SOUTHERN LINK RD - RESPONSE TO DWER (CPS 9882/1) SCHEDULE 2, ITEM 1. TARGETED FLORA AND TEC ASSESSMENT

City of Canning

ecoscape

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EXECUTIVE SUMMARY

The City of Canning is proposing to locate part of the Southern Link Road on a portion of the Grose Avenue/Lake Street Wetland (also known as Cannington Swamp and Carousel Swamp) in Cannington. According to the Department of Biodiversity, Conservation and Attractions (DBCA) this wetland is largely considered to represent the Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC) and Western Australian Biodiversity Conservation Act (BC)-listed endangered *Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain* Threatened Ecological Community (Muchea Limestone TEC).

On 29 August 2023 the Department of Water and Environmental Regulation (DWER) provided the City of Canning with its requirements in response to public consultation in regard to the City's application to clear native vegetation for the Southern Link Road (CPS 9882/1). These requirements included:

- a flora survey, specifically targeting *Eremophila glabra* subsp. *chlorella* (Threatened Flora), *Aponogeton hexatepalus* (Priority 4), *Ornduffia submersa* (P4) and *Schoenus natans* (P4), all previously recorded from within the site
- a threatened ecological assessment to determine if the listed TEC is appropriate or if a different TEC, specifically, the EPBC-listed critically endangered *Clay Pans of the Swan Coastal Plain* TEC ('Clay Pans TEC', also listed as several endangered TECs under the BC Act), occurs on the site.

The survey area has been subject to several previous flora and vegetation surveys in 2004 (Keighery & Hyder-Griffiths 2004), 2005 (Woodman Environmental Consulting Pty Ltd 2005), 2015 (Natural Area Consulting Management Services 2016) and, in part, 2018 (Ecoscape 2019).

Review of historical aerial imagery has shown that parts of the survey area have been cleared in the past, with the northern portion including a horse racetrack and having been used for cattle grazing. The racetrack appears to have been constructed of limestone fill.

A flora and vegetation survey was conducted over 4 days during November 2023; 19 floristic quadrats were recorded during the survey and the survey area traversed during searches for conservation-listed flora. The significant findings of the survey were:

- 21 *Eremophila glabra* subsp. *chlorella* plants, largely from the same locations and likely the same number of individuals as previously recorded in 2015 although, based on DBCA records, there appears to have been a large decline in the number of plants since 2011
- *Schoenus natans* occurred widely in winter-wet areas
- *Aponogeton hexatepalus* and *Ornduffia submersa*, both submerged aquatic species, were not located as there was no standing water at the time of survey
- eight vegetation types, variously wetland or upland, and/or representative of a TEC:
  - **BcCdLs**: *Bolboschoenus caldwellii*, **Cynodon dactylon* and **Lotus subbiflorus* low closed rushland/tussock grassland/forbland – 0.23 ha, all in Completely Degraded condition, occurring within an area considered as wetland
  - **Co**: *Casuarina obesa* mid woodland – 0.95 ha, 87.9% in Degraded-Completely Degraded condition, occurring within an area considered as wetland and, where in Good or better condition, representative of a TEC
  - **LcLfCd**: *Leptocarpus coangustatus*, *Lachnagrostis filiformis* and **Cynodon dactylon* mid closed rushland/grassland/tussock grassland – 0.11 ha, 44.0% in Degraded condition, occurring in a small wetland not contiguous with Carousel Swamp and not within the mapped TEC extent. It is not considered to be representative of a TEC.
  - **Ml**: *Melaleuca lateritia* mid shrubland – 2.24 ha, 4.8% in Degraded-Completely Degraded condition. This vegetation type occurs in wetland basins (sumplands) that are, where in Good or better condition and within the mapped TEC extent, considered to be representative of a TEC.
  - **MrVj**: *Melaleuca rhaphiophylla* and *Viminaria juncea* low open forest – 0.66 ha, 79.9% in Degraded-Completely Degraded condition. This vegetation type is a wetland with the longest period of inundation

and, where in Good or better condition and within the mapped TEC extent, is considered to be representative of a TEC.
  - **Vdd**: *Verticordia densiflora* var. *densiflora* mid shrubland – 0.30 ha, 45.07% in Degraded condition and occurring in a wetland, but at the highest elevation and having a short period of inundation. Where in Good or better condition it is considered representative of a TEC.
  - **VjCo**: *Viminaria juncea* and *Casuarina obesa* low woodland – 0.29 ha, 60.79% in Degraded condition. It occurs at the wetland edge but is considered as part of the wetland. Where in Good or better condition it is considered to be representative of a TEC.
  - **Vj**: *Viminaria juncea* low woodland. – 0.74 ha, all in Degraded condition. It occurs in upland areas as it is unlikely to be inundated thus is not considered part of the wetland and not part of the TEC due to its condition.
- the vegetation condition ranged from Completely Degraded to Very Good, with the condition approximately equally divided between Good-Very Good (2.73 ha; 34.35%), Degraded-Completely Degraded condition (2.79 ha; 35.12%) and not native vegetation (2.43 ha; 30.53%). The survey area's vegetation condition has declined since the 2015 (Natural Area Consulting Management Services 2016) survey, with the extent in 2023 in Good or better condition reducing to approximately half of the proportion of 2015, likely due to an increase in weediness.

Floristic analysis comparing the quadrat data from this survey with the Gibson *et al*. (1994) floristic data was not successful in identifying Swan Coastal Plain floristic community types that define some TECs. Analysis by comparing species lists, vegetation type descriptions and environmental information (including landforms) in Approved Conservation Advice (Department of Sustainability Environment Water Population and Communities 2012; Department of the Environment and Energy 2017), Listing Advice (Threatened Species Scientific Committee 2012), Interim Recovery Plans (Department of Parks and Wildlife 2015; English & Blythe 2000) and DBCA factsheet (Department of Biodiversity Conservation and Attractions 2023a) for the Muchea Limestone TEC and Clay Pans TEC resulted in the wetland being assessed as being more similar to the Clay Pans TEC than the Muchea Limestone TEC.

Vegetation types **Co**, **Ml**, **MrVj**, **Vdd** and **VjCo** were (where in Good or better condition) considered to represent the Western Australian-listed *Herb rich shrublands in clay pans (Community Type 8 (SCP08))* TEC; vegetation type **Vdd** (where in Good or better condition) was considered to represent the Western Australian-listed *Shrublands on dry clay flats (Community Type 10a (SCP10a))* TEC, both of which are sub-types of the EPBC-listed Clay Pans TEC. Vegetation type **Vj** was not representative of a TEC due to its condition which was Degraded-Completely Degraded.

Based on the assessment as above, the survey area the survey area comprises:
- 2.67 ha of vegetation representative of the EPBC-listed Clay Pans TEC, comprising of:
  - 2.50 ha of vegetation representative of the Western Australian-listed *Herb rich shrublands in clay pans (SCP08)* TEC in vegetation types **Co**, **Ml**, **MrVj**, **Vdd** and **VjCo** (where in Good or better condition
  - 0.17 ha of vegetation representative of the Western Australian-listed *Shrublands on dry clay flats (SCP10a)* TEC in vegetation type **Vdd** (where in Good or better condition)
- 5.71 ha of wetland.

1 INTRODUCTION

1.1 BACKGROUND

The City of Canning is proposing to locate part of the Southern Link Road on a portion of the Grose Avenue/Lake Street Wetland (also known as Cannington Swamp and Carousel Swamp) in Cannington. According to the Department of Biodiversity, Conservation and Attractions (DBCA) this wetland is largely considered to represent the EPBC-listed endangered *Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain* TEC.

On 29 August 2023 the Department of Water and Environmental Regulation (DWER) provided the City of Canning with its requirements in response to public consultation (FM.035.416) in regard to the City's application to clear native vegetation for the Southern Link Road (CPS 9882/1).

Amongst other requirements, the DWER requested a flora survey and threatened ecological assessment to address Item 1 of Schedule 2 of its requirements. This report details this requirement.

1.2 SURVEY AREA

The City of Canning project area, known as the 'survey area' in this report, is located in the Perth metropolitan area within the Swan Coastal Plain bioregion approximately 10.5 km south of the Perth CBD (**Figure 1**) and occupied 7.95 ha. The site is located between Grose Avenue, Lake Street, Bent Street and Franklin Avenue, near to the Cannington Greyhound Track and adjacent to a Western Power substation. The wetland is known variously as Grose Avenue/Lake Street Wetland, Cannington Swamp and Carousel Swamp.

Figure 1: Survey area location

1.3 SURVEY REQUIREMENTS

The relevant DWER survey requirements (as per Item 1 of Schedule 2 of CPS 9882/1) are as follows.

DWER Information requirements:

A targeted flora survey and threatened ecological community (TEC) assessment is required for the area proposed to be cleared.

Please note that should threatened or priority flora be identified, additional surveys of surrounding areas will also be required to determine the species' local population size and distribution.

Please note that should a TEC be identified, additional surveys of surrounding areas will also be required to determine the TEC's total size and distribution.

DWER Specifications:

The targeted flora survey and TEC assessment is to be carried out by a botanist (see below for relevant definitions). The targeted flora survey methodology must be consistent with the EPA's Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (December 2016), copies of which are available at the EPA's website. The TEC assessment must be undertaken against the Commonwealth Department of the Environment and Energy's 'Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Approved Conservation Advice (including listing advice) for the Muchea Limestone of the Swan Coastal Plain (Muchea Limestone) TEC and the Clay Pans of the Swan Coastal Plain TEC.

If the TEC is present, a map must be provided delineating the patch of the TEC identified and its size (in hectares) and condition (using the Keighery scale).

All surveys must be submitted in accordance with the EPA's IBSA, and submitted via the department's IBSA Submissions Portal. Please provide the corresponding IBSA Submissions Reference Number to the assessing officer, using the contact details located on the top right of the attached letter, once the survey has been submitted.

NOTE: The department defines a "botanist" as a person who holds a tertiary qualification in environmental science or equivalent, and has a minimum of 2 years work experience in identification and surveys of flora native to the bioregion being inspected or surveyed, or who is approved by the CEO as a suitable botanist for the bioregion.

NOTE: It is advised that the surveys requested may take flora listed as threatened under the BC Act. Please be aware that no threatened flora are to be taken unless an authorisation from the Minister for Environment under section 40 of the BC Act is obtained from DBCA. Please also be advised that an occurrence of a TEC cannot be modified, unless an authorisation from the Minister for Environment is obtained under section 45 of the BC Act has been obtained from DBCA. For further information on this matter please contact DBCA's Species and Communities Program via email sacl@dbca.wa.gov.au *or view the Threatened plants web page and Licences and Authorities – Threatened ecological community authorisation web page.*

DWER Rationale:

Previous flora and vegetation surveys of the application area (Ecoscape, 2019; Natural Area, 2016) have identified four conservation significant flora species within the greater patch of remnant native vegetation at Carousel Swamp:

- *Aponogeton hexatepalus (listed as Priority 4 by DBCA),*
- *Eremophila glabra subsp. chlorella (listed as Endangered under the BC Act and EPBC Act),*
- *Ornduffia submersa (listed as Priority 4 by DBCA), and*
- *Schoenus natans (listed as Priority 4 by DBCA).*

While it is acknowledged that none of the individuals identified during these surveys were observed within the boundaries of the application area for CPS 9882/1, the department notes that the previous surveys were undertaken in Spring 2015 and November 2018. As suitable habitat for these species also persists within the application area, it is possible that the populations of these four priority flora species have extended into the application area in the five years since the previous flora and vegetation surveys. A targeted flora survey is required to confirm the absence of individuals from the application area for CPS 9882/1 and, if observed, determine the current extent of the populations of the four conservation significant flora species known to occur within the Carousel Swamp site.

The preliminary assessment has also identified that the application area transects a mapped occurrence of the Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain (Muchea Limestone) community, which is listed as Endangered under both the state BC Act and federal EPBC Act. The flora and vegetation survey undertaken by Natural Area in Spring 2015 mapped the Muchea Limestone TEC as covering 5.8 hectares within the greater Carousel Swamp wetland. However, the TEC assessment undertaken by Ecoscape in November 2018 did not identify the requisite TEC soil conditions of the Muchea Limestone TEC and identified only three flora species in common between the application area and the Interim Recovery Plan for this TEC (Ecoscape, 2019). Comparison of the quadrat data for the application area and Swan Coastal Plain Floristic Community Types (FCTs) show that the quadrats were aligned with FCTs on the eastern Swan Coastal Plain, and most frequently those associated with seasonal wetlands of clay soils (Ecoscape, 2019). No quadrats showed affinities with the more coastal, limestone influenced FCTs which is definitive of the Muchea Limestone TEC (Ecoscape, 2019).

Based on the field survey and floristic analysis undertaken by Ecoscape (2019), the TEC assessment determined that the Melaleuca lateritia mid shrubland (MlMS) vegetation type within the application area is more likely to represent the Clay Pans of the Swan Coastal Plain TEC, which is listed as Critically Endangered under the EPBC Act. The TEC assessment determined that the MlMS vegetation type is most similar to the Swan Coastal Plain floristic community types (SCP FCTs) 7 (Herb rich saline shrublands in clay pans), 8 (Herb rich shrublands in clay pans), 9 (Dense shrublands on clay flats), and 13 (Deeper wetlands on heavy soils) as originally described in Gibson et al. (1994). The SCP07, SCP08, and SCP09 FCTs are also individually listed as Endangered under the state BC Act.

Despite the findings of the TEC assessment (Ecoscape, 2019), the supporting documentation for the clearing permit application and EPBC Act referral refers to 0.16 hectares of the Muchea Limestone TEC being present within the application area. This is also inconsistent with the vegetation mapping from the TEC assessment, which identified that the MlMS vegetation type covers an area of 0.1 hectares within the application area (Ecoscape, 2019). It is also noted that the TEC assessment only included the area within a 20-metre buffer of the proposed development envelope for the Southern Link Road (SLR) Stage 3 project and did not assess the western portion of the application area. Therefore, the TEC assessment did not define the total patch size of the Clay Pans of the Swan Coastal Plain TEC within the greater Carousel Swamp wetland.

Further detailed assessment of vegetation composition and patch size is considered necessary to accurately determine which TEC is present within the application area, the total patch size of the occurrence of the TEC, and the impacts of the proposed clearing.

1.4 COMPLIANCE

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act)
- Western Australian *Biodiversity Conservation Regulations 2018*

- Department of Environment, Water, Heritage and the Arts (DEWHA 2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*
- Department of Sustainability, Environment, Water Population and Communities (DSEWPaC 2012) *Approved Conservation Advice for Clay Pans of the Swan Coastal Plain*
- Department of the Environment and Energy (DotEE 2017) *Approved Conservation Advice for Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain.*

As well as those listed above, the assessment complied with Environmental Protection Authority (EPA) requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2016a) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*, known herein as the Flora and Vegetation Technical Guidance
- EPA (2016b) *Environmental Factor Guideline – Flora and Vegetation*
- EPA (2021) *Statement of environmental principles, factors, objectives and aims of EIA*.

Additional details (definitions and criteria) relevant to these works are available in **Appendix One**.

2 DESKTOP ASSESSMENT

A full desktop assessment has not been conducted as this assessment is in response to DWER requirements only. Aspects relevant to the DWER response are summarised below.

2.1.1 ENVIRONMENTALLY SENSITIVE AREAS

The survey area is entirely within a mapped Environmentally Sensitive Area (ESA) (DWER 2021).

2.1.2 CONSERVATION LANDS

The survey area is not within any conservation lands (DBCA 2021).

2.1.3 LAND USE HISTORY

Observations during the 2023 survey supporting the historical photography and aerial imagery are also incorporated into this report section.

Figure 2 (photograph provided by the City of Canning) shows Cannington Showgrounds in 1938. The approximate southern portion of the survey area is indicated by an orange outline. This photograph indicates that the shown portion of the current survey area is relatively undisturbed, however, the lower-lying area (indicated by a pale background with trees or shrubs appearing as speckles) may have already been disturbed, noting it is in close proximity to built structures that are no longer present.

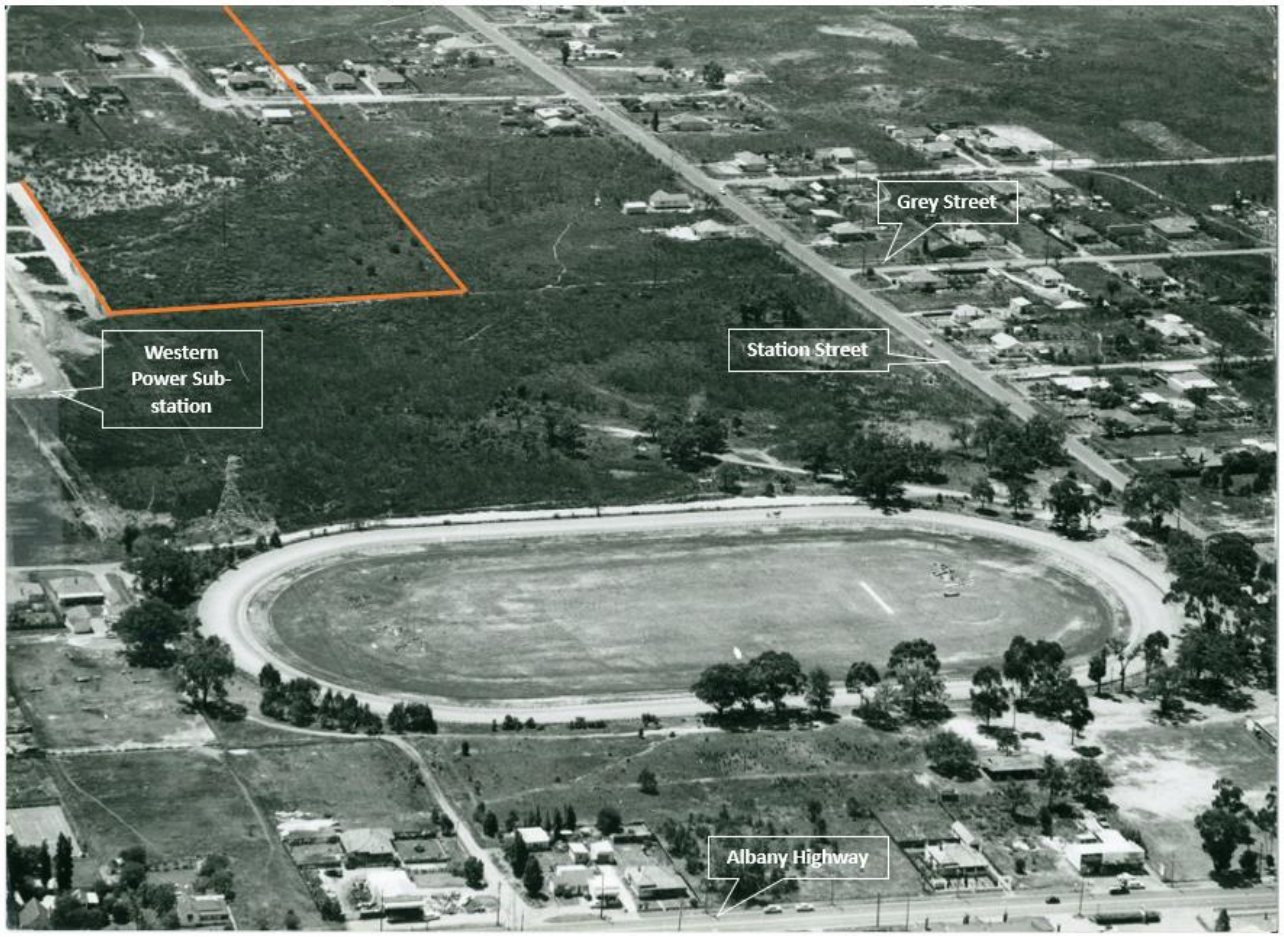

Figure 2: Cannington Showgrounds 1938

By 1961, aerial imagery (provided by the City of Canning) indicates that the majority of the survey area had been cleared or otherwise modified (**Figure 3**, survey area and current roads shown to provide context).

The southern portion of the survey area (as shown in **Figure 2**) appears to be relatively undisturbed i.e. the imagery texture appears similar to current imagery (see the **Maps** report section). However, in the survey area to the north of the substation the imagery shows only isolated trees near a roughly oval-shaped track, and open shrubs or small trees near the north-eastern corner of the adjacent substation, which has since expanded to the edge of the survey area. Apparently visible ground under these shrubs or small trees suggests that the understorey is not present, is small and sparse or consists of annual species that have dried.

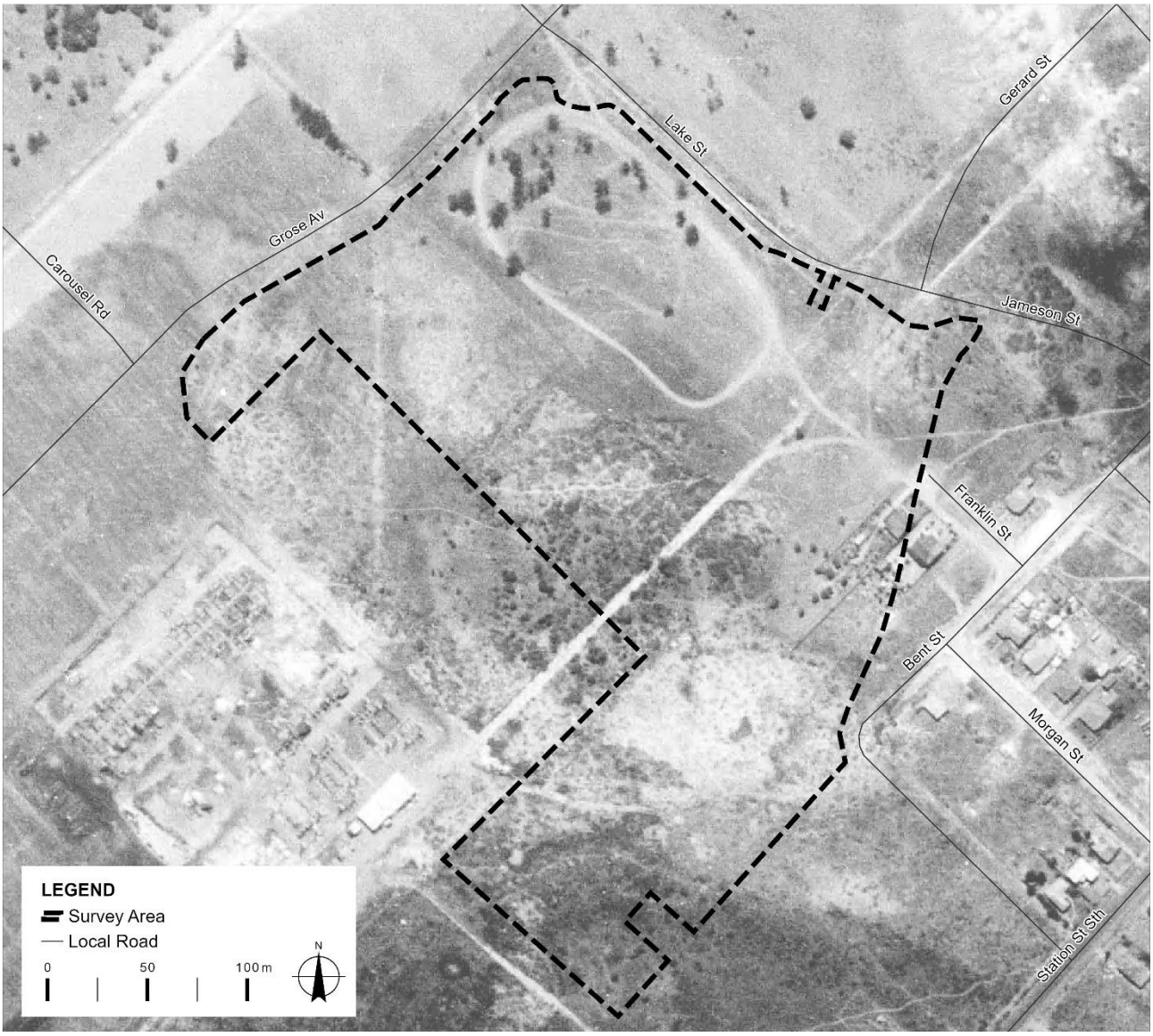

Figure 3: 1961 aerial imagery

By 1981 (**Figure 4**) the substation had increased significantly in size. The roughly oval-shaped track from the 1961 imagery is still visible but is encompassed by a larger and more clearly defined oval white track, within which many of the trees present in 1961 are no longer present. The smooth ground texture of most of this area suggests grassland rather than shrubs within the larger white track. The section of the survey area to the south of this track and north of the substation has become more densely shrubbed, although with a track roughly in the centre, and the trees near the corner of the substation have grown. Standing water is visible to the south and east of the eastern corner of the substation.

The southern section of the survey area is largely unchanged since 1961.

Figure 4: 1981 aerial imagery

Enquiries conducted by the City of Canning (Amber Currie, *pers. comm*.) of its long-term staff confirm that the survey area was used as a racetrack (horses) and for cattle grazing, confirming the following field observations:

- the large white oval is, now, structurally a raised area (bund) approximately 1 m higher than the surrounding area, approximately 10 m wide (**Image 1**) and constructed of limestone fill (**Image 2**). Currently the southern and eastern portions are the site of a tall ringlock fence (visible in **Image 1**, right side). The bund occupies the location of the horse racetrack visible in **Figure 4** (the north and eastern portions of this track are now incorporated into current roads and buildings). Limestone was not observed in other portions of the survey area except where it was used for tracks and bank stabilisation around the outside of the Western Power sub-station and in other areas near the outer edges where mixed surface stones of transported origin (mostly laterite and bluemetal, occasionally small limestone rocks) were observed.
- the smaller, internal roughly oval track can still be determined and is represented by ground height variation (indentation)
- wetland areas between the substation and track and to the east of the substation have pugged ground surface (**Image 3** and **Image 4**), which is not usual for wetlands (which are naturally smooth-surfaced), indicating grazing or (less likely) cultivation.

Image 1: Limestone bund

Image 2: Limestone fill

Image 3: Pugged clay soil surface indicating grazing

Image 4: Pugged clay soil surface indicating grazing

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

The survey area largely intersects a mapped representative of the EPBC-listed endangered *Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain Threatened Ecological Community* ('Muchea Limestone TEC'). However, Ecoscape's 2018 assessment (Ecoscape 2019) identified that the vegetation was more representative of the EPBC-listed critically endangered *Clay Pans of the Swan Coastal Plain* TEC ('Clay Pans TEC').

Details of these TECs are outlined in **Appendix Three**.

2.2.2 THREATENED AND PRIORITY FLORA

According to CPS 9882/1, six conservation-listed flora have previously been recorded from within the survey area:

- *Eremophila glabra* subsp. *chlorella* (TF)
- *Babingtonia urbana* (P3), although not confirmed by a vouchered specimen in the WAH with reliable location data. The WAH specimen attributed to this site is from 1948, the location is 'Cannington Swamp' which may refer to any number of nearby swamps that were present at that time, and the location attributed to the specimen is near Fern Road, approximately 2 km to the west of Carousel Swamp. Due to the time since collection with no more recent records from nearby, land use changes since then and lack of certainty in regard to the location, this record is considered unreliable in regard to it having occurred at Carousel Swamp.
- *Schoenus capillifolius* (P3), although not confirmed by location data attributed to a vouchered specimen in the Western Australian Herbarium (WAH).. The WAH specimen likely referenced as from the survey area is from 2005 with the locality described as 'Carousel Swamp, behind Carousel Shopping Centre', however, the location attributed to this record is in Southern River, approximately 8.5 km south of the survey area. This record is not considered as being confirmed due to the inconsistent locational information attributed to the record.
- *Aponogeton hexapetalus* (P4)
- *Ornduffia submersa* (P4)
- *Schoenus natans* (P4).

CPS 9882/1 does not list the unconfirmed species (*Babingtonia urbana* and *Schoenus capillifolius*) as requiring survey.

Targeted surveys were required for the remaining four species.

2.3 RELEVANT LITERATURE

2.3.1 PREVIOUS BIOLOGICAL SURVEYS

Ecoscape 2018 Southern Link Road Stage 3 Environmental Approvals TEC and Native Bee Survey

Ecoscape (2019) conducted a flora and vegetation survey to clearly define the extent of TEC boundaries within the proposed road development footprint and a 20 m buffer (3.2 ha in total), and determine the potential impact of the road on the TEC and Priority-listed flora populations. The proposed road development footprint intersects the southern and eastern portions of the current survey area.

The 2018 survey identified three vegetation types:

- **MIMS**: *Melaleuca lateritia* mid shrubland, mostly in Good to Very Good condition and considered to be representative of TEC vegetation
- **VjTS**: *Viminaria juncea* tall shrubland, in Degraded to Completely Degraded condition
- **VjMrLW**: *Viminaria juncea* and *Melaleuca rhaphiophylla* low woodland, in Degraded condition.

Fifty-four vascular flora species were recorded from seven floristic quadrats and opportunistic observations, including two P4-listed species: *Aponogeton hexatepalus* and the widespread *Schoenus natans*.

Ecoscape's floristic analysis and species data comparison with the information outlined in **Appendix Three** (2013, since deleted; DSEWPaC 2012; DotEE 2017; English & Blythe 2000) identified that the vegetation of the 2018 survey area was more similar to that found in the Clay Pans TEC than the Muchea Limestone TEC.

A separate native bee survey undertaken within the wider Carousel Swamp identified 47 bee species and morphospecies, however, did not identify either of the critically endangered short-tongued native bee species that have previously been recorded from the site (*Leioproctus douglasiellus*) or that was considered likely to occur (*Neopasiphae simplicior*). The native bee survey was conducted over seven survey periods that were

within the documented flight period of these species, within habitat that was considered suitable for these species.

NAH 2015 Flora, Vegetation and Fauna Survey

In 2015 the City appointed Natural Area Holdings Pty Ltd (NAH) to undertake a Level 2 Flora and Vegetation Survey and Level 2 Fauna Survey at the Grose Avenue/Lake Street Wetland site (Natural Area Consulting Management Services [NACMS] 2016). This incorporated a desktop assessment and field surveys which were conducted during September, October, November and December 2015.

The NAH field assessment included:

- revisiting and reassessing four 10 m x 10 m floristic quadrats established by Woodman Environmental in 2004 (see below) and installation of four additional floristic quadrats
- assessing and mapping of vegetation condition; weed presence, type and density; vegetation types
- searches for and mapping presence of significant flora species, including targeted searches for conservation significant flora
- collection of a flora inventory
- installation of six fauna traplines incorporating funnel and pitfall traps, and six Elliot traps, and installation of two motion activated cameras
- recording opportunistic fauna sightings and a nocturnal survey.

The key findings of the survey were:

- 111 vascular flora species; 57 native species and 54 introduced species
- two conservation significant flora species: *Eremophila glabra* subsp. *chlorella* (TF) and *Ornduffia submersa* (P4) although none were in areas anticipated to correspond with the proposed road development footprint and the plant count was not listed for either taxon
- nine vegetation types
- presence of the Muchea Limestone TEC, which was not defined in the report by vegetation types nor was any analysis conducted to confirm its presence (i.e. no independent assessment or analysis was undertaken). NAH concluded that the survey area was unlikely to be representative of any components of the EPBC-listed Clay Pans TEC (FCTs 7, 8, 9 and/or 10a) due to the degraded nature of the site and that potentially suitable vegetation had already been assigned as being the Muchea Limestone TEC. The report did not include any discussion that the Muchea Limestone TEC was also not likely due the complete absence of characteristic species as listed in Section 2.7 of the NAH report.
- the vegetation condition ranged from Excellent to Completely Degraded but was largely in Completely Degraded condition
- three mammal species (all introduced), 15 birds, five reptiles, four amphibians, 42 invertebrates
- no fauna of conservation significance including no conservation significant native bees.

NAH concluded that the proposed Southern Link Road would require clearing of 0.16 ha of the 5.8 ha Muchea Limestone TEC, of which 0.09 ha was in Good or Very Good condition.

Woodman 2005 Cannington Substation Flora and Vegetation Assessment

Woodman Environmental Consulting (2005) conducted a flora and vegetation survey of Western Power lands over multiple visits during 2004. No map is available to determine how much of the Woodman survey area intersects the current survey area.

Woodman considered the vegetation to be mostly highly disturbed and having been completely cleared in the past. Eleven plant communities and disturbance units were recorded (although only nine were listed, as below):

- W1: Low Woodland of *Casuarina obesa* over a disturbed understorey dominated by *Cyathochaeta avenacea*, *Cynodon dactylon* and *Patersonia occidentalis* on sandy clay-loam
- W1d: Degraded areas of plant community W1

- S1: Degraded Shrubland of *Jacksonia sternbergiana* and *Hakea* spp. over *Acanthocarpus preissii*, *Xanthorrhoea brunonis*, *Mesomelaena pseudostygia* and *Watsonia meriana* var. *meriana* on grey sandy clay
- S2: Seasonally inundated degraded Shrubland of *Viminaria juncea* and *Melaleuca lateritia* over a herb layer dominated by weed species and sedges on grey sandy clay
- S3: Shrubland of *Viminaria juncea* over scattered shrubs including *Verticordia densiflora*, *Xanthorrhoea brunonis* and *Pericalymma ellipticum* var. *floridum* on brown clay
- S4: Seasonally inundated degraded shrubland of *Melaleuca rhaphiophylla* over *Verticordia densiflora*
- H1: Heath dominated by *Melaleuca lateritia* over mixed species including *Meeboldina cana*, *Chorizandra enodis* and *Astartea affinis ms* in a seasonally inundated area on clay-loam
- H2: Heath dominated by *Verticordia densiflora*, *Patersonia occidentalis*, *Cyathochaeta avenacea* and *Centrolepis aristata* in a seasonally inundated area on clay-loam
- H3: Dense Heath of *Baumea juncea* on grey clay.

At the conclusion of the survey Bronwen Keighery (as per reference below) conducted a floristic analysis and determined that:

- W1, H1 and H2 were representative of FCT 8 but as an unusual mosaic combination; FCT 8 is now a vulnerable Western Australian TEC (*Herb rich shrublands in clay pans (Community Type 8 (SCP08))*) that is incorporated in the critically endangered EPBC-listed *Clay Pans of the Swan Coastal Plain* TEC
- S1 was a disturbed representative of FCT 3a, now the *Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain* listed as endangered under the Commonwealth EPBC Act and critically endangered under the Western Australian BC Act.

Overall, 188 vascular flora species (including 91 weeds) were recorded including *Schoenus capillifolius* (then P2, now P3), *Aponogeton hexatepalus* (P4) and *Villarsia submersa* (now *Orduffia submersa*; P4).

DOE 2004 Carousel Swamp Flora and Vegetation Preliminary Assessment

Keighery and Hyder-Griffiths (2004)conducted a preliminary flora and vegetation survey of the wetland in May. The key findings of this assessment were:

- most of the site was considered to be wetland, with only one portion considered as upland vegetation
- the vegetation was highly variable, forming a mosaic of units
- it was representative of wetlands on heavy soils on the eastern side of the Swan Coastal Plain
- it was associated with Muchea Limestone soils (noting that the determination of Muchea Limestone being present was determined by an observation of limestone being exposed at the base of a wooden transmission pole) and patches of ironstone
- was considered representative of FCT 7 (or FCT 7, 8 or 9), but required a spring survey to accurately determine which FCT/s were present. These FCTs are now listed individually as Western Australian TECs and combined (with other similar wetland types) in the EPBC-listed critically endangered *Clay Pans of the Swan Coastal Plain* TEC (DSEWPaC 2012).

2.3.2 HYDROLOGICAL STUDIES

Urbaqua 2017 Hydrological Studies

Urbaqua (2018a) undertook a hydrological study to:

- assess the existing condition of the Muchea Limestone TEC and supporting wetlands
- determine the potential impacts of construction of the proposed road and infrastructure
- prepare a preliminary management plan.

Eight groundwater monitoring bores (four installed by Urbaqua in 2017; two JDA bores from 2012 and two Parsons Brinkerhoff bores from 2005) were monitored monthly (July 2017-January 2018). This report (Urbaqua 2018a), and the updated report (Urbaqua 2018b) that reported on a part of the road alignment but included the same hydrological data, also reported that:

- depths to groundwater ranged from 2.28 m to 4.14 m during the monitoring period, with surface water present above one of the bores during August, September and October
- pH was within the guideline range for wetlands, nitrogen levels were relatively low, elevated total nitrogen concentration was recorded for two bores, and total phosphorus and ammonia levels exceeded the wetland criteria in all bores
- superficial groundwater is considered as Fresh
- there is no upstream catchment or surface runoff feeding into the swamp, with recharge from rainfall
- no specific data discussing the hydrological condition of the TEC was presented.

Parsons Brinckerhoff Woodman 2005 Soil and Hydrogeological Investigations

In 2005, Parsons Brinckerhoff conducted a soil and hydrogeological investigation for Woodman Environmental Consulting (2005) on behalf of Western Power which was planning on expanding the Cannington substation, including powerline upgrades that were anticipated to require excavation into the swamp surface. The investigation included determining the presence and extent of any Muchea Limestone soils.

Eight boreholes were drilled during phase 1 in February 2005 and 11 boreholes drilled during phase 2 in May 2005. Limestone gravel was occasionally encountered at approximately 1-4.5 m depth at four locations. It was determined that the limestone gravel was not formed in-situ but may have been deposited during flood events. Surficial ferricrete was inferred over part of the site and thin lenses of iron cemented sands identified, however, extensive ferricrete layers were not encountered.

Parsons Brinckerhoff determined that soils matching the description of Muchea Limestone were not intersected during its investigation.

3 METHODS

3.1 SURVEY AIMS

The aims of the targeted flora and TEC assessment were to respond to DWER's CPS 9882/1 request for further information, specifically Schedule 2, Item 1:

- accurate delineation of the TEC in size (ha) and condition
- an assessment of the TEC against the Approved Conservation Advice for the Muchea Limestone TEC (DSEWPaC 2017) using quadrat data collected during the field survey
- targeted surveys for *Aponogeton hexatepalus* (P4), *Eremophila glabra* subsp. *chlorella* (listed as Endangered under the BC Act and EPBC Act), *Ornduffia submersa* (P4), and *Schoenus natans* (P4) to determine their current extent.

3.2 GUIDING PRINCIPLES

The flora and vegetation survey was conducted as a Reconnaissance survey according to the Flora and Vegetation Technical Guidance (EPA 2016a). The EPA recommends a Reconnaissance survey should:

- provide context and gather broad information
- verify the findings of the desktop assessment
- include low intensity sampling of the flora and vegetation to describe the general vegetation characteristics and condition
- clarify if the area may support any significant flora and vegetation
- identify if a Detailed survey is required.

Targeted searches were also conducted in areas of habitat suitable for the species listed for survey in CPS 9882/1.

3.3 FIELD SURVEY METHODS

The methods utilised during the field survey followed those outlined in the Flora and Vegetation Technical Guidance (EPA 2016a), conducted as a single phase Reconnaissance survey.

Conservation criteria used in this assessment are outlined in **Table 8**, **Table 9** and **Table 10** in **Appendix One**.

Survey method details are outlined below.

3.3.1 FLORISTIC QUADRATS

Floristic quadrat ('quadrat') locations were selected using aerial photography, environmental values and field observations to represent the vegetation values existing at the site. The unmarked quadrats were 10 m x 10 m in dimension, as required according to the Flora and Vegetation Technical Guidance (EPA 2016a).

The following information was collected from within each quadrat:

- observer
- date
- quadrat/site number
- GPS location (GDA94) of the northwest corner
- digital photograph (spatially referenced with a reference number), taken from the northwest corner, looking diagonally across the quadrat
- broad soil type and colour
- topography
- list of flora species recorded with the average height and total cover within the quadrat for each species
- vegetation description (as per below)
- vegetation condition.

Quadrat locations are displayed on **Map 1**.

3.3.2 TARGETED SEARCHES

Threatened and Priority Flora identified as having been previously recorded DWER were targeted for searches in areas of potential habitat. Targeted searches were conducted in potentially suitable habitat of target species, with the remainder of the site opportunistically searched during site traverses.

The locations of all targeted taxa collected were recorded using a handheld GPS with the following data recorded:

- observer, date and time
- local abundance/population size and/or population boundary, including outside the development envelopes where possible
- landform
- brief vegetation community description
- representative photos of each species and habitat
- collection of representative specimens.

3.3.3 INTRODUCED SPECIES

Introduced species (weeds) were recorded during the collection of the overall flora inventory.

3.3.4 VEGETATION DESCRIPTION AND CLASSIFICATION

Vegetation was described from each of the quadrats using the height and estimated cover of dominant and characteristic species of each stratum based on the National Vegetation Information System, recorded at Level V (NVIS Technical Working Group & DotEE 2017) (**Table 11** and **Table 12** in **Appendix Two**). Up to three species per stratum from each stratum (upper, mid and ground) were used to formulate vegetation descriptions for each quadrat and each vegetation type.

Vegetation type descriptions were created by combining quadrat descriptions and modifying, where necessary, based on the wider vegetation. Vegetation codes for these were formulated using the characteristic species of the highest stratum with the upper case first letter referring to the genus and lower case one or two letters referring to the species e.g. **Vdd** refers to ***V****erticordia* ***d****ensiflora var.* ***d****ensiflora mid shrubland*. No stratum description is incorporated into the vegetation code due to, in several cases, their complexity.

3.3.5 VEGETATION CONDITION ASSESSMENT

Vegetation condition was assessed broadly and continuously throughout the survey area and at each quadrat using the Vegetation Condition Scale for the Southwest Botanical Province (EPA 2016a) (**Table 13** in **Appendix Two**), which is the current scale required to be used during flora and vegetation surveys in Western Australia. However, CPS9882/1 requires the use of the Keighery (1994) scale. These two scales are virtually identical with only minor wording differences between the two. **Table 13** includes both scales to illustrate their equivalence.

3.3.6 WETLAND ASSESSMENT

Wetlands were herein considered as areas that are seasonally inundated (true wetlands) or waterlogged (damplands). These areas had fine clay sediment on the soil surface. Upland areas had a sandy soil surface.

3.3.7 FIELD SURVEY TIMING

The field survey was conducted during November which is within the optimal period for a primary survey within the bioregion according the Flora and Vegetation Technical Guidance (EPA 2016a).

3.4 DATA MANAGEMENT AND ANALYSIS

3.4.1 TAXONOMIC PLANT IDENTIFICATION

Any plants that could not be identified with certainty in the field, having potential to be conservation-listed, introduced species and having significance according to the Flora and Vegetation Technical Guidance (EPA 2016a) were collected during the field survey using Western Australian Herbarium collecting protocols.

The majority of post-survey plant collection identification was undertaken by Dr Udani Sirisena using relevant literature, taxonomic keys and reference specimens held at the Western Australian Herbarium (WAH), including seeking assistance from specialist taxonomists where necessary. One specimen was formally identified by the WAH as a paid submission.

3.4.2 FLORISTIC ANALYSIS

PATN© software (Blatant Fabrications Pty Ltd 2013) was used to undertake statistical analysis to generate floristic groups using the data collected from the quadrats and relevés, in order to better understand local significance of floristic units. PATN analysis has been used for several local floristic analyses including Gibson *et al.* (1994) for the Swan Coastal Plain.

PATN is a multivariate analysis tool that generates estimates of association (resemblance, affinity, distance) between sets of objects described by a suite of variables (attributes) and classifies the objects into groups and condenses the information and displays the patterns in the data graphically. It offers a choice of data transformations prior to multivariate analysis.

Floristic groups, identified using a dendrogram output of the analysis, are used as a tool to inform vegetation type groups at various levels and scales.

Interpretation of these purely floristic groups into recognisable and mappable on-ground units is a tool used to identify broad vegetation types. Generally, quadrats that are closely floristically related on the dendrogram form identifiable vegetation units, however, interpretation is frequently required for imperfect results. Vegetation types are therefore determined as a combination of floristic analysis and on-ground interpretation using dominant and characteristic species.

3.4.2.1 Site Floristic Analysis

For this project a variety of analyses were run. The most statistically robust analysis (i.e. having the lowest ordination stress value) used the 2-Step similarity coefficient for rows (species) and columns (sites). For this analysis we used cover values for each species.

3.4.2.2 Gibson Data Floristic Analysis

A floristic analysis using the original Gibson *et. al* (1994) data (provided by DBCA upon request) and current floristic quadrat data was conducted. Presence/absence data was used as this was how the Gibson *et al.* data was provided. Prior to the analysis a species reconciliation was undertaken, where possible matching species subject to taxonomic review. Fifteen of the 82 Ecoscape quadrat species were either not present in the Gibson *et al*. data (which consisted of 1,362 taxa from 509 quadrats) or could not be taxonomically reconciled.

The clearest analysis utilised the Bray-Curtis similarity co-efficient for both rows and columns.

3.4.3 TEC ASSESSMENT CRITERIA

TEC assessment criteria are outlined in **Appendix Three**.

4 FIELD SURVEY RESULTS

The flora and vegetation survey was conducted by Lyn Atkins (Principal Ecologist, Flora Collecting Permit FB62000003-2; Threatened Flora Collecting Permit TFL 2223-0089) during 14, 16, 20 and 23 November 2023.

4.1 FLORA

4.1.1 FLORA INVENTORY

Nineteen floristic quadrats were recorded from within the survey area.

Eighty-nine vascular flora were recorded from 77 genera and 39 families from the quadrats, opportunistic observations and searches for conservation-listed flora. Of these, 34 were introduced (38.2%) and four (4.5%) could not be identified to species level due to insufficient diagnostic reproductive material.

The most commonly represented families were Poaceae (16 taxa) and Cyperaceae (10). The most commonly represented genera were *Melaleuca* with four taxa and nine genera with two species each.

The number of species per quadrat ranged from seven in quadrat C2319 to 22 in quadrat C2303, with an average species diversity per quadrat of 13.37. The most commonly recorded species were **Watsonia meriana* var. *meriana* recorded from 13 quadrats and *Cassytha racemosa* forma *racemosa*, *Lachnagrostis filiformis* and *Melaleuca lateritia* (10 quadrats each).

The combined flora inventory is presented in **Table 14** in **Appendix Four**. Quadrat data is presented in **Appendix Five**.

4.1.2 CONSERVATION-LISTED FLORA

4.1.2.1 Threatened Flora

Eremophila glabra subsp. *chlorella* (TF), previously identified from the survey area and requiring survey under CPS 9882/1, was located. This taxon is listed as endangered under both the Commonwealth EPBC Act and Western Australian BC Act.

Locations are indicated on **Map 1** and described in more detail in **Table 1**.

Table 1: TF recorded during the field survey

***Eremophila glabra* subsp. *chlorella* (TF)**	
Description: According to *FloraBase* (WAH 1998-2024, 2024), *Eremophila glabra* subsp. *chlorella* is a prostrate, spreading shrub 0.2-1 m high with yellow-green flowers between July and November growing in sandy clay soils in winter-wet depressions. Within the survey area this species was observed to match the *FloraBase* species description, although was on the edge of winter-wet depressions rather than within them. Few flowers were observed. 	**Habitat:** Wetland edge in vegetation types **Co**, **Ml**, **Vdd** and disturbed land on the limestone bund. **Location:** Two main clumps; one clump of 12 individuals were located on the western side of the bund (east of the Western Power substation), the other clump (six plants) was to the east of the bund, north of the above group. Three isolated plants were also recorded on the eastern edge of the bund and on the bund itself to the east of the other isolated plants. **Survey results**: 21 individuals in survey area. **Populations:** All were part of a single population. **Known records and distribution**: According to *Atlas of Living Australia* (ALA 2024) there are 66 records of this taxon from the Avon Wheatbelt, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain bioregions, with an overall distribution of approximately 315 km (north-south) to approximately 110 km inland. There are four main foci of this taxon, with the survey area located within the Swan Coastal Plain clump. 

4.1.2.2 Priority Flora

Only one of the target P4 were located during the field survey: *Schoenus natans* (**Table 2**).

The other target P4 species (*Aponogeton hexapetalus* and *Ornduffia submersa*) were not located. Both are aquatic plants and, as there was no standing water present during the field survey (and only very little damp soil), their habitat was not present. There is no reason to consider them to be extinct within the survey area as they most likely exist as underground structures that would have seasonal above-ground expression when there is sufficient water present.

Locations of *Schoenus natans* are indicated on **Map 1** and described in more detail in **Table 2**.

Babingtonia urbana and *Schoenus capillifolius*, both P3, were not recorded during the survey (see **Section 2.2.2**).

Table 2: PF recorded during the field survey

***Schoenus natans* (P4)**	
Description: According to *FloraBase* (WAH 1998-2024, 2024), *Schoenus natans* is an aquatic annual herb to 0.3 m high with brown flowers during October. At the time of survey there was no standing water and *Schoenus natans* was present as a mat of pale dried threads on the soil surface in areas where there would have been standing water during winter, noting that various other aquatic plants including *Ruppia* and *Lepilaena* spp. may also have contributed to this mat but were not identifiable in this condition. 	**Habitat:** Low-lying winter-wet areas in vegetation types **Co**, **Ml**, **MrVj** and **Vj**. Mostly observed on clay soils. **Location:** Occurs widely in clay wetland areas within the survey area. **Survey results**: Four records from quadrats and four opportunistic observations in the survey area but would be more widespread. Plant numbers are not possible to determine. **Populations:** A single population. **Known records and distribution**: According to ALA (2024) there are 84 records of this species from five bioregions (Avon Wheatbelt, Geraldton Sandplains, Jarrah Forest, Swan Coastal Plain, Warren) in south-western Western Australia. Its overall distribution is approximately 560 km (north-south) by 160 km (east-west). The survey area is in the western central portion of the species' distribution.

4.1.3 OTHER SIGNIFICANT FLORA

No flora taxa having other significance according to the Flora and Vegetation Technical Guidance (EPA 2016a) were recorded during the field survey.

4.1.4 FLORA OF TAXONOMIC INTEREST

No flora of taxonomic interest were recorded during the field survey.

4.1.5 INTRODUCED FLORA

Thirty-four introduced flora species (weeds) were recorded during the field survey, representing 38.2% of the overall flora inventory, including the deliberately planted *Eucalyptus camaldulensis*.

Watsonia meriana var. meriana* (Watsonia) was the most commonly recorded introduced taxon, occurring in 13 of 19 quadrats and occupying an average of 20.9% cover (where it occurred) and up to 90% cover in quadrat C2316 (Image 5**). This taxon was the most significant contributor to poor vegetation condition ratings. **Cynodon dactylon* (Couch Grass) was also a common occurrence in the survey area occurring in five quadrats where it occupied up to 40% cover in one quadrat (averaging 13.4% cover where it occurred, including in quadrat C2309; **Image 6**), and also contributed to lowering vegetation condition.

**Hyparrhenia hirta* (Tambookie Grass) was not frequently encountered within quadrats, however, it formed dense stands in disturbed areas (Image 7).

Image 5: Watsonia meriana var. meriana in C2316

Image 6: C2309 showing **Cynodon dactylon* ground cover

Image 7: * *Hyparrhenia hirta* on the 'bund'

Two of the introduced flora are Declared Pest plants (**Asparagus asparagoides*, Bridal Creeper and **Echium plantagineum*, Patterson's Curse), however, are in the exempt category under the BAM Act and have no management requirements. **Asparagus asparagoides* is also a WoNS species.

4.2 VEGETATION

4.2.1 VEGETATION TYPES

Eight vegetation types were recorded from within the survey area (**Table 3**, **Map 1**) based on a combination of structural vegetation type as identified in the field and floristic analysis.

The vegetation types within the survey area were:

- **BcCdLa**: *Bolboschoenus caldwellii*, **Cynodon dactylon* and **Lotus subbiflorus* low closed rushland/tussock grassland/forbland
- **Co**: *Casuarina obesa* mid woodland
- **LcLfCd**: *Leptocarpus coangustatus*, *Lachnagrostis filiformis* and **Cynodon dactylon* mid closed rushland/grassland/tussock grassland
- **Ml**: *Melaleuca lateritia* mid shrubland
- **MrVj**: *Melaleuca rhaphiophylla* and *Viminaria juncea* low open forest
- **Vdd**: *Verticordia densiflora* var. *densiflora* mid shrubland
- **VjCo**: *Viminaria juncea* and *Casuarina obesa* low woodland
- **Vj**: *Viminaria juncea* low woodland.

Table 3: Vegetation types

Representative quadrat for the photograph is indicated in **bold font**.

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Other characteristic species	Area (ha) and extent (%)
Wetland	**BcCdLa**	*Bolboschoenus caldwellii*, **Cynodon dactylon* and **Lotus subbiflorus* low closed rushland/tussock grassland/forbland **NVIS**: G+ ^^*Bolboschoenus caldwellii*,*Cynodon dactylon*,*Lotus subbiflorus*\^rush,tussock grass,forb\1\d	**C2304**		**Bellardia viscosa* **Briza minor* **Centaurium erythraea* **Eragrostis curvula* *Isolepis cernua* **Lolium multiflorum* **Polypogon monspeliensis* **Romulea rosea*	0.23 ha 2.87%
Wetland	**Co**	*Casuarina obesa* mid woodland over *Melaleuca lateritia* mid sparse shrubland over *Schoenus tenellus*,*Leptocarpus coangustatus* and **Watsonia meriana* var. *meriana* low rushland/forbland **NVIS**: U+ ^*Casuarina obesa*\^tree\7\c; M ^*Melaleuca lateritia*\^shrub\3\r; G ^^*Schoenus tenellus*,*Leptocarpus coangustatus*,*Watsonia meriana* var. *meriana*\^rush,forb\1\c	C2302 **C2305** C2315		**Briza maxima* **Bromus catharticus* *Ficinia nodosa* *Gahnia trifida* **Hyparrhenia hirta* **Isolepis hystrix* *Lachnagrostis filiformis* *Lepidosperma* sp. 1 *Verticordia densiflora* var. *densiflora* *Viminaria juncea*	0.95 ha 11.93%

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Other characteristic species	Area (ha) and extent (%)
Wetland	**LcLfCd**	*Leptocarpus coangustatus*, *Lachnagrostis filiformis* and **Cynodon dactylon* mid closed rushland/grassland/tussock grassland **NVIS**: G+ ^^*Leptocarpus coangustatus*,*Lachnagrostis filiformis*,*Cynodon dactylon*\^rush,other grass,tussock grass\2\d	**C2308**		*Amphibromus nervosus* *Casuarina obesa* **Eragrostis curvula* *Goodenia pulchella* subsp. Coastal Plain B (L.W. Sage 2336) *Gratiola pubescens* *Hesperantha falcata* **Isolepis hystrix* **Lolium multiflorum* **Lotus subbiflorus* **Polypogon monspeliensis* **Sonchus oleraceus* *Verticordia densiflora* var. *densiflora* **Watsonia meriana* var. *meriana*	0.11 ha 1.36%
Wetland (basin sumpland)	**Ml**	*Melaleuca lateritia* mid shrubland over *Leptocarpus coangustatus*, *Leptocarpus canus* and *Schoenus natans* mid open rushland **NVIS**: M+ ^*Melaleuca lateritia*\^shrub\3\c;G ^*Leptocarpus coangustatus*,*Leptocarpus canus*,*Schoenus natans*\^rush\2\i	C2307 **C2311** C2317 C2318 C2319		*Astartea affinis* *Cassytha racemosa* forma *racemosa* *Goodenia pulchella* subsp. Coastal Plain B (L.W. Sage 2336) Iridaceae sp. *Lachnagrostis filiformis* **Lolium multiflorum* **Lotus subbiflorus* **Lythrum hyssopifolia* **Sonchus oleraceus* **Watsonia meriana* var. *meriana*	2.24 ha 28.22%

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Other characteristic species	Area (ha) and extent (%)
Wetland (lowest-lying)	**MrVj**	*Melaleuca rhaphiophylla and Viminaria juncea* low open forest over *Verticordia densiflora* var. *densiflora* mid shrubland over **Watsonia meriana* var. *meriana*, **Watsonia meriana* var. *bulbillifera* and *Ficinia nodosa* mid forbland\rushland **NVIS**: U+ ^*Melaleuca rhaphiophylla*,^*Viminaria juncea*\^tree\6\c;M ^*Verticordia densiflora* var. *densiflora*\^shrub\3\c;G ^^*Watsonia meriana* var. *meriana*,^*Watsonia meriana* var. *bulbillifera*,*Ficinia nodosa*\^forb,rush\2\c	C2301 **C2309** C2310		**Amaryllis belladonna* *Cassytha racemosa* forma *racemosa* **Cynodon dactylon* **Ehrharta longiflora* *Lobelia anceps* **Lolium multiflorum* *Machaerina rubiginosa* *Melaleuca lateritia* *Xanthorrhoea brunonis*	0.66 ha 8.33%
Wetland	**Vdd**	*Verticordia densiflora* var. *densiflora* mid shrubland over **Watsonia meriana* var. *meriana*, *Lepidosperma* sp. 1 and *Ficinia nodosa* mid forbland/sedgeland/rushland **NVIS**: M+ ^*Verticordia densiflora* var. *densiflora*\^shrub\3\c;G ^^*Watsonia meriana* var. *meriana*,*Lepidosperma* sp. 1,*Ficinia nodosa*\^forb,sedge,rush\2\c	**C2303** C2314		**Briza maxima* **Briza minor* *Centrolepis aristata* *Drosera menziesii* *Goodenia pulchella* subsp. Coastal Plain B (L.W. Sage 2336) *Lachnagrostis filiformis* *Pimelea imbricata* var. *major*	0.31 ha 3.88%

Landform	Mapping unit	Vegetation type	Floristic quadrats	Representative photograph	Other characteristic species	Area (ha) and extent (%)
Wetland	**VjCo**	*Viminaria juncea* and *Casuarina obesa* low woodland over *Verticordia densiflora* var. *densiflora*, **Watsonia meriana* var. *meriana* and *Lepidosperma* sp. 1 low-mid shrubland/forbland/sedgeland **NVIS**: U+ ^*Viminaria juncea*,^*Casuarina obesa*\^tree\6\i;G ^^*Verticordia densiflora* var. *densiflora*,*Watsonia meriana* var. *meriana*,*Lepidosperma* sp. 1\^shrub,forb,sedge\2\c	**C2306** C2313		*Hakea varia* Iridaceae sp. *Leptocarpus coangustatus* *Melaleuca lateritia* *Melaleuca rhaphiophylla* *Pimelea imbricata* var. *major* *Xanthorrhoea brunonis*	0.29 ha 3.60%
Upland (low-lying)	**Vj**	*Viminaria juncea* low woodland over *Melaleuca lateritia* low open shrubland over **Watsonia meriana* var. *meriana* and *Verticordia densiflora* var. *densiflora* mid closed forbland/shrubland **NVIS**: U+ ^*Viminaria juncea*\^tree\6\i;M ^*Melaleuca lateritia*\^shrub\3\i;G ^^*Watsonia meriana* var. *meriana*,*Verticordia densiflora* var. *densiflora*\^forb,shrub\2\d	**C2312** C2316		*Astartea affinis* *Cassytha racemosa* forma *racemosa* *Hakea varia* **Hyparrhenia hirta* *Leptocarpus canus* *Neurachne alopecuroidea* *Xanthorrhoea brunonis*	0.74 ha 9.28%
		Not native vegetation (cleared)				2.43 ha 30.53%
		TOTAL EXTENT				**7.95 ha**

4.3 VEGETATION SIGNIFICANCE

The significance of the survey area's vegetation lies in it being representative of a TEC.

4.3.1 TECS AND PECS

DBCA considers that the majority of the survey area intersects a representative of the EPBC-listed endangered Muchea Limestone TEC, shown on **Map 3**.

However, Ecoscape's 2018 assessment (Ecoscape 2019) identified that the vegetation was more representative of the EPBC-listed critically endangered Clay Pans TEC. A representative of the Clay Pans TEC, the Brixton Street Wetlands (DBCA 2015), are approximately 2.6 km to the east and south-east.

Section 4.4 below details floristic analysis, specifically in **Section 4.4.1.1** that compares quadrats with the Gibson *et al.* (1994) data that is relevant to the TEC assignation, and TEC interpretation according to various guidelines (**Section 4.4.2**). TEC interpretation is summarised in **Section 4.4.3**.

4.3.2 OTHER SIGNIFICANT VEGETATION

No vegetation having other significance according to the Flora and Vegetation Technical Guidance (EPA 2016a) were recorded during the field survey.

4.4 DATA ANALYSIS

4.4.1 QUADRAT FLORISTIC ANALYSIS

The floristic analysis dendrogram (**Figure 5**) indicates:

- vegetation type **Ml** is well defined in terms of floristics; it occupies discrete wetland areas (sumps)
- vegetation types **BcCdLa** and **LcLfCd**, both of which are rushlands, are floristically similar. The quadrat defining **BdCdLa** was in Completely Degraded condition, representing a highly disturbed area with few native species.
- vegetation type **Co** has two floristically similar quadrats (C2302 and C2305), both in Degraded condition, and one floristic outlier quadrat (C2315) which was in Very Good condition. The latter quadrat is included in the vegetation type due to the dominance of the characteristic species (*Casuarina obesa*), noting that this was the only species that occurred in all quadrats and all other species occurred in only one of the three quadrats within this vegetation type.
- vegetation types characterised by *Viminaria juncea* (**MrVj**, **VjCo** and **Vj**) or *Verticordia densiflora* subsp. *densiflora* (**Vdd**) are, with one exception (quadrat C2309 in vegetation type **MrVj**), floristically closely similar. The vegetation types are primarily separated on the basis of the dominant species which also corresponds with their elevation, with vegetation type **MrVj** (**Mr** being *Melaleuca rhaphiophylla*, Swamp Paperbark) occupying the lowest-lying areas that are, during most winters, likely to be inundated for several months, vegetation types **VjCo** and **Vdd** occupying adjacent damplands that in wetter years may have standing water, and vegetation type **Vj** occupying upland areas that are, in most seasons, unlikely to have standing water. Of note, quadrat C2309 is in the lowest-lying (deepest) part of the wetland although there was no standing water at the time of survey.

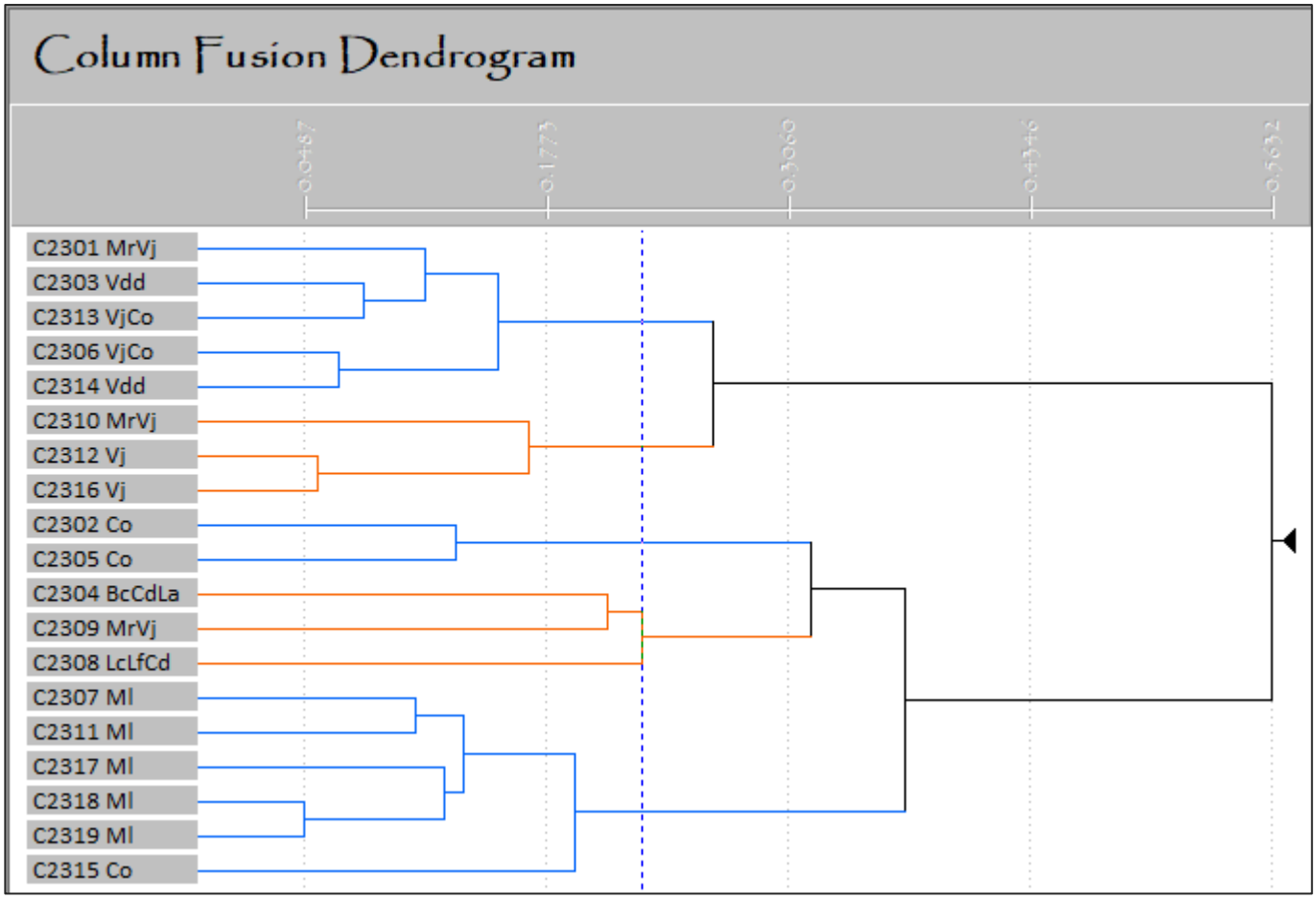

Figure 5: Floristic analysis dendrogram

4.4.1.1 Comparison with Gibson *et al.* (1994) data

TECs on the Swan Coastal Plain are frequently defined in terms of floristic community types (FCTs) which developed by Gibson *et al.* (1994), the data for which was provided by DBCA upon request. Floristic analysis, using presence/absence data was conducted using combined data, with species names reconciled where possible. However, floristic quadrats from the survey area largely grouped together rather than being spread throughout the dendrogram (partially reproduced in **Appendix Six**) which would have indicated a floristic similarity. The lack of success with this analysis is likely due to a combination of factors including that:

- the Gibson *et al*. data was collected over a number of survey periods rather than only one as for the current data, which was collected during a drier than average year and late in the season when many ephemerals were not recognisable
- time since the Gibson *et al.* data was collected as, in Ecoscape's experience, the floristic richness of the original data is rarely matched in more recent times suggesting an overall reduction in vegetation condition and floristic richness during the intervening approximately 45 plus years
- taxonomy that could not be reconciled, consisting of unidentified species in the current data (three species) and species that did not occur in the Gibson *et al*. data (12 species; six introduced and the others not regionally significant)
- previous disturbance of the site which appears to have regenerated naturally from almost complete clearing (see **Section 2.1.3**).

The only broad finding from this analysis is that the survey area shows a loose floristic similarity to a number of FCTs in the Gibson *et al.* data, specifically FCTs:

- 7 (*Herb rich saline shrublands in clay pans*); TEC (one quadrat of 18 Gibson *et al.* quadrats in group)
- 13 (*Deeper wetlands on heavy soils*)

- 15 (*Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (floristic community type 15 as originally described in Gibson et al. 1994*)); TEC
- 16 (*Highly saline seasonal wetlands*)
- 17 (*Melaleuca rhaphiophylla – Gahnia trifida season wetlands*)
- 18 (*Shrublands on calcareous silts of the Swan Coastal Plain (floristic community type 18 as originally described in Gibson et al. 1994*)); TEC
- 19 (*Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (floristic community type 19 as originally described in Gibson et al. 1994*)); TEC.

Based on geography, landform, salinity and landscape position, FCTs 7, 16 and 19 are not possible.

Previous analysis of quadrats within the southern and eastern portion of the survey area (Ecoscape 2019), conducted when Ecoscape had access to a customised multivariate analysis tool that compared quadrat data with the Gibson *et al*. (1994) data, indicated that quadrats characterised by *Melaleuca lateritia* (now vegetation type **Ml**) were most similar to FCTs 8 (*Herb rich shrublands in clay pans*) or 13 (*Deeper wetlands on heavy soils*), and quadrats characterised by *Viminaria juncea* (now vegetation type **Vj**) were most similar to FCT 8. NAH data (NACMS 2016) was also analysed although it was not possible to determine which vegetation type they were considered to represent; vegetation most likely characterised by *Melaleuca lateritia* (current vegetation type **Ml**) was most similar to FCT 9 (*Dense shrublands on clay flats*) and vegetation likely characterised by *Verticordia densiflora* (current vegetation types **Vdd** or potentially **VjCo**) was most similar to FCT 8 (*Herb rich shrublands in clay pans*). FCTs 8 and 9 are now incorporated into the EPBC-listed critically endangered *Clay Pans of the Swan Coastal Plain* TEC and are separately listed as TECs within Western Australia.

It should be noted, however, that the Muchea Limestone TEC is not defined in terms of Gibson *et al*. (1994) FCTs.

4.4.2 FLORISTIC INTERPRETATION ASSESSMENT

4.4.2.1 Muchea Limestone TEC

The Interim Recovery Plan for the Muchea Limestone TEC (English & Blythe 2000) includes a list of typical and common native species regularly associated with Muchea Limestone soils (see also **Appendix Three**). Only two species were recorded during the field survey: *Casuarina obesa*, which also occurs commonly along the edges of wetlands and in riparian areas throughout much of Western Australia and scattered in other parts of Australia (ALA 2024), and is not restricted to limestone soils, and *Melaleuca huegelii* which was recorded as an opportunistic observation of a single plant. This later species' distribution is largely coastal (*ibid*.) and it can be considered as a calcicole, thus could be considered indicative of limestone soils, however, it is also widely planted in gardens and may not be naturally occurring as its location was in a disturbed area.

English & Blythe (2000) also lists structural formations of the Muchea Limestone plant community. Communities on wet flats include *Casuarina obesa*, however, as noted, this species is characteristic of many wetlands and riparian edges, not just on limestone soils. No other listed plant community has similarities with those recorded during the field survey, nor are any of the other typical characteristic mallee species listed in English & Blythe present.

The DBCA Species and Communities fact sheet describing the Muchea Limestone TEC (DBCA 2023a) also lists *Casuarina obesa* as a typical species, noting that the fact sheet states that woodlands of this species have been recorded on Muchea Limestone but does not state that such woodlands are confined to these. Four calcicoles are listed as demonstrating that limestone influences are present; two were recorded – *Gahnia trifida*, recorded from one small patch, and *Eremophila glabra* (in this case *Eremophila glabra* subsp. *chlorella*, TF). However, neither species are entirely confined to coastal and near coastal areas (ALA 2024).

4.4.2.2 Clay Pans TEC

The Listing Advice for the Clay Pans TEC (Threatened Species Scientific Committee [TSSC] 2012) broadly describes each of the component Western Australian FCTs[1] but does not provided detailed descriptions or species lists. Based on the broad descriptions available, at least two sub-types have some similarity with the survey area:

- *Herb rich shrublands in clay pans (Community Type 8 (SCP08))* is similar to a number of vegetation types recorded during the field survey as it lists *Viminaria juncea* and *Melaleuca lateritia* as being dominant species. The landform of this TEC sub-type, described as *low lying flats with a clay impeding layer allowing seasonal inundation*, is descriptive of the landform in the lower-lying parts of the survey area.
- *Clay pans with shrubs over herbs (Community Type 117)* occurs in predominantly deeper basin clay pans and are dominated by a shrubland of *Melaleuca lateritia* with a thick understorey of herbs.

The Interim Recovery Plan for the Clay Pans TEC (Department of Parks and Wildlife [DPaW] 2015) provides more detail that indicates similarity to the TEC sub-types, specifically:

- *Herb rich saline shrublands in clay pans (Community Type 7 (SCP07))* are generally wet and have surface water present for much of the year, which is not the case within the survey area. These are generally shrublands that can include *Casuarina obesa* and have a dense herb layer although only one of the listed herb species was recorded. Three of the 13 species listed for this sub-type (Appendix 2 in DPaW 2015) were recorded during this survey. DBCA's *Methods for survey and identification of Western Australian threatened ecological communities* (DBCA 2024) indicates that at least 50% of 'common' taxa are required to be definitive of this community type, therefore, it is unlikely that this TEC sub-type is present.
- *Herb rich shrublands in clay pans (Community Type 8 (SCP08))* are less wet than the preceding sub-type. They are characterised by four species of which two (*Viminaria juncea* and *Melaleuca lateritia*) characterise several of the vegetation types within the survey area. Eight (of 15) listed associated species are also present in the survey area. As more than 50% of the 'common' taxa were recorded, according to DBCA (2024) methods, the survey area may be considered to support this TEC sub-type. Vegetation types **MI**, **MrVj** and **VjCo** have the highest potential to be representative.
- *Dense shrublands on clay flats (Community Type 9 (SCP09))* are inundated for longer periods. Some of the characteristic listed species occur (at least five of 12, perhaps more depending on taxonomy), however, not as shrublands over sedges which are typical. According to DBCA (2024) methods the survey area may support this TEC sub-type as approximately 50% of 'common' species may occur, however, this is less likely than Type 8 above.
- *Shrublands on dry clay flats (Community Type 10a (SCP10a))* occur on skeletal soils with shallow microtopography that dry rapidly. This sub-type is characterised by several listed shrub species, including *Verticordia densiflora* that characterises vegetation type **Vdd** and also occurs as a mid-stratum shrub in adjacent areas (vegetation types **MrVj** and **VjCo**, although these vegetation types are not considered representative of this sub-type). Eight (of 20) listed species were recorded. According to DBCA (2024) methods, vegetation type **Vdd** may support this TEC sub-type as approximately 50% of 'common' species may occur.
- *Clay pans with shrubs over herbs* are dominated by *Melaleuca lateritia* with dense herbs. Vegetation type **MI** is considered likely to be similar to this TEC sub-type and, in many cases has a moderate herb layer including rushes, annual grasses and forbs. The Interim Recovery Plan (DPaW 2015) has a comprehensive species list for this sub-type: 22 of 127 listed species were recorded, however, this Commonwealth TEC sub-type is not conservation-listed by DBCA.

Vegetation type **LcLfCd** does not occur within the mapped TEC extent, nor is it clearly indicative of any of the Clay Pans TEC sub-types.

[1] FCTs (floristic community types) and SCPs (Swan Coastal Plain) numbers are equivalent.

4.4.3 TEC ASSESSMENT SUMMARY

Based on a combination of listed dominant and characteristic species, particularly *Melaleuca lateritia* and *Viminaria juncea*, descriptions of landforms and soils, noting that the wetland soils are clayey and limestone was only observed in locations where it was clearly not naturally occurring (confirmed by Parsons Brinckerhoff in Woodman Environmental Consulting (2005)), it is considered that the wetlands in the survey area are more similar to the EPBC-listed Clay Pans TEC than the Muchea Limestone TEC.

Given the degree of historical disturbance it is to be expected that the species richness, and therefore floristic diversity and alignment with specific floristic groups (which define most Western Australian-based TEC sub-types of the EPBC-listed Clay Pans TEC), is not a clear match for any particular sub-type.

Based on this assessment it is considered that the majority of the survey area is most similar to sub-type *Herb rich shrublands in clay pans (SCP08)*, which is listed as endangered under the Western Australian BC Act. Vegetation in Good or Very Good condition within vegetation types **MI**, **MrVj** and **VjCo** are considered to represent this TEC; 2.50 ha.

Vegetation in Good or Very Good condition within vegetation type **Vdd** is considered to represent the endangered Western Australian *Shrublands on dry clay flats (SCP10a)*; 0.17 ha.

Vegetation in Degraded-Completely Degraded condition is not considered to represent extant native vegetation and is therefore not included as a TEC. Vegetation type **LcLfCd** is not included in the mapped TEC extent.

Map 3 indicates the extents of wetland vegetation, herein defined as areas that are seasonally inundated or waterlogged, DBCA-mapped TEC extent (as the Muchea Limestone TEC), EPBC-listed Clay Pans TEC extent (as per this assessment, Good-Very Good condition vegetation only) and Western Australian TECs as above.

4.4.3.1 Nearby Similar Vegetation

Nearby areas, identified from aerial imagery and checked using *Google Street View* (Google LLC 2024) as being potentially natural wetlands, were visited and assessed for similarity to the survey area and therefore potential to represent the same TEC as occurring in the survey area. Four nearby areas were identified (**Figure 6**), as follows. The names applied below are (except the first) unofficial and provided as locational descriptors only.

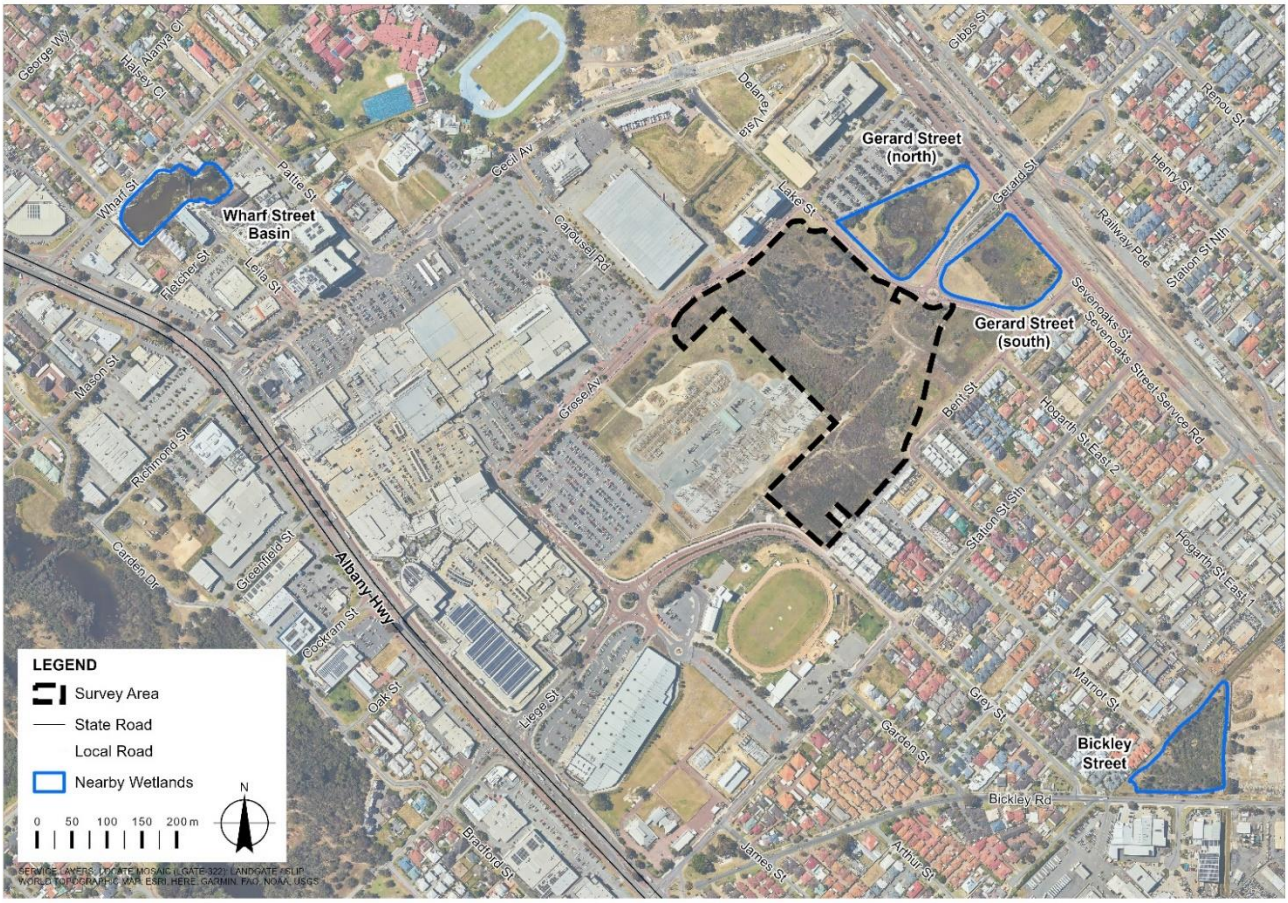

Figure 6: Nearby wetlands

Wharf Street Basin: this wetland, located approximately 680 m west of the survey area, was visited as it is close to the coordinates of an *Eremophila glabra* subsp. *chlorella* DBCA record (WAH 2024) from 1996, although the location details with this record indicated the actual location was likely closer to, or perhaps being the same location, as those within the survey area. However, this wetland (**Image 8**, **Image 9**) was highly modified, did not resemble a natural wetland and thus was not representative of the TEC (or any other natural area), nor was *Eremophila glabra* subsp. *chlorella* observed amongst the planted species.

Image 8: Wharf Street Basin

Image 9: Wharf Street Basin

Gerard Street (north): this wetland is immediately north-east of the survey area, located on the northern side of the Gerard Street overpass. It was included in the NAH 2015 survey area (NACMS 2016) and was therein mapped as being a *Degraded area with little to no natives present* and assessed as being in Completely Degraded condition. In the intervening period a few native species (e.g. *Melaleuca rhaphiophylla*, *Casuarina obesa* and *Acacia saligna*) have grown around the edges of the wetland (**Image 10**, **Image 11**), however, the NAH mapping is still considered to represent current conditions. Therefore, this wetland does not resemble the TEC from the adjacent area.

Image 10: Gerard Street (north)

Image 11: Gerard Street (north)

Gerard Street (south): this wetland is immediately north-east of the survey area, located on the southern side of the Gerard Street overpass. It was included in the NAH 2015 survey area (NACMS 2016) and was therein mapped as largely being a *Degraded area with little to no natives present* and assessed as being in Completely Degraded condition. Two small patches of native vegetation also occurred, and are still present and largely considered to be in similar condition to as assessed by NAH: *Baumea* (now *Machaerina*) *juncea sedgeland* in Very Good condition (**Image 12**) and *Open Hakea prostrata shrubland* in Degraded condition. Neither vegetation type occurred within the current survey area. Therefore, this wetland does not resemble the TEC from the adjacent area.

Image 12: Gerard Street (south)

Bickley Street: this probable wetland is on Water Corporation lands, approximately 550 m to the southeast of the survey area; it was fenced and not accessible to view closely. The basin, which appears to have been

deepened from its natural condition, had drains installed and been cleared in the past (**Image 13** (Google LLC 2024 time series, May 2003)), was densely vegetated (**Image 14**-**Image 16**) with species that occur commonly and are characteristic of several vegetation types in the current survey area including *Casuarina obesa*, *Melaleuca lateritia* and *Melaleuca rhaphiophylla*. Without a more detailed assessment it is not possible to ascertain that this site does not have vegetation that is similar to that occurring in the survey area, however, as result of its disturbance and likely condition, it is unlikely to be representative of the TEC occurring at Carousel Swamp, or any other conservation-listed ecological community.

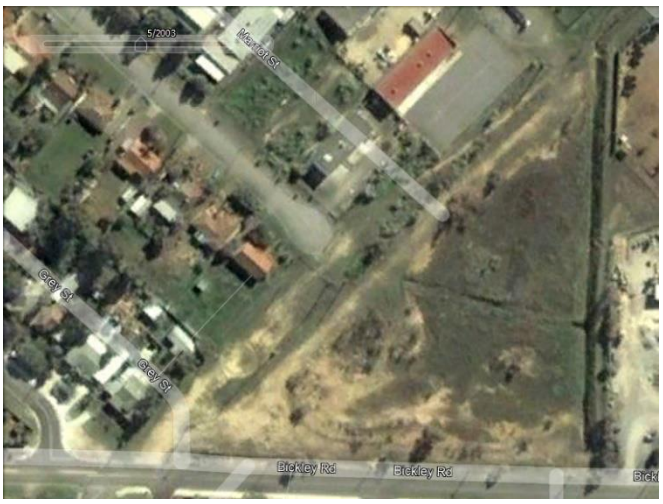

Image 13: Bickley Street (Google LLC 2024)**, May 2003**

Image 14: Bickley Street

Image 15: Bickley Street

Image 16: Bickley Street, from Marriot Street

In summary, none of the nearby wetlands are considered to be unidentified representative of the TEC occurring within the current survey area.

4.5 VEGETATION CONDITION

The vegetation condition within the survey area ranged from Completely Degraded to Very Good condition, with the majority of the vegetated portion in Degraded condition (**Table 4**, **Map 2**).

The main factors affecting vegetation condition were previous clearing and soil disturbance causing low species diversity and weediness. No portions of the survey area were considered to be in Excellent condition or better.

Table 4: Vegetation condition

Vegetation condition	Extent (ha)	Proportion (%)
Pristine	-	-
Excellent	-	-
Very Good	1.41	17.69
Good	1.32	16.61
Degraded	1.77	22.27
Completely Degraded	1.03	12.90
Not native vegetation (cleared, no native species)	2.43	30.53

4.6 BOTANICAL LIMITATIONS

Survey design and type: Single phase, quadrat-based flora and vegetation survey with extensive traverses searching for conservation-listed flora. Results from previous surveys were considered as part of survey design and the desktop assessment.

Type of vegetation classification system: Vegetation classified at NVIS Level V (NVIS Technical Working Group & DotEE 2017) using largely structural vegetation types defined using dominant and characteristic species and vegetation structure as recorded during the field surveys. Floristic analysis was used to identify major floristic groups and outlier groups of floristic interest.

A full summary of botanical limitations is presented in **Table 5**.

Table 5: Botanical limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of contextual information at a regional and local scale	No constraints	There have been several previous botanical and hydrological studies undertaken within the survey area.
Competence/experience of the team conducting the survey, including experience in the bioregion surveyed	No constraints	The lead botanist conducting the field survey has 40 years' experience surveying in the Swan Coastal Plain bioregion.
Proportion of the flora recorded and/or collected, and any identification issues	No constraints	89 vascular flora taxa were recorded during the field survey of which 4.5% could not be identified with certainty to species level due to the lack of diagnostic reproductive material. This is considered to not represent a constraint to survey accuracy. None of the unidentified taxa are considered likely to represent any conservation-listed flora from the region.
Was the appropriate area fully surveyed (effort and extent)	No constraints	The area was fully surveyed (survey track log indicated on **Map 2** showing survey effort). The far southern corner was not accessible due to vegetation density, however, was clearly visible. It was in Degraded condition with a dense understorey of *Watsonia meriana*.
Access restrictions within the survey area	No constraints	All parts of the survey area were accessible or clearly visible.

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Survey timing, rainfall, season of survey	No constraints (season of survey) Moderate constraints (rainfall and survey timing)	The field survey was conducted during November which is within the primary season for survey in the Swan Coastal Plain bioregion. The survey timing was dictated by the late engagement of Ecoscape by the City when the majority of available field survey time during spring had already been committed to other projects. However, as the survey was in the latter part of the optimal season and seasonal conditions were poor (see below), there was no standing water and potentially there may have been little or it is likely to have been of short duration due to seasonal conditions. There is a moderate constraint in regard to the combination of timing and lack of rainfall as aquatic species, including two target conservation-listed species, were not present. The rainfall in the 6 months prior to the field survey was very much below the mean for this period as indicated by the rainfall deciles (see below); Bureau of Meteorology (2024a) data indicates that rainfall was only 73.8% of the average. This represents a moderate constraint as aquatic species were not present and largely not identifiable, and some annual and ephemeral herbs may not have reached maturity or flowering before senescing and were thus not readily visible.
Disturbance that may have affected the results of the survey e.g. fire, flood, clearing	No constraints	There were no recent disturbances that would have affected the results of the survey. None of the survey area had been recently burnt or cleared and all disturbances were long-term.

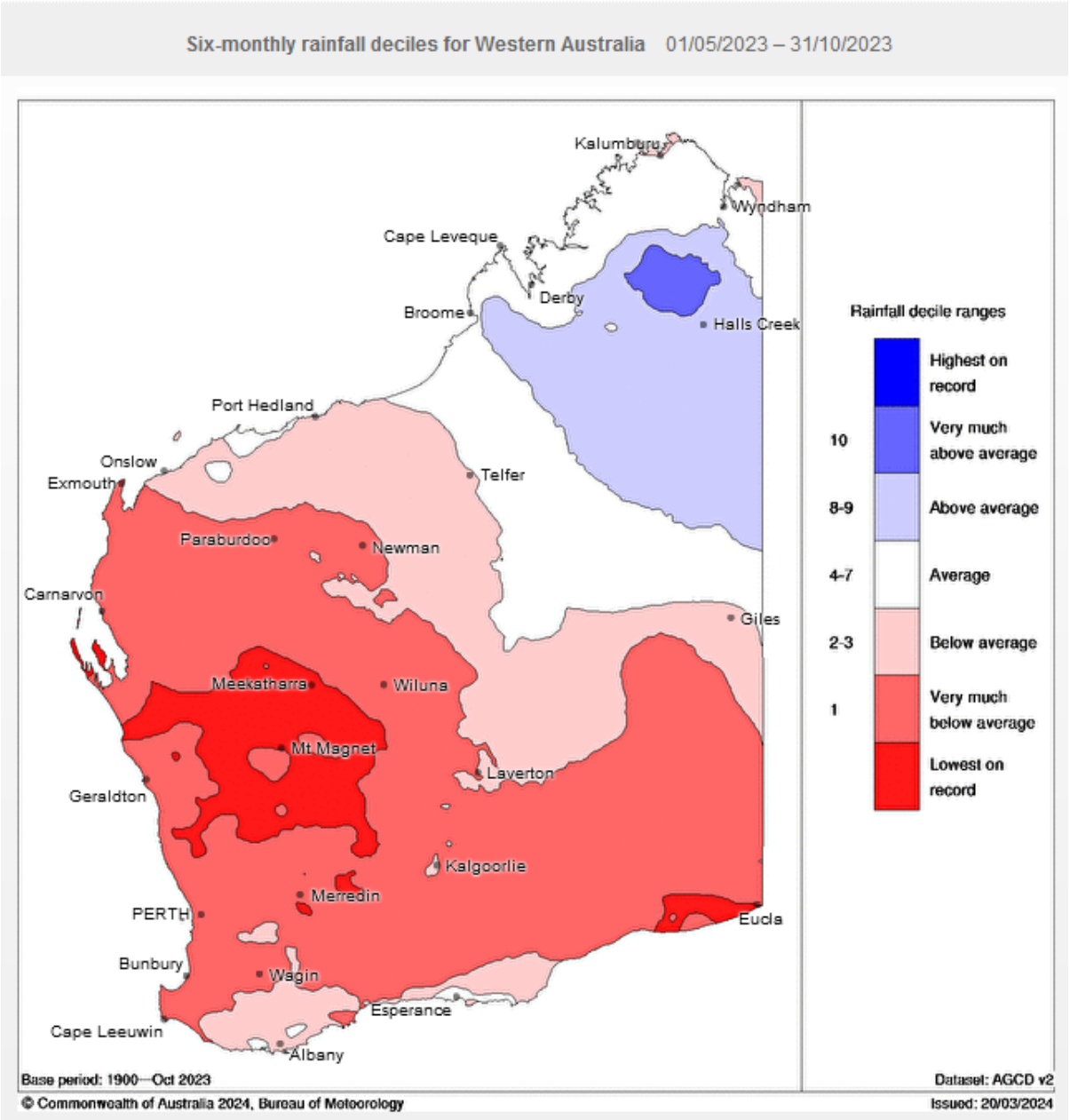

Figure 7: Rainfall deciles for the 6 months prior to the field survey (Bureau of Meteorology 2024b)

The survey area is close to, just east of, the location indicated as 'Perth'.

5 DISCUSSION

5.1 FLORA

5.1.1 FLORA INVENTORY

Eighty-nine vascular flora species were recorded from 19 floristic quadrats and opportunistic observations, including during searches for conservation-listed flora. Introduced species contributed to 38.2% of the flora inventory (34 taxa) reflecting the level of disturbance, including previous clearing and grazing, and that the area is almost entirely naturally regenerated.

NAH (NACMS 2016) recorded 111 species in 2015, 48.6% of them introduced. NAH conducted its survey over non-consecutive days during September, October and November and had a larger survey area than the current survey area extent, likely at least in part explaining the greater number of species recorded. BoM data (Bureau of Meteorology 2024b) indicates that 2015 was, similar to 2023, a drier than average year, however, the earlier (September, October) survey events suggest that more ephemeral species, including wetland species, may have been present and identifiable during NAH's survey.

Woodman Environmental Consulting (2005) recorded 188 vascular plant species over 'multiple visits from winter to spring 2004'. Details of survey dates and the extent of the survey area are not included in the copy of the report available for review thus an explanation of the variation in species richness cannot be made, although survey intensity and seasonal timing and conditions are likely to have influenced the results. Photographs included in the report show significant standing water, none of which was present during the Ecoscape 2023 survey.

5.1.2 CONSERVATION-LISTED FLORA

None of the unidentified taxa resemble any currently described TF or PF species.

5.1.2.1 Threatened Flora

Eremophila glabra subsp. *chlorella* is listed as endangered under both the Commonwealth EPBC Act and Western Australian BC Act.

Woodman Environmental Consulting (2005) recorded *Eremophila glabra sens. lat,* however, identification to subtaxon level could not be made due to lack of flowering material. At the time of the Woodman survey *Eremophila glabra* subsp. *chlorella* was not conservation-listed and no plant counts or locations from the Woodman surveys are available.

There are five DBCA database records of *Eremophila glabra* subsp. *chlorella* from this site. Chronologically:

- 2007; 10 plants were reported (herein sub-population 'A')
- 2009; no plant counts (herein sub-population 'B'), separated from record 'A' by approximately 70 m
- 2011 (22 November); as these records were all reported separately it can be assumed that they are separate sub-populations:
  - sub-population 'A' appears to have not been re-recorded
  - sub-population 'B' now has three mature and 18 juveniles
  - new sub-population 'C' located approximately 10 m northeast of record 'A': one mature and two juveniles
  - new sub-population 'D' located approximately 120 m east of record 'B' and 60-70 m from records 'A' and 'C': two mature plants.

None of the above records are from south of the fence, on Western Power lands. It is, therefore, unknown if this area was accessible or accessed during the earlier recording events and it is not possible to determine if the sub-population herein referred to as 'E' was present during these earlier events.

Eremophila glabra subsp. *chlorella* was recorded from within the survey area in 2015 by NAH (NACMS 2016), with no plant counts provided in the report although counts of locations indicated on the included map suggested 15 individuals (assuming that each indicated 'spot' was for one plant).

Twenty-one mature *Eremophila glabra* subsp. *chlorella* plants were recorded during the 2023 Ecoscape survey (**Map 1**); no juveniles were observed. The plant numbers and locations roughly correspond with those indicated in the NAH report, thus confirming that the locations are consistent and there has been little change to the taxon's population since the last known survey by NAH in 2015 (NACMS 2016).

Changes in sub-populations are summarised in **Table 1** below.

Table 6: Eremophila glabra subsp. chlorella sub-population changes over time

Sub-population ('names' nominal)	2007 (DBCA/WAH record)	2009 (DBCA/WAH record)	2011 (DBCA records)	2015 (NACMS 2016, estimated)	2023 (this survey)	Change (highest to lowest count)
A	10		-		1	-9
B		?	21	6	6	-15
C			3	1	1	-2
D			2	?1 (location not absolute match)	1	-1
E (on Western Power lands)			-	7	12	+5*
Total	**10**	**?**	**26**	**15?**	**21**	**-22 (-27 if not including 'E')**

It is not known how complete the count of *Eremophila glabra* subsp. *chlorella* plants was in 2007 thus this may represent only a portion of the total number of plants present at the time, nor is it known over what extent the count was conducted. Based on available information there has, as of 2023, been a decline of approximately two thirds of the population of *Eremophila glabra* subsp. *chlorella* present in 2011, at least north of the fence approximately delineating Western Power lands (26 plants in 2011, now nine). There is no data to determine if there has been any real change in the numbers of plants on Western Power lands as counting 'spots' on the map within the NAH (NACMS 2016) report is likely inaccurate.

No *Eremophila glabra* subsp. *chlorella* plants are located within the proposed Southern Link Road footprint, nor in close proximity. As such, direct impacts are highly unlikely.

5.1.2.2 Priority Flora

Three Priority-listed Flora species were targeted for survey, however, only one was recorded during the field survey.

***Schoenus natans* (P4)**

Schoenus natans (P4) was recorded from eight scattered low-lying locations (**Map 1**) and would be present in other low-lying areas throughout the survey area. It was not possible to estimate the number of individual plants as it is an annual species and formed dried (dead) and tangled mats that covered larger areas where observed. As such it is estimated that thousands of plants were present in the survey area. Ecoscape (2019) also recorded it in its survey area along the eastern edge of the current survey area; no plant counts were possible, despite there being standing water and living plants at that time. NAH did not record this species in 2015 (NACMS 2016).

It is highly likely that *Schoenus natans* will be directly impacted by proposed Southern Link Road works, however:

- the number of individuals occurring within the proposed roadworks footprint is likely to represent a small fraction of the total population within the survey area (estimated at 5% at most), with thousands of plants remaining in areas that will not be directly impacted

- the total area of the species' occupation within Western Australia is approximately 560 km north-south by 160 km east-west, estimated by using the distance measuring tool on the ALA (2024) spatial portal, from within five bioregions. Thus, removal of a very small proportion of the population from within this survey area are unlikely to affect the species' population as a whole.
- P4 species are not considered to be under any immediate threat (DBCA 2023b).

Other Targeted Priority-listed Flora

Aponogeton hexapetalus (P4)

According to *FloraBase* (WAH 1998-2024) *Aponogeton hexapetalus* is described as a '*Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green-white, Jul to Oct. Mud. Freshwater: ponds, rivers, claypans*.' According to ALA (2024) there are 65 records of this species (excluding one from a cultivated specimen from Victoria), all within the Jarrah Forest and Swan Coastal Plain bioregions in Western Australia and having a north-south range of approximately 290 km according to the measuring tool on the ALA website.

No standing water was present during the Ecoscape survey in November thus its aquatic habitat was not present. The lowest-lying areas and previously recorded locations were searched for evidence of dried material resembling this species, however, none was observed.

It is not known if there had been any standing water during 2023, which was significantly drier than average (73.8% of average rainfall for the 6 months prior to the survey, including the winter period; **Figure 7**, **Table 5**), or if the inundated period was extremely short. Except for the very lowest-lying area (immediately to the north of the eastern corner of the Western Power substation) the soil surface throughout the survey area was entirely dry, noting that the presence of *Schoenus natans* as dried plants suggests at least a short period of inundation.

There is no reason to consider that *Aponogeton hexapetalus* is extinct within the survey area as it is likely to occur at low densities within vegetation types **MI** and potentially **MrVj**. No plants were recorded by Ecoscape (2019) within the proposed roadworks footprint, although an opportunistic observation was recorded from the 20 m buffer area applied to the proposed roadworks footprint, within vegetation type **MI**. Woodman Environmental Consulting (2005) recorded it from one location in its plant community H1, characterised by *Melaleuca lateritia*, close to the location of the Ecoscape record but not within the proposed road development footprint or buffer. It was recorded by Woodman during August and September but was not detectable in November when the soil had dried. NAH (NACMS 2016) did not record this species during 2015.

Aponogeton hexapetalus has not been reported from within the proposed road development footprint during the three known flora and vegetation surveys that have been conducted (Ecoscape 2019; NACMS 2016; Woodman 2005), all during periods of inundation within vegetation type **MI**. Therefore, it is highly unlikely that it occurs within the proposed development footprint. It is unlikely that there would be a direct impact on this species' population within the survey area, and at most a negligible impact on the species overall population.

P4 species are not currently considered to be threatened (DBCA 2023b).

Ornduffia submersa (P4)

Ornduffia submersa is a submerged, perennial aquatic herb that grows in freshwater to 0.6 m deep, with white flowers during late winter and spring (Wheeler, Marchant & Lewington 2002, as *Villarsia submersa*).

No standing water was present during the Ecoscape survey in November thus its aquatic habitat was not present. The lowest-lying areas and previously recorded locations were searched for evidence of dried material resembling this species, however, none was observed.

According to ALA (2024) there are 76 records of *Orduffia submersa* from across five bioregions (Avon Wheatbelt, Esperance Plains, Jarrah Forest, Swan Coastal Plain, Warren) in Western Australia, with an approximate 410 km north-south distribution.

Ecoscape (2019) did not record this species within its small survey area that was confined to the eastern portion of the current survey area. Woodman Environmental Consulting (2005) recorded it from one

opportunistic observation although this location is not available. NAH (NACMS 2016) recorded it from one location near the eastern corner of the Western Power substation in a (now) recently disturbed area without any native vegetation but previously (during the NAH survey) having *Melaleuca lateritia* Heathland vegetation.

There is no reason to consider that *Ornduffia submersa* is extinct from the survey area although it is likely to be confined to only a small area, specifically near the eastern corner of the Western Power substation. This corresponds with the lowest elevation and thus is likely to be inundated for the longest period and have the deepest standing water.

The portion of the survey area that is habitat for *Ornduffia submersa* is not within the proposed road development footprint, and it is highly unlikely that it would occur within the proposed road development footprint. As such it is unlikely that there would be a direct impact on this species' population within the survey area, or on the species overall population.

P4 species are not currently considered to be threatened (DBCA 2023b).

5.1.2.3 Other Significant Flora

No species having any other significance according to the Flora and Vegetation Technical Guidance (EPA 2016a) was recorded, nor any flora of taxonomic interest.

5.1.2.4 Introduced Flora

Thirty-four introduced species were recorded during the field survey (38.2% of the flora inventory). None have any management requirements as a result of their occurrence.

5.2 VEGETATION SIGNIFICANCE

Eight vegetation types were recorded from the survey area:

- **BcCdLa**: *Bolboschoenus caldwellii*, **Cynodon dactylon* and **Lotus subbiflorus* low closed rushland/tussock grassland/forbland – 0.23 ha, all in Completely Degraded condition, occurring within an area considered as wetland
- **Co**: *Casuarina obesa* mid woodland – 0.95 ha, 87.9% in Degraded-Completely Degraded condition, occurring within an area considered as wetland and, where in Good or better condition, representative of a TEC (see **Section 5.2.1** below)
- **LcLfCd**: *Leptocarpus coangustatus*, *Lachnagrostis filiformis* and **Cynodon dactylon* mid closed rushland/grassland/tussock grassland – 0.11 ha, 44.0% in Degraded condition and occurring in a wetland that is not within the mapped TEC extent, and not considered representative of a TEC
- **Ml**: *Melaleuca lateritia* mid shrubland – 2.24 ha, 4.8% in Degraded-Completely Degraded condition. This vegetation type occurs in wetland basins (sumplands) that are, where in Good or better condition and within the mapped TEC extent, considered to be representative of a TEC (see **Section 5.2.1** below).
- **MrVj**: *Melaleuca rhaphiophylla* and *Viminaria juncea* low open forest – 0.66 ha, 79.9% in Degraded-Completely Degraded condition. This vegetation type is a wetland with the longest period of inundation and, where in Good or better condition and within the mapped TEC extent, is considered to be representative of a TEC (see **Section 5.2.1** below).
- **Vdd**: *Verticordia densiflora* var. *densiflora* mid shrubland – 0.30 ha, 45.07% in Degraded condition and occurring in a wetland, but at the highest elevation and having a short period of inundation. Where in Good or better condition it is considered representative of a TEC (see **Section 5.2.1** below).
- **VjCo**: *Viminaria juncea* and *Casuarina obesa* low woodland – 0.29 ha, 60.79% in Degraded condition. It occurs at the wetland edge but is considered as part of the wetland. Where in Good or better condition it is considered to be representative of a TEC (see **Section 5.2.1** below).
- **Vj**: *Viminaria juncea* low woodland. – 0.74 ha, all in Degraded condition. It occurs in upland areas and is not considered part of the wetland and not part of the TEC.

5.2.1 THREATENED ECOLOGICAL COMMUNITIES

The survey area includes a mapped representative of (according to the DBCA) Muchea Limestone TEC, which is listed as endangered under the Commonwealth EPBC Act and Western Australian BC Act.

However, Ecoscape's assessment (see **Sections 4.4.1.1** and **4.4.2**) has determined that the survey area is more similar to the Clay Pans TEC, listed as critically endangered under the Commonwealth EPBC Act and endangered under individual listings under the Western Australian BC Act (see **Appendix Three**), based on:

- the soil in the wetland areas is clayey (**Image 4**)
- the only limestone observed is not naturally occurring on the site and was noted on a (now) bund that appears to have formed a racetrack in approximately the 1980s (see **Figure 4**, **Image 1** and **Image 2**), confirmed by Parsons Brinckerhoff's soil and hydrogeological investigation for Woodman Environmental Consulting (2005), or as retaining walls supporting tracks around the edge of the Western Power sub-station
- there are few species that can be considered as calcicoles that would indicate a significant limestone influence, none of which, in their natural habitat (according to the distribution map indicated in WAH 1998-2024) are confined to limestone habitats. *Gahnia trifida* occurred in one small patch, partly on the limestone bund; *Eremophila glabra* (in this case subsp. *chlorella*), also partly on the bund and in close proximity; and a single plant of *Melaleuca huegelii*, which is the only species that naturally occurs predominantly on limestone soils but is also widely planted as a horticultural species.
- the landforms, vegetation and component species are a good match for various sub-types of the Clay Pans TEC described in the *Interim Recovery Plan for the Clay Pans TEC* (Department of Parks and Wildlife [DPaW] 2015), particularly *Herb rich shrublands in clay pans (Community Type 8 (SCP08)*, *Shrublands on dry clay flats (Community Type 10a (SCP10a))* and *Clay pans with shrubs over herbs.*

Regardless of which TEC the survey area is representative of, it is within an area of national environmental significance.

The extent of the wetland that supports TEC vegetation, based on elevation and interpreted inundation (**Map 3**), is 5.71 ha.

Areas not considered to have native vegetation are those that have been cleared and have virtually no native species remaining including tracks, grassed and planted areas and bare portion of the limestone bund, and areas covered with dense weeds e.g. **Hyparrhenia hirta* on the bund and areas dominated by *Watsonia meriana* but without emergent native species.

Vegetation in Degraded-Completely Degraded condition is also not considered to represent extant native vegetation.

Within the survey area vegetation types **Co**, **Ml**, **MrVj**, **Vdd** and **VjCo** potentially represent TEC areas where in Good or better condition. Vegetation type **BcCdLa** is not representative of a TEC as it is in Completely Degraded condition and has few native species, **LcLfCd** is not representative of a TEC as it occurs in an area not within the mapped TEC extent (i.e. a small wetland not contiguous with the larger wetland area) and **Vj** is not considered representative of a TEC as it occurs on upland areas.

Vegetation within the wetland portion of the survey area in Good or better condition (i.e. Good or Very Good condition) occupies 2.67 ha and is considered to be the extent of TEC vegetation within the survey area.

5.2.2 PRIORITY ECOLOGICAL COMMUNITIES

No PECs are associated with the survey area.

5.2.3 VEGETATION CONDITION

None of the vegetation within the survey area was considered to be in Excellent or Pristine condition due to weediness of the site, as well as low species richness, both considered to be a result of previous clearing and other disturbances including fire.

Of the 7.95 ha survey area, approximately one third is not native vegetation (2.43 ha; 30.53%), one third in Degraded-Completely Degraded condition (2.79 ha; 35.12%) and one third in Good or Very Good condition (2.73 ha; 34.35%).

Overall, there has been a significant decline in vegetation condition between 2015 (NACMS 2016) and 2023.

NAH (NACMS 2016) assessed 3.21% of the current survey area as being in Excellent condition, however, no parts of the 2023 survey area were assessed as this condition rating. The majority of the NAH portion in Excellent condition intersects Ecoscape's vegetation type **Vdd** which was in variable condition (Degraded-Very Good), with the poorer condition parts now having an understorey of **Watsonia meriana* (Watsonia).

NAH assessed 30.36% of its intersecting survey area as being in Very Good condition and 30.03% in Good condition. Adding in the portion assessed as Excellent condition, almost two thirds (63.60%) was considered as Good or better condition, In 2023 only 34.35% of the intersecting survey area was assessed as being in Good or better condition, and considered as extant native vegetation.

NAH did not consider any parts of its survey area to not have native vegetation and it is therefore considered that its Completely Degraded condition rating includes areas that are now considered as having been cleared. In 2015, 36.40% of the survey area was in Degraded-Completely Degraded condition; in 2023 65.65% of the survey area was assessed as being in Degraded-Completely Degraded condition or not having native vegetation (all plants were weeds, tracks, planted gardens/grass, bare areas).

While there is undoubtedly an element of assessment variation between the two surveys, the most significant temporal change is an increase in weed cover particularly of **Watsonia meriana* (Watsonia). A fire in the southeastern part of the survey area during the NAH survey period may have contributed to a reduction in condition in this portion, which was particularly densely covered with Watsonia (**Image 5**), however, Watsonia was present through much of the site. Shrub senescence was not assessed as being anthropogenic and was considered likely to be related to the age of the vegetation, and did not contribute to vegetation condition assessment.

The vegetation condition scale used during the 2023 field survey was as required for flora and vegetation surveys in Western Australia (EPA 2016a). I is based on and consistent with the descriptions used by Keighery (1994), as outlined in **Table 13** in **Appendix Two**. Therefore, the vegetation condition assessment is compliant with the requirements of DWER's request for additional information under Item 1 of Schedule 2 of CPS 9882/1.

6 CONCLUSIONS

The City of Canning is proposing to locate part of the Southern Link Road on a portion of the Grose Avenue/Lake Street Wetland (also known as Cannington Swamp and Carousel Swamp) in Cannington. This wetland is largely considered to represent the EPBC-listed endangered Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain TEC.

On 29 August 2023 the Department of Water and Environmental Regulation (DWER) provided the City of Canning with its requirements in response to public consultation (FM.035.416) in regard to the City's application to clear native vegetation for the Southern Link Road (CPS 9882/1). Part of these requirements were for a flora survey and threatened ecological assessment to address Item 1 of Schedule 2.

The flora and vegetation survey was required to include:

- a targeted flora survey, specifically for *Eremophila glabra* subsp. *chlorella* (TF), *Aponogeton hexatepalus* (P4), *Ornduffia submersa* (P4), *Schoenus natans* (P4) that have been previously recorded from the survey area
- wetland mapping
- TEC assessment to determine extent and condition of TEC patches, and identification of which TEC is present.

Examination of historical aerial imagery indicates that significant portions of the survey area have been cleared in the past, including for a horse racetrack, and have regenerated. On-site observations of clearing, the racetrack and past grazing were confirmed by the City of Canning.

A field survey was conducted over 4 days during November 2023.

FLORA

Twenty-one *Eremophila glabra* subsp. *chlorella* (TF) plants were recorded, confirming little change since 2015 (NACMS 2016), although there appears to have been a significant population decline since 2011 (see **Section 5.1.2.1**)None are in close proximity to proposed roadworks and they are unlikely to be directly impacted.

Schoenus nanus (P4) was recorded as occurring commonly in a number of vegetation types, however, it was not possible to count induvial plants of this annual species. At most 5% of the site's population may be directly impacted by the proposed works, however, given that there are likely to be thousands of plants within the survey area the local impact is likely to be not significant, and the regional impact virtually unnoticeable given the wide distribution within five bioregions.

As there was no standing water and therefore no suitable habitat present at the time of survey, *Aponogeton hexatepalus* (P4) and *Ornduffia submersa* (P4) were not located. There is no reason to consider that would have become locally extinct and are likely to persist in small numbers at their previously recorded locations during periods of inundation. However, they are unlikely to be widely distributed within the survey area. As none of the previous records are within the proposed development footprint there is no anticipated direct impact on these species.

VEGETATION

Eight vegetation types were recorded:

- **BcCdLa**: *Bolboschoenus caldwellii*, **Cynodon dactylon* and **Lotus subbiflorus* low closed rushland/tussock grassland/forbland (0.23 ha)
- **Co**: *Casuarina obesa* mid woodland (0.95 ha)
- **LcLfCd**: *Leptocarpus coangustatus*, *Lachnagrostis filiformis* and **Cynodon dactylon* mid closed rushland/grassland/tussock grassland (0.11 ha)
- **Ml**: *Melaleuca lateritia* mid shrubland (2.24 ha)
- **MrVj**: *Melaleuca rhaphiophylla* and *Viminaria juncea* low open forest (0.66 ha)
- **Vdd**: *Verticordia densiflora* var. *densiflora* mid shrubland (0.30 ha)

- **VjCo**: *Viminaria juncea* and *Casuarina obesa* low woodland (0.29 ha)
- **Vj**: *Viminaria juncea* low woodland (0.74 ha).

Approximately one third of the survey area (2.43 ha; 30.53%) did not have native vegetation. The significance of the vegetation as part of a wetland and TEC is discussed below.

The vegetation condition ranged from Very Good to Completely Degraded, with approximately one third in Good-Very Good condition (2.73 ha; 34.35%), one third in Degraded-Completely Degraded condition (2.79 ha; 35.12%) and one third not having native vegetation (2.43 ha; 30.53%). The vegetation condition has declined significantly since the NAH 2015 (NACMS 2016) survey, with only approximately half of the survey area assessed in 2015 as Good or better condition remaining in that condition, with an increase in weediness the most likely reason for the change.

Vegetation in Degraded-Completely Degraded condition is not generally regarded as extant native vegetation, however, it can still have significant value as habitat for flora and fauna, and play a significant role in site hydrology.

WETLAND AND TEC

The survey area includes parts mapped as wetlands (Carousel Swamp and a small, separated wetland near the Gerard, Lake and Jameson Streets roundabout) and TEC.

The following vegetation types occur within the mapped TEC and/or wetland extents:

- **BcCdLa**: (0.23 ha), considered part of the wetland extent as it is seasonally waterlogged but not part of the TEC due to its Completely Degraded condition
- **Co**: (0.95 ha), considered as part of the wetland extent and, where in Good or better condition (0.12 ha), part of the TEC extent
- LcLfCd (0.11 ha) occupies a small wetland separated from Carousel Swamp, not in the mapped TEC extent but included in the wetland extent
- **Ml**: (2.24 ha), considered part of the wetland and, where in Good or better condition (2.14 ha), part of the TEC extent
- **MrVj**: (0.66 ha), considered part of the wetland and, where in Good or better condition (0.13 ha), part of the TEC extent
- **Vdd**: (0.30 ha), considered part of the wetland and, where in Good or better condition (0.17 ha), part of the TEC extent
- **VjCo**: (0.29 ha), considered part of the wetland and, where in Good or better condition (0.12 ha), part of the TEC extent
- **Vj**: (0.74 ha), considered as an upland vegetation type as it is neither inundated nor seasonally waterlogged and therefore not part of the wetland or TEC. All of this vegetation type is in Degraded condition.

Wetland vegetation occupies 5.71 ha; vegetation representative of a TEC occupies 2.67 ha.

Identification of TEC Type

According to the DBCA the survey area includes a representative of the EPBC- and BC-listed endangered Muchea Limestone TEC. However, floristic analysis and an assessment against available literature identifying TECs, using quadrats located within the proposed Southern Link Road development footprint and 20 m buffer (Ecoscape 2019), considered that the area was more similar to the EPBC-listed critically endangered Clay Pans TEC, which is also listed as endangered under the BC Act as several individual TECs.

Various analyses and assessments were undertaken using the data from 19 floristic quadrats collected during 2023 as part of this survey.

Floristic analysis incorporating the current survey results and the Gibson *et al.* data (1994, provided by DBCA on request) was unsuccessful as 15 of the 19 current quadrats formed their own floristic group, with the other quadrats loosely associated with a range of wetland FCTs, some of which were listed as Swan Coastal Plain

TECs (see **Section 4.4.1.1**). However, the results were considered to be unreliable for the reasons outlined in **Section 4.4.1.1**, noting also that the Muchea Limestone TEC is not defined in terms of Gibson *et al.* floristic groups.

Comparison of the quadrat data with available information for the Muchea Limestone TEC (DBCA 2023a; DotEE 2017; English & Blythe 2000) and Clay Pans TEC (DPaW 2015; DSEWPaC 2012; TSSC 2012) determined that the wetlands within the survey area were more similar to the Clay Pans TEC.

The Muchea Limestone TEC is unlikely to be present as:

- the paucity of calcicoles (plants associated with calcium-rich soils, including limestone definitive of the Muchea Limestone TEC) in the survey area, with the species considered as calcicoles not confined to calcareous soils, thus not necessarily definitive, and only occurring sparsely within the survey area
- the only listed vegetation type from the Muchea Limestone TEC within the survey area (*Casuarina obesa* woodland) also occurs widely elsewhere in Western Australia, and none of the definitive species of other listed vegetation are present
- surface limestone was only observed in areas that were part of the former horse racetrack (now represented as an approximately 10 m-wide bund) and forming retaining walls around the Western Power substation
- drilling in 2005 by Parsons Brinkerhoff (in Woodman 2005) only identified transported (i.e. not formed *in situ*) limestone and considered the soils more representative of clay wetlands.

Where vegetation is in Good or better condition the survey area is more likely to be representative of the Clay Pans TEC as:

- the vegetation is similar to that described in the Listing Advice for the Clay Pans TEC (TSSC 2012), specifically types characterised by *Viminaria juncea* and *Melaleuca lateritia*
- commonly occurring species were highly represented in the *Herb rich shrublands in clay pans (Community Type 8 (SCP08))*, which is considered the most similar and likely EPBC TEC sub-type (also listed as a TEC by DBCA) for most of the vegetation types within the survey area (vegetation types **Co**, **Ml**, **MrVj**, **Vdd** and **VjCo**)
- commonly occurring species were moderately well represented in the *Shrublands on dry clay flats (Community Type 10a (SCP10a))* EPBC TEC sub-type (also listed as a TEC by DBCA) in vegetation type Vdd
- a representative of the Clay Pans TEC, the Brixton Street Wetlands (DBCA 2015), is approximately 2.6 km to the east and south-east
- the landform of 'clay pan' is represented in the survey area
- drilling in 2005 by Parsons Brinkerhoff (in Woodman 2005) considered the soils to be representative of clay wetlands
- lack of naturally occurring limestone
- the initial assessment of Carousel Swamp by Keighery & Hyder-Griffiths (2004) considered the wetland to be similar to Gibson *et al*. (1994) floristic groups 7, 8 or 9.

Based on the survey results and literature review it is strongly recommended that the site's TEC designation is reviewed by DBCA to more appropriately align the TEC under the EPBC and BC Acts.

These survey results have been uploaded to the EPA's IBSA portal, and identified as Muchea Limestone TEC as this is the currently recognised TEC for this site.

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MAPS

400050 400200 400350 400500

6457200 6457050 6456900

C2304 C2305 C2306 C2303 C2302 C2314 C2301 C2313 C2312 C2311 C2315 C2307 C2309 C2310 C2318 C2317 C2319 C2316

BcCdLs Co Vdd MI Vj VjCo MrVj X LcLfCd

Lake St Gerard St Grose Av Carousel Rd Jameson St Franklin St Bent St Morgan St Station St Sth

LEGEND

- Survey Area
- Quadrat

Conservation-listed Flora

- *Eremophila glabra* subsp. *chlorella* - Threatened
- *Schoenus natans* - Priority 4
- Local Road

Vegetation Type

- BcCdLs: *Bolboschoenus caldwellii, *Cynodon dactylon* and **Lotus subbiflorus* low closed rushland/tussock grassland/ forbland
- Co: *Casuarina obesa* mid woodland
- LcLfCd: *Leptocarpus coangustatus, Lachnagrostis filiformis* and **Cynodon dactylon* mid closed rushland/grassland/tussock grassland
- Ml: *Melaleuca lateritia* mid shrubland
- MrVj: *Melaleuca rhaphiophylla* and *Viminaria juncea* low open forest
- Vdd: *Verticordia densiflora* var. *densiflora* mid shrubland
- Vj: *Viminaria juncea* low woodland
- VjCo: *Viminaria juncea* and *Casuarina obesa* low woodland
- X: No native vegetation/cleared

DATA SOURCES:
SOURCE DATA: CONSERVATION-LISTED FLORA, QUADRATS AND VEGETATION (ECOSCAPE 2024) AND ROAD NETWORK (MRWA 2023)
IMAGERY: LOCATE MOSAIC (LGATE-322) (2022)
SERVICE LAYERS: LOCATE MOSAIC (LGATE-322): LANDGATE / SLIP
WORLD TOPOGRAPHIC MAP: ESRI, HERE, GARMIN, FAO, NOAA, USGS

ecoscape

CONSERVATION-LISTED FLORA, QUADRATS AND VEGETATION TYPES

SOUTHERN LINK ROAD - RESPONSE TO DWER (CPS 9882/1)

CITY OF CANNING

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

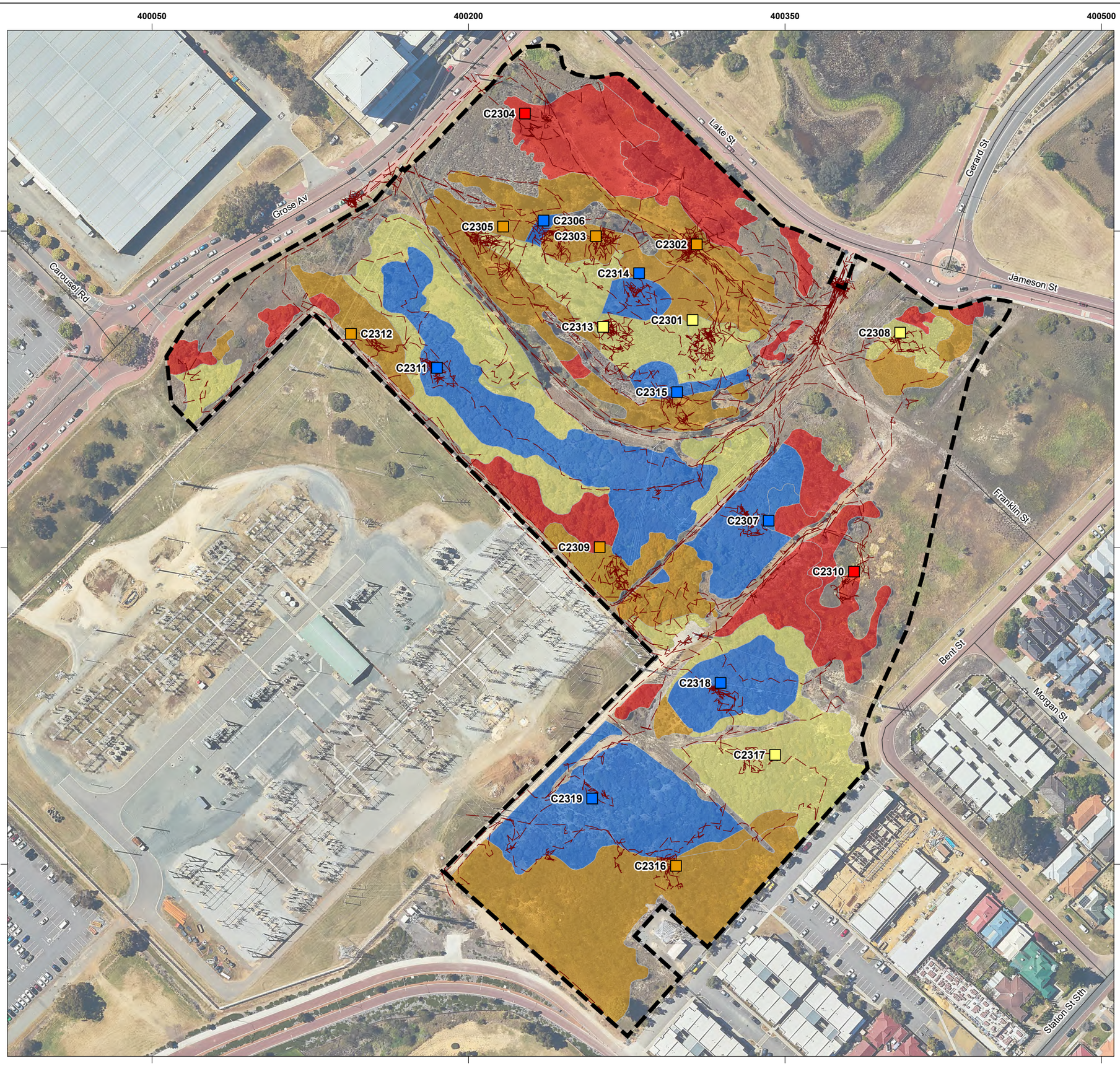
SCALE: 1:1,800 @ A3

0 20 40 60 m

PROJECT NO: 4874-23

REV	AUTHOR	APPROVED	DATE
0	NW	LA	08/05/2024

MAP 01



LEGEND

- Survey Area

Quadrat Condition

- Very Good
- Good
- Degraded
- Completely Degraded
- Local Road

Vegetation Condition

- Very Good
- Good
- Degraded
- Completely Degraded
- N/A
- Survey track

DATA SOURCES:
SOURCE DATA: QUADRATS AND VEGETATION CONDITION (ECOSCAPE 2024) AND ROAD NETWORK (MRWA 2023)
IMAGERY: LOCATE MOSAIC (LGATE-322) (2022)
SERVICE LAYERS: LOCATE MOSAIC (LGATE-322): LANDGATE / SLIP
WORLD TOPOGRAPHIC MAP: ESRI, HERE, GARMIN, FAO, NOAA, USGS

ecoscape

VEGETATION CONDITION

SOUTHERN LINK ROAD - RESPONSE TO DWER (CPS 9882/1)

CITY OF CANNING

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

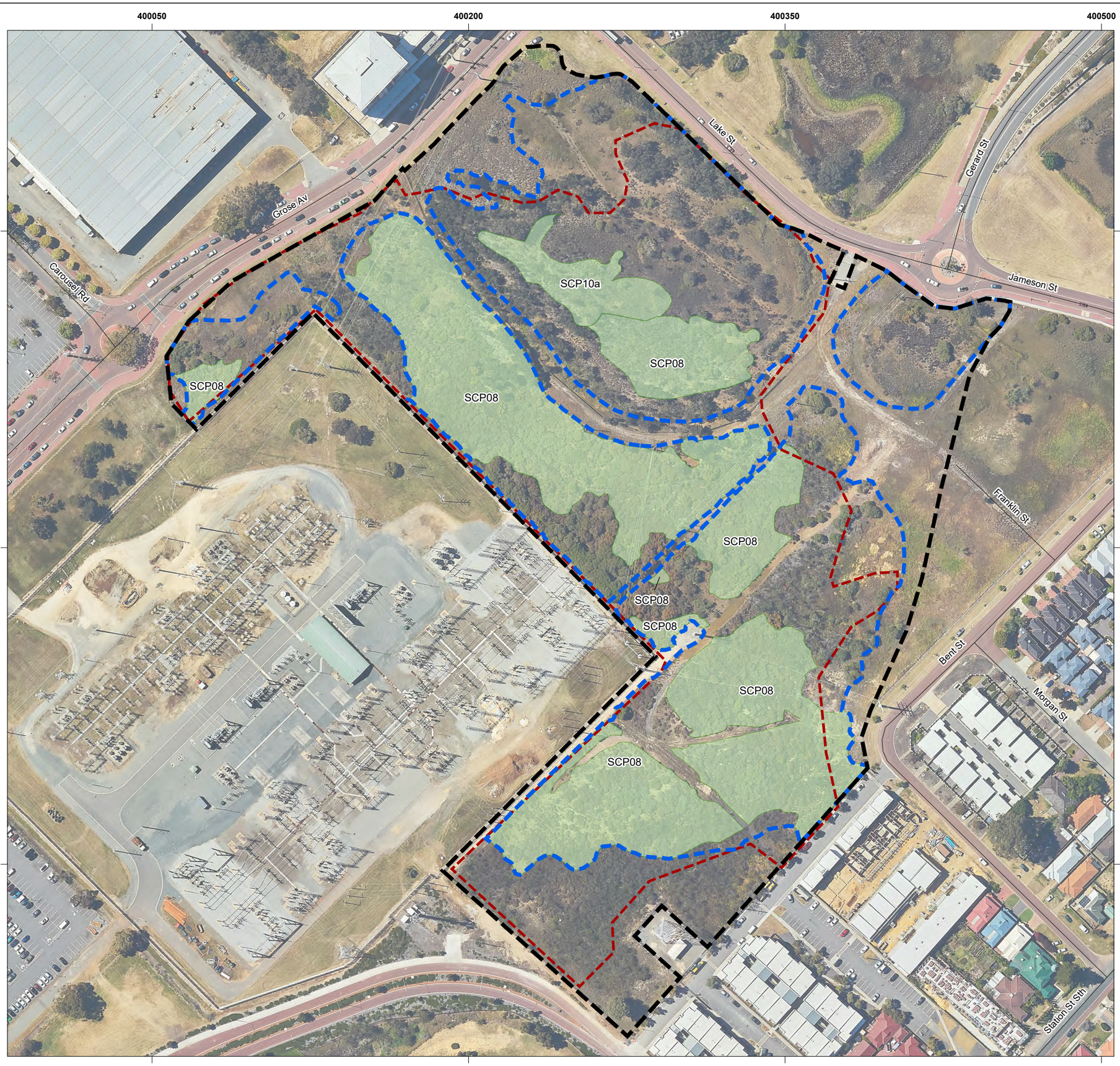
SCALE: 1:1,800 @ A3

0 20 40 60 m

PROJECT NO: 4874-23

REV	AUTHOR	APPROVED	DATE
0	NW	LA	23/04/2024

MAP 02



LEGEND

- Survey Area
- Local Road
- Wetland (seasonally inundated or waterlogged)
- DBCA Muchea Limestone TEC
- EPBC-listed Clay Pans TEC

Western Australia TECs (components of the EPBC-listed Clay Pans TEC)
SCP08: Herb rich shrublands in clay pans
SCP10a: Shrublands on dry clay flats

DATA SOURCES:
SOURCE DATA: TEC AND WETLAND (ECOSCAPE 2024), DBCA MUCHEA LIMESTONE TEC (DBCA 2018) AND ROAD NETWORK (MRWA 2023)
IMAGERY: LOCATE MOSAIC (LGATE-322) (2022)
SERVICE LAYERS: LOCATE MOSAIC (LGATE-322): LANDGATE / SLIP
WORLD TOPOGRAPHIC MAP: ESRI, HERE, GARMIN, FAO, NOAA, USGS

ecoscape

TEC AND WETLAND EXTENTS

SOUTHERN LINK ROAD - RESPONSE TO DWER (CPS 9882/1)

CITY OF CANNING

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:1,800 @ A3

0 20 40 60 m

PROJECT NO: 4874-23

REV	AUTHOR	APPROVED	DATE
0	NW	LA	24/04/2024
1	NW	LA	22/05/2024

MAP 03

ACRONYMS AND ABBREVIATIONS

Table 7: Acronyms and abbreviations

Acronyms	
BAM Act	Western Australian *Biosecurity and Agriculture Management Act 2007*
BC Act	Western Australian *Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
C1, C2, C3	Declared Pest categories under the BAM Act
CR	Critically Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DWER	Western Australian Department of Water and Environmental Regulation
DEWHA	Department of Environment, Water, Heritage and the Arts
EN	Endangered (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
Ecoscape	Ecoscape (Australia) Pty Ltd
EP Act	Western Australian *Environmental Protection Act 1986*
EPA	Western Australian Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GDA 94	Geographic Datum of Australia 1994
ha	hectare/hectares
km	kilometre/kilometres
m	metre/metres
MGA	Map Grid of Australia
NACMS	Natural Area Consulting Management Services
NAH	Natural Areas Holdings Pty Ltd, trading as Natural Area Consulting Management Services
NVIS	National Vegetation Inventory System
P; P1, P2, P3, P4, P5	Priority Flora and Fauna species rankings (P1-P4) or Priority Ecological Communities (P1-P5)
PEC	Priority Ecological Community
PF	Priority Flora
sp.	Species (generally referring to an unidentified taxon or when a phrase name has been applied)
subsp.	Subspecies (infrataxon)
TEC	Threatened Ecological Community
TF	Threatened Flora (formerly termed Declared Rare Flora, DRF, in Western Australia)
var.	Variety (infrataxon)
VU	Vulnerable (listed under Commonwealth EPBC Act and/or Western Australian BC Act)
WAH	Western Australian Herbarium
WoNS	Weeds of National Significance
*****	Introduced flora species (i.e. weed)

APPENDIX ONE LEGISLATIVE CONTEXT, DEFINITIONS AND CRITERIA

COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The EPBC Act is a legal framework to protect and manage matters of national environmental significance (MNES) including important flora, fauna, ecological communities and heritage areas listed under the Act.

Threatened taxa (flora and fauna) are protected under the EPBC Act, which lists species and ecological communities that have been assessed as meeting the criteria to be listed as Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild, as detailed in **Table 8**.

Threatened Ecological Communities protected under the EPBC Act are categorised as Critically Endangered, Endangered or Vulnerable, also detailed in this table.

Table 8: EPBC Act categories for flora, fauna and ecological communities

Category	Threatened species	Threatened Ecological Communities
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.	n/a
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.	n/a
Critically Endangered (CR)	A native species is eligible to be included in the *critically endangered* category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the *critically endangered* category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria
Endangered (EN)	A native species is eligible to be included in the *endangered* category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the *endangered* category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the *vulnerable* category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.	An ecological community is eligible to be included in the *vulnerable* category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.

Category	Threatened species	Threatened Ecological Communities
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long-term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.	n/a

WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION ACT 1986

The Western Australian EP Act was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information provided by the proponent), initiates measures to protect the environment and provides advice to the Minister responsible for environmental matters.

WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia.

Threatened species (both flora and fauna) and ecological communities that meet the categories listed within the BC Act are protected under this legislation and require authorisation by the Minister to take or disturb. These are known as Threatened Flora, Threatened Fauna and Threatened Ecological Communities. The conservation categories of Critically Endangered, Endangered and Vulnerable are detailed in **Table 9**; these categories align with those of the EPBC Act. Some State-listed threatened species and ecological communities are provided with additional protection as they are also listed under the Commonwealth EPBC Act (see **Table 8** for conservation status category descriptions).

The most recent Western Australian flora and fauna listings were published in the Government Gazette on 6 October 2023 (Western Australian Government 2023a) and ecological communities listings on 26 May 2023 (Western Australian Government 2023b).

PRIORITY-LISTED FLORA AND FAUNA

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and thereby have a greater level of protection than unlisted species.

Categories covering Western Australian-listed Threatened and Priority species are outlined in **Table 9**.

PF for Western Australia are regularly reviewed by the DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet these requirements.

Conservation-listed fauna species are listed by the DBCA as Priority Fauna where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to threatened fauna categories. Whilst Priority Fauna are not specifically listed in the BC Act, these have a greater level of significance than other native species. The categories covering Priority Fauna species are outlined in **Table 9**.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, have a restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as 'specially protected species' in the BC Act.

Table 9: Conservation category definitions for Western Australian fauna and flora (DBCA 2023b)

Conservation Category Definitions for Western Australian Fauna and Flora	
Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such. **Categories of Threatened, Extinct and Specially Protected fauna and flora are:**	
T	**Threatened species** Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act). **Threatened fauna** is the species of fauna that are listed as critically endangered, endangered or vulnerable threatened species. **Threatened flora** is the species of flora that are listed as critically endangered, endangered or vulnerable threatened species. The assessment of the conservation status of threatened species is in accordance with the BC Act listing criteria and the requirements of Ministerial Guideline Number 1 and Ministerial Guideline Number 2 that adopts the use of the International Union for Conservation of Nature (IUCN) Red List of Threatened Species Categories and Criteria[3], and is based on the national distribution of the species.
CR	*Critically endangered species* Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as critically endangered undersection 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.
EN	*Endangered species* Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines.
VU	*Vulnerable species* Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as vulnerable undersection 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.
Extinct species **Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.**	
EX	*Extinct species* Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
EW	*Extinct in the wild species* Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25of the BC Act). Currently there are no fauna or flora species listed as extinct in the wild.

Conservation Category Definitions for Western Australian Fauna and Flora	
Specially protected species Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as specially Protected species.	
MI	*Migratory species* Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA)[4], China (CAMBA)[5] and The Republic of Korea (ROKAMBA)[6], and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention)[7], an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.
CD	*Species of special conservation interest (conservation dependent)* Species of special conservation need that are dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Currently only fauna are listed as species of special conservation interest.
OS	*Other specially protected species* Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Currently only fauna are listed as species otherwise in need of special protection.
P	**Priority species** Priority is not a listing category under the BC Act. All fauna and flora are protected in WA following the provisions in Part 10 of the BC Act. The protection applies even when a species is not listed as threatened or specially protected, and regardless of land tenure (State managed land (Crown land), private land, or Commonwealth land). Species that may possibly be threatened species that do not meet the criteria for listing under the BC Act because of insufficient survey or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of prioritisation for survey and evaluation of conservation status so that consideration can be given to potential listing as threatened. Species that are adequately known, meet criteria for near threatened, or are rare but not threatened, or that have been recently removed from the threatened species list or conservation dependent or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of priority status is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.
1	*Priority 1: Poorly-known species – known from few locations, none on conservation lands* Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, for example, agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. These species are in urgent need of further survey.
2	*Priority 2: Poorly-known species – known from few locations, some on conservation lands* Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, for example, national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under threat from known threatening processes. These species are in urgent need of further survey.
3	*Priority 3: Poorly-known species – known from several locations* Species that are known from several locations and the species does not appear to be under imminent threat or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. These species need further survey.

Conservation Category Definitions for Western Australian Fauna and Flora	
4	*Priority 4: Rare, Near Threatened and other species in need of monitoring* (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy. (d) Other species in need of monitoring.

[1] The definition of flora includes algae, fungi and lichens.

[2] Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

[3] Western Australia has assigned species to threat categories using the *IUCN Red List of Threatened Species Categories and Criteria* since 1996 (referencing all criteria).

[4] JAMBA - first included in the WA migratory species list in 1980.

[5] CAMBA - first included in the WA migratory species list in 2010.

[6] ROKAMBA - first included in the WA migratory species list in 2010.

[7] Bonn Convention (Birds) - first included in the WA migratory species list in 2015.

THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

Western Australian TECs are protected under the BC Act and are categorised much like those of the EPBC Act. Western Australian definitions and criteria for TECs are shown in **Table 10**.

Currently described TECs are listed on the DBCA website, with the most recent list endorsed by the Minister for Environment published in October 2023 (DBCA 2023c).

DBCA also maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined. They are not protected under legislation but are taken into consideration as part of the environmental approvals process.

Currently described PECs are listed on the DBCA website, with the most recent list dated 19 June 2023 (Species and Communities Program, DBCA 2023).

Table 10: DBCA definitions and criteria for TECs and PECs (DBCA 2023d)

Criteria	Definition
Listed Ecological Communities	
Collapsed ecological communities (CO)	An ecological community listed by order of the Minister as collapsed under section 31(1) of the BC Act. As determined by criteria set out in section 32 of the BC Act, an ecological community is eligible for listing as a collapsed ecological community at a particular time if, at that time — (a) there is no reasonable doubt that the last occurrence of the ecological community has collapsed; or (b) the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover — (i) its species composition or structure; or (ii) its species composition and structure.
Critically endangered ecological communities (CR)	A threatened ecological community listed in the category of critically endangered under section 27(1)(a) of the BC Act, as determined by criteria set out in section 28 of the BC Act and the ministerial guidelines. A critically endangered ecological community faces an extremely high risk of becoming eligible for listing as a collapsed ecological community in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines.
Endangered ecological communities (EN)	A threatened ecological community listed in the category of endangered ecological community under section 27(1)(b) of the BC Act, as determined by criteria set out in section 29 of the BC Act and the ministerial guidelines. A threatened ecological community faces a very high risk of becoming eligible for listing as a collapsed ecological community in the near future, as determined in accordance with criteria set out in the ministerial guidelines.

Criteria	Definition
Vulnerable ecological communities (VU)	A threatened ecological community listed in the category of vulnerable ecological community under section 27(1)(c) of the BC Act, as determined by criteria set out in section 30 of the BC Act and the ministerial guidelines. A vulnerable ecological community faces a high risk of becoming eligible for listing as a collapsed ecological community in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines.
Priority ecological communities	
Priority One (P1)	*Poorly known ecological communities – very few occurrences, very restricted distribution* Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g., within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two (P2)	*Poorly known ecological communities – few occurrences, restricted distribution* Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority Three (P3)	*Poorly known ecological communities inadequately surveyed or not well defined* Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them. This category includes three sub-categories: (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation. (ii) Communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years). (iii) Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change, etc.
Priority Four (P4)	*Adequately known ecological communities – rare, near threatened, or recently removed from the threatened list* Ecological communities that are adequately known and are rare but not threatened near threatened, or have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare: ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened: ecological communities that are considered to have been adequately surveyed and that do not qualify as conservation dependent, but that are close to qualifying for a higher threat category. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five (P5)	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

FLORA CRITERIA

OTHER SIGNIFICANT FLORA

According to the Flora and Vegetation Technical Guidance (EPA 2016a) other than being listed as Threatened or Priority Flora, a species can be considered as significant if it is considered to be:

- locally endemic or association with a restricted habitat type (e.g. Groundwater Dependent Ecosystems, Sheet Flow Dependent Vegetation)

- a new species or has anomalous features that indicate a potential new species
- at the extremes of range, recently discovered range extensions (generally considered greater than 100 km or in a different bioregion), or isolated outliers of the main range
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

INTRODUCED FLORA

Introduced plant species, known as weeds, are plants that are not indigenous to an area and have been introduced either directly or indirectly (unintentionally) through human activity. Species are regarded as introduced if they are listed as 'alien' on *FloraBase* (WAH 1998) and are designated with an asterisk (*) in this document.

Weeds of National Significance

At a national level there are 32 weed species listed as Weeds o(Weeds Australia & Centre for Invasive Species Solutions 2021)Invasive Species Solutions 2021). The Commonwealth *Australian Weeds Strategy 2017-2027* (Invasive Plants and Animals Committee 2016) describes broad goals and objectives to manage these species.

Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories, or exempt:

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage
- exempt (no category).

VEGETATION CRITERIA

OTHER SIGNIFICANT VEGETATION

According to the Flora and Vegetation Technical Guidance (EPA 2016a) other than being listed as a TEC or PEC, vegetation can be considered as significant if it is considered to have:

- restricted distribution
- a degree of historical impact from threatening processes
- a role as a refuge
- provides an important function required to maintain ecological integrity of a significant ecosystem.

ENVIRONMENTALLY SENSITIVE AREAS

There are a number of areas within Western Australia identified as being of environmental significance within which the exemptions to the Native Vegetation Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs), and are declared under section 51B of the EP Act and described in the *Environmental Protection (Environmentally Sensitive Areas) Notice*.

APPENDIX TWO FIELD SURVEY CRITERIA

Table 11: NVIS structural formation terminology, terrestrial vegetation (NVIS Technical Working Group & DotEE 2017)

	Cover characteristics							
	Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	**Height Ranges (m)**	**Structural Formation Classes**						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	tree, palm
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	tree mallee
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrub, cycad, grass-tree, tree-fern
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrub
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrub
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrub
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrub
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grass
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grass
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grass
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedge
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rush
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forb
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	fern
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophyte
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichen
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vine

Table 12: NVIS height classes (NVIS Technical Working Group & DotEE 2017)

Height		Growth form				
Height Class	**Height Range (m)**	**Tree, vine (M & U), palm (single-stemmed)**	**Shrub, heath shrub, chenopod shrub, ferns, samphire shrub, cycad, tree-fern, grass-tree, palm (multi-stemmed)**	**Tree mallee, mallee shrub**	**Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)**	**Bryophyte, lichen, seagrass, aquatic**
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low
Source: (based on Walker & Hopkins 1990)						

Table 13: Vegetation condition scale for the South West and Interzone Botanical Provinces (EPA 2016a) **and Keighery** (1994) **Scale**

Condition rating	Description (EPA 2016)	Description (Keighery 1994)
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Vegetation structure altered, obvious signs of disturbance. For example: disturbance to vegetation structure caused by repeated fires; the presence of some more aggressive weeds; dieback; logging; grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example: disturbance to vegetation structure caused by frequent fires; the presence of some very aggressive weeds at high density; partial clearing; dieback; grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example: disturbance to vegetation structure caused by very frequent fires; the presence of very aggressive weeds; partial clearing; dieback; grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

APPENDIX THREE TEC ASSESSMENT CRITERIA

This section has largely been reproduced from Ecoscape's (2019) report, with some updates and additions.

MUCHEA LIMESTONE TEC

Approved Conservation Advice

The Approved Conservation Advice for the *Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain* TEC (DotEE 2017) ('Muchea Limestone TEC') describes the TEC as:

> *… occurs on the heavy soils of the eastern side of the Swan Coastal Plain. Known patches include wetland and well-drained habitats, in a variety of landforms (Tauss & Weston 2010). It is defined on the basis of rare limestone-influenced substrates. Where the best developed limestone occurs, near Gingin, the plant community is located on shallow black clay or sandy clay soils on limestone. Typical and common native species in areas of best developed limestone are the tree Casuarina obesa, the mallees Eucalyptus decipiens and Eucalyptus foecunda and the shrubs Melaleuca huegelii, Alyogyne huegelii var. huegelii, Grevillea curviloba ssp. incurva, Grevillea curviloba ssp. curviloba, Grevillea evanescens, Melaleuca acerosa, and the herb Thysanotus arenarius. Where the limestone substrate is less well developed and limestone may occur as nodules or chunks, the flora assemblages can be influenced by other characteristics of the substrate, such as clay content, with the presence of calcicoles such as Alyogyne sp. Rockingham, Alyogyne hakeifolia, Carex thecata, Hibbertia spicata subsp. spicata, Lechenaultia linarioides, Thysanotus arenarius, Gahnia trifida, Eremophila glabra and Melaleuca brevifolia providing evidence of the limestone influence.*
>
> *Melaleuca huegelii shrublands, Eucalyptus decipiens mallee, Casuarina obesa woodlands, and Melaleuca brevifolia, M. systena, or M. viminea shrublands is recorded on Muchea Limestone (Tauss & Weston 2010).; however, the full range of vegetation on the Muchea Limestone substrate is not well documented. Floristic analysis can link calcicole species in Muchea Limestone sites with floristic community types on Tamala Limestone in Spearwood dunes or floristic community type 18 shrublands on calcareous silts (Tauss & Weston 2010).*

Aspects relevant to and of potential significance for defining the TEC, as detailed in the Approved Conservation Advice, are:

- the TEC is listed as endangered under the EPBC Act
- some of the flora species are generally coastal species that do not generally occur further inland (linked to Gibson *et al*. (1994) floristic community type (FCT) 18)
- there are 16 known occurrences of the TEC (as at April 2017) including Carousel Swamp
- the required substrate is aeolian sandplain with residual deposits of limestone or Muchea Limestone or Plain limestone deposits
- the critical habitat is the area of occupancy, substrate, freshwater superficial groundwater and/or surface waters and local catchments
- no condition threshold has been set for this community due to its very restricted distribution.

Interim Recovery Plan 2000-2003

The 2000-2003 Interim Recovery Plan for the Western Australian-listed Shrublands and Woodlands (English & Blythe 2000) includes much of the information included in Approved Conservation Advice for the later Commonwealth listing of the similarly named TEC (DotEE 2017, above), however, in Western Australia the community is considered to be critically endangered. At the time of writing only four occurrences of the TEC had been identified, all in the Gingin/Muchea/Vines areas (although this is contradicted by a later listing in Appendix 2 of an occurrence in Gosnells), and it was considered that no floristic quadrats representing the TEC had been included in the Gibson *et al*. (1994) *Floristic Survey of the Southern Swan Coastal Plain*.

As well as the information also included in the Commonwealth Approved Conservation Advice, a species list of typical and common species regularly associated with Muchea Limestone soils (and therefore, presumably, the TEC although this is not specifically stated) was provided, as below.

Trees:	*Casuarina obesa*	
Mallees	*Eucalyptus decipiens*	
	Eucalyptus foecunda	
Shrubs:	*Acacia leptospermoides* ssp. *leptospermoides*	
	Allocasuarina lehmanniana	
	Alyogyne huegelii var. *huegelii*	
	Baeckea robusta	
	Comesperma integerrimum	
	Darwinia sp 'Muchea' (now *Darwinia foetida*)	
	Diplopeltis huegelii	
	Dodonaea aptera	
	Exocarpos sparteus	
	Grevillea curviloba ssp. *curviloba*	CR
	Grevillea curviloba ssp. *incurva*	CR
	Grevillea evanescens	P1
	Hibbertia spicata ssp. *spicata*	
	Lechenaultia linarioides	
	Melaleuca acerosa (now *Melaleuca systena*)	
	Melaleuca huegelii	
	Pimelea ferruginea	
	Stylobasium australe	
Herbs:	*Apium annum*	
	Conostylis candicans	
	Haloragis aculeolata	P2
	Senecio lautus ssp. *dissectifolius*	
	Thysanotus arenarius	
	Wilsonia humilis	
Grasses:	*Stipa flavescens*	
	Poa ?porphyroclados	

Major structural formations of the Muchea Limestone plant community were also provided, as follows.

Where the Muchea Limestone is best developed

On rises with outcropping limestone:

- *Eucalyptus decipiens* mallee over heath often dominated by *Melaleuca huegelii*
- *Melaleuca huegelii* heath or shrubland over *Grevillea evanescens* and *Xanthorrhoea preissii*.

On wet flats:

- Scattered *Casuarina obesa* over *Melaleuca lateriflora*[2], *Grevillea evanescens* and *Melaleuca viminea* shrubland and herbs
- *Melaleuca huegelii*, *Grevillea evanescens* and *Melaleuca* species shrubland and herbs
- *Casuarina obesa* open woodland over *Poa* grassland and herbs.

[2] *Melaleuca lateriflora* is not known from the Swan Coastal Plain IBRA region (FloraBase, WAH 1998-2024). Presumably this should be *M. lateritia*.

Creekline:

- *Eucalyptus rudis* open forest over *Melaleuca rhaphiophylla* open low forest over shrubland over tall sedgeland and grassland.

Where the limestone appears to be at greater depth, is more remote or the limestone area is geographically isolated from other limestone areas:

On sand dunes (often yellow or orange):

- Banksia woodlands over heath
- *Acacia saligna* shrubland over herbs
- *Eucalyptus decipiens* mallee.

On damper sands over limestone:

- Open Marri woodland over mixed shrublands usually containing *Melaleuca huegelii*, *Acacia saligna*, *Grevillea curviloba* and *Regelia ciliata*.

Muchea Limestone TEC Factsheet

The DBCA Species and Communities Branch produced a fact sheet describing the Muchea Limestone TEC (DBCA 2023a).

Characteristics of these plant communities noted in this document are:

- they occur on the heavy soils on the eastern side of the Swan Coastal Plain where there is a limestone influence
- the best developed examples are characterised by *Casuarina obesa*, *Eucalyptus decipiens*, *Eucalyptus foecunda*, *Melaleuca huegelii*, *Alyogyne huegelii*, *Grevillea curviloba*, *Grevillea evanescens*, *Melaleuca systena* and *Thysanotus arenarius*
- where limestone is less well developed, other characteristics like clay content of the substrate influence the flora assemblages and presence of calcicoles provide evidence of the limestone influence. Calcicoles include *Thysanotus arenarius*, *Gahnia trifida*, *Eremophila glabra* and *Melaleuca brevifolia*.
- *Melaleuca huegelii* shrublands, *Eucalyptus decipiens* mallee, *Casuarina obesa* woodlands and *Melaleuca brevifolia*, *Melaleuca systena* or *Melaleuca viminea* shrublands have been recorded on Muchea Limestone.

COMMONWEATLTH CLAY PANS OF THE SWAN COASTAL TEC

Approved Conservation Advice and Interim Recovery Plan

The *Clay Pans of the Swan Coastal Plain* TEC was endorsed as a critically endangered EPBC-listed TEC in 2012. The Approved Conservation Advice for the TEC (DSEWPaC 2012) ('Clay pans' TEC) describes the TEC as:

> *… occurs in Western Australia where clay soils form an impermeable layer close to the landscape surface, and wetlands form that rely solely on rainfall to fill and then dry to impervious pans in summer.*
>
> *The ecological community generally occurs as a shrubland (less commonly as a low, open woodland) over a ground layer of geophytes, herbs and sedges which are characteristic of the wetter parts of the sites. There are no dominant species which characterise the entire ecological community. The ecological community, however, shows similar landform and vegetation structural features across its range.*
>
> *A distinctive feature of these clay pan wetlands is the suite of geophytes and annual flora that germinates, grows and flowers sequentially as these areas dry over summer, producing a floral display for over three months. The clay pans have very high species richness, a number of local endemics and are the most floristically diverse of the Swan Coastal Plain wetlands.*
>
> *The seasonally inundated clays that support this ecological community are relatively productive agricultural soils and many were cleared and drained soon after European settlement. Others were mined for clay for brick and tile manufacture. Those that remained intact were largely located on the Swan Coastal Plain in close proximity to metropolitan Perth. In more recent years large areas have*

disappeared under urban development and today the plant communities of the clay pan wetlands are amongst the most threatened in Western Australia.

This advice, and the DBCA Interim Recovery Plan (DPaW 2015), identify that this TEC consists of a combination of Western Australian-listed TECs and one PEC:

- *Herb rich saline shrublands in clay pans (Community Type 7 (SCP07))* – endangered
- *Herb rich shrublands in clay pans (Community Type 8 (SCP08))* – endangered
- *Dense shrublands on clay pans (Community Type 9 (SCP09))* – endangered
- *Shrublands on dry clay flats (Community Type 10a (SCP10a))* – endangered
- *Clay pans with shrubs over herbs (Community Type 117)* – P1 PEC, also known as *Clay pans with mid dense shrublands of Melaleuca lateritia over herbs* (DPaW 2015).

The DBCA Interim Recovery Plan (DPaW 2015) lists characteristic taxa for each of the component Western Australian TECs and PEC.

APPENDIX FOUR FIELD SURVEY RESULTS

Table 14: Flora inventory (site x species matrix)

'X' indicates presence. Species potentially considered as calcicoles are in bold font.

Family	Species	Naturalised	Cons. status	C2301	C2302	C2303	C2304	C2305	C2306	C2307	C2308	C2309	C2310	C2311	C2312	C2313	C2314	C2315	C2316	C2317	C2318	C2319	Opportunistic
Amaryllidaceae	*Amaryllis belladonna*	*											X										
Anacardiaceae	*Schinus terebinthifolia*	*																					X
Apiaceae	*Centella asiatica*											X											
Asparagaceae	*Acanthocarpus preissii*			X	X																		
	Asparagus asparagoides	*																					X
	Lomandra suaveolens			X					X														
Asteraceae	*Erigeron sumatrensis*	*										X											
	Hyalosperma cotula									X													
	Siloxerus filifolius					X																	
	Sonchus oleraceus	*								X	X	X											
Boraginaceae	*Echium plantagineum*	*											X										
Campanulaceae	*Lobelia anceps*											X											
Casuarinaceae	*Casuarina obesa*				X			X	X		X					X		X					
Centrolepidaceae	*Centrolepis aristata*					X			X					X			X						
Colchicaceae	*Burchardia bairdiae*			X																			
Commelinaceae	*Cartonema philydroides*																						X
Cyperaceae	*Bolboschoenus caldwellii*						X																
	Ficinia nodosa			X	X	X											X						
	Gahnia trifida																	X					
	Isolepis cernua						X	X															
	Isolepis hystrix	*			X						X												
	Lepidosperma sp. 1					X		X	X							X	X						
	Lepidosperma sp. 2															X							
	Machaerina rubiginosa											X											

Family	Species	Naturalised	Cons. status	C2301	C2302	C2303	C2304	C2305	C2306	C2307	C2308	C2309	C2310	C2311	C2312	C2313	C2314	C2315	C2316	C2317	C2318	C2319	Opportunistic
Cyperaceae cont'	*Schoenus natans*		P4							X										X	X	X	
	Schoenus tenellus				X																		
Droseraceae	*Drosera menziesii*					X			X								X						
Euphorbiaceae	*Euphorbia terracina*	*																X					
	Ricinus communis	*																					X
Fabaceae	*Euchilopsis linearis*															X					X		
	Lotus subbiflorus	*				X	X				X			X						X			
	Viminaria juncea			X					X				X		X	X		X	X				
Gentianaceae	*Centaurium erythraea*	*					X							X									
Goodeniaceae	*Goodenia pulchella* subsp. Coastal Plain B (L.W. Sage 2336)				X	X				X	X			X			X			X		X	
Haemodoraceae	*Haemodorum simplex*								X														
	Haemodorum simulans					X																	
Iridaceae	*Gladiolus caryophyllaceus*	*		X		X		X	X					X									
	Hesperantha falcata	*		X		X		X			X			X									
	Iridaceae sp.			X		X		X	X	X										X	X	X	
	Patersonia occidentalis var. *occidentalis*			X		X			X									X					
	Romulea rosea	*					X																
	Watsonia meriana var. *bulbillifera*	*											X			X							
	Watsonia meriana var. *meriana*	*		X		X		X	X	X	X		X	X	X	X	X		X	X			
Juncaceae	*Juncus bufonius*	*												X									
	Juncus pallidus											X											
Lauraceae	*Cassytha racemosa forma racemosa*			X						X		X		X	X			X	X	X	X	X	
Loranthaceae	*Amyema linophylla*				X																		
Lythraceae	*Lythrum hyssopifolia*	*												X						X			
Myrtaceae	*Astartea affinis*									X				X	X				X		X		
	Eucalyptus camaldulensis	*							X														
	Melaleuca huegelii																						X

Family	Species	Naturalised	Cons. status	C2301	C2302	C2303	C2304	C2305	C2306	C2307	C2308	C2309	C2310	C2311	C2312	C2313	C2314	C2315	C2316	C2317	C2318	C2319	Opportunistic
Myrtaceae cont'	*Melaleuca lateritia*									X		X		X	X	X		X	X	X	X	X	
	Melaleuca rhaphiophylla			X					X			X	X										
	Melaleuca teretifolia															X							
	Pericalymma ellipticum var. *ellipticum*			X																			
	Verticordia densiflora var. *densiflora*			X		X			X		X				X	X	X	X					
Oleaceae	*Olea europaea*	*																					X
Orchidaceae	*Microtis media*					X																	
Orobanchaceae	*Bellardia viscosa*	*					X							X			X						
Plantaginaceae	*Gratiola pubescens*				X	X					X												
Poaceae	*Amphibromus nervosus*				X						X	X								X			
	Avena barbata	*											X					X			X		
	Briza maxima	*				X		X					X				X						
	Briza minor	*				X	X		X					X			X						
	Bromus catharticus	*																X					
	Bromus hordeaceus	*						X															
	Cenchrus clandestinus	*											X										
	Cynodon dactylon	*			X		X				X	X	X										
	Ehrharta longiflora	*		X				X					X										
	Eragrostis curvula	*					X				X		X										
	Hyparrhenia hirta	*											X					X	X				
	Lachnagrostis filiformis			X	X	X				X	X			X			X			X	X	X	
	Lolium multiflorum	*					X			X	X	X	X	X				X		X			
	Neurachne alopecuroidea							X							X	X							
	Polypogon monspeliensis	*					X				X												
	Rytidosperma caespitosum							X															
Polygonaceae	*Rumex crispus*	*										X											
Primulaceae	*Samolus junceus*				X																X		

Family	Species	Naturalised	Cons. status	C2301	C2302	C2303	C2304	C2305	C2306	C2307	C2308	C2309	C2310	C2311	C2312	C2313	C2314	C2315	C2316	C2317	C2318	C2319	Opportunistic
Proteaceae	*Hakea varia*														X	X							X
	Isopogon dubius															X							
Restionaceae	*Hypolaena exsulca*																	X					
	Leptocarpus canus													X	X				X				
	Leptocarpus coangustatus				X					X	X					X				X	X	X	
Rubiaceae	*Opercularia vaginata*					X																	
Scrophulariaceae	***Eremophila glabra* subsp. *chlorella***		T																				X
Stylidiaceae	*Stylidium divaricatum*			X		X								X		X							
Thymelaeaceae	*Pimelea imbricata* var. *major*					X			X					X			X						
Typhaceae	*Typha* sp.											X											
Xanthorrhoeaceae	*Xanthorrhoea brunonis*			X												X			X				

APPENDIX FIVE FLORISTIC QUADRAT DATA

C2301

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400306 **mE** 6457158 **mN** **Lat.** -32.0173 **Long.** 115.9444

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rocks

Loose Rock 0 % cover **Litter** 35 % cover ; 1 cm in depth

Bare ground 25 % cover **Weeds** 10 % cover

Vegetation U+ ^*Melaleuca rhaphiophylla*,^*Viminaria juncea*\^tree\6\c;M ^*Verticordia densiflora* var. *densiflora*\^shrub\3\c;G ^^*Watsonia meriana* var. *meriana*,*Xanthorrhoea brunonis*,*Ficinia nodosa*\^forb,grass tree,rush\2\i

Veg. Condition Good

Disturbance Likely previously grazed

Fire Age

Notes Wetlad. Pugged soil surface.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acanthocarpus preissii		0.2	<1	
Burchardia bairdiae		0.2	<1	

Cassytha racemosa forma *racemosa*	1.8	<1
**Ehrharta longiflora*	0.2	<1
Ficinia nodosa	0.4	2
**Gladiolus caryophyllaceus*	0.4	<1
**Hesperantha falcata*	0.2	<1
Iridaceae sp.	0.1	3
Lachnagrostis filiformis	0.3	2
Lomandra suaveolens	0.2	<1
Melaleuca rhaphiophylla	6	25
Patersonia occidentalis var. *occidentalis*	0.2	<1
Pericalymma ellipticum var. *ellipticum*	1.2	<1
Stylidium divaricatum	0.2	<1
Verticordia densiflora var. *densiflora*	2.2	35
Viminaria juncea	7	8
**Watsonia meriana* var. *meriana*	1	8
Xanthorrhoea brunonis	0.6	3

C2302

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400308 **mE** 6457194 **mN** **Lat.** -32.0170 **Long.** 115.9444

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey sandy clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 50 % cover ; 1 cm in depth

Bare ground 25 % cover **Weeds** 20 % cover

Vegetation U+ ^*Casuarina obesa*\^tree\7\c;G ^^*Schoenus tenellus*,*Leptocarpus coangustatus*,*Lachnagrostis filiformis*\^rush,other grass\1\c

Veg. Condition Degraded

Disturbance Track, potentially previously grazed

Fire Age

Notes Wetland edge. Soil surface pugged.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acanthocarpus preissii		0.1	<1	
Amphibromus nervosus		0.6	<1	
Amyema linophylla		2	<1	

Casuarina obesa	12	35
**Cynodon dactylon*	0.1	<1
Ficinia nodosa	0.4	2
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*	0.2	<1
Gratiola pubescens	0.04	<1
**Isolepis hystrix*	0.01	2
Lachnagrostis filiformis	0.2	5
Leptocarpus coangustatus	0.5	8
Samolus junceus	0.6	<1
Schoenus tenellus	0.01	25

C2303

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400260 **mE** 6457198 **mN** **Lat.** -32.0170 **Long.** 115.9439

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 25 % cover ; <1 cm in depth

Bare ground 10 % cover **Weeds** 35 % cover

Vegetation M+ ^*Verticordia densiflora* var. *densiflora*\^shrub\3\c;G ^^*Watsonia meriana* var. *meriana*, *Lepidosperma* sp. *1*,*Ficinia nodosa*\^forb,sedge,rush\2\c

Veg. Condition Degraded

Disturbance Possibly previously grazed

Fire Age

Notes Wetland or fringing vegetation. Would need soil core for more certainty

Species	WA Cons.	Height (m)	Cover (%)	Count
**Briza maxima*		0.3	<1	
**Briza minor*		0.2	1	
Centrolepis aristata		0.03	<1	

Drosera menziesii	0.2	<1
Ficinia nodosa	0.3	5
**Gladiolus caryophyllaceus*	0.3	<1
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*	0.3	<1
Gratiola pubescens	0.2	<1
Haemodorum simulans	0.3	1
**Hesperantha falcata*	0.2	<1
Iridaceae sp.	0.2	<1
Lachnagrostis filiformis	0.3	<1
Lepidosperma sp. *1*	0.5	5
**Lotus subbiflorus*	0.3	<1
Microtis media	0.5	<1
Opercularia vaginata	0.2	<1
Patersonia occidentalis var. *occidentalis*	0.2	<1
Pimelea imbricata var. *major*	0.3	<1
Siloxerus filifolius	0.01	<1
Stylidium divaricatum	0.2	<1
Verticordia densiflora var. *densiflora*	1.2	35
**Watsonia meriana* var. *meriana*	0.6	35

C2304

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400227 **mE** 6457256 **mN** **Lat.** -32.0164 **Long.** 115.9435

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 70 % cover ; <1 cm in depth

Bare ground 0 % cover **Weeds** 75 % cover

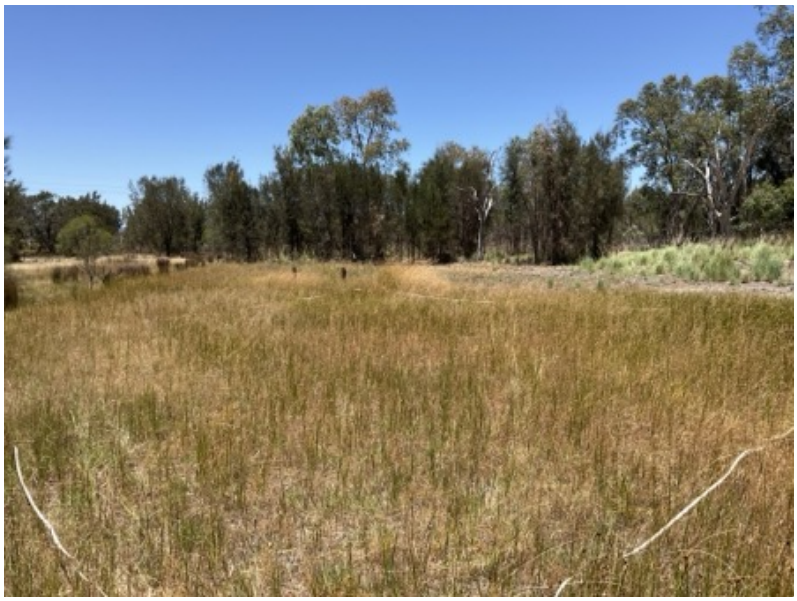
Vegetation G+ ^^*Bolboschoenus caldwellii*,*Cynodon dactylon*,*Lotus subbiflorus*\^rush,tussock grass,forb\1\d

Veg. Condition Completely Degraded

Disturbance Cleared, likely grazed

Fire Age

Notes Wetland. Soil surface pugged



Species	WA Cons.	Height (m)	Cover (%)	Count
**Bellardia viscosa*		0.3	<1	
Bolboschoenus caldwellii		0.5	40	
**Briza minor*		0.2	<1	

**Centaurium erythraea*	0.2	<1
**Cynodon dactylon*	0.1	40
**Eragrostis curvula*	0.6	2
Isolepis cernua	0.01	<1
**Lolium multiflorum*	0.3	5
**Lotus subbiflorus*	0.1	25
**Polypogon monspeliensis*	0.3	<1
**Romulea rosea*	0.1	<1

C2305

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400216 **mE** 6457202 **mN** **Lat.** -32.0169 **Long.** 115.9434

Habitat Lower-Slope

Aspect NE **Slope** Very Gentle

Soil Type Grey clayey sand

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 100 % cover ; 1-5 cm in depth

Bare ground 0 % cover **Weeds** 5 % cover

Vegetation U+ ^*Casuarina obesa*\^tree\7\c;G ^^*Watsonia meriana* var. *meriana*,*Briza maxima*,*Lepidosperma* sp. *1*\^forb,other grass,sedge\2\r

Veg. Condition Degraded

Disturbance Fire, rubbish, possible artificially raised soil surface

Fire Age >10 years

Notes Upland but may be artificially raised

Species	WA Cons.	Height (m)	Cover (%)	Count
**Briza maxima*		0.3	3	
**Bromus hordeaceus*		0.2	<1	
Casuarina obesa		13	35	

Ehrharta longiflora	0.3	<1
Gladiolus caryophyllaceus	0.3	<1
Hesperantha falcata	0.3	<1
Iridaceae sp.	0.1	<1
Isolepis cernua	0.05	<1
Lepidosperma sp. *1*	0.3	2
Neurachne alopecuroidea	0.1	<1
Rytidosperma caespitosum	0.3	<1
Watsonia meriana var. *meriana*	0.8	5

C2306

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400236 **mE** 6457205 **mN** **Lat.** -32.0169 **Long.** 115.9436

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey loamy clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 30 % cover ; <1 cm in depth

Bare ground 40 % cover **Weeds** 5 % cover

Vegetation U ^*Viminaria juncea*,^*Casuarina obesa*\^tree\6\r;M+ ^*Verticordia densiflora* var. *densiflora*\^shrub\3\d;G ^*Lepidosperma* sp. *1*,^*Watsonia meriana* var. *meriana*\^sedge,forb\2\i

Veg. Condition Very Good

Disturbance Soil surface pugged suggesting grazing or horticulture

Fire Age >10 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
**Briza minor*		0.2	<1	
Casuarina obesa		5	2	
Centrolepis aristata		0.03	<1	

Drosera menziesii	0.2	<1
Eucalyptus camaldulensis	7	1
**Gladiolus caryophyllaceus*	0.3	<1
Haemodorum simplex	0.1	<1
Iridaceae sp.	0.1	2
Lepidosperma sp. *1*	0.5	6
Lomandra suaveolens	0.2	<1
Melaleuca rhaphiophylla	2	<1
Patersonia occidentalis var. *occidentalis*	0.3	<1
Pimelea imbricata var. *major*	0.3	<1
Verticordia densiflora var. *densiflora*	1.2	75
Viminaria juncea	5	5
**Watsonia meriana* var. *meriana*	0.6	5

C2307

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400342 **mE** 6457063 **mN** **Lat.** -32.0182 **Long.** 115.9447

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 30 % cover ; <1 cm in depth

Bare ground 55 % cover **Weeds** 1 % cover

Vegetation M+ ^*Melaleuca lateritia*\^shrub\3\d;G ^^*Leptocarpus coangustatus*,*Schoenus natans*,*Goodenia pulchella* subsp. *Coastal Plain B (L.W. Sage 2336)*\^rush,forb\1\i

Veg. Condition Very Good

Disturbance Likely previously grazed and/or cultivated

Fire Age

Notes Wetland. Pugged soil.

Species	WA Cons.	Height (m)	Cover (%)	Count
Astartea affinis		1.5	<1	
Cassytha racemosa forma *racemosa*		1.4	<1	
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*		0.2	2	

Hyalosperma cotula		0.1	<1
Iridaceae sp.		0.1	<1
Lachnagrostis filiformis		0.3	1
Leptocarpus coangustatus		0.5	6
**Lolium multiflorum*		0.6	<1
Melaleuca lateritia		1.7	80
Schoenus natans	P 4	0.01	5
**Sonchus oleraceus*		0.1	<1
**Watsonia meriana* var. *meriana*		0.4	<1

C2308

Staff LJA **Date** 16/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400405 **mE** 6457152 **mN** **Lat.** -32.0174 **Long.** 115.9454

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey loamy clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 25 % cover ; <1 cm in depth

Bare ground 25 % cover **Weeds** 40 % cover

Vegetation G+ ^^*Leptocarpus coangustatus*,*Lachnagrostis filiformis*,*Cynodon dactylon*\^rush,other grass, tussock grass\2\d

Veg. Condition Good

Disturbance Past clearing, probable grazing and/or horticulture

Fire Age

Notes Wetland

Species	WA Cons.	Height (m)	Cover (%)	Count
Amphibromus nervosus		0.6	<1	
Casuarina obesa		3.5	<1	
**Cynodon dactylon*		0.2	2	

*Eragrostis curvula	0.6	1
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*	0.2	2
Gratiola pubescens	0.2	1
*Hesperantha falcata	0.3	<1
Isolepis hystrix	0.01	<1
Lachnagrostis filiformis	0.3	5
Leptocarpus coangustatus	0.6	70
Lolium multiflorum	0.4	<1
Lotus subbiflorus	0.1	<1
Polypogon monspeliensis	0.1	<1
Sonchus oleraceus	0.4	<1
Verticordia densiflora var. *densiflora*	0.4	<1
Watsonia meriana var. *meriana*	0.6	1

C2309

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400262 **mE** 6457050 **mN** **Lat.** -32.0183 **Long.** 115.9439

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clayey sand

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 95 % cover ; <1-2 cm in depth

Bare ground 2 % cover **Weeds** 40 % cover

Vegetation U+ ^*Melaleuca rhaphiophylla*\^tree\6\c;M ^*Melaleuca lateritia*\^shrub\3\c;G ^^*Machaerina rubiginosa*,*Cynodon dactylon*,*Lobelia anceps*\^rush,tussock grass,forb\2\c

Veg. Condition Degraded

Disturbance Probably previously grazed

Fire Age

Notes Wetland, currently dry surface soil

Species	WA Cons.	Height (m)	Cover (%)	Count
Amphibromus nervosus		0.8	<1	
Cassytha racemosa forma *racemosa*		1.5	<1	
Centella asiatica		0.4	<1	

*Cynodon dactylon	0.4	25
*Erigeron sumatrensis	1	<1
Juncus pallidus	1	<1
Lobelia anceps	0.5	10
*Lolium multiflorum	0.7	<1
Machaerina rubiginosa	1	30
Melaleuca lateritia	1.8	35
Melaleuca rhaphiophylla	7	70
*Rumex crispus	1.5	<1
*Sonchus oleraceus	0.5	<1
Typha sp.	2	<1

C2310

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400383 **mE** 6457039 **mN** **Lat.** -32.0184 **Long.** 115.9452

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey loamy clay

Rock Type Bog iron

Loose Rock <2 % cover; 20-60 mm in size **Litter** 100 % cover ; 5-10 cm in depth

Bare ground 2 % cover **Weeds** 95 % cover

Vegetation U+ ^*Melaleuca rhaphiophylla*,^*Viminaria juncea*\^tree\6\i;G ^^*Watsonia meriana* var. *bulbillifera*, *Watsonia meriana* var. *meriana*,*Amaryllis belladonna*\^forb\2\d

Veg. Condition Completely Degraded

Disturbance Soil disturbed (mounds)

Fire Age

Notes Wetland. Litter is dead weeds (Watsonia). Not measured

Species	WA Cons.	Height (m)	Cover (%)	Count
**Amaryllis belladonna*		0.3	10	
**Avena barbata*		0.6	<1	
**Briza maxima*		0.3	<1	

**Cenchrus clandestinus*	0.3	1
**Cynodon dactylon*	0.4	<1
**Echium plantagineum*	0.5	<1
**Ehrharta longiflora*	0.2	<1
**Eragrostis curvula*	0.8	2
**Hyparrhenia hirta*	1.2	<1
**Lolium multiflorum*	0.3	2
Melaleuca rhaphiophylla	5	25
Viminaria juncea	5	2
**Watsonia meriana* var. *bulbillifera*	0.6	35
**Watsonia meriana* var. *meriana*	0.6	30

C2311

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400185 **mE** 6457135 **mN** **Lat.** -32.0175 **Long.** 115.9431

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type Laterite

Loose Rock <2 % cover; 6-20 mm in size **Litter** 40 % cover ; <1 cm in depth

Bare ground 30 % cover **Weeds** 10 % cover

Vegetation M+ ^*Melaleuca lateritia*\^shrub\3\c;G ^^*Leptocarpus canus*,*Lachnagrostis filiformis*,*Goodenia pulchella* subsp. *Coastal Plain B (L.W. Sage 2336)*\^rush,other grass,forb\2\c

Veg. Condition Very Good

Disturbance Soil surface pugged suggesting previou grazing or cultivation

Fire Age

Notes Wetland. Water monitoring tube in quadrat

Species	WA Cons.	Height (m)	Cover (%)	Count
Astartea affinis		1.8	<1	
**Bellardia viscosa*		0.2	<1	
**Briza minor*		0.1	<1	

Cassytha racemosa forma *racemosa*	1	<1
**Centaurium erythraea*	0.2	<1
Centrolepis aristata	0.03	<1
**Gladiolus caryophyllaceus*	0.3	<1
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*	0.3	3
**Hesperantha falcata*	0.3	<1
**Juncus bufonius*	0.1	<1
Lachnagrostis filiformis	0.3	10
Leptocarpus canus	0.5	35
**Lolium multiflorum*	0.4	<1
**Lotus subbiflorus*	0.3	<1
**Lythrum hyssopifolia*	0.2	<1
Melaleuca lateritia	1.4	35
Pimelea imbricata var. *major*	0.6	<1
Stylidium divaricatum	0.2	2
**Watsonia meriana* var. *meriana*	0.8	2

C2312

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400144 **mE** 6457151 **mN** **Lat.** -32.0174 **Long.** 115.9427

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey yellow sandy clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 30 % cover ; 1-5 cm in depth

Bare ground 10 % cover **Weeds** 70 % cover

Vegetation U+ ^*Viminaria juncea*\^tree\6\i;M ^*Melaleuca lateritia*\^shrub\3\i;G ^^*Watsonia meriana* var. *meriana*,*Verticordia densiflora* var. *densiflora*,*Leptocarpus canus*\^forb,shrub,rush\2\d

Veg. Condition Degraded

Disturbance Drain dug through, soil surface pugged so likely previously grazed or cultivated

Fire Age

Notes Wetland. Not measured.

Species	WA Cons.	Height (m)	Cover (%)	Count
Astartea affinis		1.2	<1	
Cassytha racemosa forma *racemosa*		0.6	<1	
Hakea varia		1.2	<1	

Leptocarpus canus	0.5	5
Melaleuca lateritia	1.3	10
Neurachne alopecuroidea	0.3	2
Verticordia densiflora var. *densiflora*	0.6	6
Viminaria juncea	6	25
**Watsonia meriana* var. *meriana*	0.7	65

C2313

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400264 **mE** 6457155 **mN** **Lat.** -32.0173 **Long.** 115.9439

Habitat Wetland fringe

Aspect N/A **Slope**

Soil Type Grey sandy clay loam

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 70 % cover ; <1 cm in depth

Bare ground 5 % cover **Weeds** 20 % cover

Vegetation U+ ^*Viminaria juncea*,^*Casuarina obesa*\^tree\6\i;M ^*Melaleuca teretifolia*\^shrub\3\r;G ^^*Verticordia densiflora* var. *densiflora*,*Watsonia meriana* var. *meriana*,*Xanthorrhoea brunonis*\^shrub,forb,grass tree\2\c

Veg. Condition Good

Disturbance Soil surface disturbed, like previously grazed and/or cultivated

Fire Age

Notes Wetland (dampland) fringe. Edge of vegetation type (Casuarina obesa)

Species	WA Cons.	Height (m)	Cover (%)	Count
Casuarina obesa		6	8	
Euchilopsis linearis		1.2	<1	

Hakea varia	1.2	<1
Isopogon dubius	1.2	<1
Lepidosperma sp. *1*	0.3	<1
Lepidosperma sp. *2*	0.6	<1
Leptocarpus coangustatus	0.4	<1
Melaleuca lateritia	1.5	1
Melaleuca teretifolia	2	2
Neurachne alopecuroidea	0.1	<1
Stylidium divaricatum	0.2	<1
Verticordia densiflora var. *densiflora*	1	35
Viminaria juncea	6	10
**Watsonia meriana* var. *bulbillifera*	1	<1
**Watsonia meriana* var. *meriana*	0.8	20
Xanthorrhoea brunonis	0.4	2

C2314

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400281 **mE** 6457180 **mN** **Lat.** -32.0171 **Long.** 115.9441

Habitat Wetland fringe

Aspect N/A **Slope** N/A

Soil Type Grey sandy clay loam

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 35 % cover ; <1 cm in depth

Bare ground 40 % cover **Weeds** 10 % cover

Vegetation G+ ^^*Verticordia densiflora* var. *densiflora*,*Ficinia nodosa*,*Lepidosperma* sp. *1*\^shrub,rush, sedge\2\d

Veg. Condition Very Good

Disturbance Soil pugged; likely previously grazed and/or cultivated

Fire Age

Notes Wetland (dampland) fringe

Species	WA Cons.	Height (m)	Cover (%)	Count
**Bellardia viscosa*		0.2	<1	
**Briza maxima*		0.3	<1	
**Briza minor*		0.2	<1	

Centrolepis aristata	0.03	<1
Drosera menziesii	0.2	<1
Ficinia nodosa	0.4	20
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*	0.3	<1
Lachnagrostis filiformis	0.2	3
Lepidosperma sp. *1*	0.5	6
Pimelea imbricata var. *major*	0.4	<1
Verticordia densiflora var. *densiflora*	0.8	50
**Watsonia meriana* var. *meriana*	0.8	5

C2315

Staff LJA **Date** 20/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400299 **mE** 6457124 **mN** **Lat.** -32.0176 **Long.** 115.9443

Habitat Wetland fringe

Aspect N/A **Slope** N/A

Soil Type Grey clay loam

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 100 % cover ; 1-2 cm in depth

Bare ground 0 % cover **Weeds** 5 % cover

Vegetation U+ ^*Casuarina obesa*,^*Viminaria juncea*\^tree\6\c;M ^*Melaleuca lateritia*\^shrub\3\c;G ^*Gahnia trifida*,^*Hyparrhenia hirta*\^sedge,tussock grass\3\r

Veg. Condition Very Good

Disturbance Located between two man-made bunds

Fire Age

Notes Not measured due to vegetation density. Wetland fringe. Probably an ecotone.

Species	WA Cons.	Height (m)	Cover (%)	Count
**Avena barbata*		0.2	<1	
**Bromus catharticus*		0.1	1	
Cassytha racemosa forma *racemosa*		1.5	<1	

Casuarina obesa	10	40
**Euphorbia terracina*	0.2	<1
Gahnia trifida	1.5	5
**Hyparrhenia hirta*	1.5	2
Hypolaena exsulca	0.4	<1
**Lolium multiflorum*		<1
Melaleuca lateritia	1.8	50
Patersonia occidentalis var. *occidentalis*	0.2	<1
Verticordia densiflora var. *densiflora*	0.8	1
Viminaria juncea	8	15

C2316

Staff LJA **Date** 23/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400298 **mE** 6456899 **mN** **Lat.** -32.0196 **Long.** 115.9443

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 30 % cover ; <1 cm in depth

Bare ground 1 % cover **Weeds** 90 % cover

Vegetation U+ ^*Viminaria juncea*\^tree\6\i;M ^*Melaleuca lateritia*\^shrub\3\r;G ^*Watsonia meriana* var. *meriana*,*Hyparrhenia hirta*\^forb,tussock grass\2\d

Veg. Condition Degraded

Disturbance Soil surface pugged; likely grazed and/or cultivated

Fire Age

Notes Wetland close to fringe

Species	WA Cons.	Height (m)	Cover (%)	Count
Astartea affinis		1.3	<1	
Cassytha racemosa forma *racemosa*		1	<1	
**Hyparrhenia hirta*		2.8	2	

Leptocarpus canus	0.3	<1
Melaleuca lateritia	1.4	6
Viminaria juncea	5	10
**Watsonia meriana* var. *meriana*	1.4	90
Xanthorrhoea brunonis	0.3	<1

C2317

Staff LJA **Date** 23/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400345 **mE** 6456952 **mN** **Lat.** -32.0192 **Long.** 115.9448

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 20 % cover ; <1 cm in depth

Bare ground 30 % cover **Weeds** 5 % cover

Vegetation M+ ^*Melaleuca lateritia*\^shrub\3\c;G ^^*Leptocarpus coangustatus*,*Watsonia meriana* var. *meriana*,*Schoenus natans*\^rush,forb\2\i

Veg. Condition Good

Disturbance Soil surface pugged; likely previously grazed and/or cultivated

Fire Age

Notes Wetland

Species	WA Cons.	Height (m)	Cover (%)	Count
Amphibromus nervosus		0.6	<1	
Cassytha racemosa forma *racemosa*		1.2	<1	
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*		0.3	<1	

Iridaceae sp.		0.1	<1
Lachnagrostis filiformis		0.3	2
Leptocarpus coangustatus		0.5	15
**Lolium multiflorum*		0.6	<1
**Lotus subbiflorus*		0.1	<1
**Lythrum hyssopifolia*		0.1	<1
Melaleuca lateritia		1.6	50
Schoenus natans	P 4	0.01	3
**Watsonia meriana* var. *meriana*		0.8	5

C2318

Staff LJA **Date** 23/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400319 **mE** 6456986 **mN** **Lat.** -32.0189 **Long.** 115.9445

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 5 % cover ; <1 cm in depth

Bare ground 40 % cover **Weeds** 1 % cover

Vegetation M+ ^*Melaleuca lateritia*\^shrub\3\c;G ^*Leptocarpus coangustatus*,^*Schoenus natans*\^rush\2\c

Veg. Condition Very Good

Disturbance Soil surface pugged; likely previously grazed and/or cultivated

Fire Age

Notes Wetland

Species	WA Cons.	Height (m)	Cover (%)	Count
Astartea affinis		1.3	<1	
**Avena barbata*		0.5	<1	
Cassytha racemosa forma *racemosa*		1	1	

Euchilopsis linearis		1	<1
Iridaceae sp.		0.1	<1
Lachnagrostis filiformis		0.3	1
Leptocarpus coangustatus		0.6	40
Melaleuca lateritia		1.6	35
Samolus junceus		0.6	<1
Schoenus natans	P 4	0.01	2

C2319

Staff LJA **Date** 23/11/2023 **Season** P

Revisit

Type Q 10 m x 10 m

Location Carousel Swamp

MGA Zone 50 400259 **mE** 6456931 **mN** **Lat.** -32.0194 **Long.** 115.9438

Habitat Wetland

Aspect N/A **Slope** N/A

Soil Type Grey clay

Rock Type No surface rock

Loose Rock 0 % cover **Litter** 20 % cover ; <1 cm in depth

Bare ground 40 % cover **Weeds** 2 % cover

Vegetation M+ ^*Melaleuca lateritia*,^*Cassytha racemosa* forma *racemosa*\^shrub,vine\3\c;G ^^*Leptocarpus coangustatus*,*Schoenus natans*,*Lachnagrostis filiformis*\^rush,other grass\2\i

Veg. Condition Very Good

Disturbance Soil surface suggests some grazing or other previous disturbance

Fire Age

Notes Wetland. Quadrat not measured due to broken tape.

Species	WA Cons.	Height (m)	Cover (%)	Count
Cassytha racemosa forma *racemosa*		1	2	
Goodenia pulchella subsp. *Coastal Plain B (L.W. Sage 2336)*		0.3	<1	
Iridaceae sp.		0.1	<1	

Lachnagrostis filiformis		0.3	2
Leptocarpus coangustatus		0.6	25
Melaleuca lateritia		1.2	35
Schoenus natans	P 4	0.01	3

APPENDIX SIX FLORISTIC ANALYSIS DENDROGRAM

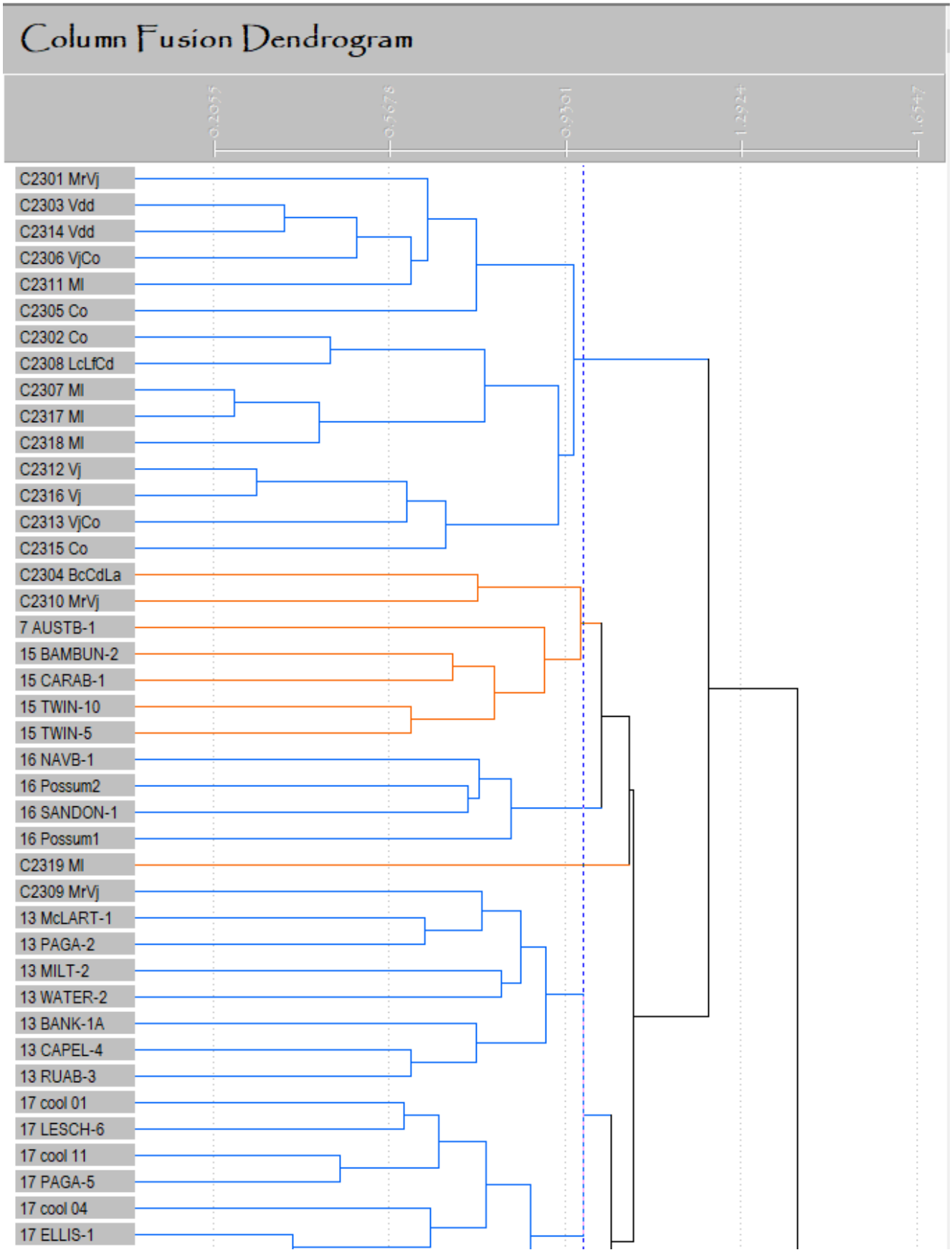


Figure 8: Floristic analysis dendrogram (partial) – current survey and Gibson *et al.* (1994) data