2019

CITY OF ROCKINGHAM

Tamworth Hill Swamp Management Plan

city of Rockingham

where the coast comes to life

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1.0

INTRODUCTION

1 Introduction

1.1 Background

The City of Rockingham is situated in the unique biogeographic region of south-western Australia, which is classed as one of the 35 global biodiversity hotspots (Mittermeier et al., 2011). These hotspots are identified on the basis of containing large numbers of endemic species found nowhere else on Earth, while also being vulnerable to significant threats. The City manages 25 natural area reserves across 940 ha of diverse bushland, wetland and foreshore environments.

In 2015, the City prepared a Reserve Prioritisation Report that provided a broad framework for the ongoing management of the majority of reserves it manages, including Tamworth Hill Swamp. Tamworth Hill Swamp is an offset site required under an *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval for sand and limestone extraction near Millar Road in Baldivis. As part of the environmental offset, the reserve underwent extensive revegetation with black cockatoo foraging species between 2015 and 2017, in accordance with the approved offset management plan.

Following endorsement of the City's Community Plan Strategy: Natural Area Conservation in 2017, the majority of the City's natural area reserves now fall under combined management plans grouped according to their respective bushland, foreshore or wetland environments. The Community Plan Strategy: Natural Area Conservation also detailed that reserve specific environmental management plans should only be prepared where reserves have very unique conservation and recreation values.

This Management Plan (the Plan) has been prepared for Tamworth Hill Swamp reserve, acknowledging its local and regional environmental significance. This Plan includes a detailed assessment of the environmental values and infrastructure within Tamworth Hill Swamp following the completion of the revegetation undertaken as part of the environmental offset.

This Plan has been prepared under the direction of Community Plan Strategy: Natural Area Conservation, guided by the City's overarching Strategic Community Plan 2019-2029.

1.2 Vision

This Plan addresses the following aspiration contained in the City's Strategic Community Plan 2019-2029:

Aspiration 3: Plan for Future Generations

Strategic Objective - Preservation and management of bushland and coastal reserves:

Encourage the sustainable management and use of the City's bushland and coastal reserves.

1.3 Purpose

The purpose of this Plan is to provide key directions for the protection and enhancement of conservation, recreation and landscape values within Tamworth Hill Swamp over next five years.

1.4 Objectives

This Plan is driven by the following overarching objectives:

- Protect and enhance conservation values through the removal of threatening processes
- Encourage a range of sustainable recreational experiences through suitably located infrastructure and services
- Ensure equity and safety of all reserve users

1.5 Study Area

Tamworth Hill Swamp (the study area) is one of the largest and most significant wetland reserves managed by the City. It is 66.3 hectares in size, situated within Baldivis, approximately 41 km to the south-west of the Perth central business district (CBD). The study area forms part of Rockingham Lakes Regional Park, an important ecological linkage that connects a series of reserves and regionally significant bushland (Bush Forever) across the City's municipality.

The location of the study area in relation to the Rockingham Lakes Regional Park is shown in Figure 1. The study area is shown at a closer scale is shown in Figure 2.

FIGURE 1 - Rockingham Lakes Regional Park

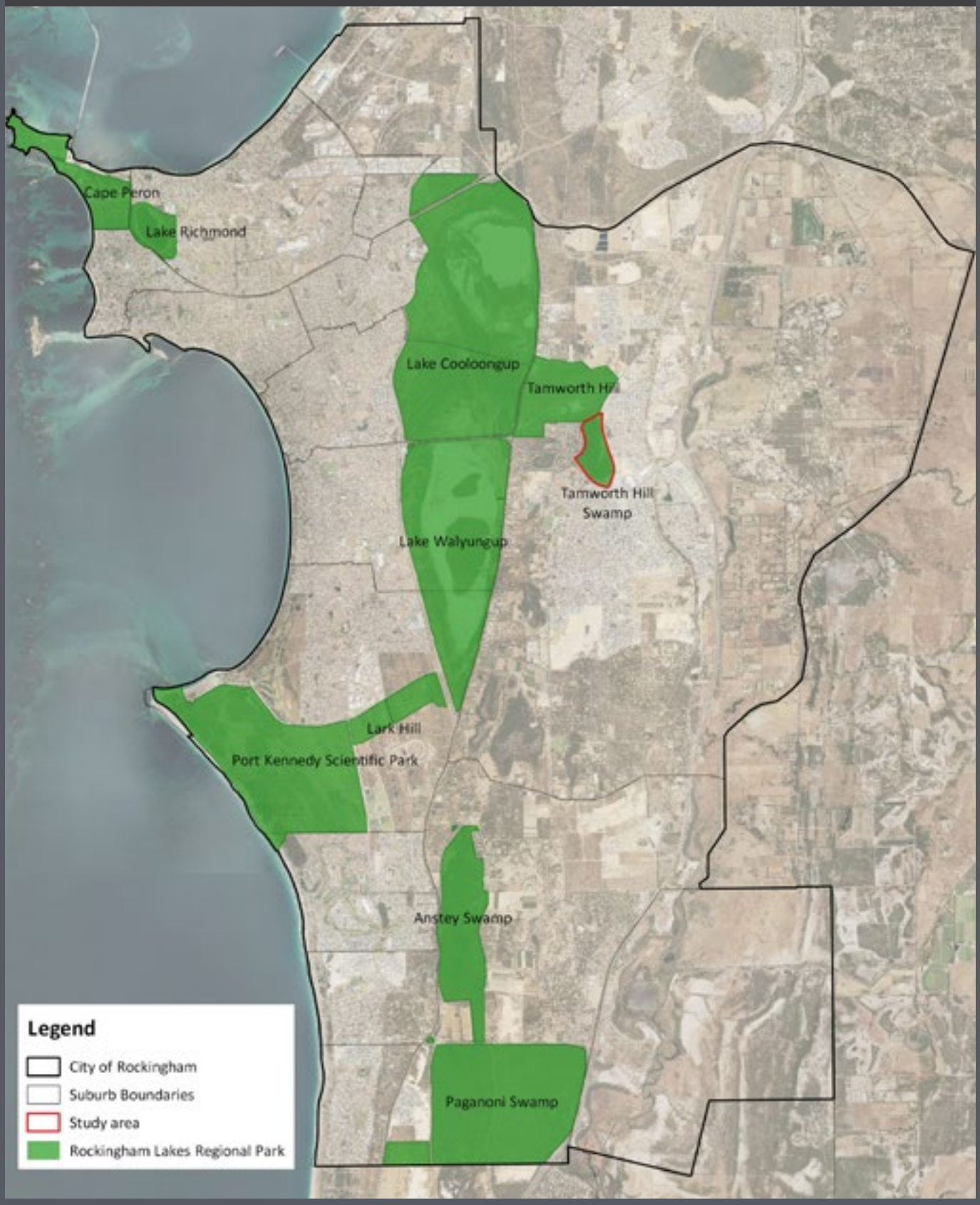


FIGURE 2 - Site Location

2.0

METHODS

2 Methods

2.1 Desktop Assessment

A desktop assessment was undertaken to identify flora and fauna (vertebrate and invertebrate) species that have the potential to occur within the study area.

2.1.1 Database Searches

The following databases were searched for records of conservation significant flora, fauna and ecological communities previously recorded within or in the locality of the study area:

1. Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap database using a 10km buffer of the survey area for vertebrate fauna and flora, and a 20 km buffer of the survey area for invertebrate fauna
2. EPBC Act Protected Matters Search Tool (PMST) using a 10 km buffer of the site
3. DBCA database of Threatened and Priority flora, fauna and ecological communities within the City's municipality.

2.1.2 Literature Review

Publicly available literature was searched for relevant biological surveys within and surrounding the study area. A number of biological surveys and environmental management plans within and surrounding the study area were reviewed as part of the desktop assessment. The following relevant surveys or management plans have previously been undertaken within the study area:

- Bamford (2018), *Motion Camera Surveys for Quenda*
- Bennett Environmental Consulting Pty Ltd (2011), *The Botanical Assessment of Tamworth Hill Swamp*
- Biologic (2015), *Vertebrate Fauna Survey*
- Biota (2014, 2015, 2016 and 2018), *Frog Population Monitoring Reports*
- City of Rockingham (2015), *Reserve Prioritisation Report*
- City of Rockingham (2018), *Tamworth Hill Swamp Revegetation Project Report 2017/2018*
- Cole (2004), *Bird surveys in selected Perth metropolitan reserves*
- Conservation Commission of Western Australia (2010), *Rockingham Lakes Regional Park Management Plan*
- Coterra Environment (2013), The *Environmental Management and Implementation Plan - Tamworth Hill Swamp*
- Coterra Environment (2013), *Tamworth Hill Swamp Reserve Revegetation Plan.*

2.1.3 Assessment of Likelihood of Occurrence

In order to determine which conservation significant species have the potential to occur in the study area, the results of the database, literature searches and survey records were examined in the context of species known distributions and habitat preferences and whether suitable habitat was considered to be present on site. Species with habitat preferences that are not present within the study area were deemed unlikely to occur.

Of the threatened ecological communities (TECs) and priority ecological communities (PECs) recorded within the City's municipality, the likelihood of occurrence was determined for each community by comparing the known topography, hydrology, geology and flora species composition of each community to that present in the site.

2.2 Field Surveys

Extensive field surveys were undertaken to assess the sites environmental values and infrastructure.

Timing of the field surveys was selected to provide optimal conditions for the detection of flora and fauna species, particularly those of conservation significance that may have been present in the study area. The surveys were undertaken between the end of September and mid November 2018 by suitably qualified environmental consultants Emerge Associates, Greg Harewood and Biologic Environmental Survey (Biologic).

A summary the different field survey types is shown in Table 1 below.

2.2.1 Flora and Vegetation

A targeted and detailed flora and vegetation survey was undertaken in accordance with Environmental Protection Authority (EPA) Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016).

In order to identify, describe and map the flora and vegetation in the study area, the field survey included:

- traversing the site on foot to record the composition and condition of vegetation
- undertaking searches for threatened and priority flora species with potential to occur in the study area, with a particular focus on identifying areas of suitable habitat
- undertaking detailed sampling of vegetation through quadrat sampling (non-permanent 10 m x 10 m quadrats). A total of eleven quadrats were sampled and the position of each sample location was recorded with a hand-held GPS unit, as shown in Figure 3
- recording additional plant taxa not observed within quadrats samples opportunistically as the botanist traversed the site.

Species Identification and Nomenclature

All plant specimens collected during the field survey were dried, pressed and then named in accordance with requirements of the Western Australian Herbarium. Flora nomenclature and conservation significance rankings used in this Plan are in accordance with the current listing of flora recognised by the Western Australian Herbarium, as per Florabase (WAH 1998). Flora Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk ('*').

TABLE 1 - Summary of surveys undertaken within the study area to inform this Plan

Survey Type	Survey Timing	Sampling Type	Consultant	Personnel
Flora and vegetation survey	5 and 19 October 2018	Searches across site and detailed sampling within eleven 10 x 10 m quadrats	Emerge Associates	Two botanists
Searches for conservation significant flora	5, 11 and 19 October 2018	Searches with a focus on suitable habitat	Emerge Associates	Two botanists
Revegetation performance assessment	9 and 19 October 2018	Traversing 21 pre-determined sampling sites	Emerge Associates	Two botanists
Weed assessment	11 and 19 October 2018	Recording weeds in 50 x 50 m sampling units	Emerge Associates	Two botanists and two ecologists
Bat, volant mammal and pest fauna surveys	26, 27, 28 September and 6, 7 and 8 November 2018	Observations (visual and calls), camera trap and bat detector	Greg Harewood	One zoologist
Invertebrate assessment and water quality testing	16 and 17 October 2018	48 samples using a mix of aquatic and invertebrate sampling techniques over eight sites	Biologic	Four zoologists
Infrastructure assessment	13 November 2018	Visual observations of the adequacy of infrastructure	Emerge Associates	Landscape architect

2 Methods (continued)

Plant Communities

The local plant communities within the site were identified from the sample data collected during the field survey. A cluster analysis was performed by converting the foliage projective cover for each species in each sample to a Domin value (Kent and Coker 1994). Classification into communities was undertaken using hierarchical clustering within the analysis package PRIMER v6 (Clarke and Gorley 2006), with groups defined using the Bray-Curtis distance measure and further refined using a similarity probability measure (significance level of 0.05).

Once a group was defined from the cluster analysis, the vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (ESCAVI 2003). The identified plant communities were then mapped on aerial photography (1:15,000) from the sample locations and boundaries were interpreted from aerial photography and notes taken in the field.

Assignment of Floristic Community Types

Subsequent to plant communities being identified, they were compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* (Gibson et al. 1994) by standardising the names of taxa with those used in the earlier study. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level.

The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006). As data from a localised survey is often spatially correlated, data for each sample was compared to Gibson et al. (1994) separately. This removed the influence of spatial correlation when assigning a FCT. Classification was then undertaken using a group-mean hierarchical clustering technique using the Bray-Curtis distance measure (as described above for plant community determination).

Where the sample tended to cluster with a grouping of different FCTs, samples were assessed separately to differentiate between FCTs. Ultimately the cluster analysis, as well as contextual information relating to the soils, landforms and known locations of FCTs within the region, was considered in the final determination of an FCT for vegetation within the site.

Threatened and Priority Ecological Communities

Database searches identify the 'sedgelands in Holocene dune swales of the southern Swan Coastal Plain' TEC to the west of the site. Areas of native vegetation potentially representing the 'sedgelands in Holocene dune swales of the southern Swan Coastal Plain' TEC were assessed against diagnostic characteristics provided in the *Interim Recovery Plan No. 314 Sedgelands in Holocene Dune Swales* (DEC 2011).

Vegetation Condition

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the study area. Vegetation condition was mapped on aerial photography (1:13,000) based on the locations and notes recorded during the field survey to define areas with differing condition. The vegetation condition was assessed using methods from the Keighery (1994) vegetation condition rating scale as defined in EPA (2016) for the South West and Interzone Botanical Provinces (Table 2).

TABLE 2 - Vegetation condition rating scale (EPA 2016)

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

FIGURE 3 - Flora and Vegetation Quadrat Sampling Locations

2.2.2 Revegetation Performance Assessment

The Tamworth Hill Swamp Revegetation Project Report 2017/2018 (CoR 2018) and a digital mapping file of the revegetation areas were reviewed to identify the boundaries and previous planting information for the seven revegetation areas within the study area. A sampling frame comprising a grid of 10 x 10 m (Plate 1) sample units was overlaid over each of the seven revegetation areas. Three sample units were randomly selected within each revegetation area (21 in total).

The site was traversed on foot and vehicle and the 21 pre-determined samples were surveyed and photographed. The position of each sample was located using a hand-held GPS unit connected to a Samsung tablet displaying the sampling frame. The north-west corner of each sample was permanently marked with a metal post.

The boundaries of the seven revegetation areas were ground-truthed and any additional areas of revegetation within the site were mapped.

Data Analysis and Mapping

Sample data was used to demonstrate revegetation performance for each revegetation area. One of the three samples within RA2 was separated from the other two RA2 samples for some analyses due to differences in vegetation type (wetland vs. dryland).

Analysis was undertaken using Microsoft Excel to determine plant density, plant survival, species richness, species diversity and weed cover. Results were assessed against revegetation 'performance targets' provided in Tamworth Hill Swamp Reserve Revegetation Plan (Coterra Environment 2013a), which defined a minimum target of 1 plant/m^2, at least 75% of the revegetation species list and less than 20% weed cover.

Mean values for plant density and species richness were calculated from the three samples surveyed in each revegetation area. A sample mean is a statistic that indicates the central tendency of a population. An upper and lower 95% confidence interval (CI) was then calculated for each sample mean. A 95% CI is a statistic that provides indication of the spread of expected values within a sampled population.

Species diversity is presented graphically based on composition obtained across all three samples within each revegetation area. The species and number of plants installed in each revegetation area each year (CoR 2018) and the species recorded in samples within each revegetation area were compared directly to these lists.

Revegetation success was mapped using a categorical scale based on the three performance targets outlined in Coterra Environment 2013a. The performance categories adopted include 'no targets met', 'one target met', 'two targets met' and 'all targets met' (success).

2.2.3 Weeds

A sampling frame comprising a grid of 50 x 50 m sample units was overlaid across the study area. All sample units were assessed using a combination of physical inspection and interpretation from aerial imagery where areas were inaccessible due to inundation, or where access was not considered necessary because ground-truthing confirmed low or zero weed occurrences.

The site was traversed on foot to record 'foliage projective cover' of five weed suites (annual and perennial grasses/pampas grass/woody/herbaceous/bulbous) within each 50 x 50 m sample unit. The weed suites were identified by broadly grouping weed species by an appropriate control method (except pampas grass (**Cortaderia selloana*) had its own suite). The dominant weed species within each weed suite were recorded as the botanists and ecologists traversed the site. The following categories were used when recording weed cover:

- 0% (not present)
- >0-1%
- >1-5%
- >5-20%
- >20-50%
- >50%.

Point locations of Declare Pest plants, Weeds of National Significance (WoNS) and prominent isolated woody weeds or isolated plants that could be controlled to prevent spreading were recorded using a hand-held GPS unit.

PLATE 1 - 10 x 10 m sample unit example from a revegetation area

2.2.4 Vertebrate Fauna

The study area was traversed by foot and records were made of all birds and volant mammals detected. Birds were identified through visual features (using the naked eye/ binoculars) and calls. Opportunistic records of birds were also made whilst undertaking the other biological surveys.

A Wildlife Acoustics SM2+ Bat Detector was deployed at two locations, each for one night (27 September and 7 November) from sunset to sunrise. Bat detector data was analysed by a Western Australian bat specialist to confirm species identification.

A motion sensing infrared camera (Acorn model LTI 5210A) was deployed at four locations. Each camera trap was left within the study area for a total of 41 days (26 September to 6 November). The camera traps were set to take three consecutive pictures when triggered, with a 15 second time lapse before any subsequent trigger event. Fish oil was placed in front of the camera traps when they were first deployed. Photographic images recorded on the camera traps were viewed by a zoologist to identify species and provide counts for birds and pest fauna.

Broad fauna habitat types were determined from the native plant communities identified during the flora and vegetation survey and observations recorded during the fauna field survey.

2.2.5 Invertebrate Fauna

Sampling Sites

Four terrestrial and four aquatic sites were chosen within Tamworth Hill Swamp to provide good spatial representation around the study area for the invertebrate survey (Table 3 and Figure 4). The outer edges of the study area that have been revegetated were excluded from the survey area boundary to limit the survey to remnant vegetation likely to support the most diverse range of invertebrates.

At Terrestrial Site 1 (CoRT1) and Terrestrial Site 2 (CoRT2), sampling was divided into a dry zone and a wet zone (delineated by the access track) as each site had a significant amount of both dry riparian vegetation and seasonally inundated fringing vegetation. Within each vegetation type at these two sites, all three collection methods were implemented. Terrestrial Site 3 (CoRT3) was a dry riparian vegetation site and Terrestrial Site 4 (CoRT4) was a seasonally inundated fringing vegetation site (Table 3).

At all aquatic sites (CoRA1 to CoRA4), four methods of biotic (invertebrate) and two methods of abiotic (water quality) sampling was conducted. A broad habitat assessment was also undertaken at all sites. Aquatic sites CoRA1 and CoRA4 comprised areas of inundated *Baumea sedgeland* and CoRA2 and CoRA3 comprised inundated *Melaleuca rhaphiophylla* forest. Opportunistic observations were also made of aquatic vertebrates (primarily amphibians).

TABLE 3 - Survey sites, sampling habitats types and intensity

Site	No. of samples	Habitat Type
CoRT1	6	Dry riparian vegetation/ Seasonally inundated fringing vegetation
CoRT2	6	Dry riparian vegetation/ Seasonally inundated fringing vegetation
CoRT3	6	Dry riparian vegetation
CoRT4	6	Seasonally inundated fringing vegetation
CoRA1	6	Inundated *Baumea* sedgeland
CoRA2	6	Inundated *Melaleuca rhaphiophylla* forest
CoRA3	6	Inundated *Melaleuca rhaphiophylla* forest
CoRA4	6	Inundated *Baumea* sedgeland
Total	48	

Terrestrial Invertebrate Sampling

The following sampling methods were utilised at each sampling site:

- net sweeping with an entomological net over grass and low vegetation with contents being emptied into a bag (five sweeps per sample per site). See Plate 2
- leaf litter sieving (two sieves per site 1 m^2 quadrats) extracting invertebrates by a Berlese funnel in the laboratory
- hand collection on vegetation and bark (60 person minutes). Sightings of flying invertebrates were also recorded.

All invertebrate samples were placed into 100% ethanol for preservation.

Aquatic Invertebrate Sampling

The following sampling methods were utilised at each sampling site:

- macroinvertebrate sampling using a 250 µm mesh D - framed net using the "kick" and "sweep" methods over a distance of approximately 50 m
- microinvertebrate sampling using a 53 µm mesh zooplankton net which was towed through the water column (avoiding the benthos) along a distance of 20-30 m
- baited box trapping, with the traps left over night to determine the presence of freshwater crayfish. Box traps were set with an air pocket in the back to prevent any potential turtle bycatch fatalities. Invertebrate bycatch collected preserved and recorded. Vertebrate (e.g. tadpole) bycatch was recorded and released
- hand collection in submerged vegetation and under woody debris (30 person minutes)
- *in situ* water quality testing measured with a portable YSI Pro Plus PSE2 water quality meter
- collection of water samples for nutrient analysis using sterilised bottles provided by a NATA-accredited laboratory. See Plate 3.

All invertebrate samples were placed into 100% ethanol for preservation.

FIGURE 4 - Invertebrate Survey Sampling Sites

Taxonomy

All invertebrate specimens were identified to the lowest taxonomic resolution possible using a dissecting microscope. The abundance of aquatic invertebrates were recorded, however where aquatic taxa were recorded in large numbers, an estimate of the total abundance was made, and a subsample taken for higher taxonomic resolution. Most specimens were identified to Order or Family level, with some groups identified further where possible; *i.e.* to genus or species. All ants were identified to species using Heterick (2009).

Each taxon was then categorised into the following functional groups, or a combination of groups, based on the overall behaviour of the group. These functional groups were as follows:

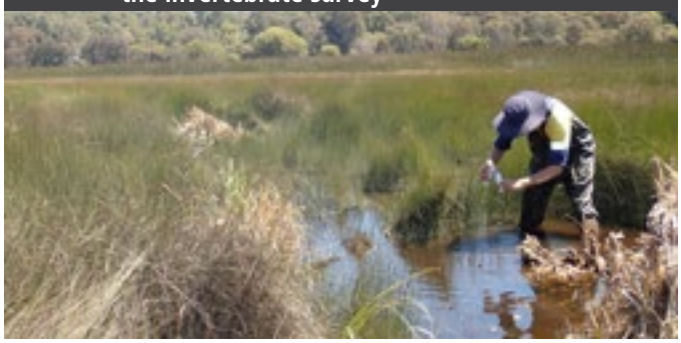
- pollinator *e.g.* bees, butterflies, hoverflies
- herbivore *e.g.* plant hoppers, snails, thrips, crawling water beetles, mayflies
- detritivore *e.g.* earthworms, millipedes, wood lice, soldier flies
- predator/parasite *e.g.* centipedes, spiders, wasps, diving beetles, dragonflies, damselflies; freshwater leeches
- generalists *e.g.* water scavenger beetles.

Predators and parasites were lumped into one group as they represent an upper level of diversity for an ecosystem. Both predators and parasites require prey (either directly as food or as hosts for their young) and so are considered similar in their requirements for a given habitat.

Aquatic taxa were often placed in two or more functional groups as they will fill both niches based on the availability of food. Some taxa also fill different niches at different life stages.

PLATE 2 - Sampling for terrestrial invertebrates with an entomological net

PLATE 3 - Water quality testing undertaken as part of the invertebrate survey



2.2.6 Infrastructure

An assessment of the adequacy of the infrastructure within the study area was undertaken. The following was identified in the infrastructure assessment:

- location and adequacy of site access points
- type, condition, length and adequacy of fencing and the ability to restrict pedestrian and/or vehicular access
- type, condition, length and adequacy of paths
- type, condition and adequacy of current signage. Current signage was categorized into type using four categories (regulatory, directional, interpretive, reserve name)
- type and condition of reserve structures (including furniture)
- adequacy and condition of bin and dog waste bag provisions.

Fence and path condition was categorized as 'good' or 'poor' as follows:

Good: Does not require upgrade or maintenance

Poor: Requires replacement or maintenance

2.2.7 Field Survey Limitations

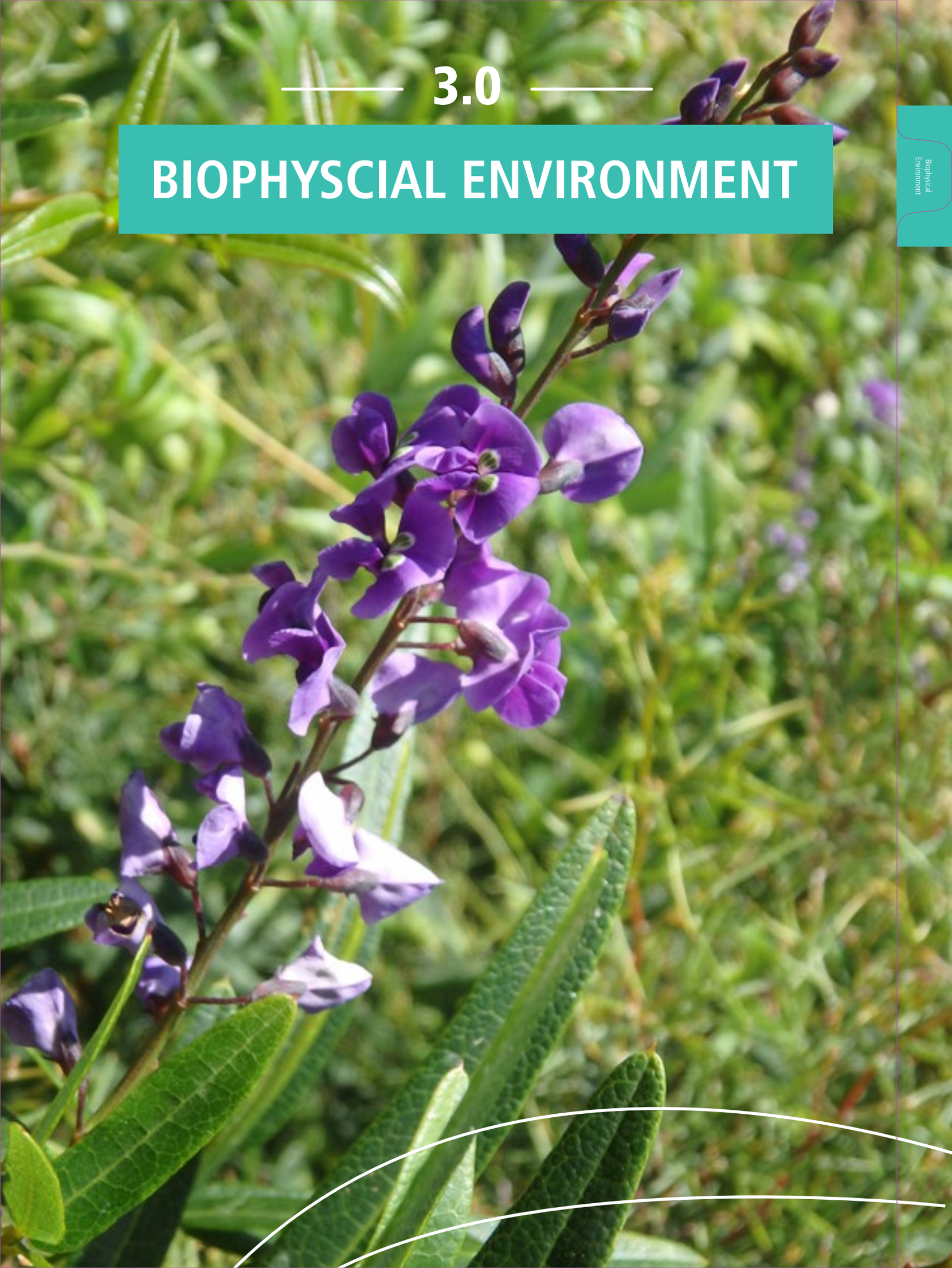
Access to the north-western portion of the reserve was restricted due to the long period of inundation. Sampling was restricted in this inundated portion of the reserve for all of the field surveys, resulting in some estimations needing to be made (i.e. sampling around the edges of the inundated areas and some results needing to be estimated). However, the habitat within the north-western portion of the reserve was represented in other sampling sites for the biological surveys.

Only single season targeted bird, volant mammal and invertebrate surveys were undertaken to inform this Plan. A series of other targeted fauna surveys have been undertaken in the past that have been reviewed to determine the fauna potentially present within the study area. A comprehensive assessment of all animal classes has not been undertaken. Not all fauna species present within the reserve would have been recorded, particularly as the surveys were undertaken over single seasons. However, information available from field survey findings, literature and database searches provides a good indication of the fauna species likely to be present within the study area.

Due to the 50 x 50 m size of samples of weed data being recorded, there is a possibility that not all weeds present in each sample unit were recorded. However, the majority of the site was visited and the weed data recorded is considered to provide a thorough indication of weed type and cover across the site.

3.0

BIOPHYSCIAL ENVIRONMENT



3 Biophysical Environment

The conservation framework relevant to this section is detailed in Appendix A.

3.1 Land Use

The study area historically formed part of farmland. During the last few decades Baldivis has experienced rapid urban development and associated population growth. The study area is primarily used for conservation and recreation by the local community offering a range of active and passive recreation opportunities such as walking, dog walking and nature observation. Given the reserve has no formal car parking or picnic areas, it is not typically visited by the wider community or tourists. The study area is surrounded by a mix of Commercial development and residential and special residential housing.

3.2 Bioregion

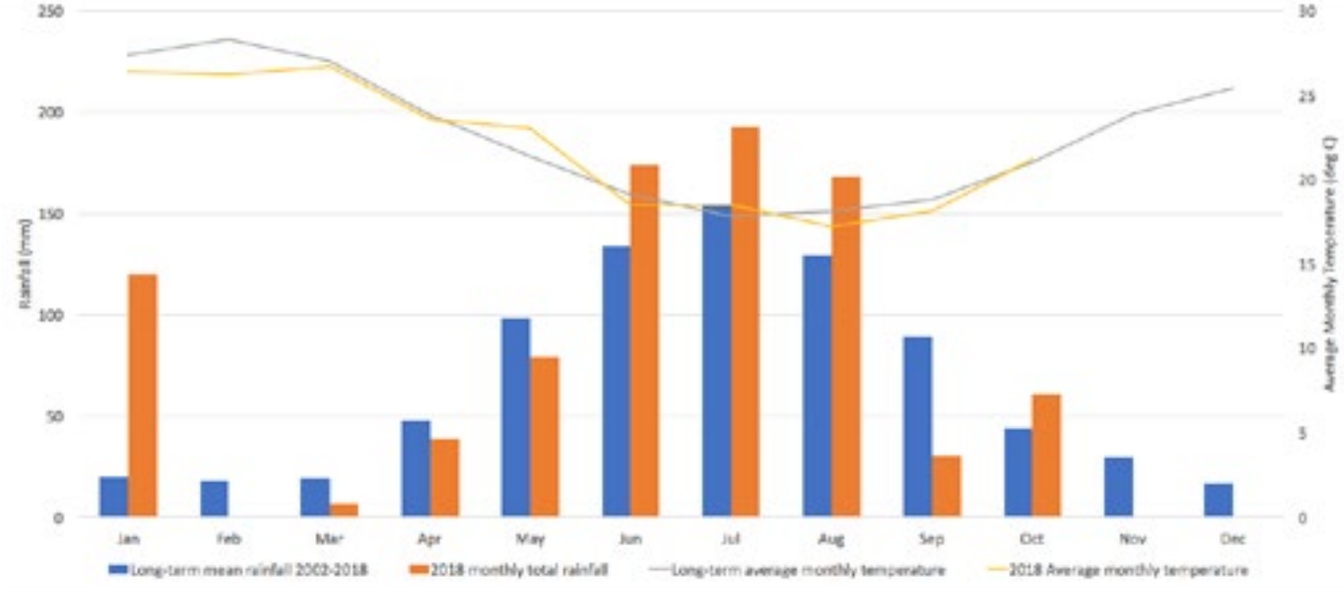
The study area is situated in the Swan Coastal Plain (SWA) bioregion and the Perth (SWA2) subregion as described by the Interim Biogeographic Regionalisation for Australia (IBRA) (DotEE 2019a). The Perth subregion is characterised by colluvial and aeolian sands, alluvial river flats, coastal limestone, *Banksia* and jarrah (*Eucalyptus marginata*) - *Banksia* woodlands on Quarternary marine dunes of various ages and marri (*Corymbia calophylla*) on colluvial and alluvials (Mitchell et al. 2002).

3.3 Climate

The study area has a warm Mediterranean climate, with hot, dry summers and cool, wet winters. The closest weather station at Anketell Station was used to identify the long-term average rainfall and the total monthly rainfall for 2018 (Figure 5). The next closest weather station at Garden Island was used to determine long-term and 2018 average monthly data for temperature, as Anketell Station does not have this long-term data (Figure 5).

All surveys undertaken to inform this Plan took place during spring 2018, between September and November. The Rockingham area received higher than average winter rainfall in 2018 (Figure 5), resulting in high amounts of water retention at the study area during the surveys.

Figure 5. Long-term average temperature and rainfall, the total monthly rainfall and average monthly temperature recorded for 2018 (BoM 2018)



3.4 Landforms

The study area occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area. The Swan Coastal Plain consists of two sedimentary belts of different origin. Its eastern side has formed from the deposition of alluvial material washed down from the Darling Scarp, while its western side is comprised of three dune systems that run roughly parallel to the Indian Ocean coastline (Seddon 2004). These dune systems, referred to as Quindalup, Spearwood and Bassendean dunes, represent an ion of coastal deposition that has occurred since the late Quaternary period (approximately two million years ago) (Kendrick et al. 1991) and, as a result, they contain soils at different stages of leaching and formation.

The site occurs within the Spearwood dune landform (Gozzard 2011), which comprises the intermediary aged dune system that lies between the youngest Quindalup dunes and the older Bassendean dunes, and consists of limestone overlain by yellow sands (Churchward and McArthur 1980).

Majority of study area that forms part of the geomorphic wetland sits at an elevation of 2 m Australian Height Datum (m AHD), with the edges of the study area slightly increasing in elevation. The greatest slope in the study area is within the south eastern portion, which reaches an elevation of 13 m AHD.

3.5 Geology and Soils

The Spearwood dune system has undergone differential wind erosion which has resulted in two landscapes: the Cottesloe unit on the western side and the Karrakatta unit on the western side. Broad scale soil mapping places the north western portion of the site within the Cottesloe soil association and the south eastern portion of the site within the Karrakatta soil association (Churchward and McArthur 1980). The Cottesloe association typically comprises a 'low hilly landscape with shallow brown sands over limestone (with) much exposed limestone' and the Karrakatta association comprises an 'undulating landscape with deep yellow sands over limestone' (Churchward and McArthur 1980).

3.6 Hydrology and Wetlands

The Department of Water and Environmental Regulation (DWER) online Perth Groundwater Map shows that regional groundwater beneath the study area ranges from 2 m AHD in the northern portion to 4 m AHD in the southern portion (DWER 2018a). DWER's hydrography dataset shows one 'perennial swamp' feature in the site (DWER 2018b).

Wetlands of national or international significance may be afforded special protection under the following Commonwealth or international agreements:

- Ramsar List of Wetlands of International Importance
- A Directory of Important Wetlands in Australia.

No Ramsar or listed 'important wetlands' are located within the study area (DBCA 2018a). The closest Ramsar site is the Becher Point Wetlands, which is approximately 6.8 km south west of the site.

On the Swan Coastal Plain DBCA (2018b) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence. The DBCA maintains the Geomorphic Wetlands of the Swan Coastal Plain dataset (DBCA 2018b), which further categorises geomorphic wetland features into specific management categories based on their conservation status. As this dataset was drafted at a regional scale, the boundaries of mapped wetland features are often inconsistent with physical wetland boundaries.

The Geomorphic Wetlands, Swan Coastal Plain dataset (DBCA 2018b) identifies one conservation category wetland feature (UFI 15186) across majority of the study area which extends beyond the western boundary of the reserve. Three smaller multiple use wetland features (UFIs 6619, 14420 and 14658) also occur, one of which extends beyond the north eastern portion of the reserve. All four of these features are classified as basin wetlands and referred to as 'Tamworth Hill Swamp'. The locations of the geomorphic wetlands in the study area are shown in Figure 6.

FIGURE 6 - Geomorphic Wetlands

3 Biophysical Environment (continued)

3.6.1 Water Quality

Water quality testing was undertaken at the four aquatic sites shown on Figure 4 as part of the invertebrate assessment. Water quality results are included in Table 4, compared to ANZECC guideline default trigger values for freshwater wetlands in South-West Australia (ANZECC and ARMCANZ 2000).

The surface water pH recorded ranged from 6.54 to 7.23 with the lowest pH recorded at CoRA3 and the highest at CoRA4 (Table 4). Surface water pH at three of the four sites (CoRA1, CoRA2 and CoRA3) was below the ANZECC guideline range for 80% protection of species at freshwater wetlands (7.0 – 8.5). The acidic pH recorded is typical for tannin-stained freshwater swamps and can be attributed to the large amount of decaying vegetation in the wetland (ANZECC and ARMCANZ, 2000; Boulton and Brock, 1999).

Electrical conductivity, a measure of salinity, classed the wetland as freshwater (less than 5,000 µS/cm) at all sites and ranged from 578 µS/cm at CoRA3 to 1463 µS/cm at CoRA1. Electrical conductivity was within ANZECC guideline range for 80 % protection of species at freshwater wetlands (300 – 1,500 µS/cm) at all sites and is comparable to that of inland wetlands and creeks in Western Australia (Pinder et al., 2004).

Dissolved oxygen percentage saturation at Tamworth Hill Swamp was low, ranging from 6.6 % at CoRA3 to 25.3% at CoRA4. The lower dissolved oxygen concentration is likely caused by the decomposition of dead plant matter and lack of water movement. Super saturation (>100%) of dissolved oxygen, a potential result of high photosynthesis caused by an algal bloom, was not recorded during the survey.

Total Nitrogen ranged from 2 mg/L at CoRA4 to 4.8 mg/L at CoRA2 and exceeded the ANZECC and ARMCANZ (2000) trigger values for freshwater wetlands (1.5 mg/L) at all sites. The highest Total Phosphorus was also recorded from CoRA2 (0.13 mg/L). Total Phosphorus concentrations exceeded the ANZECC and ARMCANZ (2000) trigger values for freshwater wetlands (0.06 mg/L) at CoRA2 and CoRA3. CoRA1 and CoRA4 had Total Phosphorus concentrations below laboratory detection. NOx (total nitrates/nitrites) was highest at CoRA3, while Ammonia exceeded the ANZECC and ARMCANZ (2000) trigger values for freshwater wetlands (0.04 mg/L) at CoRA1, CoRA2 and CoRA3.

The wetland was classed as eutrophic with respect to Total Nitrogen and Total Phosphorus (Ryding and Rast, 1989). All the sites were most likely susceptible to nutrient loading from adjacent residential properties, as well as run off from properties and roads. Despite these disturbances, no algal blooms (an indication of eutrophication) were observed. However, this is often contingent on the time of year that observations are made.

TABLE 4 - Water quality results from four sampling sites

Parameter		Unit	CoRA1	CoRA2	CoRA3	CoRA4	ANZECC Guidelines		
								Freshwater	
							Estuarine	Upland river	Wetland
Basic	pH	units	6.93	6.8	6.54	7.23	7.5 - 8.5	6.5 - 8.0	7.0 - 8.5
	Electrical Conductivity	µS/cm	1463	728	578	934		120 - 300	300 - 1,500
	Salinity	ppt	0.8	0.43	0.35	0.54			
	Redox	mV	-48.2	-79.7	-126	-119.1			
	Dissolved Oxygen	ppm	1.74	1.45	0.65	2.27			
	Dissolved Oxygen	%	18.8	15.1	6.6	25.3		>90	90 - 120
	Temperature	°C	20.7	16.7	15.2	18.2			
Nutrients	Total Nitrogen	mg/L	2.4	4.8	2.9	2	0.75	0.45	1.5
	Total Phosphorus	mg/L	<0.05	0.13	0.08	<0.05	0.03	0.02	0.06
	Total Kjeldahl Nitrogen	mg/L	2.4	4.7	2.3	2			
	NOx as N	mg/L	0.006	0.026	0.54	<0.025		0.2	0.1
	Nitrate as N	mg/L	<0.005	<0.005	<0.005	<0.005			
	Nitrite as N	mg/L	0.012	<0.005	<0.005	0.024			
	Ammonia as N	mg/L	0.52	0.41	0.7	0.034		0.06	0.04
	Phosphate as P	mg/L	<0.005	0.039	0.013	<0.005			

Notes: Pink shading indicates data compared to the (ANZECC and ARMCANZ, 2000) default trigger values for South-West Australia. Shading indicates exceedance of default trigger values or ranges.

3.7 Vegetation

3.7.1 Regional Vegetation

Variations in native vegetation within the study area can be classified based on regional vegetation associations. Beard et al. (2013) mapping shows the site comprises vegetation association 'Spearwood 998', which is described as jarrah, marri (*Corymbia calophylla*) and wandoo (*Eucalyptus wandoo*) woodland (Beard et al. 2013). Spearwood 998 association has approximately 36.42% of its pre-European extent remaining on the Swan Coastal Plain (Government of Western Australia 2018).

Finer scale vegetation mapping of pre-European vegetation complexes by Heddle et al. (1980) indicates that the north western portion of the site lies within the 'Cottesloe – central and south' vegetation complex and the central and south eastern portion of the site lies within the 'Karrakatta – central and south' vegetation complex, which is described as an 'open forest of tuart - jarrah – marri' (Heddle et al. 1980). Descriptions of these complexes are included in Table 5.

Studies have indicated that the loss of biodiversity caused by habitat fragmentation is significantly greater once a habitat type falls below 30% of its original extent (Miles 2001). Pre-European vegetation complexes on the Swan Coastal Plain were mapped by the EPA (2015), with the extent remaining within the City calculated by Eco Logical Australia (2017). The 'Cottesloe Complex - Central and South' still retains >30% of its pre-European extent within the City and the Swan Coastal Plain (Table 5). The 'Karrakatta Complex – Central and South' has 14% of its pre-European extent remaining within the Swan Coastal Plain, however 47% of its pre-European extent within the City remains.

TABLE 5 - Extent of pre-European vegetation complexes

Vegetation Complex	Description	Pre-European extent		Pre-European extent remaining (ha and %)	
		Swan Coastal Plain	City of Rockingham	Swan Coastal Plain (2015)	City of Rockingham (2016)
Cottesloe Complex - Central and South	Mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *E. gomphocephala – E. marginata – Corymbia calophylla*; closed heath on the limestone outcrops.	45,226 ha	2,017 ha	15,180 ha (34%)	1,172 ha (58%)
Karrakatta Complex - Central and South	Predominantly open forest of *E. gomphocephala – E. marginata – C. calophylla* and woodland of *E. marginata – Banksia* species.	50,080 ha	4,276 ha	11,518 ha (14%)	1,990 ha (47%)

3.7.2 Plant Communities

The flora and vegetation survey identified four native plant communities, non-native vegetation and two types of revegetation areas (dry shrubland and low wet forest) (Figure 7). Descriptions and area breakdowns of the different types of plant communities identified are shown in Table 6. The most widespread plant community within the study area was Mr 'Low open forest *Melaleuca rhaphiophylla* over tall open shrubland *Melaleuca teretifolia* over tall sedgeland *Gahnia trifida* or *Baumea articulata*, in moderately deep water with occasional non-native grasses in drier areas' that covered 34% of the study area.

The plant communities recorded in the latest 2018 survey are very similar to those identified in the 2012 survey included in the Environmental Management and Implementation Plan - Tamworth Hill Swamp (Coterra Environment 2013b), indicating the vegetation structure and composition has not significantly changed between 2012 and 2018.

TABLE 6 - Plant communities identified

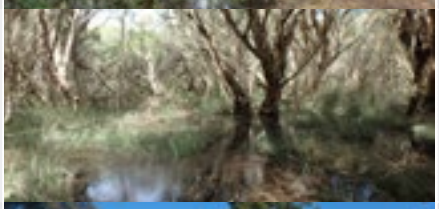
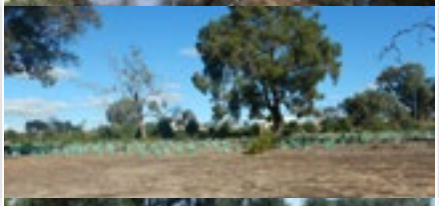
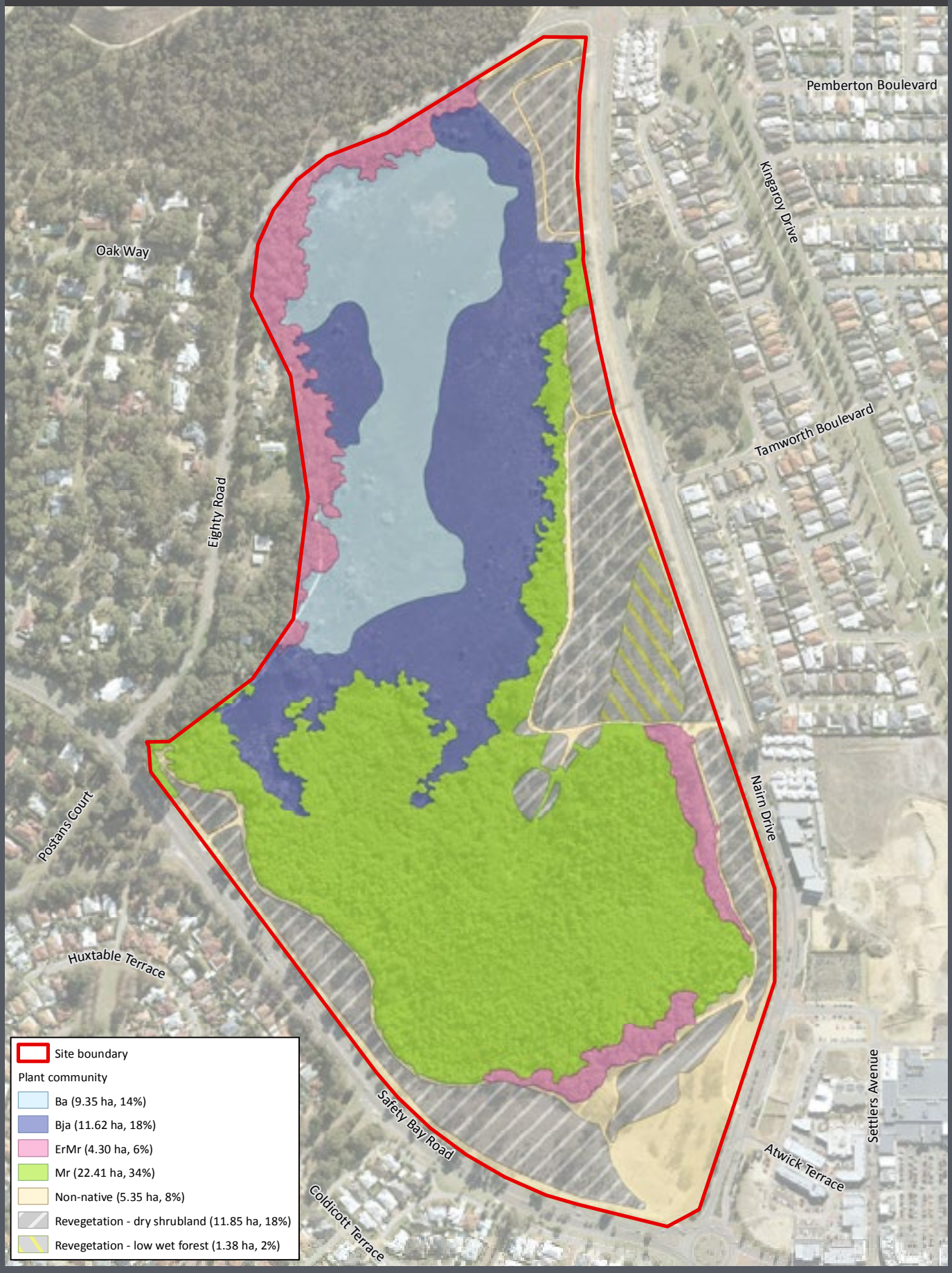
Plant community	Photograph	Description	Area (ha)	% of study area
Ba		Tall closed sedgeland *Baumea articulata* in deep water.	9.35	14
Bja		Closed sedgeland *Baumea juncea* and *Baumea arthrophylla* over scattered herbland *Triglochin striata* in moderate to deep water.	11.62	18
ErMr		Open forest *Eucalyptus rudis* subsp. rudis with some *Melaleuca rhaphiophylla* over tall sedgeland *Baumea preissii* in wetter areas and mixed non-native grassland or forland *Centella asiatica* on drier edges.	4.30	6
Mr		Low open forest *Melaleuca rhaphiophylla* over tall open shrubland *Melaleuca teretifolia* over tall sedgeland *Gahnia trifida* or *Baumea articulata*, in moderately deep water with occasional non-native grasses in drier areas.	22.41	34
Non-native vegetation		Heavily disturbed areas comprising paths and weeds with occasional native trees, shrubs and herbs.	5.35	8
Revegetation – dry shrubland		Low open shrubland to tall shrubland of planted native shrubs and sapling species over non-native grassland and bare ground.	11.85	18
Revegetation – low wet forest		Low closed forest *Eualyptus rudis* over tall open shrubland *Melaleuca* spp. over herbland *Centella asiatica* and non-native species.	1.38	2

FIGURE 7 - Plant Communities



3.7.3 Vegetation Condition

The highest quality vegetation in the study area occurs in the central portion, in association with plant communities **Ba, Baj** and **Mr**. These communities were mapped as being in 'excellent' condition due to their intact vegetation structure and low disturbance levels. The **Ba** and **Baj** vegetation comprised a dense cover of native wetland sedges over occasional native herbs. This area supported few non-native species, likely due to the deep water levels present during the survey.

Plant community **Mr** comprised an intact native canopy over a predominantly native understorey and was inundated at the time of the survey. Towards the perimeter of **Mr** water levels were lower and some non-native grasses were present. It is considered unlikely that high levels of non-native species would be present in **Ba**, **Baj** and the wetter areas of **Mr** when (and if) water levels recede due to the long periods of inundation.

The Keighery (1994) vegetation condition scale used for assessing native vegetation was not intended for use in the assessment of revegetation areas. However, if applied, most revegetation areas would be considered to be in 'degraded' condition due to the lack of an intact (natural) vegetation structure and lack of appropriate native species diversity. However, revegetation area RA2ii does support wetland vegetation with appropriate species and structure and as such it was assigned a 'good' condition.

Areas of the study area containing tracks, bare ground and scattered native trees and shrubs over a non-native understorey were mapped as being in 'completely degraded' condition.

An area breakdown of vegetation condition across the study area is included in Table 7 and shown on Figure 8. The latest flora and vegetation found that many patches of vegetation have improved in condition since the 2012 survey reported in the Environmental Management and Implementation Plan - Tamworth Hill Swamp (2013) and in the Reserve Prioritisation Report (2015).

TABLE 7 - Vegetation condition categories

Vegetation Condition	Area (ha)	% of the study area
Pristine	0	0
Excellent	43.19	65
Very Good	1.74	3
Good	4.13	6
Degraded	11.85	18
Completely Degraded	5.35	8

FIGURE 8 - Vegetation Condition

3 Biophysical Environment (continued)

3.7.4 Floristic Community Type Assessment

An assessment of the plant communities within the study area against floristic community types (FCTs) is presented in Table 8 below. The native plant communities were considered to represent two FCTs, FCT 13 and 17 as detailed in Table 8. The revegetation areas in the study area were considered too degraded to assign to a FCT.

3.7.5 Conservation Significant Vegetation

Although the 'sedgelands in Holocene dune swales of the southern Swan Coastal Plain', TEC occurs within the same Bush Forever site as the study area, the FCT analysis confirmed this TEC is not present in the study area. A different TEC listed under the EPBC Act, 'banksia woodlands of the Swan Coastal Plain' is listed as occurring within the study area in the DBCA database. The survey confirmed that that vegetation in the study area does not represent the 'banksia woodlands of the Swan Coastal Plain' TEC and the occurrence in the database is an error.

TABLE 8 - Plant community and likely FCT represented for each sample

Plant community	Sample	Most similar Gibson et al. (1994) sites	Similarity (%)	FCT	Reservation and conservation status (Gibson et al. 1994)
Ba	Q10	MILT-2 (FCT 13) PAGA-2 (FCT 13)	29 22	FCT 13: deeper wetlands on heavy soils	Well reserved Low risk
	Q11	MTB-5 (FCT 17) WATER-2 (FCT 13)	20 17		
ErMr	Q4	PRES-1 (FCT 29a) LOW10B (FCT 11)	27 23		
	Q7	ELLEN-7 (FCT 6) PAGA-2 (FCT 13) MODO-3 (FCT 11)	21 20 19		
	Q8	WOODP-1 (FCT 30a) PAGA-2 (FCT 13)	21 19		
Bja	Q3	MTB-5 (FCT 17) ELLIS-1 (FCT 17) PAGA-5 (FCT 17)	36 25 25	FCT 17: *Melaleuca rhaphiophylla* – *Gahnia trifida* seasonal wetlands	Well reserved Low risk
	Q9	MTB-5 (FCT 17) ELLIS-1 (FCT 17)	46 33		
Mr	Q1	COOL04 (FCT 17) ELLIS-1 (FCT 17) MTB-5 (FCT 17) PAGA-5 (FCT 17)	40		
	Q2	ELLIS-1 (FCT 17) MTB-5 (FCT 17)	48 40		
	Q5	ELLIS-1 (FCT 17) MILT-2 (FCT 13) MTB-5 (FCT 17)	43 36 33		
	Q6	MTB-5 (FCT 17) ELLIS-1 (FCT 17)	44 43		

3.8 Flora

3.8.1 Flora Diversity

A total of 26 native species (30%) and 60 weed species (70%) were recorded in the study area, representing 37 families and 73 genera. The dominant families recorded were Poaceae (14 weed taxa), Fabaceae (two native and 10 weed taxa) and Asteraceae (eight weed taxa). The most common genus was *Baumea* with four native taxa. Of the species recorded, 38 were recorded in sample locations and 48 were recorded opportunistically. A complete species list is provided in Appendix B and sampled quadrat data in Appendix C.

3.8.2 Weeds

Weeds were common and widespread throughout the study area, particularly around the edges of the reserve. The weed species within the reserve have been sorted by weed suites, which groups the weeds based on their recommended control method. Five weed suites were identified in the study area. A description of each weed suite and the dominant species in each suite in the study area is provided in Table 9. A complete list of weed species, sorted by weed suites is provided in Table D1 of Appendix D. Weed suite mapping broken into percentage cover across the study area is shown in Figures 9 to 13. The areas in the study area with deep water levels had absent to low weed coverage.

Two prominent weeds, fig (**Ficus carica)* and Brazilian peppertree (**Schinus terebinthifolius*) were recorded within the southern half of the study area (locations shown on Figure 12). Photos of these significant weeds are shown in Plates 4A and 4B and their GPS locations are included in Table D2 in Appendix D.

TABLE 9 - Weed suite descriptions

Weed suite	Dominant weed species
1 – annual and perennial grasses	**Avena* spp., **Briza* spp., **Cenchrus clandestinus, *Cynodon dactylon, *Ehrharta* spp., **Lolium rigidum, *Stenotaphrum secundatum*
2 - pampas grass	**Cortaderia selloana*
3 – herbaceous weeds	**Asparagus asparagoides, *Conyza sumatrensis, *Cotula sp., *Erodium botrys, *Fumaria capreolata, *Lupinus* spp., **Lysimachia arvensis, *Solanum americanum, *Solanum nigrum*
4 - woody weeds	**Ficus carica,* Gomphocarpus fruticosus, *Nerium oleander, *Schinus terebinthifolia, *Solanum linnaeanum*
5 – bulbous weeds	**Oxalis pes-caprae, *Romulea rosea var. australis,* Zantedeschia aethiopica*

PLATE 4A - Fig (Ficus carica*)**

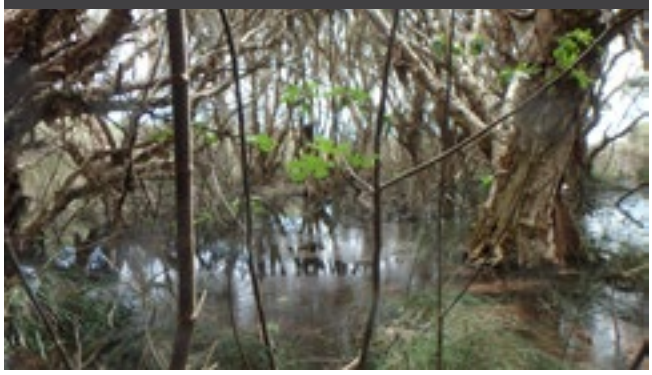
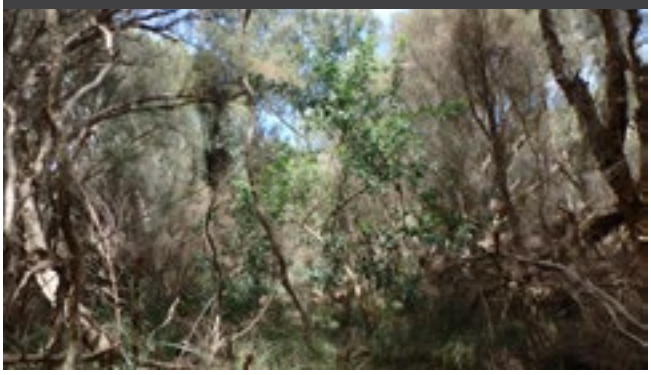


PLATE 4B - Brazilian peppertree (Schinus terebinthifolius*)**



3 Biophysical Environment (continued)

Significant weeds

Four significant weeds identified in the study area (Figures 11 to 13). Photos of these significant weeds are shown in Plates 5A to 5D and their GPS locations are included in Table D3 in Appendix D.

- bridal creeper (**Asparagus asparagoides*) - WoNS and Declared Pest plant. A single plant was recorded in the central eastern portion of the study area.
- narrow leaf cotton bush (**Gomphocarpus fruticosus*) - Declared Pest plant. This species was found at a high density, predominantly in the northern half of the study area (311 plants recorded).
- apple of sodom (**Solanum linnaeanum*) - Declared Pest plant. Eight plants were recorded in the southern half of the study area.
- arum lily (**Zantedeschia aethiopica*) - Declared Pest plant. Four plants were recorded in the southern portion of the study area.

PLATE 5A - Bridal creeper (*Asparagus asparagoides)

PLATE 5B - Narrow Leaf Cotton Bush (*Gomphocarpus fruticosus)

PLATE 5C - Apple of sodom (*Solanum linnaeanum)

PLATE 5D - Arum Lily (*Zantedeschia aethiopica)

FIGURE 9 - Weed Suite 1 - Annual and Perennial Grasses

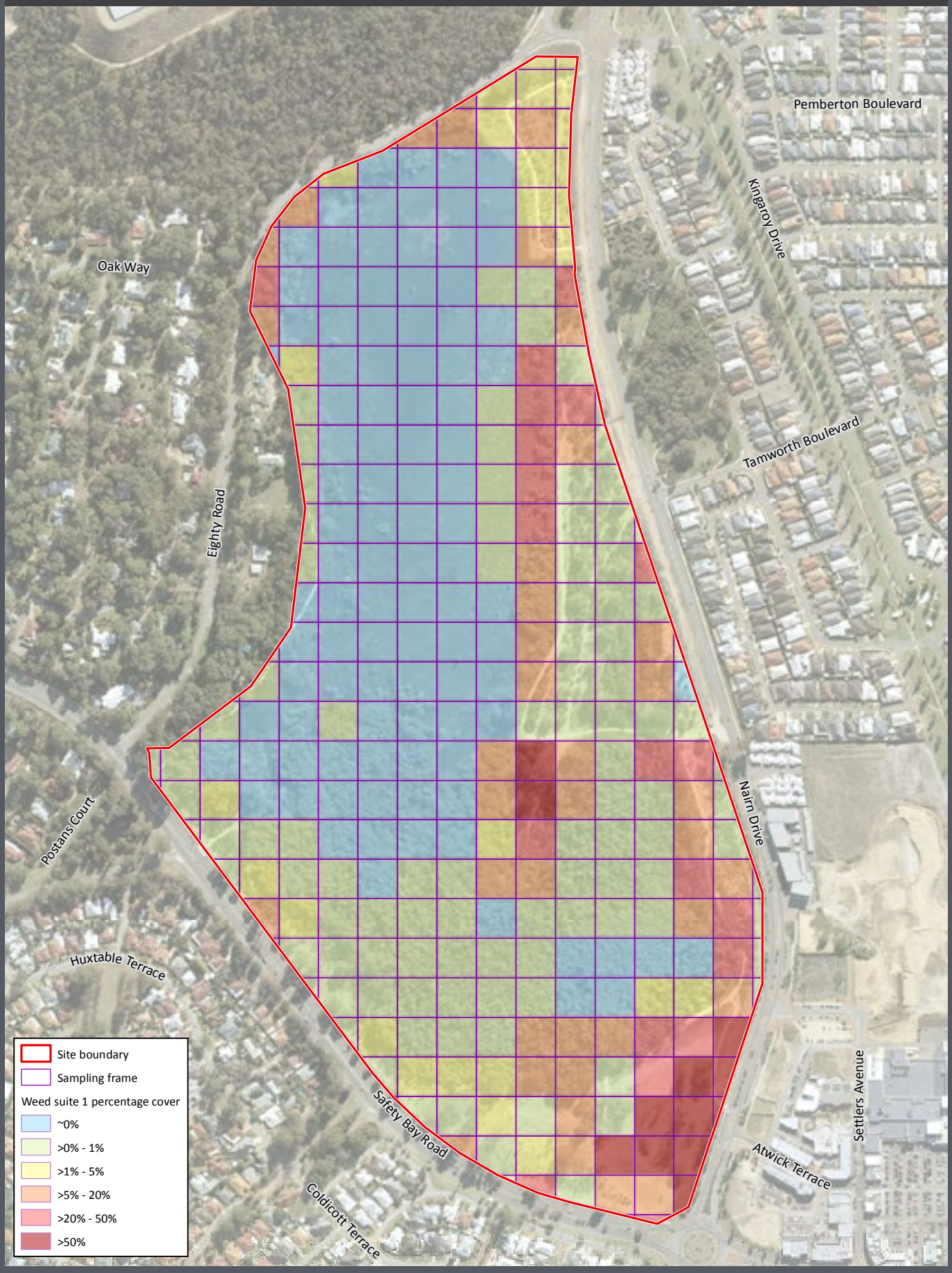


FIGURE 10 - Weed Suite 2 - Pampas Grass

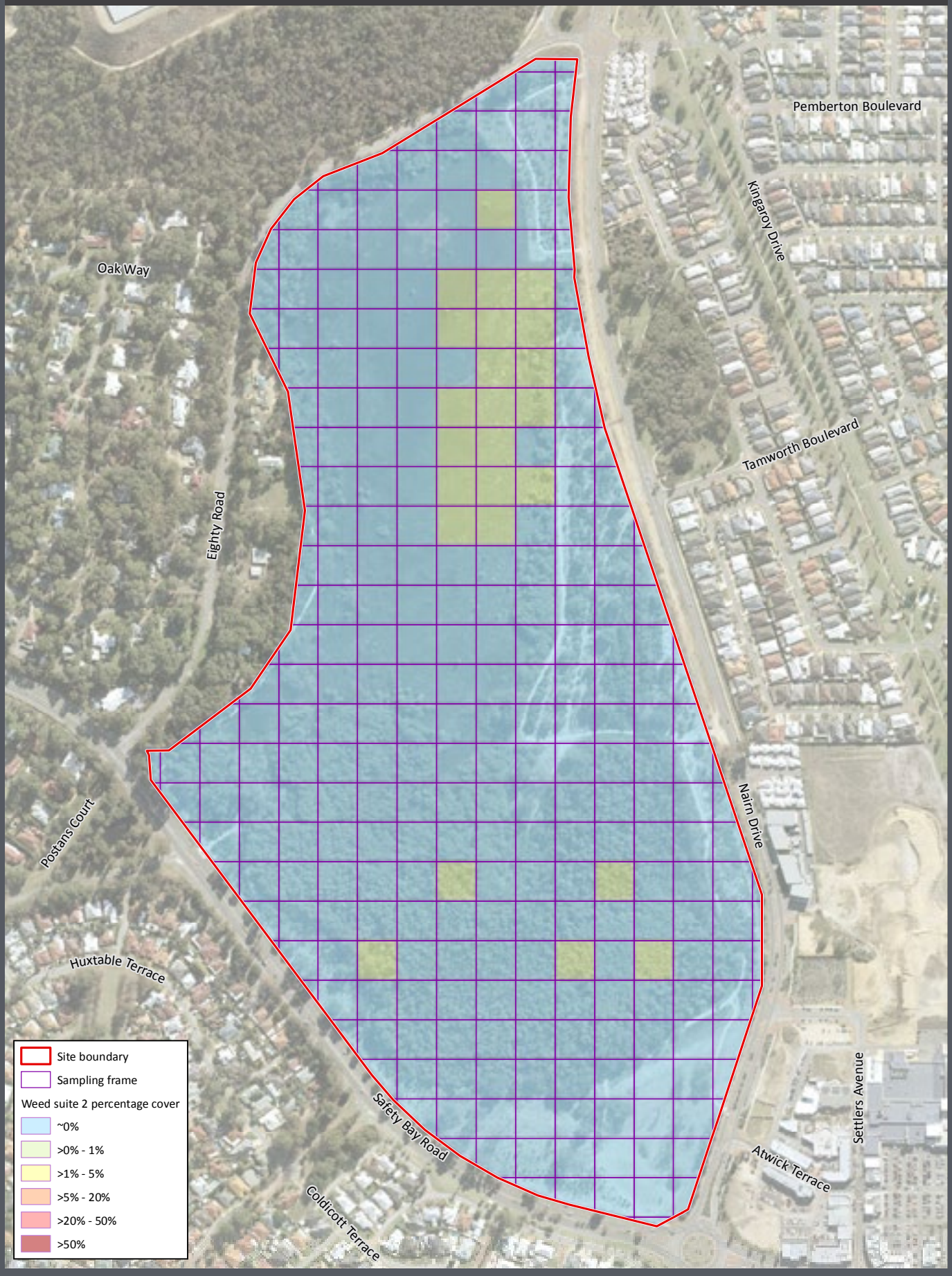


FIGURE 11 - Weed Suite 3 - Herbaceous Weeds

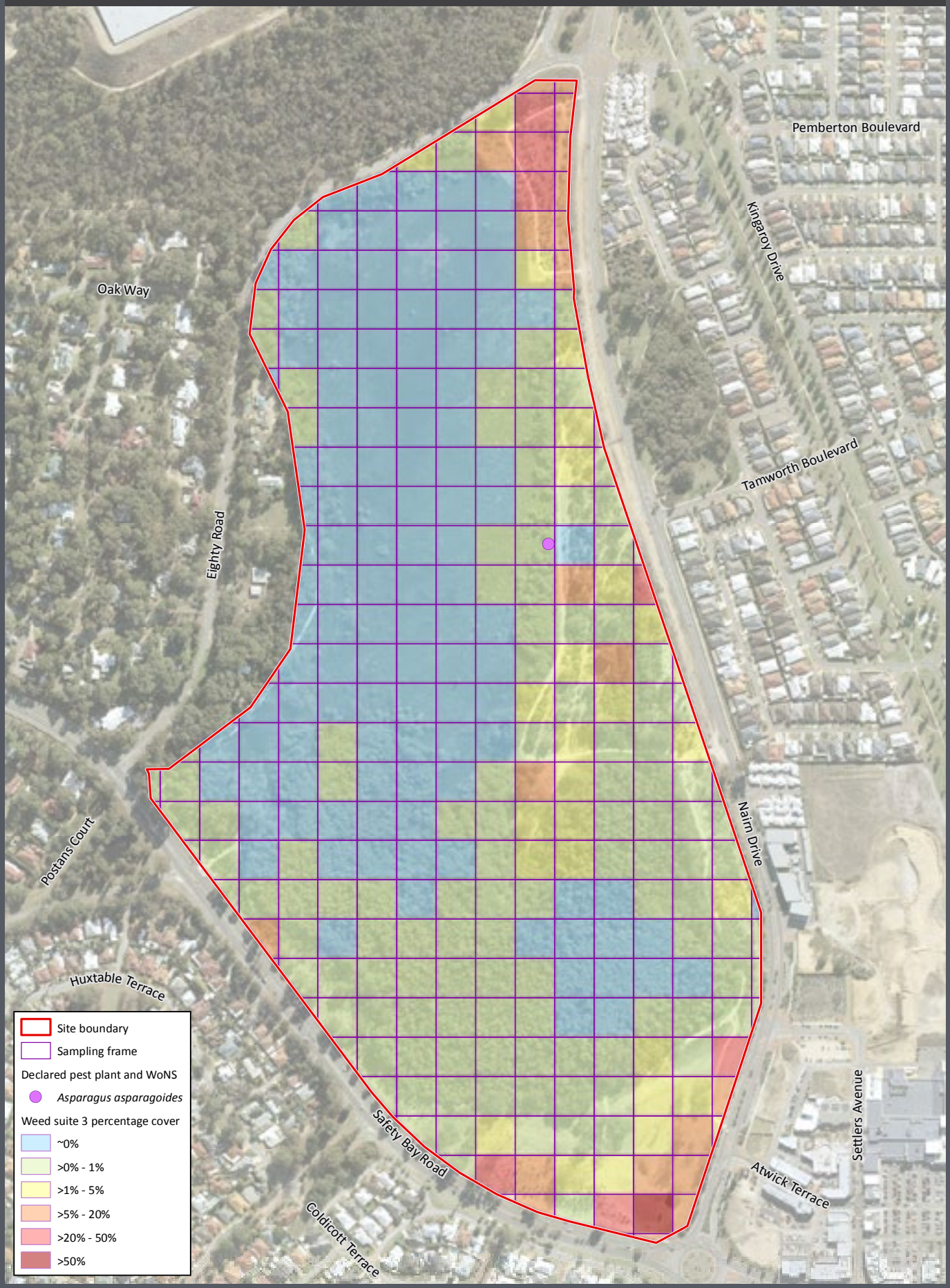


FIGURE 12 - Weed Suite 4 - Woody Weeds

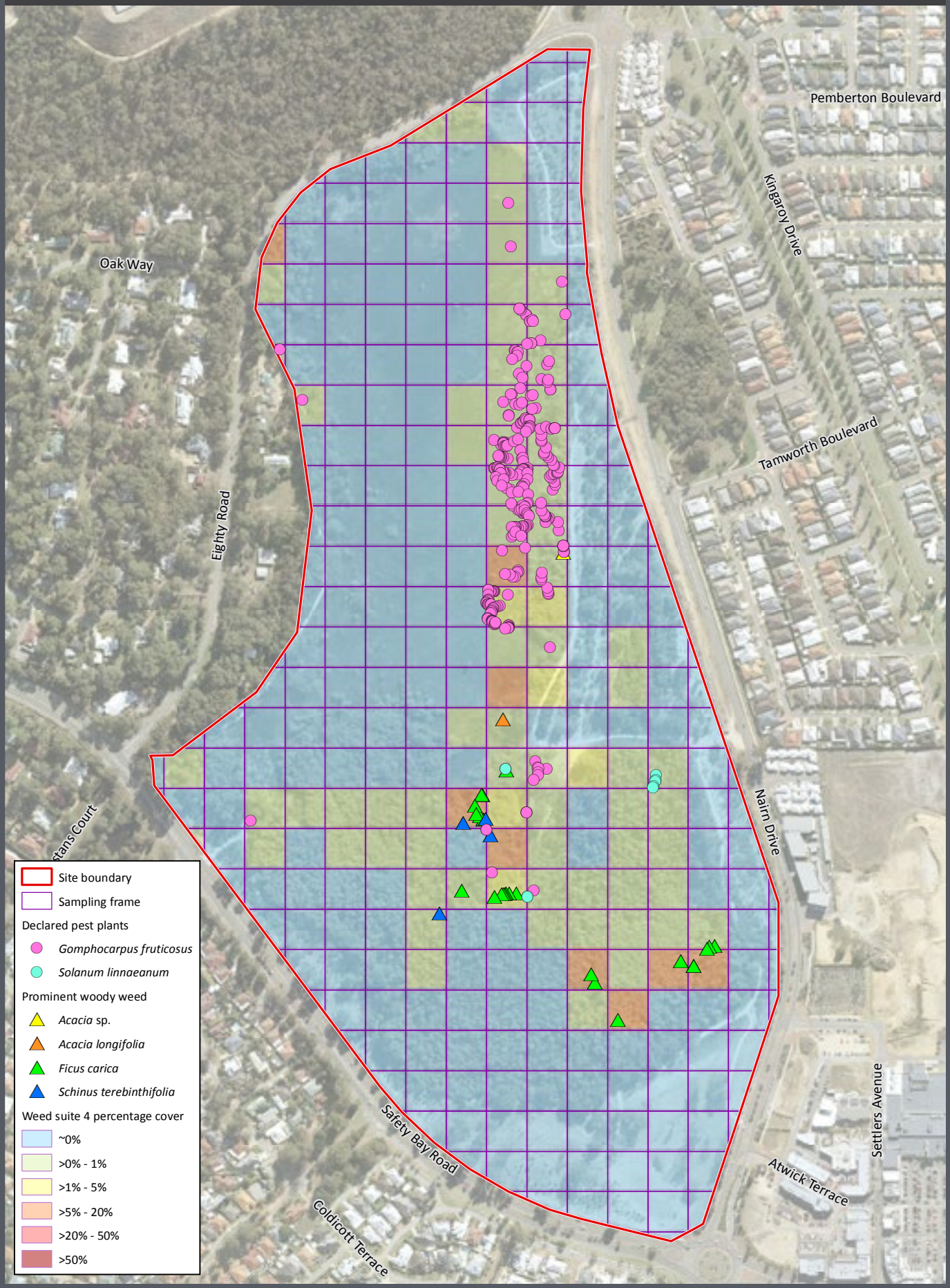
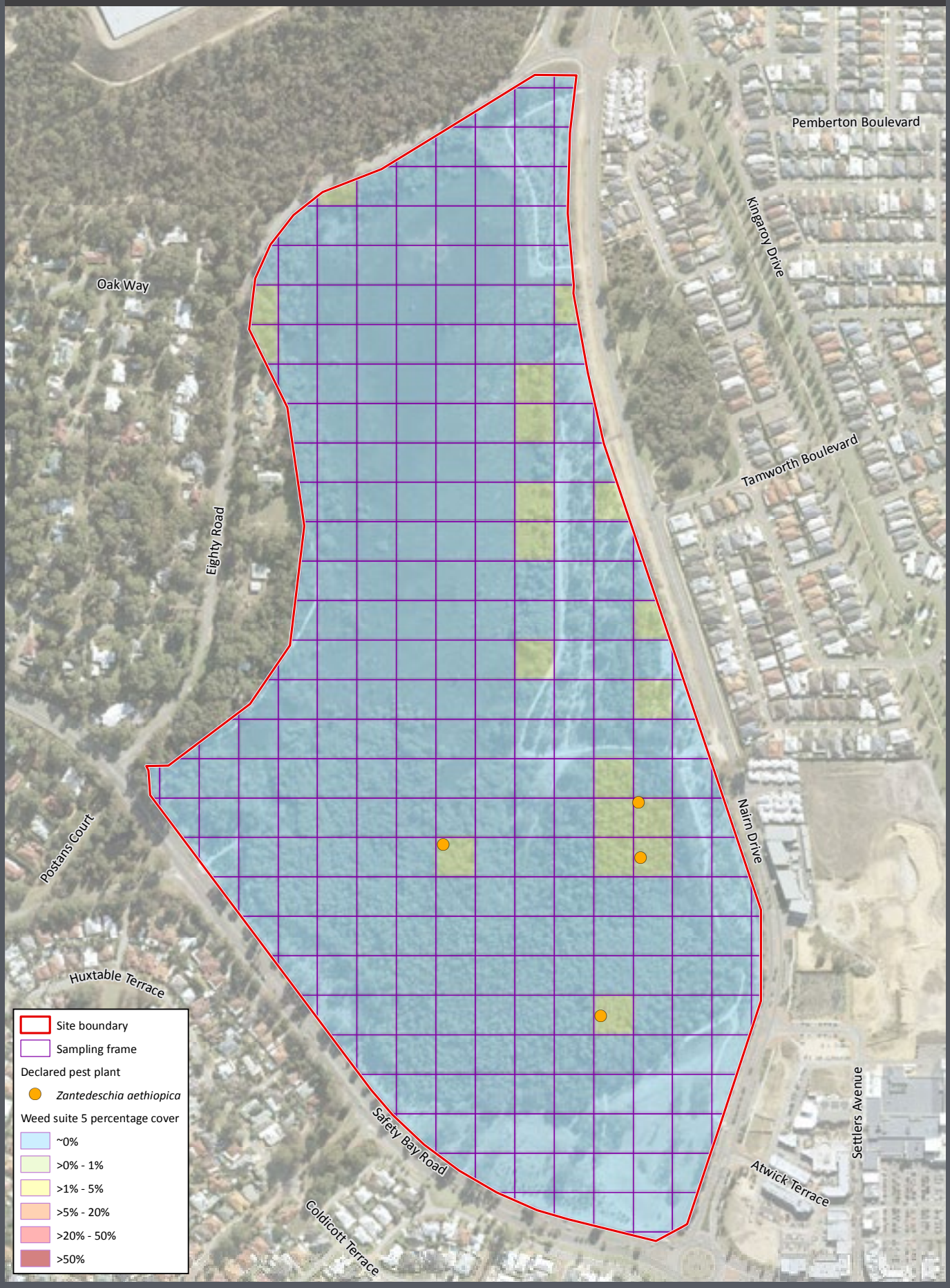


FIGURE 13 - Weed Suite 5 - Bulbous Weeds



3.8.3 Conservation Significant Flora

DBCA's threatened and priority flora database identified known records of 11 threatened flora species and 39 priority flora species within the City's municipality. No threatened or priority flora species have been previously recorded within the study area.

The likelihood of occurrence was determined for each conservation significant species according to known habitat preferences and whether suitable habitat was considered to be present. Only species with habitat preferences of wetlands, moist areas or grey coastal sands were deemed to possibly occur in the site. Species with habitat preferences that do not exist in the site were deemed unlikely to occur in the site.

On this basis five threatened flora species and 31 priority flora species were identified as possibly occurring within the site. Appendix E includes a likelihood assessment of the 50 conservation significant species known to occur within the City's municipality. Many species were considered to potentially occur within the study area, however, no species were considered 'likely to occur'.

No threatened or priority flora species were recorded during the optimal survey timing to detect conservation significant species.

3.9 Revegetation Areas

Portions of the study area that have undergone revegetation are shown on Figure 14. RA (revegetation area) 1-7 form part of the environmental offset and RA8-14 are small areas of the study area that have undergone additional revegetation. Revegetation areas 1-7 are mostly located in a dryland setting on sandy soils. The exception to this is the central portion of RA2, herein referred to as RA2ii, which is low lying and supported some standing water during the field survey.

The revegetation areas vary in age, composition and native species density. General details about each revegetation area are provided in Table 10. A detailed assessment of the environmental offset revegetation areas including a series of tables and figures is detailed in the below sections and presented in Appendix F. Examples of revegetation areas at different stages of maturity are shown in Plates 6 and 7 below.

PLATE 6 - Example of juvenile dry shrubland revegetation within RA7

PLATE 7 - Example of mature wet (low-lying) revegetation within RA2ii

TABLE 10 - Summary information for each revegetation area

Source	Hydrology	Revegetation area ID	Area (ha)	Plant type/s	Vegetation structure
Part of offset revegetation	Dry	RA1	1.14	Mature shrubs, juvenile trees and semi-mature trees	Low forest/open woodland/open shrubland
		RA2i	3.00	Mature shrubs and semi-mature trees	Woodland over shrubland/open shrubland
	Wet (low-lying)	RA2ii	1.38	Mature herbs, shrubs and trees	Closed forest
	Dry	RA3	3.79	Mature shrubs, juvenile trees and semi-mature trees	Woodland over shrubland/open shrubland
		RA4	1.74	Mature shrubs and juvenile trees	Open woodland over shrubland/open shrubland
		RA5i	0.29	None - bare	N/A
		RA5ii	0.62	Juvenile (tubestock) with tree bags	Too immature to classify
		RA6i	0.25	Mature shrubs and juvenile (tubestock) with tree bags	Shrubland
		RA6ii	0.61	Juvenile (tubestock) with tree bags	Too immature to classify
		RA7	0.77		
Identified by Emerge during field survey		RA8	0.04		
		RA9	0.11		
		RA10	0.20	Mature and semi-mature shrubs	Open shrubland
		RA11	0.05		
		RA12	0.02		
		RA13	0.06		
		RA14	0.09	Mature shrubs and small trees	Closed forest

3.9.1 Plant Survival and Density

Of the seven revegetation areas, RA2 supported the highest number of living plants and RA1 the lowest, as shown in Figure F1 in Appendix F. The number of dead plants was able to be determined for recently planted revegetation areas (RA5, RA6 and RA7) due to the presence of empty tree bags. For RA1-4 the tree bags have been removed as they were planted in 2015. Therefore the number of dead plants within RA1-4 was calculated by comparing the number of planted and surviving plants. Evidence of ongoing infill planting was observed within multiple revegetation areas.

All revegetation areas, except RA2ii supported a density of less than the target density of one living plant/m^2, as shown in Figure F2 in Appendix F. Note that no confidence interval (CI) is provided for RA2ii as only one sample was located within this area. A count of dead and alive plant species recorded within each sampling unit in each revegetation area is provided in Tables F1 to F7 in Appendix F.

3.9.2 Species Richness and Diversity

Species richness differed significantly between revegetation areas, with the mean value ranging from four to 13 species, as shown in Figure F3 in Appendix F. The wider confidence intervals for RA5 and RA6 indicate a greater variability in species richness from samples in these revegetation areas.

Five of the revegetation areas, RA2ii, RA4, RA5, RA6 and RA7 met the performance target in that they supported equal or greater than 75% of the number of species planted, as shown in Figure F4 in Appendix F. RA2i supported the lowest percentage of species with 30% of the species planted recorded. However, only two samples were located in this area, rather than three in all other revegetation areas, due to the separation of RA2 into wet and dry portions. RA2ii supported more than 100% of the number of species planted which is likely due to natural recruitment from wetland vegetation within the site.

The composition of species varied considerably within and across revegetation areas and most areas lacked native ground layer species, as shown in Figure F5 in Appendix F. Five native ground layer species were recorded and the highest cover of native ground layer species was recorded in RA2, due to the presence of dense *Centella asiatica* in low lying areas. A total of 16 native shrub species were recorded, with many species, such as *Hakea trifurcata*, recorded within all sampled revegetation areas. A total of 12 tree species were recorded in the site. It was difficult to distinguish between the multiple *Eucalyptus* species planted in the site due to the juvenile stage of the plants and so some individuals were identified as *Eucalyptus* sp.

3.9.3 Weed Cover

Weed cover was variable within revegetation areas and also varied across revegetation areas, as shown Figure F6 in Appendix F. The highest weed cover was recorded in RA4 (mean 41.7 % ± CI), and the lowest weed cover was recorded in RA1 (7.0% ± CI). The spread of 95% CI for sample means indicates that only RA1 can be expected to have weed cover consistently below the target of 20%.

3.9.4 Revegetation Success

One revegetation area, RA2ii, met two out of three of the performance targets, and was the only revegetation area to meet the plant density target of ≥1 plant/m^2, as shown in Table 11. Five of the seven revegetation areas supported at least 75% of the species planted, and only one revegetation area, RA1, met the weed cover target. The performance of the environmental revegetation areas against the targets is shown in Figure 15.

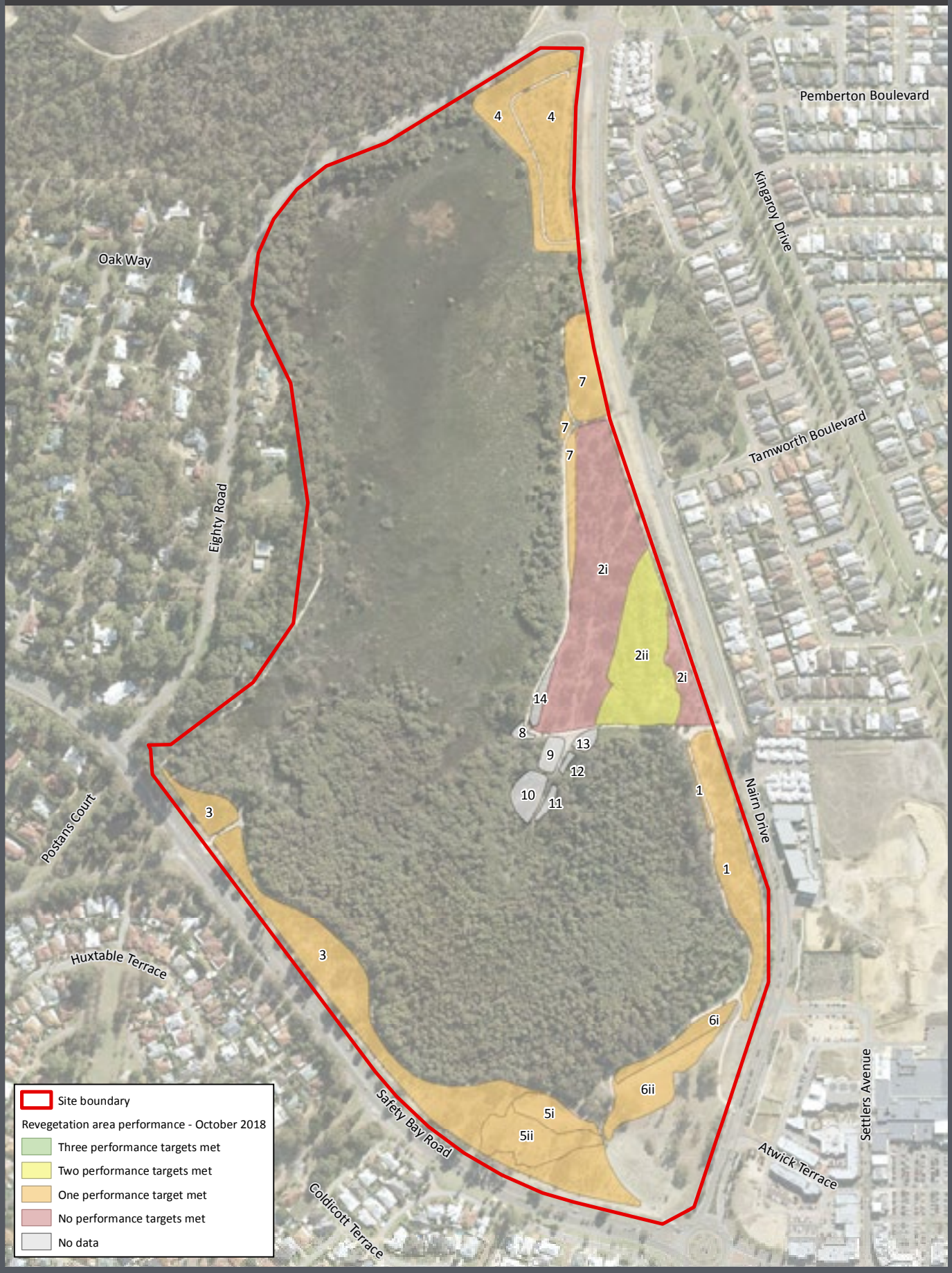
This highlights the importance of planting at a greater density than 1 plant/m^2, if performance targets for revegetation are to be achieved.

TABLE 11 - Summary of performance targets within each environmental offset revegetation area

Revegetation Area	Performance target (Coterra Environment 2013a)		
	≥1 plant/m^2	≥75% of Revegetation species list	<20% weed cover
RA1	✗	✗	✓
RA2i	✗	✗	✗
RA2ii	✓	✓	✗
RA3	✗	✓	✗
RA4	✗	✓	✗
RA5	✗	✓	✗
RA6	✗	✓	✗
RA7	✗	✓	✗

FIGURE 14 - Revegetation Areas

FIGURE 15 - Revegetation Performance against Targets



3.10 Fauna

3.10.1 Vertebrate Fauna

A number of targeted fauna surveys have previously been undertaken within the study area, including:

- Level 1 fauna survey in 2012 (Coterra 2013c)
- Vertebrate fauna survey (focusing on ground dwelling fauna, including reptiles and mammals) in 2015 (Biologic 2015)
- Quenda (*Isoodon fusciventer*) population monitoring in 2018 (Bamford 2018)
- Frog population monitoring between 2014 and 2018 (Biota 2014-2018).

A targeted bird and volant mammal survey was undertaken in spring 2018 to address the gap in information on bird and bat species at the reserve. As birds are highly mobile and able to travel large distances across the landscape in search of foraging, roosting and breeding habitat it is important to understand the bird species likely to utilise the study area.

Fauna Habitat Types

Four main fauna habitat types were identified in the study area, as described in Table 12 and on shown on Figure 16. The forest habitat mapped in the study area is likely to support the greatest number of bird species as it covers the largest area, supports many native flora species within multiple strata and has both wetland (seasonal) and terrestrial habitat components.

TABLE 12 - Broad fauna habitat types identified

Habitat type	Description	Hydrology
Closed sedgeland	Dense sedgeland dominated by *Baumea* spp.	Seasonally inundated with some areas of open water in wetter seasons
Forest	Forest dominated by trees such as *Melaleuca rhaphiophylla* and *Eucalyptus rudis* over open water and sedges in wetter areas and non-native grasses on drier edges.	Seasonally inundated/waterlogged
Open woodland	Scattered native trees such as *Corymbia calophylla*, *Eucalyptus gomphocephala* and *Eucalyptus rudis* over open non-native grassland and bare ground and tracks.	Dry
Emergent trees over shrubs and saplings (revegetation)	Occasional emergent native trees over various species of planted tree saplings and shrub over predominantly non-native grasses and herbs.	Dry

Fauna Species

Previous fauna surveys commissioned by the City recorded a number of amphibian (Plate 8), reptile, mammal and bird species within the study area. A list of all species recorded within the study area is provided in Appendix G.

PLATE 8 - A species of frog that has been recorded in the study area: Moaning Frog (*Heleioporus eyrei*)

The south-western snake-necked turtle (*Chelodina colliei*) has the potential to occur within Tamworth Hill Swamp as it inhabits a variety of freshwater wetlands within south-western Western Australia. The south-western snake-necked turtle is the only native freshwater turtle species found in the Perth Metropolitan region, following reduction in the range of the western swamp tortoise (*Pseudemydura umbrina*). A study of 35 Perth wetlands undertaken by Santoro (2017) revealed the populations of the species are alarmingly low, with less than 25 turtles being captured at approximately 60% of wetlands, and no juvenile turtles in approximately 40% of wetlands studied. An assessment of the population status and viability of the south-western snake-necked turtle within Tamworth Hill Swamp is necessary to inform any future management actions required to protect the species.

Birds and Volant Mammals

The targeted bird and volant mammal survey recorded a total of 38 bird species comprising 32 native species and six non-native species and five native volant mammal species (bats) in the study area (Table H1 in Appendix H). The majority of birds were detected using a combination of sightings and calls, and all bats were recorded using the bat detector device.

Numerous individuals of the following bat species were recorded in the study area:

- Gould's wattled Bat (*Chalinolobus gouldii*)- see Plate 9.
- Chocolate wattled bat (*Chalinolobus morio*).
- Lesser long-eared bat (*Nyctophilus geoffroyi*).
- South-western Freetail-bat (*Ozimops kitcheneri*).
- Southern forest bat (*Vespadelus regulus*).

PLATE 9 - Gould Wattled Bat (Photo source. S. Ford)

Evidence of breeding was recorded in the study area for one native species, Pacific Black Duck (*Anas superciliosa*), with adults and ducklings observed several times. No other evidence of native fauna species breeding was recorded in the study area. Many of the bird and bat species recorded would be resident and likely to breed onsite. During wetter months of the year non-resident wetland bird species are likely to move to the study area to breed, and a small number of species (e.g. larger birds of prey) may have large home ranges and utilise the study area occasionally i.e. for foraging. The bat species recorded in the study area are likely to roost in tree hollows, under bark and within dense foliage during the day and forage at night time in the air space over all other habitat types.

The fauna species recorded in the study area were expected to occur based on the habitat types present. Given that the study area contains extensive wetland and dryland habitats with native vegetation, it is unsurprising that a wide range of native bird and bat species were recorded. It is also likely that other species of birds and bats utilise the study area that were not recorded during this survey.

Conservation Significant Fauna

The study area has the potential to support a number of conservation significant bird species, including numerous marine species, as identified in Table H2 in Appendix H. One conservation significant fauna species, Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) was recorded in the study area. Forest Red-tailed Black Cockatoos are listed as 'vulnerable' under the EPBC Act and 'Schedule 3' under the BC Act. The large Eucalyptus trees along the fringes of the wetland are likely to provide habitat for all three threatened black cockatoo species (Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and Forest Red-tailed Black Cockatoo). The study area may provide roosting habitat for the Baudin's and Carnaby's Cockatoo as they are known to roost in or near riparian environments or permanent water sources (DSEWPaC 2012).

The 2015 Vertebrate fauna survey recorded the Quenda (*Isoodon fusciventer*), a Priority 4 species listed by DBCA in the study area. The study area has the potential to support the Water-rat (*Hydromys chrysogaster*), a Priority 4 species that inhabits aquatic environments that has been recorded in the locality (DBCA 2019a).

PLATE 10 - Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) (Photo Source. Australasian Ecological Services)

FIGURE 16 - Fauna Habitat Types and Survey Locations

Introduced Vertebrates

Six introduced bird species and three introduced mammal species were recorded in the study area (Table 13). Of these, the feral cat and red fox, are predator species (Plates 11A and 11B). All introduced birds were recorded by calls/sightings and all introduced mammals were recorded by the camera traps.

TABLE 13 - Introduced fauna species recorded

Group	Species	Common name
Bird	*Cacatua sanguinea gymnopis*	Little corella
	Cacatua tenuirostris	Eastern long-billed corella
	Columba livia	Rock Dove
	Dacelo novaeguineae	Laughing kookaburra
	Streptopelia senegalensis	Laughing turtle-dove
	Trichoglossus haematodus	Rainbow lorikeet
Mammal	*Felis catus*	Cat
	Mus Musculus	House Mouse
	Rattus rattus	Black rat
	Vulpes vulpes	Red Fox

Note. The House Mouse was recorded during the 2015 vertebrate fauna survey, while all other species were recorded from the 2018 fauna survey.

PLATE 11A - Feral Cat (*Felis mellifera*) recorded by the camera trap in the study area

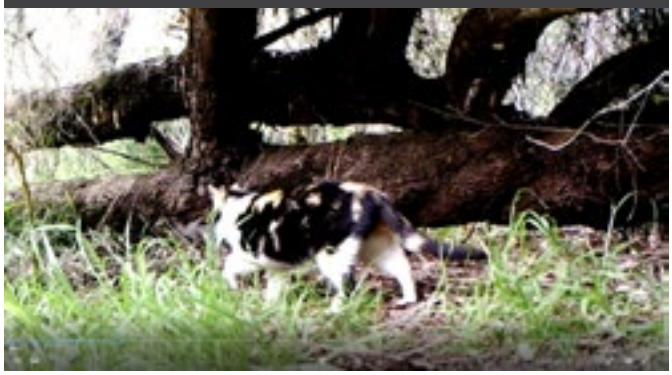


PLATE 11B - Red Fox (*Vulpes vulpes*) recorded by the camera trap in the study area

Feral animals such as foxes and cats pose a threat to native wildlife in the study area, particularly ground dwelling species such as waterbirds, mammals, frogs and lizards. Foxes and cats have the potential to impact the number and range of species present. A large portion of the study area is inundated for extended periods and would provide protected breeding habitat for native birds during this time. Bats are less likely to be impacted by cats and foxes as roost sites are often up high and have small entrances, making them difficult for cats and red foxes to reach.

Evidence of breeding was recorded in the site for two non-native fauna species: little corellas and eastern long-billed corellas. Birds of these species were observed sitting at tree hollow entrances for extended periods of time.

3.10.2 Invertebrate Fauna

The abundance and diversity of invertebrates can be used as leading indicators of wetland health, as invertebrates are critical to ecosystem function and provide a food source for mammals, birds, reptiles and frogs.

Habitat Characterisation

A summary of the habitat characteristics for each of the terrestrial and aquatic sampling sites assessed as part of the survey is provided in Tables I1 and I2 in Appendix I.

Invertebrate Species

More than 1,100 terrestrial invertebrates and 8,413 aquatic invertebrates were identified from eight sampling sites. This consisted of terrestrial invertebrates belonging to 23 Orders, representing more than 74 Families and aquatic invertebrates from 40 taxa (lowest possibly taxonomic level). A list and count of all aquatic and terrestrial invertebrates recorded in each sample site in the study area, identified to the lowest taxonomic level possible and assigned to functional groups is included in Appendix I.

The terrestrial and aquatic invertebrates collected within the study area were representative of those found in wetlands of the Swan Coastal Plain. A number of interesting fauna were collected such as the Common western scorpion fly (*Harpobittacus similis*) and the Common peacock spider (*Maratus pavonis*). While these species are widespread in southern Western Australia (ALA 2018), they are both predators of other insects and are indicative of a healthy ecosystem.

3 Biophysical Environment (continued)

PLATE 12 - Common peacock spider (*Maratus pavonis*) (Photo Source. M. Duncan)

Terrestrial Invertebrates

The majority of the terrestrial invertebrate specimens recorded in the study area belonged to the Insecta group (ants, beetles etc.) (~60%), followed by the Arachnida group (spiders) (~14%) (Table J1 in Appendix J). The remaining terrestrial invertebrates belonged to soil dwelling groups such as the centipedes and millipedes (Chilopoda and Diplopoda), snails (Gastropoda), springtails (Collembola), woodlice (Isopoda), and worms (Annelida). All four sampling sites appeared to be evenly diverse in terms of the taxa represented.

All three functional groups: Predators/Parasites; Detritivores; and Herbivores were all well represented. There were generally equal abundances of all three functional groups. With respect to taxa richness, there were almost twice the number of taxa representing the predators/parasites functional group than the other two groups (Detritivores and Herbivores).

While some invertebrate specimens were identified to species in different groups, all ant specimens were positively identified to species or morphospecies (referred to as JDM as it yet to be described as a formal species). The ants were represented by 17 species in six subfamilies, all known to occur in the South West Botanical province (Table J2 in Appendix 2). Ant species were well represented across all four sites and mainly collected from the leaf litter samples.

Ant species in the Swan Coastal Plain have also been well-documented (Heterick et al., 2013). Ant species lend themselves well to long-term monitoring of landscapes and can be indicators of ecosystem health. Ants especially, have been used for the monitoring of rehabilitation success after clearing (Alonso and Agosti 2000; Andersen 1997; Majer and Nichols 1998; Oliver and Beattie 1996). As ants have been well-studied in the Swan Coastal Plain, targeting this group across the site may also indicate the success of rehabilitation.

PLATE 13A - Prowling Spider (a member of Miturgidae family)

PLATE 13B- Beetle (*Stenoderus suturalis*)

PLATE 13C - Mantidae (*Gyromantis kraussi*)

PLATE 13D - Weevil (*Curculionidae* sp.)

Aquatic Invertebrates

Microcrustaceans, such as water fleas (Cladocera), copepods (Copepoda) and seed shrimp (Ostracoda) dominated the aquatic invertebrate community, accounting for approximately 80% of the aquatic invertebrate specimens recorded in the study area (Table J3 in Appendix J). Cladocerans were the most abundant group across all sites, and cyclopoid and calanoid copepods and Ostracoda were the next most dominant groups. Aquatic insects, while less abundant, were well represented in the survey accounting for approximately 18% of the total abundance of aquatic invertebrates. Fly larvae (Diptera), beetles (Coleoptera), true bugs (Hemiptera) and dragonflies and damselflies (Odonata) were the most abundant insect Orders, all represented by two or more families.

Despite the successful deployment of box traps, no freshwater crayfish (large decapod crustaceans) were recorded during the survey.

First order consumers (Herbivores and Detritivores) made up approximately 84% of the total aquatic invertebrate abundance, mainly due to microcrustaceans such as Cladocera and copepods. Second order consumers (Predators/Parasites) made up a smaller proportion of the overall abundance, accounting for approximately 6% and Generalist feeders accounted for 10% of the total abundance. In terms of group diversity, the first order consumers and second order consumers were more comparable with approximately 46% of taxa classed as herbivores and or detritivores and approximately 39% of groups classed at predators and or parasites. The remaining 15% of groups were generalist feeders.

The high abundance of water fleas may represent a potential issue for the wetland in summer as large numbers of the water flea *Daphnia carinata* in spring are an early warning indicator of poor water quality (Davis and Christidis 1997). Generally, large numbers of this species of water flea can mean that there is an abundance of algae in the water column and when summer comes, and the water fleas die off, the algal blooms can often become nuisance algal blooms

Several pollution sensitive aquatic invertebrate groups were recorded in the study area including:

- water mites (Acari) – well represented
- marsh beetles (Scirtidae) - well represented
- mayflies (Ephemeroptera) – low representation
- scorpion flies (Mecoptera) – low representation
- caddisflies (Trichoptera) – low representation

While these orders can be recorded from degraded wetlands, their representation, and the representation of several groups, is often an indication of a well-functioning aquatic system (Chessman 2003; Gooderham and Tsyrlin 2002). Monitoring these groups over time can give an indication of the health of the system and can help monitor any changes to the swamp. These groups can be used as an early warning system, as their disappearance from a wetland often indicates the onset of degradation.

PLATE 14A - Australian emperor (*Anax papuensis*)

PLATE 14B- Diving Beetle Larvae (*Hyphydrus elegans*)

PLATE 14C - Diving Beetle Adult (*Megaporus* sp.)

PLATE 14D - Water Flea (*Cladocera* spp.)

Invasive Invertebrates

The following invasive terrestrial invertebrate species were recorded in the study area:

- The Argentine ant (*Linepithema humile*) - 4 individuals at CoRT4
- Spotted snake millipede *(Blaniulus guttulatus)* - 21 individuals from CoRT1, 2 and 3
- Portuguese millipede (*Ommatoiulus moreletii*) - 5 individuals from CoRT1, 2 and 3.

European honey bees (*Apis mellifera*) were identified in the hollows of two Tuart trees during the 2012 fauna survey (Coterra 2013b). The locations of the two nests are included in the Section 7.

Only four specimens of the Argentine ant were collected and there is evidence that this ant is not able to compete well with more aggressive and heat tolerant native species (Thomas and Holway 2005). In contrast, higher numbers of the invasive Spotted snake millipede (*Blaniulus guttulatus*) and Portuguese millipede (*Ommatuoilus moreletti*) were collected in three of the four terrestrial sites, which is not surprising as these European millipedes have invaded most urban gardens and reserves. Eradication would be difficult, but it would be important to monitor their populations to ensure they do not outcompete the native millipedes in the area.

No invasive aquatic invertebrate species were recorded. Yabbies (*Cherax destructor*) or Mosquito fish (*Gambusia holbrooki*) were not detected in the study area; however, it is important to monitor for these ecologically destructive species. There is the potential that two native crayfish, the Gilgie (*Cherax quinquecarinatus*) and the Koonac (*Cherax preissii*) could occur in the study area. Both species range from approximately Moore River, to just east of Albany, and are able to persist in seasonally drying wetlands by burrowing (Beatty et al., 2006). Gilgies (*Cherax quinquecarinatus*) have also been recorded from nearby Lake Cooloongup (Conservation Commission 2010). Both native species of crayfish would be severely impacted by the presence of yabbies in the Study Area. Yabbies and mosquito fish have the potential to reproduce quickly and severely impact aquatic ecosystems.

3.11 Conservation Areas

3.11.1 Regional Parks

Regional parks consist of areas of land that have been identified as having outstanding conservation, landscape and recreation values (Conservation Commission 2010). The majority of the site forms part of the Rockingham Lakes Regional Park, which extends to the north and west of the site, as shown in Figure 1 and 17.

3.11.2 Bush Forever

The Government of Western Australia's *Bush Forever* policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

The majority of the study area lies within Bush Forever Site No. 356 (Figure 17). This *Bush Forever* site extends beyond the study area to the north and north-west. Other smaller *Bush Forever* sites occur to the west, east and south east of the study area.

3.11.3 Environmentally sensitive areas

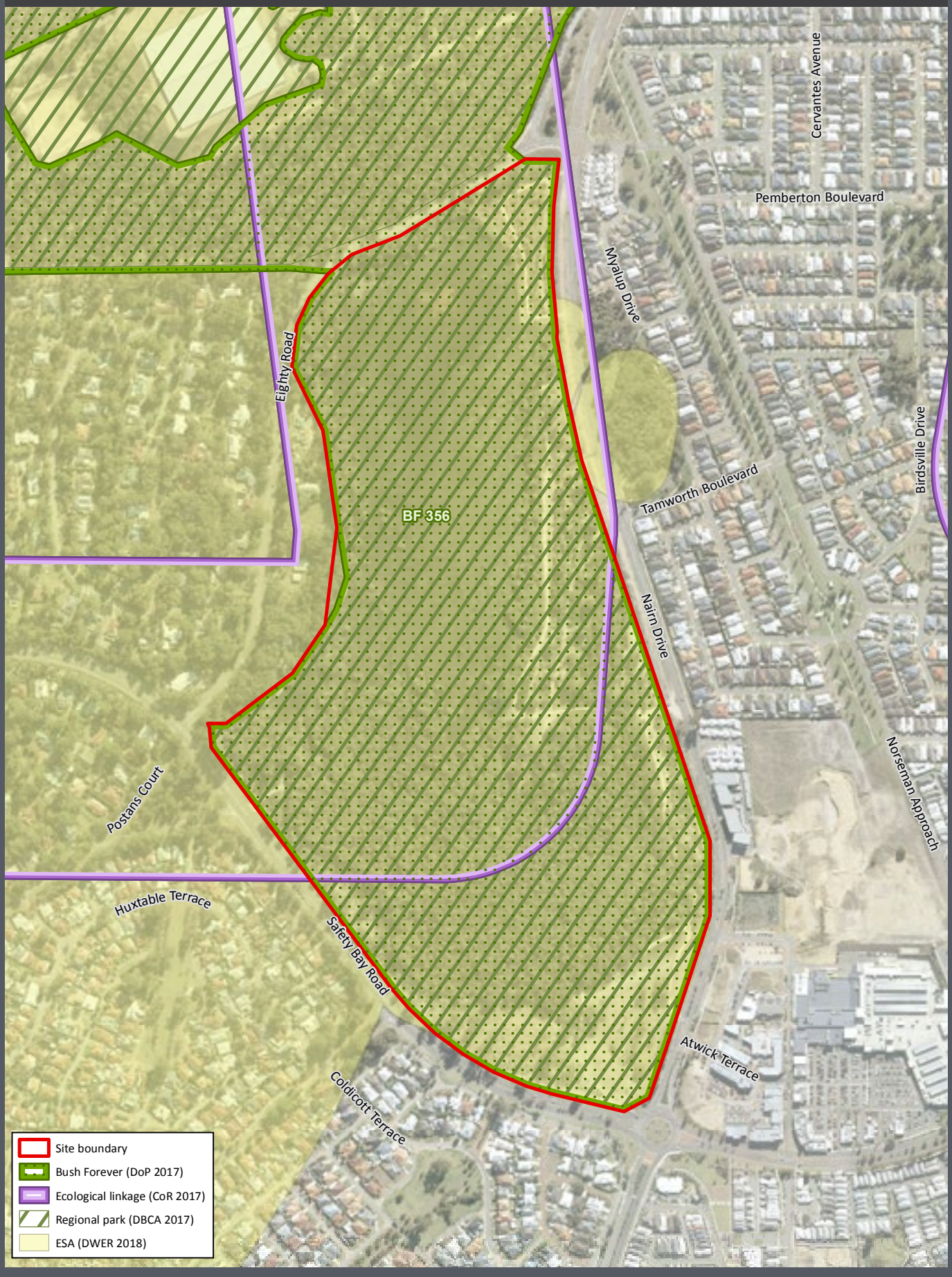
'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection* (*Clearing of Native Vegetation*) *Regulations 2004* and have been identified to protect native vegetation values of areas surrounding significant, threatened or scheduled flora, vegetation communities or ecosystems. An ESA covers the entire study area. This ESA is very large and extends to the north, west and south-west of the site (Figure 17).

3.11.4 Ecological Linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. The movement of fauna and the exchange of genetic material between vegetation remnants improve the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

Ecological linkages across the City's municipality were defined as part of a Natural Areas Technical Assessment undertaken by Eco Logical Australia in 2017. Ecological linkages were initially constructed as linear pathways joining reserves and larger patches of remnant vegetation. Paths were then expanded into 500 m corridors as this was considered suitable given the scale of the City's municipality. The Natural Areas Technical Assessment identified one ecological linkage running through majority of the study area which extends to the north of the study area through Tamworth Hill (Figure 17). Any natural areas within or contiguous with these defined ecological linkages were defined as 'linking vegetation'. The study area was also identified as supporting 'linking vegetation' that is greater than 4 ha in size.

FIGURE 17 - Conservation Areas



3.12 Heritage Sites

The Rockingham area has long been occupied by the Nyoongar people. The area holds significance to the traditional owners and many sacred sites occur within the region (Conservation Commission 2010).

A search of the Department of Aboriginal Affairs (DAA) *Aboriginal Heritage Inquiry System* did not identify any Aboriginal heritage sites (DAA 2019). The closest registered Aboriginal heritage site is located directly to the north of the study area (Site ID 4323) within Tamworth Hill. This Aboriginal heritage site 'Gas Pipeline 82' comprises 'artefacts/scatter'.

A review of the following sources was undertaken to determine the actual or potential presence of non-indigenous heritage significance:

- World Heritage Sites
- National Heritage Places
- Commonwealth Heritage Places
- City of Rockingham Municipal Heritage Inventory
- City of Rockingham Heritage List.

This review did not identify any heritage features within the study area.

4.0

INFRASTRUCTURE ASSESSMENT

4 Infrastructure Assessment

Well maintained and appropriately located reserve infrastructure plays an important role in ensuring recreational uses are controlled and do not adversely impact on the reserve's conservation values.

Infrastructure within the study area is in relatively new and in good condition. A small portion of recorded infrastructure would benefit from maintenance or upgrade. Figure 18 shows the current and potential future infrastructure including infrastructure in need of upgrade and replacement. A number of major infrastructure options for the study area are presented on Figure 18 (boardwalks, picnic shelters, bird hides, carparks). These items should not be installed ad hoc but considered holistically as part of the future implementation of the Tamworth Hill Swamp Master Plan and Discovery Park Concept discussed in Sections 6 and 7.

Representative photos of the infrastructure in the study area, assigned a good or poor condition, are shown in Appendix K.

4 Infrastructure Assessment (continued)

4.1 Fencing

The majority of the reserve's boundary is fenced, except for the northern portion of the reserve abutting Eighty Road. Fencing is not required in this portion of the reserve due to the presence of a steep downward grade from Eighty Road with dense vegetation and the absence of a pedestrian route. Given the swamp is densely vegetated and inundated/waterlogged for long periods of time it is unlikely that pedestrians would degrade the area by gaining access via the northern reserve boundary.

Two types of fences were identified along the boundaries of the study area:

- 'Wire mesh': timber posts interspersed with three metal star pickets with plastic protectors, with a top wire strand (plain or barbed and the lower half covered in metal mesh
- 'Wood post and wire': timber posts with three wire strands and box strainers.

Most of the wire mesh fencing was determined to be in good condition. Some portions, particularly along Safety Bay Road, were in poor and very poor condition due to loose top wire strands and buckled wire mesh. All of the wood post and wire fencing was determined to be in good condition. 'Poor condition' is assigned where fencing is considered adequate for restricting vehicular access but requires maintenance to ensure the condition does not decline further. The type, condition and extent of fencing within the reserve is detailed in Table 14.

TABLE 14 - Fencing type, condition and extent

Fence type	Description	Condition	Length (m)	Restrict Access to?	
				Pedestrians	Vehicles
Wire mesh	Parts of this fence were under water at the time of the infrastructure assessment (on western boundary adjacent to residential lots).	Good	1454	Yes, mostly. A large gap beneath the fence exists between access point 1 and 2, where an existing bubble-up pit has created a low level depression at the fence line.	✓
		Poor	900		
		Very Poor	344		
Wood post and wire	Parts of this fence were under water at the time of the Infrastructure assessment (on western boundary adjacent to residential lots).	Good	519	✓	✓

4.2 Access Points

The seven access points to the reserve are shown on Figure 18. The adequacy of the access points in terms of condition and type of infrastructure is identified in Table 15.

Access points A1-A7 were considered adequate to allow pedestrian access and restrict unauthorised vehicular access. Surface upgrades of the access points are required to improve the safety and accessibility of access points 1, 3, 4, 5 and 8. No new reserve access points are required. None of the access points currently have formal car parking. However Access Point 7 has compacted sand car parking areas across Safety Bay Road at either side of Eighty Road south.

TABLE 15 - Details of the reserve access points

Access point No.	Fence type and condition at access points	Access type and condition
A1	Wire mesh: • North of A1: good condition. • South of A1: good condition, some sections of top wire loose and rusted.	Pedestrian access (metal and wood post chicane) in good condition.
A2	Wire mesh: south and north of A2 in good condition.	Vehicular access (locked metal gate) in good condition. Adequate to restrict vehicles.
A3	Wire mesh: south and north of A3 in good condition.	• Pedestrian access (metal kissing gate) in good condition • Vehicular access (locked metal gate) in good condition. Adequate to restrict vehicles.
A4	Wire mesh: south and north of A4 in good condition.	• Pedestrian access (metal and wood post chicane) in good condition. • Vehicular access (locked metal gate) in good condition. Adequate to restrict vehicles.
A5	Wire mesh: south and north of A5 in good condition.	• Pedestrian access (metal and wood post chicane) in good condition. Pram ramp from road edge to path.
A6	Wire mesh: • west of A6 in poor condition. • northeast of A6 in good condition with few sections of poor condition.	• Pedestrian access (metal kissing gate) in good condition.
A7	Wire mesh: north and south of A7 in poor condition.	• Pedestrian access (metal and wood post chicane) in good condition. • Vehicular access (locked metal gate) in good condition. Adequate to restrict vehicles.
A8	Wood post and wire that adjoins residential lot fence in good condition.	• Pedestrian access (metal kissing gate) in good condition but very weedy and difficult to see entry. • Vehicular access (locked metal gate) in good condition. Adequate to restrict vehicles.

TABLE 15 - Details of the reserve access points

Path type and condition at access	Signage type, condition and number	Structure type and condition	Bins and dog waste bag dispenser type and condition
• Crushed limestone path into reserve in good condition. • Sandy section between with Nairn Drive footpath and entry. • Possible trip hazard at material change (limestone/asphalt).	1 regulatory sign: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition.	None	None
Crushed limestone path into reserve in good condition.	1 regulatory sign: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition.	None	None
• Sandy/boggy area up to and through pedestrian entry (no defined path) in poor condition. • Crushed limestone path into reserve in good condition.	2 regulatory signs: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition. • 1 x small metal sign: '*$200 fine if dogs not kept on leash*' in good condition.	None	None
• Sections of existing limestone car park are sandy/boggy. • Crushed limestone path in good condition.	1 regulatory sign: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition.	1 x Signage shelter with no signage attached in good condition.	• 1 x Sulo wheelie bin chained to pole in good condition. • 1 x dog waste bag dispenser attached to pole in good condition.
• Crushed limestone path in good condition. Possible trip hazard at material change between limestone path and concrete pram ramp: poor condition.	1 regulatory sign: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition.	Nonet	None
• Concrete path outside of reserve up to turnstile in good condition. • Crushed limestone within reserve in poor condition, sandy.	2 regulatory signs: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition. • 1 x small metal sign: '*$200 fine if dogs not kept on leash*' in good condition.	1 x Signage shelter with no signage attached in good condition.	None
Crushed limestone path in poor condition.	2 regulatory signs: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition. • 1 x small metal sign: '*$200 fine if dogs not kept on leash*' in good condition. 1 reserve name sign: • 1 x medium-sized metal sign: '*Rockingham Lakes Regional Park*' in poor condition.	1 x Signage shelter with no signage attached in good condition.	None
Sand pedestrian entry and vehicular access in poor condition. Track under water at time of survey.	2 regulatory signs: • 1 x small metal sign: '*Caution keep dogs on leash*' in good condition. • 1 x small metal sign: '*$200 fine if dogs not kept on leash*' in good condition.	None	None

4 Infrastructure Assessment (continued)

4.3 Paths

The type, condition, length and adequacy of paths in the site are listed in Table 16 below. Most of the existing limestone paths are in good condition, with some in the southern portion of the site in poor condition. All of the sand paths are in poor condition as they are boggy and informal. The path on the western boundary is subject to inundation during the wetter months. The number and locations of paths in the site are considered adequate and no new paths are recommended to be installed. Six informal sandy paths were also identified. As shown on the Tamworth Hill Swamp Master Plan in Section 6, all of these informal paths are recommended to be closed and revegetated.

TABLE 16 - Path type and condition

Path type	Description	Condition	Length
Limestone Path	Formal crushed, compacted limestone 2-3m wide	Good	2545 m
		Poor	374 m
	Formal crushed, compacted limestone 2-3m wide (Under water)	Good	600 m
Sand Path	Informal sand tracks	Poor	524 m

4.4 Signage

Two types of regulatory signs and one reserve name sign were recorded in the site. The number and type of existing signage in the site is not considered adequate. The existing sign in poor condition is inadequate to identify the site and requires upgrading and more reserve name signs are recommended. No signage with maps of the reserve and paths or interpretive signage exists in the site. A summary of the signage within the site is provided in Table 17 below.

TABLE 17 - Signage type and condition

Signage type ID	Category	Description	Condition	Number
S1	Regulatory	Small metal sign: (*Caution keep dogs on leash*)	Good	12
S2	Regulatory	Small metal sign: (*$200 fine if dogs not kept on leash*)	Good	
S3	Reserve Name	Medium-sized metal sign: (*Rockingham Lakes Regional Park*):	Poor	1

4 Infrastructure Assessment (continued)

4.5 Other Infrastructure

The study area does not contain any barbeques, picnic facilities or play equipment.

A summary of all 'other' structures, including benches, shelters and bins is provided in Table 18.

TABLE 18 - Type and condition of structures

Structure ID	Type and description	Location	Condition
SH1	Shelter for signage: metal structure and blue colorbond roof.	Access point 4.	Good
SH2	Shelter for signage: metal structure and blue colorbond roof.	Access point 6.	Good
SH3	Shelter for signage: metal structure and blue colorbond roof.	Access point 7.	Good
B1	Bench seat with back, anodised aluminium.	• Between access points 6 and 7. • In semi-shaded position.	Good
B2	Bench seat with back, anodised aluminium.	• Between access points 6 and 7. • In sunny position, no view.	Good
B3	Bench seat with back, anodised aluminium.	• Near access point 4. • In sunny position.	Good
B4	Bench seat with back, anodised aluminium.	• Between access points 5 and 6. • In sunny position.	Good
B5	Bench seat with back, anodised aluminium.	• Near access point 3. • In sunny position.	Good
Bin	Sulo wheelie bin chained to pole with dog waste bag dispenser attached to pole.	Access point 4.	Good

FIGURE 18 - Current and potential infrastructure

5.0

THREATENING PROCESSES

5 Threatening Processes

One of the key overarching objectives for the ongoing management of the study area is to protect and enhance conservation values through the removal of threatening processes. Threatening processes, management approaches and the corresponding key management objectives are discussed in this section. Detailed management recommendations are included under **Section 7 – Recommendations and Implementation.**

5.1 Weed Invasion

Invasive weeds are amongst the most serious threats to Australia's natural environment, threatening our unique biodiversity and reducing overall species abundance and diversity (DotEE 2019b). Weeds are plants that grow in areas where they are not wanted and where they have an environmental or economic impact. Weeds can impact natural values by:

- out-competing native species for nutrients, water, space and sunlight
- reducing the natural diversity by smothering native plants or preventing them from growing back
- reducing habitat for native animals
- altering fire regimes (DBCA 2019b).

Weeds were common and widespread throughout the study area, particularly around the edges of the reserve (70% of all plant species recorded). Four significant weeds were found within the study area (Figures 11 to 13) that are highly likely to threaten native plant communities if they are not actively managed:

- bridal creeper (**Asparagus asparagoides*) - WoNS and Declared Pest plant. A single plant was recorded in the central eastern portion of the study area.
- narrow leaf cotton bush (**Gomphocarpus fruticosus)* - Declared Pest plant. This species was found at a high density, predominantly in the northern half of the study area (311 plants recorded).
- apple of sodom (**Solanum linnaeanum*) - Declared Pest plant. Eight plants were recorded in the southern half of the study area.
- arum lily (**Zantedeschia aethiopica)* - Declared Pest plant. Four plants were recorded in the southern portion of the study area.

Two prominent weeds, fig (**Ficus carica*) and Brazilian peppertree (**Schinus terebinthifolius*) were recorded within the southern half of the study area (locations shown on Figure 12). While these are of lower priority than WoNS and Declared Pests, they should also be actively managed to limit their spread and impacts on the conservation value of the reserve.

PLATE 15 - Cluster of Arum Lily (Zantedeschia aethiopica*)**

Sensitive environments such as Tamworth Hill Swamp should utilise an integrated approach to weed management, which involves a combination of mechanical and chemical treatment coupled with revegetation to increase the ecosystems resilience in the long term.

Revegetation is recommended within the existing environmental offset revegetation areas and degraded areas that have resulted from inappropriate access. Revegetation is not recommended within the areas of remnant native plant communities as the high condition and value of remnant vegetation could become degraded from disturbances (i.e. spreading weeds and trampling vegetation).

The key objectives for weed management within the study area are to:

- prevent the introduction of additional weed species
- reduce the extent of weed coverage and density, with a particular focus on significant and prominent weeds
- ensure weed control actions do not negatively impact flora and fauna
- support weed management with revegetation of suitable native species.

5 Threatening Processes (continued)

5.2 Feral Animals

A number of introduced fauna species have the potential to occur within the study area. These animals can have detrimental effects on the conservation value of the ecosystem through:

- predation on native fauna, potentially impacting on the number and range of native fauna species present
- habitat destruction and land degradation
- competition for food and shelter with native fauna
- introduction and spreading of diseases.

Introduced fauna species that pose a threat to the study area are:

- European wild rabbit (*Oryctolagus cuniculus*): grazes on native vegetation, may impact on revegetation efforts as well as lead to erosion of banks
- European red fox (*Vulpes vulpes*): preys on native fauna species, competes with native fauna for food, habitat and other resources
- Feral cat (*Felis mellifera*): preys on native fauna species, competes with native fauna for food, habitat and other resources
- European honey bee (*Apis mellifera*): competition with native fauna species such as black cockatoos for habitat in tree hollows.

Foxes, cats and rabbits are listed under the EPBC Act as key threatening processes to the conservation of biodiversity in Australia.

The camera traps installed during spring 2018 identified one feral fox and one feral cat (shown in Plate 16A and 16B). Controlling feral animals is particularly important for the study area as it is known to support Southern Brown Bandicoots (*Isoodon fusciventer*), a conservation significant species susceptible to predation (Bamford 2018). A feral animal control program for reducing the population of foxes, feral cats and rabbits is currently in place at Tamworth Hill Swamp.

The key objectives for feral animal control within the study area are to:

continue to target feral animal species (foxes, cats and rabbits) known to occur within the reserve

ensure feral animal control methods are suitable for use in an urban environment.

5.3 Inappropriate Access

Inappropriate access, such as the use of undefined tracks through the reserves can result in habitat degradation or loss through trampling of native vegetation. Trampling of vegetation can lead to changes in flora composition through introduction of non-native species and reduced vegetation cover. Trampling impacts can also lead to soil erosion which can affect wetland health.

Inappropriate access in the form of undefined sandy tracks was observed at five locations throughout the study area, including to the south of access point 2; between access points 3 and 4; off the existing limestone track, into the centre of the wetland, near access point 4; and off the existing limestone track near access point 7. Of the eight reserve access points, all but access point 2 include pedestrian access.

Access point 2 contains only emergency vehicle access, which means pedestrians are likely to jump the fence at the end of the formal crushed limestone track or use the informal sandy track to exit from access point 3. To manage the potentially adverse environmental impacts resulting from undefined sandy tracks within the reserve, they must be either closed by revegetation or formalised. Pedestrian access is required at access point 2 to prevent pedestrians using informal access tracks to exit the reserve.

Portions of fencing along the perimeter of the reserve are in poor condition and require upgrading or replacement to ensure access within the reserve is controlled.

PLATE 16A - Feral Cat (Felis mellifera*)**

PLATE 16B - Fox (Vulpes vulpes*)**

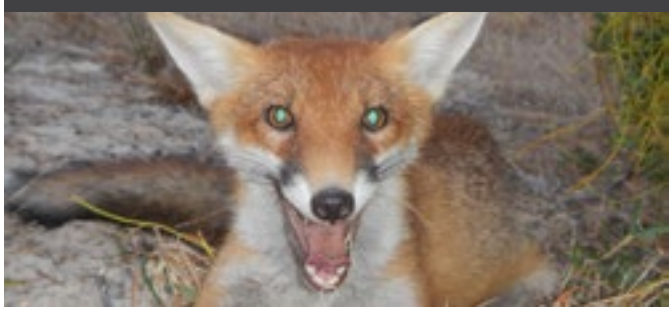


PLATE 17 - Inappropriate access to the south of access point 2

The key objectives for access management within the study area are to:

- formalise undefined tracks where suitable
- rehabilitate unauthorised tracks through weed control and revegetation
- ensure areas of damaged fencing are repaired/upgraded in a timely manner, with old fencing upgraded to rural style
- undertake upgrades where necessary to ensure all access points include safe (no trip hazards and not overgrown) pedestrian access

5.4 Rubbish Dumping

A flow-on effect of inappropriate access is that it may promote vandalism and rubbish dumping. Dumping of rubbish reduces the visual amenity of the reserve and the overall recreational value to the wider community. Rubbish dumping can also cause the spread of non-native plant species. Rubbish dumping was identified along the informal sandy access track to the south of access point 2. The dumped rubbish included a mattress, pillow and large pipe. No vandalism was identified in the study area.

The key objectives for rubbish management within the study area are to ensure:

- adequate provisions of rubbish bins and dog waste bags in locations suitable for collection by rubbish trucks
- bins are emptied regularly
- unauthorised access is restricted

PLATE 18 - Rubbish dumping to the south of access point 2

5.5 Nutrient Runoff

Nutrient loading is one of the leading causes of wetland degradation in south-western Australia, with urban wetlands being particularly vulnerable due to nutrient runoff (often from fertiliser) from residential properties or roads (Davis and Froend 1999; WRC 2001). Nutrient loading has ecosystem health implications, such as noxious and potentially toxic cyanobacterial blooms, which can cause fauna death (ANZECC and ARMCANZ 2000; Boulton and Brock 1999).

The water quality sampling undertaken in October 2018 classed the wetland as eutrophic in terms of Total Nitrogen and Total Phosphorus levels, which is typical of wetlands in the Perth metropolitan area (Biologic 2019). High nutrient concentrations were likely a result of the natural decay of vegetation in the swamp as well as run-off from roads and surrounding residential properties. The rural properties directly abutting the western portion of the reserve sit partially within the mapped CCW. As these rural properties are not connected to sewer there is potential that theirs effluent disposal systems are causing elevated nutrients in the wetland. Aerial photography from November 2018 identifies potential algae along the limestone track adjoining the southern property, however this appears to have subsided by the following month.

Effluent from the effluent disposal systems in these adjacent western properties is at risk of leaching into the wetland due to the: minimal clearance to groundwater; the flood risks within the properties; and the direction of groundwater flow towards the wetland. Figure 19 shows the modelled depth to the maximum recorded groundwater level within these properties based on DWER long-term groundwater monitoring data from a bore at the corner of Eighty Road and Safety Bay Road. As can be seen on Figure 19, in the event that groundwater reaches the historical maximum level, groundwater would likely to be expressed at the surface within parts of the two northern properties adjoining the reserve and majority of the two southern properties adjoining the reserve. It is recommended the potential to reduce water quality impacts from the adjacent properties not connected to sewer be investigated.

Although no algal blooms (an indication of eutrophication) were observed at the time of the surveys being undertaken, this could have been due to the time of year observations were made. Biannual water quality monitoring is recommended to be undertaken to monitor the potential for nuisance algal blooms.

5 Threatening Processes (continued)

As stormwater discharges into the reserve, a survey of the catchment area (identifying pits, pipes and other drainage infrastructure) will enable a broad stormwater and catchment analysis. This will allow the City to identify where potential retrofitting of drainage infrastructure is recommended to improve stormwater quality in accordance with Water Sensitive Urban Design (WSUD) principles and the City's Planning Policy 3.4.3 – *Urban Water Management objectives.*

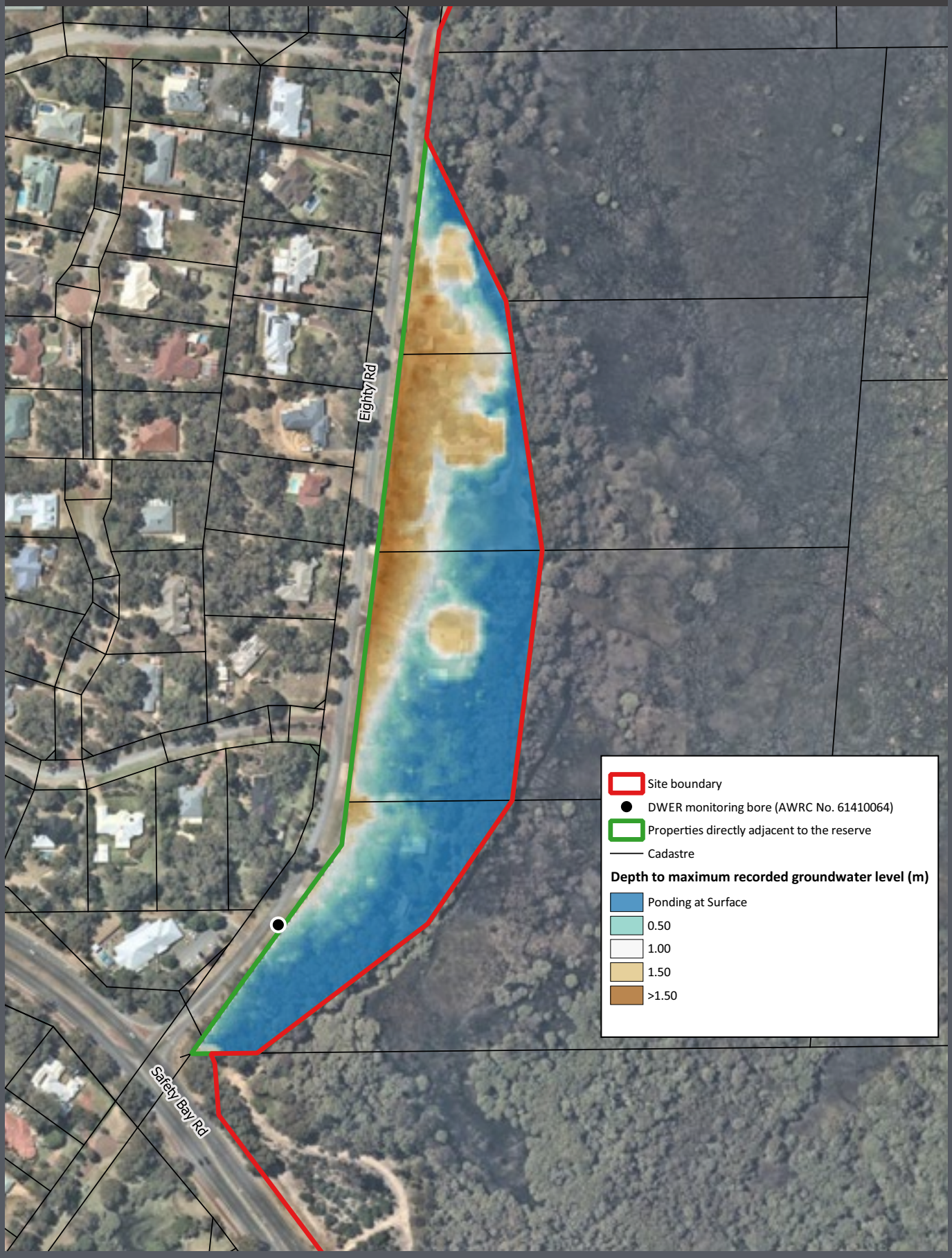
The key objectives for access management within the study area are to:

undertake bi-annual water quality monitoring to gauge the potential for nuisance algal blooms

survey the drainage catchment to identify opportunities for improving stromwater quality entering the reserve.

PLATE 19 - Example of elevated nutrients within the waterbody of the study area

FIGURE 19 - Depth to maximum recorded groundwater level



6.0

LANDSCAPE MASTER PLAN

6 Landscape Master Plan

The environmental significance and unique features of Tamworth Hill Swamp reserve creates an ideal location for both a nature based play area and opportunities to facilitate environmental education for the local and regional community. Baldivis lends itself to a landmark nature play area given its growing population and young family demographic. Currently 52% of people living in the area have children, of which 23% of the children are between 0 and 11.

An overall landscape master plan has been prepared to illustrate future improvements within the reserve and provide guidance for implementation to ensure that the character of the reserve is maintained and enhanced.

The landscape master plan illustrates a continuous looped pathway around the entire swamp, with multiple signed entrance points to ensure the reserve is well connected to the neighbourhood. The looped path provides an opportunity to discover different vegetation communities, places to rest and learn more about the reserve. Due to parts of the western section of path being inundated in cases of high, continuous rainfall events, an alternative track will be created as part of the future improvements to enable use of the reserve throughout the year.

A boardwalk is proposed in the north eastern portion of the reserve to connect the existing limestone tracks, while providing a unique experience crossing a portion of the wetland where the water levels enable a different type of vegetation community to flourish. The boardwalk will allow the community to directly connect with the wetland and enable observation of native fauna such as birds without impacting on the conservation values of the reserve.

The landscape masterplan describes the type, materiality and placement of infrastructure such as signs, seats and bins to ensure that they are sympathetic to the natural surroundings and enhance the site character and user experience.

A nature based play area, titled the '*Tamworth Hill Swamp Discovery Park*' is proposed in the south-eastern portion of the reserve (as shown on Plate 20 and Figures 19 and 20) which is central to the Baldivis community, close to the Baldivis Civic Centre, Mary Davies Library and Community Centre, Shopping precinct, public transport and the Kwinana Freeway.

The Tamworth Hill Swamp Discovery Park is designed to accommodate accessible play for all ages and abilities, while interweaving learning opportunities of the swamp environment. The Park includes educational themes about collection of stormwater, vegetation types and their uses and the various insects and fauna found in the swamp such as bats, frogs and possibly turtles. There is a relaxed grass amphitheatre area for community, educational groups and schools to use as an outside classroom or event space, accompanied with shade structures, BBQ's to enjoy a full day of exploring the swamp, pathways and the Discovery Park.

In conjunction with proposing a 'destination' nature playground at Tamworth Hill Swamp a brief desktop overview of the City's existing playground spaces has been completed to ascertain the current distribution and style of existing playgrounds (see Appendix L). For the purpose of this overview, only existing playgrounds that contain a minimum of five (5) pieces of play equipment for varying ages, key amenities such as BBQ, shelter and a public toilet have been considered.

The playspaces within the City which currently meet the criteria as described above and shown in Appendix L can be classified as follows:

Traditional Play Spaces:

- City Park (Rockingham)
- Don Cuthbertson Park (Cooloongup)
- Tuart Park (Secret Harbour)
- Steel Tree Reserve (Baldivis)

Imagination Based Play

- Fantasy Park (Waikiki)

Foreshore Playground

- Golden Bay Foreshore Playground (Golden Bay)

All-abilities Playground

- The Harbour Playground (Secret Harbour)

From the desktop review it reveals that the City has a unique opportunity to provide a destination playspace at Tamworth Hill Swamp that offers a nature based play space which is focused on environmental education. It will create a unique destination where a variety of ages and abilities can engage with the overall site.

The scale of the proposed playground at Tamworth Hill Swamp can be considered similar to the Bibra Lake Adventure Playground and Kwinana Adventure Park, which are regional attracting playspaces.

The reserve has the ability to support a potential Environmental Education Centre within the Tamworth Hill Swamp Discovery Park. If an Environmental Education Centre is built, it must be designed and constructed to ensure no vegetation is impacted (including for bushfire management) and ties in with the natural character of the site.

6 Landscape Master Plan

PLATE 20 - Proposed nature play location in the south-eastern portion of the reserve

PLATE 21 - Proposed boardwalk location where the limestone track currently ends to the north of access point 3

FIGURE 20

FLORA CONSERVATION AND REVEGETATION

FAUNA CONSERVATION

WATER CONSERVATION AND MANAGEMENT

BIRD WATCHING

EDUCATION

NATURE PLAY

WALKING TRAILS

This Tamworth Hill Swamp Landscape Masterplan has been developed to support the implementation and key objectives of the Management Plan, which include:

- *Protect and enhance conservation values through the removal of threatening processes,*
- *Encourage a range of sustainable recreational experiences through suitably located infrastructure and services*
- *Ensure equity and safety of all reserve users.*

The Landscape Masterplan identifies seven (7) key elements to respond to the management plan objectives, these are:

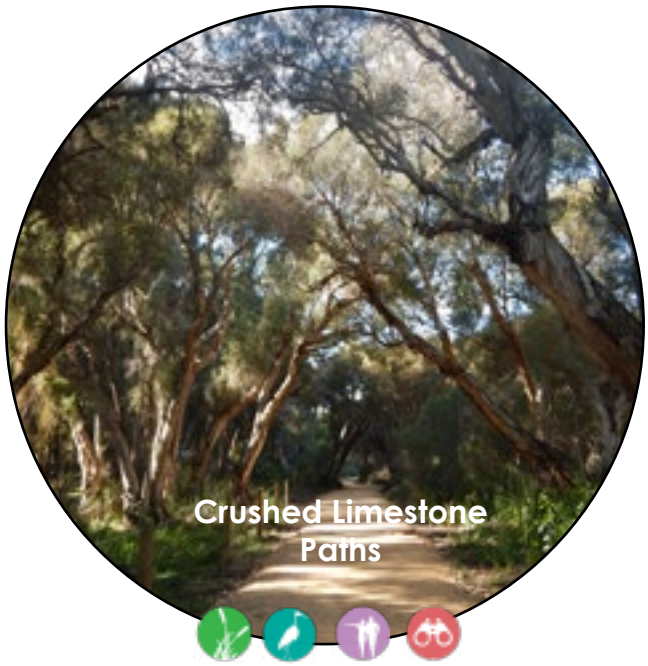
Tamworth Hill Swamp is positioned in the heart of central Baldivis next to the town centre precinct and the Mary Davies Library and Community Centre, this makes the reserve all the more valuable for recreation, education and nature appreciation.

The key design elements for Tamworth Hill Swamp aim to provide the park user with a unique experience. This is achieved through a number of activities such as the 'Tamworth Hill Swamp Discovery Park' full of play, learning and exploring, alongside the many tracks and interpretation opportunities

Maintaining the reserve character is critical and all new infrastructure must align to a consistent palette of materials and suite of signs.

LEGEND

- Existing revegetation areas
- Redundant sandy paths to be revegetated
- Crushed limestone paths
- Crushed limestone paths to be upgraded
- Seasonal alternative route to continue the looped track around the Reserve in periods of high groundwater and rainfall.
- New path adjacent to Eighty Road asphalt (Detailed design to be undertaken with City's Traffic Engineers).
- Fencing
- Boardwalk
- Pedestrian Entry Point
- Maintenance & Emergency Entry Point
- Parking Area
- Signage Location
- Seating
- Shelter and Picnic Bench
- Bird Hide
- Nature Play
- Bin Locations
- Toilet Facility
- Mary Davis Library - Baldivis Stockland Civic Centre



Materials Palette

Boardwalk

Corten Steel

Compacted Limestone

Boulders and Natural Timbers

Natural Logs and Exposed Aggregate

Shelter and Bird Hide

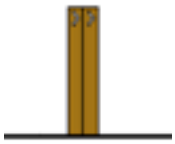
Proposed shelters and Bird Hides should relate to the sites characteristics and material palette. See examples shown below.

Photo Source: OpisArchitecture

Directional Signage

Proposed signage is to be selected in keeping with the Perth Regional Parks Sign System and Brand Images Manual. See below for images relating to proposed design character and themes.

Entry Signage



Trailmarker Sign

Signage within the Tamworth Hill Swamp Discovery Park (playground and immediate surrounds) should be consistent with the proposed materials palette. See examples shown below.

Furniture and Infrastructure

Preference is for all proposed infrastructure and furniture to be chosen from a collection of items which fit with the materials palette. See examples shown below.

Image Sources: UAP Supply

Bench Seat with Back

Drinking Fountain

Bollards

Rubbish Bin

Bike Racks

Bench Seat and/or Picnic Table

BBQ

FIGURE 21

TAMWORTH HILL SWAMP DISCOVERY PARK CONCEPT

NOT FOR CONSTRUCTION.

THIS PLAN IS CONCEPTUAL, AND FOR ILLUSTRATIVE PURPOSES ONLY. A DETAILED SITE SURVEY AND DESIGN PROCESS MUST BE UNDERTAKEN PRIOR TO ANY FUTURE WORKS.

Version 01 - March 2019

1 **Parking area**
Detailed design to incorporate natural materials where possible eg. logs for wheelstops, stormwater to drain into adjacent swale planting.

2 **Existing Trees to be Retained**

3 **Proposed Liquid Limestone All-abilities pathway**

4 **Proposed 2m wide bitumen stabilised limestone pathways**

5 **Open turf areas**
To be irrigated in high use zones for events and picnic areas only and hydrozone towards the perimeter of the site. Irrigation to be sourced from an existing groundwater mainline connection in Settlers Avenue Reserve (R52070).

6 **Proposed Tree Planting**

7 **Pedestrian Entry Point**

8 **Cubby building area**
Utilising existing dead logs onsite, children are able to build their own cubby's.

9 **Seating Node**
Allowance for picnic table settings, shade shelter and BBQ.

10 **Colourful Timber Poles Reflect the Flow of Water**
Tell the story of how water Is collected from the road surface, into a treatment swale and flows down to the lowest point and into the swamp. Can also contain musical elements and/or tactile play eg. stilts.

11 **Climbing Stack**
Utilizing existing dead logs to create a climbing challenge for older children.

12 **Spinner**
Located with all abilities access in mind.

13 **Water Play Hand Pump**
All-abilities accessible hand pump which flows water out into a narrow channel like lined rock/boulder stream, which runs down the site towards item 18 and remains dry when not in use.

14 **Climbing Challenge, Slide and Tunnel**
Aimed towards younger children, also includes a small viewing platform at the top with binoculars so children can see out across the park and swamp. Tunnel is also designed to be all-abilities accessible.

15 **Climbing Tower and Slide**
Play equipment for older children. Located at the higher side of the site to ensure views of the swamp from the top of the towers and into the canopy of existing trees.

16 **Bridge across Boulder clad Seasonal Stream**

17 **Sand and Water Play Table**
All-abilities accessible

18 **'The Swamp'**
Water collection point surrounded and lined with boulders. Includes drainage element to cycle water back up towards Water Play Hand Pump at point 13.

19 **Swamp Planting**
Proposed areas of sedgeland planting along 'water lines' to be used as an educational point with plants which are found within Tamworth Hill Swamp.

20 **Chalkboard & 'Musical Reeds' Play**
Located adjacent to a path, and includes hard surface underneath to be all-abilities accessible.

21 **Tree House 'Swamp House'**
Imaginative play item - circular platforms located around existing tree, designed for young children.

22 **Areas of Native Planting and Proposed Revegetation**
Planting within playground area would be low ground planting to allow views into and across the park.

23 **'Bat Cave'**
A bespoke design and all-abilities accessible cubby with educational activities within the structure, telling the story of bat life and where you might find them and discover them.

24 **Other Play Items**
Such as: Invertebrate Discovery Dig, Animal play sculptures, Swing etc.

25 **Log Steppers and Balancing Play**

26 **Seating Circle and bench**

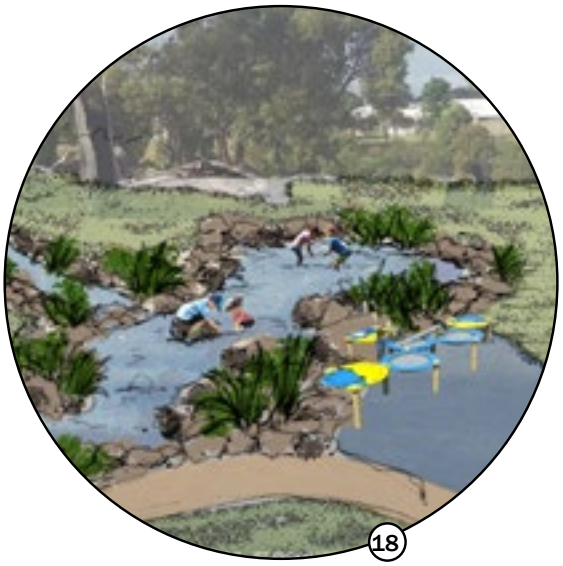
27 **Large Seating Area**
Allowance for several picnic tables, BBQ and overhead shelter designed to reflect flow of water.

28 **Grassed Amphitheater**
Limestone block seats in grass. Can be used for passive recreation, and for educational purposes - school excursions etc.

29 **Streetbond and Rubber Softfall Pathway**
Designed to tell the story of overland waterflow traveling from highest point to lowest point. Mix of 'MPS Streetbond Paving', and Rubber softfall (Softfall only to be installed within play item fallzones).

30 **Area of Mulch or Sand Soft-fall and Mulch Pathways**

31 **Location options for possible Environmental Education Centre and Toilet Facility**



7.0

RECOMMENDATIONS AND IMPLEMENTATION

7 Recommendations and Implementation

7.1 Weed Control

Weed suite mapping broken into percentage cover across the study area is shown on Figures 9 to 13. A summary of the recommended control method and timing for each weed suite is provided in Table 19 below. A complete list of weed species and specific control methods for individual species is provided in Table D1 in Appendix D. The GPS locations of prominent weeds and significant weeds (WoNS and Declared Pest plants) are shown on Figures 11 to 13 and presented in Table D2 and D3 in Appendix D.

The recommended weed control options include manual and herbicide based approaches. The appropriateness of these methods at any given time will depend on an assessment of the weed density, age and habitat (for example in locations that have standing water or where high quality native vegetation occurs). Control methods in sensitive areas may be limited to manual methods such as hand pulling. Therefore, multiple control methods have been provided for some weed suites and the appropriate method should be determined by a Department of Health licensed 'pest management technician'.

Priority areas for weed control across the site, using the 50 x 50 m sampling frame and the above classification system, are shown on Figure 22.

Priority areas for weed control (Priority 1) are proposed based on the location of:

- Individual woody weeds and declared pests and WoNS (to prevent spreading); and
- Weeds within high quality native vegetation, to avoid spread and reduce degradation of native vegetation.

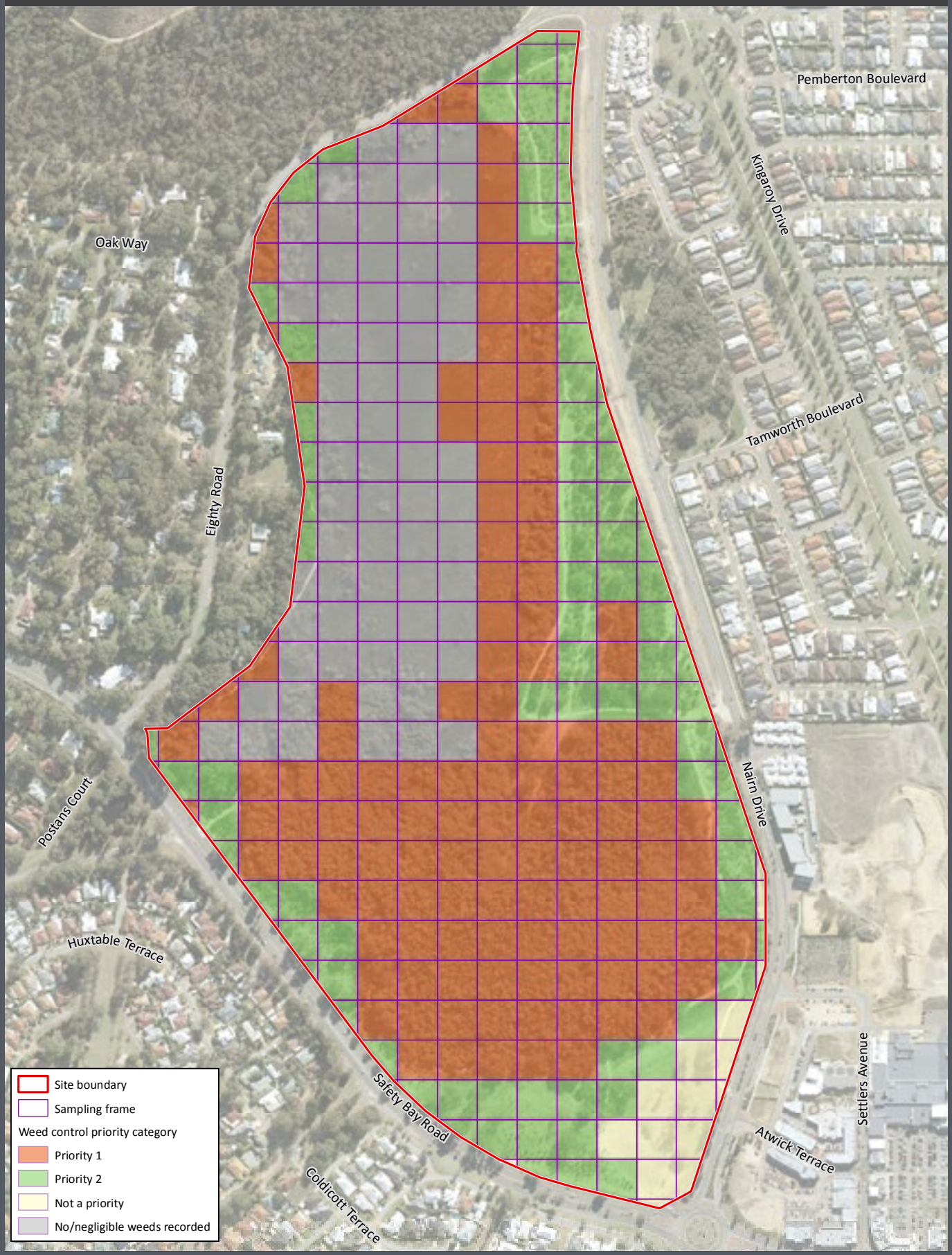
All revegetation areas have been assigned an equal priority (Priority 2) for weed control. Weed control within revegetation should particularly focus on revegetation areas RA3, RA4 and RA5 which are yet to meet weed cover performance targets.

Bulrush (*Typha orientalis*) was previously listed as a non-native plant species but was recently reclassified to native by the DBCA. Bulrush is a natural component of wetlands on the Swan Coastal Plain and was previously recorded in one area of Tamworth Hill Swamp in the previous 2012 survey. Two small areas of Bulrush occur in the site on the edge of the swamp, and the previously recorded area has not increased in size since 2012. Given the lack of change in Bulrush cover, it is unlikely the species will displace other native vegetation in the study area. It is recommended the Bulrush be monitored to determine if it is spreading. Management intervention may be necessary if the species is found to be spreading and displacing other native plant species.

TABLE 19 - Recommended control methods for each weed suite

Weed suite	Recommended treatment/product			Application notes	Herbicide timing
	Manual method	Herbicide			
		Type	Method		
1 - annual and perennial grasses	Not recommended.	Selective (e.g. Fusilade® Forte/ fluazifop)	Foliar spray	Mix herbicide with a wetting agent. May need repeat applications.	Oct-Feb
		Broad spectrum (e.g. glyphosate)	Foliar spray		
2 - pampas grass	Yes - particularly for plants in inundated areas. Cut out small plants, remove unrooted plants to avoid resprouting.	Selective (e.g. Fusilade® Forte/ fluazifop)	Foliar spray	Mix herbicide with spray oil. Remove flower heads. Can slash/burn clumps. May require more than one application.	Dec-Mar
		Broad spectrum (e.g. glyphosate)	Foliar spray		
3 - woody weeds	Yes - particularly for plants in inundated areas. Hand pull small plants, remove as much root material as possible and dispose of plants off-site.	Selective (e.g. Access)	Basal bark large plants using diesel	void root disturbance until confirmed dead.	Dec-Mar
		Broad spectrum (e.g. glyphosate)	Stem inject and/or foliar spray and/or cut and paint		
4 - herbaceous	Yes - particularly for plants in inundated areas. Hand-pull small plants.	Selective (e.g. metsulfuron methyl)	Foliar spray	Mix herbicide with a wetting agent. May need repeat applications.	Jul-Sep
		Broad spectrum (e.g. glyphosate)	Foliar spray		
5 - bulbous	Not recommended.	Selective (e.g. metsulfuron methyl)	Foliar spray		Jun-Sep

FIGURE 22 - Priority areas for weed control



7.2 Revegetation

All revegetation is proposed to use tubestock sourced from local nurseries where possible. Prior to planting, weed control must be undertaken to increase the rate of revegetation success. Tree guards can prevent animals such as rabbits grazing on the tubestock. However, if tree guards are not removed they can become litter resulting in negative impacts to the plants, native fauna and wetland. If tree guards are used for revegetation it is recommended they be made from compostable material and removed in the first winter following planting if the plants are well established. Alternative measures to prevent animal grazing should be considered such as fencing off revegetation areas to prevent kangaroo and rabbit access.

7.2.1 Planting Densities

The infill planting strategy for the next five years and associated costings are presented in Table 20, below.

All existing and proposed revegetation areas are shown on the Landscape Master Plan in Section 6. No additional planting is currently recommended for RA2ii as it meets the density and diversity targets. Future monitoring should be undertaken within RA2ii to determine whether additional planting is required at a later date. RA2i has been assigned the highest priority for infill planting within the environmental offset revegetation areas as it does not currently meet any of the performance targets.

Additional planting within all revegetation areas, including RA1 to RA14 (shown on Figure 14), and sandy paths are recommended to have a planting density of **one plant per m^2** across the entire revegetation areas, not just areas of bare ground. The recommended planting density accounts for existing plant density and future, unavoidable plant death. The plant densities within the revegetation areas should be reassessed as part of the updated management plan in five years to determine if additional planting is required in order to achieve one plant per m^2, with the aim of achieving complete species diverse plant communities.

7.2.2 Plant species selection

The revegetation areas that lack well established shrubs and trees suitable for black cockatoo foraging habitat should be planted with tubestock using species identified in the previous planting lists for each revegetation area in the *Tamworth Hill Swamp Reserve Revegetation Plan* (Coterra 2013). Where revegetation areas have well established shrubs and trees suitable for black cockatoo foraging habitat, planting of tubestock using native ground cover species is recommended to establish a more complete plant community. The recommended ground cover species for revegetation areas with established trees and shrubs has been derived from Gibson et al. (1994) FCT species lists 21a and 21c which reflect nearby banksia woodland vegetation and are a suitable target ecosystem for dryland areas within the study area.

Table 21 provides a list of recommended revegetation species broken into dryland and wetland areas. This table includes a list of suitable wetland species for sandy tracks to be revegetated within the '**Mr**' plant communities and within RA2ii if revegetation is required in the future in this area.

Weed control should be undertaken prior to revegetation to increase the plant survival rate and prevent further weed infestation. It is recommended that all staff members and contractors are trained in hygiene practices while undertaking works in the revegetation areas to reduce potential for pathogen introduction.

TABLE 20 - Infill planting strategy and costings

Revegetation area	Average bare ground	Total area (m^2)	Bare ground area (m^2)	Recommended planting ratio (plants/m^2)	Number of plants required	Cost to plant bare ground area ($4 per plant)
1	52%	11,434	5,946	1	5,946	$23,600
2	32%	29,977	9,593	1	9,593	$38,372
3	32%	37,902	12,129	1	12,129	$48,516
4	32%	17,350	5,552	1	5,552	$22,208
5	47%	9,165	4,308	1	4,308	$17,232
6	25%	8,568	2,142	1	2,142	$8,568
7	40%	7,655	3,062	1	3,062	$12,248
TOTAL		122,051	42,732		42,732	$170,744

7 Recommendations and Implementation (continued)

TABLE 21 - Recommended control methods for each weed suite

Lifeform	Species name*	Wetland areas (RA2ii and sandy tracks within 'Mr')	Dryland areas (RA1 to RA14 and sandy tracks)	
			RAs with established trees and shrubs	RAs lacking established trees and/or shrubs
Grass	*Austrostipa compressa*		✓	
	Austrostipa flavescens		✓	
	Microlaena stipoides		✓	
	Rytidosperma occidentale		✓	
Herb	*Centella asiatica*	✓		
	Chamaescilla corymbosa		✓	
	Conostylis aculeata		✓	
	Conostylis juncea		✓	
	Dasypogon bromeliifolius		✓	
	Isotropis cuneifolia		✓	
	Kennedia prostrata		✓	
	Lobelia alata	✓		
	Lomandra caespitosa		✓	
	Lomandra hermaphrodita		✓	
	Lomandra sericea		✓	
	Patersonia occidentalis		✓	
	Phlebocarya ciliata		✓	
	Sowerbaea laxiflora		✓	
	Xanthosia huegelii		✓	
Rush	*Desmocladus flexuosus*		✓	
	Hypolaena exsulca		✓	
	Juncus subsecundus	✓		
Sedge	*Baumea articulata*	✓		
	Baumea juncea	✓		
	Baumea preissii	✓		
	Gahnia trifida	✓		
	Lepidosperma angustatum		✓	
	Lepidosperma longitudinale	✓		
	Schoenus curvifolius		✓	
Shrub	*Acacia huegellii*			✓
	Acacia pulchella			✓
	Acacia saligna			✓
	Acacia sessilis			✓

**Some species may require prior ordering with specialist nursery providers in order to secure adequate tubestock supply.*

TABLE 21 - Recommended control methods for each weed suite (continued)

Lifeform	Species name*	Wetland areas (RA2ii and sandy tracks within 'Mr')	Dryland areas (RA1 to RA14 and sandy tracks)	
			RAs with established trees and shrubs	RAs lacking established trees and/or shrubs
Shrub	*Allocasuarina humilis*			✓
	Astartea scoparia	✓		
	Calothamnus quadrifidus			✓
	Casuarina obesa			✓
	Eutaxia virgata	✓		
	Hakea lissocarpha			✓
	Hakea prostrata			✓
	Hakea ruscifolia			✓
	Hakea trifurcata			✓
	Hakea varia			✓
	Hardenbergia comptoniana			✓
	Hypocalymma angustifolium	✓		
	Jacksonia furcellata			✓
	Leptospermum erubescens			✓
	Melaleuca laterita	✓		
	Melaleuca teretifolia	✓		
	Melaleuca trichophylla			✓
	Pericalymma ellipticum	✓		
	Spyridium globulosum			✓
	Taxandria linearifolia	✓		
	Viminaria juncea	✓		
	Xanthorrhoea preissii			✓
Tree	*Allocasuarina fraseriana*			✓
	Banksia attenuata			✓
	Banksia grandis			✓
	Banksia ilicifolia			✓
	Banksia litoralis	✓		
	Banksia menziesii			✓
	Banksia sessilis			✓
	Corymbia calophylla			✓
	Eucalyptus gomphocephala			✓
	Eucalyptus marginata			✓
	Eucalyptus rudis	✓		
	Melaleuca rhaphiophylla	✓		

7.3 Infrastructure

Figure 18 shows current and potential future infrastructure, including infrastructure in need of upgrade and replacement. A number of major infrastructure options for the study area are presented on Figure 18 (boardwalks, picnic shelters, bird hides, carparks). These items should not be installed ad hoc but considered holistically as part of the future implementation of the Tamworth Hill Swamp Landscape Master Plan and Discovery Park Concept (presented in Section 6), subject to funding availability and the outcomes of detailed design. All new infrastructure should be sympathetic to the natural landscape to ensure it positively contributes to the reserve's visual amenity. On this basis, consideration should be given to replacing all existing metal benches which do not reflect the natural setting of the reserve. The City's standard three strand rural style fencing for conservation reserves should be used for all fencing replacement. Seating has been proposed in locations with views of the wetland and shade from trees. Future signage is to be in accordance with the City's Public Open Space Signage Strategy currently being developed.

Table 22 identifies environmental management measures proposed to enhance the conservation values of the reserve through removal of threatening processes.

7.4 Proposed Management Actions

The recommended environmental management actions for the study area, including potential costs, priorities, responsibilities and timing are shown in Table 22.

It must be noted that the environmental offset revegetation proposed for the 2024/2025 will extend into the next revision of the Management Plan.

TABLE 22 - Proposed environmental management implementation

Threats/Issues	No.	Proposed Management Actions	Potential Costs	Team Plan	Team	Indicative Timing	Priority
Weed invasion and spread	1	Removal of all significant weeds (WoNS and Declared Pests) and prominent woody weeds identified on Figures 11 to 13.	OT	O	PS	Between 2019/2020 and 2021/2022	High
	2	Ongoing control of significant weeds (WoNS and Declared Pests) and prominent woody weeds as (and if) they reappear.	OT	O	PS	Ongoing	High
	3	Ongoing control of weeds shown on Figures 9 to 13 within Priority 1 areas (30.29 ha) as shown on Figure 22.	$30,500*	C	PS	Ongoing	Medium
	4	Ongoing control of weeds shown on Figures 9 to 13 (16.55 ha) within Priority 2 areas shown on Figure 22.	$33,500*	C	PS	Ongoing	Medium
	5	Monitor the cover of Bulrush (*Typha orientalis*) to determine if it is spreading and whether management intervention is necessary.	OT	O	PS	Ongoing	Low
	6	Engage a consultant to undertake a bushfire risk assessment and recommend actions to reduce the risk rating held by adjacent properties. Recommended actions must not detrimentally impact upon the biodiversity conservation or landscape amenity values of the reserve.	$12,000	O	PS	Ongoing	High
Fire Management	7	Maintain existing firebreaks adjacent to Safety Bay Road and Nairn Drive.	OT	O	PS	Ongoing	High
Informal pedestrian access leading to degradation of the environmental values	8	Revegetate informal sandy paths (0.27 ha) using a planting density of one plant per m^2 using the species list in Table 21. Weed control must be undertaken prior to tubestock planting.	$12,500	O	PS	2019/2020: planting to be undertaken in winter 2019 with the exception of the path to the south of access point 2, which is to be revegetated following installation of the boardwalk	High

TABLE 22 - Proposed environmental management implementation (continued)

Threats/Issues	No.	Proposed Management Actions	Costs	Team Plan	Team	Indicative Timing	Priority
Vegetation degradation from weed dominance and human disturbance, reducing native species coverage	9	Infill planting within RA11, RA12 and RA13 (0.13 ha) shown on the Figure 14 with a planting density of one plant per m^2 using the species list in Table 21. Weed control must be undertaken prior to tubestock planting.	$6,000	O	PS	2019/2020: planting to be undertaken in winter 2019 along with planting informal sandy paths	High
	10	Infill planting within RA 8, RA9, RA10 and RA14 (0.44 ha) shown on the Figure 14 with a planting density of one plant per m^2 using the species list in Table 21. Weed control must be undertaken prior to tubestock planting.	$19,500	O	PS	2020/2021: planting to be undertaken in winter 2020	High
Environmental offset revegetation areas (except RA2ii) have not met the targets stated in the Tamworth Hill Swamp Reserve Revegetation Plan (Coterra 2013a)	11	Revegetate with a total of 42,732 plants over the next 5 years, as per the infill strategy identified in Table 20.	$170,744	C	PS	2020 - 2024	High
	12	Undertake a detailed assessment of the environmental offset revegetation areas using the same quadrat sampling locations used in the 2018 assessment (Figure 3) to inform the next revision of the Management Plan. The assessment must ascertain whether the performance targets stated in the Tamworth Hill Swamp Reserve Revegetation Plan (Coterra 2013a) have been met.	TBD	OP	SPE	2023/2024: During spring 2023	High
Animals grazing on plants in the revegetation areas	13	Consider alternative measures to prevent animal grazing on revegetation such as fencing off revegetation areas to prevent kangaroo and rabbit access.	TBD	O	PS	Ongoing	Medium
Feral animals	14	Continue fox, cat and rabbit population control.	$1,500 p.a	O	PS	Ongoing (annual)	High
	15	Investigate ways to control corellas, or disrupt their breeding within the reserve in consultation with the DBCA.	OT	O	PS	2019/2020	Medium

TABLE 22 - Proposed environmental management implementation (continued)

Threats/Issues	No.	Proposed Management Actions	Costs	Team Plan	Team	Indicative Timing	Priority
Feral animals	16	European honey bees nests in 2012 still contain bees. If European honey bees nests are identified, engage an exterminator. Locations: **Eastings Northings** 388162 6422129 387592 6422401	OT	O	PS	2019/2020	High
Potential impacts to native turtle populations	17	Engage with a university to undertake a baseline assessment of the population status of the south-western snake-necked turtles.	$20,000	OP	SPE	2019/2020	Medium
	18	If the baseline assessment of the south-western snake-necked turtles confirms their presence in Tamworth Hill Swamp, undertake a detailed assessment of their nesting habitat; determine potential impacts from feral animal predation; and management actions to protect the species.	$20,000	OP	SPE	2020/2021	Medium
Fragmentation of fauna habitat link due to Eighty Road	19	Subject to findings of the south-western snake-necked turtle population assessment and detailed nesting habitat assessment, investigate mechanisms to facilitate fauna movement between Tamworth Hill Swamp Reserve and Tamworth Hill to the north.	OT	O	SPE	2021/2022	Medium
Opportunity to increase suitable nesting habitat for the threatened black cockatoos	20	Investigate suitable locations for artificial black cockatoo nesting boxes and install up to four nesting boxes.	$4,800	O	PS	2019/2020	Medium
Opportunity to increase suitable roosting habitat for bats that are known to occur within the reserve	21	Investigate suitable locations for installation of bat boxes with interpretive signage to educate reserve users about bats.	$5,000	O	PS	2020/2021	Low
Rubbish dumping to the south of access point 2	22	Remove rubbish dumped along informal sandy access track to the south of access point 2.	OT	O	PS	2019/2020	High
Lack of ongoing monitoring of the wetlands health	23	Undertake an invertebrate assessment using an indicator species to inform the next revision of the Management Plan as an indicator of wetland ecosystem health. As part of the survey, determine whether invasive species such as yabbies and mosquito fish are present.	TBD	OP	SPE	2023/2024: During spring 2023	Low
Potential degradation of the wetland from poor quality stormwater	24	Include Tamworth Hill Swamp in the City's existing water monitoring programme, for bi-annual water quality monitoring.	TBD	OP	PS	Ongoing, commencing in 2019/2020	Medium

TABLE 22 - Proposed environmental management implementation (continued)

Threats/Issues	No.	Proposed Management Actions	Costs	Team Plan	Team	Indicative Timing	Priority
Potential degradation of the wetland from poor quality stormwater	25	Undertake a detailed site inspection to determine gaps in the pits and pipes layer on Intramaps, to confirm the locations of all drainage infrastructure surrounding the swamp and identify any directly discharging into the swamp. The findings of the site inspection should inform the future detailed drainage assessment.	OT	O	ES with input from LDI	2019/2020	Medium
	26	Engage a specialist consultant to: undertake a drainage assessment, including surveying all connected drainage infrastructure; preparing a local catchment map; completing preliminary hydrological modelling of catchment flows; and recommending a conceptual retrofitting design with options for improving water quality.	TBD	OP	ES with input from LDI	2020/2021	Medium
	27	Undertake retrofitting to drainage infrastructure based on recommendations (if any) from the drainage assessment.	TBD	OP	ES	2021/2022	Medium
	28	Investigate the potential to reduce water quality impacts from effluent disposal in the adjacent properties.	OT	O	SPE with input from LDI	2019/2020	Medium
Poor condition fencing	29	Replace 900 m of poor to very poor condition fencing along the southern boundary of the reserve (along Safety Bay Road) shown on Figure 18	$15,000	C	PS	2020/2021	Medium
	30	Replace 344 m of poor condition fencing in locations shown on Figure 18.	$5,600	C	PS	2021/2022	Low
Poor condition limestone paths	31	Repair 374 m of poor condition limestone paths (1,122 m^2) in locations shown on Figure 18.	$31,500	C	PS	2022/2023	Medium
Portions of access points in poor condition	32	Undertake surface upgrades to access points 1, 3, 4, 5 and 8 to improve their safety and accessibility. Sandy areas to be upgraded to limestone and material changes to be repaired to remove trip hazards. Weeds to be removed from access point 8. Refer to Table 15 for details.	$8,000	C	PS	2020/2021	Medium
Lack of appropriate signage	33	Install new signage in the signage shelters at access points 4, 6 and 7 (one reserve name sign and three interpretive signs at each shelter).	$6,000	O	PS	2019/2020	High
	34	Install signage at access points 7 and 8 to warn of potential path inundation along western side of reserve in wetter months.	$200	O	PS	2019/2020	High
Lack of bins and dog waste bags	35	Install four bins and dog waste bags at access points 1, 3, 5 and 7.	$9,150	C	PS	2020/2021	Medium

Notes: p.a: per annum | OT: Officer Time

Team Plan- O: Operational, C: Capital, Operating Project

Team - LDI: Land Development and Infrastructure, SPE: Strategic Planning and Environment, PS: Park Services, ES: Engineering Services, CIP: Community Infrastructure Planning

*The costs stated for weed control are for the control of Priority 1 and Priority 2 areas per financial year. Given the percentage cover of weeds across the Priority 1 areas is predominantly low (0-1% weed cover across extensive areas for all weed suites, with small patches of higher cover ranging from >5% to >50% for suites 1, 2 and 3), it is estimated that on average only 20% of the Priority 1 areas will require active weed control. It is estimated that on average of 40% of the Priority 2 areas will require active weed control, considering mean weed cover and the spread of the 95% CI. The costs for weed control will reduce over time, relative to the control effort required

The implementation of these management actions is ultimately subject to securing funding relative to other operational priorities.

7.4.1 Proposed Tamworth Hill Swamp Landscape Master Plan Implementation

The next course of actions for determining the feasibility of delivering the Tamworth Hill Swamp Landscape Master Plan and Discovery Park Concept are identified in Table 23 below.

TABLE 23 - Proposed Landscape Master Plan Implementation

Action	Potential Costs	Team Plan	Team	Indicative Timing	Priority
Commission an independent QS cost analysis for the proposed Tamworth Hill Swamp Landscape Master Plan and Discovery Park Concept.	$5,000	OP	SPE with input from LDI	2019/2020	High
Following the QS cost analysis, determine the feasibility of including the Tamworth Hill Swamp Landscape Master Plan and Discovery Park Concept in the City's Business Plan for detailed design and construction.*	OT	O	SPE and LDI, with input from CIP	2019/2020	High

* All infrastructure proposed in the Tamworth Hill Swamp Landscape Master Plan including the boardwalk, shelters, bird hides, seats and signage are to be of a consistent infrastructure palette that is sympathetic to the natural surroundings, enhancing the site character and user experience.

7.5 Measuring Success

Over the next five years, the City will continue to work towards the performance targets identified in the Tamworth Hill Swamp Reserve Revegetation Plan (Coterra 2013a) for the environmental offset revegetation areas (RA1 to RA7):

- ≥1 plant/m^2
- ≥75% of Revegetation species list
- <20% weed cover

Permanent quadrats assessed by Emerge will be monitored twice a year for five years in spring and autumn, recording photos, species and survival rates.

A detailed assessment of the environmental offset revegetation areas will be undertaken after five years, to assess whether the above performance targets have been met. If the targets have not been met, additional management actions will be included in the next revision of the management plan as required.

The Strategic Planning and Environment team will liaise with the City's Parks Services and the relevant team responsible for the delivery of the Landscape Master Plan and Discovery Park Concept at the start of each calendar year to discuss and review:

- the completion of management actions identified for the financial year
- the plan to undertake management actions remaining for the financial year
- the plan to undertake management actions for the next financial year
- progression of the Landscape Master Plan concept
- success from management actions implemented
- lessons learnt and potential improvements for the following years.

Implementation progress will be reported annually in the Sustainability Snapshot Report.

8.0

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9.0

APPENDICES

9 Appendix A - Legislation, Background Information and Conservation Codes

Federal *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as matters of national environmental significance (MNES).

There are currently nine MNES protected under the EPBC Act, these include:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines)
- a water resource, in relation to coal seam gas development and large coal mining development.

In addition to MNES, a number of marine fauna species are also protected under s248 of the EPBC Act. Special permits are required to kill, injure, take, trade, keep or move a listed marine species.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN).

The EPBC Act is administered by the Federal Department of the Environment and Energy (DotEE).

State *Biodiversity Conservation Act 2016*

The *Biodiversity Conservation Act 2016* (BC Act) recently replaced the outdated *Wildlife Conservation Act 1950*. The objects of the BC Act are:

- to conserve and protect biodiversity and biodiversity components in the State; and
- to promote ecologically sustainable use of biodiversity components in the State.

The BC Act's associated *Biodiversity Conservation Regulations 2018* are administered by the DBCA and provide the licensing arrangements for activities involving the State's fauna and flora.

Under the BC Act the Minster for the Environment can list a native species or ecological community as "Threatened" if a species are considered to be at risk of extinction or a community is at risk of becoming eligible for being a collapsed ecological community. The BC Act provides protection for threatened species, including conservation of their habitats and measures to conserve threatened ecological communities and critical habitats.

The State conservation level of flora and fauna species are listed on the *Wildlife Conservation (Rare Flora) Notice 2018* and *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

State *Biosecurity and Agriculture Management Act 2007*

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) provides for the declaration of Declared Pests by the Department of Primary Industries and Regional Development (DPIRD) which are prohibited organisms or organisms for which a declaration under Section 22(2) is in force. The main purposes of the BAM Act and its regulations are to:

- prevent new animal and plant pests and diseases from entering Western Australia
- manage the impact and spread of those pests already present in the state
- safely manage the use of agricultural and veterinary chemicals
- increased control over the sale of agricultural products that contain violative chemical residues.

Introduced plants (weeds)

Declared Pests

The DPIRD maintains a list of Declared Pests for Western Australia that have been declared under the BAM Act. If a Pest is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to comply with the specific category of control. Declared Pests are gazetted under categories, which define the action required. The category may apply to the whole of the State, districts, individual properties or even paddocks. Among the factors considered in categorising Declared Pests as Category C1 to C3 (with C3 being the most severe pests):

- the impact of the plant on individuals, agricultural production and the community in general
- whether it is already established in the area
- the feasibility and cost of possible control measures.

Weeds of National Significance

To help focus national efforts to address weed problems in Australia, a list of Weeds of National Significance (WoNS) was compiled. The assessment of WoNS is based on four major criteria:

- invasiveness
- impacts
- potential for spread
- environmental, social and economic impacts.

Australian state and territory governments have identified thirty two WoNS; a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012.

Conservation Codes for Western Australian Flora and Fauna (DBCA 2019)

Threatened, Extinct and 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.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the 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.

CR **Critically endangered species**

Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines".

Listed as critically endangered 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.

EN **Endangered species**

Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. 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.

VU **Vulnerable species**

Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines".

Listed as vulnerable 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

EX **Extinct species**

Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

Specially protected species

MI **Migratory species**

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), 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.*

9 Appendix A (continued)

CD **Species of special conservation interest (conservation dependent fauna)**

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*.

OS **Other specially protected fauna**

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*.

P **Priority species**

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.

1 **Priority 1: 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.

2 **Priority 2: 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.

3 **Priority 3: 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.

4 **Priority 4: Rare, Near Threatened and other species in need of monitoring**

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

9 Appendix B - Flora Species List for the Study Area

Flora Species list for the Study Area		
Family	**Status**	**Species**
Araceae	DP*	*Zantedeschia aethiopica*
Arecaceae	*	*Washingtonia filifera*
Aizoaceae		*Carpobrotus edulis*
Apiaceae		*Centella asiatica*
Anacardiaceae	*	*Schinus terebinthifolia*
Apocynaceae	DP*	*Gomphocarpus fruticosus*
Asparagaceae	DP,WoNS*	*Asparagus asparagoides*
Asteraceae	* * * * * * * *	*Arctotheca calendula* *Carduus pycnocephalus* *Conyza sumatrensis* *Cotula coronopifolia* *Cotula turbinata* *Hypochaeris glabra* *Lactuca serriola* *Sonchus oleraceus*
Brassicaceae	* * *	*Brassica tournefortii* *Heliophila pusilla* *Raphanus raphanistrum*
Campanulaceae		*Lobelia anceps*
Caryophyllaceae	* *	*Silene gallica* *Stellaria media*
Crassulaceae		*Crassula colorata*
Cyperaceae		*Baumea arthrophylla* *Baumea articulata* *Baumea juncea* *Baumea preissii* *Carex fascicularis* *Gahnia trifida* *Lepidosperma longitudinale*
Euphorbiaceae	*	*Euphorbia terracina*
Fabaceae	* * * * * * * *	*Acacia longifolia* *Acacia saligna* *Lotus subbiflorus* *Lupinus angustifolius* *Lupinus cosentinii* *Lupinus luteus* *Ornithopus compressus* *Trifolium campestre* *Vicia sativa* *Viminaria juncea*
Geraniaceae	* *	*Erodium botrys* *Pelargonium capitatum*
Iridaceae	*	*Romulea rosea var. australis*
Juncaceae		*Juncus pallidus*
Juncaginaceae		*Triglochin striata*
Lauraceae		*Cassytha racemosa forma racemosa*
Moraceae	*	*Ficus carica*
Myrtaceae		*Eucalyptus gomphocephala* *Eucalyptus rudis subsp. rudis* *Kunzea glabrescens*

Note: * denotes introduced weed species, DP= Declared pest under BAM Act, WoNS=Weed of National Significance

9 Appendix B (continued)

Flora Species list for the Study Area		
Family	**Status**	**Species**
Myrtaceae		*Melaleuca rhaphiophylla* *Melaleuca teretifolia*
Onagraceae	*	*Oenothera mollissima*
Orchidaceae		*Cyrtostylis ?huegelii*
Orobanchaceae	*	*Orobanche minor*
Oxalidaceae	*	*Oxalis pes-caprae*
Papaveraceae	*	*Fumaria capreolata*
Plantaginaceae	*	*Plantago lanceolata*
Phytolaccaceae	*	*Phytolacca octandra*
Primulaceae	*	*Lysimachia arvensis* *Samolus junceus*
Poaceae	* * * * * * * * * * * * * *	*Avena barbata* *Briza maxima* *Briza minor* *Bromus diandrus* *Cenchrus clandestinus* *Cortaderia selloana* *Cynodon dactylon* *Ehrharta calycina* *Ehrharta longiflora* *Lagurus ovatus* *Lolium rigidum* *Polypogon maritimus* *Stenotaphrum secundatum* *Vulpia bromoides*
Polygonaceae	 * *	*Muehlenbeckia adpressa* *Persicaria decipiens* *Polygonum aviculare* *Rumex acetosella*
Rhamnaceae		*Spyridium globulosum*
Rubiaceae	*	*Galium murale*
Scrophulariaceae		*Dischisma arenarium*
Solanaceae	* * DP*	*Solanum americanum* *Solanum nigrum* *Solanum linnaeanum*
Typhaceae		*Typha orientalis*

Note: * denotes introduced weed species, DP= Declared pest under BAM Act, WoNS=Weed of National Significance

9 Appendix C - Flora and Vegetation Survey Quadrat Data

Sample Name: Q1

Project no: EP18-105 | **Date:** 5/10/18 | **Author:** SKP | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387901
Altitude (m): 0
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: clay with organic layer
Rocks (%) & type: No rocks
Litter: 45% (twigs,bark,branches)

Size: 10 m x 10 m
NW corner northing: 6422420
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: low - weeds, track, kangaroos
Bare ground (%): 2
Soil colour: brown/grey
Vegetation condition: very good

Strata	Cover (%)	Height (m)
Upper	30 to 70	<10
Mid	0	0
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	<0.5

Vegetation description

Low open forest *Melaleuca rhaphiophylla* over tall sedgeland *Gahnia trifida* over grassland **Ehrharta longiflora* over low open herbland *Centella asiatica*.

Species Data		
Status	Confirmed name	**Cover (%)**
	Baumea juncea	5
	Centella asiatica	20
*	*Conyza sumatrensis*	0.5
*	*Ehrharta longiflora*	40
*	*Ficus carica*	3
	Gahnia trifida	40
	Lobelia anceps	5
*	*Lysimachia arvensis*	<1
	Melaleuca rhaphiophylla	65
*	*Schinus terebinthifolia*	1

*denotes non-native species

9 Appendix C (continued)

Sample Name: Q2

Project no: EP18-105 | **Date:** 5/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387959
Altitude (m): 5
Soil water content: near saturated
Time since fire: no evidence
Soil type/texture: sand/loam with organic layer
Rocks (%) & type: No rocks
Litter: 30% (branches,leaves)
Size: other
NW corner northing: 6422630
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: moderate - weeds, animals
Bare ground (%): 5
Soil colour: grey/black
Vegetation condition: very good

Strata	Cover (%)	Height (m)
Upper	30 to 70	<10
Mid	0	>2
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	<0.5

Vegetation description

Low open forest *Melaleuca rhaphiophylla* over tall open shrubland *Melaleuca teretifolia* over tall closed sedgeland *Gahnia trifida* over low open tussock grassland of non-native species.

Species Data

Status	Confirmed name	Cover (%)
	Baumea juncea	5
*	*Brassica tournefortii*	<1
*	*Carduus pycnocephalus*	<1
	Cassytha racemosa forma racemosa	10
*	*Cenchrus clandestinus*	10
	Centella asiatica	1
*	*Conyza sumatrensis*	<1
	Ehrharta longiflora	10
*	*Ficus carica*	<1
	Gahnia trifida	70
	Lepidosperma longitudinale	10
	Melaleuca rhaphiophylla	40
	Melaleuca teretifolia	10
*	*Solanum nigrum*	<1

*denotes non-native species

Sample Name: Q3

Project no: EP18-105 | **Date:** 5/10/18 | **Author:** SKP | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
Size: 10 m x 10 m
NW corner easting: 387961
NW corner northing: 6423173
Altitude (m): 0
Geographic datum/zone: GDA94/Zone 50
Soil water content: saturated
Landform: depression
Time since fire: no evidence
Disturbance: low - edge
Soil type/texture: unknown - likely sandy loam
Bare ground (%): 0
Rocks (%) & type: No rocks
Soil colour: unknown
Litter: 0%
Vegetation condition: very good-excellent

Strata	Cover (%)	Height (m)
Upper	30 to 70	Treeless
Mid	0	0
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	>0.5

Vegetation description

Tall closed sedgeland *Baumea arthrophylla* and *Baumea juncea* over tall sparse herbland *Triglochin striata*.

Species Data

Status	Confirmed name	Cover (%)
	Baumea arthrophylla	5
	Baumea juncea	96
	Samolus junceus	opp
	Triglochin striata	1

*denotes non-native species, opp = opportunistic

9 Appendix C (continued)

Sample Name: Q4

Project no: EP18-105 | **Date:** 5/10/18 | **Author:** SKP | **Status:** Non-Permanent

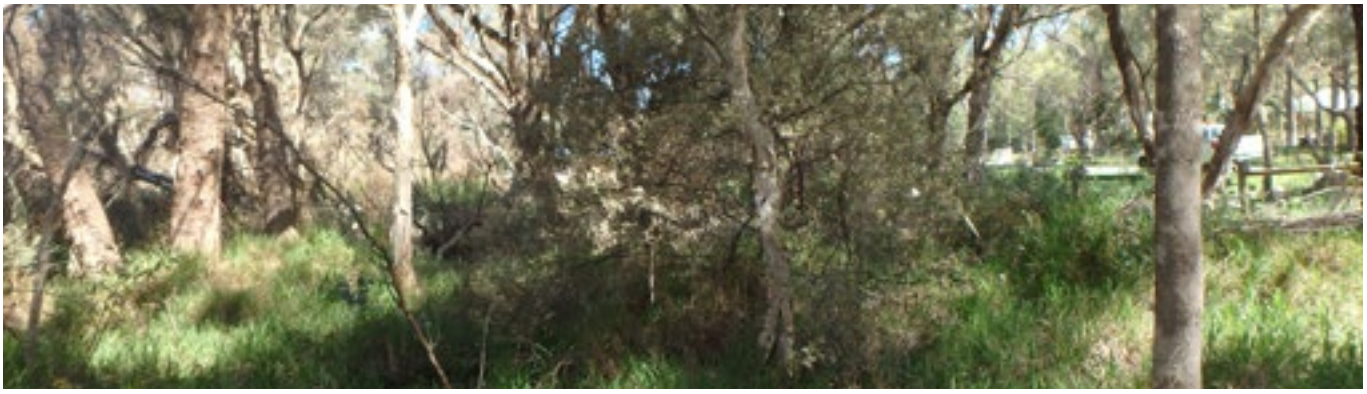
Quadrat and landform details

Sample type: quadrat
Size: 10 m x 10 m
NW corner easting: 387629
NW corner northing: 6423116
Altitude (m): 0
Geographic datum/zone: GDA94/Zone 50
Soil water content: saturated
Landform: depression
Time since fire: no evidence
Disturbance: high - weeds, animals, clearing
Soil type/texture: sand/loam with organic layer
Bare ground (%): 0
Rocks (%) & type: No rocks
Soil colour: brown/grey
Litter: 5% (branches,leaves)
Vegetation condition: good-degraded

Strata	Cover (%)	Height (m)
Upper	30 to 70	10 to 30
Mid	0	1 to 2
Ground layer 1	30 to 70	<0.5
Ground layer 2	10 to 30	0

Vegetation description

Open forest *Eucalyptus rudis* and *Melaleuca rhaphiophylla* over shrubland *Spyridium globulosum* over low closed tussock grassland **Stenotaphrum secundatum.*



Species Data

Status	Confirmed name	Cover (%)
*	*Avena barbata*	opp
*	*Bromus diandrus*	1
	Cassytha racemosa forma racemosa	<1
*	*Cotula coronopifolia*	opp
*	*Ehrharta longiflora*	<1
	Eucalyptus rudis subsp. rudis	30
*	*Euphorbia terracina*	<1
*	*Lolium rigidum*	opp
*	*Lysimachia arvensis*	opp
	Melaleuca rhaphiophylla	10
*	*Oxalis pes-caprae*	<1
*	*Sonchus oleraceus*	opp
	Spyridium globulosum	40
*	*Stenotaphrum secundatum*	70

*denotes non-native species, opp = opportunistic

Sample Name: Q5

Project no: EP18-105 | **Date:** 5/10/18 | **Author:** SKP | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387615
Altitude (m): 0
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: unknown - likely sandy loam
Rocks (%) & type: No rocks
Litter: 5% (branches,bark)

Size: 10 m x 10 m
NW corner northing: 6422428
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: low - weeds
Bare ground (%): 0
Soil colour: unknown
Vegetation condition: excellent

Strata	Cover (%)	Height (m)
Upper	30 to 70	<10
Mid	0	0
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	<0.5

Vegetation description

Low open forest *Melaleuca rhaphiophylla* over tall closed sedgeland *Baumea juncea* over low sparse herbland *Centella asiatica*.

Species Data

Status	Confirmed name	Cover (%)
	Baumea articulata	5
	Baumea juncea	80
*	*Carduus pycnocephalus*	1
	Cassytha racemosa forma racemosa	1
	Centella asiatica	5
	Eucalyptus rudis subsp. rudis	opp
	Gahnia trifida	2
	Melaleuca rhaphiophylla	50
*	*Solanum americanum*	1
*	*Solanum nigrum*	<1
*	*Triglochin striata*	<1

*denotes non-native species, opp = opportunistic

9 Appendix C (continued)

Sample Name: Q6

Project no: EP18-105 | **Date:** 19/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387909
Altitude (m): 7
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: unknown - likely sandy loam
Rocks (%) & type: No rocks
Litter: 10% (branches)

Size: 10 m x 10 m
NW corner northing: 6422194
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: low - weeds
Bare ground (%): 0
Soil colour: unknown
Vegetation condition: very good

Strata	Cover (%)	Height (m)
Upper	30 to 70	<10
Mid	0	>2
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	<0.5

Vegetation description

Low open forest *Melaleuca rhaphiophylla* over tall open shrubland *Melaleuca teretifolia* over tall sedgeland *Baumea articulata* over low sparse herbland *Triglochin striata*.

Species Data

Status	Confirmed name	Cover (%)
	Baumea articulata	30
	Baumea juncea	5
	Carex fascicularis	<1
	Cassytha racemosa forma racemosa	1
*	*Cotula coronopifolia*	opp
*	*Cotula turbinata*	5
*	*Ehrharta longiflora*	<1
	Gahnia trifida	2
	Juncus pallidus	1
	Melaleuca rhaphiophylla	50
	Melaleuca teretifolia	10
*	*Polypogon maritimus*	<1
	Triglochin striata	10

*denotes non-native speciess, opp = opportunistic

Sample Name: Q7

Project no: EP18-105 | **Date:** 19/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 388035
Altitude (m): 7
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: sand/loam with organic layer
Rocks (%) & type: No rocks
Litter: 5% (branches,leaves)

Size: 10 m x 10 m
NW corner northing: 6422138
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: high - weeds
Bare ground (%): 0
Soil colour: brown/grey
Vegetation condition: degraded

Strata	Cover (%)	Height (m)
Upper	30 to 70	10 to 30
Mid	0	0
Ground layer 1	30 to 70	<0.5
Ground layer 2	10 to 30	0

Vegetation description

Open forest *Eucalyptus rudis* over low closed tussock grassland of non-native species such as **Cenchrus clandestinus* and **Bromus diandrus*.

Species Data		
Status	**Confirmed name**	**Cover (%)**
*	*Bromus diandrus*	10
	Cassytha racemosa forma racemosa	1
*	*Cenchrus clandestinus*	80
*	*Ehrharta longiflora*	<1
	Eucalyptus rudis subsp. rudis	60

*denotes non-native species

9 Appendix C (continued)

Sample Name: Q8

Project no: EP18-105 | **Date:** 19/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
Size: 10 m x 10 m
NW corner easting: 388132
NW corner northing: 6422209
Altitude (m): 6
Geographic datum/zone: GDA94/Zone 50
Soil water content: saturated
Landform: depression
Time since fire: no evidence
Disturbance: low - weeds
Soil type/texture: unknown - likely sandy loam
Bare ground (%): 0
Rocks (%) & type: No rocks
Soil colour: unknown
Litter: 10% (logs)
Vegetation condition: very good

Strata	Cover (%)	Height (m)
Upper	30 to 70	10 to 30
Mid	0	0
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	<0.5

Vegetation description

Open forest *Eucalyptus rudis* over tall closed sedgeland *Baumea preissii* over low isolated tussock grassland **Ehrharta longiflora*.

Species Data		
Status	**Confirmed name**	**Cover (%)**
	Baumea articulata	<1
	Baumea preissii	70
	Centella asiatica	<1
*	*Ehrharta longiflora*	<1
	Eucalyptus rudis subsp. rudis	40
*	*Fumaria capreolata*	<1
	Juncus pallidus	opp
	Melaleuca rhaphiophylla	<1

*denotes non-native species, opp = opportunistic

Sample Name: Q9

Project no: EP18-105 | **Date:** 19/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387938
Altitude (m): 7
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: unknown - potentially black sand/peat
Rocks (%) & type: No rocks
Litter: 1% (leaves)

Size: 10 m x 10 m
NW corner northing: 6422634
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: low - weeds
Bare ground (%): 0
Soil colour: unknown
Vegetation condition: excellent

Strata	Cover (%)	Height (m)
Upper	30 to 70	Treeless
Mid	0	>2
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	<0.5

Vegetation description

Tall sparse shrubland *Melaleuca teretifolia* over tall closed sedgeland *Baumea* spp. over low isolated herbland *Centella asiatica* and *Triglochin striata*.

Species Data

Status	Confirmed name	Cover (%)
	Baumea arthrophylla	70
	Baumea juncea	10
	Centella asiatica	1
	Gahnia trifida	1
	Melaleuca teretifolia	5
	Triglochin striata	1

*denotes non-native species

9 Appendix C (continued)

Sample Name: Q10

Project no: EP18-105 | **Date:** 19/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387716
Altitude (m): 5
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: unknown - potentially black sand/peat
Rocks (%) & type: No rocks
Litter: 1% (leaves)

Size: 10 m x 10 m
NW corner northing: 6422658
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: low - none
Bare ground (%): 0
Soil colour: unknown
Vegetation condition: excellent

Strata	Cover (%)	Height (m)
Upper	30 to 70	Treeless
Mid	0	0
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	0

Vegetation description

Tall closed sedgeland *Baumea articulata*.

Species Data		
Status	**Confirmed name**	**Cover (%)**
	Baumea articulata	90
	Baumea juncea	<1
	Eucalyptus rudis subsp. rudis	<1

*denotes non-native species

Sample Name: Q11

Project no: EP18-105 | **Date:** 19/10/18 | **Author:** RAO | **Status:** Non-Permanent

Quadrat and landform details

Sample type: quadrat
NW corner easting: 387809
Altitude (m): 5
Soil water content: saturated
Time since fire: no evidence
Soil type/texture: unknown - potentially black sand/peat
Rocks (%) & type: No rocks
Litter: 5% (leaves)

Size: 10 m x 10 m
NW corner northing: 6423242
Geographic datum/zone: GDA94/Zone 50
Landform: depression
Disturbance: low - none
Bare ground (%): 0
Soil colour: unknown
Vegetation condition: excellent

Strata	Cover (%)	Height (m)
Upper	30 to 70	Treeless
Mid	0	0
Ground layer 1	30 to 70	>0.5
Ground layer 2	10 to 30	0

Vegetation description

Tall closed sedgeland *Baumea articulata*.

Species Data

Status	Confirmed name	Cover (%)
	Baumea articulata	80
	Baumea juncea	1
	Baumea arthrophylla	1

*denotes non-native species

9 Appendix D - Weed Species List, Locations and Treatment Methods

Table D1. - Weed Species Recorded Within Each Weed Suite and Recommended Control Methods

Weed suite	Dominant species	Status	Recommended control method	Control timing
1 - annual and perennial grasses	*Briza* spp.	*	Spray at 3-5 leaf stage with Fusilade® Forte at 16 ml/10 L or 800 ml/ha (based on 500 L water/ha) + wetting agent or for generic fluazifop-p (212g/L active ingredient) 10ml/10L or 500ml/ha + wetting agent.	Jul-Aug (May/Oct)
	Cynodon dactylon	*	Spray Fusilade® Forte at 13 ml/L + wetting agent or for generic fluazifop-p (212g/L active ingredient) 8mL/L + wetting agent when plants are small and beginning new growth, or 1% glyphosate in late spring/summer and autumn when rhizomes are actively growing. In sensitive areas try painting runners or crowns with 50% glyphosate. Follow-up is nearly always required.	Nov-Feb (Mar-Apr)
	Ehrharta spp.	*	Spray with Fusilade Forte® 30 ml/10 L or 1.6 L/ha (based on 500 L water/ha) + wetting agent or for generic fluazifop-p (212g/L active ingredient) 18ml/10L or 1L/ha + wetting agent before flowering stem emerges, or at 3-5 leaf stage. Secondary seedling flush often occurs, repeat treatment if necessary.	Aug-Oct
	Avena spp.	*	Spray at 3-5 leaf stage with Fusilade® Forte at 16 ml/10 L + wetting agent or for generic fluazifop-p (212g/L active ingredient) 10mL/10L or 0.5L/ha + wetting agent. Repeat over the following 2 years. Aim to prevent seed production.	Jul-Oct
	Cenchrus clandestinus	*	Spray with 1% glyphosate or Fusilade® Forte at 16 ml/L + wetting agent or for generic fluazifop-p (212g/L active ingredient) 10ml/L + wetting agent. 2-3 sprays over a single growing season are often required.	Nov-Jan (Feb-Apr)
	Lolium rigidum	*	Fusilade® Forte in winter 4-6 weeks after opening rains. For larger plants up to flowering, increase rates of grass selective herbicide 3 to 4 fold. In agricultural areas, populations may be resistant to these herbicides and glyphosate may be needed. Spray 10 ml/10 L glyphosate when plants are vegetative up to when seed heads are emerging.	Jun-Oct (Nov-Jan)
	Stenotaphrum secundatum	*	Spray with 1% glyphosate 2-3 times over a single growing season, alternatively spray Fusilade® Forte 13ml/L + wetting agent or for generic fluazifop-p (212g/L active ingredient) 8ml/L.	Nov-May
	Bromus diandrus	*	Prevent seed set. Hand pull plants. In degraded areas use 1% glyphosate on seedlings, young plants or when flowering. Alternatively spray plants at 3-5 leaf stage with Fusilade® Forte at 16 ml/10 L or 800 ml/ha (based on 500 L water/ha) + wetting agent or for generic fluazifop-p (212g/L active ingredient) 10ml/10L or 500ml/ha + wetting agent. An early and late application may be required where two Bromus species are present.	Jun-Aug
	Lagurus ovatus	*	Prevent seed set. Hand removal small isolated infestations. In selective situations spray with 16 ml/10 L (800 ml/ha) Fusilade® Forte + spray oil or for generic fluazifop-p (212g/L active ingredient) 10ml/10L or 500ml/ha + spray oil any time before flowering. A lower rate of 13 ml/10 L Fusilade® Forte or for generic fluazifop-p (212g/L active ingredient) 8ml/10L can be used in winter at the 2-8 leaf stage before stem elongation.	Jun-Dec
	Polypogon maritimus	*	Spot spray 1% glyphosate.	Jun-Oct
	Vulpia bromoides	*	Prevent seed set. Hand pull plants or spray with Select® 10 ml/10 L (500 ml/ha) prior to boot stage. It is important to minimise bare ground through autumn and winter to suppress annual weed population growth.	Jul-Aug/Sep

Table D1. - Weed Species Recorded Within Each Weed Suite and Recommended Control Methods

Weed suite	Dominant species	Status	Recommended control method	Control timing
2 - pampas grass	*Cortaderia selloana*	*	Cut out small plants, remove uprooted plants to avoid them resprouting. Treat young plants with13ml/L Fusilade Forte® + spray oil or for generic fluazifop-p (212g/L active ingredient) 8mL/L + spray oil. May require more than one application. Alternatively foliar spray glyphosate at 4%. Remove flower heads. Slash/burn clumps. Spray regrowth with 1% glyphosate in spring.	Jul-Nov
3 - woody weeds	*Ficus carica*	*	Hand remove seedlings. Stem inject with 50% glyphosate and foliar spray regrowth with 10% glyphosate. For stems less than 30 cm diametre apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark).	Dec-Feb (Mar)
	Solanum linnaeanum	*Declared Pest	Hand pull seedlings ensuring removal of all root material. Stem inject older plants using 50% glyphosate or basal bark with 250 ml Access® in 15 L of diesel to bottom 50 cm of trunk during summer. Avoid root disturbance until trees are confirmed dead.	Sep-Feb
	Schinus terebinthifolia	*	Hand pull seedlings ensuring removal of all root material. Stem inject older plants using 50% glyphosate or basal bark with 250 ml Access® in 15 L of diesel to bottom 50 cm of trunk during summer. Avoid root disturbance until trees are confirmed dead.	Dec-Mar
	Gomphocarpus fruticosus	*Declared Pest	Hand pull small plants, ensuring removal of as much root material as possible. Hand removing plants with mature fruits can lead to realease and rapid spread of wind dispered seed. Foliar spray with 1.5% glyphosate or try cut and paint using 50% glyphosate.	Sep-Dec (Jan-Aug)
	Nerium oleander	*	Hand pull seedlings. Fell mature plants. Apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk. Basal bark application plants up to 5 cm basal diameter. Cut stump application plants over 5 cm. Remove refuse to avoid resprouting.	Sep-Feb
	Acacia longifolia	*	Hand pull seedlings. Fell mature plants. Apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk, or cut and paint or drill and fill with 50% glyphosate. Older plants can be ringbarked.	Mar-Aug
4 - herbaceous	*Conyza sumatrensis*	*	Hand pulling of small and/or isolated infestations after stem elongation prior to seed set. Apply 25 ml/ 10L glyphosate after stem elongation and before flowering in late spring to summer each year when the plants are actively growing. A mixture of 50% glyphosate can be used to wipe the stems of plants. Lontrel® 4 g/ 10 L (200 g/ha) + wetting agent can be spot sprayed for fairly selective control.	Jun-Nov
	Cotula spp.	*	Consult a Department of Health licensed 'pest management technician'.	-
	Solanum americanum	*	Hand weed small infestations.	Jul-Jan (Feb-Jun)
	Solanum nigrum	*	Hand weed small infestations.	Jun-Nov (Dec-May)
	Lupinus spp.	*	Hand remove scattered plants. Spray dense infestations with metsulfuron methyl 0.1 g/15 L (2-3 g/ha) + wetting agent or spot spray Lontrel® 6 ml/10 L (300 ml/ha) + wetting agent to late flowering, this will prevent seed set.	Jul-Sep (Oct)
	Fumaria capreolata	*	Spray metsulfuron methyl at 0.1 g/15 L (2.5 g/ha) + wetting agent or glyphosate 0.5%.	Jul-Sep
	Erodium botrys	*	Apply Lontrel® at 6 ml/10 L + wetting agent applied before flowering or Verdict 520® at 1.5 ml/ 10 L + wetting agent.	May-Jul

9 Appendix D (continued)

Table D1. - Weed Species Recorded Within Each Weed Suite and Recommended Control Methods

Weed suite	Dominant species	Status	Recommended control method	Control timing
4 - herbaceous	*Lysimachia arvensis*	*	Consult a Department of Health licensed 'pest management technician'.	-
	Asparagus asparagoides	*Declared Pest, WoNS	Spray 0.2 g metsulfuron methyl + Pulse® in 15 L water (or 2.5 - 5g /ha + Pulse®). Best results achieved when flowering.	Jul-Aug
	Arctotheca calendula	*	Chip out small infestations,ensuring root is severed well below ground level to prevent re-sprouting from the crown. For large infestations apply Lontrel® 6 ml/10 L (300 ml/ha) in early growth stages. Glyphosate at 0.2% will provide some selective control if the plants are young or at the budding stage, otherwise spot spraying glyphosate at 10 ml/L will control capeweed at all growth stages. A combination of chemical and physical control with follow up treatment provides optimal control.	Jun-Nov
	Carduus pycnocephalus	*	Hand remove isolated plants through spring and early summer. Glyphosate at 50% applied by wick or spot spraying with 0.5% glyphosate provides good control. Alternatively spot spray Lontrel® 10 ml/10 L + wetting agent. Best controlled at rosette stage. An integrated program involving a combination of techniques will be most effective.	Jul-Dec
	Hypochaeris glabra	*	Mowing and grazing are ineffective and often promote growth and flowering. Hand remove small infestations and/or isolated plants, ensuring the taproot is removed. Alternatively wipe rosettes with glyphosate at 30%. For dense infestations, apply Lontrel® 10 ml /10 L + wetting agent. Apply herbicide regularly to prevent seeding.	May-Oct
	Lactuca serriola	*	Manually remove small and/or isolated infestations, ensuring entire plant is removed especially the taproot. Apply glyphosate at early growth or rosette stages in spring, summer or autumn or metsulfuron methyl 5 g/ha (based on a minimum of 50 L/ha of water) + surfactant. Plants are difficult to control with herbicides once the flowering stems have begun to elongate.	Jun-Jan
	Sonchus oleraceus	*	Remove small and/or isolated populations manually prior to seed set. Slashing is often ineffective as flowers continue to be produced. Spot spray Lontrel® 10 ml/10 L + wetting agent preferably at the rosette stage.	Jun-Oct
	Brassica tournefortii	*	Consult a Department of Health licensed 'pest management technician'.	-
	Heliophila pusilla	*	Consult a Department of Health licensed 'pest management technician'.	-
	Raphanus raphanistrum	*	Hand remove isolated plants several times throughout the year. Spot spray 1% glyphosate before flowering. A combination of approaches is usually most successful.	Jun-Dec/all year
	Silene gallica	*	Consult a Department of Health licensed 'pest management technician'.	-
	Stellaria media	*	Consult a Department of Health licensed 'pest management technician'.	-

Table D1. - Weed Species Recorded Within Each Weed Suite and Recommended Control Methods				
Weed suite	**Dominant species**	**Status**	**Recommended control method**	**Control timing**
4 - herbaceous	*Euphorbia terracina*	*	Logran® at 12.5 g/100L + the penetrant Pulse ® is very effective on adults and juveniles with little off target damage in coastal heathlands. Hand removal can stimulate germination of the soil seedbank. Ensure adequate personal protective clothing is worn to avoid contact with sap. Since seed production is highest from plants which emerge early, it is important to control early cohorts, if not treated when small these become increasingly tolerant to herbicides. Control of the late emergents before seed formation will prevent fresh seeds being added to the existing seed bank. Slashing in November after seed production may result in no vegetative regeneration, due to lack of food reserves in the underground roots and stem - the remaining underground plant parts cannot withstand hot dry summer conditions.	Jun-Aug(Nov)
	Lotus subbiflorus	*	Likely similar to other lotus species: spot spray Lontrel® at 10 ml/10 L + 25 mL wetting agent.	Oct-Feb
	Ornithopus compressus	*	Consult a Department of Health licensed 'pest management technician'.	-
	Trifolium campestre	*	Spot spray with 1% glyphosate before flowering, alternatively spot spray Lontrel® 3 ml/10 L (150 ml/ha) up to the 6 leaf stage.	Jun-Aug
	Vicia sativa	*	Hand remove small/isolated populations. Lontrel® 10 mL/10 L + wetting agent provides effective control in early growth stages, otherwise apply metsulfuron methyl 0.1 g/10 L + wetting agent.	Jul-Sep
	Erodium botrys	*	Apply Lontrel® at 6 ml/10 L + wetting agent applied before flowering or Verdict 520® at 1.5 ml/ 10 L + wetting agent.	May-Jul
	Pelargonium capitatum	*	Hand pull isolated plants taking care to remove the entire stem as it can reshoot from below ground level. Spot spray metsulfuron methyl 5 g/ha + Pulse®.	Jun-Oct
	Oenothera mollissima	*	Control in seedling stage, as older plants are relatively resistant to herbicides, including glyphosate. Hand remove small populations, ensuring removal of entire root stystem. Spot spray chlorsulfuron 0.4 g/10 L + spray oil.	Uncertain
	Orobanche minor	*	Consult a Department of Health licensed 'pest management technician'.	-
	Plantago lanceolata	*	Hand remove small/isolated infestations. Spray in early stages of growth with 1% glyphosate.	May-Oct
	Phytolacca octandra	*	Dig out isolated plants and cut root at least 5 cm below ground level. Otherwise spray with 1% glyphosate + Pulse®.	Oct-Dec
	Polygonum aviculare	*	Consult a Department of Health licensed 'pest management technician'.	-
	Rumex acetosella	*	Consult a Department of Health licensed 'pest management technician'.	-
	Galium murale	*	Consult a Department of Health licensed 'pest management technician'.	-
	Dischisma arenarium	*	Spot spray 0.2% glyphosate.	Jul-Sep

9 Appendix D (continued)

Table D1. - Weed Species Recorded Within Each Weed Suite and Recommended Control Methods

Weed suite	Dominant species	Status	Recommended control method	Control timing
5 - bulbous	*Zantedeschia aethiopica*	*Declared Pest	Spot spray metsulfuron methyl 0.4 g/15 L of water (or 5g / ha) + 225 mL glyphosate + Pulse®. As glyphosate is non selective, only apply where there is no chance of off target application on native vegetation. Otherwise, spot spray metsulfuron methyl or chlorsulfuron 0.4 g/15 L of water (or 5g /ha) + Pulse®. Herbicide application can send some tubers into dormancy therefore any control program needs to continue for at least five years.	Jul-Sep
	Oxalis pes-caprae	*	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse®, or 1% glyphosate. Apply at bulb exhaustion, generally just on flowering.	Jun-Jul
	Romulea rosea var. australis	*	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse® or 2.5-5 g/ha + Pulse® . Apply just on flowering at corm exhaustion.	Jul-Aug

Note - control methods sourced from https://florabase.dpaw.wa.gov.au, http://www.agriculture.gov.au and https://www.dpi.nsw.gov.au
*=non-native (weed) species, WoNS='weed of National significance'

Table D2. - Prominent weed species locations			
Species	**Status**	**Easting**	**Northing**
Acacia longifolia	*	387921	6422585
Acacia sp.	*	387995	6422793
Ficus carica	*	387937	6422370
Ficus carica	*	387928	6422370
Ficus carica	*	387924	6422370
Ficus carica	*	387922	6422370
Ficus carica	*	387921	6422369
Ficus carica	*	387919	6422369
Ficus carica	*	387910	6422366
Ficus carica	*	387896	6422462
Ficus carica	*	387896	6422462
Ficus carica	*	387891	6422465
Ficus carica	*	387895	6422492
Ficus carica	*	387894	6422492
Ficus carica	*	387925	6422523
Ficus carica	*	387886	6422479
Ficus carica	*	387887	6422469
Ficus carica	*	388183	6422305
Ficus carica	*	388176	6422304
Ficus carica	*	388174	6422301
Ficus carica	*	388157	6422280
Ficus carica	*	388157	6422280
Ficus carica	*	388141	6422286
Ficus carica	*	388063	6422213
Ficus carica	*	388034	6422259
Ficus carica	*	388030	6422270
Ficus carica	*	387869	6422374
Schinus terebinthifolia	*	387905	6422442
Schinus terebinthifolia	*	387899	6422463
Schinus terebinthifolia	*	387842	6422345
Schinus terebinthifolia	*	387871	6422457

9 Appendix D (continued)

Table D3. - Significant weed species locations

Species	Weed Status	Easting	Northing
Asparagus asparagoides	*Declared Pest & WoNS	387992.21	6422826.56
Gomphocarpus fruticosus	*Declared Pest	387927.17	6423225.86
Gomphocarpus fruticosus	*Declared Pest	387930.08	6423171.90
Gomphocarpus fruticosus	*Declared Pest	387974.65	6422523.77
Gomphocarpus fruticosus	*Declared Pest	387923.83	6422524.34
Gomphocarpus fruticosus	*Declared Pest	387949.60	6423086.75
Gomphocarpus fruticosus	*Declared Pest	387948.98	6423087.08
Gomphocarpus fruticosus	*Declared Pest	387942.83	6423093.58
Gomphocarpus fruticosus	*Declared Pest	387941.11	6423094.85
Gomphocarpus fruticosus	*Declared Pest	387940.77	6423095.10
Gomphocarpus fruticosus	*Declared Pest	387953.84	6423079.37
Gomphocarpus fruticosus	*Declared Pest	387954.17	6423079.68
Gomphocarpus fruticosus	*Declared Pest	387956.78	6423080.63
Gomphocarpus fruticosus	*Declared Pest	387957.86	6423079.72
Gomphocarpus fruticosus	*Declared Pest	387967.36	6423055.23
Gomphocarpus fruticosus	*Declared Pest	387955.61	6423051.79
Gomphocarpus fruticosus	*Declared Pest	387955.60	6423051.76
Gomphocarpus fruticosus	*Declared Pest	387950.64	6423051.03
Gomphocarpus fruticosus	*Declared Pest	387935.41	6423043.00
Gomphocarpus fruticosus	*Declared Pest	387935.58	6423042.09
Gomphocarpus fruticosus	*Declared Pest	387937.69	6423040.72
Gomphocarpus fruticosus	*Declared Pest	387939.14	6423040.45
Gomphocarpus fruticosus	*Declared Pest	387937.74	6423035.87
Gomphocarpus fruticosus	*Declared Pest	387932.17	6423032.10
Gomphocarpus fruticosus	*Declared Pest	387949.49	6423023.29
Gomphocarpus fruticosus	*Declared Pest	387940.20	6423014.27
Gomphocarpus fruticosus	*Declared Pest	387944.70	6423008.93
Gomphocarpus fruticosus	*Declared Pest	387968.48	6423007.42
Gomphocarpus fruticosus	*Declared Pest	387942.01	6422995.74
Gomphocarpus fruticosus	*Declared Pest	387931.23	6422988.50
Gomphocarpus fruticosus	*Declared Pest	387930.14	6422988.01
Gomphocarpus fruticosus	*Declared Pest	387920.70	6422978.68
Gomphocarpus fruticosus	*Declared Pest	387935.99	6422976.72
Gomphocarpus fruticosus	*Declared Pest	387940.71	6422975.54

Table D3. - Significant weed species locations (continued)			
Species	**Weed Status**	**Easting**	**Northing**
Gomphocarpus fruticosus	*Declared Pest	387943.75	6422978.05
Gomphocarpus fruticosus	*Declared Pest	387954.84	6422986.62
Gomphocarpus fruticosus	*Declared Pest	387957.10	6422986.95
Gomphocarpus fruticosus	*Declared Pest	387961.15	6422970.99
Gomphocarpus fruticosus	*Declared Pest	387956.73	6422970.33
Gomphocarpus fruticosus	*Declared Pest	387927.39	6422962.49
Gomphocarpus fruticosus	*Declared Pest	387927.62	6422961.80
Gomphocarpus fruticosus	*Declared Pest	387937.70	6422947.64
Gomphocarpus fruticosus	*Declared Pest	387942.16	6422952.63
Gomphocarpus fruticosus	*Declared Pest	387943.19	6422953.68
Gomphocarpus fruticosus	*Declared Pest	387945.69	6422954.46
Gomphocarpus fruticosus	*Declared Pest	387946.30	6422955.19
Gomphocarpus fruticosus	*Declared Pest	387948.14	6422958.65
Gomphocarpus fruticosus	*Declared Pest	387948.41	6422958.43
Gomphocarpus fruticosus	*Declared Pest	387949.27	6422956.75
Gomphocarpus fruticosus	*Declared Pest	387953.22	6422956.38
Gomphocarpus fruticosus	*Declared Pest	387953.33	6422956.31
Gomphocarpus fruticosus	*Declared Pest	387950.82	6422948.33
Gomphocarpus fruticosus	*Declared Pest	387952.00	6422948.26
Gomphocarpus fruticosus	*Declared Pest	387953.48	6422948.25
Gomphocarpus fruticosus	*Declared Pest	387953.92	6422948.48
Gomphocarpus fruticosus	*Declared Pest	387953.77	6422947.93
Gomphocarpus fruticosus	*Declared Pest	387953.11	6422946.33
Gomphocarpus fruticosus	*Declared Pest	387951.64	6422945.93
Gomphocarpus fruticosus	*Declared Pest	387948.94	6422942.15
Gomphocarpus fruticosus	*Declared Pest	387923.97	6422928.45
Gomphocarpus fruticosus	*Declared Pest	387922.67	6422926.86
Gomphocarpus fruticosus	*Declared Pest	387922.08	6422926.05
Gomphocarpus fruticosus	*Declared Pest	387919.80	6422925.41
Gomphocarpus fruticosus	*Declared Pest	387917.96	6422925.65
Gomphocarpus fruticosus	*Declared Pest	387909.60	6422931.52
Gomphocarpus fruticosus	*Declared Pest	387921.01	6422929.34
Gomphocarpus fruticosus	*Declared Pest	387921.16	6422928.08
Gomphocarpus fruticosus	*Declared Pest	387921.17	6422927.89

9 Appendix D (continued)

Table D3. - Significant weed species locations (continued)

Species	Weed Status	Easting	Northing
Gomphocarpus fruticosus	*Declared Pest	387920.65	6422927.37
Gomphocarpus fruticosus	*Declared Pest	387922.07	6422923.98
Gomphocarpus fruticosus	*Declared Pest	387923.90	6422924.05
Gomphocarpus fruticosus	*Declared Pest	387924.81	6422924.08
Gomphocarpus fruticosus	*Declared Pest	387925.91	6422925.05
Gomphocarpus fruticosus	*Declared Pest	387934.37	6422930.07
Gomphocarpus fruticosus	*Declared Pest	387938.91	6422932.47
Gomphocarpus fruticosus	*Declared Pest	387941.82	6422919.13
Gomphocarpus fruticosus	*Declared Pest	387926.58	6422909.00
Gomphocarpus fruticosus	*Declared Pest	387920.95	6422910.16
Gomphocarpus fruticosus	*Declared Pest	387918.06	6422910.40
Gomphocarpus fruticosus	*Declared Pest	387917.45	6422910.44
Gomphocarpus fruticosus	*Declared Pest	387915.99	6422910.90
Gomphocarpus fruticosus	*Declared Pest	387915.45	6422911.23
Gomphocarpus fruticosus	*Declared Pest	387914.93	6422911.53
Gomphocarpus fruticosus	*Declared Pest	387909.10	6422896.56
Gomphocarpus fruticosus	*Declared Pest	387910.42	6422896.80
Gomphocarpus fruticosus	*Declared Pest	387910.71	6422896.95
Gomphocarpus fruticosus	*Declared Pest	387913.41	6422897.88
Gomphocarpus fruticosus	*Declared Pest	387913.84	6422897.42
Gomphocarpus fruticosus	*Declared Pest	387914.45	6422895.80
Gomphocarpus fruticosus	*Declared Pest	387915.27	6422893.65
Gomphocarpus fruticosus	*Declared Pest	387916.05	6422892.00
Gomphocarpus fruticosus	*Declared Pest	387916.55	6422891.89
Gomphocarpus fruticosus	*Declared Pest	387943.76	6422908.98
Gomphocarpus fruticosus	*Declared Pest	387944.84	6422909.73
Gomphocarpus fruticosus	*Declared Pest	387945.76	6422905.91
Gomphocarpus fruticosus	*Declared Pest	387951.12	6422896.72
Gomphocarpus fruticosus	*Declared Pest	387950.36	6422894.10
Gomphocarpus fruticosus	*Declared Pest	387946.59	6422895.73
Gomphocarpus fruticosus	*Declared Pest	387946.13	6422895.79
Gomphocarpus fruticosus	*Declared Pest	387945.71	6422895.17
Gomphocarpus fruticosus	*Declared Pest	387945.57	6422894.96
Gomphocarpus fruticosus	*Declared Pest	387945.36	6422894.66

Table D3. - Significant weed species locations (continued)			
Species	**Weed Status**	**Easting**	**Northing**
Gomphocarpus fruticosus	*Declared Pest	387942.42	6422893.18
Gomphocarpus fruticosus	*Declared Pest	387941.76	6422892.00
Gomphocarpus fruticosus	*Declared Pest	387939.30	6422888.54
Gomphocarpus fruticosus	*Declared Pest	387932.12	6422888.29
Gomphocarpus fruticosus	*Declared Pest	387928.65	6422890.84
Gomphocarpus fruticosus	*Declared Pest	387923.42	6422890.79
Gomphocarpus fruticosus	*Declared Pest	387922.12	6422891.12
Gomphocarpus fruticosus	*Declared Pest	387921.59	6422892.11
Gomphocarpus fruticosus	*Declared Pest	387919.66	6422893.42
Gomphocarpus fruticosus	*Declared Pest	387916.53	6422895.57
Gomphocarpus fruticosus	*Declared Pest	387916.66	6422894.72
Gomphocarpus fruticosus	*Declared Pest	387917.51	6422891.12
Gomphocarpus fruticosus	*Declared Pest	387917.44	6422890.82
Gomphocarpus fruticosus	*Declared Pest	387911.51	6422886.06
Gomphocarpus fruticosus	*Declared Pest	387913.28	6422880.96
Gomphocarpus fruticosus	*Declared Pest	387921.02	6422880.01
Gomphocarpus fruticosus	*Declared Pest	387921.22	6422883.41
Gomphocarpus fruticosus	*Declared Pest	387950.44	6422891.07
Gomphocarpus fruticosus	*Declared Pest	387950.38	6422882.96
Gomphocarpus fruticosus	*Declared Pest	387946.62	6422877.19
Gomphocarpus fruticosus	*Declared Pest	387943.90	6422874.60
Gomphocarpus fruticosus	*Declared Pest	387943.77	6422873.87
Gomphocarpus fruticosus	*Declared Pest	387945.86	6422872.80
Gomphocarpus fruticosus	*Declared Pest	387929.96	6422870.15
Gomphocarpus fruticosus	*Declared Pest	387925.17	6422872.31
Gomphocarpus fruticosus	*Declared Pest	387918.84	6422875.12
Gomphocarpus fruticosus	*Declared Pest	387931.31	6422866.47
Gomphocarpus fruticosus	*Declared Pest	387939.40	6422867.45
Gomphocarpus fruticosus	*Declared Pest	387951.58	6422864.40
Gomphocarpus fruticosus	*Declared Pest	387951.89	6422854.03
Gomphocarpus fruticosus	*Declared Pest	387950.04	6422853.22
Gomphocarpus fruticosus	*Declared Pest	387947.31	6422849.69
Gomphocarpus fruticosus	*Declared Pest	387944.31	6422846.90
Gomphocarpus fruticosus	*Declared Pest	387939.22	6422845.07

9 Appendix D (continued)

Table D3. - Significant weed species locations (continued)

Species	Weed Status	Easting	Northing
Gomphocarpus fruticosus	*Declared Pest	387932.57	6422850.35
Gomphocarpus fruticosus	*Declared Pest	387931.07	6422853.02
Gomphocarpus fruticosus	*Declared Pest	387944.86	6422840.68
Gomphocarpus fruticosus	*Declared Pest	387945.81	6422842.01
Gomphocarpus fruticosus	*Declared Pest	387945.84	6422843.48
Gomphocarpus fruticosus	*Declared Pest	387945.63	6422844.26
Gomphocarpus fruticosus	*Declared Pest	387945.27	6422845.57
Gomphocarpus fruticosus	*Declared Pest	387945.13	6422846.08
Gomphocarpus fruticosus	*Declared Pest	387944.90	6422846.51
Gomphocarpus fruticosus	*Declared Pest	387944.41	6422850.92
Gomphocarpus fruticosus	*Declared Pest	387941.45	6422845.67
Gomphocarpus fruticosus	*Declared Pest	387943.36	6422846.53
Gomphocarpus fruticosus	*Declared Pest	387947.57	6422848.42
Gomphocarpus fruticosus	*Declared Pest	387947.37	6422844.63
Gomphocarpus fruticosus	*Declared Pest	387950.13	6422840.62
Gomphocarpus fruticosus	*Declared Pest	387951.10	6422839.55
Gomphocarpus fruticosus	*Declared Pest	387952.75	6422838.18
Gomphocarpus fruticosus	*Declared Pest	387951.11	6422826.77
Gomphocarpus fruticosus	*Declared Pest	387949.70	6422825.47
Gomphocarpus fruticosus	*Declared Pest	387948.28	6422824.17
Gomphocarpus fruticosus	*Declared Pest	387946.13	6422824.49
Gomphocarpus fruticosus	*Declared Pest	387945.00	6422824.83
Gomphocarpus fruticosus	*Declared Pest	387944.56	6422824.75
Gomphocarpus fruticosus	*Declared Pest	387942.42	6422824.28
Gomphocarpus fruticosus	*Declared Pest	387939.26	6422823.28
Gomphocarpus fruticosus	*Declared Pest	387936.39	6422823.52
Gomphocarpus fruticosus	*Declared Pest	387935.93	6422823.59
Gomphocarpus fruticosus	*Declared Pest	387935.01	6422821.61
Gomphocarpus fruticosus	*Declared Pest	387933.48	6422824.17
Gomphocarpus fruticosus	*Declared Pest	387931.31	6422824.35
Gomphocarpus fruticosus	*Declared Pest	387931.44	6422811.79
Gomphocarpus fruticosus	*Declared Pest	387933.82	6422814.20
Gomphocarpus fruticosus	*Declared Pest	387935.53	6422818.11
Gomphocarpus fruticosus	*Declared Pest	387943.04	6422812.79

Table D3. - Significant weed species locations (continued)			
Species	**Weed Status**	**Easting**	**Northing**
Gomphocarpus fruticosus	*Declared Pest	387947.87	6422798.39
Gomphocarpus fruticosus	*Declared Pest	387918.99	6422794.53
Gomphocarpus fruticosus	*Declared Pest	387939.15	6422770.57
Gomphocarpus fruticosus	*Declared Pest	387939.39	6422768.20
Gomphocarpus fruticosus	*Declared Pest	387938.19	6422766.99
Gomphocarpus fruticosus	*Declared Pest	387935.25	6422762.95
Gomphocarpus fruticosus	*Declared Pest	387932.71	6422762.44
Gomphocarpus fruticosus	*Declared Pest	387929.35	6422765.19
Gomphocarpus fruticosus	*Declared Pest	387923.28	6422765.51
Gomphocarpus fruticosus	*Declared Pest	387926.18	6422740.36
Gomphocarpus fruticosus	*Declared Pest	387909.78	6422743.95
Gomphocarpus fruticosus	*Declared Pest	387909.30	6422744.19
Gomphocarpus fruticosus	*Declared Pest	387908.53	6422744.57
Gomphocarpus fruticosus	*Declared Pest	387907.59	6422744.39
Gomphocarpus fruticosus	*Declared Pest	387905.48	6422743.82
Gomphocarpus fruticosus	*Declared Pest	387904.92	6422744.45
Gomphocarpus fruticosus	*Declared Pest	387902.35	6422746.20
Gomphocarpus fruticosus	*Declared Pest	387901.94	6422745.73
Gomphocarpus fruticosus	*Declared Pest	387902.04	6422740.26
Gomphocarpus fruticosus	*Declared Pest	387902.74	6422734.27
Gomphocarpus fruticosus	*Declared Pest	387901.86	6422733.00
Gomphocarpus fruticosus	*Declared Pest	387901.51	6422732.50
Gomphocarpus fruticosus	*Declared Pest	387900.22	6422730.32
Gomphocarpus fruticosus	*Declared Pest	387900.26	6422729.95
Gomphocarpus fruticosus	*Declared Pest	387901.39	6422728.06
Gomphocarpus fruticosus	*Declared Pest	387901.70	6422727.98
Gomphocarpus fruticosus	*Declared Pest	387902.00	6422727.90
Gomphocarpus fruticosus	*Declared Pest	387903.22	6422727.58
Gomphocarpus fruticosus	*Declared Pest	387905.14	6422727.26
Gomphocarpus fruticosus	*Declared Pest	387905.61	6422728.07
Gomphocarpus fruticosus	*Declared Pest	387916.76	6422726.15
Gomphocarpus fruticosus	*Declared Pest	387913.72	6422725.83
Gomphocarpus fruticosus	*Declared Pest	387910.81	6422724.93
Gomphocarpus fruticosus	*Declared Pest	387908.58	6422723.91

9 Appendix D (continued)

Table D3. - Significant weed species locations (continued)

Species	Weed Status	Easting	Northing
Gomphocarpus fruticosus	*Declared Pest	387908.06	6422722.52
Gomphocarpus fruticosus	*Declared Pest	387907.08	6422721.25
Gomphocarpus fruticosus	*Declared Pest	387906.75	6422719.74
Gomphocarpus fruticosus	*Declared Pest	387906.71	6422719.01
Gomphocarpus fruticosus	*Declared Pest	387906.50	6422717.72
Gomphocarpus fruticosus	*Declared Pest	387905.02	6422717.20
Gomphocarpus fruticosus	*Declared Pest	387901.50	6422710.81
Gomphocarpus fruticosus	*Declared Pest	387901.60	6422710.75
Gomphocarpus fruticosus	*Declared Pest	387901.55	6422710.18
Gomphocarpus fruticosus	*Declared Pest	387906.34	6422707.99
Gomphocarpus fruticosus	*Declared Pest	387906.89	6422707.77
Gomphocarpus fruticosus	*Declared Pest	387907.07	6422707.50
Gomphocarpus fruticosus	*Declared Pest	387907.41	6422706.95
Gomphocarpus fruticosus	*Declared Pest	387907.50	6422706.81
Gomphocarpus fruticosus	*Declared Pest	387907.67	6422706.54
Gomphocarpus fruticosus	*Declared Pest	387909.95	6422703.40
Gomphocarpus fruticosus	*Declared Pest	387910.77	6422704.10
Gomphocarpus fruticosus	*Declared Pest	387911.03	6422704.96
Gomphocarpus fruticosus	*Declared Pest	387911.08	6422705.11
Gomphocarpus fruticosus	*Declared Pest	387911.22	6422706.13
Gomphocarpus fruticosus	*Declared Pest	387927.54	6422702.20
Gomphocarpus fruticosus	*Declared Pest	387926.90	6422701.41
Gomphocarpus fruticosus	*Declared Pest	387927.28	6422699.65
Gomphocarpus fruticosus	*Declared Pest	387927.38	6422699.28
Gomphocarpus fruticosus	*Declared Pest	387927.20	6422698.95
Gomphocarpus fruticosus	*Declared Pest	387927.15	6422698.90
Gomphocarpus fruticosus	*Declared Pest	387926.71	6422698.79
Gomphocarpus fruticosus	*Declared Pest	387923.33	6422697.71
Gomphocarpus fruticosus	*Declared Pest	387978.79	6422675.45
Gomphocarpus fruticosus	*Declared Pest	387977.05	6422740.75
Gomphocarpus fruticosus	*Declared Pest	387976.49	6422741.78
Gomphocarpus fruticosus	*Declared Pest	387976.31	6422743.90
Gomphocarpus fruticosus	*Declared Pest	387975.58	6422749.05
Gomphocarpus fruticosus	*Declared Pest	387968.36	6422759.05

Table D3. - Significant weed species locations (continued)			
Species	**Weed Status**	**Easting**	**Northing**
Gomphocarpus fruticosus	*Declared Pest	387968.22	6422761.31
Gomphocarpus fruticosus	*Declared Pest	387968.67	6422767.14
Gomphocarpus fruticosus	*Declared Pest	387996.02	6422792.70
Gomphocarpus fruticosus	*Declared Pest	387995.85	6422793.30
Gomphocarpus fruticosus	*Declared Pest	387995.25	6422799.96
Gomphocarpus fruticosus	*Declared Pest	387995.17	6422800.38
Gomphocarpus fruticosus	*Declared Pest	387995.12	6422800.62
Gomphocarpus fruticosus	*Declared Pest	387995.10	6422800.74
Gomphocarpus fruticosus	*Declared Pest	387995.07	6422800.92
Gomphocarpus fruticosus	*Declared Pest	387989.64	6422819.17
Gomphocarpus fruticosus	*Declared Pest	387988.49	6422830.20
Gomphocarpus fruticosus	*Declared Pest	387977.66	6422835.27
Gomphocarpus fruticosus	*Declared Pest	387975.74	6422833.23
Gomphocarpus fruticosus	*Declared Pest	387973.00	6422830.04
Gomphocarpus fruticosus	*Declared Pest	387973.31	6422836.65
Gomphocarpus fruticosus	*Declared Pest	387973.27	6422836.87
Gomphocarpus fruticosus	*Declared Pest	387973.22	6422837.08
Gomphocarpus fruticosus	*Declared Pest	387972.57	6422838.16
Gomphocarpus fruticosus	*Declared Pest	387972.46	6422838.34
Gomphocarpus fruticosus	*Declared Pest	387971.51	6422839.84
Gomphocarpus fruticosus	*Declared Pest	387968.15	6422844.30
Gomphocarpus fruticosus	*Declared Pest	387967.57	6422853.79
Gomphocarpus fruticosus	*Declared Pest	387981.73	6422870.05
Gomphocarpus fruticosus	*Declared Pest	387985.42	6422876.26
Gomphocarpus fruticosus	*Declared Pest	387984.40	6422880.12
Gomphocarpus fruticosus	*Declared Pest	387980.55	6422884.82
Gomphocarpus fruticosus	*Declared Pest	387978.93	6422886.69
Gomphocarpus fruticosus	*Declared Pest	387980.87	6422888.84
Gomphocarpus fruticosus	*Declared Pest	387983.43	6422889.62
Gomphocarpus fruticosus	*Declared Pest	387987.44	6422891.01
Gomphocarpus fruticosus	*Declared Pest	387987.79	6422891.40
Gomphocarpus fruticosus	*Declared Pest	387988.83	6422892.58
Gomphocarpus fruticosus	*Declared Pest	387990.17	6422898.19
Gomphocarpus fruticosus	*Declared Pest	387984.00	6422900.44

9 Appendix D (continued)

Table D3. - Significant weed species locations (continued)

Species	Weed Status	Easting	Northing
Gomphocarpus fruticosus	*Declared Pest	387982.94	6422900.84
Gomphocarpus fruticosus	*Declared Pest	387980.43	6422907.50
Gomphocarpus fruticosus	*Declared Pest	387976.68	6422909.91
Gomphocarpus fruticosus	*Declared Pest	387974.06	6422912.65
Gomphocarpus fruticosus	*Declared Pest	387970.82	6422914.85
Gomphocarpus fruticosus	*Declared Pest	387971.72	6422916.32
Gomphocarpus fruticosus	*Declared Pest	387973.92	6422922.45
Gomphocarpus fruticosus	*Declared Pest	387968.15	6422930.38
Gomphocarpus fruticosus	*Declared Pest	387968.16	6422932.31
Gomphocarpus fruticosus	*Declared Pest	387968.01	6422937.58
Gomphocarpus fruticosus	*Declared Pest	387966.78	6422945.67
Gomphocarpus fruticosus	*Declared Pest	387973.54	6422947.97
Gomphocarpus fruticosus	*Declared Pest	387980.11	6422945.92
Gomphocarpus fruticosus	*Declared Pest	387984.44	6422946.39
Gomphocarpus fruticosus	*Declared Pest	387984.47	6422946.43
Gomphocarpus fruticosus	*Declared Pest	387984.50	6422946.49
Gomphocarpus fruticosus	*Declared Pest	387979.24	6422994.76
Gomphocarpus fruticosus	*Declared Pest	387979.03	6422995.10
Gomphocarpus fruticosus	*Declared Pest	387976.18	6423004.32
Gomphocarpus fruticosus	*Declared Pest	387976.43	6423006.33
Gomphocarpus fruticosus	*Declared Pest	387975.19	6423025.70
Gomphocarpus fruticosus	*Declared Pest	387977.71	6423029.68
Gomphocarpus fruticosus	*Declared Pest	387998.07	6423087.81
Gomphocarpus fruticosus	*Declared Pest	387993.68	6423128.69
Gomphocarpus fruticosus	*Declared Pest	387643.67	6423044.35
Gomphocarpus fruticosus	*Declared Pest	387671.84	6422981.43
Gomphocarpus fruticosus	*Declared Pest	387958.42	6422373.53
Gomphocarpus fruticosus	*Declared Pest	387906.60	6422395.98
Gomphocarpus fruticosus	*Declared Pest	387899.96	6422448.69
Gomphocarpus fruticosus	*Declared Pest	387899.96	6422448.69
Gomphocarpus fruticosus	*Declared Pest	387949.37	6422469.86
Gomphocarpus fruticosus	*Declared Pest	387949.37	6422469.86
Gomphocarpus fruticosus	*Declared Pest	387949.37	6422469.86
Gomphocarpus fruticosus	*Declared Pest	387960.70	6422534.05

Table D3. - Significant weed species locations (continued)			
Species	**Weed Status**	**Easting**	**Northing**
Gomphocarpus fruticosus	*Declared Pest	387963.13	6422525.67
Gomphocarpus fruticosus	*Declared Pest	387964.37	6422525.00
Gomphocarpus fruticosus	*Declared Pest	387964.03	6422519.60
Gomphocarpus fruticosus	*Declared Pest	387963.80	6422516.20
Gomphocarpus fruticosus	*Declared Pest	387958.19	6422510.51
Gomphocarpus fruticosus	*Declared Pest	387607.56	6422459.41
Solanum linnaeanum	*Declared Pest	387950.59	6422365.41
Solanum linnaeanum	*Declared Pest	387950.53	6422365.40
Solanum linnaeanum	*Declared Pest	388110.04	6422516.61
Solanum linnaeanum	*Declared Pest	388109.69	6422510.63
Solanum linnaeanum	*Declared Pest	388108.90	6422508.54
Solanum linnaeanum	*Declared Pest	388106.62	6422502.51
Solanum linnaeanum	*Declared Pest	388106.25	6422501.52
Solanum linnaeanum	*Declared Pest	387923.83	6422524.34
Zantedeschia aethiopica	*Declared Pest	388107.10	6422494.82
Zantedeschia aethiopica	*Declared Pest	388109.32	6422424.37
Zantedeschia aethiopica	*Declared Pest	388058.86	6422223.75
Zantedeschia aethiopica	*Declared Pest	387859.32	6422440.75

*=non-native (weed) species, WoNS='weed of National significance'

9 Appendix E - Conservation Significant Flora Likelihood of Occurrence

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	State	EPBC Act				
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	T	CE	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep - Nov	Unlikely
Synaphea sp. Pinjarra Plain (A.S. George 17182)	T	CE	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct	Possible
Acacia imitans	T	E	P	Rocky red loam. Rocky hills.	Aug - Sept	Unlikely
Acacia unguicula	T	E	P	Rocky clay or loam. Upper slopes & summit of mountain.	Aug - Sept	Unlikely
Caladenia huegelii	T	E	P	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov	Unlikely
Drakaea elastica	T	E	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps.	Sep-Oct (survey Jul-Aug)	Unlikely
Hybanthus cymulosus	T	E	P	Clay, rocky loam clay.	May - Jul	Unlikely
Diuris drummondii	T	V	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	Possible
Diuris micrantha	T	V	PG	Dark grey-black sandy clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep - early Oct	Possible
Tetraria australiensis	T	V	P	Sand over clay, winter wet depressions and drainage lines.	Nov-Dec	Possible
Synaphea sp. Serpentine (G.R. Brand 103)	T		P	Seasonally damp areas, loam - sand.	Sep-Oct	Possible
Acacia cerastes	P1		P	Skeletal soil. Rocky ironstone hillslopes.	Aug or Nov	Unlikely
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1		P	Grey or black sand over clay in winter wet areas.	May-Aug	Possible
Boronia juncea subsp. *juncea*	P1		P	Sand in low scrub.	April	Possible
Grevillea scabrida	P1		P	Red clay loam, stony loam.	Jul	Unlikely
Grevillea subtiliflora	P1		P	Red-brown loam.	Apr - Jul	Unlikely
Lachnagrostis nesomytica subsp. *paralia*	P1		P/A	Calcareous sands. Coastal dunes and swales.	Unknown (likely Nov)	Possible
Stachystemon sp. Keysbrook (R. Archer 17/11/99)	P1		P	White grey sand.	Oct	Possible
Acacia benthamii	P2		P	Sand, typically on limestone breakaways.	Aug - Sept	Possible
Cardamine paucijuga	P2		A	Winter wet areas, sand or clay.	Sep-Oct	Possible
Johnsonia pubescens subsp. *cygnorum*	P2		P	Grey white yellow sands on flats and seasonally wet areas.	Sept	Possible
Thelymitra variegata	P2		PG	Sandy clay, sand, laterite.	Jun-Sep	Possible
Austrostipa mundula	P3		P	Grey sand over limestone.	Sep-Nov	Possible
Beyeria cinerea subsp. *cinerea*	P3		P	Sand, limestone.	May-Oct	Possible

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	State	EPBC Act				
Boronia capitata subsp. *gracilis*	P3		P	White/grey or black sand in winter-wet swamps, hillslopes.	Jun-Nov	Possible
Calandrinia oraria	P3		A	Coastal dunes, in low heath, sand over limestone.	Aug-Oct	Unlikely
Carex tereticaulis	P3		P	Black peaty sand.	Sep-Oct	Possible
Cyathochaeta teretifolia	P3		P	Grey sand, sandy clay in swamps and creek edges.	Oct-Jan	Possible
Dillwynia dillwynioides	P3		P	Winter wet depressions on sandy soils.	Aug - Dec	Possible
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	P3		P	Grey brown sand or clay in winter wet flats.	Sep-Nov	Possible
Jacksonia gracillima	P3		P	Sand, often adjacent to winter wet areas.	Sep-Dec	Possible
Lasiopetalum membranaceum	P3		P	Sand over limestone.	Sep-Dec	Possible
Pimelea calcicola	P3		P	Sand, limestone, coastal ridges.	Sep-Nov	Possible
Schoenus capillifolius	P3		A	Brown mud in claypans.	Oct-Nov	Unlikely
Sphaerolobium calcicola	P3		P	White-grey-brown sand, sandy clay over limestone, black peaty sandy clay. Tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	Jun or Sep-Nov	Possible
Stylidium paludicola	P3		P	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland.	Oct-Dec	Possible
Styphelia filifolia	P3		P	Brown over pale yellow sand in woodland.	April	Unlikely
Aponogeton hexatepalus	P4		P	Mud. Freshwater: ponds, rivers, claypans.	Jul-Oct	Possible
Caladenia speciosa	P4		PG	White, grey or black sand.	Sep-Oct	Possible
Conostylis pauciflora subsp. *pauciflora*	P4		*P*	Grey sand, limestone. Hillslopes, consolidated dunes.	Aug-Oct	Possible
Dodonaea hackettiana	P4		P	Sand, outcropping limestone.	Jul-Oct	Possible
Eucalyptus rudis subsp. *cratyantha*	P4		P	Loam on flats and hillsides.	Jul-Sep	Possible
Jacksonia sericea	P4		P	Calcareous and sandy soils on Swan Coastal Plain.	Dec-Feb	Possible
Lepidium puberulum	P4		A	Sandy soils.	Jul - Aug or Oct - Nov	Possible
Myosotis australis	P4		A	Grey sand over limestone.	Aug - Nov	Possible
Ornduffia submersa	P4		A	Sandy clay in inundated wetland/creek.	Aug-Nov	Possible
Parsonsia diaphanophleba	P4		P	Alluvial soils along rivers.	Jan-Feb or Apr-Sep	Unlikely
Stylidium ireneae	P4		P/A	Sandy loam in valleys near creeklines.	Oct-Dec	Unlikely
Stylidium longitubum	P4		A	Sandy clay, clay. Seasonal wetlands.	Oct-Dec	Possible
Verticordia lindleyi subsp. *lindleyi*	P4		P	Sand and sandy clay in winter wet areas.	May or Nov-Jan	Possible

Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual.

Threatened flora (T) is that subset of 'Rare Flora' listed under schedules 1 to 3 of the State's *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

Priority species= Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Flora Lists under Priorities 1, 2 or 3 , ranked in order of priority.

9 Appendix F - Detailed Findings of the Environmental Offset Revegetation Performance

Table F1. Count of dead and alive plant species recorded within each sampling unit of RA1

Species Name	Sample Unit 1 (P231-R1-E)		Sample Unit 2 (P178-R1-M)		Sample Unit 3 (P124-R1-Y)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Eucalyptus gomphocephala					1	
Eucalyptus marginata			4			
Eucalyptus rudis	7				6	
Acacia saligna	2		7			
Hakea varia	3		5			
Hakea prostrata	1		1			
Melaleuca teretifolia					1	
Kunzea glabrescens			6			
dead unknown				1		

Table F2. Count of dead and alive plant species recorded within each sampling unit of RA2 (continued)

Species Name	Sample Unit 1 (P337-R2-K)		Sample Unit 2 (P283-R2-D)		Sample Unit 3 (P245-R2-Y)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Banksia attenuata	2		1		1	
Banksia menziesii	3				5	
Calothamnus quadrifidus					1	
Centella asiatica			100			
Corymbia calophylla	2					
Eucalyptus marginata					5	
Eucalyptus rudis			11		2	
Gahnia trifida			3			
Hakea prostrata	1				10	
Hakea trifurcata	2					
Hakea varia					1	
Hardenbergia comptoniana	3					
Melaleuca laterita			3			
Melaleuca raphiophylla			20			
Melaleuca teretifolia			27	1		
Hakea ruscifolia (assume planted)	3					
Eucalyptus sp.		1				

9 Appendix F (continued)

Table F3. Count of dead and alive plant species recorded within each sampling unit of RA3

Species Name	Sample Unit 1 (P47-R5-T)		Sample Unit 2 (P65-R5-G)		Sample Unit 3 (P46-R5-W)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Eucalyptus gomphocephala	1		1			
Acacia saligna	2				5	
Spyridium globulosum	1		2		1	
Eucalyptus rudis			2		2	
Corymbia calophylla	2		2		2	
Melaleuca raphiophylla			1			
Eucalyptus marginata	2		2		1	
Jacksonia furcellata	5		4		2	
Banksia attenuata	2	2			2	
Banksia menziesii	1				1	
Melaleuca teretifolia	2				3	
Hakea varia					2	
Banksia ilicifolia	1					
Hakea trifurcata					3	
Hakea prostrata	14	1	1			
Hakea lissocarpha			3			
Acacia pulchella	7		1		1	1
Gahnia trifida	5					
Banksia grandis	5		8		13	
dead unknowns		1				1
Allocasuarina sp.					1	

Table F4. Count of dead and alive plant species recorded within each sampling unit of RA4

Species Name	Sample Unit 1 (P47-R5-T)		Sample Unit 2 (P65-R5-G)		Sample Unit 3 (P46-R5-W)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Acacia saligna	2		2			
Gahnia trifida			1			
Acacia pulchella					1	
Melaleuca raphiophylla	2		3	1	2	
Melaleuca teretifolia					1	
Corymbia calophylla	1				2	
Eucalyptus marginata					2	
Jacksonia furcellata	3				2	
Banksia attenuata	1					
Hakea varia			1		3	
Hakea trifurcata					2	
Hakea ruscifolia	2					
Banksia sessilis					1	
Banksia grandis	1					
Jacksonia sternbergiana	2			1		
Kunzea glabrescens	1		2			
Melaleuca lateritia	2		1			
Lechenaultia floribunda	1					
Juncus pallidus			1			
Acacia truncata						1

9 Appendix F (continued)

Table F5. Count of dead and alive plant species recorded within each sampling unit of RA5

Species Name	Sample Unit 1 (P47-R5-T)		Sample Unit 2 (P65-R5-G)		Sample Unit 3 (P46-R5-W)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Acacia saligna					2	
Eucalyptus gomphocephala			3		1	
Corymbia calophylla	3				4	
Eucalyptus marginata					1	
Banksia attenuata				2		
Banksia menziesii			1	1	2	
Banksia ilicifolia	4				2	
Banksia grandis		1				
Eucalyptus rudis			1		2	
Jacksonia furcellata	4				4	
Hakea varia					3	
Hakea trifurcata			2		7	
Hakea prostrata	3				2	
Hakea ruscifolia	2					
Xanthorrhoea preissii					1	2
Hakea lissocarpha					3	1
dead unknowns		14		5		15
Eucalyptus sp.					1	
Melaleuca rhaphiophylla			1			

Table F6. Count of dead and alive plant species recorded within each sampling unit of RA6

Species Name	Sample Unit 1 (P47-R5-T)		Sample Unit 2 (P65-R5-G)		Sample Unit 3 (P46-R5-W)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Acacia saligna	2		4			
Allocasuarina fraseriana			2			
Banksia attenuata	9	2		1		
Banksia grandis	12		2	2		
Banksia ilicifolia	2		2			
Banksia litoralis	4					
Banksia menziesii	1					
Banksia sessilis	1		1			
Corymbia calophylla	8		3			
Eucalyptus marginata	6				1	
Eucalyptus rudis	18		2			
Hakea lissocarpha	1					
Hakea prostrata	8		1		10	1
Hakea ruscifolia	6		6		8	1
Hakea trifurcata	7		1		1	
Hakea varia	12		7		1	
Jacksonia furcellata	6	1	3	2	1	
Xanthorrhoea preissii	1					
dead unknown		14		12		5
Allocasuarina sp.	8		5			

9 Appendix F (continued)

Table F7. Count of dead and alive plant species recorded within each sampling unit of RA7

Species Name	Sample Unit 1 (P47-R5-T)		Sample Unit 2 (P65-R5-G)		Sample Unit 3 (P46-R5-W)	
	No. Alive	No. Dead	No. Alive	No. Dead	No. Alive	No. Dead
Acacia saligna	1					
Banksia attenuata		1				
Banksia grandis		7		1	1	4
Banksia menziesii	3	7	1		1	1
Banksia sessilis					2	1
Corymbia calophylla					7	
Eucalyptus gomphocephala	1					
Eucalyptus rudis	1				2	
Hakea lissocarpha	3	7		1		
Hakea prostrata		3	1		2	
Hakea ruscifolia			1			
Jacksonia furcellata	4					1
Xanthorrhoea preissii					1	
dead unknown		22		4		1
Melaleuca rhaphiophylla (maybe natural recruit)					7	1
Allocasuarina sp.					1	
Eucalyptus sp.				3		
Acacia pulchella			1	1		

Table F8. - General data for the Revegetation Areas						
RA	Sample Unit No.	Native planted (%)	Native natural %	Weeds (%)	Bare ground (%)	Litter (%)
1	1	50	2	1	75	20
1	2	30	10	20	40	5
1	3	60	0	0.1	40	30
2	1	60	0.1	0.1	35	5
2	2	70	30	5	15	40
2	3	35	0	30	45	3
3	1	50	10	5	25	5
3	2	40	0	50	10	30
3	3	60	0	10	60	15
4	1	50	1	15	40	5
4	2	50	0	80	5	10
4	3	30	5	30	50	10
5	1	25	0	60	25	5
5	2	20	10	10	90	5
5	3	30	0.5	40	25	15
6	1	70	0	25	5	40
6	2	35	15	20	40	10
6	3	10	25	5	30	40
7	1	12.5	25	5	50	10
7	2	4	30	2	10	85
7	3	25	0.1	25	60	10

9 Appendix F (continued)

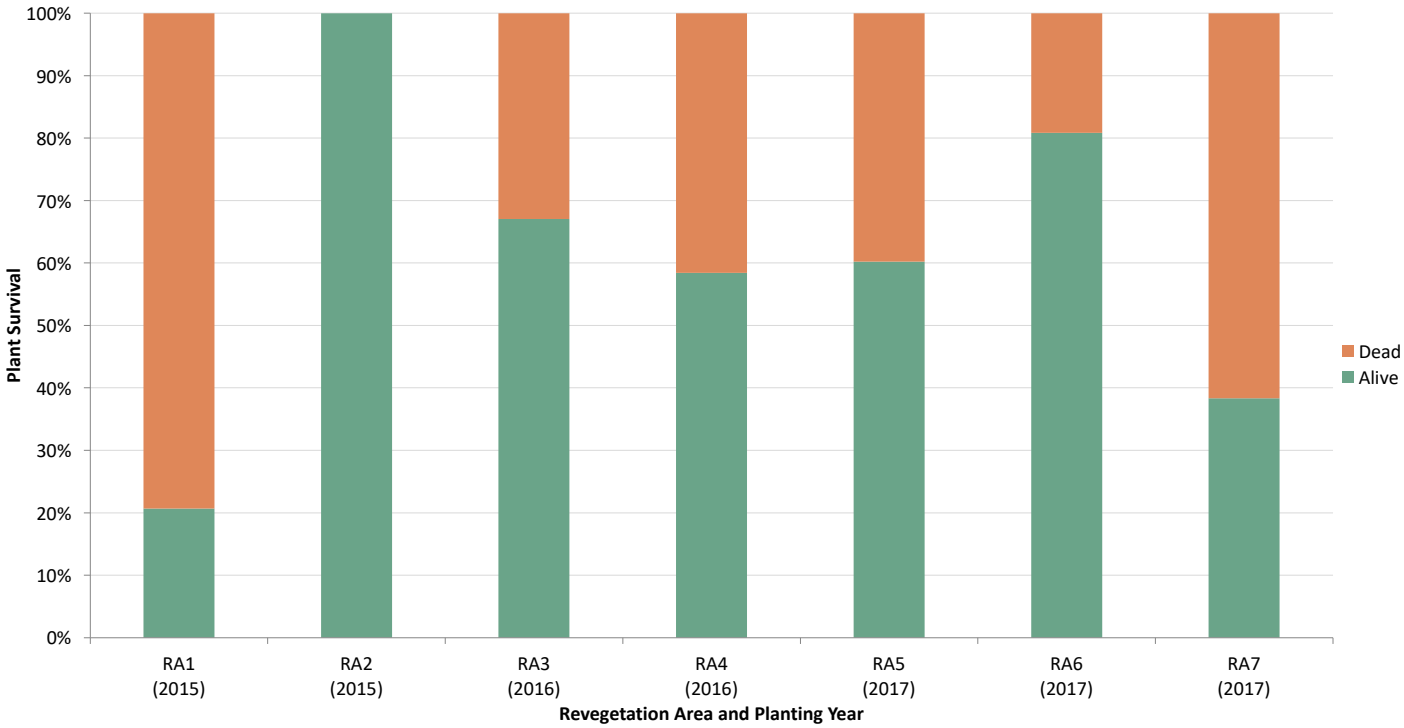


Figure F1. Proportion of plant survival for each revegetation area

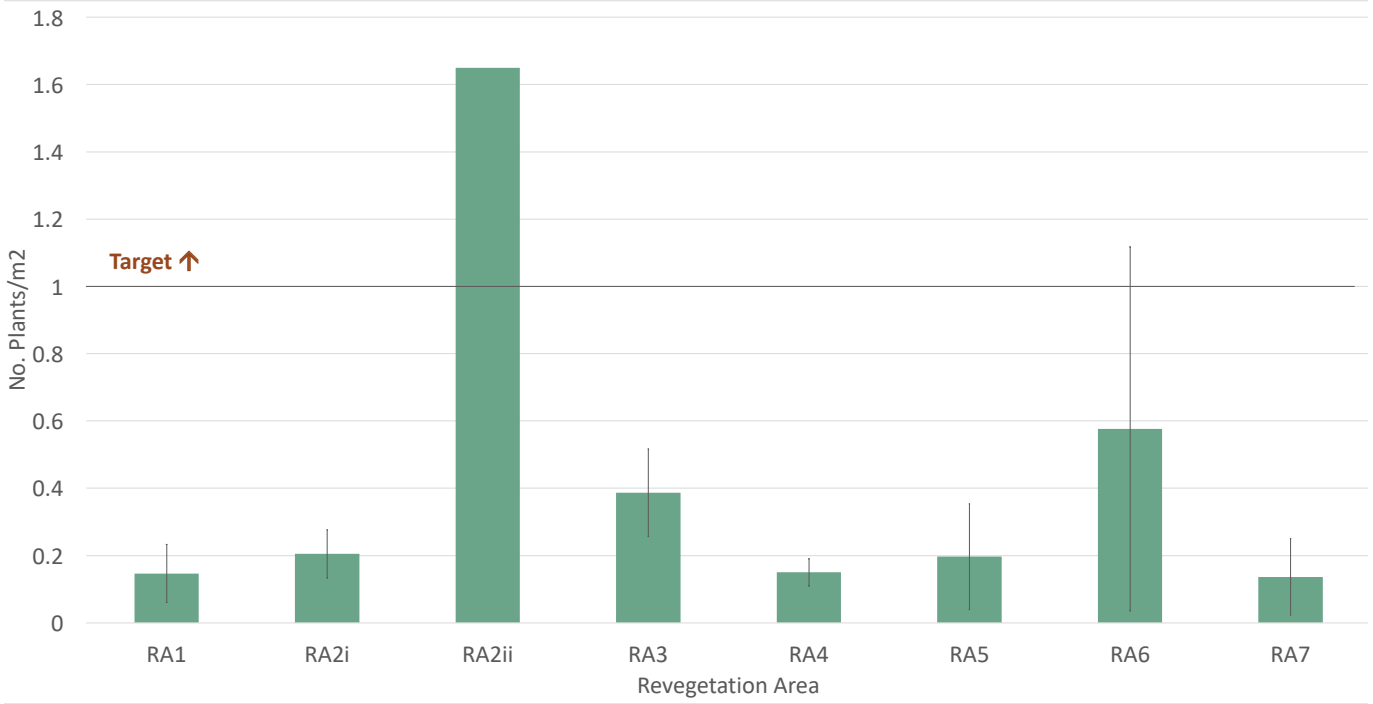


Figure F2. Density of living plants within each revegetation area in the site (± 95% CI)

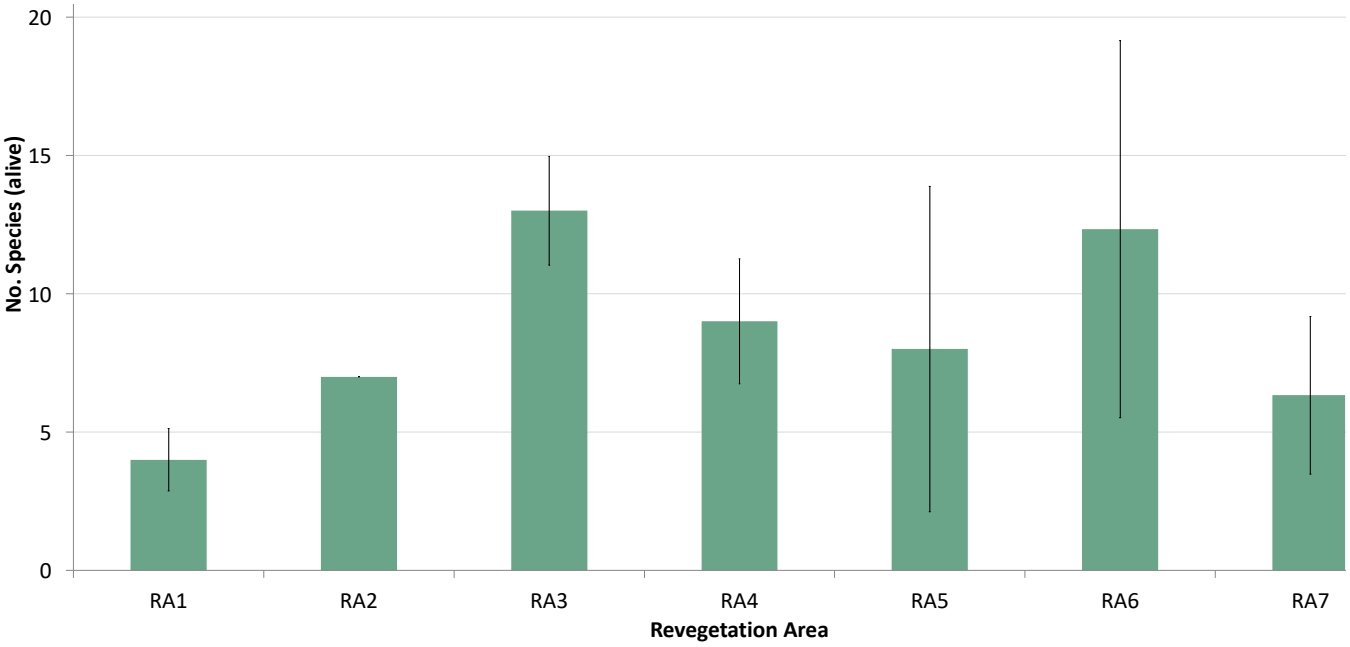


Figure F3. Mean number of species recorded alive within each revegetation area (± 95% CI)

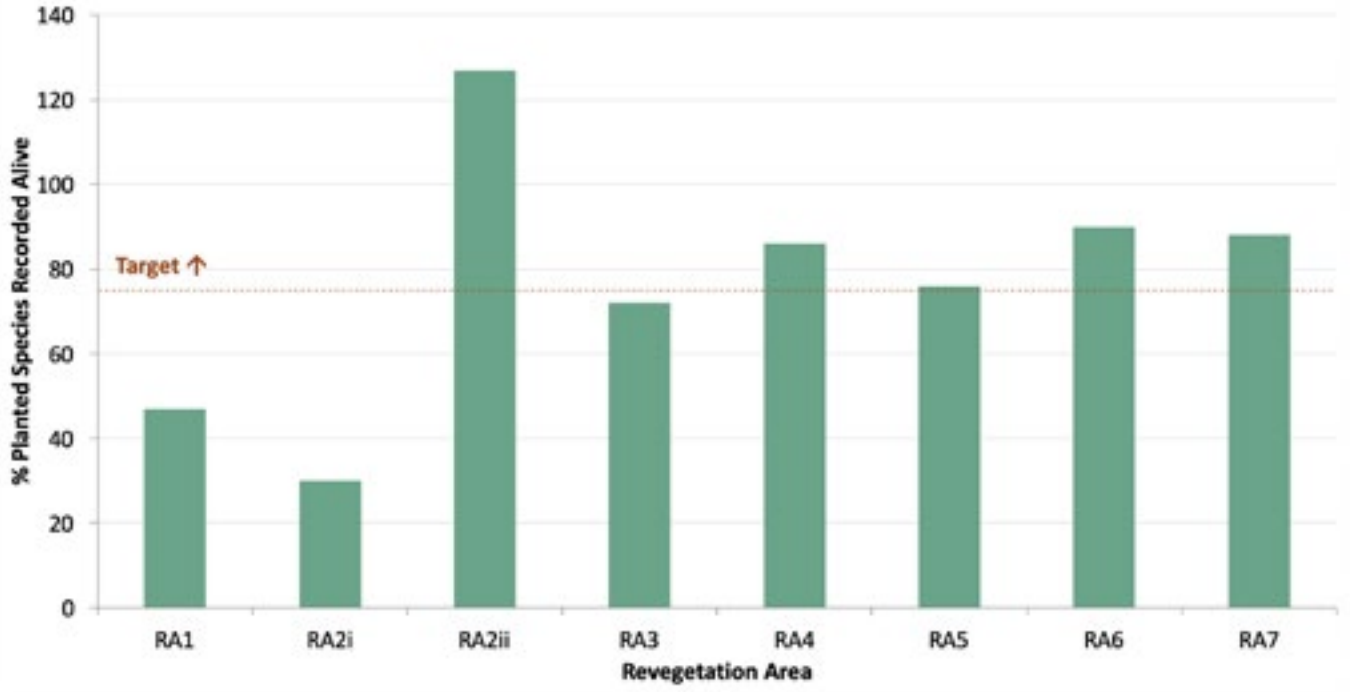


Figure F4. Proportion of number of species recorded in each revegetation area compared to the number planted

9 Appendix F (continued)

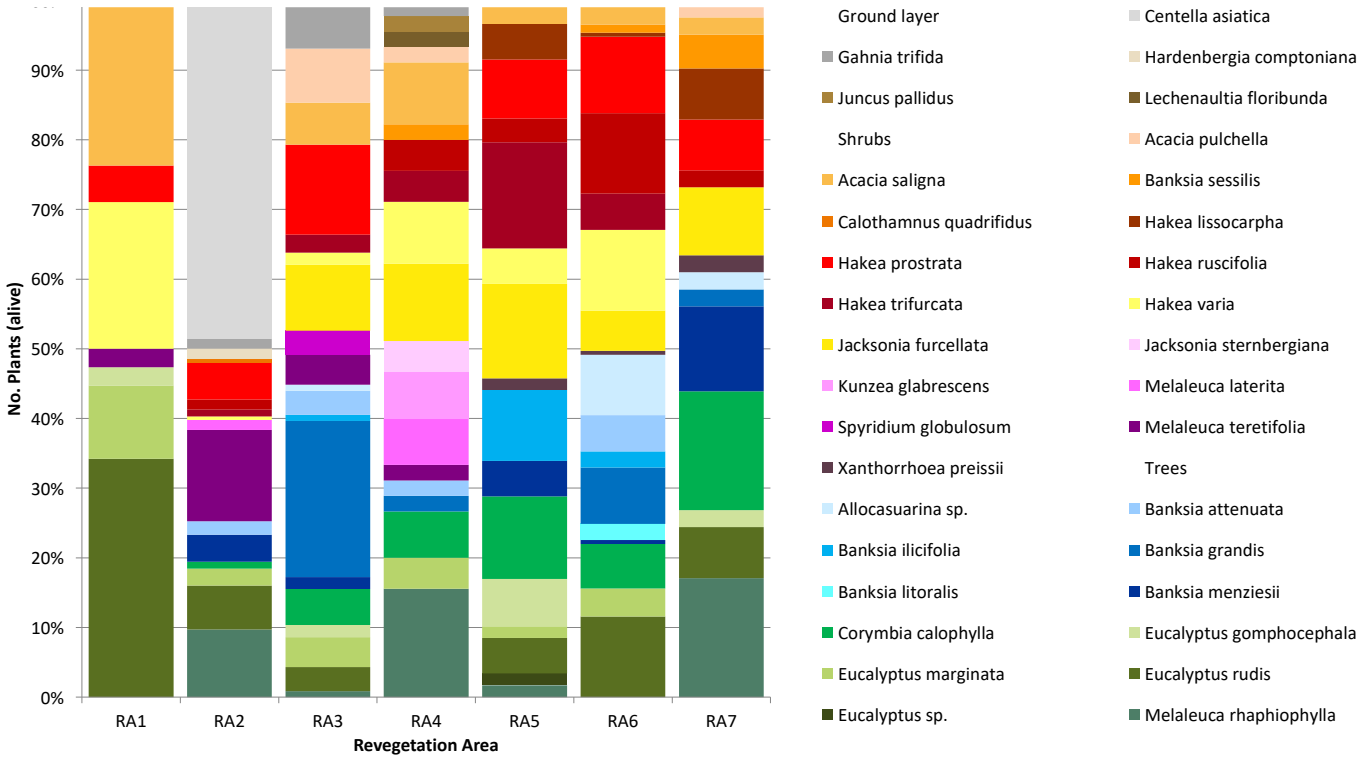


Figure F5. Species diversity (alive) within samples in each revegetation area

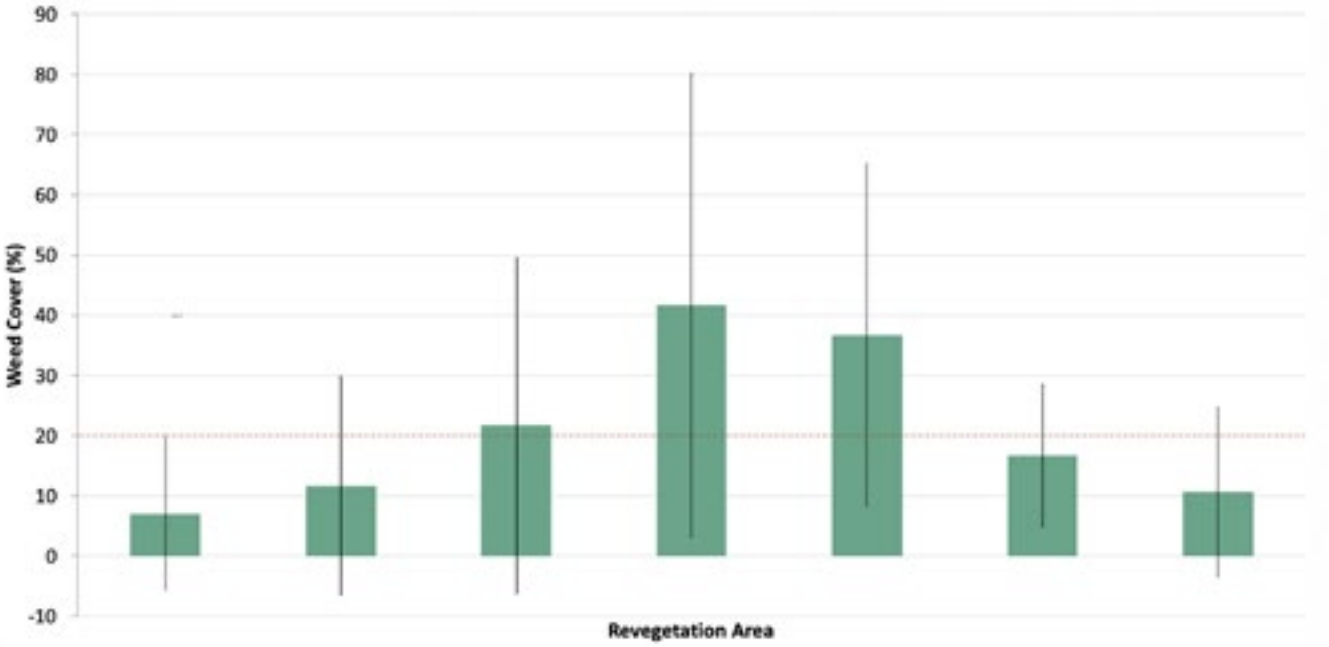


Figure F6. Weed cover (%) recorded within samples in each revegetation area (±95% CI)

9 Appendix G - List of Fauna Species Previously Recorded in the study Area

Species name	Common name	Significance	Survey detection method	Survey that recorded the species
Reptiles				
Acritoscincus trilineatus	Western Three-lined Skink	-	-	Biologic (2015)
Cryptoblepharus buchananii	Fence Skink	-	Observation	Coterra (2013)
Ctenotus fallens	West Coast Ctenotus	-	Observation	Coterra (2013)
Hemiergis quadrilineata	Two-toed Earless Skink	-	-	Biologic (2015)
Amphibians				
Crinia glauerti	Clicking Frog	-	Call*/Observation	Biota (2014, 2015, 2016, 2018), Coterra (2013)
Crinia insignifera	Squelching Frog	-	Call*/Observation	Biota (2014, 2015, 2016, 2018), Biologic (2015)
Crinia pseudinsignifera	Bleating Frog	-	Call*	Biota (2014)
Heleioporus eyrei	Moaning Frog	-	Call*/Observation	Biota (2014)
Limnodynastes dorsalis	Western Banjo Frog	-	Call*/Observation	Biota (2014, 2015)
Litoria adelaidensis	Slender Tree Frog	-	Call*/Observation	Biota (2014, 2015, 2016)
Litoria moorei	Motorbike Frog	-	Observation	Biota (2015, 2016)
Mammals				
Isoodon fusciventer	Quenda	Priority 4	Camera trap / Indirect evidence	Coterra (2013), Bamford (2018)
Macropus fuliginosis	Western Grey Kangaroo	-	Observation	Coterra (2013)
Mus Musculus	House Mouse	Introduced	-	Biologic (2015)
Vulpes vulpes	Red Fox	Introduced	Indirect evidence	Coterra (2013)
Avifauna				
Anthochaera lunulata	Western Little Wattlebird	-	-	Coterra (2013)
Artamus cinereus	Black-faced Woodswallow	-	-	Coterra (2013)
Barnardius zonarius	Australian Ringneck Parrot	-	-	Coterra (2013)
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	S3 under the BC Act; V under EPBC Act	Indirect evidence (chewed Marri nut)	Coterra (2013)
Columba livia	Rock Dove	Introduced	-	Coterra (2013)
Coturnix ypsilophora	Brown Quail	-	-	Coterra (2013)
Corella sp.	-	-	-	Coterra (2013)
Corvus coronoides	Australian Raven	-	-	Biologic (2015), Coterra (2013)
Cracticus tibicen	Australian Magpie	-	-	Biologic (2015), Coterra (2013)
Dacelo novaeguineae	Laughing Kookaburra	Introduced	-	Coterra (2013)
Eolophus rosiecapillus	Galah	-	-	Coterra (2013)
Gerygone fusca	Western Gerygone	-	-	Coterra (2013)
Grallina cyanoleuca	Magpie-lark	-	-	Biologic (2015)
Haliastur sphenurus	Whistling Kite	-	-	Coterra (2013)

9 Appendix G (continued)

Species name	Common name	Significance	Survey detection method	Survey that recorded the species
Avifauna				
Lalage sueurii	White-winged Triller	-	-	Coterra (2013)
Lichenostomus virescens	Singing Honeyeater	-	-	Biologic (2015)
Lichmera indistincta	Brown Honeyeater	-	-	Biologic (2015)
Malurus splendens	Splendid Fairy Wren	-	-	Coterra (2013)
Ocyphaps lopphotes	Crested Pigeon	-	-	Biologic (2015), Coterra (2013)
Phaps chalcoptera	Common Bronzewing	-	-	Coterra (2013)
Rhipidura leucophrys	Willie Wagtail	-	-	Biologic (2015)
Threskiornis molucca	Australian White Ibis	-	-	Coterra (2013)

*Call recorded from SM2BAT unit

- indicates the survey detection method is unknown, i.e. detection may have been from observations (direct or indirect), calls or trapping

BC Act: State *Biodiversity Conservation Act 2016*

EPBC Act: *Environment Protection and Biodiversity Conservation Act 1999*

Descriptions of the conservation statuses can be found in Appendix A.

References

- Biota (2014). *City of Rockingham Frog Population Monitoring.* Prepared for the City of Rockingham, October 2014.
- Biota (2015). *City of Rockingham Frog Population Monitoring 2015.* Prepared for the City of Rockingham, November 2015.
- Biota (2016). *City of Rockingham Frog Population Monitoring 2015 - 2016.* Prepared for the City of Rockingham, October 2016.
- Biota (2018). C*ity of Rockingham Frog Population Monitoring 2015 - 2018.* Prepared for the City of Rockingham, December 2018.
- Biologic (2015). *City of Rockingham Vertebrate Fauna Survey.* Prepared for the City of Rockingham, August 2015.
- Coterra Environment [Coterra]. (2013). *Level 1 Fauna Survey Tamworth Hill Swamp, Baldivis.* Prepared for the City of Rockingham, February 2013.

9 Appendix H - Bird and Volant Mammal Species Likely to Occur and Recorded in the Study Area

Table H1 - Inventory of birds, volant mammals and introduced mammals recorded in the study area

Group	Origin	Conservation status	Species	Common name	Survey detection method	No. records	Standing water required	Habitat type within the study area
Bird	Native	-	*Acanthiza apicalis*	Broad-tailed thornbill	Sight	2	No	Foraging/breeding/ roosting
	Native	-	*Acanthiza chrysorrhoa*	Yellow-rumped thornbill	Sight	4	No	Foraging/breeding/ roosting
	Native	Ma (EPBC Act)	*Accipiter fasciatus*	Brown goshawk	Sight	1	No	Foraging/breeding/ roosting
	Native	Ma (EPBC Act)	*Acrocephalus australis*	Australian reed warbler	Sight	1	No	Foraging/breeding/ roosting
	Native	-	*Anas superciliosa*	Pacific black duck	Sight	6	Yes	Foraging/breeding/ roosting
	Native	-	*Anthochaera carunculata*	Red wattlebird	Call/Sight	5	No	Foraging/breeding/ roosting
	Native	-	*Ardea novaehollandiae*	White-faced heron	Sight	1	Yes	Foraging/breeding/ roosting
	Native	-	*Cacatua roseicapilla*	Galah	Call/Sight	6	No	Foraging/breeding/ roosting
	Non-native	-	*Cacatua sanguinea*	Little corella	Sight	5	No	Foraging/breeding/ roosting
	Non-native	-	*Cacatua tenuirostris*	Eastern long-billed corella	Sight	2	No	Foraging/breeding/ roosting
	Native	V (EPBC Act) S3 (BC Act)	*Calyptorhynchus banksii naso*	Forest red-tailed black cockatoo	Sight	1	No	Foraging/breeding/ roosting
	Native	Ma (EPBC Act)	*Circus approximans*	Swamp harrier	Sight	1	No	Foraging/breeding/ roosting
	Non-native	-	*Columba livia*	Rock dove	Sight	1	No	Foraging/breeding/ roosting
	Native	Ma (EPBC Act)	*Coracina novaehollandiae*	Black-faced cuckoo-shrike	Sight	2	No	Foraging/breeding/ roosting
	Native	-	*Corvus coronoides*	Australian raven	Call/Sight	10	No	Foraging/breeding/ roosting
	Native	-	*Cracticus tibicen*	Australian magpie	Sight	4	No	Foraging/breeding/ roosting
	Native	-	*Cracticus torquatus*	Grey butcherbird	Call/Sight	1	No	Foraging/breeding/ roosting
	Non-native	-	*Dacelo novaeguineae*	Laughing kookaburra	Call/Sight	2	No	Foraging/breeding/ roosting
	Native	-	*Gerygone fusca*	Western gerygone	Call	10	No	Foraging/breeding/ roosting
	Native	-	*Hirundo nigricans*	Tree martin	Sight	3	No	Foraging/breeding/ roosting
	Native	-	*Hiruno neoxena*	Welcome swallow	Sight	7	No	Foraging/breeding/ roosting
	Native	-	*Lichenostomus virescens*	Singing honeyeater	Call/Sight	8	No	Foraging/breeding/ roosting
	Native	-	*Lichmera indistincta*	Brown honeyeater	Call/Sight	10	No	Foraging/breeding/ roosting

9 Appendix H (continued)

Table H1 - Inventory of birds, volant mammals and introduced mammals recorded in the study area

Group	Origin	Conservation status	Species	Common name	Survey detection method	No. records	Standing water required	Habitat type within the study area
Bird	Native	-	*Malurus splendens*	Splendid fairy-wren	Sight	10	No	Foraging/breeding/roosting
	Native	-	*Pachycephala rufiventris*	Rufous whistler	Call/Sight	5	No	Foraging/breeding/roosting
	Native	-	*Pardalotus striatus*	Striated pardalote	Call/Sight	3	No	Foraging/breeding/roosting
	Native	-	*Phaps chalcoptera*	Common bronzewing	Sight	3	No	Foraging/breeding/roosting
	Native	-	*Platycercus spurius*	Red-capped parrot	Sight	6	No	Foraging/breeding/roosting
	Native	-	*Platycercus zonarius*	Australian ringneck	Sight	6	No	Foraging/breeding/roosting
	Native	-	*Polytelis anthopeplus*	Regent parrot	Sight	3	No	Foraging/breeding/roosting
	Native	-	*Rhipidura albiscapa*	Grey fantail	Call/Sight	5	No	Foraging/breeding/roosting
	Native	-	*Sericornis frontalis*	White-browed scrubwren	Call	1	No	Foraging/breeding/roosting
	Native	-	*Smicrornis brevirostris*	Weebill	Call	20	No	Foraging/breeding/roosting
	Non-native	-	*Streptopelia senegalensis*	Laughing turtle-dove	Sight	1	No	Foraging/breeding/roosting
	Native	Ma (EPBC Act)	*Threskiornis molucca*	Australian white ibis	Sight	4	No	Foraging/breeding/roosting
	Native	Ma (EPBC Act)	*Threskiornis spinicollis*	Straw-necked ibis	Sight	2	No	Foraging/breeding/roosting
	Non-native	-	*Trichoglossus haematodus*	Rainbow lorikeet	Call/Sight	5	No	Foraging/breeding/roosting
	Native	-	*Zosterops lateralis*	Silvereye	Sight	12	No	Foraging/breeding/roosting
Mammal	Non-native	-	*Felis catus*	Cat	Camera trap	1	No	Foraging/breeding/refuge
	Non-native	-	*Rattus rattus*	Black rat	Camera trap	1	No	Foraging/breeding/refuge
	Non-native	-	*Vulpes vulpes*	Red fox	Camera trap	1	No	Foraging/breeding/refuge
Volant mammal	Native	-	*Chalinolobus gouldii*	Gould's wattled Bat	Acoustic recording	Numerous	No	Foraging/breeding/roosting
	Native	-	*Chalinolobus morio*	Chocolate wattled bat	Acoustic recording	Numerous	No	Foraging/breeding/roosting
	Native	-	*Nyctophilus geoffroyi*	Lesser long-eared bat	Acoustic recording	Numerous	No	Foraging/breeding/roosting
	Native	-	*Ozimops kitcheneri*	South-western Freetail-bat	Acoustic recording	Numerous	No	Foraging/breeding/roosting
	Native	-	*Vespadelus regulus*	Southern forest bat	Acoustic recording	Numerous	No	Foraging/breeding/roosting

* Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): V= Vulnerable
State *Biodiversity Conservation Act 2016* (BC Act): S3= Schedule 3 (Vulnerable) Refer to Appendix A for detailed descriptions

Table H2 - Species of birds and volant mammals each fauna habitat type is likely to support							
Category	**Scientific name**	**Common name**	**Conservation Status***	**Closed sedgeland**	**Forest**	**Emergent trees over shrubs and saplings (revegetation)**	**Open woodland**
Bat	*Austronomus australis*	White-striped Freetail-bat	-	✓	✓	✓	✓
Bat	*Chalinolobus gouldii*	Gould's Wattled Bat	-	✓	✓	✓	✓
Bat	*Chalinolobus morio*	Chocolate Wattled Bat	-	✓	✓	✓	✓
Bat	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	-	✓	✓	✓	✓
Bat	*Nyctophilus gouldi*	Gould's Long-eared Bat	-	✓	✓	✓	✓
Bat	*Nyctophilus major*	Western Long-eared Bat	-	✓	✓	✓	✓
Bat	*Ozimops kitcheneri*	South-western Freetail-bat	-	✓	✓	✓	✓
Bat	*Vespadelus regulus*	Southern Forest Bat	-	✓	✓	✓	✓
Bird	*Acanthiza apicalis*	Broad-tailed Thornbill	-	✓	✓	✓	✓
Bird	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	-		✓	✓	✓
Bird	*Acanthiza inornata*	Western Thornbill	-		✓	✓	✓
Bird	*Acanthorhynchus superciliosus*	Western Spinebill	-			✓	✓
Bird	*Accipiter cirrocephalus*	Collared Sparrowhawk	-	✓	✓	✓	✓
Bird	*Accipiter fasciatus*	Brown Goshawk	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Acrocephalus australis*	Australian Reed Warbler	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Aegotheles cristatus*	Australian Owlet-nightjar	-		✓	✓	✓
Bird	*Anas castanea*	Chestnut Teal	-	✓	✓		
Bird	*Anas gracilis*	Grey Teal	-	✓	✓		✓
Bird	*Anas platyrhynchos*	Mallard	-	✓	✓		
Bird	*Anas rhynchotis*	Australasian Shoveler	-	✓			
Bird	*Anas superciliosa*	Pacific Black Duck	-	✓	✓	✓	✓
Bird	*Anthochaera carunculata*	Red Wattlebird	-		✓	✓	✓
Bird	*Anthochaera lunulata*	Western Little Wattlebird	-			✓	✓
Bird	*Anthus australis*	Australian Pipit	-			✓	✓
Bird	*Aquila audax*	Wedge-tailed Eagle	-	✓	✓	✓	✓
Bird	*Aquila morphnoides*	Little Eagle	-	✓	✓	✓	✓
Bird	*Ardea alba*	Great Egret	Ma (EPBC Act)	✓	✓		
Bird	*Ardea garzetta*	Little Egret	-	✓	✓		
Bird	*Ardea ibis*	Cattle Egret	Ma (EPBC Act)	✓	✓		
Bird	*Ardea novaehollandiae*	White-faced Heron	-	✓	✓		
Bird	*Artamus cinereus*	Black-faced Woodswallow	-	✓		✓	✓

9 Appendix H (continued)

Table H2 - Species of birds and volant mammals each fauna habitat type is likely to support

Category	Scientific name	Common name	Conservation Status*	Closed sedgeland	Forest	Emergent trees over shrubs and saplings (revegetation)	Open woodland
Bird	*Artamus cyanopterus*	Dusky Woodswallow	-			✓	✓
Bird	*Aythya australis*	Hardhead	-	✓	✓		
Bird	*Biziura lobata*	Musk Duck	Ma (EPBC Act)	✓			
Bird	*Cacatua roseicapilla*	Galah	-			✓	✓
Bird	*Cacatua sanguinea gymnopis*	Little Corella	-			✓	✓
Bird	*Cacatua tenuirostris*	Eastern Long-billed Corella	-			✓	✓
Bird	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	Ma (EPBC Act)		✓	✓	✓
Bird	*Calyptorhynchus banksii naso*	Forest Red-tailed Black-Cockatoo	V (EPBC Act) S3 (BC Act)			✓	✓
Bird	*Calyptorhynchus baudinii*	Baudin's Black Cockatoo	E (EPBC Act) S2 (BC Act)			✓	✓
Bird	*Calyptorhynchus latirostris*	Carnaby's Black-Cockatoo	E (EPBC Act) S2 (BC Act)			✓	✓
Bird	*Chenonetta jubata*	Australian Wood Duck	-	✓	✓		✓
Bird	*Chrysococcyx basalis*	Horsfield's Bronze Cuckoo	Ma (EPBC Act)		✓	✓	✓
Bird	*Chrysococcyx lucidus*	Shining Bronze Cuckoo	Ma (EPBC Act)		✓	✓	✓
Bird	*Cincloramphus cruralis*	Brown Songlark	-			✓	✓
Bird	*Cincloramphus mathewsi*	Rufous Songlark	-			✓	✓
Bird	*Circus approximans*	Swamp Harrier	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Circus assimilis*	Spotted Harrier	-	✓		✓	✓
Bird	*Cladorhynchus leucocephalus*	Banded Stilt	-	✓			
Bird	*Colluricincla harmonica*	Grey Shrike-thrush	-		✓		
Bird	*Columba livia*	Rock Dove	-			✓	✓
Bird	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	Ma (EPBC Act)			✓	✓
Bird	*Corvus coronoides*	Australian Raven	-		✓	✓	✓
Bird	*Coturnix pectoralis*	Stubble Quail	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Coturnix ypsilophora*	Brown Quail	-	✓	✓	✓	✓
Bird	*Cracticus tibicen*	Australian Magpie	-		✓	✓	✓
Bird	*Cracticus torquatus*	Grey Butcherbird	-		✓	✓	✓
Bird	*Cuculus pallidus*	Pallid Cuckoo	Ma (EPBC Act)		✓	✓	✓
Bird	*Cygnus atratus*	Black Swan	-	✓			

Table H2 - Species of birds and volant mammals each fauna habitat type is likely to support							
Category	**Scientific name**	**Common name**	**Conservation Status***	**Closed sedgeland**	**Forest**	**Emergent trees over shrubs and saplings (revegetation)**	**Open woodland**
Bird	*Dacelo novaeguineae*	Laughing Kookaburra	-			✓	✓
Bird	*Daphoenositta chrysoptera*	Varied Sittella	-		✓	✓	✓
Bird	*Dicaeum hirundinaceum*	Mistletoebird	-			✓	✓
Bird	*Elanus caeruleus*	Black-shouldered Kite	-			✓	✓
Bird	*Eurostopodus argus*	Spotted Nightjar	Ma (EPBC Act)		✓	✓	✓
Bird	*Falco berigora*	Brown Falcon	-	✓		✓	✓
Bird	*Falco cenchroides*	Australian Kestrel	-			✓	✓
Bird	*Falco longipennis*	Australian Hobby	-	✓	✓	✓	✓
Bird	*Falco peregrinus*	Peregrine Falcon	OS (BC Act)	✓	✓	✓	✓
Bird	*Fulica atra*	Eurasian Coot	-	✓	✓		
Bird	*Gallinula tenebrosa*	Dusky Moorhen	-	✓	✓		
Bird	*Gallinula ventralis*	Black-tailed Native-hen	-	✓	✓		
Bird	*Gallirallus philippensis*	Buff-banded Rail	-	✓	✓		
Bird	*Gerygone fusca*	Western Gerygone	-		✓	✓	✓
Bird	*Grallina cyanoleuca*	Magpie-lark	Ma (EPBC Act)		✓	✓	✓
Bird	*Haliastur sphenurus*	Whistling Kite	Ma (EPBC Act)	✓		✓	✓
Bird	*Hamirostra isura*	Square-tailed Kite	-	✓	✓	✓	✓
Bird	*Himantopus himantopus*	Black-winged Stilt	Ma (EPBC Act)	✓			
Bird	*Hirundo neoxena*	Welcome Swallow	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Hirundo nigricans*	Tree Martin	Ma (EPBC Act)		✓	✓	✓
Bird	*Lalage tricolor*	White-winged Triller	-			✓	✓
Bird	*Larus novaehollandiae*	Silver Gull	Ma (EPBC Act)	✓			
Bird	*Lichenostomus virescens*	Singing Honeyeater	-		✓	✓	✓
Bird	*Lichmera indistincta*	Brown Honeyeater	-		✓	✓	✓
Bird	*Malacorhynchus membranaceus*	Pink-eared Duck	-	✓			
Bird	*Malurus splendens*	Splendid Fairy-wren	-	✓	✓	✓	✓
Bird	*Megalurus gramineus*	Little Grassbird	-	✓			
Bird	*Merops ornatus*	Rainbow Bee-eater	Ma (EPBC Act)			✓	✓
Bird	*Neophema elegans*	Elegant Parrot	-			✓	✓
Bird	*Ninox novaeseelandiae*	Boobook Owl	Ma (EPBC Act)	✓	✓	✓	✓

9 Appendix H (continued)

Table H2 - Species of birds and volant mammals each fauna habitat type is likely to support

Category	Scientific name	Common name	Conservation Status*	Closed sedgeland	Forest	Emergent trees over shrubs and saplings (revegetation)	Open woodland
Bird	*Nycticorax caledonicus*	Rufous Night Heron	Ma (EPBC Act)	✓	✓		
Bird	*Ocyphaps lophotes*	Crested Pigeon	-			✓	✓
Bird	*Oxyura australis*	Blue-billed Duck	P4	✓	✓		
Bird	*Pachycephala pectoralis*	Golden Whistler	-		✓	✓	✓
Bird	*Pachycephala rufiventris*	Rufous Whistler	-		✓	✓	✓
Bird	*Pardalotus punctatus*	Spotted Pardalote	-		✓	✓	✓
Bird	*Pardalotus striatus*	Striated Pardalote	-		✓	✓	✓
Bird	*Pelecanus conspicillatus*	Australian Pelican	Ma (EPBC Act)	✓			
Bird	*Petroica multicolor*	Scarlet Robin	V (EPBC Act)		✓	✓	✓
Bird	*Phalacrocorax melanoleucos*	Little Pied Cormorant	-	✓	✓		
Bird	*Phalacrocorax sulcirostris*	Little Black Cormorant	-	✓	✓		
Bird	*Phaps chalcoptera*	Common Bronzewing	-		✓	✓	✓
Bird	*Phylidonyris nigra*	White-cheeked Honeyeater	-			✓	✓
Bird	*Phylidonyris novaehollandiae*	New Holland Honeyeater	-			✓	✓
Bird	*Platalea flavipes*	Yellow-billed Spoonbill	-	✓	✓		
Bird	*Platycercus icterotis icterotis*	Western Rosella (western sp)	-			✓	✓
Bird	*Platycercus spurius*	Red-capped Parrot	-			✓	✓
Bird	*Platycercus zonarius*	Australian Ringneck Parrot	-		✓	✓	✓
Bird	*Podargus strigoides*	Tawny Frogmouth	-		✓	✓	✓
Bird	*Poliocephalus poliocephalus*	Hoary-headed Grebe	-	✓			
Bird	*Polytelis anthopeplus*	Regent Parrot	-			✓	✓
Bird	*Porphyrio porphyrio*	Purple Swamphen	Ma (EPBC Act)	✓	✓		
Bird	*Porzana fluminea*	Australian Spotted Crake	-	✓			
Bird	*Porzana pusilla*	Baillon's Crake	Ma (EPBC Act)	✓			
Bird	*Porzana tabuensis*	Spotless Crake	Ma (EPBC Act)	✓			
Bird	*Rhipidura fuliginosa*	Grey Fantail	-		✓	✓	✓
Bird	*Rhipidura leucophrys*	Willie Wagtail	-		✓	✓	✓
Bird	*Sericornis frontalis*	White-browed Scrubwren	-	✓	✓	✓	✓

Table H2 - Species of birds and volant mammals each fauna habitat type is likely to support							
Category	**Scientific name**	**Common name**	**Conservation Status***	**Closed sedgeland**	**Forest**	**Emergent trees over shrubs and saplings (revegetation)**	**Open woodland**
Bird	*Smicrornis brevirostris*	Weebill	-		✓	✓	✓
Bird	*Streptopelia chinensis*	Spotted Turtle-Dove	-			✓	✓
Bird	*Streptopelia senegalensis*	Laughing Turtle-Dove	-			✓	✓
Bird	*Tachybaptus novaehollandiae*	Australasian Grebe	-	✓			
Bird	*Tadorna tadornoides*	Australian Shelduck	-	✓	✓		✓
Bird	*Threskiornis molucca*	Australian White Ibis	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Threskiornis spinicollis*	Straw-necked Ibis	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Todiramphus sanctus*	Sacred Kingfisher	Ma (EPBC Act)	✓	✓	✓	✓
Bird	*Trichoglossus haematodus*	Rainbow Lorikeet	-			✓	✓
Bird	*Tyto alba*	Barn Owl	-	✓	✓	✓	✓
Bird	*Zosterops lateralis*	Silvereye	Ma (EPBC Act)		✓	✓	✓

* Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): V= Vulnerable; E= Endangered
State *Biodiversity Conservation Act 2016* (BC Act): OS= Other specially protected fauna; S2= Schedule 2 (Endangered); S3= Schedule 3 (Vulnerable)
Listed by DBCA: P4= Priority 4
Refer to Appendix A for detailed descriptions of each conservation status.

9 Appendix I - Habitat Characterisation of Terrestrial and Aquatic Invertebrate Sampling Sites in the Study Area

Table I1 - Habitat characterisation summary of terrestrial invertebrate sampling sites in the study area.

Site	Latitude	Longitude	Subsample #	Site Description/ Vegetation characteristics	Soil characteristics	Litter characteristics	Disturbances
CoRT1	-32.329	115.81	Subsample 1	Rehabilitated areas with mixed vegetation containing flowering *Acacia* spp. and mixed shrubland.	Gravelly sand, friable, moderately deep (10-20 cm).	Leaf litter and woody debris cover in the dry areas were moderate (< 50% cover) and generally shallow (1-3 cm) but became deep (5-10 cm) in some areas especially under older trees.	Runoff from roads and residential properties, plastic waste from rehabilitation effort.
			Subsample 2	*Melaleuca* spp. woodland with partially submerged woody debris and leaf litter. Inundated clover, grasses and annuals. Some casuarina trees and native and non-native grasses along the water edge.	Loamy sand, moderately deep (10-20 cm). The soils were very damp, especially closer to the water line.	Leaf litter and woody debris covered almost the entire area (no bare ground was observed). Leaf litter was generally deep (5-10 cm) or moderate (3-5 cm).	Runoff from roads and residential properties, plastic waste from rehabilitation effort.
CoRT2	-32.329	115.805	Subsample 1	Rehabilitated areas with mixed vegetation containing flowering *Acacia* spp. and mixed shrubland interspersed with tall Eucalyptus trees.	Gravelly sand, friable, moderately deep (10-20 cm).	Leaf litter and woody debris cover in the dry areas were moderate (< 50% cover) and generally shallow (1-3 cm) but became deep (5-10 cm) in some areas especially under older trees.	Runoff from roads and residential properties, plastic waste from rehabilitation effort.
			Subsample 2	*Melaleuca* spp. woodland with partially submerged woody debris and leaf litter. Some casuarina trees and native and non-native grasses along the water edge.	Loamy sand, moderately deep (10-20 cm). The soils were very damp, especially closer to the water line.	Leaf litter and woody debris covered almost the entire area (no bare ground was observed). Leaf litter was generally deep (5-10 cm) or moderate (3-5 cm).	Runoff from roads and residential properties, plastic waste from rehabilitation effort.
CoRT3	-32.332	115.809	Subsample 1	Well shaded section of *Melaleuca* woodland with abundant woody debris and leaf litter. No standing water was observed. The litter was damp but not inundated and covered 100% of the subsample area.	Loamy sand, moderately deep (10-20 cm). The soils were very damp, especially closer to the water line.	Containing very deep leaf litter (<10 cm) and dense woody debris. The litter was damp but not inundated and covered 100% of the subsample area.	Plastic waste from rehabilitation effort.

Table I1 - Habitat characterisation summary of terrestrial invertebrate sampling sites in the study area.

Site	Latitude	Longitude	Subsample #	Site Description/ Vegetation characteristics	Soil characteristics	Litter characteristics	Disturbances
CoRT3	-32.332	115.809	Subsample 2	Tall mixed *Eucalyptus* spp over grassland and some old vehicle tracks. Most of the site was open canopy and dry underfoot.	Gravelly sand, friable, moderately deep (10-20 cm).	There was sparse leaf litter and woody debris (20%) except for under the large Eucalyptus trees in the area.	Vehicle Tracks, BMX bike track, plastic waste from rehabilitation effort.
CoRT4	-32.324	115.81	Subsample 1	*Eucalyptus rudis* and *Melaleuca* mixed woodland providing patchy shade with a moderately dense submerged and emergent *Baumea* sp. understory near the water line. Some native and non-native grasses along the water's edge.	Loamy sand, moderately deep (10-20 cm). The soils were very damp, especially closer to the water line.	Containing deep leaf litter (5-10 cm) and dense woody debris. The litter was damp but not inundated and covered 100% of the subsample area.	Runoff from roads and residential properties, plastic waste from rehabilitation effort.
			Subsample 2	*Eucalyptus rudis* and *Melaleuca* mixed woodland providing patchy shade with a moderately dense submerged and emergent *Baumea* sp. understory near the water line. Some native and non-native grasses along the water's edge.	Loamy sand, moderately deep (10-20 cm). The soils were very damp, especially closer to the water line.	Containing deep leaf litter (5-10 cm) and dense woody debris. The litter was damp but not inundated and covered 100% of the subsample area.	Runoff from roads and residential properties, plastic waste from rehabilitation effort

Table I2 - Habitat characterisation summary of aquatic invertebrate sampling sites in the study area.

Site	Site Location		Water Depth	Site Description/ Vegetation characteristics	Vegetation	Vertebrate Fauna Observations	Disturbances
	Latitude	Longitude					
CoRA1	-32.323	115.811	Shallow: 20 - 35 cm	Northern site. Thickets of submerged and emergent *Baumea* sp. with some narrow open areas between thickets. Limited shade and woody debris. Homogenous habitat. Water was a consistent depth and tannin stained but clear. No algal blooms were observed.	Dense stands of *Baumea* sp. with patches of degraded *Typha* sp. sparsely distributed throughout the site. Evidence of *Typha* management.	Tadpoles (captured in box trap or nets);	Vehicle Tracks Runoff from roads and residential properties Recreational use

9 Appendix I (continued)

Table I2 - Habitat characterisation summary of aquatic invertebrate sampling sites in the study area. (continued)

Site	Site Location		Water Depth	Site Description/ Vegetation characteristics	Vegetation	Vertebrate Fauna Observations	Disturbances
	Latitude	Longitude					
CoRA2	-32.328	115.811	Shallow: 10 - 35 cm	Eastern site. Diverse habitat types consisting of a section of inundated access track with hard rocky substrate, a shallow section of submerged herbs and grasses, stand of *Baumea* sp. and an inundated section of *Melaleuca* spp. woodland with submerged wood debris and leaf litter. Sections of open water particularly on the inundated track. Approximately two thirds of the site was in full sun, becoming shaded into the *Melaleuca* woodland. Water was shallow in sections of the submerged track and inundated clover, deepening into sections of the *Melaleuca* woodland and *Baumea* stand. Water was tannin stained and turbid. No algal blooms were observed.	Inundated clover, grasses and annuals moving into a moderately dense *Melaleuca* sp. Woodland with a clover and grass understory. Eastern section of site contains stands of *Baumea* sp. adjacent to *Eucalyptus rudis* and *Melaleuca* mixed woodland.	Tadpoles (captured in box trap or nets); Motorbike frogs (*Litoria moorei*) and Rattling or Clicking Froglets (*Crinia glauerti*) identified by call.	Vehicle Tracks Runoff from roads and residential properties Recreational use
CoRA3	-32.332	115.808	Shallow: 15- 45 cm	Southern site. Well shaded section of *Melaleuca* woodland with understory of inundated and emergent *Baumea* and mixed grasses and herbs. Abundant woody debris and leaf litter. Shallow water getting deeper further into the *Melaleuca* woodland. Water was tannin stained and turbid. No algal blooms were observed.	Moderately dense *Melaleuca* sp. woodland with an understory of sparse *Baumea* sp. and mixed clover and grasses.	None.	
CoRA4	-32.327	115.806	Shallow: 50 - 60 cm	Western site, closest to residential properties. Inundated access track fringed by open *Eucalyptus rudis* woodland providing patchy shade with a moderately dense submerged and emergent *Baumea* sp. understory. Open water section along inundated access track with hard rocky substrate. Some submerged woody debris and leaf litter. Water deepest of any site and consistent depth throughout. Water was clear, and tannin stained. Clumps of filamentous green algae throughout site. No algal blooms were observed.	Open *Eucalyptus* rudis woodland over a moderately dense *Baumea* sp. understory. West of the site moved into a denser mixed *Eucalyptus* rudis and *Melaleuca* sp. Woodland.	Tadpoles (captured in box trap or nets); Rattling or Clicking Froglets (*Crinia glauerti*) identified by call	

9 Appendix J - List of Terrestrial and Aquatic Invertebrate Taxa Recorded in the Study Area

Table J1 - List of terrestrial invertebrate groups within the study area identified to Family level and their functional group designations

Class/Order	Family	Common Name	Functional Group	CoRT1	CoRT2	CoRT3	CoRT4
Annelida							
Haplotaxida	indet.	Haplotaxids	Detritivore	4	5	12	
Arachnida							
Acari	indet.	Mites and ticks	Detritivore	11	3	12	15
Araneae	Anapidae	Ground Orbweavers	Predator/Parasite		1		
	Araneidae	Orbweaver spiders	Predator/Parasite	9	3	5	9
	Gnaphosidae	Ground spiders	Predator/Parasite	1			1
	Miturgidae	Prowling spiders	Predator/Parasite	1			
	Oxyopidae	Lynx spiders	Predator/Parasite	7	1		2
	Salticidae	Jumping spiders	Predator/Parasite		7	6	5
	Theridiidae	Cobweb spiders	Predator/Parasite	2			1
	Thomisidae	Crab spiders	Predator/Parasite	3	14	1	2
	Zodariidae	Ant spiders	Predator/Parasite		4		1
	indet.	Pseudoscorpions	Predator/Parasite	2	2	5	8
Pseudoscorpionida	indet.	Pseudoscorpions	Predator/Parasite	2	5	7	6
Chilopoda							
Geophilomorphae	Chilenophilidae	Centipedes	Predator/Parasite				1
indet.	indet.	Centipedes	Predator/Parasite	1			
Collembola							
indet.	indet.	Springtails	Detritivore	31	15	5	13
Crustacea							
Isopoda	Armadillidae	Woodlice	Detritivore	14	15	55	34
	Porcellionidae	Woodlice	Detritivore		2	13	16
Diplopoda							
Julida	Blaniulidae	Millipedes	Detritivore	8	12	1	
	Julidae	Millipedes	Detritivore	1	3	1	
Polydesmida	indet.	Millipedes	Detritivore	4			
Gastropoda							
indet.	indet.	Snails and slugs	Herbivore	1	2	3	2

9 Appendix J (continued)

Table J1 - List of terrestrial invertebrate groups within the study area identified to Family level and their functional group designations (Continued)

Class/Order	Family	Common Name	Functional Group	CoRT1	CoRT2	CoRT3	CoRT4
Insecta							
Coleoptera	Anthelidae	Australian lappet moths	Herbivore	1			
	Carabidae	Ground beetles	Predator/Parasite	4			11
	Cerambycidae	Longhorn beetles	Herbivore			1	
	Chrysomelidae	Leaf Beetles	Herbivore	11	6	4	4
	Coccinellidae	Lady Beetles	Predator/Parasite	2	2		
	Curculionidae	Weevils	Herbivore	9	22	22	
	Elateridae	Click beetles	Herbivore			1	
	Melyridae	Soft-winged flower beetles	Herbivore	3			
	Pselaphidae	-	Herbivore		1	12	13
	Ptinidae	Spider beetles	Herbivore	1			3
	Scarabaeidae	Scarab beetles	Detritivore			2	
	Staphylinidae	Rove beetles	Detritivore	13	1	4	12
	Tenebrionidae	Darkling beetles	Detritivore				1
	indet.	-			5	8	5
Dermaptera	Anisolabididae	Earwigs	Predator/Parasite	1		3	
Diplura	Campodeidae	-	Predator/Parasite	21			
Diptera	Chironomidae	Non-biting midges	Herbivore	3	1	8	10
	Dolichopodidae	Long-legged flies	Predator/Parasite	6	18	5	4
	Ephydridae	Shore flies	Herbivore	3			
	Heleomyzidae	True flies	Detritivore		3		1
	Lauxaniidae	Acalyptrate flies	Detritivore	2	20	5	
	Muscidae	House flies	Detritivore	11	24	6	3
	Pipunculidae	Big-headed flies	Predator/Parasite	1	1		
	Platystomatidae	Signal Flies	Detritivore	12	22	7	1
	Syrphidae	Hoverflies	Herbivore				1
	Tachinidae	Tachinid flies	Predator/Parasite		1		
	Tipulidae	Crane fly	Herbivore	1	3		
	indet.	-				1	
Hemiptera	Aphididae	Aphids	Herbivore	1		11	6
	Aphrophoridae	Spittlebugs	Herbivore		2		1
	Cicadellidae	Leafhoppers	Herbivore	4	3	4	2
	Cicadellidae	Leafhoppers	Herbivore	4	3	4	2

Table J1 - List of terrestrial invertebrate groups within the study area identified to Family level and their functional group designations (Continued)

Class/Order	Family	Common Name	Functional Group	CoRT1	CoRT2	CoRT3	CoRT4
Insecta							
Hemiptera	Coreidae	Leaf-footed bugs	Herbivore	1	2	1	
	Flatidae	Flatid planthoppers	Herbivore				1
	Lygaeidae	Milkweed bugs	Herbivore			2	
	Membracidae	Treehoppers	Herbivore		1		
	Miridae	Plant bugs	Herbivore	3	3	1	1
	Pentatomidae	Stink bugs	Herbivore	3	3	2	
	Psyllidae	Jumping plant lice	Herbivore	1	6	1	22
	Reduviidae	Assassin Bug	Predator/Parasite				1
	Scutelleridae	Jewel bugs	Herbivore	1			
	Tingidae	Lace bugs	Herbivore			1	
	Triozidae	Jumping plant lice	Herbivore		2		
Hymenoptera	Braconidae	Braconid wasps	Predator/Parasite		2		1
	Crabronidae	Crabronid wasps	Predator/Parasite			1	
	Diapriidae	Diapriidae wasps	Predator/Parasite			2	
	Encyrtidae	Parasitic wasps	Predator/Parasite	1		1	
	Eulophidae	-	Predator/Parasite	1			
	Formicidae	Ants	Predator/Parasite	47	26	53	40
	Halictidae	Sweat bees	Herbivore			1	
	Perilampidae	Hyperparasitoids	Predator/Parasite		1		
	Scoliidae	Scoliid wasps	Predator/Parasite	1			
	Selenopidae	Araneomorph spiders	Predator/Parasite	1			
	Vespidae	Vespids	Predator/Parasite	1			
Isoptera	Blattellidae	Cockroaches	Detritivore	1	2		
	Ectobiidae	Wood cockroaches	Detritivore		3		
Lepidoptera	Lycaenidae	Gossamer-winged butterflies	Herbivore		1		
	indet.	-	Herbivore			1	1
Mantodea	Amorphoscelidae	Mantises	Predator/Parasite			1	
	indet.	-	Predator/Parasite				1
Mecoptera	Bittacidae	Hangingfly	Predator/Parasite				1
Neuroptera	Hemerobiidae	Brown lacewings	Predator/Parasite	1	4		1

9 Appendix J (continued)

Table J1 - List of terrestrial invertebrate groups within the study area identified to Family level and their functional group designations (Continued)

Class/Order	Family	Common Name	Functional Group	CoRT1	CoRT2	CoRT3	CoRT4
Insecta							
Odonata	Lestidae	Spread-winged damselflies	Predator/Parasite	4	1	3	1
Orthoptera	Acrididae	Grasshoppers	Herbivore	4	1	4	4
	Gryllidae	Crickets	Herbivore		1	1	
	Tettigoniidae	Bush crickets	Herbivore	4	1		1
	Trigoniidae	Saltwater clams	Herbivore	1			
Psocoptera	indet.	Booklice	Detritivore	1		1	1
	Liposcelidae	Booklice	Detritivore				1
Zygentoma	indet.	Silverfish	Detritivore	2			
Total Abundance				**291**	**28**	**307**	**272**
Family diversity				**57**	**50**	**47**	**47**

Table J2 - Ant species (Formicidae) collected at each site in the study area				
Subfamily/Genus/Species	**CoRT1**	**CoRT2**	**CoRT3**	**CoRT4**
Dolichoderinae				
Dolichoderus formosus				1
Iridomyrmex discors	1	1		
Linepithema humile				1
Ochetellus sp. JDM 19				1
Tapinoma sp. JDM 78				1
Ectatomminae				
Rhytidoponera inornata	1	1		1
Rhytidoponera metallica		1		1
Formicinae				
Camponotus minimus				1
Paraparatrechina minutula	1	1	1	1
Paratrechina braueri glabrior				1
Stigmacros sp. JDM 115	1	1	1	1
Stigmacros spinosa		1		
Myrmeciinae				
Myrmecia urens complex sp. JDM 1	1			1
Myrmicinae				
Crematogaster laeviceps chasei	1		1	1
Solenopsis clarki	1		1	
Tetramorium impressum	1	1	1	
Ponerinae				
Hypoponera congrua	1			
Total no. of species	**9**	**8**	**5**	**12**

9 Appendix J (continued)

Table J3 - List of aquatic invertebrate taxa within the study area identified to Family level and their functional group designations

Class/Order	Family	Taxon ID	Common Name	Functional Group	CoRA1	CoRA2	CoRA3	CoRA4
Arachnida								
		Acari spp.	Water Mites	Predators/Parasites	3	4	1	
Branchiopoda								
Cladocera		indet.	Water Fleas	Herbivores/Detritivores	400	1000	1000	800
Gastropoda								
		indet.	Snails	Herbivore	7	74	19	36
Hirudiniida								
	Glossiphoniidae	indet.	Freshwater Leeches	Predators/Parasites	2			5
Insecta								
Coleoptera	Dytiscidae	*Antiporus femoralis*	Diving beetles	Predators/Parasites		1		
		Hyphydrus elegans	Diving beetles	Predators/Parasites	7	3		
		Liodessus sp. indet.	Diving beetles	Predators/Parasites	2	2	1	
		Megaporus howitti	Diving beetles	Predators/Parasites	1	1		
		Megaporus sp. Indet.	Diving beetles	Predators/Parasites	1	3		
		Onychohydrus scutellaris	Diving beetles	Predators/Parasites		1		
		Paroster sp. indet.	Diving beetles	Predators/Parasites	1	12		
		Rhantus suturalis	Diving beetles	Predators/Parasites	3	2	3	2
		Spencerhydrus sp. indet.	Diving beetles	Predators/Parasites				1
		indet.	Diving beetles	Predators/Parasites	4	23	53	3
	Haliplidae	*Haliplus* sp. indet.	Crawling water beetles	Herbivores/Detritivores				2
	Hydrophilidae	*Berosus* sp. indet	Water scavenger beetles	Predators/Parasites		6		
		Hydrophilidae spp.	Water scavenger beetles	Predators/Parasites	10	11	3	8
		Limnoxenus zealandicus	Water scavenger beetles	Predators/Parasites		1		
	Scirtidae	indet.	Marsh beetles	Herbivores/Detritivores	1	117	5	
Diptera	Ceratopogonidae	indet.	Marsh beetles	Herbivores/Detritivores		1		
	Chironomidae	indet.	Non-biting midges	Generalists	203	200	143	200

Table J3 - List of aquatic invertebrate taxa within the study area identified to Family level and their functional group designations								
Class/Order	**Family**	**Taxon ID**	**Common Name**	**Functional Group**	**CoRA1**	**CoRA2**	**CoRA3**	**CoRA4**
Insecta								
	Culicidae	indet.	Mosquitoes	Herbivores/Detritivores	100	46	10	
	Sciomyzidae	indet.	Marsh flies	Predators/Parasites		4		1
	Stratiomyidae	indet.	Soldier flies	Detritivores		1	1	
Ephemeroptera		indet	Mayflies	Herbivores	8			
Hemiptera	Corixidae	indet.	Water boatmen	Generalists		17		8
	Hydrometridae	indet.	Water measurers	Predators/Parasites	1			
	Notonectidae	indet.	Backswimmers	Predators/Parasites	74	12		102
	Veliidae	indet.	Small water striders	Predators/Parasites	1	2		1
Mecoptera		indet.	Scorpion flies	Predators/Parasites			1	
Odonata	Aeshnidae	*Adversaeschna brevistyla*	Blue-spotted hawker	Predators/Parasites				3
	(Dragonflies)	*Anax papuensis*	Australian emperor	Predators/Parasites	3			
	Lestidae	*Austrolestes analis*	Slender ringtail	Predators/Parasites	53	7		107
	(Damselflies)	*Austrolestes io*	Iota ringtail	Predators/Parasites	14			18
		Lestidae sp. indet.		Predators/Parasites		2		
Trichoptera		indet.	Caddisflies	Generalists	1			1
Maxillopoda								
Calanoida		indet.	Calanoid copepods	Herbivores	204		101	300
Cyclopoida		indet.	Cyclopoid copepods	Herbivores	300	300	401	700
Harpacticoida		indet.	Harpacticoid copepods	Herbivores				2
Ostracoda								
		indet.	Seed shrimp	Herbivores	400	300	13	400
Total Abundance					**1804**	**2153**	**1755**	**2701**
Family Diversity					**26**	**28**	**15**	**22**

Note: Dark grey shading indicates Family/Order used for functional group organisation.

9 Appendix K - Representative Photos of the Infrastructure in the Study Area

Fencing

PLATE 1 - Existing wire mesh fence in poor condition (southern portion of the study area)

PLATE 2 - Existing wire mesh fence in good condition (eastern portion of the study area)

PLATE 3 - Existing wood post and wire in good condition (western portion of the study area)

Access Points

PLATE 4 - Access Point 1

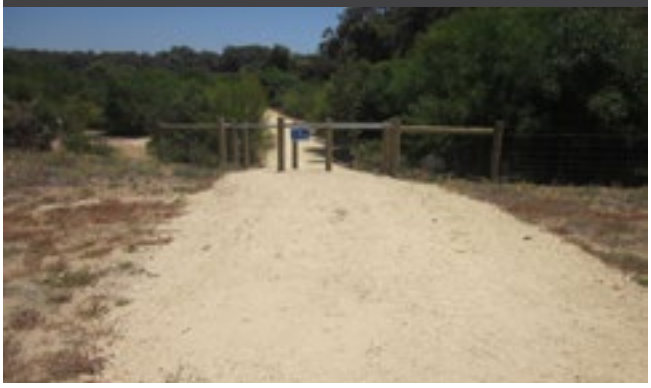


PLATE 5 - Access Point 1 intersecting Nairn Drive

PLATE 6 - Access Point 2

PLATE 7 - Access Point 3 - pedestrian access

PLATE 8 - Access Point 3 - vehicular access

PLATE 9 - Access Point 4

PLATE 10 - Access Point 5

PLATE 11 - Access Point 5 - interface with existing pram ramp

PLATE 12 - Access Point 6

PLATE 13 - Access Point 6- pedestrian access

PLATE 14 - Access Point 7

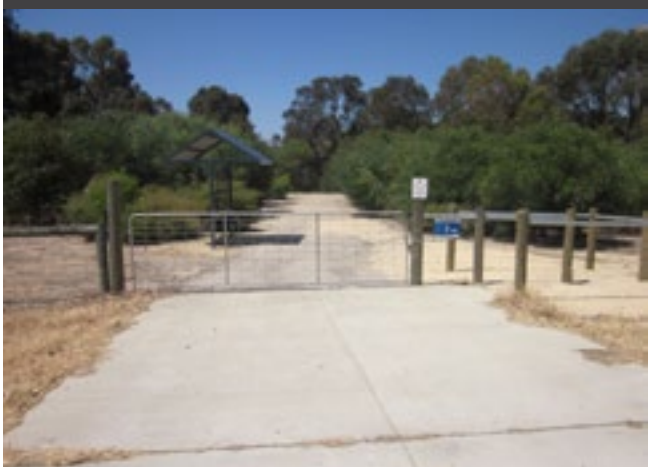


PLATE 15 - Access Point 8

Paths

PLATE 16 - Existing crushed limestone path in good condition (south eastern portion of the study area)

PLATE 17 - Existing crushed limestone path in poor condition (southern portion of the study area)

PLATE 18 - Informal sandy path to the south of access point 2

Signage

PLATE 19 - Existing Regulatory signage in good condition (eastern portion of the study area)

PLATE 20 - Existing Reserve Name signage in poor condition (south western portion of the study area)

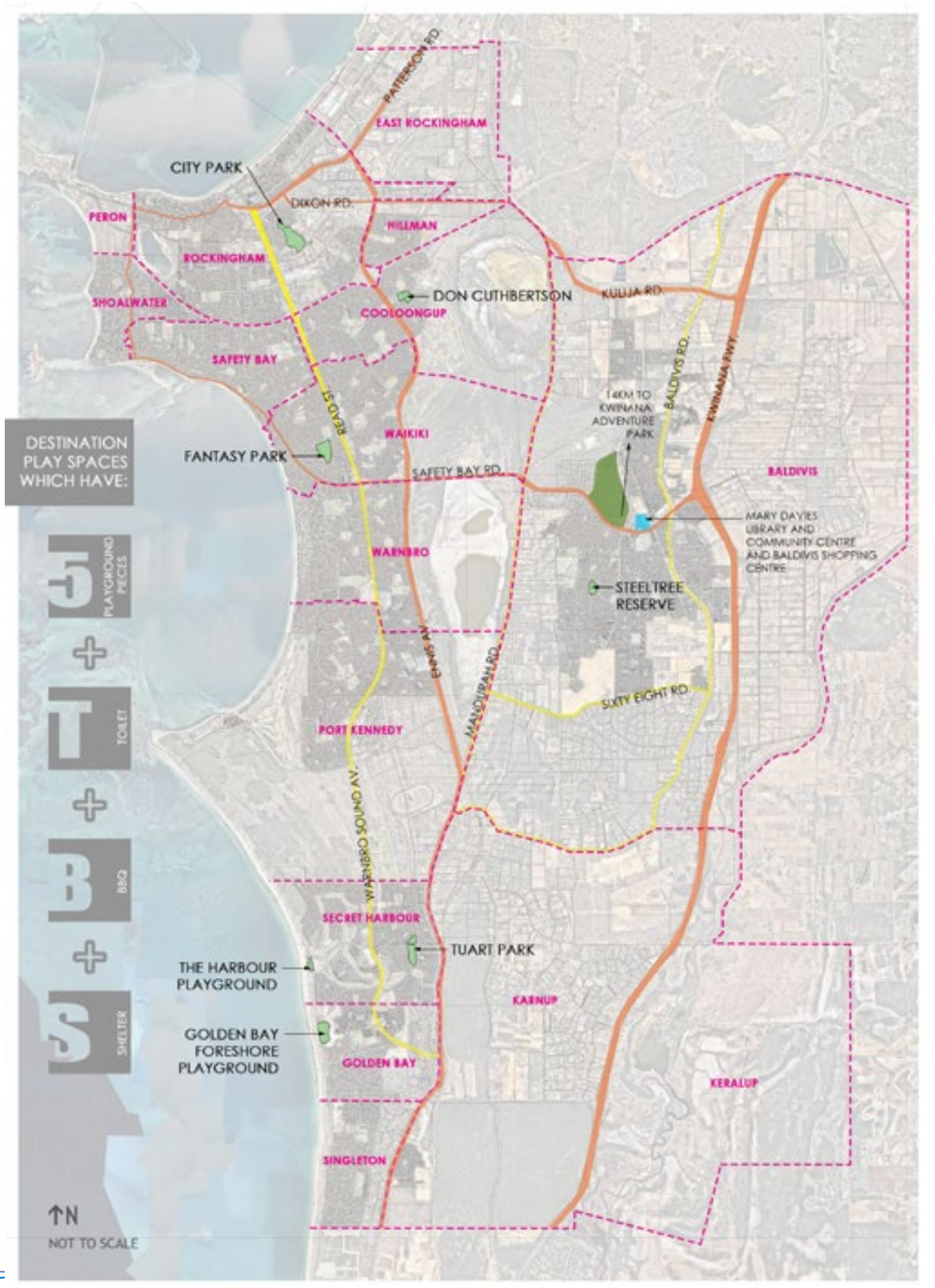
Other Infrastructure

PLATE 21 - Existing signage shelter in good condition (central eastern portion of the study area)

PLATE 22 - Existing bench in good condition (south eastern portion of the study area)

PLATE 23 - Existing bin and dog waste bag dispenser at Access Point 4 in good condition

9 Appendix L - Existing Park Assessment within the CoR



CITY OF ROCKINGHAM

Tamworth Hill Swamp
Management Plan

city of Rockingham

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