Mullaloo Foreshore Reserve Flora Survey and Vegetation Condition Assessment

City of Joondalup

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Mullaloo Foreshore Reserve Flora Survey and Vegetation Condition Assessment
Project Number	22PER3250
Project Manager	Jeni Morris
Prepared by	Jeni Morris
Reviewed by	Jeff Cargill
Approved by	Jeff Cargill
Status	**Final**
Version Number	**v2**
Last saved on	**15 February 2023**

This report should be cited as 'Eco Logical Australia 2023. *Mullaloo Foreshore Reserve Flora Survey and Vegetation Condition Assessment*. Prepared for City of Joondalup.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from the City of Joondalup.

Template 2.8.1

Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
BAM Act	State *Biosecurity and Agriculture Management Act 2007*
BC Act	State *Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
CLUSTER	Hierarchical Clustering
CR	Critically Endangered
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DotEE	Department of the Environment and Energy
DPIRD	Department of Primary Industries and Regional Development
DRF	Declared Rare Flora
DWER	Department of Water and Environmental Regulation
ELA	Eco Logical Australia
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Act 1999*
ESA	Environmentally Sensitive Area
FCT	Floristic Community Type
ha	hectare
IBRA	Interim Biogeographical Regionalisation for Australia
km	kilometre
KPI	Key Performance Indicator
m	metre
mm	millimetre
MDS	Multi-Dimensional Scaling
P	Priority
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
PRIMER	Plymouth Routines in Multivariate Ecological Research v6
SIMPER	Similarity Percentages
TEC	Threatened Ecological Community
the City	City of Joondalup
TSSC	Threatened Species Scientific Committee

Abbreviation	Description
VU	Vulnerable
WA	Western Australia
WAH	Western Australian Herbarium
WAM	Western Australian Museum
WAOL	Western Australian Organism List
WoNS	Weed of National Significance

Executive Summary

Eco Logical Australia was engaged by the City of Joondalup to undertake a Detailed and Targeted flora survey and vegetation condition assessment of Mullaloo Foreshore Reserve, an area of bushland approximately 17.15 hectares in size, located in the suburb of Mullaloo, Western Australia. The information provided from the current assessment will be used to report on the change in vegetation condition in accordance with the City's endorsed Natural Area Key Performance Indicators, and to inform a review and update of the existing Mullaloo Foreshore Reserve Management Plan.

The field survey was conducted in Spring from 15 to 16 September 2022 in accordance with the Environmental Protection Authority *Technical Guidance*: *Flora and Vegetation Surveys for Environmental Impact Assessment* (2016).

Vegetation communities were described through the establishment and survey of thirteen 10 x 10 metre quadrats, six of which were previously established by Natural Area Consulting Management Services in 2016. A Targeted flora survey was conducted to record occurrences of any conservation significant flora species and/or communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the State *Biodiversity Conservation Act 2016* or by the Department of Biodiversity, Conservation and Attractions. Opportunistic flora species were also recorded across the survey area.

A Targeted weed survey was conducted to record weed species within the survey area, including mapping of City of Joondalup pest plant (Caltrop), City of Joondalup priority weed species and species listed as a Weed of National Significance or as a Declared Pest under the State *Biosecurity and Agriculture Management Act 2007*.

A total of 105 flora taxa (53 native and 52 introduced) were recorded within the survey area from quadrats and opportunistic collections, representing a 32.5% increase in species recorded from the 2016 survey (80 species total; 37 native and 43 introduced; Natural Area 2017). No Threatened (Declared Rare), Priority listed flora species by the Department of Biodiversity, Conservation and Attractions or Bush Forever significant species for 'Site 325: Coastal Strip from Burns Beach to Hillarys' were recorded within the survey area. Of the 52 introduced (weed) species recorded within the survey area, **Asparagus asparagoides* (Bridal Creeper) is listed as a Weed of National Significance and **Moraea flaccida* (One-leaf Cape Tulip) is listed as a Declared Pest under the State *Biosecurity and Agriculture Management Act 2007*, categorised as s22(2) (exempt).

A total of five vegetation communities were delineated and mapped within the survey area, four of which were consistent with those originally described and mapped by Natural Area Consulting Management Services in 2017 (Natural Area 2017; City of Joondalup 2017):

- AcS: *Acacia cyclops* shrubland.
- ArS: *Acacia rostellifera* shrubland.
- OaScOS: *Olearia axillaris* and *Scaevola crassifolia* open shrubland.
- SgMsOS: *Spyridium globulosum* and *Melaleuca systena* open shrubland^.
- ShTdOG: *Spinifex hirsutus* and **Thinopyrum distichum* open grassland.

^New vegetation community in 2022

Intact vegetation within the survey area comprised 13.77 hectares (80.3% of the survey area), while planted/sumpland areas comprised 0.16 hectares (0.9% of the survey area). The remaining 3.22 hectares (18.8% of the survey area) comprised open beach and tracks/cleared areas. Vegetation Community OaScOS was the most widespread vegetation community recorded, covering 39.9% (6.85 hectares) of the survey area.

Results of the multivariate analysis showed that quadrats within vegetation communities AcS, ArS, OaScOS and ShTdOG had a strong affiliation with Floristic Community Type 29a. Floristic Community Type 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community. A total of 13.48 hectares (78.6% of the survey area) was considered as representing this Priority 3 ecological community.

The singular quadrat within SgMsOS, Q13, had a strong affiliation with FCT 24, described as 'Northern Spearwood shrublands and woodlands; heaths with scattered *Eucalyptus gomphocephala*', which is a Priority 3 ecological community. This community, covering a total area of 0.3 hectares (1.7% of the survey area), was considered to represent floristic aspects of FCT 24.

Vegetated areas within the survey area accounted for 80.3% (13.77 hectares), and ranged from Degraded to Very Good condition, based on the Keighery (1994) vegetation scale provided in the Environmental Protection Authority *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). The majority of the survey area was observed to be in Very Good condition (7.58 hectares; 44.2% of the survey area) and Good condition (6.25 hectares; 36.4% of the survey area). A small area of Degraded condition (0.11 hectares; 0.7% of the survey area) was identified north of the SgMsOS vegetation community between Merrifield Place to the north and west and Northshore Drive to the east, comprising a planted/sumpland area. Disturbances within the survey area included the presence of weeds, edge effects (lesser condition) adjacent to tracks/cleared areas and minor rubbish dumping.

A total of two fungi species were identified within the survey area, namely Common Pholiota (*Pholiota communis*) and Scarlet Bracket Fungi (*Pycnoporus coccineus*). Scarlet Bracket Fungi was recorded from one location growing on dead wood, while Common Pholiota was recorded from two locations growing on sandy substrate. Neither of these fungi species are of conservation significance. A total of 22 fauna species (18 native; one naturalised exotic and three pests) were recorded opportunistically within the survey area, comprising 17 birds, four insects and one reptile. No conservation significant fauna species were recorded within the survey area during the field survey. A total of five introduced fauna species were recorded during the field survey. These comprised one bird listed as naturalised exotic in Western Australia, namely **Spilopelia senegalensis* (Laughing Dove; Western Australian Museum 2022) and three invertebrates listed as pest species namely **Ischnura heterosticta* (Common Bluetail Dragonfly) **Mamestra brassicae* (Cabbage Moth) and **Ommatoiulus moreleti* (Portuguese Millipede).

Based on results of the current survey, the following recommendations have been made to assist in the conservation of native flora, vegetation and environmental values present within Mullaloo Foreshore Reserve:

- Continue long-term monitoring of weed populations within the survey area. Implement weed control, particularly for the Declared Pest species **Moraea flaccida* (One-leaf Cape Tulip), the Weed of National Significance **Asparagus asparagoides* (Bridal Creeper) and for City of

Joondalup priority weeds. Concentrate weed control activities along track edges and boundaries between remnant bushland and cleared areas.

- Prioritise maintenance of the vegetation at Mullaloo Foreshore Reserve due to the presence of the Floristic Community Type 24 and Floristic Community Type 29a Priority 3 Ecological Communities.
- It is recommended to continue monitoring for evidence of dieback and other pathogens, and to maintain correct hygiene practices within the survey area.
- It is recommended to monitor the dumping of rubbish and remove where necessary.
- Undertake monitoring and maintenance of fencing and formal signage to prevent use of unauthorised walking tracks and rubbish dumping within the survey area, particularly in the dune/foreshore areas.

1. Introduction

1.1 Project background

Eco Logical Australia (ELA) was engaged by the City of Joondalup (the City) to undertake a Detailed and Targeted flora survey and vegetation condition assessment of Mullaloo Foreshore Reserve, an area of approximately 17.15 hectares (ha; the survey area) in size located in the suburb of Mullaloo, approximately 20 kilometres (km) north-northwest of Perth, Western Australia (WA; **Figure 1**).

Mullaloo Foreshore Reserve is a major conservation area within the City, with high biodiversity values and is vested with, and managed by, the City. The bushland contains regionally significant plant communities and has been recognised for its regional environmental significance by being designated as a Bush Forever site (325) by the Western Australian Planning Commission (Government of Western Australia 2000). Information provided from the current assessment will be used to report on the change in vegetation condition in accordance with the City's endorsed Natural Area Key Performance Indicators (KPIs), and to inform an update of the existing Mullaloo Foreshore Reserve Management Plan.

The most recent ecological survey of the survey area was undertaken by Natural Area Consulting Management Services (Natural Area; 2017) to collect baseline information on ecological values to be utilised in the development of a management plan for the reserve. The Natural Area Consulting Management Services survey area, approximately 12.5 ha in size, did not include the southern portion of the survey area, located south of the surf club adjacent to Merrifield Place (Natural Area 2017; City of Joondalup 2017). Mapping of this area was undertaken Natural Area Consulting Management Services in 2017, with an additional vegetation type recorded and included in the Mullaloo Foreshore Reserve Management Plan (City of Joondalup 2017).

More specifically, the objectives of this survey include:

- An assessment of flora and vegetation communities in accordance with the Environmental Protection Authority (EPA) *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016);
- Undertake a vegetation condition assessment using the Keighery vegetation condition scale (1994; EPA 2016);
- A Targeted survey for State, Federal and/or Department of Biodiversity, Conservation and Attractions (DBCA) conservation significant flora, including Bush Forever significant flora and/or vegetation;
- An assessment to verify if the vegetation meets the requirements specified in the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) 'Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community', using the four-stage assessment process itemised in the Approved Conservation Advice (Threatened Species Scientific Committee [TSSC] 2016);
- An assessment to verify if the vegetation meets the requirement specified in the Department of Environment and Energy (DotEE) 'Approved Conservation Advice (incorporating listing advice) for the Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community' using the assessment process outlines in the Conservation Advice (DotEE 2019a);
- Record and mapping of all weed species encountered including State, Federal (Weed of National Significance [WoNS], Declared Pests listed under the State *Biosecurity and Agriculture*

Management Act 2007 [BAM Act]), City of Joondalup pest plant and/or priority weeds in the City of Joondalup (priority species list provided by the City);

- Record opportunistic sightings of fauna (including invertebrates) and fungi during the flora survey, in particular fauna species of State or Federal conservation significance; and
- Make recommendations to conserve biodiversity values.

Figure 1: Survey Area Location

Survey area

N

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER3250-ED Date: 1/11/2022

ecological AUSTRALIA
A TETRA TECH COMPANY

2. Environmental setting

2.1 Regional context

Broad environmental values for the region relevant to the survey area are presented in **Table 1**.

Table 1: Environmental values of the region

Existing environmental attributes	Survey area
Interim Biogeographical Regionalisation for Australia (IBRA) Bioregion (Department of Agriculture, Water and the Environment [DAWE] 2022a)	Swan Coastal Plain (SWA).
IBRA Subregion (DAWE 2022a)	Perth (SWA02).
Geology, landform and soils (Department of Primary Industries and Regional Development [DPIRD] 2022a)	**Quindalup South System**: Coastal dunes, of the Swan Coastal Plain, with calcareous deep sands and yellow sands. Coastal scrub.
Floristic Community Types (FCTs) inferred within Bush Forever Site 325 (Government of Western Australia 2000) *Not sampled; types inferred	**Supergroup 2**: Seasonal Wetlands - ***FCT16**: Highly saline seasonal wetlands (*Frankenia pauciflora* Low Shrubland on Tamala Limestone Cliffs) **Supergroup 4**: Uplands centred on Spearwood and Quindalup dunes. - **FCT27**: Species-poor mallees and shrublands on limestone. - **FCT29a**: Coastal shrublands on shallow sands. - ***FCT29b**: Acacia shrublands on taller dunes. - ***FCT S11**: Northern *Acacia rostellifera – Melaleuca acerosa* shrublands. - ***FCT S13**: Northern *Olearia axillaris – Scaevola crassifolia* shrublands. - ***FCT S14**: *Spinifex longifolius* grassland and low shrublands.
Bush Forever (Government of Western Australia 2000)	Bush Forever Site 325.
Beard's (1975) vegetation mapping	**Guilderton 129**: Bare areas; dune sand **Guilderton 1007**: Mosaic: Shrublands; *Acacia lasiocarpa* & *Melaleuca acerosa* heath / Shrublands; *Acacia rostellifera* & *Acacia cyclops* thicket.

3. Methodology

3.1 Desktop review

3.1.1 Database searches and literature review

The following Commonwealth and State databases were searched for information relating to conservation listed flora and ecological communities in order to compile and summarise existing data to inform the field survey. Database searches undertaken around the central coordinate 381735 metres (m) E; 6481092m S are presented in **Table 2**. Applied buffers below are considered suitable based on flora and fauna assemblages expected to occur within the survey area.

Table 2: Database searches undertaken for the survey area

Database	Reference	Buffer (km)
EPBC Act Protected Matters Search Tool (PMST) for Threatened species and communities listed under the EPBC Act.	DAWE 2022b	10
DBCA Threatened and Priority flora database searches for Declared Rare Flora (DRF) listed under the latest WA Wildlife Conservation (Rare Flora) Notice and Priority Flora.	DBCA 2022a	30
DBCA Threatened and Priority Ecological Communities' database search.	DBCA 2022b	10
DAFWA Western Australian Organism List (WAOL)	DPIRD 2022b	-
Department of Water and Environmental Regulation (DWER) Environmentally Sensitive Area (ESA) Database	DWER 2022	-

In addition, the following documents were also reviewed:

- City of Joondalup. 2017. *Mullaloo Foreshore Reserve Management Plan.*
- Natural Area Consulting Management Services (Natural Area). 2017. *Mullaloo Foreshore Flora, Fauna and Fungi Report*.
- City of Joondalup *Priority Weed List for Mullaloo Foreshore Reserve*.

3.2 Field survey

3.2.1 Survey team and timing

A Detailed and Targeted flora and vegetation survey was conducted by Jeff Cargill (Principal Botanist), Jeni Morris (Ecologist) and Maitland Ely (Graduate Ecologist) from 15 to 16 September 2022. The survey team's relevant qualifications, experience and licences are provided in **Table 3** below.

A total of 3.6 millimetres (mm) of rainfall was recorded from the nearby Wanneroo weather station (station number 9105; rainfall data 1905-present; located approximately 8 km northeast of the survey area) during the field survey (BoM 2022). In the three months prior to the field survey (June to August), a total of 441.3 mm of rainfall was recorded, which is comparable to the long-term average for the same period (446 mm; BoM 2022). Survey conditions during the field survey were considered suitable, with the majority of species in various stages of reproduction (e.g., flowering, seeding, fruiting), allowing for positive identification of both common and cryptic species.

Table 3: Survey team

Name	Qualification	Relevant experience	Licenses
Dr. Jeffry Cargill	BSc. Hons. PhD Environmental Sciences	Jeff has extensive experience in botanical and ecological studies throughout Western Australia including baseline vegetation studies (Reconnaissance and Detailed surveys), Targeted threatened and priority flora surveys, fauna and black cockatoo surveys, MNES surveys and rehabilitation and vegetation monitoring programs.	Flora Taking (Biological Assessment) Licence number: FB62000138-2 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 48-1920
Jeni Morris	BSc. Conservation and Wildlife Biology	Jeni has completed several flora and vegetation surveys on the Swan Coastal Plain and within the City of Joondalup including at Shepherd's Bush Reserve, Iluka-Burns Beach Coastal Reserve, Warwick Open Space, Craigie Bushland Reserve and Yellagonga Regional Park.	Flora Taking (Biological Assessment) Licence number: FB62000070-2 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 178-2122
Maitland Ely	BSc. Conservation Biology and Botany	Maitland joined ELA as a Graduate Environmental Scientist in 2020. He has experience undertaking Baseline and Targeted flora and vegetation survey and Basic and Detailed fauna survey in Western Australia.	Flora Taking (Biological Assessment) Licence number: FB62000455
Daniel Brassington	BSc Environmental Science (Hons)	Daniel has over 10 years' experience in botanical surveys and environmental services throughout Western Australia. This includes baseline vegetation studies (reconnaissance and detailed surveys), threatened and priority flora surveys, rehabilitation and vegetation monitoring, targeted species surveys, weed control, seed collection and processing, nursery operations and revegetation operations.	Flora Taking (Biological Assessment) Licence number: FB62000196 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 2223-0033

3.3 Flora and vegetation survey

A Detailed and Targeted flora and vegetation survey was conducted in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). A total of 13 quadrats were sampled during the field survey, six of which were originally established by Natural Area (Natural Area 2017; **Figure 2**).

Dominant vegetation communities were described, with respect to dominant species, structure and overall condition. The survey involved the use of 10 x 10 m quadrats as recommended for the Swan Coastal Plain bioregion (EPA 2016). Opportunistic sampling of species not recorded within the quadrats was undertaken to supplement the existing list of species recorded from within the survey area.

Where possible, photos were taken from the same position as those undertaken in 2016 (Natural Area 2017) and taken from the northwest corner of newly established quadrats. The following data was recorded within each quadrat:

- Site details (site name, site number, observers, date and location);
- Environmental information including landform, soil type and colour, bare ground and leaf litter cover, rock outcropping and time since last fire event; and
- Biological information including vegetation structure, vegetation condition in accordance with Keighery (1994), degree of disturbance, species present and species percentage cover.

A Targeted survey was completed within the survey area to identify any conservation significant flora or communities potentially occurring, including:

- Threatened flora or Threatened Ecological Communities (TECs) listed under the EPBC Act;
- Threatened (Declared Rare) Flora listed under the latest WA Wildlife Conservation (Rare Flora) Notice under the State *Biodiversity Conservation Act 2016* (BC Act);
- Priority Ecological Communities (PECs) endorsed by the Western Australian Minister for the Environment;
- Priority (P) flora recognised by DBCA; and
- Bush Forever significant flora (Government of Western Australia 2000).

The survey methodology involved personnel walking transects across the survey area, with transects spaced (on average) 5-30 m apart depending on factors such as habitat type, disturbance (e.g., tracks) and landform. Locations of survey transects are shown in **Figure 2** below. Flora species able to be identified in the field were recorded, and voucher specimens of unfamiliar species were collected for later identification. All collections were assigned a unique collecting number. For conservation significant flora species identified in the field, the following was recorded:

- A colour photograph;
- GPS location;
- Population size estimate;
- Location of population boundaries;
- Associated habitat/landscape element;
- Time and date observed;
- Observer details; and
- A voucher specimen suitable for use as a reference specimen (if appropriate to do so for conservation significant flora).

3.4 Weed survey and mapping

The survey area was surveyed and mapped for State, Federal and/or Priority weeds as specified by the City of Joondalup, including all WoNS, Declared Pests listed under the BAM Act and City of Joondalup declared pest plants. The City of Joondalup *Priority Weed List for Mullaloo Foreshore Reserve* list is provided in **Table 4**.

For each priority weed species, including WoNS and/or Declared Pest species encountered, a GPS location coordinate was recorded using points for individual plants or polygons for populations. Weed data was collected in accordance with the DBCA (previously Department of Environment and Conservation [DEC]) Standard Operating Procedure 22.1 *Techniques for mapping weed distribution and cover in bushland and wetlands* (DEC 2011).

Table 4: City of Joondalup Priority weed species list for Mullaloo Foreshore Reserve

Species (Common Name)	Ranking
**Agave americana* (Agave)	-
**Alysumm* sp. (Sweet Alyssum)	-
**Arctotis* sp. (Arctotis)	-
**Asparagus asparagoides* (Bridal Creeper)	WoNS
**Cakile edentula* (Sea Rocket)	-
**Carpobrotus edulis* (Pigface)	-
**Centranthus macrosiphon* (Pretty Betsy)	-
**Ehrharta calycina* (Perennial Veldt Grass)	-
**Ehrharta longiflora* (Annual Veldt Grass)	-
**Euphorbia paralias* (Sea Spurge)	-
**Euphorbia terracina* (Geraldton Carnation Weed)	-
**Fumaria* sp. (Fumitory)	-
**Gazania linearis* (Gazania)	-
**Moraea flaccida* (One-leaf Cape Tulip)	Declared Pest – s22(2) under the BAM Act
**Osteospermum ecklonis* (Veldt Daisy; previously **Dimorphotheca ecklonis*)	-
**Oxalis pes-caprae* (Soursob)	-
**Pelargonium capitatum* (Rose Pelargonium)	-
**Ricinus communis* (Caster Oil Plant)	-
**Schinus terebinthifolius* (Japanese Pepper)	-
**Tetragonia decumbens* (Sea Spinach)	-
**Thinopyrum distichum* (Sea Wheat)	-
**Trachyandra divaricata* (Dune Onion Weed)	-
^Unknown (Stock Plant)	-
**Urospermum picaroides* (False Hawkbit)	-

Note: * refers to an introduced species.
^Likely *Arabus* sp.

3.5 Data analysis

3.5.1 Flora species accumulation curve

A flora species accumulation curve was undertaken to indicate adequacy of the survey effort (Clarke and Gorley 2006). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence-based coverage estimator of species richness. When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered adequate.

3.5.2 Vegetation communities

Plymouth Routines in Multivariate Ecological Research v6 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites based on their species composition (Clarke and Gorley 2006). A presence/absence transformation was applied to the dataset to align with Gibson *et al.* (1994). Introduced species (weeds), specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component) were excluded from the data set prior to analysis. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Data were analysed using a series of multivariate analysis routines including Hierarchical Clustering (CLUSTER) and Similarity Percentages (SIMPER). Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities.

Where relevant, previously assigned vegetation mapping codes and descriptions (Natural Area 2017) were retained during the current assessment to maintain consistency between survey periods.

A Threatened and Priority Ecological Community (TEC/PEC) Occurrence Report Form was completed and submitted for all TECs and PECs identified within the survey area.

3.5.2.1 FCT analysis

Species within the Gibson *et al*. (1994) data set were updated to align with current names as specified by FloraBase (DBCA and Western Australian Herbarium [WAH] 2022). Using current records, several species in the Gibson *et al*. (1994) data set were shown to be significant range extensions from the Swan Coastal Plain, where appropriate such cases were removed. Excluded and misapplied names were removed from the data set and infra-specific names were reduced. The merged dataset was analysed using a combination of pre-treatments such as the inclusion and/or removal of introduced species and singletons. The removal of singletons from the merged dataset, an accepted pre-treatment for such analysis, produced the best results (e.g., stronger correlations; Clarke and Gorley 2006). Inclusion of such data merely served to confound the dataset by introducing stochastic and 'site' artefact data. Transformed data were analysed using a combination of multivariate analysis routines including Bray-Curtis Similarity Matrices, single insertion Cluster Analysis (Flexible Beta) and Multi-Dimensional Scaling (MDS).

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994). To identify the presence of FCT's appropriate multivariate analyses comparing current data to that of Gibson *et al*. (1994) species by quadrat data, and inferences based on dominant species and geomorphology were used. Given the nature of the data (e.g., spatial and temporal differences), results and subsequent extrapolations, assigned FCT's within the survey area were inferred and not absolute, i.e., a vegetation code assigned to an FCT was inferred

to comprise, to varying degrees, floristic aspects of that FCT as defined by Gibson *et al*. (1994). Species lists for the survey area were updated, and one additional vegetation community was identified and mapped in addition to those originally mapped within the survey area by Natural Area (2017) and by the City of Joondalup (2017). FCTs were unable to be compared with vegetation communities delineated by Natural Area (2017) and the City of Joondalup (City of Joondalup 2017), due to FCT analysis results being incorrect or unavailable.

3.5.2.2 Assessment of diagnostics to assess presence of Threatened Ecological Communities

The 'Banksia Woodlands of the Swan Coastal Plain' TEC is listed as Endangered under the EPBC Act (TSSC 2016). For information to assist in referral, environmental assessment and compliance issues, it has been recommended to refer to the Listing Advice and/or Conservation Advice and Recovery Plan on the DotEE Species Profile and Threats Database (TSSC 2016). The Listing Advice and/or Conservation Advice defines the national ecological community and includes key diagnostic characteristics, condition thresholds and additional considerations (TSSC 2016).

In order to determine whether the 'Banksia Woodlands of the Swan Coastal Plain' TEC is present in the survey area key diagnostic characteristics must be met under Section 2 of the Conservation Advice (TSSC 2016). As no *Banksia* species were identified as occurring within the survey area, the four-stage assessment identified by DotEE to ascertain the presence of the Banksia Woodlands endangered ecological community within the site was not undertaken by ELA following the field survey.

The 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' ecological community is listed as Critically Endangered under the EPBC Act (DotEE 2019). For information to assist in referral, environmental assessment and compliance issues, it has been recommended to refer to the Listing Advice and/or Conservation Advice on the DotEE Species Profile and Threats Database (DotEE 2019). The Listing Advice and/or Conservation Advice defines the national ecological community and includes key diagnostic characteristics, condition thresholds and additional considerations (DotEE 2019a).

In order to determine whether the 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC is present in the survey area key diagnostic characteristics must be met under Section 3.2 of the Conservation Advice (DotEE 2019). As no Tuart (*Eucalyptus gomphocephala*) individuals were identified as occurring within the survey area, the assessment identified by DotEE to ascertain the presence of the Tuart (*Eucalyptus gomphocephala*) critically endangered ecological community within the site was not undertaken by ELA following the field survey.

3.6 Flora identification and nomenclature

Flora specimen identification was undertaken by ELA Principal Botanist Jeff Cargill. Species identification utilised taxonomic literature and keys and where required specimens were confirmed using the WAH collection. Where considered appropriate, specimens that meet WAH specimen lodgement requirements (e.g., Threatened and Priority Flora, range extensions), will be submitted along with Threatened and Priority Report forms to DBCA. Nomenclature used for the flora species within this report follows the WA Plant Census as available on FloraBase (DBCA and WAH 2022).

3.7 Limitations

The EPA *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) recommends including discussion of the constraints and limitations of the survey methods used.

Constraints and limitations for the Detailed and Targeted flora and vegetation for the survey area are summarised in **Table 5** below. No constraints were identified.

Table 5: Survey limitations

Constraint	Limitations
Sources of information	**Not a constraint**: The Swan Coastal Plain has been well surveyed, with increasing survey work occurring due to the ongoing urban development of the Perth metropolitan area. Flora surveys have been undertaken in the survey area which have been utilised for the purposes of this survey. Gibson *et al*. 1994 was a primary source for determination of methods, analysis and results for assessing FCTs. Broad-scale vegetation mapping at a scale of 1:1,000,000 was available. Land system mapping at a scale of 1:2,000,000 and soil and landform mapping was also available. The information which was available was sufficient and as such sources of information were not considered a major limitation.
Scope of work	**Not a constraint:** The survey requirement for a Detailed and Targeted flora and vegetation survey in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) was adequately met.
Completeness of survey	**Not a constraint:** The area was surveyed to the satisfaction of the scope and a Detailed and Targeted flora and vegetation survey as per relevant guidelines.
Intensity of survey	**Not a constraint:** Survey effort was considered adequate to meet objectives of the scope. The area was surveyed for conservation significant flora species and vegetation communities by field staff undertaking transects across the survey area spaced 5-30 m apart on average. This method provided an accurate assessment of habitat characteristics and likelihood of conservation significant species. The number of quadrats established was sufficient to determine the vegetation communities present and to identify any vegetation of conservation significance. Adequacy of the current sampling effort was tested via a species accumulation curve; approximately 84.4% of the flora potentially present within the survey area was recorded, not including the additional 34 species collected opportunistically during the field survey.
Timing, weather, season, cycle	**Not a constraint:** The survey area is located in the Swan Coastal Plain bioregion of Western Australia. Recommended survey timing for this region is in spring (September – November; EPA 2016). The field survey was undertaken at the beginning of September, with comparable to average rainfall recorded in the three months preceding the field survey (BoM 2022). Many flora species were flowering at the time of the field survey or had sufficient material (fruit) available to identify the dominant and target species. The timing was appropriate for conducting this level of survey.
Disturbances	**Not a constraint:** Disturbances within the survey area included the presence of weeds, minor rubbish dumping and edge effects. These disturbances did not negatively impact the ability to meet objectives outlined in the scope of works.
Resources	**Not a constraint:** The personnel conducting this field survey were suitably qualified to identify specimens, having previously undertaken flora and vegetation assessments on the Swan Coastal Plain, including in several reserves for the City of Joondalup.
Accessibility	**Not a constraint:** All relevant areas of the survey area were easily accessed and able to be surveyed.

Figure 2: Survey effort

Survey area
Quadrat
Transect

N

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER3250-ED Date: 8/11/2022

eco logical AUSTRALIA
A TETRA TECH COMPANY

4. Results

4.1 Desktop review

4.1.1 Conservation significant flora species and ecological communities

A DBCA Threatened and Priority Flora and Ecological Communities' database search was undertaken to identify conservation significant flora species and communities recorded within, or nearby to, the survey area (current and historic). Additional documents reviewed included:

- City of Joondalup. 2017. *Mullaloo Foreshore Reserve Management Plan*, and
- Natural Area Consulting Management Services (Natural Area). 2017. *Mullaloo Foreshore Flora, Fauna and Fungi Report*.

A total of 14 flora species of conservation significance were identified from the desktop assessment occurring within a 10 km radius of the survey area, including one species listed under the EPBC Act and BC Act as Endangered (EN), and 13 species listed as Priority (P) by DBCA. Of these, a single point-record, situated on a foredune, containing *Leucopogon maritimus* (P1), *Conostylis bracteata* (P3) and *Jacksonia sericea* (P4) was located within the survey area, dated from 1966, 1962 and 2002, respectively:

- *Marianthus paralius* (listed as EN under the EPBC Act and BC Act);
- *Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425; listed as P1 by DBCA);
- *Grevillea* sp. Ocean Reef (D. Pike Joon 4; listed as P1 by DBCA);
- *Leucopogon maritimus* (listed as P1 by DBCA);
- *Acacia benthamii* (listed as P2 by DBCA);
- *Thelymitra variegata* (listed as P2 by DBCA);
- *Austrostipa mundula* (listed as P3 by DBCA);
- *Conostylis bracteata* (listed as P3 by DBCA);
- *Hibbertia leptotheca* (listed as P3 by DBCA);
- *Pimelea calcicola* (listed as P3 by DBCA);
- *Sarcozona bicarinata* (listed as P3 by DBCA);
- *Stylidium paludicola* (listed as P3 by DBCA);
- *Styphelia filifolia* (listed as P3 by DBCA);
- *Eucalyptus foecunda* subsp. *foecunda* (listed as P4 by DBCA); and
- *Jacksonia sericea* (listed as P4 by DBCA).

A total of six conservation significant ecological communities were identified as occurring within a 10 km radius of the survey area (DBCA 2022b), none of which intersects with the survey area (**Table 6**). Conservation codes, categories and criteria for flora and fauna protected under the EPBC Act and the BC Act are provided in **Appendix A**.

Table 6: Conservation significant ecological communities occurring within, or in proximity to, the survey area (DBCA 2022b)

Community ID	Community description	Ranking (Federal)	Ranking (State)
Tuart woodlands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain	Critically Endangered	Priority 3
Banksia WL SCP	Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Priority 3
SCP24	Northern Spearwood shrublands and woodlands	-	Priority 3
SCP25	Southern *Eucalyptus gomphocephala-Agonis flexuosa* woodlands	-	Priority 3
SCP29a	Coastal shrublands on shallow sands	-	Priority 3
SCP29b	*Acacia* shrublands on taller dunes	-	Priority 3

4.1.2 Expected flora assemblages

A summary of the number of flora species (native and introduced) previously recorded from within Mullaloo Foreshore Reserve is provided in **Table 7** below.

Table 7: Summary of flora species and conservation significant species recorded within Mullaloo Foreshore Reserve from previous studies

Study	Number of species			Number of quadrats established	Conservation significant species/communities recorded
	Native	Introduced	Total		
Natural Area (2017)	37	43	80	6	Nil

4.2 Flora and vegetation

4.2.1 Flora overview

A total of 105 taxa (53 native and 52 introduced taxa) from 85 genera and 41 families were recorded across 13 quadrats established within the survey area and from opportunistic collections. Average species richness per quadrat was 21.5 species, ranging from a low of 12 species at Q7 to a high of 39 species at Q13. Families with the highest number of species included Fabaceae (14 species), Poaceae (10 species) and Asteraceae (9 species). *Acacia* was the best represented genera throughout the survey area with 6 taxa recorded. No orchid species were recorded within the survey area. A flora species list is provided in **Appendix B** and a site by species matrix is provided in **Appendix C**. Quadrat site data is presented in **Appendix D**.

4.2.2 Accumulated species – site surveyed (species-area curve)

A species accumulation curve (**Figure 3**) was used to evaluate the adequacy of sampling (Clarke and Gorley 2006). Only species data recorded from defined quadrats were used; no opportunistic flora collections were included. The asymptotic value was determined using Michaelis Menten modelling. Using this analysis, the incidence-based coverage estimator of species richness was calculated to be 85.3. Based on this value, and the total of 72 species recorded within quadrats, approximately 84.4% of the flora species potentially present within the survey area were recorded. This result, in addition to a total of 34 opportunistic collections, indicates that the majority of flora potentially present within the survey area were recorded.

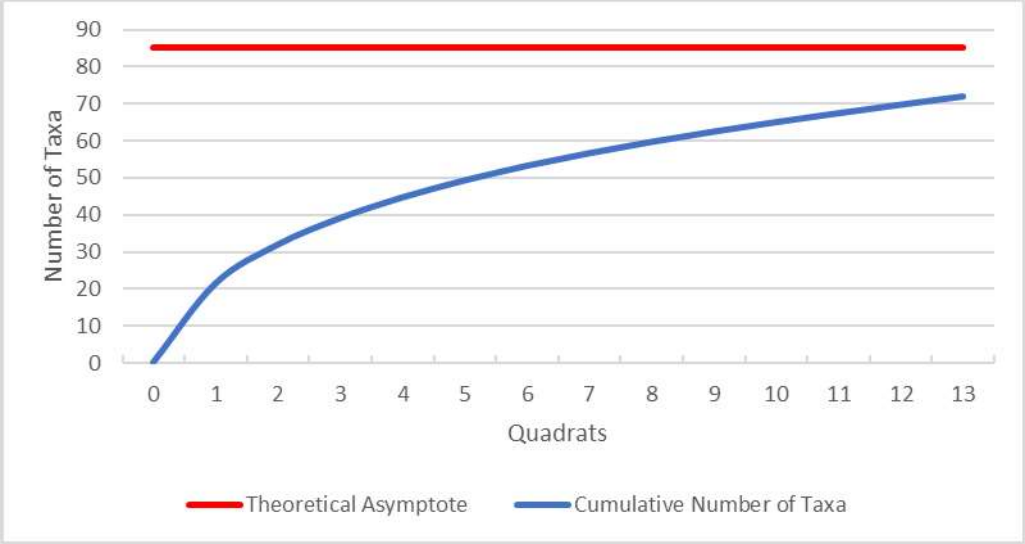


Figure 3: Average randomised species accumulation curve

4.2.3 Conservation and Bush Forever significant flora

No Threatened or Priority flora species listed under the EPBC Act, the BC Act or by DBCA were recorded within the survey area. The single point-location of *Leucopogon maritimus* (P1), *Conostylis bracteata* (P3) and *Jacksonia sericea* (P4), previously recorded within the survey area (DBCA 2022a), was visited during the field survey, however these species were not located. All three species are considered as unlikely to occur, based on adequate search effort within the survey area and species habitat preferences. This record is considered as likely to be an erroneous database search location, as appropriate habitat for these species does not occur within the survey area. No Bush Forever significant species were recorded within the survey area from the field survey.

4.2.4 Introduced flora

A total of 52 introduced (weed) species were recorded within the survey area, representing 49.5% of the total species recorded. Of these, **Asparagus asparagoides* (Bridal Creeper) is listed as a WoNS and **Moraea flaccida* (One-leaf Cape Tulip) is listed as a Declared Pest under the BAM Act, categorised as s22(2) (exempt; **Plate 1**). Declared Pests "must satisfy any applicable import requirements when imported and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia" (DPIRD 2022b).

Asparagus asparagoides* (Bridal Creeper) was recorded within the survey area at two point-locations within the ArS vegetation community (Appendix E**). **Moraea flaccida* (One-leaf Cape Tulip) was recorded within the survey area at one point-location within the AcS vegetation community in the south of the survey area (**Appendix E**). **M. flaccida* was previously recorded from one location within the survey area by Natural Area, located just north of the southern car park (Natural Area 2017). **A. asparagoides* has not previously been recorded within the survey area.

Of the 52 introduced (weed) species recorded, 21 are listed on the City of Joondalup priority weed list for Mullaloo Foreshore Reserve. The City's declared pest plant, **Tribulus terrestris* (Caltrop), was not recorded during the current survey. A list of all City of Joondalup priority weeds, Declared Pests and WoNS recorded within the survey area are listed in **Table 8** and presented in **Appendix E**.

Plate 1: Left: *Asparagus asparagoides* (Bridal Creeper; listed as a WoNS) and Right: *Moraea flaccida* (One-leaf Cape Tulip; listed as a Declared Pest) recorded within the survey area © Eco Logical Australia 2022

Table 8: CoJ Priority weed species, Declared Pests or WoNS recorded within Mullaloo Foreshore Reserve

Species (Common Name)	Ranking
**Agave* sp. (Agave)	-
**Alyssum* sp. (Sweet Alyssum)	-
**Arabis* sp. (Pink Arabis; Stock Plant)	-
**Arctotis stoechadifolia* (Arctotis)	-
**Asparagus asparagoides* (Bridal Creeper)	WoNS
**Cakile maritima* (Sea Rocket)	-
**Centranthus macrosiphon* (Long-spurred Valerian)	-

Species (Common Name)	Ranking
**Ehrharta longiflora* (Annual Veldt)	-
**Euphorbia paralias* (Sea Spurge)	-
**Euphorbia terra*cina (Geraldton Carnation Weed)	-
**Fumaria capreolata* (Fumitory)	-
**Gazania linearis* (Gazania)	-
**Moraea flaccida* (One-leaf Cape Tulip)	Declared Pest – s22(2) under the BAM Act
**Osteospermum ecklonis* (Veldt Daisy)	-
**Oxalis pes-caprae* (Soursob)	-
**Pelargonium capitatum* (Rose Pelargonium)	-
**Schinus terebinthifolia* (Japanese Pepper)	-
**Tetragonia decumbens* (Sea Spinach)	-
**Thinopyrum distichum* (Sea Wheat)	-
**Trachyandra divaricata* (Onion Weed)	-
**Urospermum picroides* (False Hawkbit)	-

4.2.5 Vegetation communities

A total of five vegetation communities were delineated and mapped within the survey area (**Appendix F**). Where relevant, vegetation codes previously assigned by Natural Area (2017) and the City of Joondalup (2017) were validated during the current analysis and subsequently retained for consistency purposes. Where new vegetation communities were identified, similar naming conventions were applied to vegetation communities:

- AcS: *Acacia cyclops* Shrubland.
- ArS: *Acacia rostellifera* Shrubland.
- OaScOS: *Olearia axillaris* and *Scaevola crassifolia* Open Shrubland.
- SgMsOS: *Spyridium globulosum* and *Melaleuca systena* Open Shrubland^.
- ShTdOG: *Spinifex hirsutus* and **Thinopyrum distichum* Open Grassland.

Vegetation communities are described in **Table 9** and presented in **Figure 4** below. Intact vegetation within the survey area comprised 13.77 ha (80.3% of the survey area), with the remaining 3.22 ha (18.8%) comprising open beach (2.36 ha; 13.8%), tracks/cleared areas (0.85 ha; 5%) and planted/sumpland areas (0.16 ha; 0.9%).

While three quadrats were established per vegetation community for AcS, ArS, OaScOS and ShTdOG, only one quadrat was established within the SgMsOS vegetation community, due to its restricted size within the survey area.

^New vegetation community in 2022

Table 9: Vegetation communities recorded within the survey area

Image	Vegetation community	Vegetation description	Quadrats	Extent within the survey area (ha)	Proportion of the survey area (%)
	AcS: *Acacia cyclops* Shrubland	*Acacia cyclops* tall shrubland over *Rhagodia baccata*, *Scaevola crassifolia* mid open shrubland and *Lepidosperma gladiatum* mid open sedgeland over **Pelargonium capitatum*, *Threlkeldia diffusa*, *Acanthocarpus preissii* low open herbland.	Q10, Q11, Q12	1.75	10.2
	ArS: *Acacia rostellifera* Shrubland	*Acacia rostellifera* shrubland over mixed shrubland; *Scaevola crassifolia*, *Rhagodia baccata* and *Spyridium globulosum* and a weedy grass understory; **Bromus diandrus*. This vegetation type occurs on the tertiary dunes at the eastern edge of the site.	Q1, Q5, Q8	3.05	17.8

Image	Vegetation community	Vegetation description	Quadrats	Extent within the survey area (ha)	Proportion of the survey area (%)
	OaScOS: Olearia axillaris and Scaevola crassifolia Open Shrubland	*Olearia axillaris* and *Scaevola crassifolia* open shrubland over a grassy herb understorey; **Lagurus ovatus*, *Ficinia nodosa* and weedy herb; **Trachyandra divericata*. This vegetation type occurs on the secondary dunes in between the other two vegetation types along the entire length of the site.	Q2, Q6, Q9	6.85	39.9
	SgMsOS: *Spyridium globulosum* and *Melaleuca systena* Open Shrubland	*Spyridium globulosum*, *Templetonia retusa*, *Acacia saligna* tall open shrubland over *Melaleuca systena*, *Acacia lasiocarpa* mid open shrubland over **Bromus diandrus* low open grassland and *Lomandra maritima*, *Acanthocarpus preissii* low open herbland.	Q13	0.30	1.7

Image	Vegetation community	Vegetation description	Quadrats	Extent within the survey area (ha)	Proportion of the survey area (%)
	ShTdOG: *Spinifex hirsutus* and **Thinopyrum distichum* Open Grassland	Open *Spinifex hirsutus* and **Thinopyrum distichum* grassland with sparse patches of *Olearia axillaris*. This vegetation type occurs along the foredunes on the western edge of the site.	Q3, Q4, Q7	1.82	10.6
Open beach			N/A	2.36	13.8
Tracks / cleared areas			N/A	0.85	5.0
Planted / sumpland			N/A	0.16	0.9
Total				**17.15**	**100.0**

4.2.6 Conservation significant ecological communities

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994). Results of this analysis are shown below in **Table 10**.

Results of the multivariate analysis showed that quadrats within vegetation community ArS had a strong affiliation with FCT 29a and, to a lesser extent to FCT 29b and FCT 30a. This community, covering a total area of 3.05 ha (17.8% of the survey area), was considered to represent floristic aspects of FCT 29a (**Figure 5**). FCT 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community (DBCA 2022c). FCT 30a (SCP 30a), described as '*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain', is listed as a Vulnerable (VU) TEC under the EPBC Act. Although two quadrats within vegetation community ArS (Q1 and Q8) showed a weak affiliation with FCT 30a, this vegetation community is not considered as representing this TEC as it doesn't comprise key floristic and structural aspects of the FCT i.e., overarching *C. preissii* and/or *M. lanceolata* forest or woodland.

Quadrats within vegetation communities OaScOS and AcS had a strong affiliation with FCT 29a. These communities, covering a total area of 8.60 ha (50.2% of the survey area), are considered as representing floristic aspects of the FCT 29a (listed as P3 by DBCA; **Figure 5**).

Quadrats within vegetation community ShTdOG had a strong affiliation with FCT 29a and, to a lesser extent, FCT 16 and FCT 19. This community, covering a total area of 1.82 ha (10.6% of the survey area), is considered as representing floristic aspects of FCT 29a (listed as P3 by DBCA; **Figure 5**). FCT 19, described as "Sedgelands in Holocene dune swales of the southern Swan Coastal Plain" is listed as Critically Endangered (CR) under WA criteria and as EN under the EPBC Act. Although one quadrat within the ShTdOG vegetation community (Q3) showed a weak affiliation to FCT 19, this community is not considered as representing this TEC as it doesn't comprise key floristic, landform and structural aspects of the FCT, with only one similar species (*Ficinia nodosa*) and high densities of weeds (>25%).

The singular quadrat established within SgMsOS, Q13, had a strong affiliation with FCT 24, which is described as 'Northern Spearwood shrublands and woodlands; heaths with scattered *Eucalyptus gomphocephala'.* This FCT is recognised as being a subcomponent of the 'Banksia Woodlands of the Swan Coastal Plain' ecological community (TSSC 2016) and as an FCT that includes Tuart (*Eucalyptus gomphocephala*), indicating the potential for this community to represent the 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' ecological community (DotEE 2020). Each of these communities are listed as Threatened under the EPBC Act (EN and CR, respectively), and as a Priority 3 ecological community by DBCA (DBCA 2022c). This community, covering a total area of 0.30 ha (1.7% of the survey area), was considered to represent floristic aspects of FCT 24 (**Figure 5**), however was not considered as representing the 'Banksia Woodlands of the Swan Coastal Plain' TEC or the 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC, due to the absence of any *Banksia* tree species or Tuart within the survey area, with vegetation comprising low shrubland / heath species.

A graphical representation of relationships between ELA vegetation communities and Floristic Community Types (FCTs) defined by Gibson *et al.* (1994) is shown in **Appendix G**.

Table 10: Relationships between ELA vegetation communities and FCTs defined by Gibson *et al.* (1994)

ELA Vegetation Community	ELA Quadrat	Gibson site	FCT	%Bray-Curtis Similarity
ArS	Q1	PRES-1	29a	28.6
		TRIG-1	29b	27.4
		WOODP-1	30a	30.8
	Q5	PRES-1	29a	30.4
	Q8	PRES-1	29a	32.6
		WOODP-1	30a	36.4
		TRIG-1	29b	26.7
OaScOS	Q2	PRES-1	29a	27.9
		TRIG-2	29a	36.4
	Q6	BURN-2	29a	33.9
		TRIG-2	29a	32.6
	Q9	PRES-1	29a	28.6
		TRIG-2	29a	37.2
ShTdOG	Q3	PRES-1	29a	21.1
		PB-1	19	31.2
		PB-6	19	26.7
	Q4	BURN-2	29a	26.3
	Q7	PRES-1	29a	11.4
		NAVB-1	16	9.1
AcS	Q10	BURN-2	29a	26.7
		TRIG-2	29a	36.4
	Q11	BURN-2	29a	36.7
		TRIG-2	29a	37.5
	Q12	BURN-2	29a	32.6
		TRIG-2	29a	37.5
SgMsOS	Q13	COOL08	24	40
		COOL02	24	39.4
		COOL03	24	29.4

4.2.6.1 Banksia Woodlands of the Swan Coastal Plain TEC diagnostic

Vegetation within the survey area is not considered as having the potential to represent the Banksia Woodlands of the Swan Coastal Plain TEC, due to there being no *Banksia* tree species recorded within the survey area. As such, the full assessment for this TEC, as outlined in the approved conservation advice (TSSC 2016), was not completed for the survey area.

4.2.6.2 Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain TEC diagnostic

Vegetation within the survey area is not considered as having the potential to represent the Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC, due to there being no *E. gomphocephala* individuals recorded within the survey area. As such, the full assessment for this TEC, as outlined in the approved conservation advice (DotEE 2019), was not completed for the survey area.

4.2.7 Vegetation condition

Vegetated areas within the survey area accounted for 81.2% (13.93 ha), and ranged from Degraded to Very Good condition, based on the Keighery (1994) vegetation scale provided in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). Majority of the survey area was observed to be in Very Good (7.58 ha; 44.2% of the survey area) and Good condition (6.25 ha; 36.4% of the survey area). A small area of vegetation in Degraded condition (0.11 ha; 0.7% of the survey area) was identified north of the SgMsOS vegetation community between Merrifield Place to the north and west and Northshore Drive to the east, comprising a planted/sumpland area. Disturbances within the survey area included the presence of weeds, edge effects (lesser condition) adjacent to tracks/cleared areas and minor rubbish dumping.

A comparison of vegetation condition between the current survey and those recorded by Natural Area is presented in **Table 11**. Vegetation condition within the survey area is presented in **Figure 6** below. Vegetation condition per vegetation community is presented in **Table 12** and **Figure 7**.

Table 11: Vegetation condition within the survey area in 2022 compared to vegetation condition recorded by Natural Area (Natural Area 2017)

Vegetation condition	Natural Area 2017		Current assessment (2021)	
	Total area (ha)	Proportion of the survey area (%)	Total area (ha)	Proportion of the survey area (%)
Pristine	0	0	0	0
Excellent	0	0	0	0
Very Good	7.38	59.0	7.58	44.2
Good	2.96	23.7	6.25	36.4
Degraded	0.29	2.3	0.11	0.7
Completely Degraded	0.12	1.0	0	0
Total vegetated areas	**10.75**	**86**	**13.93**	**81.2**
Other (tracks, open beach, cleared areas)	1.75	14	3.22	18.8
Total survey area	**12.5**	**100**	**17.15**	100.0

*Completely Degraded vegetation condition previously included tracks and cleared areas however they have been separated for the current assessment

Table 12: Vegetation condition per community within the survey area

Vegetation community	Vegetation Condition ha (% of total of vegetation community)						
	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded	Total ha (%)
AcS	0 (0)	0 (0)	0 (0)	1.75 (100)	0 (0)	0 (0)	1.75 (100)
ArS	0 (0)	0 (0)	0.75 (24.7)	2.30 (75.3)	0 (0)	0 (0)	3.05 (100)
OaScOS	0 (0)	0 (0)	6.63 (96.7)	0.22 (3.3)	0 (0)	0 (0)	6.85 (100)
SgMsOS	0 (0)	0 (0)	0.20 (65.3)	0.10 (34.7)	0 (0)	0 (0)	0.3 (100)
ShTdOG	0 (0)	0 (0)	0 (0)	1.82 (100)	0 (0)	0 (0)	1.82 (100)
Planted / Sumpland	0 (0)	0 (0)	0 (0)	0.05 (30)	0.11 (70)	0 (0)	0.16 (100)

*Totals are subject to rounding errors of 0.01-0.1

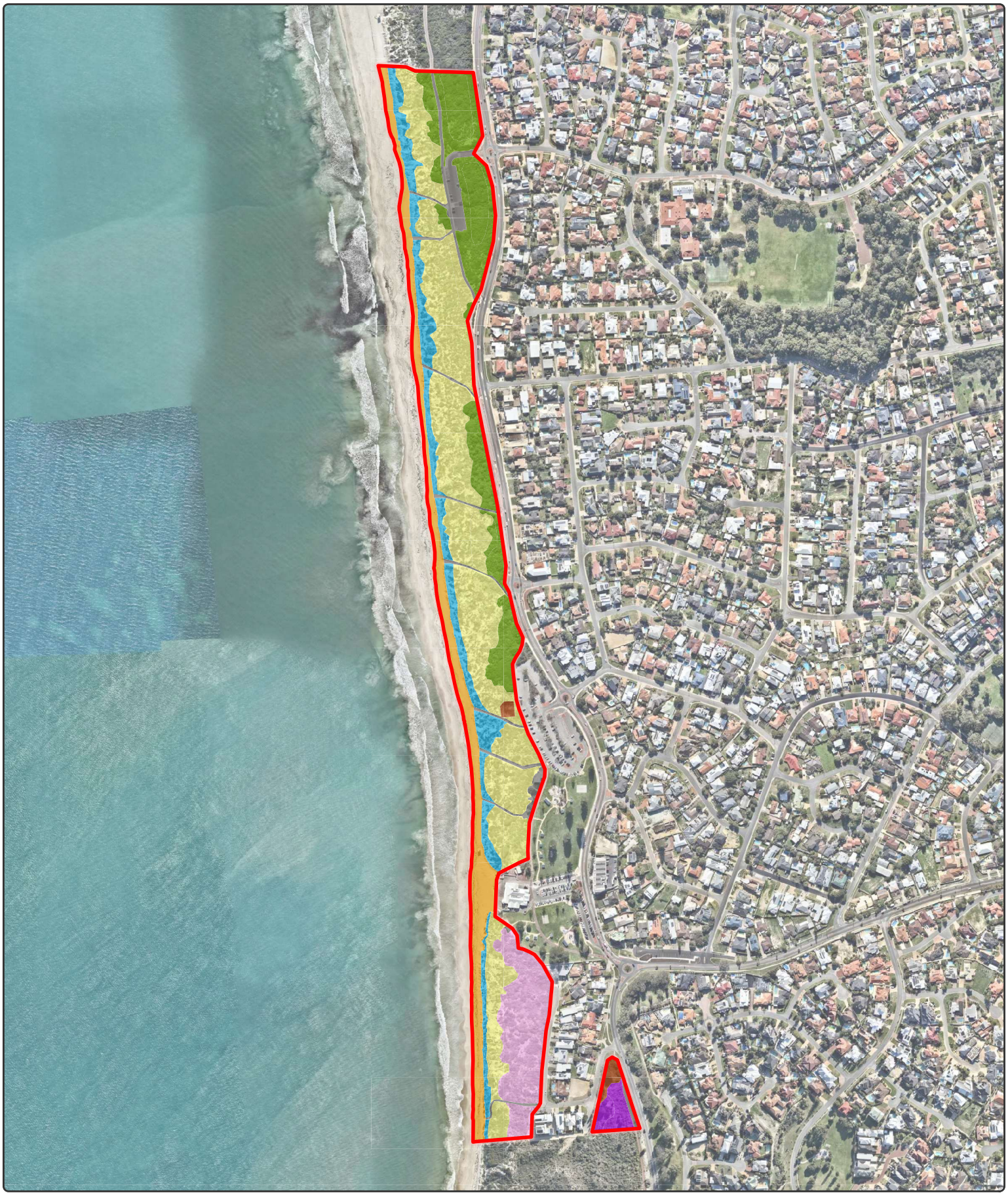


Figure 4: Vegetation communities recorded within the survey area

Survey area
Tracks / Cleared Areas
Open Beach
Planted / Sumpland

Vegetation Communities

AcS
ArS
OaScOS
SgMsOS
ShTdOG

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER3250-ED Date: 15/02/2023

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

Figure 5: Conservation significant vegetation communities recorded within the survey area

Survey area
Tracks / Cleared Areas
Open Beach
Planted / Sumpland

Conservation Significant Vegetation Communities

FCT 24: Northern Spearwood shrublands and woodlands (P3)
FCT 29a: Coastal shrublands on shallow sands (P3)

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER3250-ED Date: 15/02/2023

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

Figure 6: Vegetation condition recorded within the survey area

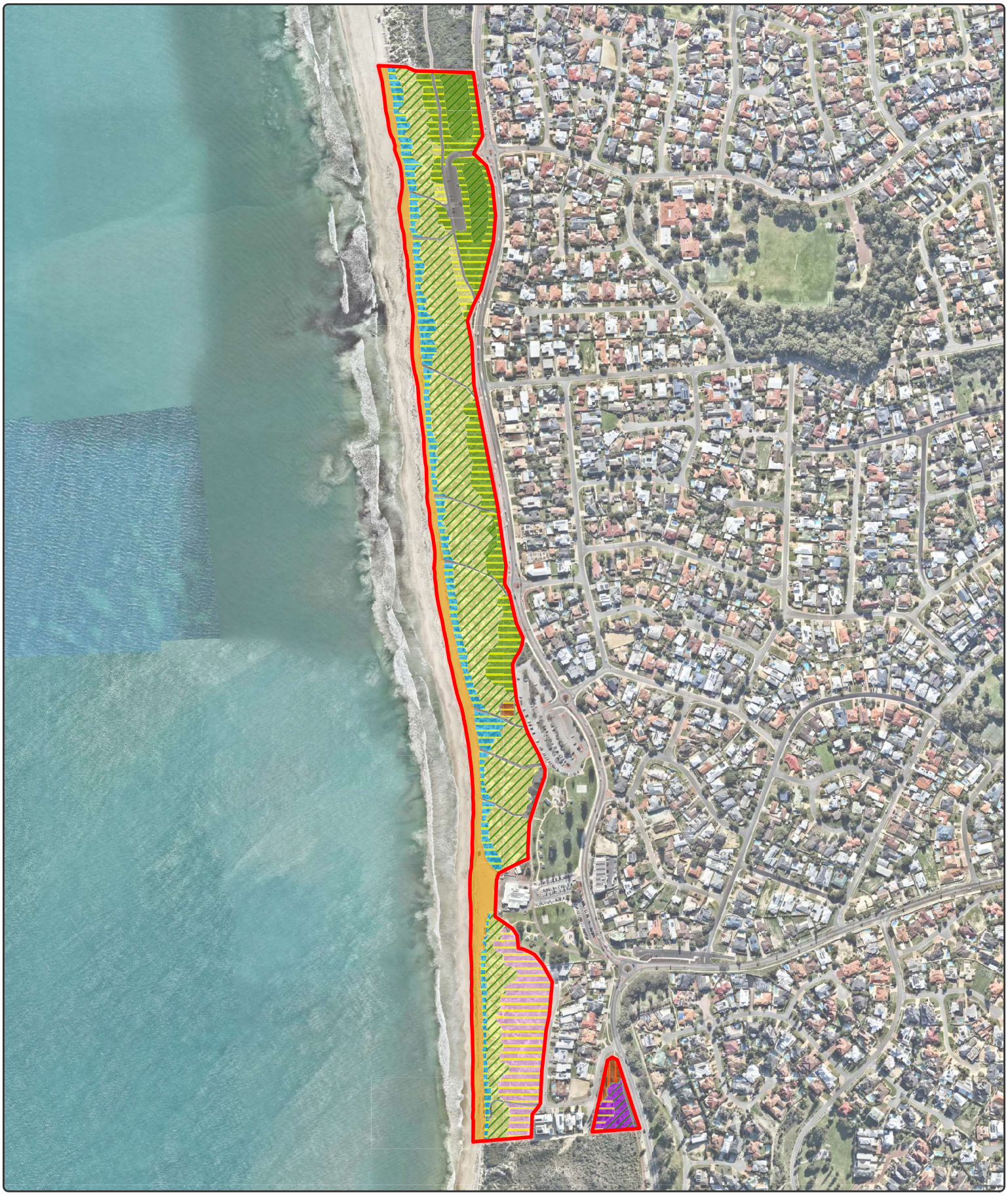


Figure 7: Vegetation condition per community within the survey area

Survey area
Tracks / Cleared Areas
Open Beach
Planted / Sumpland

Vegetation Communities

AcS
ArS
OaScOS
SgMsOS
ShTdOG

Vegetation Condition

Very Good
Good
Degraded

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER3250-ED Date: 15/02/2023

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

4.3 Fungi

A total of two fungi species were identified within the survey area, namely Common Pholiota (*Pholiota communis*) and Scarlet Bracket Fungi (*Pycnoporus coccineus*) (**Table 13**). Scarlet Bracket Fungi was recorded from one location growing on dead wood, while Common Pholiota was recorded from two locations growing on sandy substrate. Neither of these fungi species are of conservation significance.

Table 13: Locations of fungi species recorded in Mullaloo Foreshore Reserve

Photo	Species	Habitat	Location/s
	Common Pholiota (*Pholiota communis*)	Ground	m3800001E; 6483590N m379991E; 6483648N
	Scarlet Bracket Fungi (*Pycnoporus coccineus*)	Dead wood	m380087E; 6483718N

4.4 Fauna

A total of 22 fauna species (18 native; one naturalised exotic and three pests) were recorded opportunistically within the survey area, comprising 17 birds, four insects and one reptile (**Table 14**). No conservation significant fauna species were recorded within the survey area during the field survey.

A total of five introduced fauna species were recorded during the field survey. These comprised one bird listed as naturalised exotic in Western Australia, namely **Spilopelia senegalensis* (Laughing Dove; Western Australian Museum [WAM] 2022) and three invertebrates listed as pest species namely **Ischnura heterosticta* (Common Bluetail Dragonfly) **Mamestra brassicae* (Cabbage Moth) and **Ommatoiulus moreleti* (Portuguese Millipede; DPIRD 2022c).

Table 14: Fauna species recorded opportunistically within the survey area

Type	Species	Common name	Observation type
Bird	*^Spilopelia senegalensis*	Laughing Dove	Directly observed
Bird	*Anthochaera carunculata*	Red Wattlebird	Directly observed
Bird	*Cacatua sanguinea*	Little Corella	Directly observed
Bird	*Chroicocephalus novaehollandiae*	Silver Gull	Heard, observed flying overhead
Bird	*Columbia livia domestica*	Feral Pigeon, Rock Dove	Heard
Bird	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	Directly observed
Bird	*Corvus coronoides*	Australian Raven	Directly observed
Bird	*Eolophus roseicapilla*	Galah	Directly observed
Bird	*Falco cenchroides*	Nankeen Kestrel	Directly observed
Bird	*Gymnorhina tibicen*	Australian Magpie	Directly observed
Bird	*Hirundo neoxena*	Welcome Swallow	Directly observed
Bird	*Lichenostomus virescens*	Singing Honeyeater	Directly observed
Bird	*Malurus lamberti*	Variegated Fairywren	Directly observed
Bird	*Phalacrocorax varius*	Pied Cormorant	Directly observed
Bird	*Phylidonyris novaehollandiae*	New Holland Honeyeater	Directly observed
Bird	*Rhipidura leucophrys*	Willie Wagtail	Directly observed
Bird	*Zosterops lateralis*	Silvereye	Directly observed
Insect	**Ischnura heterosticta*	Common Bluetail Dragonfly	Directly observed
Insect	**Mamestra brassicae*	Cabbage Moth	Directly observed
Insect	**Ommatoiulus moreleti*	Portuguese Millipede	Directly observed
Insect	*Nephila edulis*	Australian Golden Orb-Weaving Spider	Directly observed
Reptile	*Tiliqua rugosa*	Blue-tongued Skink, Bobtail Lizard	Directly observed

Note: * refers to a pest species; ^ refers to a naturalised exotic species

5. Discussion and recommendations

5.1 Flora

A total of 105 taxa (53 native and 52 introduced taxa) from 85 genera and 41 families were recorded across 13 quadrats established within the survey area and from opportunistic collections. This number is an increase from the number of species recorded by Natural Area (80 species; 37 native and 43 introduced; Natural Area 2017), likely due to the increased survey effort (13 quadrats established in 2022 compared to six quadrats established by Natural Area; larger survey area of 17.15 ha compared with 12.5 ha). The number of species recorded from the current survey is slightly less that the number of species recorded from the nearby Burns Beach-Iluka Foreshore Reserve (121 species; 74 native and 47 introduced; ELA 2021) and the Hillarys-Kallaroo Coastal Foreshore Reserve (117 species; 68 native and 49 introduced; ELA 2020), although this can be attributed to the smaller size of Mullaloo Foreshore Reserve; 17.15 ha compared to 94 ha (Hillarys-Kallaroo), 31.3 ha (Iluka) and 29.3 ha (Burns Beach).

Average species richness per quadrat was 21.5 species, ranging from a low of 12 species at Q7 to a high of 39 species at Q13. This is higher than recorded by Natural Area, where an average species richness of 15.6 species (range 9-20 species) was recorded (Natural Area 2017), and comparable to average species richness recorded by ELA at Burns Beach-Iluka Foreshore Reserve in 2021 (25.62 species; range 17 to 40 species).

A species accumulation curve determined that approximately 84.4% of the flora species potentially present within the survey area were recorded from quadrats (72 species). This result, in addition to flora species recorded opportunistically (34 species), indicates that the majority of flora potentially present within the survey area were recorded. This figure suggests that a comprehensive flora inventory of the survey area has been compiled.

No Threatened or Priority flora listed under the EPBC Act, the BC Act or by DBCA were recorded within the survey area. The single point-location of *Leucopogon maritimus* (P1), *Conostylis bracteata* (P3) and *Jacksonia sericea* (P4), previously recorded within the survey area (DBCA 2022a), was visited during the field survey, however these species were not located. All three species are considered as unlikely to occur, based on adequate search effort within the survey area and species habitat preferences. This record is considered as likely to be an erroneous database search location, as appropriate habitat for these species does not occur within the survey area. No conservation significant species were previously recorded within the survey area by Natural Area (2017). No Bush Forever significant species for the Bush Forever site 325: Coastal Strip from Burns Beach to Hillarys were recorded within the survey area; a result consistent with ELA (2016).

Weed species comprised 49.5% (52 species) of the total flora taxa recorded. This result, in comparison to Natural Area (2017), represents an overall increase in the number of weed species (43 introduced species recorded by Natural Area), and a decrease in the percentage of weed species compared to native species 53.8% in 2016; Natural Area 2017). An increase in the number of weed species recorded could be attributed to several factors including seasonal differences (i.e., rainfall increase/decrease prior to field surveys), natural fluctuations in occurrence, time between surveys conducted (2016 to 2022) and increased search effort undertaken during the current assessment (a greater number of quadrats and larger survey area size). A decrease in the percentage weed species compared to native species recorded is likely attributed to the increased survey effort resulting in an increase in the number of

native species recorded (53 native species from the current survey compared to 37 native species recorded by Natural Area; Natural Area 2017).

Of the 48 weed species recorded, **Asparagus asparagoides* (Bridal Creeper) is listed as a WoNS and **Moraea flaccida* (One-leaf Cape Tulip) is listed as a Declared Pest under the BAM Act. **M. flaccida* was previously recorded within the survey area by Natural Area, recorded from one location just north of the southern car park (Natural Area 2017).

Asparagus asparagoides* (Bridal Creeper) is a rhizomatous and tuberous perennial herb / climber, 1-5m high with white flowers from August to September which grows in sand, loam, clay and granite (DBCA and WAH 2022). This species is regarded as one of the worst weeds in Australia because of its invasiveness and environmental impacts which include smothering native species, dominating the lower layers of vegetation, forming dense underground tubers which impede the root growth of other plants, reducing soil moisture available to other plants and preventing seedling establishment (Weeds of Australia 2022a). **A. asparagoides* was recorded within the survey area at two-point locations within the ArS vegetation community (Appendix E**).

Moraea flaccida* is a perennial herb to 70 centimetres with orange to salmon pink flowers from September to November, underground bulbs and a single large, strap-like leaf (DBCA and WAH 2022; Weeds of Australis 2022b). It grows in white sand and grey sandy loam over limestone, laterite, clay and gravel in seasonally wet sites, along creeklines, hilltops, pastures and on disturbed land (DBCA and WAH 2022). This species was originally introduced as a garden plant in the 19th century and is extremely toxic to livestock (Weeds of Australia 2022b). **M. flaccida* has a legal status of S22(2) and "may be subject to control and keeping requirements once within Western Australia" (DPIRD 2022). **M. flaccida* (One-leaf Cape Tulip) was within the survey area at one point location within the AcS vegetation community in the south of the survey area (Appendix E**).

5.2 Vegetation

A total of five vegetation communities were delineated and mapped within the survey area. Quadrats previously established by Natural Area (2017) were re-surveyed (six in total), with seven additional quadrats established, ensuring a minimum of three quadrats established per vegetation community (where possible), as specified in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

Vegetation codes previously assigned by Natural Area (2017) and the City of Joondalup (2017) remained valid between the two survey periods and as such were retained for consistency, with additional quadrats established in these communities in order to ensure a minimum of three quadrats established per vegetation community where possible. A total of three vegetation communities were originally established within the Natural Area survey area, which was approximately 12.5 ha in size and did not include the southern portion of the survey area, located south of the surf club adjacent to Merrifield Place (City of Joondalup 2017). Mapping of this additional area was undertaken by Natural Area Consulting Management Services in 2017, with an additional vegetation type recorded and included in the Mullaloo Foreshore Reserve Management Plan (City of Joondalup 2017; four previously identified vegetation communities total). One additional vegetation community was identified and delineated during the current survey, namely AcS: *Acacia cyclops* Shrubland and SgMsOS: *Spyridium globulosum* and *Melaleuca systena* Open Shrubland. Only one quadrat was able to be established within the SgMsOS

vegetation community due to its restricted distribution within the survey area (recorded across 0.3 ha; 1.8% of the survey area).

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994). Results of the multivariate analysis showed that quadrats within vegetation communities AcS, ArS, OaScOS and ShTdOG had strong affiliations with FCT 29a. These communities, covering a total of 1.75 ha, 3.05 ha, 6.85 ha and 1.82 ha respectively, (13.47 ha total; 78.6% of the survey area) are considered to represent floristic aspects of FCT 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast'. Common species recorded include **Bromus diandrus*, **Galium murale*, **Lysimachia arvensis*, **Sonchus oleraceus*, *Acanthocarpus preissii*, *Daucus glochidiatus*, *Olearia axillaris*, *Rhagodia baccata* and *Spyridium globulosum* (DBCA 222c). This community is listed as a Priority 3 ecological community by DBCA. This FCT aligns with those stated as occurring within Bush Forever site 325 (Government of Western Australia 2000).

The singular quadrat established within vegetation community SgMsOS, Q13, had a strong affiliation with FCT 24. This community, covering a total area of 0.30 ha (1.7% of the survey area), was considered to represent floristic aspects of FCT 24, described as 'Northern Spearwood shrublands and woodlands; heaths with scattered *Eucalyptus gomphocephala*' (DBCA 2022c). Vegetation community SgMsOS comprises heath species associated with FCT 24 including **Bromus diandrus*, **Lagurus ovatus*, **Lysimachia arvensis*, **Sonchus oleraceus*, *Conostylis aculeata*, *Desmocladus flexuosus* (previously *Loxocarya flexuosa*), *Hardenbergia comptoniana*, *Lepidosperma* sp., *Lomandra maritima*, *Lysiandra calycina* (previously *Phyllanthus calycinus*) and *Melaleuca systena* (previously *M. acerosa*; Gibson *et al*. 1994). FCT 24 is listed as a Priority 3 ecological community by DBCA.

Vegetation within the survey area is not considered to represent the Banksia Woodlands of the Swan Coastal Plain TEC due to there being no key diagnostic *Banksia* species present within the survey area (e.g., *Banksia attenuata*, *B. menziesii*, B. *prionotes*, *B. ilicifolia*; TSSC 2016). As such, the full four-stage assessment for this TEC, as outlined in the approved conservation advice (TSSC 2016), was not completed for the survey area.

Vegetation within the survey area is not considered to represent the Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC due to there being no *Eucalyptus gomphocephala* individual species present within the survey area. As such, the full assessment for this TEC, as outlined in the approved conservation advice (DotEE 2019), was not completed for the survey area.

Vegetation condition within the survey area ranged from Degraded to Very Good condition, based on the Keighery (1994) vegetation scale provided in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). Majority of the survey area was observed to be Very Good (7.58 hectares; 44.2% of the survey area) and Good condition (6.25 hectares; 36.4% of the survey area). Vegetation condition within the survey area has remained relatively consistent since 2016, with majority of the survey area recorded in Very Good (7.58 ha; 68.7%) and Good (2.96 ha; 27.5%) condition by Natural Area (Natural Area 2017). An increase of areas classed as Good condition in 2022 can be attributed to the increase in survey area size compared with that of Natural Area in 2017 (17.15 ha compared to 12.5 ha). Areas of poor condition (e.g., Degraded) remained fairly consistent between survey periods. Disturbances within the survey area included the presence of weeds, edge effects (lesser condition) adjacent to tracks/cleared areas and minor rubbish dumping.

5.3 Recommendations

Based on results of the current survey, the following recommendations have been made to assist in the conservation of native flora, vegetation and environmental values present within Mullaloo Foreshore Reserve:

- Continue long-term monitoring of weed populations within the survey area. Implement weed control, particularly for the Declared Pest species **Moraea flaccida* (One-leaf Cape Tulip), the Weed of National Significance **Asparagus asparagoides* (Bridal Creeper) and for City of Joondalup priority weeds. Concentrate weed control activities along track edges and boundaries between remnant bushland and cleared areas.
- Prioritise maintenance of the vegetation at Mullaloo Foreshore Reserve due to the presence of the Floristic Community Type 24 and Floristic Community Type 29a Priority Ecological Communities.
- It is recommended to continue monitoring for evidence of dieback and other pathogens, and to maintain correct hygiene practices within the survey area.
- It is recommended to monitor the dumping of rubbish and remove where necessary.
- Undertake monitoring and maintenance of fencing and formal signage to prevent use of unauthorised walking tracks and rubbish dumping within the survey area, particularly in the dune/foreshore areas.

6. References

Beard, J. S. 1975. *Vegetation of the Perth area, Western Australia: map and explanatory memoir, 1:250 000 series*, Vegmap Publications, Perth.

Bureau of Meteorology (BoM). 2022. *Climate Data Online*. Available: http://www.bom.gov.au/climate/data/. Accessed in December 2021.

City of Joondalup. 2017. *Mullaloo Foreshore Reserve Management Plan*. Perth, WA.

Clarke, K.R., and Gorley, R.N. 2006. *PRIMER v6: User Manual/Tutorial*. PRIMER-E: Plymouth.

Department of Agriculture, Water and the Environment (DAWE). 2022a. *Australia's bioregions (IBRA).* Available from: https://www.environment.gov.au/land/nrs/science/ibra.

Department of Agriculture, Water and the Environment (DAWE). 2022b. *EPBC Act Protected Matters Search Tool* (PMST). Available: http://www.environment.gov.au/epbc/pmst/index.html. Accessed October 2019.

Department of Biodiversity, Conservation and Attractions (DBCA). 2022a. *Threatened and Priority Flora database search*. Reference number 98-0822FL. Department of Biodiversity, Conservation and Attractions, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA). 2022b. *Threatened and Priority Communities database search*. Reference number 69-0822EC. Department of Biodiversity, Conservation and Attractions, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA). 2022c. *Priority Ecological Communities for Western Australia Version 33.* Species and Communities Program, Department of Biodiversity, Conservation and Attractions. 1 June 2022.

Department of Biodiversity, Conservation and Attractions and the Western Australian Herbarium (DBCA and WAH). 2022. *FloraBase—the Western Australian Flora. Department of Biodiversity, Conservation and Attractions*. Available from: https://florabase.dpaw.wa.gov.au/. Accessed December 2022.

Department of Environment and Conservation (DEC). 2011. *Standard Operating Procedure: Techniques for mapping weed distribution and cover in bushlands and wetlands*. SOP:22.1.

Department of the Environment and Energy. 2019. Approved Conservation Advice (incorporating listing advice) for the Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community. Canberra: Department of the Environment and Energy.

Department of Primary Industries and Regional Development (DPIRD). 2022a. *Soil-landscape systems mapping of Western Australia, version 5*. Department of Agriculture and Food Western Australia, Perth.

Department of Primary Industries and Regional Development (DPIRD). 2022b. *Western Australian Organism List*. Available from: https://www.agric.wa.gov.au/organisms

Department of Primary Industries and Regional Development (DPIRD). 2022c. *Pest insects [online]* Available from: https://www.agric.wa.gov.au/pests-weeds-diseases/pests/pest-insects

Department of Water and Environmental Regulation (DWER). 2022. *Clearing Permit System.* Available:https://cps.dwer.wa.gov.au/main.html#[{%22xclass%22%3A%22app.map.Main%22}%2C{%22xclass%22%3A%22app.Content%22}]

Environmental Protection Authority (EPA). 2016. T*echnical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment*. Perth, Western Australia.

Gibson, N., Keighery, B. J., Keighery, G. J., Burbidge, A. H. and Lyons, M. N. 1994. *A Floristic Survey of the Southern Swan Coastal Plain*. Report prepared for the Australian Heritage Commission. Western Australian Department of Conservation and Land Management, and Western Australia Conservation Council.

Government of Western Australia. 2000. *Bush Forever Volume 2: Directory of Bush Forever Sites*. Western Australian Planning Commission, Perth, Western Australia.

Keighery, B. J. 1994. *Bushland Plant Survey: A guide to plant community survey for the community*. Wildflower Society of Western Australia, Nedlands.

Natural Area Consulting Management Services (Natural Area). 2017. *Mullaloo Foreshore Flora, Fauna and Fungi Report*. Prepared for the City of Joondalup.

Threatened Species Scientific Committee (TSSC). 2016. *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community*. Canberra: Department of the Environment and Energy. Available: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/131-conservation-advice.pdf

Weeds of Australia. 2022a. *Fact Sheet Index: Asparagus asparagoides* [online]. Available from https://keyserver.lucidcentral.org/weeds/data/media/Html/asparagus_asparagoides.htm

Weeds of Australia. 2022b. *Fact Sheet Index: Moraea flaccida* [online]. Available from https://keyserver.lucidcentral.org/weeds/data/media/Html/moraea_flaccida.htm

Western Australian Museum (WAM). 2022. *WA Checklist for Terrestrial Vertebrates*. Department of terrestrial zoology, Western Australian Museum. Updated November 2020.

Appendix A Framework for conservation significant flora and fauna ranking

CATEGORIES OF THREATENED SPECIES UNDER THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

Threatened fauna and flora may be listed in any one of the following categories as defined in Section 179 of the EPBC Act. Species listed as 'conservation dependent' and 'extinct' are not Matters of National Environmental Significance and therefore do not trigger the EPBC Act.

Category	Definition
Extinct (EX)	There is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Taxa known to survive only in captivity or as a naturalised population well outside its past range; or taxa 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.
Critically Endangered (CE)	Taxa considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Taxa considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Taxa considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	Taxa has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	Taxa has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	There is inadequate information to make a direct, or indirect, assessment of taxa's risk extinction based on its distribution and/or population status.
Not Evaluated (NE)	Taxa has not yet been evaluated against the criteria.
Migratory (M)	Not an IUCN category. Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; • the agreement between the Government of Australian and the Government of the People's Republic of China for the Protection of Migratory Birds and their environment (CAMBA); • the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); or • the agreement between Australia and the Republic of Korea to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (ROKAMBA).

CONSERVATION CODES FOR WESTERN AUSTRALIA FLORA AND FAUNA

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Specially protected fauna or flora are species 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.

Threatened species (T)
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 that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

Category	Code	Description
Critically Endangered species	CR	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 under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
Endangered species	EN	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. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.

Category	Code	Description
Vulnerable species	VU	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 under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.

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, as follows:

Category	Code	Description
Extinct species	EX	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
Extinct in the wild species	EW	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 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

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.

Categories are detailed below.

Category	Code	Description
Migratory species	M	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), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), 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. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Species of special conservation interest (conservation dependent fauna)	CD	Fauna of special conservation need being species 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). Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Other specially protected species	OS	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). Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

Priority species (P)

Possibly threatened species that do not meet survey criteria, 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 priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes 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.

Category	Code	Definition
Priority 1	P1	*Poorly-known species* 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, e.g. 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. Such species are in urgent need of further survey.
Priority 2	P2	*Poorly-known species* 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, e.g. 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 and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	P3	*Poorly-known species* 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. Such species are in need of further survey.
Priority 4	P4	*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.

Appendix B Flora species list

Family	Species	Common name	Conservation status			Reference	
			EPBC Act	BC Act	Weed	DBCA 2022a	ELA 2022	Natural Area 2017
Aizoaceae	**Tetragonia decumbens*	Sea Spinach			*		X	X
Aizoaceae	*Carpobrotus virescens*	Coastal Pigface					X	X
Aizoaceae	*Sarcozona bicarinata*			P3		X		
Anacardiaceae	**Schinus terebinthifolia*	Japanese Pepper			*		X	X
Apiaceae	*Daucus glochidiatus*	Australian Carrot					X	
Araliaceae	**Trachymene pilosa*	Native Parsnip			*		X	
Arecaceae	**Washingtonia filifera*	California Palm			*		X	
Asparagaceae	**Agave* sp.	Century Plant			*		X	
Asparagaceae	**Asparagus asparagoides*	Bridal Creeper			*		X	
Asparagaceae	*Acanthocarpus preissii*						X	X
Asparagaceae	*Lomandra maritima*						X	X
Asphodelaceae	**Trachyandra divaricata*	Dune Onion Weed			*		X	X
Asteraceae	**Arctotheca calendula*	Cape Weed			*		X	X
Asteraceae	**Arctotis stoechadifolia*	White Arctotis			*		X	
Asteraceae	**Erigeron* sp.				*		X	
Asteraceae	**Gazania linearis*	Gazania			*		X	X
Asteraceae	**Leontodon rhagadioloides*	Cretan Weed			*			X
Asteraceae	**Osteospermum ecklonis*	Veldt Daisy			*		X	X
Asteraceae	**Sonchus asper*	Rough Sowthistle			*			X
Asteraceae	**Sonchus oleraceus*	Common Sowthistle			*		X	X
Asteraceae	**Urospermum picaroides*	False Hawkbit			*		X	X

Family	Species	Common name	Conservation status				Reference	
			EPBC Act	BC Act	Weed	DBCA 2022a	ELA 2022	Natural Area 2017
Asteraceae	*Leucophyta brownii*							X
Asteraceae	*Olearia axillaris*	Coastal Daisybush					X	X
Asteraceae	*Senecio pinnatifolius*						X	
Brassicaceae	**Alyssum* sp.	Sweet Alyssum			*		X	
Brassicaceae	**Arabis* sp.	Pink Arabis - Stock Plant			*		X	
Brassicaceae	**Brassica tournefortii*	Mediterranean Turnip			*		X	X
Brassicaceae	**Cakile edentula*	Sea Rocket			*		X	
Brassicaceae	**Cakile maritima*	Sea Rocket			*		X	X
Brassicaceae	*Arabis* sp. (Unknown Stock Plant)	Arabis					X	
Caprifoliaceae	**Centranthus macrosiphon*	Pretty Betsy			*		X	
Casuarinaceae	**Casuarina equisetifolia*				*		X	X
Celastraceae	*Stackhousia monogyna*						X	
Chenopodiaceae	*Atriplex cinerea*	Grey Saltbush					X	X
Chenopodiaceae	*Atriplex isatidea*	Coast Saltbush					X	X
Chenopodiaceae	*Rhagodia baccata*	Berry Saltbush					X	X
Chenopodiaceae	*Threlkeldia diffusa*	Coast Bonefruit					X	X
Convolvulaceae	**Cuscuta epithymum*	Lesser Dodder			*		X	
Crassulaceae	**Crassula glomerata*				*		X	X
Cupressaceae	*Callitris preissii*	Rottnest Island Pine					X	X
Cyperaceae	*Ficinia nodosa*	Knotted Club Rush					X	X
Cyperaceae	*Isolepis cernua* var. *setiformis*	Nodding Club-rush					X	X
Cyperaceae	*Lepidosperma gladiatum*	Coast Sword-sedge					X	X
Cyperaceae	*Lepidosperma* sp.						X	

Family	Species	Common name	Conservation status			Reference		
			EPBC Act	BC Act	Weed	DBCA 2022a	ELA 2022	Natural Area 2017
Dilleniaceae	*Hibbertia leptotheca*			P3		X		
Dilleniaceae	*Hibbertia racemosa*	Stalked Guinea Flower					X	X
Ericaceae	*Leucopogon maritimus*			P1		X		
Ericaceae	*Leucopogon parviflorus*	Coast Beard-heath					X	
Ericaceae	*Styphelia filifolia*			P3		X		
Euphorbiaceae	**Euphorbia paralias*	Sea Spurge			*		X	X
Euphorbiaceae	**Euphorbia peplus*	Petty Spurge			*		X	X
Euphorbiaceae	**Euphorbia terracina*	Geraldton Carnation Weed			*		X	X
Euphorbiaceae	**Ricinus communis*	Castor Oil Plant			*			X
Fabaceae	**Lupinus cosentinii*				*		X	X
Fabaceae	**Medicago polymorpha*	Burr Medic			*		X	X
Fabaceae	**Melilotus indicus*				*		X	X
Fabaceae	**Trifolium campestre*	Hop Clover			*		X	X
Fabaceae	*Acacia benthamii*			P2		X		
Fabaceae	*Acacia cochlearis*	Rigid Wattle					X	X
Fabaceae	*Acacia cyclops*	Coastal Wattle					X	X
Fabaceae	*Acacia lasiocarpa*	Panjang					X	X
Fabaceae	*Acacia rostellifera*	Summer-scented Wattle					X	X
Fabaceae	*Acacia saligna*	Orange Wattle					X	X
Fabaceae	*Acacia truncata*						X	X
Fabaceae	*Hardenbergia comptoniana*	Native Wisteria					X	X
Fabaceae	*Jacksonia sericea*			P4		X		
Fabaceae	*Medicago polymorpha*	Burr Medic					X	

Family	Species	Common name	Conservation status			Reference		
			EPBC Act	BC Act	Weed	DBCA 2022a	ELA 2022	Natural Area 2017
Fabaceae	*Templetonia retusa*	Cockies Tongues					X	
Fabaceae	*Templetonia sulcata*	Centipede Bush					X	
Geraniaceae	**Geranium molle*	Dove's Foot Cranesbill			*		X	
Geraniaceae	**Pelargonium capitatum*	Rose Pelargonium			*		X	X
Goodeniaceae	*Scaevola crassifolia*	Thick-leaved Fan-flower					X	X
Goodeniaceae	*Scaevola repens*						X	
Haemodoraceae	*Conostylis aculeata* subsp. *preissii*	Prickly Conostylis					X	
Haemodoraceae	*Conostylis bracteata*			P3		X		
Haemodoraceae	*Conostylis candicans* subsp. *calcicola*	Grey Cottonhead					X	X
Iridaceae	**Gladiolus caryophyllaceus*	Wild Gladiolus			*		X	
Iridaceae	**Moraea flaccida*	One-leaf Cape Tulip			*		X	X
Iridaceae	**Romulea rosea*	Guildford Grass			*		X	X
Lamiaceae	*Hemiandra glabra*						X	
Malvaceae	**Malva parviflora*	Marshmallow			*		X	X
Malvaceae	*Thomasia triphylla*							X
Myrtaceae	**Eucalyptus utilis*	Coastal Moort			*		X	X
Myrtaceae	**Melaleuca nesophila*	Mindiyed			*		X	X
Myrtaceae	*Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425)			P1		X		
Myrtaceae	*Corymbia calophylla*	Marri					X	
Myrtaceae	*Eucalyptus foecunda subsp. foecunda*			P4		X		
Myrtaceae	*Leptospermum laevigatum*	Coast Teatree					X	
Myrtaceae	*Melaleuca cardiophylla*	Tangling Melaleuca						X
Myrtaceae	*Melaleuca huegelii*	Chenille Honeymyrtle					X	X

Family	Species	Common name	Conservation status			Reference		
			EPBC Act	BC Act	Weed	DBCA 2022a	ELA 2022	Natural Area 2017
Myrtaceae	*Melaleuca lanceolata*	Rottnest Teatree						X
Myrtaceae	*Melaleuca systena*						X	X
Onagraceae	**Oenothera drummondii*	Beach Evening Primrose			*		X	X
Orchidaceae	*Thelymitra variegata*	Queen of Sheba		P2		X		
Oxalidaceae	**Oxalis pes-caprae*	Soursob			*		X	X
Papaveraceae	**Fumaria capreolata*	Fumitory			*		X	X
Phyllanthaceae	*Calycina calycina*	False Boronia					X	
Phyllanthaceae	*Lysiandra calycina* (previously *Phyllanthus calycinus*)						X	
Pittosporaceae	*Marianthus paralius*		EN			X		
Poaceae	**Avena barbata*	Bearded Oat			*		X	X
Poaceae	**Bromus diandrus*	Great Brome			*		X	X
Poaceae	**Ehrharta calycina*	Perennial Veldt Grass			*		X	
Poaceae	**Ehrharta longiflora*	Annual Veldt Grass			*		X	X
Poaceae	**Lagurus ovatus*	Hare's Tail Grass			*		X	X
Poaceae	**Lolium rigidum*	Wimmera Ryegrass			*		X	X
Poaceae	**Poa annua*	Winter Grass			*		X	X
Poaceae	**Thinopyrum distichum*				*		X	X
Poaceae	*Austrostipa mundula*			P3		X		
Poaceae	*Spinifex hirsutus*	Hairy Spinifex					X	X
Poaceae	*Spinifex longifolius*	Beach Spinifex					X	X
Primulaceae	**Lysimachia arvensis*	Pimpernel			*		X	X
Proteaceae	*Grevillea crithmifolia*							X
Proteaceae	*Grevillea* sp. Ocean Reef (D. Pike Joon 4)			P1		X		

Family	Species	Common name	Conservation status				Reference	
			EPBC Act	BC Act	Weed	DBCA 2022a	ELA 2022	Natural Area 2017
Proteaceae	*Grevillea thelemanniana*	Spider Net Grevillea						X
Ranunculaceae	*Clematis linearifolia*						X	
Restionaceae	*Desmocladus flexuosus*						X	
Rhamnaceae	*Spyridium globulosum*	Basket Bush					X	X
Rubiaceae	**Galium murale*	Small Goosegrass			*		X	X
Rubiaceae	*Opercularia vaginata*	Dog Weed					X	
Santalaceae	*Exocarpos sparteus*	Broom Ballart					X	
Santalaceae	*Leptomeria preissiana*						X	X
Santalaceae	*Santalum acuminatum*	Quandong					X	
Santalaceae	*Santalum spicatum*	Sandalwood					X	
Scrophulariaceae	**Dischisma arenarium*				*		X	X
Scrophulariaceae	*Eremophila glabra*	Tar Bush					X	X
Scrophulariaceae	*Myoporum insulare*	Blueberry Tree					X	X
Stylidiaceae	*Stylidium paludicola*			P3		X		
Thymelaeaceae	*Pimelea calcicola*			P3		X		
Tropaeolaceae	**Tropaeolum majus*	Garden Nasturtium			*			X
Typhaceae	*Typha orientalis*	Bulrush						X
Urticaceae	*Parietaria debilis*	Pellitory					X	

Appendix C Species by site matrix

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Opportunistic
**Agave* sp.													X	
**Alyssum* sp.								X						
**Arabis* sp. (Unknown Stock Plant)														X
**Arctotheca calendula*														X
**Arctotis stoechadifolia*										X		X		
**Asparagus asparagoides*														X
**Avena fatua*	X								X					
**Brassica tournefortii*										X			X	
**Bromus diandrus*	X	X	X		X	X	X	X	X	X	X	X	X	
**Cakile edentula*														X
**Cakile maritima*			X	X			X							
**Centranthus macrosiphon*														X
**Crassula glomerata*		X	X	X	X	X		X	X	X	X	X	X	
**Cuscuta epithymum*		X									X	X	X	
**Dischisma arenarium*														X
**Ehrharta calycina*														X
**Ehrharta longiflora*	X				X			X					X	
**Erigeron* sp.								X						
**Eucalyptus utilis*														X
**Euphorbia paralias*			X	X			X							
**Euphorbia peplus*													X	
**Euphorbia terracina*	X				X	X		X		X	X	X	X	
**Fumaria capreolata*								X		X	X		X	
**Galium murale*	X				X			X					X	

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Opportunistic
**Gazania linearis*		X												
**Geranium molle*													X	
**Gladiolus caryophyllaceus*													X	
**Lagurus ovatus*	X	X	X		X	X			X				X	
**Lolium rigidum*	X	X	X						X				X	
**Lupinus cosentinii*														X
**Lysimachia arvensis*	X				X			X			X	X	X	
**Malva parviflora*														X
**Medicago polymorpha*	X				X								X	
**Melaleuca nesophila*														X
**Melilotus indicus*														X
**Moraea flaccida*														X
**Oenothera drummondii*														X
**Osteospermum ecklonis*								X						
**Oxalis pes-caprae*													X	
**Pelargonium capitatum*	X	X	X	X		X	X	X	X	X	X	X	X	
**Poa annua*														X
**Romulea rosea*					X			X						
**Schinus terebinthifolia*														X
**Sonchus oleraceus*	X	X	X		X	X			X	X	X	X	X	
**Tetragonia decumbens*		X	X	X		X	X		X			X		
**Thinopyrum distichum*		X	X	X			X							
**Trachyandra divaricata*	X	X	X	X		X	X	X	X	X	X	X	X	
**Trachymene pilosa*	X				X									

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Opportunistic
**Trifolium campestre*														X
**Urospermum picroides*	X	X			X									
**Washingtonia filifera*														
Acacia cochlearis	X													
Acacia cyclops	X			X						X	X	X		
Acacia lasiocarpa	X				X								X	
Acacia rostellifera	X				X			X						
Acacia saligna													X	
Acacia truncata														X
Acanthocarpus preissii	X	X						X	X	X	X	X	X	
Atriplex cinerea														X
Atriplex isatidea														X
Callitris preissii														X
Calycina calycina														X
Carpobrotus virescens											X			
Casuarina equisetifolia														X
Clematis linearifolia													X	
Conostylis aculeata subsp. *preissii*													X	
Conostylis candicans subsp. *calcicola*					X					X	X	X		
Corymbia calophylla														X
Daucus glochidiatus										X	X	X		
Desmocladus flexuosus													X	
Eremophila glabra														X
Exocarpos sparteus						X								

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Opportunistic
Ficinia nodosa	X	X	X	X	X	X	X		X	X	X	X		
Hardenbergia comptoniana													X	
Hemiandra glabra														X
Hibbertia racemosa													X	
Isolepis cernua var. setiformis	X	X			X	X		X	X	X	X	X	X	
Lepidosperma gladiatum	X							X		X	X	X		
Lepidosperma sp.													X	
Leptomeria preissiana					X	X								
Leptospermum laevigatum														X
Leucopogon parviflorus													X	
Lomandra maritima													X	
Lysiandra calycina (previously *Phyllanthus calycinus*)													X	
Medicago polymorpha														X
Melaleuca huegelii														X
Melaleuca systena													X	
Myoporum insulare									X					
Olearia axillaris	X	X	X	X	X	X	X	X	X	X	X	X	X	
Opercularia vaginata													X	
Parietaria debilis					X			X			X	X		
Rhagodia baccata	X	X			X	X		X	X	X	X	X		
Santalum acuminatum												X		
Santalum spicatum		X												
Scaevola crassifolia	X	X	X		X	X	X	X	X	X	X	X		
Scaevola repens														X

Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Opportunistic
Senecio pinnatifolius		X				X	X		X					
Spinifex hirsutus			X	X			X							
Spinifex longifolius				X		X					X			
Spyridium globulosum	X	X		X	X	X		X	X		X	X	X	
Stackhousia monogyna													X	
Templetonia retusa													X	
Templetonia sulcata														X
Threlkeldia diffusa		X				X		X	X	X	X	X		

Appendix D Quadrat data

Quadrat	Date	Site type	Observer
Q1	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Weeds	Old (>20)	ArS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey Fine Moist Sand	20	15	0.1
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
Southeast 0.2	Consolidated dune	380116	6482998

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	50	M	Shrubs 1-2m
Olearia axillaris	8	M	Shrubs 1-2m
Acacia cyclops	2.5	M	Shrubs 1-2m
Acacia cochlearis	2	M	Shrubs 1-2m
Spyridium globulosum	1.5	M	Shrubs 1-2m
Acacia lasiocarpa	0.5	M	Shrubs <1m
Rhagodia baccata	0.5	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Scaevola crassifolia	0.2	M	Shrubs <1m
Lepidosperma gladiatum	0.2	G	Sedges
Ficinia nodosa	0.1	G	Sedges
Isolepis cernua var. *setiformis*	0.05	G	Sedges
**Bromus diandrus*	40	G	Grasses
**Lagurus ovatus*	0.2	G	Grasses
**Lolium rigidum*	0.1	G	Grasses
**Ehrharta longiflora*	0.05	G	Grasses
**Avena fatua*	0.02	G	Grasses
**Trachyandra divaricata*	1.5	G	Herbs
**Euphorbia terracina*	0.4	G	Herbs
Acanthocarpus preissii	0.2	G	Herbs
**Pelargonium capitatum*	0.1	G	Herbs
**Lysimachia arvensis*	0.05	G	Herbs
**Medicago polymorpha*	0.05	G	Herbs
**Trachymene pilosa*	0.05	G	Herbs
**Galium murale*	0.01	G	Herbs
**Sonchus oleraceus*	0.01	G	Herbs
**Urospermum picroides*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q2	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20)	OaScOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey white Fine Moist Sand	70	1	0
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West 0.1	Dune slope	380084	6483012

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	25	M	Shrubs 1-2m
Santalum spicatum	0.5	M	Shrubs 1-2m
Scaevola crassifolia	5	M	Shrubs <1m
Rhagodia baccata	3	M	Shrubs <1m
**Tetragonia decumbens*	2.5	M	Shrubs <1m
Spyridium globulosum	0.5	M	Shrubs <1m
Ficinia nodosa	6	G	Sedges
Isolepis cernua var. *setiformis*	0.1	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Lagurus ovatus*	3	G	Grasses
**Bromus diandrus*	2	G	Grasses
**Lolium rigidum*	0.2	G	Grasses
**Thinopyrum distichum*	0.2	G	Grasses
**Trachyandra divaricata*	3.5	G	Herbs
**Pelargonium capitatum*	3	G	Herbs
**Gazania linearis*	0.5	G	Herbs
Threlkeldia diffusa	0.1	G	Herbs
**Crassula glomerata*	0.05	G	Herbs
Acanthocarpus preissii	0.05	G	Herbs
Senecio pinnatifolius	0.02	G	Herbs
**Sonchus oleraceus*	0.01	G	Herbs
**Urospermum picroides*	0.01	G	Herbs
Cuscuta epithymum	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q3	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds (Wind erosion)	Old (>20)	ShTdOG
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey white Fine Dry Sand	65	0.1	0
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West 0.5	Foredune	380095	6482731

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Scaevola crassifolia	20	M	Shrubs <1m
Olearia axillaris	10	M	Shrubs <1m
**Tetragonia decumbens*	0.2	M	Shrubs <1m
Ficinia nodosa	1.5	G	Sedges
**Thinopyrum distichum*	20	G	Grasses
**Bromus diandrus*	0.2	G	Grasses
Spinifex hirsutus	0.2	G	Grasses
**Lagurus ovatus*	0.1	G	Grasses

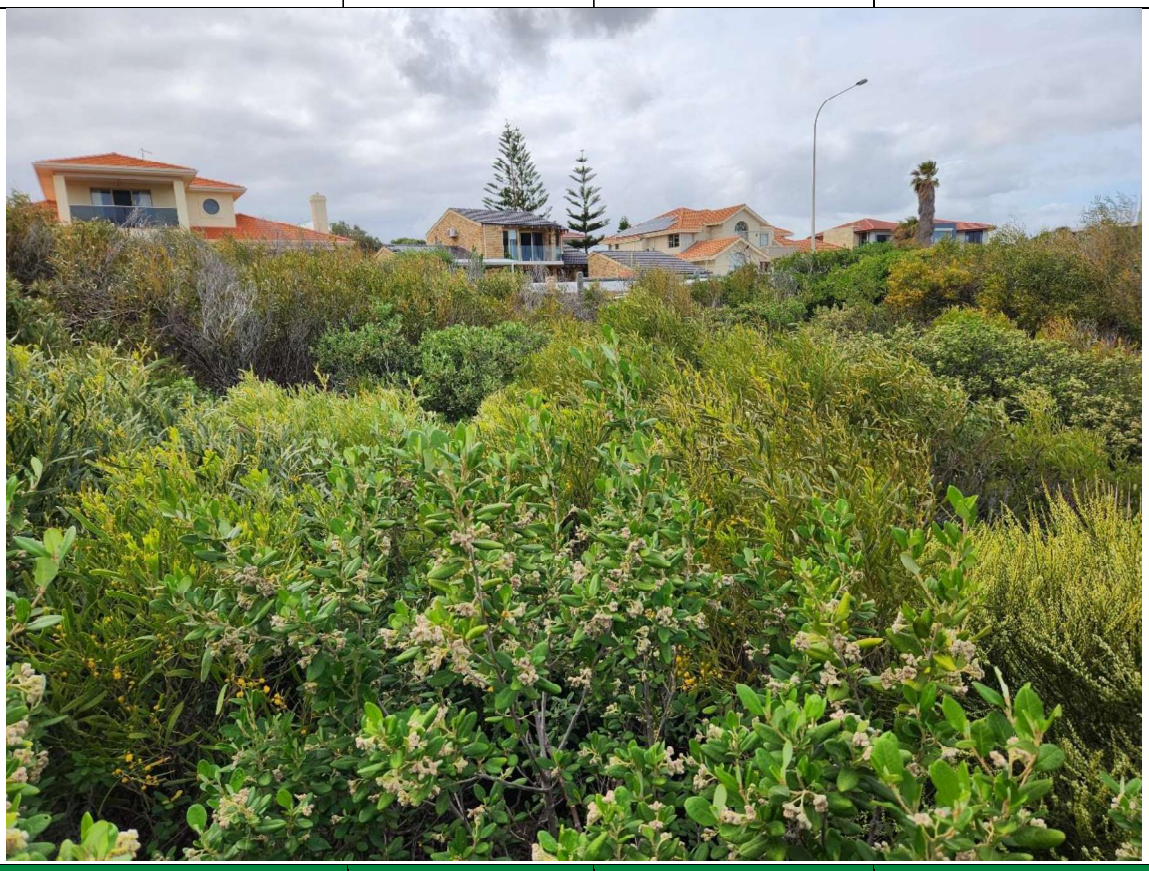
Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Lolium rigidum*	0.01	G	Grasses
**Trachyandra divaricata*	5	G	Herbs
**Pelargonium capitatum*	0.1	G	Herbs
**Cakile maritima*	0.05	G	Herbs
**Crassula glomerata*	0.01	G	Herbs
**Euphorbia paralias*	0.01	G	Herbs
**Sonchus oleraceus*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q4	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds (rubbish, wind erosion)	Old (>20)	ShTdOG
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey white Fine Dry Sand	80	0.2	0
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West 0.1	Foredune	379976	6483769

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	8	M	Shrubs <1m
**Tetragonia decumbens*	2	M	Shrubs <1m
Acacia cyclops	0.1	M	Shrubs <1m
Spyridium globulosum	0.1	M	Shrubs <1m
Ficinia nodosa	0.5	G	Sedges
**Thinopyrum distichum*	25	G	Grasses
Spinifex longifolius	15	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spinifex hirsutus	5	G	Grasses
**Euphorbia paralias*	0.2	G	Herbs
**Trachyandra divaricata*	0.2	G	Herbs
**Cakile maritima*	0.1	G	Herbs
**Pelargonium capitatum*	0.05	G	Herbs
**Crassula glomerata*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q5	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Weeds (Rubbish)	Old (>20)	ArS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey Fine Moist Sand	30	20	0.5
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
Southwest 0.5	Consolidated dune	380056	6483854



Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	60	M	Shrubs 1-2m
Spyridium globulosum	10	M	Shrubs 1-2m
Leptomeria preissiana	0.6	M	Shrubs 1-2m
Olearia axillaris	0.5	M	Shrubs 1-2m
Rhagodia baccata	0.5	M	Shrubs 1-2m
Acacia lasiocarpa	0.2	M	Shrubs 1-2m
Scaevola crassifolia	0.05	M	Shrubs <1m
Ficinia nodosa	0.2	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Isolepis cernua var. *setiformis*	0.05	G	Sedges
**Bromus diandrus*	2	G	Grasses
**Ehrharta longiflora*	1.5	G	Grasses
**Lagurus ovatus*	0.02	G	Grasses
**Lysimachia arvensis*	1.5	G	Herbs
**Euphorbia terracina*	0.1	G	Herbs
**Galium murale*	0.1	G	Herbs
Parietaria debilis	0.1	G	Herbs
**Crassula glomerata*	0.05	G	Herbs
**Medicago polymorpha*	0.05	G	Herbs
**Sonchus oleraceus*	0.05	G	Herbs
**Trachymene pilosa*	0.02	G	Herbs
**Urospermum picroides*	0.02	G	Herbs
Conostylis candicans subsp. *calcicola*	0.02	G	Herbs
**Romulea rosea*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q6	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds (planting and revegetation works)	Old (>20)	OaScOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey white Fine Moist Sand	55	0.5	0.1
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
Southeast 0.1	Dune slope	380034	6483466

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Exocarpos sparteus	0.5	M	Shrubs 1-2m
Spyridium globulosum	0.5	M	Shrubs 1-2m
Scaevola crassifolia	25	M	Shrubs <1m
Olearia axillaris	4	M	Shrubs <1m
Rhagodia baccata	0.5	M	Shrubs <1m
**Tetragonia decumbens*	0.2	M	Shrubs <1m
Leptomeria preissiana	0.2	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Ficinia nodosa	1.5	G	Sedges
Isolepis cernua var. *setiformis*	0.1	G	Sedges
**Bromus diandrus*	4	G	Grasses
Spinifex longifolius	2	G	Grasses
**Lagurus ovatus*	0.2	G	Grasses
**Trachyandra divaricata*	2	G	Herbs
**Crassula glomerata*	0.5	G	Herbs
**Pelargonium capitatum*	0.5	G	Herbs
**Euphorbia terracina*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Threlkeldia diffusa	0.1	G	Herbs
Senecio pinnatifolius	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q7	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds (Wind erosion)	Old (>20)	ShTdOG
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey	65	0.1	0
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
West 0.5	Foredune	380018	6483307

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	10	M	Shrubs <1m
Scaevola crassifolia	4	M	Shrubs <1m
**Tetragonia decumbens*	0.4	M	Shrubs <1m
Ficinia nodosa	0.2	G	Sedges
**Thinopyrum distichum*	3	G	Grasses
**Bromus diandrus*	0.5	G	Grasses
Spinifex hirsutus	0.2	G	Grasses
**Pelargonium capitatum*	6	G	Herbs

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Trachyandra divaricata*	2	G	Herbs
**Cakile maritima*	0.1	G	Herbs
**Euphorbia paralias*	0.01	G	Herbs
Senecio pinnatifolius	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q8	15-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20)	ArS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey	5	30	2
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
East 0.1	Consolidated dune	380085	6483305

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	40	M	Shrubs 1-2m
Spyridium globulosum	1	M	Shrubs 1-2m
Rhagodia baccata	2	M	Shrubs <1m
Scaevola crassifolia	0.2	M	Shrubs <1m
Olearia axillaris	0.1	M	Shrubs <1m
Lepidosperma gladiatum	0.1	G	Sedges
Isolepis cernua var. *setiformis*	0.01	G	Sedges
**Bromus diandrus*	0.5	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Ehrharta longiflora*	0.1	G	Grasses
**Fumaria capreolata*	10	G	Herbs
**Pelargonium capitatum*	1	G	Herbs
**Osteospermum ecklonis*	0.5	G	Herbs
Acanthocarpus preissii	0.2	G	Herbs
**Lysimachia arvensis*	0.1	G	Herbs
Parietaria debilis	0.1	G	Herbs
**Euphorbia terracina*	0.05	G	Herbs
**Galium murale*	0.05	G	Herbs
**Trachyandra divaricata*	0.05	G	Herbs
Threlkeldia diffusa	0.05	G	Herbs
**Alyssum* sp.	0.02	G	Herbs
**Crassula glomerata*	0.01	G	Herbs
**Erigeron* sp.	0.01	G	Herbs
**Romulea rosea*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q9	16-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20)	OaScOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey	40	2	0.1
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
West 5	Dune slope	380115	6482482

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	2.5	M	Shrubs 1-2m
Scaevola crassifolia	25	M	Shrubs <1m
Spyridium globulosum	1.5	M	Shrubs <1m
**Tetragonia decumbens*	0.5	M	Shrubs <1m
Rhagodia baccata	0.2	M	Shrubs <1m
Myoporum insulare	0.1	M	Shrubs <1m
Ficinia nodosa	0.1	G	Sedges
Isolepis cernua var. *setiformis*	0.01	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Bromus diandrus*	5	G	Grasses
**Lagurus ovatus*	0.1	G	Grasses
**Lolium rigidum*	0.05	G	Grasses
**Avena fatua*	0.01	G	Grasses
**Trachyandra divaricata*	3	G	Herbs
**Pelargonium capitatum*	2	G	Herbs
Threlkeldia diffusa	1.5	G	Herbs
**Sonchus oleraceus*	0.05	G	Herbs
Acanthocarpus preissii	0.05	G	Herbs
**Crassula glomerata*	0.02	G	Herbs
Senecio pinnatifolius	0.01	G	Herbs
**Washingtonia filifera*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q10	16-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20)	AcS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey	10	20	2
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
East 0.2	Consolidated dune	380161	6482465

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia cyclops	20	M	Shrubs 1-2m
Scaevola crassifolia	15	M	Shrubs <1m
Rhagodia baccata	5	M	Shrubs <1m
Olearia axillaris	0.1	M	Shrubs <1m
Lepidosperma gladiatum	0.2	G	Sedges
Ficinia nodosa	0.1	G	Sedges
Isolepis cernua var. *setiformis*	0.1	G	Sedges
**Bromus diandrus*	5	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Pelargonium capitatum*	25	G	Herbs
Threlkeldia diffusa	1.5	G	Herbs
**Trachyandra divaricata*	0.5	G	Herbs
**Euphorbia terracina*	0.2	G	Herbs
Acanthocarpus preissii	0.2	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Conostylis candicans subsp. *calcicola*	0.1	G	Herbs
Daucus glochidiatus	0.1	G	Herbs
**Arctotis stoechadifolia*	0.05	G	Herbs
**Fumaria capreolata*	0.05	G	Herbs
**Brassica tournefortii*	0.02	G	Herbs
**Crassula glomerata*	0.02	G	Herbs

Quadrat	Date	Site type	Observer
Q11	16-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20)	AcS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey	15	10	5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
Southwest 0.1	Consolidated dune swale	380158	6482401

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia cyclops	45	M	Shrubs 1-2m
Rhagodia baccata	3	M	Shrubs 1-2m
Spyridium globulosum	0.1	M	Shrubs 1-2m
Scaevola crassifolia	2	M	Shrubs <1m
Olearia axillaris	0.2	M	Shrubs <1m
Lepidosperma gladiatum	0.5	G	Sedges
Ficinia nodosa	0.2	G	Sedges
Isolepis cernua var. *setiformis*	0.01	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Bromus diandrus*	1.5	G	Grasses
Spinifex longifolius	0.1	G	Grasses
**Pelargonium capitatum*	5	G	Herbs
Carpobrotus virescens	0.4	G	Herbs
Acanthocarpus preissii	0.2	G	Herbs
Threlkeldia diffusa	0.2	G	Herbs
**Fumaria capreolata*	0.1	G	Herbs
**Trachyandra divaricata*	0.1	G	Herbs
Conostylis candicans subsp. *calcicola*	0.1	G	Herbs
**Lysimachia arvensis*	0.05	G	Herbs
**Sonchus oleraceus*	0.05	G	Herbs
Daucus glochidiatus	0.05	G	Herbs
**Crassula glomerata*	0.02	G	Herbs
Parietaria debilis	0.02	G	Herbs
**Euphorbia terracina*	0.01	G	Herbs
Cuscuta epithymum	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q12	16-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20)	AcS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Grey	30	5	0.5
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
Northwest 0.1	Consolidated dune swale	380145	6482288

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia cyclops	15	M	Shrubs 1-2m
Santalum acuminatum	5	M	Shrubs 1-2m
Spyridium globulosum	0.2	M	Shrubs 1-2m
Rhagodia baccata	4.5	M	Shrubs <1m
Scaevola crassifolia	3	M	Shrubs <1m
**Tetragonia decumbens*	0.5	M	Shrubs <1m
Olearia axillaris	0.05	M	Shrubs <1m
Lepidosperma gladiatum	10	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Ficinia nodosa	0.2	G	Sedges
Isolepis cernua var. *setiformis*	0.05	G	Sedges
**Bromus diandrus*	0.1	G	Grasses
**Arctotis stoechadifolia*	6	G	Herbs
Threlkeldia diffusa	5	G	Herbs
Acanthocarpus preissii	3	G	Herbs
**Pelargonium capitatum*	0.5	G	Herbs
**Trachyandra divaricata*	0.5	G	Herbs
Daucus glochidiatus	0.1	G	Herbs
Parietaria debilis	0.1	G	Herbs
**Euphorbia terracina*	0.05	G	Herbs
**Crassula glomerata*	0.02	G	Herbs
**Sonchus oleraceus*	0.02	G	Herbs
Conostylis candicans subsp. *calcicola*	0.02	G	Herbs
**Lysimachia arvensis*	0.01	G	Herbs
Cuscuta epithymum	0.01	G	Herbs

Quadrat	Date	Site type	Observer
Q13	16-09-22	10x10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds (Rubbish)	Old (>20)	SgMsOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Brown	10	30	1
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
East 0.2	Dune swale	380284	6482282

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Melaleuca systena	5	U	Trees <10m
Templetonia retusa	3	M	Shrubs 1-2m
Leucopogon parviflorus	2	M	Shrubs 1-2m
Acacia saligna	0.5	M	Shrubs 1-2m
Olearia axillaris	0.2	M	Shrubs 1-2m
Spyridium globulosum	10	M	Shrubs 1-2m
Acacia lasiocarpa	0.5	M	Shrubs <1m
Lysiandra calycina	0.2	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Hibbertia racemosa	0.1	M	Shrubs <1m
**Agave* sp.	0.05	M	Shrubs <1m
Lepidosperma sp.	0.5	G	Sedges
Isolepis cernua var. *setiformis*	0.05	G	Sedges
**Bromus diandrus*	0.5	G	Grasses
**Ehrharta longiflora*	0.2	G	Grasses
**Lagurus ovatus*	0.1	G	Grasses
**Lolium rigidum*	0.05	G	Grasses
Lomandra maritima	10	G	Herbs
Acanthocarpus preissii	5	G	Herbs
**Brassica tournefortii*	0.2	G	Herbs
**Lysimachia arvensis*	0.2	G	Herbs
**Pelargonium capitatum*	0.2	G	Herbs
**Trachyandra divaricata*	0.2	G	Herbs
Conostylis aculeata subsp. *preissii*	0.2	G	Herbs
Hardenbergia comptoniana	0.2	G	Herbs
**Fumaria capreolata*	0.1	G	Herbs
**Geranium molle*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Clematis linearifolia	0.1	G	Herbs
Desmocladus flexuosus	0.1	G	Herbs
Opercularia vaginata	0.1	G	Herbs
**Galium murale*	0.05	G	Herbs
**Medicago polymorpha*	0.05	G	Herbs
**Oxalis pes-caprae*	0.05	G	Herbs
Cuscuta epithymum	0.05	G	Herbs
Stackhousia monogyna	0.05	G	Herbs
**Euphorbia peplus*	0.02	G	Herbs
**Gladiolus caryophyllaceus*	0.02	G	Herbs
**Crassula glomerata*	0.01	G	Herbs

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Euphorbia terracina*	0.01	G	Herbs

Appendix E Weed mapping

*Agave americana (Agave)

Survey area

Weed location

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***_Alysumm_ sp. (Sweet Alyssum)**

Survey area

Weed location

0 50 100 200

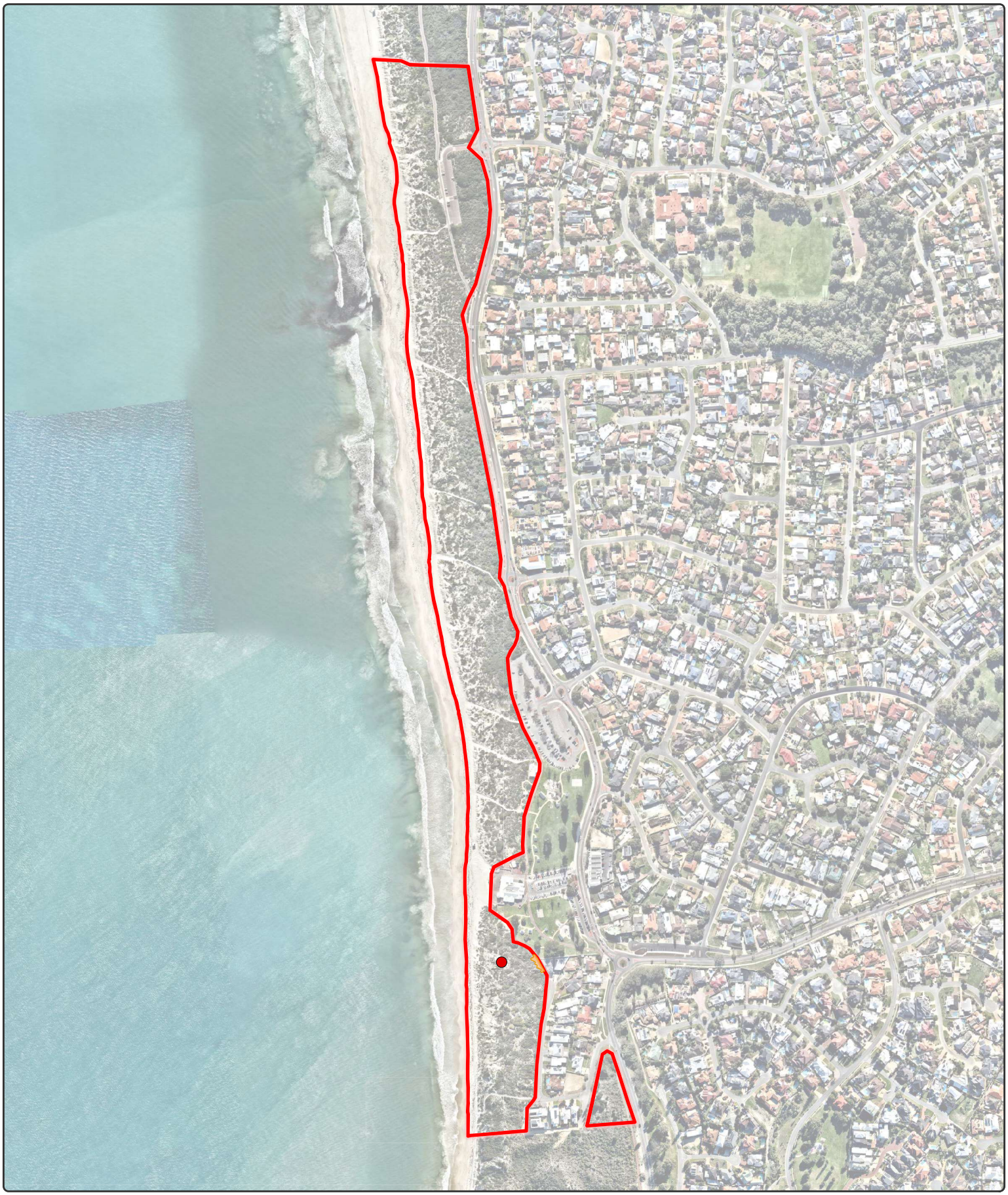
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



***_Arabus_ sp. (Stock Plant)**

Survey area

Weed location

Weed Coverage (%)

0-5%

0 50 100 200

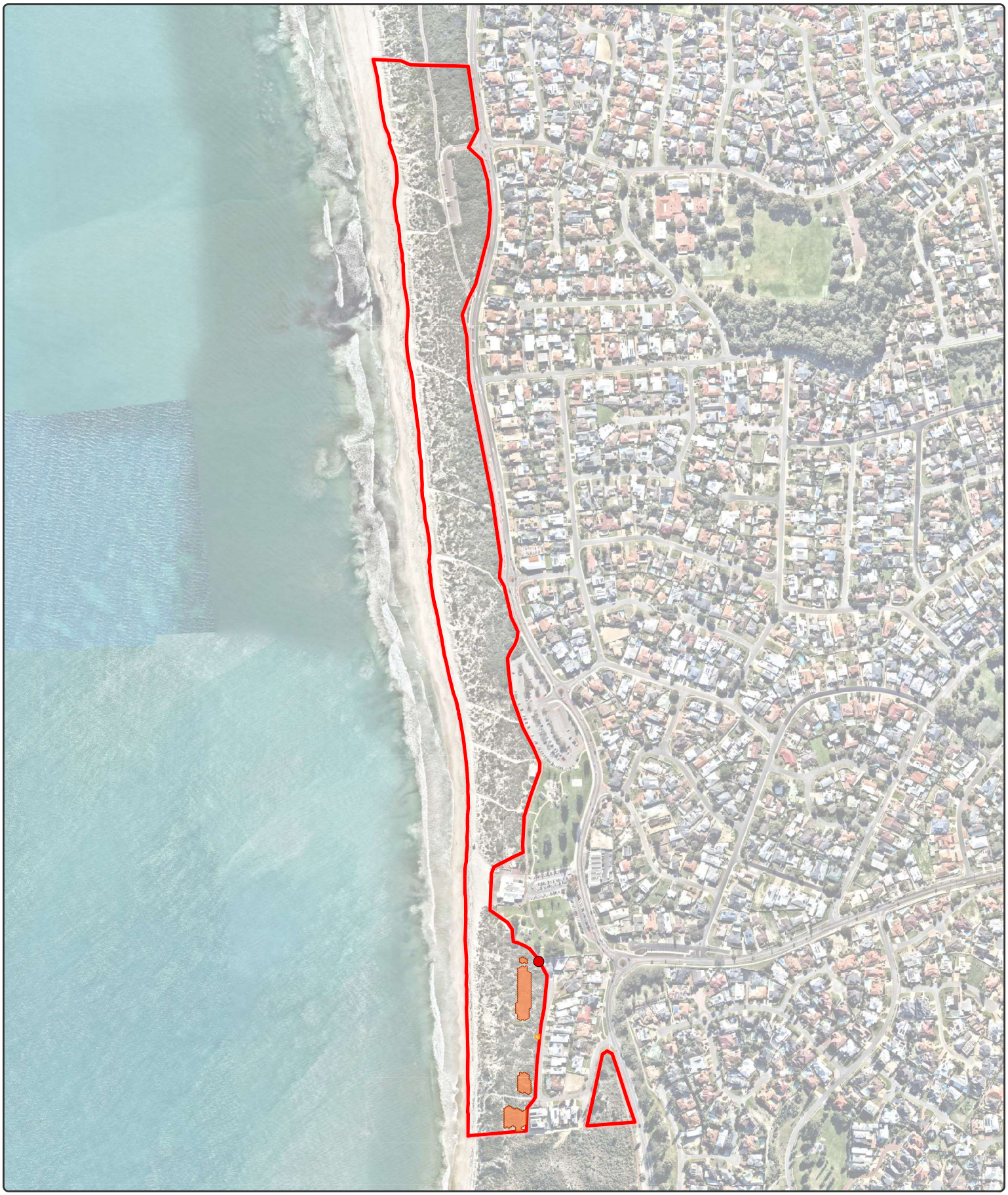
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



***_Arctotis_ sp. (Arctotis)**

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

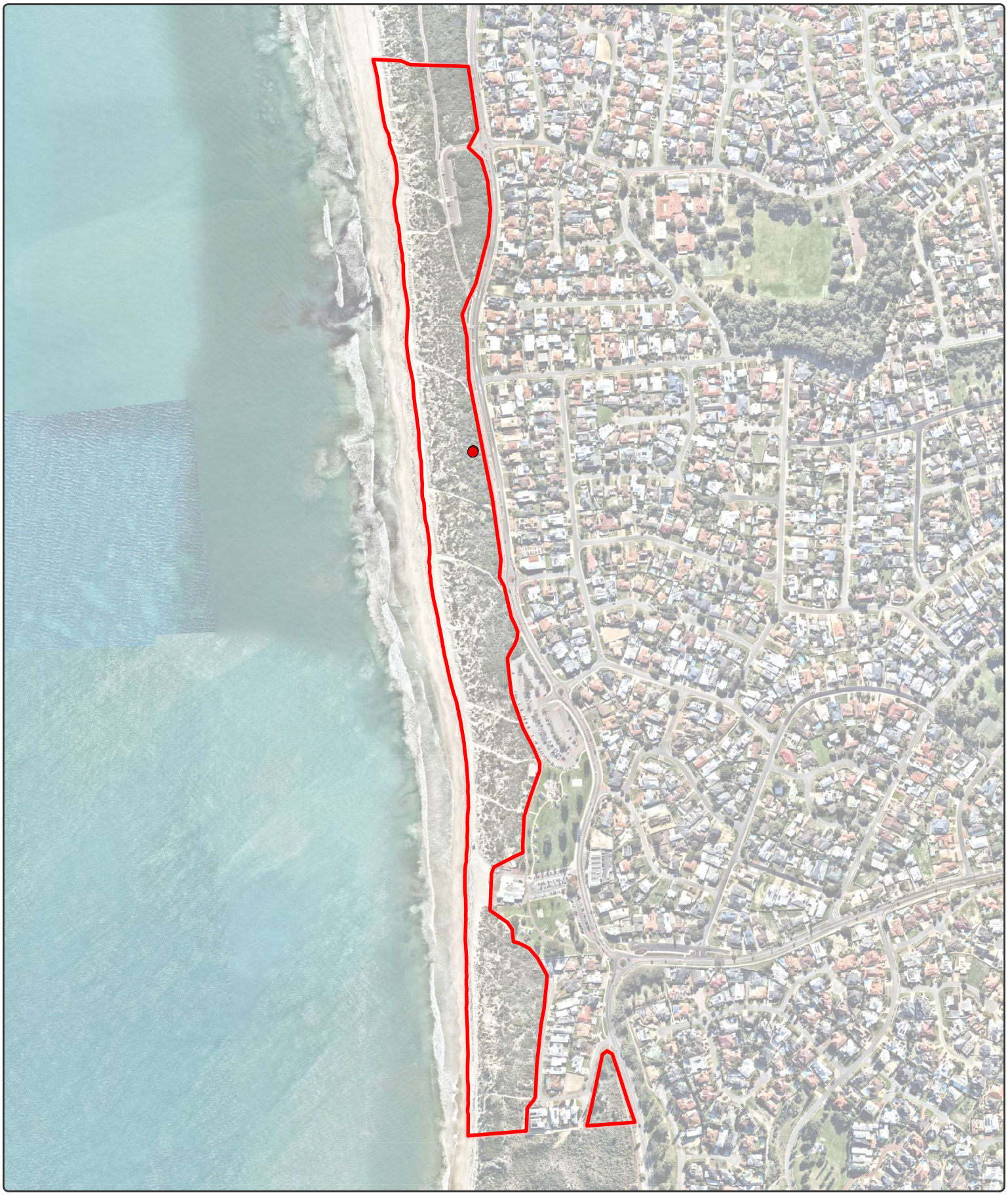
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



***_Asparagus asparagoides_ (Bridal Creeper; WoNS)**

Survey area

Weed location

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Cakile edentula* (Sea Rocket)**

Survey area

Weed location

Weed Coverage (%)

0-5%

0 50 100 200

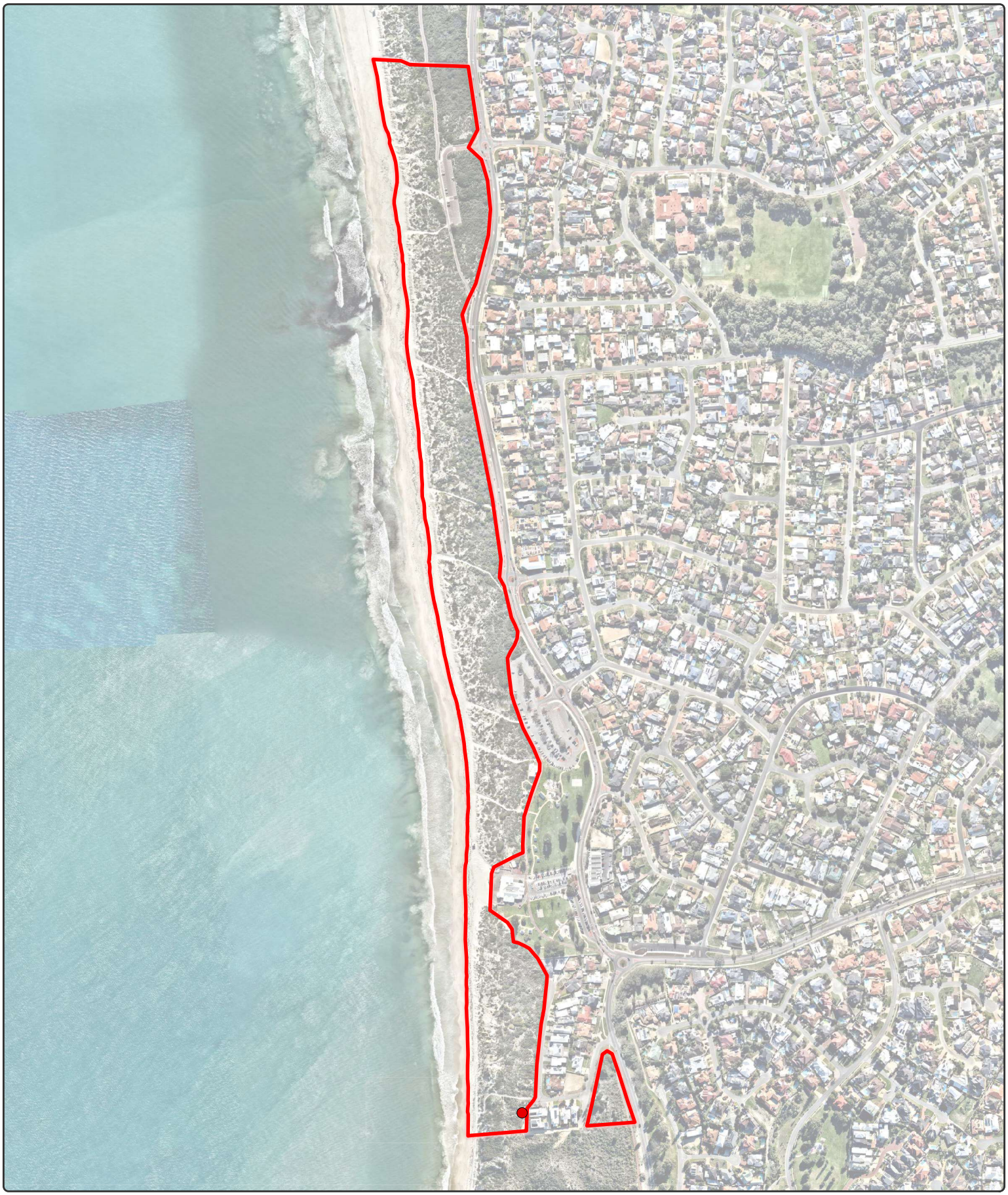
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



***Centranthus macrosiphon* (Pretty Betsy)**

Survey area

Weed location

0 50 100 200

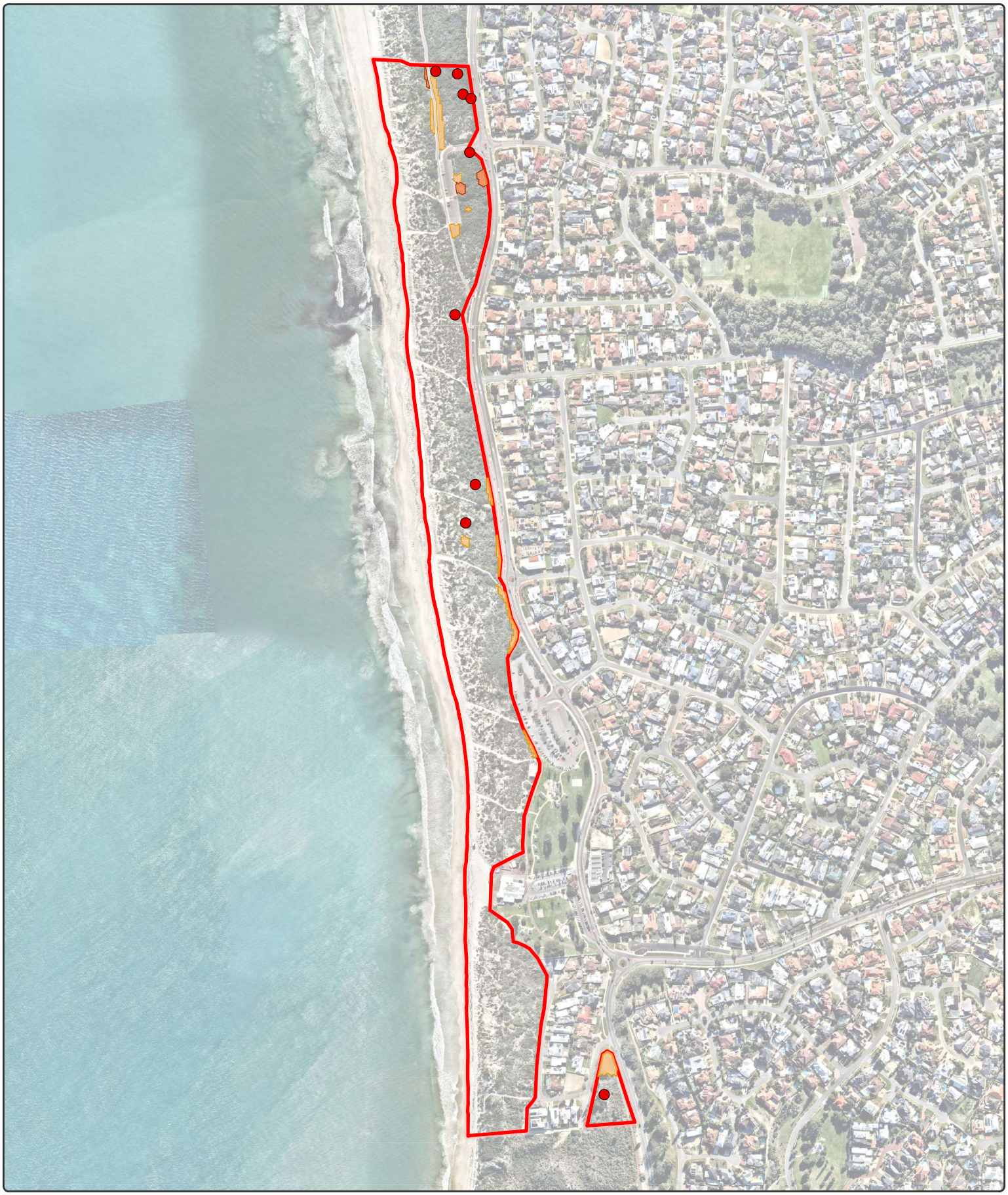
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



**Ehrharta longiflora* (Annual Veldt Grass)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

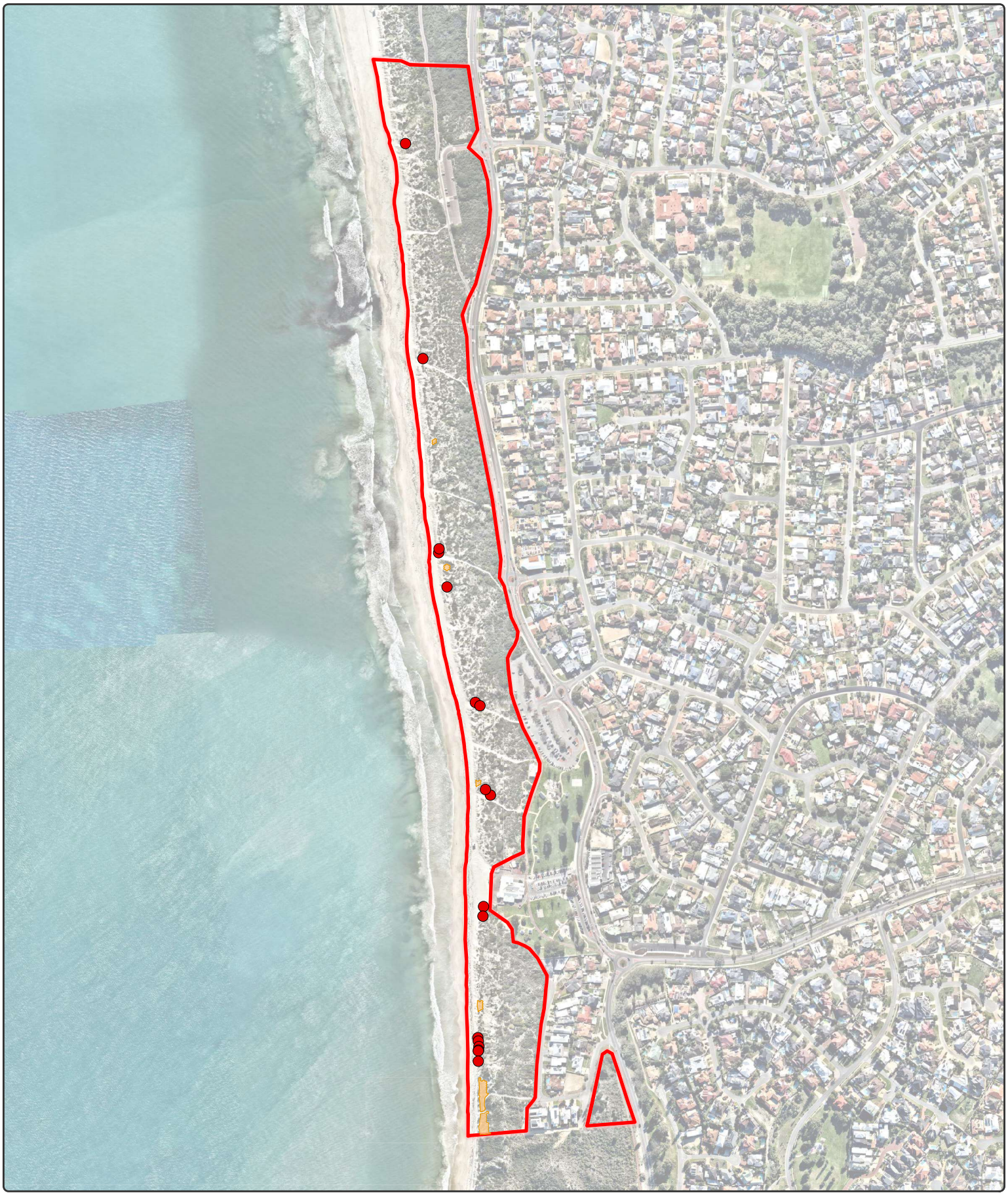
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



**Euphorbia paralias* (Sea Spurge)

Survey area

Weed location

Weed Coverage (%)

0-5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

**Euphorbia terracina* (Geraldton Carnation Weed)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***_Fumaria_ sp. (Fumitory)**

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

**Gazania linearis* (Gazania)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Moraea flaccida* (One-leaf Cape Tulip; Declared Pest - s22(2))**

Survey area

Weed location

Weed Coverage (%)

0-5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

**Osteospermum ecklonis* (Veldt Daisy)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 7/12/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

**Oxalis pes-caprae* (Soursob)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

**Pelargonium capitatum* (Rose Pelargonium)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Schinus terebinthifolius* (Japanese Pepper)**

Survey area

Weed location

0 50 100 200

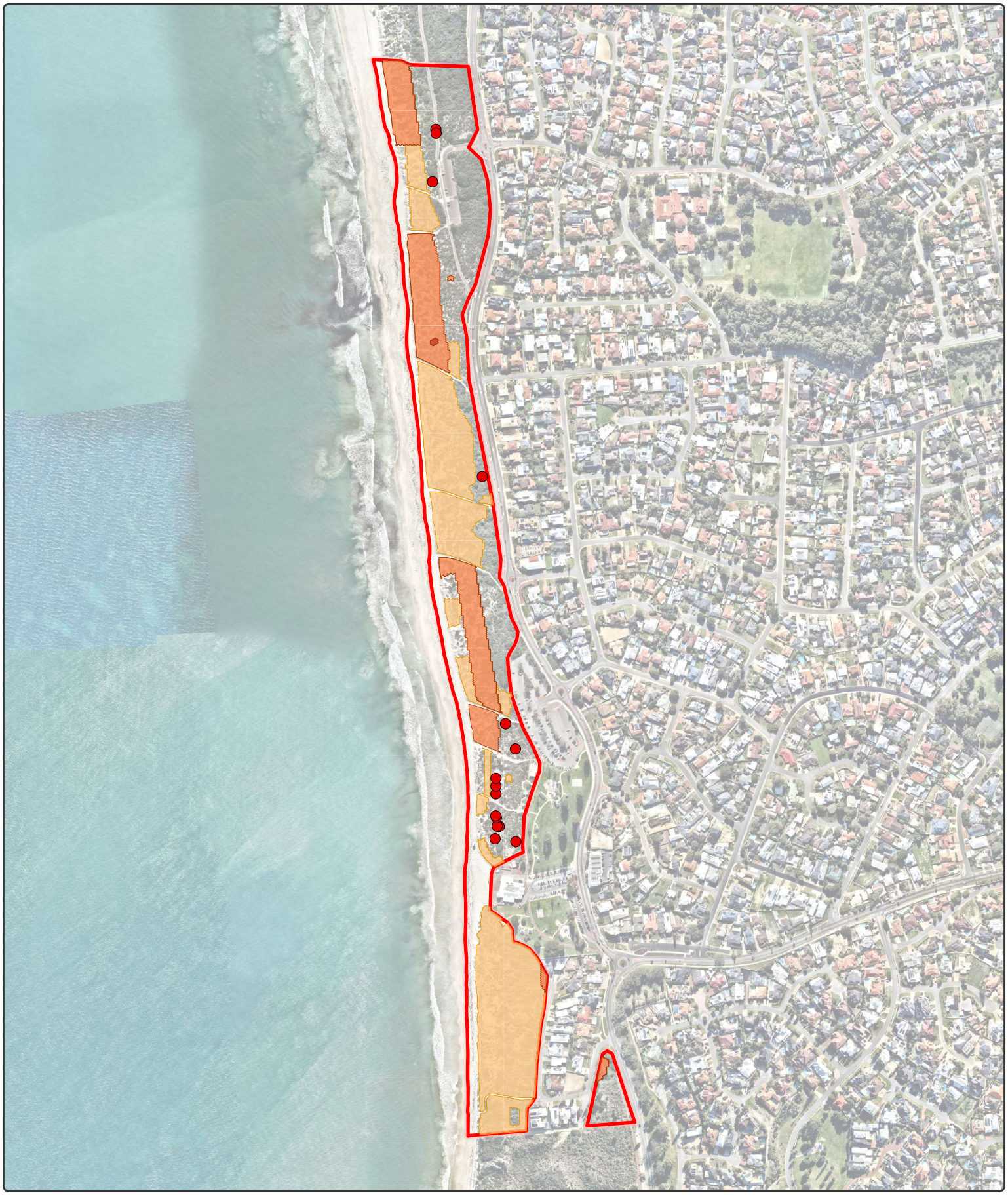
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



***Tetragonia decumbens* (Sea Spinach)**

Survey area

Weed location

Weed Coverage (%)

- 0-5%
- 6-75%
- 76-100%

0 50 100 200

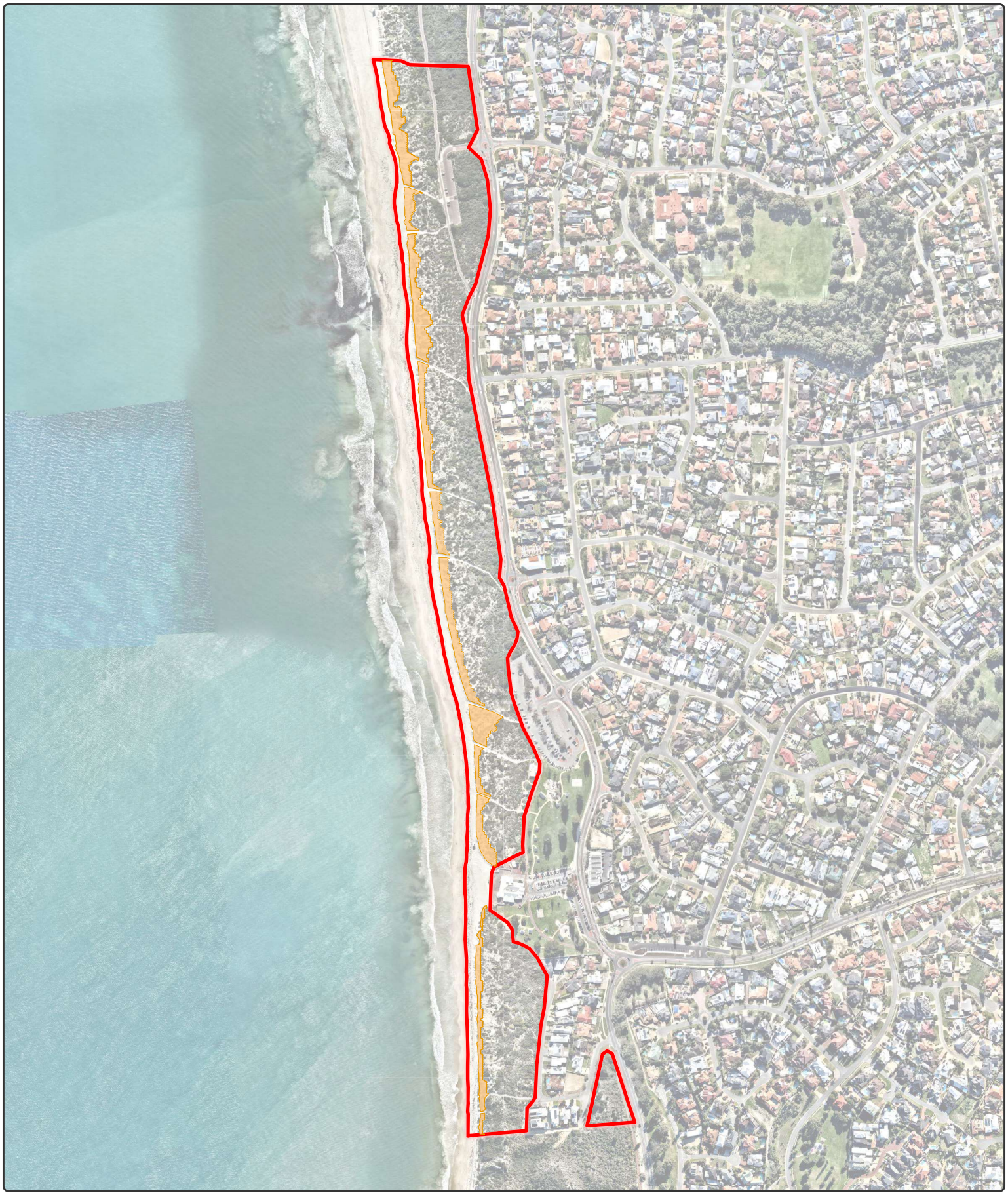
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



***_Thinopyrum distichum_ (Sea Wheat)**

Survey area

Weed Coverage (%)

0-5%

0 50 100 200

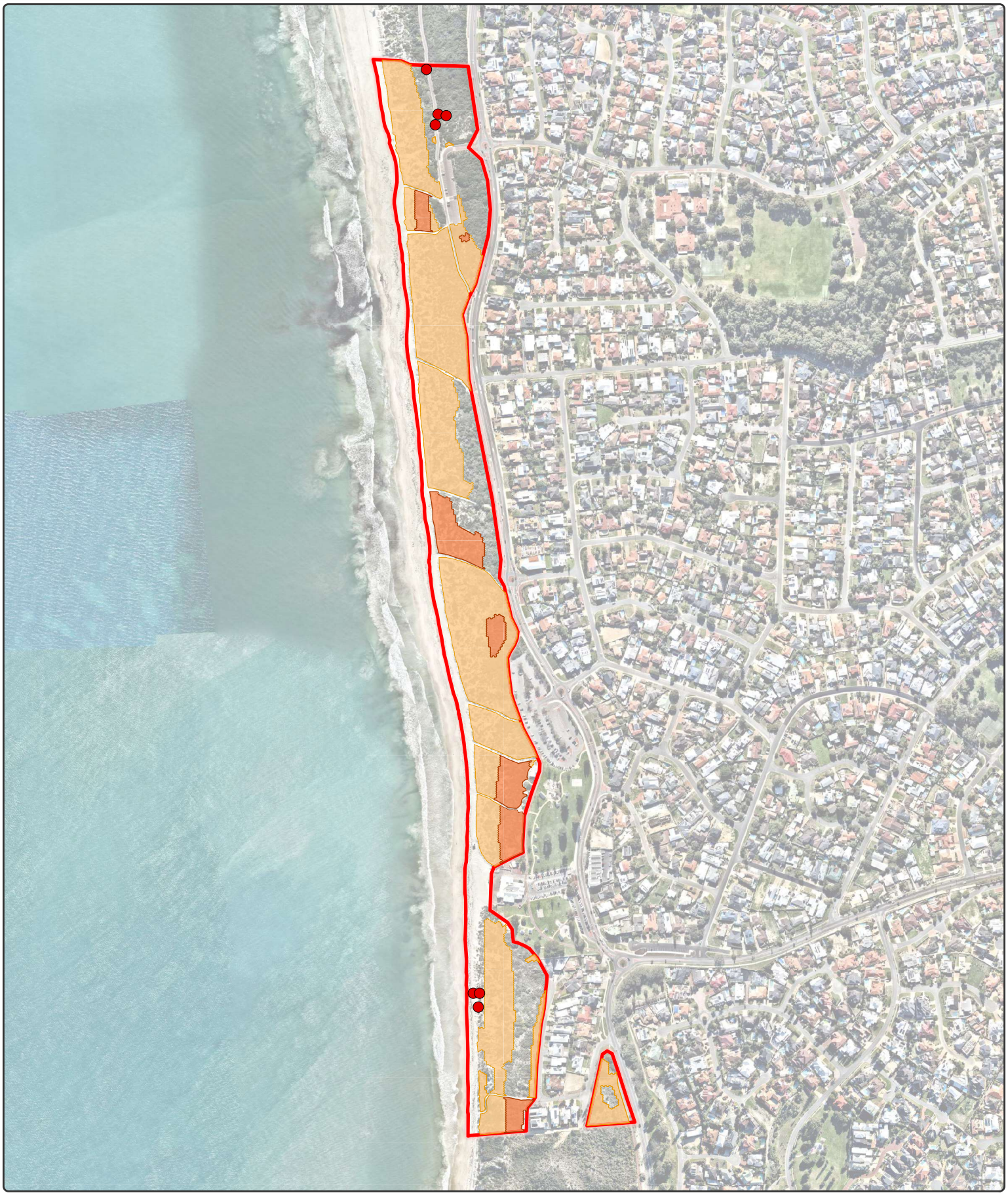
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

ecological AUSTRALIA
A TETRA TECH COMPANY



**Trachyandra divaricata* (Dune Onion Weed)

Survey area

Weed location

Weed Coverage (%)

0-5%

6-75%

0 50 100 200

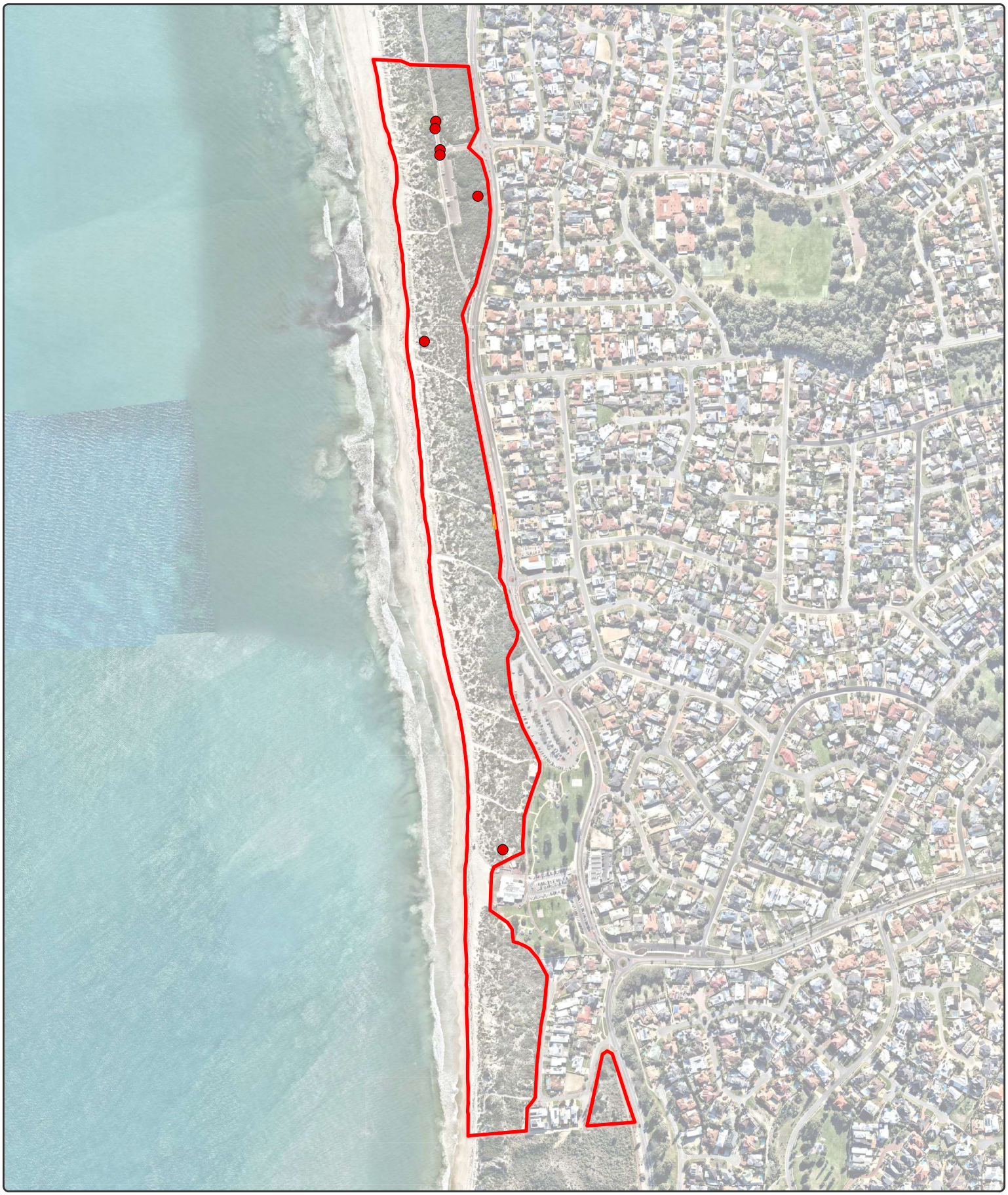
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



**Urospermum picaroides* (False Hawkbit)

Survey area

Weed location

Weed Coverage (%)

0-5%

0 50 100 200

Metres

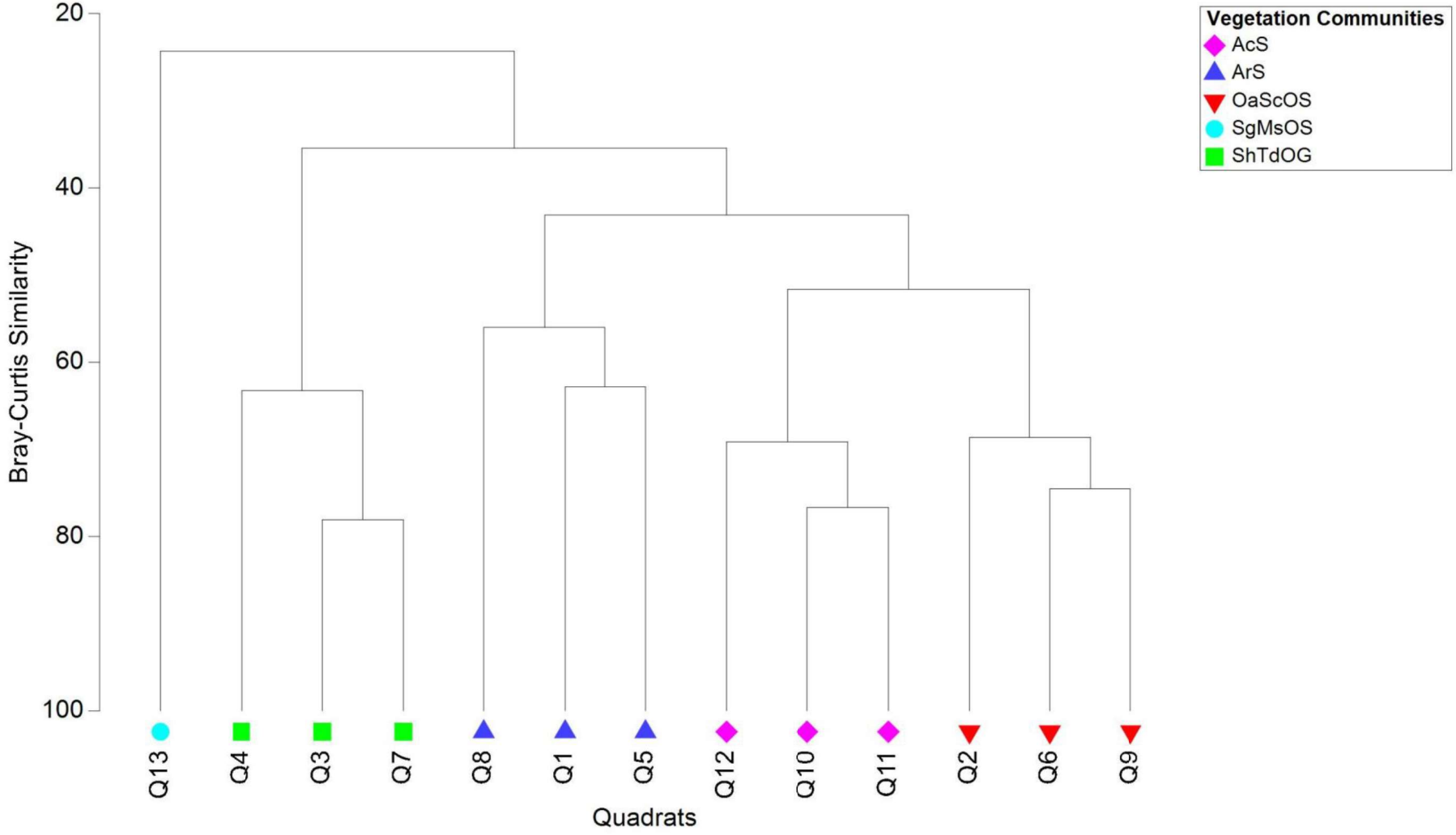
Datum/Projection:
GDA 1994 MGA Zone 50

22PER2350-SM Date: 11/11/2022

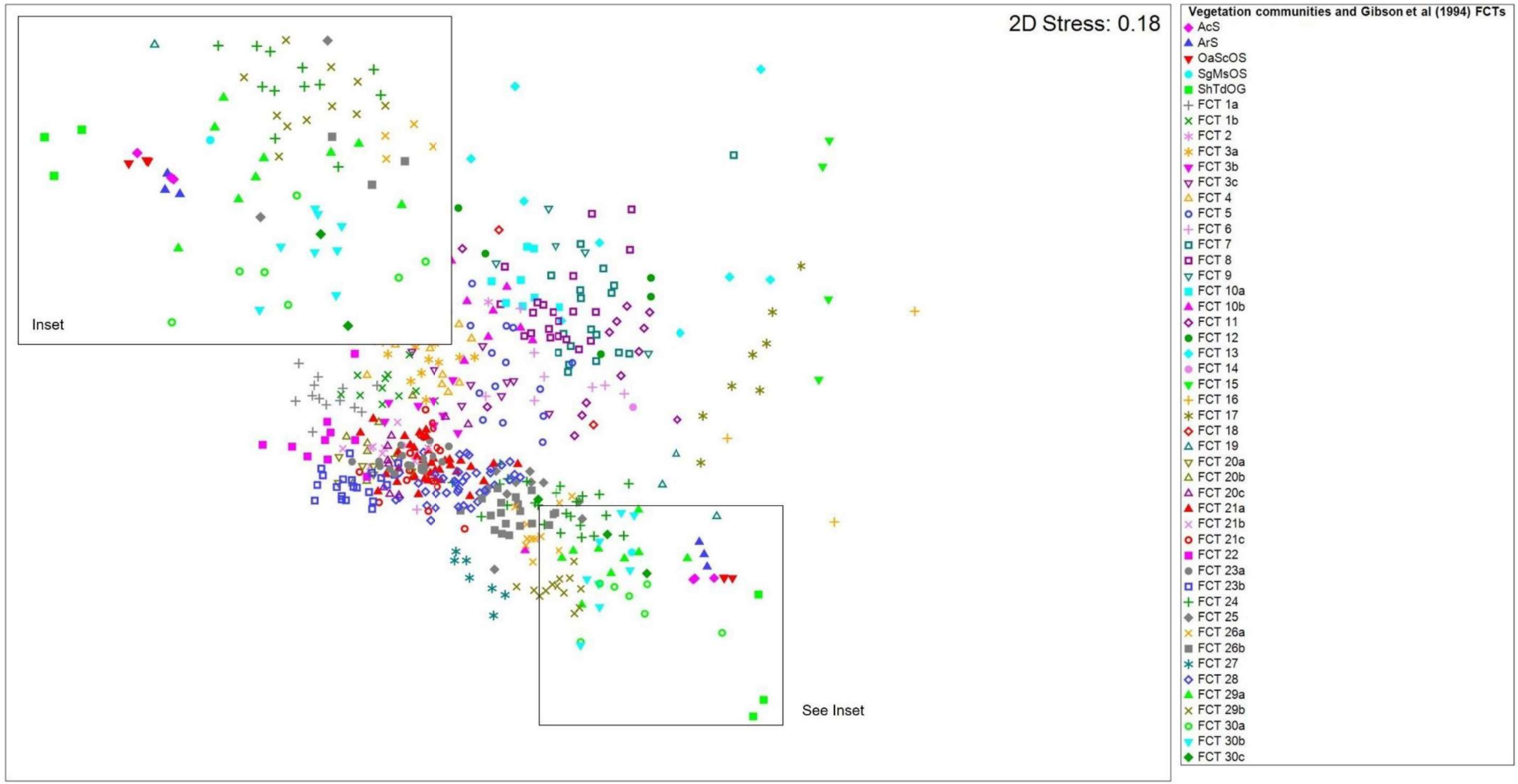
N

eco logical AUSTRALIA
A TETRA TECH COMPANY

Appendix F Hierarchical clustering dendrogram


Vegetation Communities
AcS
ArS
OaScOS
SgMsOS
ShTdOG
Bray-Curtis Similarity
20
40
60
80
100
Q13
Q4
Q3
Q7
Q8
Q1
Q5
Q12
Q10
Q11
Q2
Q6
Q9
Quadrats

Appendix G MDS: Relationships between ELA vegetation communities and Floristic Community Types (FCTs) defined by Gibson et al. (1994)


2D Stress: 0.18
Inset
See Inset
Vegetation communities and Gibson et al (1994) FCTs
AcS
ArS
OaScOS
SgMsOS
ShTdOG
FCT 1a
FCT 1b
FCT 2
FCT 3a
FCT 3b
FCT 3c
FCT 4
FCT 5
FCT 6
FCT 7
FCT 8
FCT 9
FCT 10a
FCT 10b
FCT 11
FCT 12
FCT 13
FCT 14
FCT 15
FCT 16
FCT 17
FCT 18
FCT 19
FCT 20a
FCT 20b
FCT 20c
FCT 21a
FCT 21b
FCT 21c
FCT 22
FCT 23a
FCT 23b
FCT 24
FCT 25
FCT 26a
FCT 26b
FCT 27
FCT 28
FCT 29a
FCT 29b
FCT 30a
FCT 30b
FCT 30c

eco logical AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au