to its original (pre-1750) extent and condition. On this basis a BioEVC will have a BCS of endangered, vulnerable, depleted, least concern or rare (DEPI, 2014a). The study area falls within the Gippsland Plains Bioregion. While formal BCS ratings are available for the terrestrial EVCs, they are frequently lacking for the wetland EVCs, as the latter were not well resolved during the broad-scale vegetation mapping projects conducted during the previous couple of decades. A provisional set of BCS values have been developed for the IWC support materials but are yet to be formally approved, although in cases where the wetland EVCs were recognised during the State-wide vegetation mapping, many (e.g. Swamp Scrub and Plains Grassy Wetland) retain the same status in the provisional wetland BCS as in the existing formal DELWP BCS listing). Accordingly, either the formal or provisional BCS ratings are provided below.

4.6 SHORT DESCRIPTIONS OF THE EVCs REPRESENTED IN THE LOWER LATROBE WETLANDS

The following EVCs are recognised as applying to the vegetation of the lower Latrobe wetlands and fringing terrestrial zones. One previous assessment interprets the woodland vegetation at Sale Common as representing Swampy Riparian Woodland (EVC 83). While the wettest wooded areas at Sale Common have some floristic similarities with this EVC, these are here treated as ecotonal transitions between Floodplain Riparian Woodland and Swamp Scrub or Tall Marsh, and the drier areas there are referred to Floodplain Riparian Woodland.

Aquatic Grassy Wetland (EVC 306)

This EVC refers to vegetation dominated by rhizomatous or stoloniferous aquatic grasses including *Amphibromus fluitans* (Graceful Swamp Wallaby-grass) and entities within *Lachnagrostis filiformis* s.l. (perennial variants of Common Blown-grass or Wetland Blown-grass). This vegetation type occurs as a minor component of the complex mosaic of vegetation types which occupy the outer zones of the wetlands at Sale Common, and characteristic component species have been recorded from a small wetland adjacent to the

Latrobe River within the Wet Trust area of Heart Morass. It does not occur at a sufficient scale to allow discrete mapping as a single EVC (being included as a minor component within Map units 041 and 071).

Provisional BCS: Endangered.

Aquatic Herbland (EVC 653)

This EVC refers to vegetation dominated by emergent aquatic herbs. In the lower Latrobe wetlands, the main relevant species include *Cycnogeton* spp. (Water Ribbons), *Myriophyllum* spp. (Water Milfoil) and *Ludwigia peploides* (Clove-strip); however the introduced *Myriophyllum aquaticum* (Parrot's Feather) is often the most conspicuous component within the relevant vegetation. This vegetation type has relatively restricted occurrences within the wetlands at Sale Common and the fresher portions of Heart Morass, but mostly does not occur at a sufficient scale to allow discrete mapping as a single EVC (being included as a component within Map units 031, 041, 042 and 051).

Provisional BCS: Endangered.

Aquatic Sedgeland (EVC 308)

This EVC refers to vegetation dominated by one or more of a range of robust aquatic sedges, and within the lower Latrobe wetlands is dominated by *Eleocharis sphacelata* (Tall Spike-sedge). Most occurrences within these wetlands are too small to allow discrete mapping and instead are included as minor components of Map units 031, 041 and 042; however at Sale Common, there are restricted patches of this vegetation which are extensive enough to be mapped (as Map unit 043).

Provisional BCS: Vulnerable.

Billabong Wetland (EVC 334)

This aggregate EVC refers to the mosaics of component EVCs occurring in association with the water bodies and wet banks of lagoons/billabongs on floodplains. It is mapped as Map unit 031. The component EVCs can occur in extremely fine-scale mosaics or vary in their extent of expression during wetting and drying cycles. The relevant EVCs variously include Aquatic Herbland, Aquatic Sedgeland, Floodway Pond Herbland, Dwarf Floating Aquatic Herbland, Tall Marsh and Open Water, and sometimes a fringe of Wet Verge Sedgeland or

Swamp Scrub. This habitat occurs at Sale Common and within the western to central parts of Heart Morass. In some cases, remnants of these formations are apparent as deeper areas within the main wetland body, but lack the vegetation types otherwise associated with these habitats and consequently are not delineated on the mapping.

Provisional BCS: Endangered.

Brackish Grassland (EVC 934)

This EVC refers to vegetation dominated by terrestrial grasses in association with salt-tolerant forbs (dicotyledonous herbs) and rhizomatous grasses. More intact areas are locally dominated by *Poa labillardierei* (Common Tussock-grass), with vegetation inferred to represent more modified areas of this vegetation lacking *P. labillardierei* but retaining the salt-tolerant associated grasses *Sporobolus virginicus* (Salt Couch) and/or *Distichlis distichophylla* (Australian Salt-grass) in association with terrestrial introduced grasses, or sometimes the native *Rytidosperma* species (Wallaby Grass) or *Hemarthria uncinata* (Mat Grass). These two variations are mapped as Map units 551 and 552. Within the study area, relevant vegetation primarily occurs within narrow zones around the northern fringes of Heart Morass and the south-eastern portion of Dowd Morass. Its occurrence is believed to be due to seepage of brackish groundwater, and appears to be at least in part natural. The most structurally intact and extensive remnants of this EVC occurred within the Heart Morass State Game Reserve, but have recently been badly damaged by revegetation works.

Provisional BCS: Endangered.

Brackish Lake Bed Herbland (EVC 539)

This EVC refers to vegetation dominated by salt-tolerant forbs which grow on the periodically exposed beds of brackish wetlands. The main relevant species in the lower Latrobe wetlands are *Chenopodium glaucum* (Glaucous Goosefoot), *Atriplex australasica* (Native Orache) and *Mimulus repens* (Creeping Monkey-flower). The potential of this EVC to express on a broader scale within Dowd Morass and parts of Heart Morass is inferred from observations of partial exposure of the edges of the wetlands, and it is presumed to be more widely represented during draw-down phases. As its potential for presence was largely based on inference, it was not mapped during the current assessment. Its potential occurrence at the lower Latrobe wetlands is presumably at least mostly due to increased salinity of the water bodies as a consequence of anthropogenic modification of the Gippsland Lakes system. It is

presumed to occur as a component of a temporal mosaic within some of the areas ascribed to Map unit 001, and a small area of herbland dominated by *C. glaucum* was noted as expressing on the wetland floor within Map unit 014 following drawdown.

Provisional BCS: Not available.

Brackish Wetland Aggregate (EVC 656)

This aggregate EVC refers to vegetation dominated by salt-tolerant herbs, variously with a component of salt-tolerant sedges or rushes. In relatively intact condition it frequently includes a component of species shared with less saline sites. Vegetation referred to this EVC is currently widespread along the fringes of the wetlands of parts of both Heart Morass and Dowd Morass. While it is considered that some amount of this vegetation was naturally present within the wetland system, it appears certain that its extent has increased substantially as a consequence of anthropogenic modification of the Gippsland Lakes system.

The Brackish Wetland Aggregate variously includes Brackish Sedgeland (EVC 13) and Brackish Herbland (EVC 538) as components; however it was not feasible to attempt to resolve these or any other component EVCs in the mapping, given the complexity of the local variation in relative extent of development of these elements. The character of the vegetation has been affected by structural and floristic changes, as a consequence of prior grazing and subsequent recovery following its cessation. Altered hydrology and apparent increased salinity have also influenced its character. It also varies with subtle hydrological factors.

Several variants are mapped (as Map units 531, 532 and 533). Two of these occur in areas where *Bolboschoenus caldwellii* (Salt Club-rush) or *Juncus kraussii* (Sea Rush) respectively are potentially associated with the salt-tolerant herbs. Another variant occurs in more elevated sites, and is dominated by combinations of salt-tolerant introduced herbs and *Atriplex australasica* (Native Orache). In areas where *B. caldwellii* can occur, *Sarcocornia quinqueflora* (Beaded Glasswort) can become locally dominant in slightly drier areas, resulting in vegetation closely resembling a community of Coastal Saltmarsh Aggregate (EVC 9). Given the subtleties and potential fine-scale of such variation, it was not pragmatic to attempt to distinguish, within the mapping, those portions of the vegetation which were dominated by *S. quinqueflora*. This latter vegetation can mostly be distinguished from Coastal Saltmarsh by at least a minor component of less halophytic species. Similarly, the extensive areas dominated by *Selliera radicans* (Shiny Swamp-mat) that were mapped as Brackish Wetland Aggregate in the current project bear a similarity to variants of Coastal

Saltmarsh. Where *J. kraussii* becomes dominant in this vegetation, it can superficially resemble a drier variant of Estuarine Wetland (EVC 10). The pragmatic solution to these variations was to adopt a broad characterisation of Brackish Wetland Aggregate which is variously presumed to have been influenced by increased salinity and a history of modified land-use.

Provisional BCS: Endangered.

Coastal Dry Saltmarsh (provisional EVC A110)

This provisional EVC is a component of the Aggregate EVC Coastal Saltmarsh, and refers to relatively species-poor vegetation dominated by halophytic herbs or semi-shrubs, occurring in salinised sites which are above the regular tidal range and only infrequently inundated. While some examples of vegetation referred to salinised variants of Brackish Wetland Aggregate during the current study strongly resemble this provisional EVC, the EVC label was used conservatively, and reserved for vegetation which consistently lacked less salt tolerant species and was of open structure with salinised bare ground evident in the spaces between plants. It was recorded from Heart Morass, primarily within a relatively extensive patch in the north-east corner, adjacent to Lake Wellington. The main species at Heart Morass were *Sarcocornia quinqueflora* (Beaded Glasswort) and *Disphyma crassifolium* (Rounded Noon-flower). See notes under Coastal Saltmarsh Aggregate.

Provisional BCS: Endangered.

Coastal Saline Grassland (provisional EVC A109)

This provisional EVC is a component of the Aggregate EVC Coastal Saltmarsh, and refers to dense, species-poor vegetation dominated by the rhizomatous, salt-tolerant grasses *Distichlis distichophylla* (Australian Salt-grass) and/or *Sporobolus virginicus* (Salt Couch). It occurs on the outer edges of saltmarsh, where it is subject to some reduced salinity due to seepage from adjacent areas. This vegetation can be difficult to distinguish from modified Brackish Grassland, however in the latter the performance of these grasses is typically less vigorous and a range of less salt tolerant species is usually present. Vegetation referable to Coastal Saline Grassland was noted along the wetland verge in the south-eastern corner of Dowd Morass, where it was mapped as Map unit 521. While the majority of the saltmarsh in the north-eastern corner of Heart Morass is mostly referable to Dry Coastal Saltmarsh, small areas within this zone support vegetation matching the description of Coastal Saline Grassland, but

were not distinguished separately on the mapping. See notes under Coastal Saltmarsh Aggregate.

Provisional BCS: Rare.

Coastal Saltmarsh Aggregate (EVC 9)

This EVC refers to vegetation potentially dominated by a range of salt-tolerant, usually under influence of at least highest tides, but sometimes extending to other salinised sites in near coastal sites. It can be difficult to precisely delineate Coastal Saltmarsh from more salinised versions of both Brackish Wetland Aggregate (see notes under this latter EVC) or degraded versions of Brackish Grassland. Rightly or otherwise, for pragmatic reasons this study has adopted a relatively narrow perspective on coastal saltmarsh. It was mapped only in restricted areas of the further eastern parts of the two morasses in the vicinity of Lake Wellington, with additional very small patches recorded in fringing sites along the northern boundary of Heart Morass, where it was associated with particularly saline seepage which may have been enhanced by irrigation. Where saline floodwaters have killed off *Melaleuca ericifolia* (Swamp Paperbark) stands in parts of the effectively inaccessible, far-western portion of Dowd Morass, further areas of vegetation matching Coastal Saltmarsh may have developed. However, if so this could not be determined during the current study, and these areas will not be separated in the mapping from the broader expanses mapped as Estuarine Scrub or Open water/bare ground.

Boon *et al.* (2014) provided resolution of the Coastal Saltmarsh Aggregate, defining a number of components which have not yet received formal recognition as EVCs by DELWP, but which are outlined as provisional EVCs in the Index of Wetland Condition support materials. Of these, the main components in the areas mapped on the periphery of the morasses include Coastal Dry Saltmarsh and to a lesser extent Coastal Saline Grassland. These are outlined separately above, and the areas in which they predominated were mapped as Map units 511 and 521 respectively.

Provisional BCS: Depleted.

Damp Melaleuca Scrub (EVC 948)

This EVC refers to scrub or shrubland vegetation dominated by *Melaleuca ericifolia* (Swamp Paperbark) over a ground-layer dominated by terrestrial species. The ground-layer is often grassy-herbaceous and bryophytes (mosses and liverworts) can be conspicuous. This vegetation type has limited occurrences as a narrow band fringing parts of the wetlands, notably along the southern edge of the western part of Dowd Morass and on the verge of Freshwater hole at Heart Morass. Where occurring on a sufficient scale to represent, it is mapped as Map unit 201. In the lower Latrobe wetlands, *Poa labillardierei* (Common Tussock-grass) is prevalent in the ground-layer of more open stands with *Microlaena stipoides* (Weeping Grass) more usual in denser stands.

BCS: Not available (previously not distinguished from Swamp Scrub, BCS Endangered).

Damp Sands Herb-rich Woodland (EVC 3)

This EVC refers to vegetation potentially dominated by a range of eucalypts, occurring on relatively fertile sandy soils. *Pteridium esculentum* (Austral Bracken) is frequently conspicuous in the ground-layer, and tough leaved monocots such as *Lomandra longifolia* (Spiny-headed Mat-rush) and *Ficinia nodosa* (Knobby Club-sedge) can also be prevalent. A range of grasses, forbs and geophytes is also typically present in relatively intact examples. This vegetation type occurs to the south of Dowd Morass, where at its best development it is dominated by *Eucalyptus viminalis* subsp. *pryoriana* (Coast Manna-gum), but can also include *Eucalyptus tereticornis* subsp. *mediana* (Gippsland Red-gum) as an overstorey dominant. Much of the fringing zone above the wetland on the south side of Dowd Morass is presumed to have supported woodland vegetation dominated by *E. tereticornis* which would have been best referred to Plains Grassy Woodland, even if present only as a relatively narrow band around the swamp verge. However, it is likely that some of the small degraded remnants along this fringe have been derived from vegetation which would have either matched or been ecotonal towards Damp Sands Herb-rich Woodland. In the absence of more definitive information these small patches have been mapped as Plains Grassy Woodland/Damp Sands Herb-rich Woodland. These potentially ambiguous sites have been mapped as Map units 401, 403 and 404, with these variations being indicative of persistence or otherwise of some understorey species, or the presence of salt-tolerant ground-layer species.

BCS: Vulnerable.

Dwarf Floating Aquatic Herbland (EVC 949)

This EVC refers to vegetation dominated by very small, floating aquatic plants, of which the most common species variously include the minute flowering plant *Lemna disperma* (Common Duckweed), the floating fern *Azolla filiculoides* (Pacific Azolla) and the liverwort *Ricciocarpus natans* (Fringed Heartwort). It occurs as components of both temporal and spatial mosaics, and the distribution of the indicative plants can be influenced by the effects of wind. While it can be a component within the range of Map units allocated to aquatic vegetation, particularly those providing open water with some protection from the action of wind and waves, the spatially and temporally transitory character of this EVC prohibits sensible mapping of its distribution. The relevant species were observed at Sale Common and in the fresher parts of Heart Morass.

Provisional BCS: Least Concern.

Estuarine Reedbed (EVC 952)

This EVC refers to vegetation dominated by *Phragmites australis* (Common Reed) in association with a component of salt-tolerant species. The stature of the *P. australis* plants is reduced by the effects of increased salinity, relative to the taller stands of less saline sites which are referred to variants of Tall Marsh. This vegetation was recorded from small areas of both Heart Morass and Dowd Morass and is mapped as Map unit 501. Extensive areas of vegetation dominated by *P. australis* occur in the eastern parts of both Heart Morass and Dowd Morass where they are potentially influenced by salinity from Lake Wellington as well as freshwater inputs from the Latrobe River. Due to poor accessibility of the sites it remains unclear the extent to which this vegetation best fits the descriptions of Tall Marsh or Estuarine Reedbed. Consequently the current extent of Estuarine Reedbed within these areas may be under-estimated in the mapping. Within the lower Latrobe wetlands, most patches of the vegetation referred to Estuarine Reedbed are considered likely to have developed as a consequence of anthropogenic modification of the Gippsland Lakes system. However, some occurrences may be a reflection of natural inputs of salinity from ground-water seepage.

Provisional BCS: Endangered.

Estuarine Scrub (EVC 953)

This EVC refers to vegetation dominated by *Melaleuca ericifolia* (Swamp Paperbark), variously with *Myoporum insulare* (Common Boobialla) also prevalent, in association with a ground-layer in which salt-tolerant herbaceous species are typically prevalent, and sometimes also including *Juncus kraussii* (Sea Rush). This vegetation type is widespread in the eastern parts of the morasses, and is particularly extensive in Dowd Morass. It is likely that some areas on the periphery of the wetlands naturally supported this vegetation type, where stands of *M. ericifolia* occurred in association with seepage of brackish ground-water. However, the greater majority of the vegetation currently referred to this EVC is considered to have developed from Swamp Scrub as a consequence of anthropogenic modification of the Gippsland Lakes system. Extensive die-back of *M. ericifolia* has occurred as a consequence of saline flooding from Lake Wellington, resulting in an often dense shorter layer of regeneration beneath dead trunks and scattered taller surviving stems. Two Map units were used (541 and 542), respectively for stands where the structural dominant has survived, and areas (typically on grazed private land) where this species is mostly represented by dead stems. See notes under Coastal Saltmarsh in relation to the potential mortality of stands of *M. ericifolia* within inaccessible eastern areas of the morasses.

Provisional BCS: Endangered.

Floodplain Riparian Woodland (EVC 56)

This EVC refers to eucalypt-dominated vegetation representative of lowland floodplain habitats. This vegetation type occurs adjacent to the Latrobe River, with small remnants also persisting along Flooding Creek. Remnants of this vegetation in varying condition are present in each of the wetlands. Substantial areas have been allowed to regenerate following the cessation of agricultural practises, particularly in the Wet Trust portion of Heart Morass, and there has been extensive revegetation undertaken, particularly at Sale Common and in parts of Heart Morass. The main tree species in the lower Latrobe wetlands are *Eucalyptus camaldulensis* (River Red-gum), *Eucalyptus tereticornis* subsp. *mediana* (Gippsland Red-gum), and apparent intermediates between these two. In relatively intact examples a mid-storey including a range of shrubs and small trees is present, particularly along the river levees, with a range of *Acacia* (Wattle) species and *Melicytus dentatus* (Tree Violet) often prevalent. *Poa labillardierei* (Common Tussock-grass) is frequently prevalent in the ground-layer, with *Carex* (Sedge) species occasionally locally conspicuous in low-lying patches.

Where flooding is more frequent, *Melaleuca ericifolia* (Swamp Paperbark) and *Phragmites australis* (Common Reed) become more prevalent in the vegetation. Small areas of woodland on the floodplain within the morasses include salt tolerant species in the ground-layer, with the condition of the associated trees varying from apparently healthy to very poor. A range of Map units have been used to indicate general variation in condition and maturity / means of origin of the stands. These include Map units 301, 302, 303, 304, 305, 306 and 307.

BCS: Endangered.

Floodplain Wetland Aggregate (EVC 172)

This is an aggregate EVC used to describe the range of wetlands occurring on lowland floodplains. These are typically associated with the residues of prior channels and floodways, and are variously sustained by combinations of flooding, ground-water or rainfall run-off from adjacent land. The larger residual cut-off meanders in the study area are described under Billabong Wetland, with the Floodplain Wetland Aggregate being here used for smaller, more seasonal wetlands which are not so readily described as billabongs. The latter label was used to map a couple of small wetlands near the Latrobe River within the Wet Trust area (as Map units 071, 072), and some others on private land to the near north-west of the extent of the extensive wetlands of Heart Morass and adjacent to Sale Common. These small wetlands supported grassy-herbaceous vegetation. A range of significant species have been previously recorded from the fresher of the small wetlands within the Wet Trust area, where the vegetation has affinities with Plains Grassy Wetland, but most of the prior diversity of this site was not evident during the current study due to the dominance of introduced grasses. Other small but potentially relevant patches of seasonal wetland may have been overlooked during the current study due to the extremely vigorous growth of *Paspalum distichum* (Water Couch) which has occupied low-lying parts of the floodplain as a consequence of the recent wet summers.

Provisional BCS: Endangered.

Floodway Pond Herbland (EVC 810)

This EVC refers to vegetation dominated by small herbs which grow on exposed mud following wetland drawdown. Towards the end of this project this vegetation type had commenced developing around the exposed edges of the wetlands at Sale Common.

Component species at this location included *Centipeda elatinoidea* (Creeping Sneezeweed),

Callitriche sonderi (Matted Water-starwort), *Fimbristylis velata* (Veiled Fringe-sedge), *Limosella australis* (Austral Mudwort) and *Persicaria lapathifolia* (Knotweed). This EVC is included as a temporal component with open water in two Map units (002 and 012), with the second of these also including a component of scattered *Juncus ingens* (Giant Rush) in mosaic.

Provisional BCS: Endangered.

Indeterminate EVC - *Carex longebrachiata* sedgeland (EVC 55/999)

The relevant vegetation, comprising a species-poor sedgeland dominated by a species which was presumed to be *Carex longebrachiata* (Bergalia Tussock), but fertile material was lacking. This vegetation type had an extremely localised occurrence towards the south-west corner of Dowd Morass. While the relevant EVC remains somewhat indeterminate, this vegetation is presumed to have been at least largely derived from a variant of Plains Grassy Woodland /

Damp Sands Herb-rich Woodland. It was mapped as Map unit 411.

BCS: Not available. Presumed derived from vegetation with BCS of endangered or vulnerable.

Indeterminate EVC - Disturbed habitats (EVC 999)

This default EVC was used for modified dryland sites, such as those dominated by introduced grasses, non-native plantations, crops, levees, embankments and buildings (Map units 611, 621, 631, 701). It was also used in a symbolic mosaic with the generalised EVC label 'Wetland Formation', to indicate wetland habitats dominated by introduced species (Map units 601, 602, 603 and 604).

Provisional BCS: Not available.

Plains Grassland (EVC 132)

This EVC refers to terrestrial vegetation dominated by native tussock grasses, notably members of the genera *Themeda*, *Rytidosperma*, *Austrostipa* and *Poa*. In relatively intact examples, the inter-tussock spaces typically support a range of non-halophytic forbs and geophytes. This EVC is associated with relatively fertile soils. Areas of species-poor

grassland dominated by *Poa labillardierei* (Common Tussock-grass) occur at Dowd Morass and Heart Morass. While it is likely that these grasslands have at least mostly been derived through prior clearing of trees from vegetation referable to Floodplain Riparian Woodland, it is possible that some of these areas may have been naturally treeless, in which case the closest relevant EVC would be Plains Grassland. Consequently these grasslands are ambiguously attributed to a symbolic mosaic including both of these EVCs. They have been mapped as Map unit 211.

BCS: Endangered.

Plains Grassy Wetland (EVC 125)

This EVC refers to vegetation dominated by inundation tolerant grasses and other semi-aquatic herbs, occupying shallow, seasonally inundated wetlands on fertile, heavy soils. Vegetation with these characteristics has been previously reported from the Wet Trust portion of Heart Morass, but was not recognizable during the current study due to heavy growth of *Paspalum distichum* (Water Couch) following recent wet summers. An example of this EVC was reported from a small wetland here mapped under the EVC Floodplain Wetland Aggregate (as Map unit 071). It may well have also occurred in areas which were dominated by *P. distichum* and mapped as disturbed versions of the generalised default EVC 'Wetland Formation' (under Map unit 611) during the current study, given that scattered plants of indicator species such as *Glyceria australis* (Austral Sweet-grass), *Eleocharis acuta* (Common Spike-sedge) and *Cycnogeton* spp. (Water Ribbons) were evident in some of these locations. Whether these areas would revert to more native vegetation under seasonally drier conditions is not known.

Provisional BCS: Endangered.

Plains Grassy Woodland (EVC 55)

This EVC refers to open eucalypt-dominated woodland vegetation which was previously extensive on more elevated fertile soils around the wetlands, particularly to the north. The ground-layer of the prior vegetation was grassy, with a range of forbs and geophytes also present. This vegetation has been comprehensively modified, and only a very small proportion of the original extent persists. Some small degraded remnants persist in the study area, and other areas have been allowed to regenerate or otherwise revegetated. Map units 402, 405 and 406 have been used to indicate maturity and/or means of origin of the stands.

Some small patches along the southern boundary of Heart Morass were mapped as Plains Grassy Woodland/Damp Sands Herb-rich Woodland. These potentially ambiguous sites have been mapped as Map units 401, 403 and 404. For additional context, see the explanatory notes under Damp Sands Herb-rich Woodland.

BCS: Endangered.

Spike-sedge Wetland (EVC 819)

This EVC refers to species-poor vegetation dominated by small species of *Eleocharis*, usually *E. acuta* (Common Spike-sedge). It has localised occurrences in shallow seasonal wetland habitat in the north-western portion of Dowd Morass, where it has been mapped as unit 081. In this area, this vegetation appears to largely comprise mono-specific swards of *E. acuta*, but can include a minor component of herbaceous species shared with Brackish Wetland Aggregate in the vicinity of where these two vegetation types abut.

Provisional BCS: Vulnerable.

Submerged Aquatic Herbland (EVC 918)

This EVC refers to vegetation dominated by submerged aquatic herbs, notably *Vallisneria australis* (Eel Grass) and some *Myriophyllum* spp. (e.g. *M. salsugineum*: Lake Water-milfoil). While it has been reported that *V. australis* previously occurred as extensive stands within Dowd Morass, this species was not observed in the wetlands during the current survey. It is unknown whether or not this species will return under more favourable conditions. Incidental plants of *M. salsugineum* were observed in Heart Morass, but nowhere near in sufficient numbers to warrant recognition as forming a plant community. In the absence of current evidence of representation, this EVC was not mapped.

Provisional BCS: Endangered.

Swamp Scrub (EVC 53)

In the lower Latrobe wetlands, this EVC refers to vegetation dominated by *Melaleuca ericifolia* (Swamp Paperbark) occurring in association with lower strata species characteristic of fresh to partly brackish wetland habitats. In denser stands, the ground-layer can be minimal, being restricted to sparse small sedges and aquatic to semi-aquatic herbs. In relatively open stands, a more substantial component of aquatic herbs or *Phragmites australis*

(Common Reed) can be present. This vegetation occurs in less saline parts of the morasses and was mapped as unit 111, and as a component of mosaics with Aquatic Herbland and Wet Sedgy Herbland (Map units 051 and 101). It is restricted in extent at Sale Common.

Vegetation intermediate in character between the descriptions of Floodplain Riparian Woodland and Swamp Scrub, occurred in more inundation prone areas of woodland at Dowd Morass and Sale Common, and was mapped as unit 131. Vegetation comprising scattered *M. ericifolia* within otherwise open water or mud-flat was mapped as unit 021.

Provisional BCS: Endangered.

Tall Marsh (EVC 821)

This EVC refers to wetland vegetation dominated by tall robust graminoids (variously reeds, rushes, and sedges). In well-developed examples these plants form dense, species-poor swards. These are mapped, according to the dominant genus, as units 061, 062, 063 and 064. The dominant species variously include *Phragmites australis* (Common Reed), *Typha* spp. (Cumbungi), *Bolboschoenus medianus* (Marsh Club-sedge), *Bolboschoenus fluviatilis* (Tall Club-sedge) and *Juncus ingens* (Giant Rush), of which *P. australis* forms the most extensive stands within the study area. The scrambler *Calystegia sepium* can also be conspicuous within stands of *P. australis*. Open water / mud flats including sparse components of several of these species (other than *Bolboschoenus* spp.) were for practical purposes interpreted as mosaic units including open water and components of Tall Marsh (units 011, 012, 013 and 014), and in the case of unit 012, with Floodway Pond Herbland as an additional temporal component. Vegetation referable to Tall Marsh can be a component of other mosaic units (e.g. with other aquatic vegetation, notably Aquatic Herbland, in units 041 and 042), or in vegetation transitional/ecotonal to Floodplain Riparian Woodland (unit 121).

Provisional BCS: Endangered.

Unvegetated (open water / mud flat) (EVC 990)

This default EVC refers to areas lacking vascular vegetation. As well as occurring as an apparently long-term condition, this habitat type may also occur as part of a temporal mosaic with vegetated EVCs (e.g. those characterised by herbs which germinate on exposed mud). It is also a component of a range of spatial mosaics where small patches or clumps of wetland plants are interspersed with open water. This EVC is mapped as units 001 and 002 where either long-term or potentially occurring as part of a temporal mosaic, and also occurs as a

component of a range of other sparsely vegetated units (011, 012, 013, 014, 015, 021, 031 and 042).

Provisional BCS: Not available.

Wet Sedgy Herbland (provisional EVC A116)

This provisional EVC refers to species-poor seasonal wetland vegetation dominated by herbaceous monocots other than grasses, but sometimes including sparse, taller emergent rushes. It has been included within the IWC support materials, but is yet to be formally recognised by DELWP. It is dominated by *Isolepis inundata* (Swamp Club-sedge) and robust forms of *Triglochin striata* (Streaked Arrowgrass), variously with *Eleocharis acuta* (Common Spike-sedge) and/or *Eleocharis pusilla* (Small Spike-sedge), and includes a sparse component of aquatic to semi-aquatic herbs. It has localised occurrences in the south-eastern corner of Dowd Morass and in the vicinity of Freshwater Hole at Heart Morass. It was mapped as unit 091, and as a component of unit 101 where occurring in mosaic with Swamp Scrub.

Provisional BCS: Endangered.

Wet Verge Sedgeland (EVC 932)

This EVC refers to vegetation dominated by species of *Carex*, notably *C. appressa* (Tall Sedge), and medium-sized species of *Juncus* (Rush). It can occur in a range of shallow wetland habitats including the verges of billabongs and swamps of cooler parts of the State, frequently occurring as narrow bands or parts of broader vegetation mosaics. It has extremely limited occurrences in the lower Latrobe wetlands (e.g. in the south-eastern corner of Dowd Morass and at Sale Common), but is likely to have been more extensive prior to their modification. These occurrences were present as very narrow bands or very small patches within more complex mosaics, but were too restricted in extent to map discretely.

Provisional BCS: Vulnerable.

Wetland Formation [undefined EVC] (EVC 74)

This EVC label has been used as general default unit for wetland vegetation which has not been allocated to a defined EVC. In the current study it was used in two contexts. The first of these was to map apparently modified native vegetation for which no other label was available (as part of a mosaic including sparse *Juncus pallidus* (Pale Rush) with *Eleocharis pusilla*

(Small Spike-sedge) and open water in the case of unit 015). The second of these was for wetland vegetation largely dominated by introduced species such as inundation tolerant grasses or willows, where it was used as a component of a mosaic with the default EVC 999 ('unclassified') which was used for modified sites dominated by introduced species. The purpose of allocating this mosaic unit was to indicate wetness and consequently distinguish these sites from modified dryland habitats. These disturbed wet sites were variously mapped as units 601, 602, 603 and 604. Some of these sites (notably those mapped within unit 601) may be determined as other wetland types such as Plains Grassy Wetland, Spike-sedge Wetland or possibly Wet Sedgy Herbland, should climatic conditions and inundation regimes become less favourable for species such as *Paspalum distichum* (Water Couch) which are currently severely limiting the expression of native species.

Provisional BCS: Not available.

4.7 OUTLINE OF THE MAPPING UNITS

A brief outline of the mapping units follows. They are grouped on the basis of generalised habitat characteristics.

Open water / exposed mud, variously including vegetation which expresses on exposed mud

001: Open Water (+/- *Eleocharis parvula* submerged to emergent herbland, potentially in temporal mosaic with 091 or species characteristic of Brackish Lakebed Herbland).

002: Open Water +/- Floodway Pond Herbland in temporal mosaic (Sale Common).

Open water with scattered emergents

011: Open Water - scattered *Juncus ingens*.

012: Open water - scattered *Juncus ingens* - Floodway Pond Herbland (Sale Common).

013: Open Water - sparse *Phragmites australis*.

014: Open Water - sparse *Typha* spp.

015: Open Water - *Juncus pallidus* - *Eleocharis pusilla*.

021: Open water - scattered *Melaleuca ericifolia*.

Lagoons / billabongs

031: Lagoons / Billabongs - Open water, various EVCs including similar to Map unit 042.

Aquatic herblands and sedgeland and associated vegetation mosaics

041: Weedy Aquatic Herbland - Tall Marsh complexes (Sale Common).

042: Modified Aquatic Creek-line / drain (Aquatic Herbland - Aquatic Sedgeland: *Eleocharis sphacelata*, *Myriophyllum amphibium*, *Azolla filiculoides* +/- *Typha* spp., *Phragmites australis* etc.).

043: *Eleocharis sphacelata* (Aquatic Sedgeland).

051: Swamp Scrub - Weedy Aquatic Herbland Mosaic (*Melaleuca ericifolia* - *Myriophyllum aquaticum* - *Cycnogeton* spp.).

Tall dense reedbeds, rushlands and sedgeland (Tall Marsh)

061: *Phragmites communis*.

062: *Juncus ingens*.

063: *Typha* spp.

064: *Bolboschoenus medianus* (in part also *Bolboschoenus fluviatilis*).

Small seasonal wetlands on floodplains

071: Floodplain Wetland Aggregate (*Glyceria australis* - *Amphibromus* spp. - *Paspalum distichum*).

072: Brackish wetland depressions on Floodplain (*Chenopodium glaucum* - *Eleocharis acuta* - *Paspalum distichum*).

Low sedgy wetlands

081: *Eleocharis acuta* Spike-sedge Wetland.

091: *Isolepis inundata* - *Triglochin striata* s.l. herbland (+/- *Eleocharis acuta*, *Eleocharis pusilla*, *Eleocharis parvula*, +/- occasional *Juncus ingens*) (Wet Sedgy Herbland).

Swamp scrubs (note also Map unit 051)

101: *Melaleuca ericifolia* Swamp Scrub / *Isolepis inundata* - *Triglochin striata* s.l. herbland (Wet Sedgy Herbland) mosaic.

111: *Melaleuca ericifolia* Swamp Scrub.

Floodplain Riparian Woodland transitions to Tall Marsh / Swamp Scrub

121: *Eucalyptus camaldulensis* - *Phragmites australis*.

131: *Eucalyptus camaldulensis* - *Melaleuca ericifolia* - *Phragmites australis*.

Damp scrub or more open shrubland (non-saline, non-wetland)

201: Damp Melaleuca Scrub (*Melaleuca ericifolia*, with e.g. *Poa labillardierei* or *Microlaena stipoides*).

Tussock grassland (non-saline, non-wetland)

211: *Poa labillardierei* Grassland (non-saline - presumed at least largely derived from Floodplain Riparian Woodland).

Floodplain Riparian Woodland

301: Floodplain Riparian Woodland with *Poa labillardierei*.

302: Floodplain Riparian Woodland, generally weedy but with a native understorey component (e.g. *Melicytus dentatus*).

303: Floodplain Riparian Woodland with predominantly introduced ground-layer.

304: Floodplain Riparian Woodland with +/- brackish wetland understorey component.

305: Floodplain Riparian Woodland with +/- brackish grassland understorey component.

306: Regeneration / revegetation - primarily species from Floodplain Riparian Woodland (or in habitat).

307: Older dense plantations of species from Floodplain Riparian Woodland (or in relevant habitat).

Plains Grassy Woodland / Damp Sands Herb-rich Woodland (and associated sedgelands)

401: Plains Grassy Woodland / Damp Sands Herb-rich Woodland with remnant understorey component.

402: Plains Grassy Woodland with modified (primarily introduced) understorey.

403: Plains Grassy Woodland / Damp Sands Herb-rich Woodland with +/- Brackish Grassland understorey component.

404: Plains Grassy Woodland / Damp Sands Herb-rich Woodland with *Carex longebrachiata* dominated understorey.

405: Regeneration / revegetation - primarily species from Plains Grassy Woodland (or in relevant habitat).

406: Older dense plantations of species from Plains Grassy Woodland (or in relevant habitat).

411: *Carex longebrachiata* sedgeland.

Saline reedbeds

501: Estuarine Reedbed (*Phragmites australis* - halophytes).

Saltmarsh and brackish wetlands

511: Coastal Saltmarsh Agg. - mostly Dry Coastal Saltmarsh (*Sarcocornia quinqueflora* - *Disphyma crassifolium*).

521: Coastal Saltmarsh Agg. - Coastal Saline Grassland (closed *Distichlis distichophylla* - *Sporobolus virginicus*).

531: Brackish Wetland Aggregate (*Selliera radicans* - *Isolepis cernua* - *Triglochin striata*, +/- *Juncus kraussii*, *Juncus pallidus*, *Eleocharis acuta*, *Mimulus repens*).

532: Brackish Wetland Aggregate (*Bolboschoenus caldwellii* / *Sarcocornia quinqueflora* with other salt tolerant herbs).

533: *Aster subulatus* - *Atriplex prostrata* - *Atriplex australasica* - *Polygonum aviculare* s.l. herbland (marginal zones of Brackish Wetland Aggregate).

Brackish / saline scrub and shrublands

541: Estuarine Scrub (*Melaleuca ericifolia* - halophytes).

542: Modified Estuarine Scrub (primarily dead *Melaleuca ericifolia* with salt-tolerant herbs as for brackish wetland).

Brackish grasslands (non-wetland)

551: Brackish Grassland (*Poa labillardierei* - *Selliera radicans* - *Sporobolus virginicus* - *Distichlis distichophylla* - *Disphyma crassifolium*).

552: Modified Brackish Grassland (weedy, open *Distichlis distichophylla* - *Sporobolus virginicus*).

Disturbed wet sites dominated by introduced grasses (sometimes with robust short-lived, introduced herbs)

601: Wet *Paspalum distichum* (sometimes with dense growth of introduced herbs - e.g. *Aster subulatus*, *Conyza sumatrensis*), with component of *Eleocharis acuta*, *Cycnogeton* spp., etc.

602: *Juncus amabilis* - *Paspalum distichum* open rushland.

603: *Phalaris arundinacea* closed grassland (+/- *Paspalum distichum*).

Disturbed dry to damp sites largely dominated by introduced grasses

611: Disturbed: Anthropogenic grasslands (Dampland to Terrestrial - primarily introduced grasses - e.g. *Paspalum distichum*, *Dactylis glomerata*, *Cenchrus clandestinus*, *Holcus lanatus*, *Phalaris aquatica*, *Lolium rigidum*; but sometimes *Rytidosperma* spp. and/or *Hemarthria uncinata* can be locally conspicuous). Including small areas of *Hemarthria uncinata* (damp grassland).

Vegetation dominated by introduced woody species

621: Exotic plantations.

622: Willows (main stands).

Other highly modified sites

631: Crops.

701: Modified - levees, embankments, buildings and associated grounds, etc.

4.8 SUMMARY OF EVCs REPRESENTED BY MAPPING UNITS

The following list provides an inventory of the EVCs (including complexes and mosaics) for which polygons were mapped and the relevant included Map units.

- Billabong Wetland (EVC 334) [Map unit 031].
- Brackish Grassland (EVC 934) [Map units 551, 552].
- Brackish Wetland Aggregate (EVC 656) [Map units 531, 532, 533].
- Coastal Saltmarsh Aggregate (EVC 9 (A109), provisional EVC A109 Coastal Saline Grassland [Map unit 521].
- Coastal Saltmarsh Aggregate (EVC 9), (mostly) provisional EVC A110 Coastal Dry Saltmarsh (A110) [Map unit 511].
- Complexes and mosaics involving Aquatic Hermland, Tall Marsh and other minor component EVCs (including weedy/ modified sites) (EVC 653/821) [Map units 041, 042].
- Damp Melaleuca Scrub (EVC 948) [Map unit 201].
- Disturbed dampland to terrestrial habitats (EVC 999), largely dominated by introduced grasses [Map unit 611]; non-native plantations and crops [Map units 621, 631]; and modified sites - e.g. levees, embankments, buildings [Map unit 701].
- Disturbed wet habitats (EVC 999/74), dominated by introduced grasses [Map units 601, 602, 603] or willows [Map unit 662].
- Estuarine Reedbed (EVC 952) [Map unit 501].
- Estuarine Scrub (EVC 953) [Map units 541, 542].
- Floodplain Riparian Woodland (EVC 56) [Map units 301, 302, 303, 304, 305, 306, 307].
- Floodplain Wetland Aggregate (in part close to EVC 125 Plains Grassy Wetland) (EVC 172) [Map units 071, 072].
- Indeterminate EVC, presumed at least largely derived from a variant of Plains Grassy Woodland / Damp Sands Herb-rich Woodland (EVC 55/999) [Map unit 411: *Carex longibrachiata* sedgeland].

- Indeterminate EVC, presumed at least largely derived from Floodplain Riparian Woodland, but possibly including vegetation with affinities to Plains Grassland (EVC 56/132). *Poa labillardierei* grassland (non-saline) [Map unit 211].
- Mosaic of Swamp Scrub and (mostly weedy) Aquatic Herbland (EVC 653/53) [Map unit 051].
- Mosaic of Swamp Scrub and Wet Sedgy Herbland (EVC 53/A116) [Map unit 101].
- Plains Grassy Woodland (EVC 55) [Map units 402, 405, 406].
- Plains Grassy Woodland / Damp Sands Herb-rich Woodland (EVC 55/3). Plains Grassy Woodland, presumably including some prior stands of (or ecotones with) EVC 3, Damp Sands Herb-rich Woodland [Map units 401, 403, 404].
- Spike-sedge Wetland (EVC 819) [Map unit 081].
- Swamp Scrub (EVC 53) [Map unit 111].
- Tall Marsh (EVC 821) [Map units 061, 062, 063, 064].
- Transition/ecotone between Floodplain Riparian Woodland and Swamp Scrub (EVC 56/53) [Map unit 131].
- Transition/ecotone between Floodplain Riparian Woodland and Tall Marsh (EVC 56/821) [Map unit 121].
- Unvegetated (open water / mud flat) (EVC 990). Potentially in temporal mosaic with various aquatic and mud-flat EVCs [Map unit 001].
- Unvegetated (open water / mud flat), in transition to / with components of Tall Marsh (EVC 990/821) [Map units 011, 013, 014].
- Unvegetated (open water / mud flat), in transition to / with components of undefined EVC (referred to generalised unit 'Wetland Formation') (EVC 990/74). *Juncus pallidus* - *Eleocharis pusilla*: undefined vegetation possibly allied to Tall Marsh, Plains Rushy Wetland, Wet Sedgy Herbland or Spike-sedge Wetland [Map unit 015].
- Unvegetated (open water / mud flat), in transition to / with components of Swamp Scrub (EVC 990/53) [Map unit 021].
- Unvegetated / Floodway Pond Herbland (EVC 990/810) [Map unit 002].
- Unvegetated / Floodway Pond Herbland / with components of Tall Marsh (EVC 990/810/821) [Map unit 012].

- Wet Sedgy Herbland (previously undescribed EVC: provisional EVC A116) [Map unit 091].

The following EVCs were not assigned to Map units, due to either their extremely limited scale of expression within mosaics or the temporal transience of their expression:

- Aquatic Grassy Wetland (EVC 306)
- Brackish Lake Bed Herbland (EVC 539)
- Dwarf Floating Aquatic Herbland (EVC 949)
- Submerged Aquatic Herbland (EVC 918)
- Wet Verge Sedgeland (EVC 932).

5. INDEX OF WETLAND CONDITION

The Index of Wetland Condition (IWC) has been used by DEPI (now part of DELWP) and by Catchment Management Authorities (CMAs) for state-wide and regional wetland condition assessments. The IWC measures aspects of a wetland's soils, water, hydrology, physical form, plants, and the wetland catchment to provide an assessment of its health (condition). The information generated from IWC assessments is used by DEPI (now part of DELWP) and CMAs to identify and assess risks to wetlands, determine management priorities and monitor long-term trends in condition (DEPI, 2014c).

5.1 ASSESSMENT OF THE VEGETATION COMPONENT OF THE INDEX OF WETLAND CONDITION

Only assessment of the vegetation component (also referred to as the biota sub-index) of this method was required for the current project. This component utilises EVC-based benchmarks to assess four aspects of the vegetation: Critical life-forms (diversity and cover), lack of weeds, indicators of altered processes, and vegetation structure and health. In modified sites, as far as feasible, the IWC assessment is based on the pre-modification EVCs. If it is apparent that recognisable EVCs have replaced former EVCs (e.g. Coastal Saltmarsh has invaded a previously fresher site), then comment on the condition of the adventive vegetation relative to examples in less modified sites and implications for future management is made. However

such opportunistic communities are not properly amenable to a normal IWC assessment, given there is no clear way of addressing the altered processes component if the vegetation has established as the product of an altered process.

The vegetation component of the IWC (biota subindex) does not provide a score for open water or unvegetated mud flats. As the unvegetated condition can occur as a temporal mosaic with various aquatic or mud flat vegetation types, the vegetation score determined at a wetland can vary during different phases of the wetting and drying cycles. Consequently, in the case of such temporally variable wetlands, care needs to be taken before reaching conclusions based on differences in scores between assessments undertaken during different conditions. In such cases, it may be more helpful to focus on variations in the score obtained for particular EVCs rather than for the system as a whole.

The observations and interpretations used to allocate scores during the IWC assessment will be expanded on in a subsequent section of the report, to provide a more detailed interpretation of condition and processes influencing condition.

5.2 DISTRIBUTION OF THE MAP UNITS ACROSS THE WETLAND AREAS AND APPLICATION OF THE VEGETATION COMPONENT OF THE IWC

Table 1 displays the Map units, the relevant EVCs, and in which portions of the wetlands they were recorded. It also shows the relevance of the Index of Wetland Condition vegetation benchmarks to each of the Map units.

The relevant sections of the wetland systems as utilised in Table 1 are shown on Map 3 (below). These sections of the wetlands and relevant codes are the same as used in the species lists for Appendix 2, other than this appendix does not provide separate species lists for the private land areas of Heart Morass other than the Wet Trust properties. For the purpose of interpreting the wetland condition, Heart Morass was assessed as comprising a range of different sections. This was in order to accommodate the different ownership and management histories at Heart Morass. The recent history of Sale Common and Dowd Morass has been under the one management, allowing the application of a simpler interpretation.

Scattered specimens of species characteristic of particular species can be dispersed through areas otherwise lacking vascular vegetation, but without developing the structure or diversity of the relevant EVC. Open water or unvegetated mud flats are not assessed by the vegetation component of the IWC. Similarly the vegetation component of the IWC is not able to sensibly

evaluate these habitats: If it were to treat these areas as extremely open examples of the relevant EVC, they would score extremely poorly and hence have an undue potential to greatly lower the overall score of the wetland. Consequently, in the current project, it was decided not to attempt to provide assessments for these very sparsely vegetated zones.

Some vegetation types can be intermediate between wetland and truly terrestrial vegetation. They may either occur in sites which are seasonally waterlogged due to seepage or subject to periodic brief flooding, or occur around the wetland boundary in such a way that while most examples are not truly wetland, the lowest lying areas or examples at some sites may at least in part constitute marginal wetland. Here these vegetation types are characterised as 'dampland'. The IWC provides benchmarks for a range of primarily dampland EVCs. This does not mean that these EVCs should be assessed wherever they occur, but merely provides benchmarks for those occasions where consideration of the relevant EVC is appropriate to an IWC assessment. Hence scores have been calculated for some EVCs (e.g. Floodplain Riparian Woodland and Brackish Grassland) for potential future reference or comparative purposes, but were not included in the calculations of the overall scores provided for the wetlands in Appendix 6.

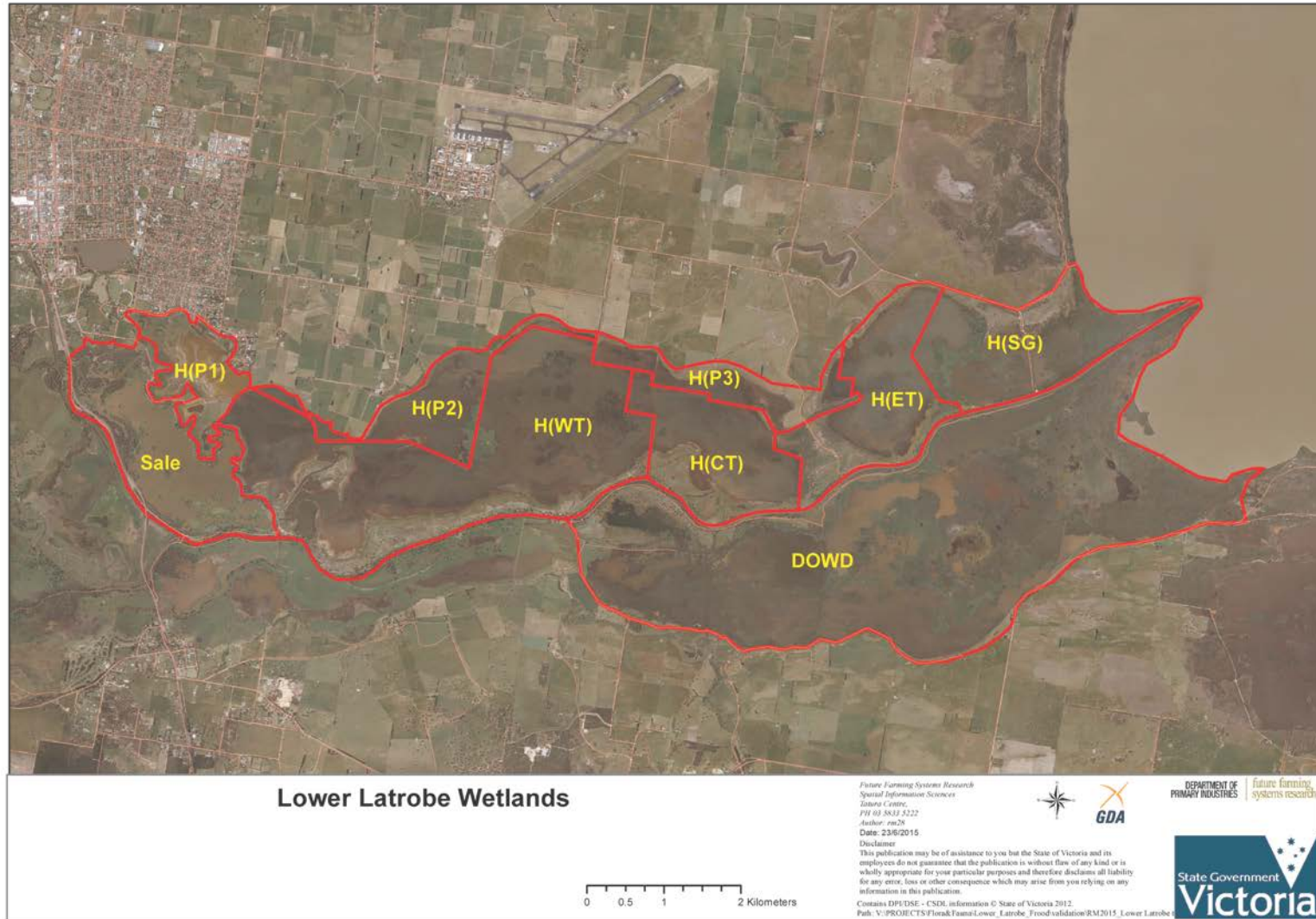
Codes for IWC relevance used in Table 1:

N: Map units which are wetland but were not assessed due to their lack of sufficient vegetation.

W: Map units which comprise Wetland and were assessed. In the cases of some of the more disturbed habitats the assessments may be somewhat provisional, being based on assumptions about the character of the prior vegetation.

D: Map units which comprise Dampland habitats.

T: Map units which comprise Terrestrial habitats.



Map 3. Sections of wetland as assessed for the vegetation component of the IWC.

TABLE 1. MAP UNITS RECORDED FROM WETLAND AREAS.

MAP UNIT	EVC	Sale Common	Heart Morass (P1)	Heart Morass (P2)	Heart Morass (P3)	Heart Morass (WT)	Heart Morass (CT)	Heart Morass (ET)	Heart Morass (SG)	Heart Morass (all)	Dowd Morass	IWC RELEVANCE	EVC name
001	990		X	X	X	X	X	X	X	X	X	N	Unvegetated (open water / mud flat)
002	990/810	X										W	Unvegetated / Floodway Pond Herbland
011	990/821			X	X	X	X	X	X	X	X	N	Unvegetated with components of Tall Marsh
012	990/810/821	X										W	Unvegetated / Floodway Pond Herbland / Tall Marsh
013	990/821			X	X	X	X	X		X	X	N	Unvegetated with components of Tall Marsh
014	990/821								X	X	X	N	Unvegetated with components of Tall Marsh
015	990/74				X					X		W	Open Water / Wetland Formation (indeterminate EVC)
021	990/53	X						X		X	X	N	Unvegetated, with components of Swamp Scrub
031	334	X	X		(X)		(X)	(X)		X		W	Billabong Wetland
041	653/821	X										W	Complexes and mosaics including Aquatic Herbland and Tall Marsh
042	653/821	X	(X)	X	X	(X)	X	(X)		X	X	W	Complexes and mosaics including Aquatic Herbland and Tall Marsh
043	308	X										W	Aquatic Sedgeland
051	653/53								X	X		W	Aquatic Herbland / Swamp Scrub mosaic
061	821	X	X	X	X	X	X	X	X	X	X	W	Tall Marsh
062	821			X		X	X	X		X		W	Tall Marsh
063	821	X		X	(X)	(X)		X	X	X		W	Tall Marsh
064	821	X	X	X		(X)				X	(X)	W	Tall Marsh
071	172	X	X			X				X		W	Floodplain Wetland Aggregate
072	172					X				X		W	Floodplain Wetland Aggregate

MAP UNIT	EVC	Sale Common	Heart Morass (P1)	Heart Morass (P2)	Heart Morass (P3)	Heart Morass (WT)	Heart Morass (CT)	Heart Morass (ET)	Heart Morass (SG)	Heart Morass (all)	Dowd Morass	IWC RELEVANCE	EVC name
081	819										X	W	Spike-sedge Wetland
091	A116						X	X		X		W	Wet Sedgy Herbland
101	53/A116						X	X		X		W	Swamp Scrub / Wet Sedgy Herbland
111	53	X				X	X	X	X	X	X	W	Swamp Scrub
121	56/821	X									X	W	Transition between Floodplain Riparian Woodland and Tall Marsh
131	56/53	X						X			X	W	Transition between Floodplain Riparian Woodland and Swamp Scrub
201	948							X	X	X	X	D	Damp Melaleuca Scrub
211	56/132					(X)	X	X	(X)	X	X	D	Plains Grassland / modified Floodplain Riparian Woodland
301	56					X	X	X	X	X	X	D	Floodplain Riparian Woodland
302	56	X	X					X			X	D	Floodplain Riparian Woodland
303	56	X	X			X	X	X	X	X	X	D	Floodplain Riparian Woodland
304	56							X	X			D	Floodplain Riparian Woodland
305	56										X	D	Floodplain Riparian Woodland
306	56	X	X	X		X	X	X	X	X	X	D	Floodplain Riparian Woodland
307	56											D	Floodplain Riparian Woodland
401	55/3										X	T	Plains Grassy Woodland or Damp Sands Herb-rich Woodland
402	55		X	(X)		(X)		(X)	X	X	X	T	Plains Grassy Woodland
403	55/3											T	Plains Grassy Woodland or Damp Sands Herb-rich Woodland
404	55/3											T	Plains Grassy Woodland or Damp Sands Herb-rich Woodland
405	55				X				X	X		T	Plains Grassy Woodland
406	55								X	X	X	T	Plains Grassy Woodland

MAP UNIT	EVC	Sale Common	Heart Morass (P1)	Heart Morass (P2)	Heart Morass (P3)	Heart Morass (WT)	Heart Morass (CT)	Heart Morass (ET)	Heart Morass (SG)	Heart Morass (all)	Dowd Morass	IWC RELEVANCE	EVC name
411	55/999										X	T	Indeterminate (presumed derived from modified Plains Grassy Woodland / Damp Sands Herb-rich Woodland)
501	952					X			X	X	X	W	Estuarine Reedbed
511	9 (A110)			X					X	X	(X)	W	Coastal Salt Marsh Aggregate (predominately Coastal Dry Saltmarsh)
521	9 (A109)										X	W	Coastal Salt Marsh Aggregate (Coastal Saline Grassland)
531	656			X	X	X	X	X	X	X	X	W	Brackish Wetland
532	656										X	W	Brackish Wetland
533	656										X	W	Brackish Wetland
541	953				X	(X)		X	X	X	X	W	Estuarine Scrub
542	953				X			X		X	X	W	Estuarine Scrub
551	934							X	X	X		D	Brackish Grassland
552	934				X		X	X	(X)	X	X	D	Brackish Grassland
601	999/74	X	X				X	X	X	X	(X)	W	Indeterminate / Wetland Formation (disturbed sites)
602	999/74										(X)	W	Indeterminate / Wetland Formation (disturbed sites)
603	999/74	X									X	W	Indeterminate / Wetland Formation (disturbed sites)
611	999	X	X	X	X	X	X	X	X	X	X	T/D	Indeterminate (disturbed terrestrial sites usually dominated by introduced species)
621	999	X									X	T	Indeterminate (disturbed terrestrial sites dominated by introduced species)
622	999/74	X										W	Indeterminate / Wetland Formation (disturbed sites)
631	999			(X)						(X)		T	Indeterminate (modified sites)
701	999	X	X	X	X	X		X	X	X	X	T	Indeterminate (modified sites)

5.3 IWC SCORES

The scores attributed to each relevant EVC, for each attribute of the assessments, in each of these wetland areas, are included as Appendix 6.

6. VEGETATION CONDITION, MANAGEMENT ISSUES AND RECOMMENDATIONS

6.1 CONTEXT

The dominant themes of the wetlands vary from extensive areas of open water, variously with scattered emergent clumps of reeds, rushes or paperbark shrubs, to dense thickets of paperbarks and reedbeds. These reedbeds and thickets can occur as an outer fringe or in parts extend across the wetland, the latter context being particularly prevalent in the eastern portions of the morasses abutting Lake Wellington. The more seasonal areas of the wetland support a variety of vegetation types, ranging from aquatic vegetation to herblands expressing on the muddy flats/floor following recession of the water, to various sedge and rush dominated communities. The wetlands were previously fringed by woodlands, mostly dominated by red gums, and possibly including patches of tussock grassland dominated by *Poa labillardierei* on heavy soils on the river flats. In addition, some small wetlands occurred in association with the woodland areas on the floodplains.

Salinity has influenced the vegetation of Dowd Morass and much of Heart Morass, whereas Sale Common has remained fresh. This salinity has arisen as a consequence of the artificial opening of the entrance to the Gippsland Lakes and, on a more localised scale, presumably naturally due to groundwater seepage around the verges of parts of the wetlands.

Consequently, a wide range of vegetation communities are represented in and fringing the wetlands, ranging from communities of highly saline conditions to those of freshwater habitats.

A range of fringing aquatic to semi-aquatic introduced plants prosper under warm and wet conditions, posing threats to the maintenance of diversity under prolonged shallow inundation, either following wet summers or artificial watering to encourage occupation by waterbirds.

While anecdotal evidence indicates that the wetlands previously supported extensive areas of submerged aquatic vegetation, notably Eel Grass (*Vallisneria australis*), these are no longer evident. This component of the vegetation is presumably suppressed by some combination of interrelated factors including sustained water depth through summer or lack of drawdown, substrate instability and associated turbidity, carp activity, and the effects of salinity.

Disturbance events such as major back-flooding of saline water from Lake Wellington during 1998 may also have been highly influential on the aquatic vegetation.

Floristic variation across time in the monitoring data, and differences in the fine-scale extent of the reed beds between the two sets of aerial photography, are indicative of both high seasonal variability and the potential for dynamic changes in the extent of expression of some of the vegetation communities within the wetlands. It is likely that this variability in the expression of the vegetation has been exaggerated by the extremes of variability in seasonal rainfall occurring during the previous decade.

Due to the extent of modification to the hydrology and the land-use history, determination of the range of vegetation communities which were likely present with the wetlands prior to these modifications, and the relative extent of their occurrence, can be extremely challenging and in part largely guesswork.

6.2 DYNAMICS OF THE WETLAND VEGETATION

From review of the monitoring data and observations during the field assessment, a number of relatively recent changes in the vegetation, or active processes potentially leading to vegetation change, are apparent at the wetlands. These variously include:

- Localised tree decline (presumably due to the effects of salt, drought or waterlogging).
- Extensive recruitment of red gum saplings, including within shallow fresh and brackish wetland habitats. Generally indicative of desirable regeneration of the woodland vegetation, but potentially of concern within the smaller wetlands, where some localised control appears desirable.
- Increase in extent and performance of introduced species favoured by warm and wet conditions (notably *Paspalum distichum*, *Eleocharis parvula* and *Myriophyllum aquaticum*).

- Apparent decline in wetland diversity in areas now occupied by dense *Paspalum distichum*.
- Increased density of *Phragmites australis* in the eastern part of Dowd Morass.
- Varied responses in smaller isolated patches of *Phragmites australis* (variously local dieback or expansion), presumably primarily as a response to increased wetness.
- Colonisation of some areas by *Melaleuca ericifolia*.
- Colonization of more elevated saline areas at Dowd Morass by *Sarcocornia quinqueflora*.
- Loss of the majority of the native aquatic component in less seasonal wetland areas.
- Dense local recruitment of *Juncus kraussii*.
- Dense recruitment of *Juncus gregiflorus* in the parts of the drawdown zone at Sale Common (however it is not known whether these plants will survive the next inundation event).

6.3 MANAGEMENT ISSUES IN RELATION TO THE VEGETATION CONDITION

The management issues largely relate to implementation of suitable wetting and drying regimes in the wetlands, management of salinity, introduced species (both plants and animals) and the impacts of recreational activities.

In more detail, these include:

- Timing, duration and extent of filling and subsequent drawdown in the wetlands.
- Lack of flushing of the wetlands, nutrient accumulations and algal blooms.
- Managing draw-down events in association with the risk of activating acid sulfate soils.
- Altered hydrology (inputs and drainage), and capacity for regulation of inflows into wetlands.
- Recruitment and performance of *Juncus ingens* according to different water regimes.
- Effects of shallow, warm season flushes on recruitment events and performance of competitive species (both native and introduced).

- Damage to native vegetation from revegetation activities.
- Impacts of recreational activities (loss of coarse woody debris as firewood, off-track vehicle use).
- Potential conflicts between optimal timing of draw-down events and demands for water availability in the wetlands (for shooting, wildlife refuge, aesthetic reasons, etc.).
- Impacts of salinity (inputs from Lake Wellington and intrusions of the saline wedge further upstream within the Latrobe River)
- Uncertain impacts of dynamics of brackish groundwater - at least in part natural - and its interplay with adjacent land-use practises and sustained inundation of the wetlands.
- Potential impacts of responses to manage saline intrusions
- Maintenance of species diversity in the wetlands, particularly of small herbs of damp to seasonally wet sites.
- Maintenance of habitat quality for the range of fauna using the wetlands, notably waterbirds.
- Maintenance of populations of rare/threatened species, in particular noting the small size of the *Eucalyptus ?strzeleckii* population.
- Management of introduced species, including plants, feral animals and intrusions of domestic stock.
- While some weed species are readily manageable (e.g. blackberries, willows) over broader areas, ranges of other high threat species (especially grasses) are not.
- Minimisation of off-target impacts of weed management, in particular ensuring that weed management activities such as spraying are not higher threats to the biodiversity / significant flora than the weeds would have been.
- It is noted that a high quality of weed control work is being achieved in the Wet Trust area, where blackberries have been effectively sprayed without killing the associated *Poa* tussocks, presumably through careful selection of suitable herbicides. This level of care and competence appears unfortunately rare in weed management on public land across much of the State.

Plants whose enhanced performance can provide indication of altered processes at the wetlands include *Eleocharis parvula*, *Paspalum distichum*, *Myriophyllum aquaticum*, *Eucalyptus camaldulensis* seedlings, *Juncus kraussii* and *Sarcocornia quinqueflora*. Grazing by domestic stock is not here considered to be an effective management tool for control of introduced grasses at the wetlands, as the impacts are highly likely to outweigh any benefits. A key management objective is to accommodate a balance between the relative extent of *Phragmites australis*, *Melaleuca ericifolia*, *Juncus ingens* and open water. *Typha domingensis* could also be included in these considerations, but is currently a relatively restricted and minor component of the vegetation. A recovery in the aquatic vegetation would be desirable, but it is not clear how this could be achieved.

6.4 INTERPETATION OF THE INDEX OF WETLAND CONDITION SCORING

The IWC is intended to be used to assess wetlands with their natural (i.e. pre-modification) condition as a reference. While the current vegetation which can be clearly allocated to a described EVC can be assessed using this method, these assessments can be presumed to be to some extent distorted by the altered habitat conditions in the lower Latrobe wetlands. Consequently it is not always possible to use the IWC method consistently with its intended perspective.

The major difficulties are encountered on the floor of the morasses, where it is unknown what the prior vegetation was and the current sparse vegetation structures are a poor match to existing EVC descriptions. Consequently the open areas of the wetlands are largely omitted from the current assessments as effectively unvegetated, but if they were assessed as, for example, Submerged Aquatic Herbland, this would generate an extremely low score for the wetland as a whole. Similarly at Sale, the Floodway Pond Herbland community developed on mud of the emergent verges scores highly, but the open water with sparse Giant Rush (*Juncus ingens*) is not amenable to scoring, at least in relation to the current expression of the vegetation. Hence, scores can be applied to areas of recognizable EVCs, allowing for a loose interpretation of altered processes (i.e. basing it purely on the current expression of the vegetation), but it can be very difficult to consistently integrate these into an overall score for the wetlands. At the lower Latrobe wetlands, more so than at many other wetlands, the overall scoring will be dependent on the phase in the wetting and drying cycles during which the wetland is scored.

6.5 WATER AND SALINITY CHARACTERISTICS OF THE EVCs

Information on the water and salinity characteristics of the EVCs recorded from the lower Latrobe wetlands is presented below as Table 2. This information has been extracted from the documentation which was used to prepare DSE (2012), with information for the additional provisional EVC A116 Wet Sedgy Herbland added. This later document (DSE, 2012) is currently under revision, which will include further annotation to refine the potential for application of this information.

Rather than defining optimal watering requirements, the information in this table allocates wetland EVCs to ranges of water and salinity regime. While not suggesting that the EVC occupies the entire range of the relevant categories, exceeding these ranges is likely to be deleterious to the relevant vegetation.

The outlined regimes are based on an assumption of average climatic conditions, and are not necessarily sustained during periods of protracted drought or extreme rainfall events. The listed characteristics are generalised and based on current perceptions – these may be subject to modification with increased understanding of the relevant EVCs.

It is noted that some of these EVCs also occur in habitats subject to tidal influence or in groundwater fed bogs, however these habitats are not considered relevant to the lower Latrobe wetlands.

Key to codes for categories used in Table 2:

Codes in brackets indicate that the relevant characteristic of the EVC can on occasion extend into part of the relevant range provided by the bracketed code.

Frequency categories

Code	Water regime category	Frequency of inundation
P	Permanent	Constant, annual or less frequently but before wetland dries
S	Seasonal	Annual or near annual inundation (e.g. 8-10 years in every 10)
I	Intermittent	Inundated 3-7 years in every 10
E	Episodic	Inundated less than 3 years in every 10
F	Fringing	Inundation periodic but brief

Duration categories

Code	Maximum usual event duration	
	Waterlogging	Inundation
1	Variable (fringing wetland)	Variable, usually brief
2	1-6 months	<1 month
3	>6 months	<1 month
4	1-6 months	1-6 months
5	>6 months	1-6 months
6		>6 months (but not permanent)
7		permanent

Maximum depth of regular or sustained inundation categories

1	< 30 cm
2	30 cm – 1m
3	1-2 m
4	>2 m

Salinity categories

Code	Salinity category	Lower salinity (mg/L)	Upper salinity (mg/L)
F	Fresh	0	3,000
B	Hyposaline	3,000	10,000
S	Mesosaline	10,000	50,000
H	Hypersaline	50,000	350,000

Phases of wetland during which EVC is represented (note that EVCs with continuous representation may exhibit greater diversity during wet or dry phases)

C	Continuous
I	Inundated
D	Drying

TABLE 2: WATER AND SALINITY CHARACTERISTICS OF THE EVCs

EVC NO.	EVC NAME	Frequency	Duration	Depth	Salinity	Phases
306	Aquatic Grassy Wetland	S, I	4, 5, 6	3	F	C
653	Aquatic Herbland	P, S	5, 6, 7	(2-) 3, 4	F (- B)	I (-D)
308	Aquatic Sedgeland	P, S	5, 6, 7	1, 2	F (- B)	C
334	Billabong Wetland (aggregate)	P, S, I	5, 6, 7	3, 4	F	C, I, D
934	Brackish Grassland	F	1, 2	1	B	C
538	Brackish Herbland	S, I, E	3, 4, 5	1, 2	B (- S)	D
539	Brackish Lake Bed Herbland	I, E	(5 -) 6	3	B	D
13	Brackish Sedgeland	I, E, F	1, 3, 4, 5	1, 2	B	C
656	Brackish Wetland Aggregate	S, I	3, 4, 5, 6	1, 2	B (- S)	C
A110	Coastal Dry Saltmarsh	F	2	1	S (- H)	C
A109	Coastal Saline Grassland	F	2, 3	1	S	C
9	Coastal Saltmarsh Aggregate	F	2, 3, 4, 5	1, 2	S - H	C
949	Dwarf Floating Aquatic Herbland	P, S, I, E	4, 5, 6, 7	2, 3 (- 4)	F	I
952	Estuarine Reedbed	P, S	5, 6	1, 2	B (- S)	C
953	Estuarine Scrub	F	1, 3	1	B (- S)	C
56	Floodplain Riparian Woodland	(I, E -) F	1	1	F	C
172	Floodplain Wetland Aggregate	S, I, E	2, 3, 4, 5, 6	1, 2, 3	F	C, I, D
810	Floodway Pond Herbland	S, I	5, 6	2, 3, 4	F	D
125	Plains Grassy Wetland	S, I	4	1	F	C
819	Spike-sedge Wetland	S, I, E	4, 6	1, 2, 3	F	C
918	Submerged Aquatic Herbland	P, I	6, 7	2, 3, 4	F (- B)	C
53	Swamp Scrub	S	3, 5	1	F	C
821	Tall Marsh	P, S	6, 7	2, 3	F (-B)	C
990	Unvegetated (open water / mud – ‘Non Vegetation’)	P, I, E	3, 6, 7	2, 3, 4	F - B -S - H	C, I, D
A116	Wet Sedgy Herbland	S, I	2, 3, 4	1	F - B	C, D
932	Wet Verge Sedgeland	P, S, I	4, 5	1, 2	F	C

6.6 ENVIRONMENTAL WEEDS RECORDED FROM THE WETLANDS

Potentially high threat woody species which are readily controllable by suitable means without causing unacceptable non-target damage. Potentially transforming species within relevant habitat.

Acacia decurrens (Early Black-wattle)

Chrysanthemoides monilifera (Boneseed)

Coprosma repens (Mirror Bush)

Fraxinus spp. (Ash)

Hedera helix (English Ivy)

Lycium ferocissimum (African Box-thorn)

Melaleuca armillaris subsp. *armillaris* (Giant Honey-myrtle)

Prunus cerasifera (Cherry Plum)

Rosa rubiginosa (Sweet Briar)

Rubus anglocandicans (Blackberry)

Rubus fruticosus spp. agg. (Blackberry)

Salix cinerea (Grey Sallow)

Salix fragilis (Crack Willow)

Solanum pseudocapsicum (Madeira Winter-cherry)

Ulex europaeus (Gorse)

Ulmus sp. (Elm) [presuming these are not regarded as of historical value - it is noted that suckering from these plants has been managed by herbicide application.]

Perennial herbs potentially warranting selective management, apparently generally restricted to small populations

Dimorphotheca fruticosa (Trailing African Daisy)

Onopordum acanthium subsp. *acanthium* (Scotch Thistle)

Phytolacca octandra (Red-ink Weed)

Silybum marianum (Variegated Thistle)

Verbena bonariensis (Purple-top Verbena)

Xanthium spinosum (Bathurst Burr)

A *Myosotis* species has been recorded under the common name Water Forget-me-not, which usually refers to *M. laxa*, but was listed as *M. ?sylvatica*. If present, *M. laxa* would warrant inclusion in the above short list, whereas *M. sylvatica* is a relatively benign annual species.

Very high threat perennial herbs which are unlikely to be effectively manageable at other than a very local scale / without unacceptable non-target damage. Potentially transforming species within relevant habitat.

Bidens tripartita (Trifid Burr-marigold)

Myriophyllum aquaticum (Parrot's Feather)

Oxalis pes-caprae (Soursob)

Ranunculus repens (Creeping Buttercup)

Tradescantia fluminensis (Wandering Jew) [still apparently very localised and manageable]

While *Bidens pilosa* (Cobbler's Pegs) and *Heracleum* spp. (Hogweed) have been recorded from the wetlands, in the absence of confirmatory material, these records are suspected to be respectively based on misidentification and confusion due to a shared common name with an unrelated species.

Very high threat perennial grasses, sedges and rushes species which are unlikely to be effectively manageable at other than a very local scale / without unacceptable non-target damage. Potentially transforming species within relevant habitat.

Agrostis capillaris (Brown-top Bent)

Agrostis stolonifera (Creeping Bent)

Alopecurus pratensis (Meadow Fox-tail)
Cenchrus clandestinus (Kikuyu)
Ehrharta erecta var. *erecta* (Panic Veldt Grass)
Eleocharis parvula (Dwarf Spike-sedge)
Festuca arundinacea (Tall Fescue)
Holcus lanatus (Yorkshire Fog)
Juncus articulatus (Jointed Rush)
Juncus microcephalus (Tiny-headed Rush)
Paspalum dilatatum (Paspalum)
Paspalum distichum (Water Couch)
Paspalum vaginatum (Salt-water Couch)
Phalaris aquatica (Toowoomba Canary-grass)
Phalaris arundinacea (Reed Canary-grass)
Polypogon viridis (Water Bent)
Stenotaphrum secundatum (Buffalo Grass)
Typha latifolia (Lesser Reed-mace)

Other generally intractable perennial herbs. Mostly moderate to high threat species which are probably unmanageable at other than a very local scale / generally without unacceptable non-target damage, or if currently very localised, then of lower impact.

Asparagus officinalis (Asparagus)
Cotula coronopifolia (Water Buttons)
Helminthotheca echioides (Ox-tongue)
Hypochaeris radicata (Flatweed)
Leontodon taraxacoides subsp. *taraxacoides* (Hairy Hawkbit)
Modiola caroliniana (Red-flowered Mallow)
Paronychia brasiliiana (Nailwort)
Plantago coronopus (Buck's-horn Plantain)

Plantago lanceolata (Ribwort)
Plantago major (Greater Plantain)
Rumex conglomeratus (Clustered Dock)
Rumex crispus (Curled Dock)
Rumex pulcher (Fiddle Dock)
Taraxacum officinale spp. agg. (Dandelion)
Tragopogon porrifolius (Salsify)
Trifolium fragiferum (Strawberry Clover)
Trifolium repens (White Clover)
Viola sp. (Garden Violet)

While *Hydrocotyle bonariensis* (American Pennywort) and *Persicaria maculosa* (Redshank) have been recorded from the wetlands, in the absence of confirmatory material, these records are suspected to be based on misidentification.

Other generally intractable perennial grasses, sedges and rushes. Moderate to high threat species which are probably unmanageable at other than a very local scale / generally without unacceptable non-target damage.

Anthoxanthum odoratum (Sweet Vernal-grass)
Cynodon dactylon var. *dactylon* (Couch)
Cyperus eragrostis (Drain Flat-sedge)
Dactylis glomerata (Cocksfoot)
Echinochloa crus-galli (Common Barnyard Grass)
Eleusine tristachya (American Crow's-foot Grass)
Lolium perenne (Perennial Rye-grass)
Romulea rosea (Onion-grass)
Sporobolus africanus (Rat-tail Grass)

Other generally intractable annual to biennial / short-lived perennial herbs which are either unmanageable at other than a very local scale without unacceptable non-target damage, or if very localised, of relatively low impact.

Amaranthus deflexus (Spreading Amaranth)

Amaranthus viridis (Green Amaranth)

Arctotheca calendula (Cape Weed)

Aster subulatus (Aster-weed)

Callitriche stagnalis (Water Starwort)

Centaureum erythraea (Common Centaury)

Centaureum tenuiflorum (Slender Centaury)

Cerastium glomeratum s.l. (Common Mouse-ear Chickweed)

Chenopodium album (Fat Hen)

Chenopodium murale (Sowbane)

Cirsium vulgare (Spear Thistle)

Conyza bonariensis (Flaxleaf Fleabane)

Conyza sumatrensis var. *sumatrensis* (Tall Fleabane)

Cyclosporum leptophyllum (Slender Celery)

Daucus carota (Carrot)

Erodium cicutarium (Common Heron's-bill)

Euphorbia peplus (Petty Spurge)

Galium aparine (Cleavers)

Gamochaeta purpurea s.l. (Purple Cudweed)

Hirschfeldia incana (Buchan Weed)

Lactuca saligna (Willow-leaf Lettuce)

Lactuca serriola (Prickly Lettuce)

Lepidium africanum (Common Peppergrass)

Lepidium bonariense (Argentine Peppergrass)

Lepidium didymum (Lesser Swine-cress)

Lotus angustissimus (Slender Bird's-foot Trefoil)
Lotus corniculatus (Bird's-foot Trefoil)
Lotus subbiflorus (Hairy Bird's-foot Trefoil)
Lysimachia arvensis (Pimpernel)
Malva nicaeensis (Mallow of Nice)
Malva parviflora (Small-flowered Mallow)
Medicago arabica (Spotted Medic)
Medicago lupulina (Black Medic)
Polygonum arenastrum (Wireweed)
Polygonum aviculare s.s. (Hogweed)
Ranunculus sceleratus subsp. *sceleratus* (Celery Buttercup)
Raphanus raphanistrum (Wild Radish)
Rorippa palustris (Marsh Yellow-cress)
Sisymbrium officinale (Indian Hedge-mustard)
Solanum americanum (Glossy Nightshade)
Solanum nigrum s.s. (Black Nightshade)
Sonchus asper s.l. (Rough Sow-thistle)
Sonchus oleraceus (Common Sow-thistle)
Spergularia rubra (Red Sand-spurrey)
Stellaria media (Chickweed)
Trifolium dubium (Suckling Clover)
Verbascum thapsus subsp. *thapsus* (Great Mullein)
Verbascum virgatum (Twiggy Mullein)

Other generally intractable annual grasses which are generally unmanageable at other than a very local scale without unacceptable non-target damage, or if very localised, of relatively low impact.

Aira spp. (Hair Grass)

Avena sativa (Oat)

Bromus catharticus (Prairie Grass)

Bromus diandrus (Great Brome)

Bromus hordeaceus subsp. *hordeaceus* (Soft Brome)

Digitaria sanguinalis (Summer Grass)

Echinochloa colona (Awnless Barnyard Grass)

Eragrostis pilosa (Soft Love-grass)

Hainardia cylindrica (Common Barb-grass)

Hordeum hystrix (Mediterranean Barley-grass)

Hordeum leporinum (Barley Grass)

Hordeum marinum (Sea Barley-grass)

Lolium rigidum (Wimmera Rye-grass)

Phalaris minor (Lesser Canary-grass)

Poa annua (Annual Meadow-grass)

Polypogon monspeliensis (Annual Beard-grass)

Setaria pumila (Pale Pigeon-grass)

Vulpia myuros f. *myuros* (Rat's-tail Fescue)

Currently low impact non-native woody species

Eucalyptus cladocalyx (Sugar Gum)

Eucalyptus leucoxylon (Yellow Gum)

Malus pumila (Apple)

6.7 IMPLICATIONS OF PERMANENT INUNDATION FOR FAUNA

High water levels have been maintained almost continuously at Dowd Morass since the mid-1970s to create suitable breeding conditions for colonially-nesting waterbirds, and to prevent saline intrusions from Lake Wellington (Raulings *et al.* 2010). This artificial water regime is likely to be beneficial for some fauna species, while making the wetland habitat less suitable for others.

The breeding of egrets, spoonbills, cormorants and ibis is usually triggered by winter-spring flood events creating suitably vegetated areas that are surrounded by water and are relatively disturbance-free. The permanently high water level at Dowd Morass allows these birds to breed at any time of year. Such conditions also provide breeding habitat and drought refuge for many ducks, swans and other waterfowl, and a constant avian food source for raptors including Swamp Harriers, Whistling Kites, White-bellied Sea-eagles and Peregrine Falcons (Corrick and Norman 1980).

In addition to suitable fringing vegetation, waterbirds also require a variety of vertebrate and invertebrate prey species, and these in turn need a diversity of emergent and submerged macrophytes to live and feed on (Batzer and Wissinger 1996; DSE 2010). Retaining fresh water in the wetlands dilutes the saline water that intrudes during floods and from groundwater, thereby keeping overall salinity low and preventing the loss of relatively salt-intolerant plants such as *Phragmites*, which provide important habitat for a variety of birds including Purple Swamphen, Eurasian Coot, Australasian Bittern, Clamorous Reed-warbler, Little Grassbird and Swamp Harrier, as well as the Green and Golden Bell Frog and Growling Grass Frog (Bird 1961; DSE 2010).

However, permanent inundation favours the rapid spread of emergent macrophytes such as *Phragmites* and *Cumbungi*, particularly if nutrient levels are high, such as in wetlands with catchments dominated by agriculture. Both macrophyte species are able to colonise shallow water of depths up to 1 – 1.5 metres. These reedbeds, whilst an important habitat component of a wetland system, can drastically reduce the biodiversity values of the system by reducing the amount of open water and mudflats.

Additionally, species such as *Melaleuca* and red gums that occur on the edges of, and within, the wetlands, and are able to tolerate temporary flooding, cannot survive permanent waterlogging. Their seeds are also unable to germinate when the soil is under water, so permanent inundation prevents recruitment of new individuals (Raulings *et al.* 2010). The loss of fringing plants, due to the persistence of high water levels, inevitably results in a loss

of fauna species, both aquatic and terrestrial, that rely upon them. In the long-term, the loss of mature red gums without replacement means there is a loss of habitat for numerous species that rely on large trees adjacent to water for nesting, such as White-faced Heron, Yellow-billed Spoonbill and Whistling Kite. Numerous species that utilise tree hollows will also suffer possible localised declines including many species of arboreal mammals, Brushtail Possum, Ringtail Possum and Sugar Glider as well as cockatoo and parrots.

The drooping foliage of the regenerating red gums provide habitat for a range of small passerine birds including the declining woodland species Regent Honeyeater and Diamond Firetail, as well as residents including Yellow-rumped Thornbill, and enhances the foraging/gleaning opportunities for mixed flocks.

A decline or dieback in areas of *Melaleuca*, either around the fringes of the wetland or in areas surrounded by water, will negatively impact on the colonial breeding waterbirds. Fringing paperbark stands buffer the wetland from disturbance.

A further benefit of reducing water levels is that areas of mud will be exposed and create feeding opportunities for bird species that may not be present at other times. Crakes, rails and snipe are shy birds that inhabit dense vegetation and forage for invertebrates in adjacent muddy substrates (Marchant and Higgins 1993). Other birds that feed on exposed mud or in shallow water, but prefer to feed in the open where they can maintain vigilance for predators, are the international migrants Sharp-tailed Sandpiper, Common Greenshank, Eastern Curlew and Red-necked Stint (Corrick and Norman 1980). Many resident birds will also take advantage of pools created by receding floodwaters. White-faced and White-necked Herons, egrets, ibis, Masked Lapwings and dotterels will take small fish, trapped terrestrial invertebrates and aquatic insect larvae that are developing in the warm, shallow waters (Batzer and Wissinger 1996).

If the flood regime outlined by DSE (2010), of allowing the water level to drop for several months every few years, facilitates the persistence of fringing vegetation, it would increase the diversity of wildlife using the wetland. Lowering water levels would also result in decomposition of accumulated organic matter in the soil, making nutrients available to the system as the water levels rise again and increasing productivity at all trophic levels (Batzer and Wissinger 1996; DSE 2010).

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