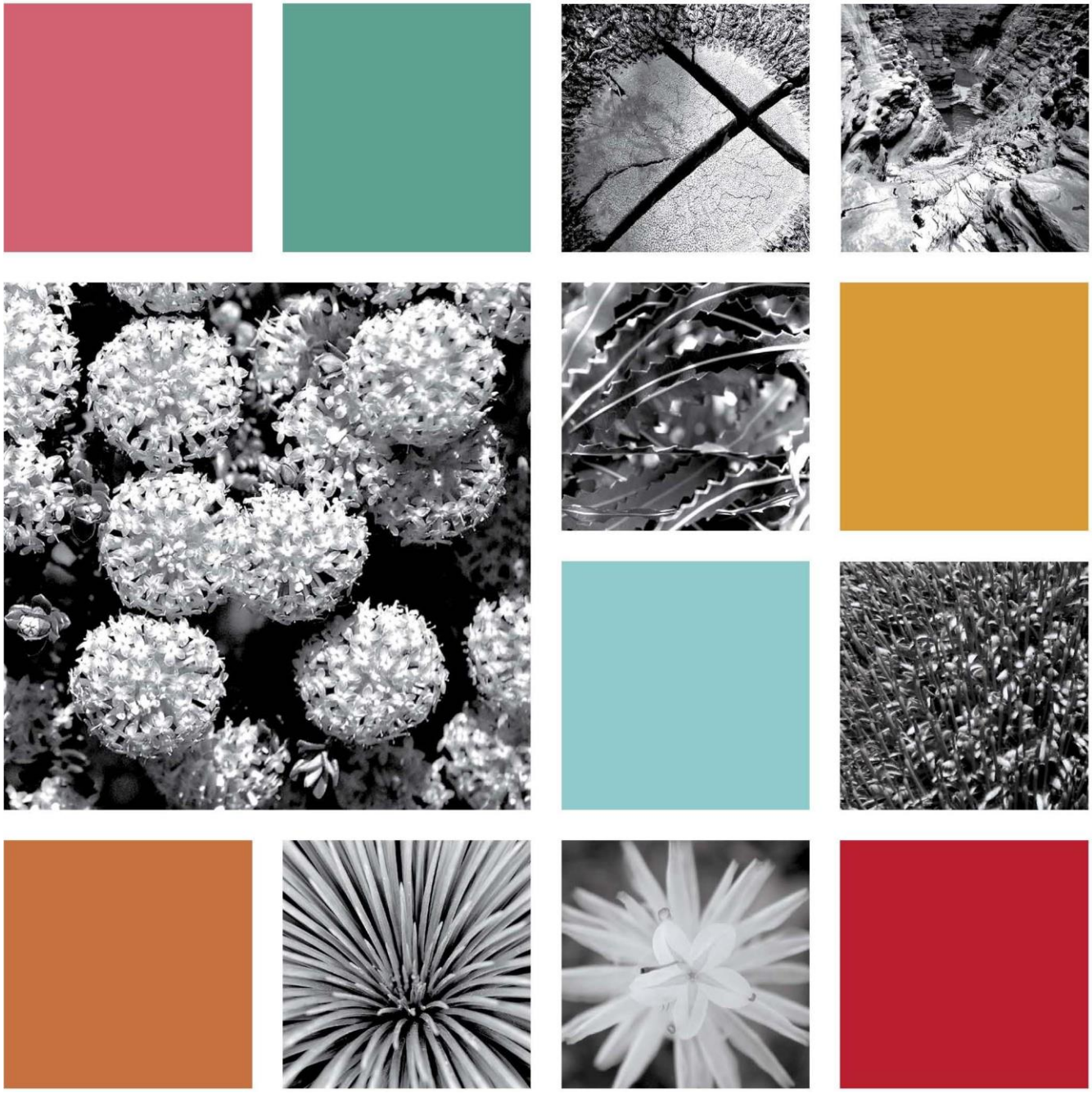
Port Kennedy Botanical Survey

Department of Fire and Emergency Services

ecoscape



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SUMMARY

The City of Rockingham has offered the Department of Fire and Emergency Services (DFES) approximately 3.5 ha of Crown Land on the corner of Ennis Avenue and Ennis Avenue, Port Kennedy. One of the conditions of transfer is that DFES has the land surveyed to determine the conservation status of its flora, vegetation and fauna. The Department of Parks and Wildlife (now Department of Biodiversity, Conservation and Attractions, DCBA) advised DFES that flora and floristic (vegetation) surveys would be required. Ecoscape was commissioned to conduct these surveys.

Advice from DPaW, including a flora database search, indicated that seven Priority Flora species are known to occur nearby (within 5 km of the site), and that the vegetation may represent one of two Priority Ecological Communities (PECs), although neither conservation significant flora nor conservation significant ecological communities had previously been recorded from within the study area.

Ecoscape conducted a field survey of the site in September 2017 and identified:

- 44 flora species, 25 of which were introduced species (weeds), noting that due to late rains many of the annual weeds had not yet flowered and were as yet unidentifiable
- no flora of conservation significance (i.e. no Priority Flora species) were recorded, and none were considered likely to have been overlooked during the field survey
- the vegetation was in Degraded and Completely Degraded condition due to its weed cover (generally 70-90% cover in the ground stratum) and species poor state
- one vegetation type (*Acacia rostellifera*, *Clematis linearifolia* and *Spyridium globulosum* open to dense tall shrubland over *Austrostipa flavescens*, *introduced herbs and *Acanthocarpus preissii* closed low tussock grassland/grassland/forbland) was recorded from three floristic quadrats
- floristic analysis identified that the vegetation was marginally similar to Swan Coastal Plain (SCP) Floristic Community Type SCP29b, but was also similar to SCP29a, both of which are PECs. However, the floristic similarity was low and the vegetation, due to its poor condition, is not considered to be extant native vegetation thus the site is unlikely to be representative of either of the PECs.

Based on these findings, Ecoscape considers that the site (of itself) does not have high conservation value. Its conservation value lies in its role as part of a native vegetation linkage between the coast and inland lake systems. Ecoscape regards this as the significant contributing factor for its inclusion as a Bush Forever site. Ecoscape recommends DFES discuss the site's inclusion in a Bush Forever site with regulatory authorities to determine if this will affect likely approvals to develop the site.

1 INTRODUCTION

1.1 PROJECT PURPOSE

The City of Rockingham has offered the Department of Fire and Emergency Services (DFES) approximately 3.5 ha of Crown Reserve land on the corner of Ennis Avenue and Stakehill Road, Port Kennedy.

One of the conditions of transfer was that the land is surveyed to determine the conservation status of the flora, vegetation and fauna present. Advice provided to DFES by the Department of Parks and Wildlife (DPaW, now Department of Biodiversity, Conservation and Attractions, DBCA) in May 2017 indicated that a botanical survey was required, specifically a flora survey to determine if any conservation significant flora were present, and a floristic (vegetation) survey to determine if the vegetation was representative of any Threatened or Priority Ecological Community.

1.2 STUDY AREA

The location of the subject lands, known as the 'study area' in this report, is indicated on **Figure 1**.

Figure 1: Study area

1.3 STATUTORY FRAMEWORK

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

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Wildlife Conservation Act 1950* (WC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act, partly enacted)
- Department of Environment Water Heritage and the Arts (2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999.*

In addition, the Minister for the Environment has published lists of fauna and flora species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listings were published in the *Government Gazette* on 6 January 2017 (Government of Western Australia 2017) and was taken into account.

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

- EPA (2016b) *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*, known as the *Flora and Vegetation Technical Guidance.*

1.3.1 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian *Biodiversity Conservation Act 2016* (BC Act) provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. It will eventually replace the *Wildlife Conservation Act 1950* (WC Act), however, until relevant Conservation Regulations are in place, provisions under the WC Act still apply. The parts currently in effect are listed on the DBCA website (BDCA 2017a, accessed 17 September 2017).

Threatened species (both flora and fauna) that meet the categories listed within the BC Act are highly protected and require authorisation by the Minister to take or disturb. These are known as Threatened Flora and Threatened Fauna. The conservation categories of critically endangered, endangered and vulnerable have been aligned with those detailed in the EPBC Act, as below.

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

Threatened Ecological Communities are also protected under the BC Act and are categorised using the same criteria as threatened species.

At the time of writing this report, most provisions within the BC Act have not been yet been proclaimed, including those relating to species of conservation interest (Specially Protected Species) and Threatened Ecological Communities. As these are not included in the WC Act, there is currently no specific legal protection afforded to these within Western Australia beyond the usual protection of unlisted species and native vegetation under the *Native Vegetation Clearing Regulations* (Government of Western Australia 2004), unless they are protected under the Commonwealth EPBC Act. Threatened Flora and Threatened Fauna are protected under the provisions of the WC Act until further sections of the BC Act are enacted.

1.3.2 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

At a Commonwealth level, Threatened taxa are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, or Extinct in the Wild (detailed in **Table 3** in **Appendix One**).

1.3.3 THREATENED AND PRIORITY FLORA

Conservation significant flora species are those that are listed as TF (Threatened Flora) and (within Western Australia) as PF (Priority Flora). TF species are listed as threatened by the Western Australian Department Biodiversity, Conservation and Attractions (DBCA) and protected under the provisions of the BC Act. Some State-listed TF are provided with additional protection as they are also listed under the Commonwealth EPBC Act.

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

There are seven categories covering State-listed TF and PF species (DPaW 2017) which are outlined in **Table 4** in **Appendix One** (noting that the definitions for TF included in the BC Act have been aligned with those in the EPBC Act). PF for Western Australia are regularly reviewed by the DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in **Table 4**.

1.3.4 INTRODUCED FLORA

Introduced plant species, known as weeds, are plants that are not indigenous to an area and have been introduced either directly or indirectly (unintentionally) through human activity. Species are regarded as introduced if they are listed as 'alien' on *FloraBase* (Western Australian Herbarium 1998-2017).

1.3.4.1 Weeds of National Significance (WONS)

At a national level there are thirty-two weed species listed as Weeds of National Significance (WONS) (Commonwealth of Australia 2017). The Commonwealth *National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance* (2012) describes broad goals and objectives to manage these species.

1.3.4.2 Declared Pest Plants

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

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage.

1.3.5 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1.3.5.1 Nationally Listed Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat (Government of Western Australia 2016). At Commonwealth level, Threatened Flora and Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. An ecological community may be categorised into one of the three sub-categories:

- Critically Endangered, if it is facing an extremely high risk of extinction in the wild in the immediate future.
- Endangered, if it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
- Vulnerable, if it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

1.3.5.2 State Listed Threatened Ecological Communities

The Western Australian DBCA also maintains a list of TECs which are further categorised into three subcategories much like those of the EPBC Act. The full details of DBCA criteria are shown in **Table 5** in **Appendix One**.

1.3.5.3 State Listed Priority Ecological Communities

DBCA maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined.

1.3.6 TECS AND PECS ON THE SWAN COASTAL PLAIN

Most TECs and PECs occurring on the Swan Coastal Plain are defined in terms of the Floristic Community Type.

FCTs are groups of co-occurring plant species, identified (on the Swan Coastal Plain) by floristic analysis from over 500, 10 m x 10 m quadrats located on the southern Swan Coastal Plain (SCP) between Seabird and the foothills of the Wicher Range by Gibson *et al.* (1994). This floristic analysis defined 43 community types and subtypes. The major correlations with the floristic classification were seasonal moisture regime and geomorphology; however there was poor correlation with vegetation structure and mapped vegetation units. Despite the poor correlation with mapped vegetation units, DPaW defines many TECs and PECs on the SCP in terms of FCTs, as identified from the Gibson *et al.* (1994) data.

The extent of an FCT is not mapped in the same way as vegetation complexes or vegetation units, thus their presence cannot be determined by desktop assessment.

Ecoscape conducted two forms of floristic analysis to compare the study area quadrat data with the Gibson *et al.* (1994) data.

1.3.6.1 Identification of the Most Similar FCTs

Affinities with FCTs are identified after analysis of field survey quadrat data. There were three types of comparisons conducted:

- statistical analysis, discounting FCTs from different landforms or landscape positions (i.e. in this case not including FCTs from low-lying FCTs)
- comparing dominant species to FCT descriptions
- examining inferred FCT types and soil types of surrounding bushlands.

FCT analysis of the collected data is conducted using an in-house database program which compares the species list collected from the quadrat data with the information in Table 12 of Gibson *et al.* (1994) and includes data from additional unpublished sites. The analysis produces a list of possible FCTs, with the output including:

- the number of FCT species in the quadrat in relation to the defined FCT list
- the percentage of FCT species in the quadrat in relation to the defined FCT list
- the total cumulative frequency (i.e. running total) of FCT species in the quadrat for each defined FCT, which weights typical FCT species.

The output list of possible FCTs is compared with landform, landscape position, distribution, typical species and descriptions in Gibson *et al.* (1994) to indicate the best possible match with an FCT.

2 DESKTOP ASSESSMENT

2.1 CONSERVATION SIGNIFICANT FLORA

DFES commissioned a DPaW database search for conservation significant flora (search reference 13-0517FL) of the study area, to which DPaW applied a 5 km buffer.

No conservation significant flora species have previously been recorded from within the study area.

The species listed in **Table 1** have been previously recorded from within 5 km of the study area. The highlighted species have a moderate to high likelihood of occurring in the study area due to suitable habitat being present.

Table 1: Conservation significant flora database search results

Species Name	Conservation Code	Flowering	Habitat
Acacia benthamii	P2	Aug-Sep	Limestone, grey sand. Tuart and Jarrah woodland.
Beyeria cinerea subsp. *cinerea*	P3	July-Nov	Sand over limestone. Scrub.
Calandrinia oraria	P3	Aug-Oct	Coastal dunes, limestone. Characteristic species: *Melaleuca systena*, *Lomandra maritima*.
Dillwynia dillwynioides	P3	Aug-Dec	Sand, damplands. *Melaleuca rhaphiophylla*, *Eucalyptus rudis*.
Jacksonia sericea	P4	Dec-Jan	Sand, calcareous sand. Heath of *Grevillea preissii*, *Rhagodia baccata* and *Melaleuca acerosa* (now *M. systena*).
Schoenus capillifolius	P3	Oct-Nov	Mud, claypans. *Melaleuca rhaphiophylla* woodland.
Sphaerolobium calcicola	P3	Jun-Nov	Wetland, dampland. *Melaleuca rhaphiophylla* woodland.

2.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

DFES sought DPaW's advice regarding the potential conservation status of the vegetation of the study area. The advice received from DPaW (email from Wendy Hudleston (Chow), 4 May 2017) was that no TECs or PECs are currently known from the study area, however, the following PECs may occur:

- *SCP29a – Coastal shrublands on shallow sands*
- *SCP29b – Acacia shrublands on taller dunes*.

2.3 BUSH FOREVER

The study area is included in Bush Forever site 356 Lake Cooloongup, Lake Walyungup and adjacent bushland, Hillman to Port Kennedy (Government of Western Australia 2000; Western Australian Planning Commission 2000).

Whilst many Bush Forever sites, or parts thereof, are not included in the formal conservation estate, the general objective of the *Urban Bushland Strategy* (Government of Western Australia 1995), under which the Bush Forever project was implemented, is:

> *'to ensure that bushland, an important aspect in the urban environment, is given proper recognition and consideration in the development of Western Australia's cities, particularly Perth'.*

The inclusion of an area as a Bush Forever site is given consideration by regulatory authorities in the environmental approvals process.

3 METHODS

The activities conducted during the field survey were the equivalent of a Detailed flora and vegetation survey as described in the *Flora and Vegetation Technical Guidance* (EPA 2016b). The field survey consisted of:

- recording floristic quadrats (three per vegetation type) to enable comparison with SCP FCTs
- vegetation type mapping
- vegetation condition assessment and mapping
- searches for conservation significant flora species.

Detailed methods are provided below.

3.1.1.1 Field Survey Timing

The field survey was conducted in September. This corresponds with the recommended timing, as detailed in the *Flora and Vegetation Technical Guidance* (EPA 2016b), of vegetation surveys in the southwest botanical province being conducted in spring. The survey also corresponded with the flowering period of conservation significant flora species considered most likely to occur during the desktop assessment.

3.1.1.2 Floristic Quadrats

Floristic quadrats ('quadrats') were located within representative vegetation on the study area. As per the *Flora and Vegetation Technical Guidance*, they were 10 m x 10 m in size. Quadrats were measured *in situ* but not permanently marked.

The following information was collected from within each quadrat sampled:

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

3.1.1.3 Conservation Significant Flora Searches (Targeted Searches)

The entire study area was subject to a grid survey. Potentially occurring species were identified by the database searches, with species with similar habitat requirements targeted during the search.

3.1.1.4 Vegetation Description and Classification

Vegetation was described from each of the quadrats using the height and estimated cover of dominant and characteristic species of each stratum based on the National Vegetation Information System (NVIS; Executive Steering Committee for Australian Vegetation Information [ESCAVI] 2003) (**Table 6** and **Table 7** in **Appendix One**), recorded at Level V. Up to three species per stratum from each stratum (upper, mid and ground) were used to formulate vegetation descriptions for each quadrat and each vegetation type.

Vegetation type descriptions were created by combining quadrat descriptions and modifying, where necessary, based on the wider vegetation.

3.1.1.5 Vegetation Condition and Mapping

Vegetation condition was assessed continuously throughout the study area and at each quadrat using the Vegetation Condition Scale described in the *Flora and Vegetation Technical Guidance* (EPA 2016b), shown in **Table 8** in **Appendix One**.

The spatial extent of the varying vegetation condition was mapped using GIS and a vegetation condition map is provided in this report.

3.2 BOTANICAL LIMITATIONS

Survey design: The field survey was designed to determine if there were conservation significant flora species or ecological communities present on site.

Survey type: The conservation significant flora survey consisted of a grid search at approximately 30 m spacing. The grid spacing was due to dense clumps of vegetation that consisted of large *Acacia rostellifera* and *Spyridium globulosum* shrubs, tangled with *Clematis linearifolia* vines and dead foliage, as well as the poor condition of the vegetation that was, in most places, 70-90% cover of weeds in the ground stratum.

Type of vegetation classification system: Vegetation was classified at NVIS Level V (ESCAVI 2003) using largely structural vegetation types defined using dominant and characteristic species and vegetation structure.

Table 2: Botanical limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of contextual information at a regional and local scale	No	Ecoscape has conducted a number of botanical surveys in coastal areas of the Swan Coastal Plain, and has viewed many other reports and documents.
Competency/experience of the team conducting the survey, including experience in the bioregion surveyed	No	Lyn Atkins has conducted a number of botanical surveys on the Swan Coastal Plain.
Proportion of the flora recorded and/or collected, and any identification issues	No	All shrub and vine species were identifiable, however, most annual grasses were not flowering, and flowering had not yet been initiated. Therefore, annual grasses may have been overlooked in the flora inventory, however, they were all likely to be introduced species and therefore not of significance.
Was the appropriate area fully surveyed (effort and extent)	No	Yes; the area was small (approximately 3.5 ha), consisted of a single vegetation type and was adequately surveyed to meet the survey objectives.
Access restrictions within the survey area	No	The site was readily accessible.
Survey timing, rainfall, season of survey	No	The survey was conducted in September, which met the optimal survey timing as outlined in the Flora and Vegetation Technical Guidance and corresponded with the flowering period of the conservation significant flora likely to occur in the study area. The rainfall for the two months preceding the field survey was above average, however, the three prior were well below average. Annual species appeared to have had a shorter growing period than usual, and many annual herbs (particularly grasses) were not flowering. However, as these were most likely to have been entirely introduced, there was no limitation in terms of rainfall and plant growth.
Disturbance that may have affected the results of the survey e.g. fire, flood, clearing	No	There was no recent disturbance affecting the results of the study area. It is likely that the study area has been grazed and potentially cleared in the past.

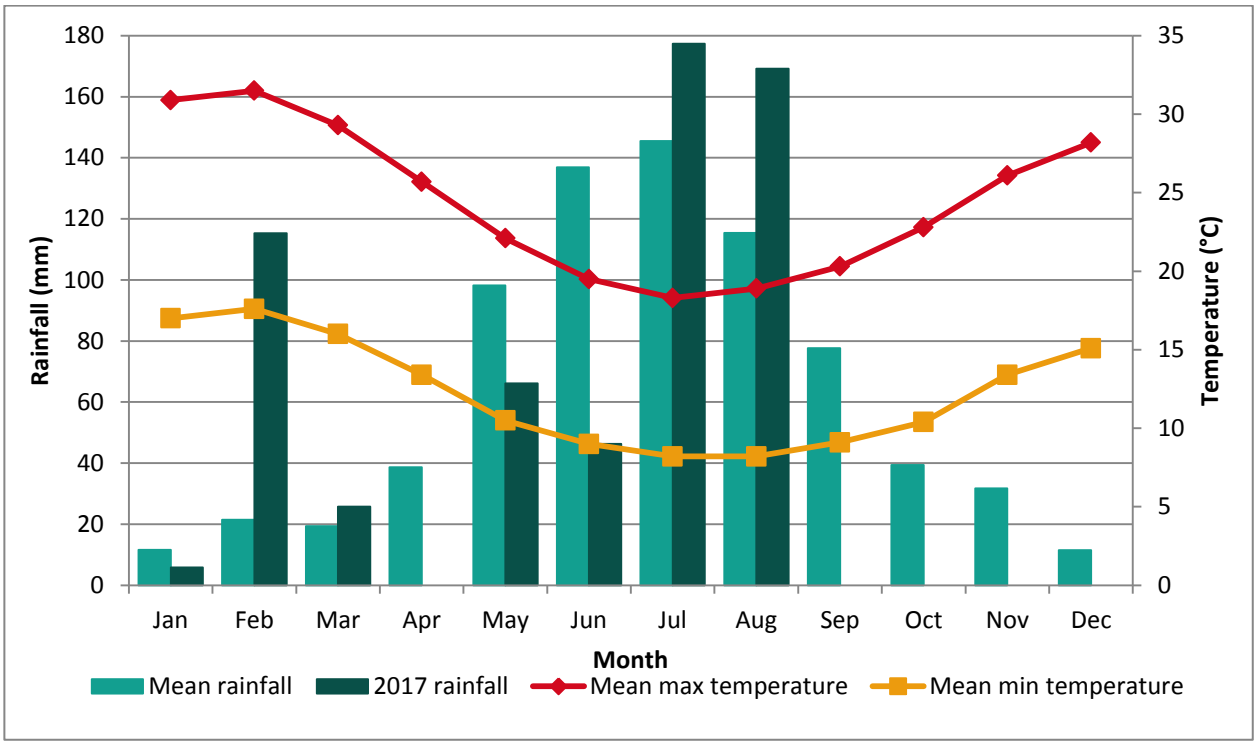

Figure 2: Monthly climate data, Medina Research Centre (Bureau of Meteorology 2017, accessed 11 September 2017))

4 RESULTS

The botanical survey of the study area was conducted by Lyn Atkins (Associate Environmental Scientist, Ecologist/Botanist, flora collecting permit SL012011) on 6 September 2017.

4.1 FLORA

Forty four[1] flora species were identified from a combination of species recorded in quadrats and opportunistic observations recorded during conservation significant flora search traverses. Of these, 25 species (57% of the total) were introduced species (weeds). The flora inventory is provided in **Table 9** in **Appendix Two**.

4.1.1 CONSERVATION SIGNIFICANT FLORA

No species of conservation significance (i.e. listed as TF under the Commonwealth EPBC Act or Western Australian BC Act, nor as PF by DBCA) were recorded from the study area.

4.1.2 SIGNIFICANT WEEDS

No weeds listed as Declared Pest plants for the City of Rockingham were recorded during the survey (Department of Primary Industries and Regional Development 2017, accessed 13 September 2017).

No WONS were recorded during the survey.

4.2 VEGETATION TYPE

The study area is occupied by a single vegetation type:

- *Acacia rostellifera*, *Clematis linearifolia* and *Spyridium globulosum* open to dense tall shrubland over *Austrostipa flavescens*, *introduced herbs and *Acanthocarpus preissii* closed low tussock grassland/grassland/forbland.

Plate 1 and **Plate 2** illustrate vegetation that is representative of most of the study area.

Plate 1: Representative vegetation

Plate 2: Representative vegetation

Parts of the western side of the study area were in a poorer condition than the bulk of the study area, with a lower density of shrubs but also a higher density of native perennial grass (*Austrostipa flavescens*). **Plate 3** and **Plate 4** illustrate these areas.

[1] Species counts do not include the broad category of 'introduced herbs' as a species. Due to the late initiation of flowering, many annual species (largely grasses) were not identifiable.

Plate 3: Poorer condition vegetation

Plate 4: Poorer condition vegetation

4.2.1 FLORISTIC SURVEY/FLORISTIC ANALYSIS

Three floristic quadrats were recorded in the study area; their locations are shown on **Map 1**. Quadrat details are provided in **Appendix Three**.

These data from the quadrats were used to undertake a floristic analysis, comparing the quadrats with those of Gibson *et al.* (1994) on the Swan Coastal Plain. A summary of the analysis is included in **Table 10** in **Appendix Four**.

All three of the quadrats showed a low degree of similarity with two FCTs; SCP29a and SCP29b, both of which are PECs. The analysis indicated that the vegetation was marginally more similar to SCP29b, however, the study area had a low number of species in the study area quadrats (14, 13 and eight) when compared with mean species richness in the Gibson *et al.* (1994) data (40.7 for SCP29a and 35.6 for SCP29b) and a low number of FCT species in each quadrat. This low degree of similarity, coupled with the poor vegetation condition (see below), indicates that the vegetation is unlikely to be considered to represent either PEC.

4.3 VEGETATION CONDITION

The vegetation condition of the study area ranged from Completely Degraded to Degraded, shown on **Map 1**. These condition ratings were assigned due to the high density of weeds that were generally 70-90% cover in the ground stratum, and the species-poor vegetation.

While the specific land use history of the site is unknown, the study area is located between the Stakehill Racecourse and Lark Hill Vets, and has potentially been either partly or entirely cleared, subject to frequent fires in the past (although no recent evidence was observed), or subject to historical horse grazing prior to the urbanisation of the surrounds, or at the least, frequent traverses by horses. Additionally, the area is also infested with rabbits, with frequent rabbit holes and warrens encountered during traverses of the site. Rabbit grazing may have affected species richness, particularly by selective grazing of the ground stratum species and seedlings of larger species.

4.4 FAUNA

While not specifically included in the project objectives, the following fauna and fauna habitat observations were made during the field survey:

- the area is (or was, as no animals or recent dung were sighted) heavily infested with rabbits
- Western Grey Kangaroos visit the site ('lies' and fresh dung sighted)
- the site may be suitable for Quenda (Southern Brown Bandicoot) due to dense patches of vegetation providing suitable habitat; none were sighted, however, there were some ground diggings that may have been this species

- the area does not represent Black Cockatoo habitat as no foraging species are present (Department of Sustainability Environment Water Populations & Communities 2012), nor are there any trees suitable for roosting or nesting (the only trees were European Olives).

5 DISCUSSION

5.1 FLORA

Forty four flora species were identified from the study area, 25 (57%) of which were introduced species (weeds).

Three floristic quadrats were recorded; the species richness of these (14, 13 and eight; mean 11.67 species) was extremely low compared with the Gibson *et al.* (1994) data for similar vegetation (i.e. FCT SCP29a and SCP29b; see **Section 4.2.1**), that had mean species richness of 40.7 and 35.6 respectively. Whilst it is possible that additional species could have occurred within these quadrats, they were most likely to have been introduced weeds (i.e. included in the broad category of 'introduced herbs' that has not been included in the species count), and are unlikely to have significantly added to the species count.

Ecoscape has previously conducted flora and vegetation surveys in nearby areas, including:

- Singleton (Ecoscape 2008), where seven quadrats were recorded with a species richness ranging from 11 to 27 (mean 18.14). Five of these quadrats were in similar vegetation (i.e. most similar to FCT SCP29a or SCP29b); the mean species richness of these quadrats was 19.6.
- Madora Bay (Ecoscape 2011b), where nine quadrats were recorded with a species richness ranging from nine to 24 (mean 15.11). Eight of these quadrats were in similar vegetation; the mean species richness for these was 14.63.
- Dawesville (Ecoscape 2011a), where eight quadrats were recorded with a species richness ranging from 11 to 34 (mean 20.0). Three of these quadrats were in similar vegetation; the mean species richness for these was 23.0.

The species richness of the current study area at Port Kennedy is lower than any of the above listed surveys, confirming its poor condition.

5.1.1 CONSERVATION SIGNIFICANT FLORA

No species of conservation significance were recorded from the study area. The study area was traversed broadly during the field survey.

The DPaW database search results and likelihood assessment (**Table 1**) identified four species as potentially occurring. Following the field survey and taking into account the vegetation present (species and condition, including the weed cover that generally ranged between 70% and 90%), Ecoscape considers that none are likely to have occurred and been overlooked during the field survey.

5.2 ECOLOGICAL COMMUNITIES

According to advice provided to DFES by DPaW, no TECs or PECs have previously been recorded from within the study area, although two PECs (*SCP29a – Coastal shrublands on shallow sands*, and *SCP29b – Acacia shrublands on taller dunes*) were considered, by DPaW, as having potential to occur. Information available on *NatureMap* (DBCA 2017b) shows that the study area is within the buffers of TECs and potentially close to buffers of PECs (although *NatureMap* does not identify TECs or PECs by name, only their presence, including buffers); **Figure 3**, study area extent shown approximately in red. The most likely TEC to occur nearby is *SCP19 Sedgelands in Holocene Dune Swales* that is listed as Critically Endangered under the Western Australian BC Act and Endangered under the Commonwealth EPBC Act. The study area was not similar to this TEC as the vegetation was not defined by sedge species with none of the dominant species present, the site was not and wetland, and it did not occupy the required swale landform (the study area was largely flat, with a definite dune to the east but no clear dune features to the west).

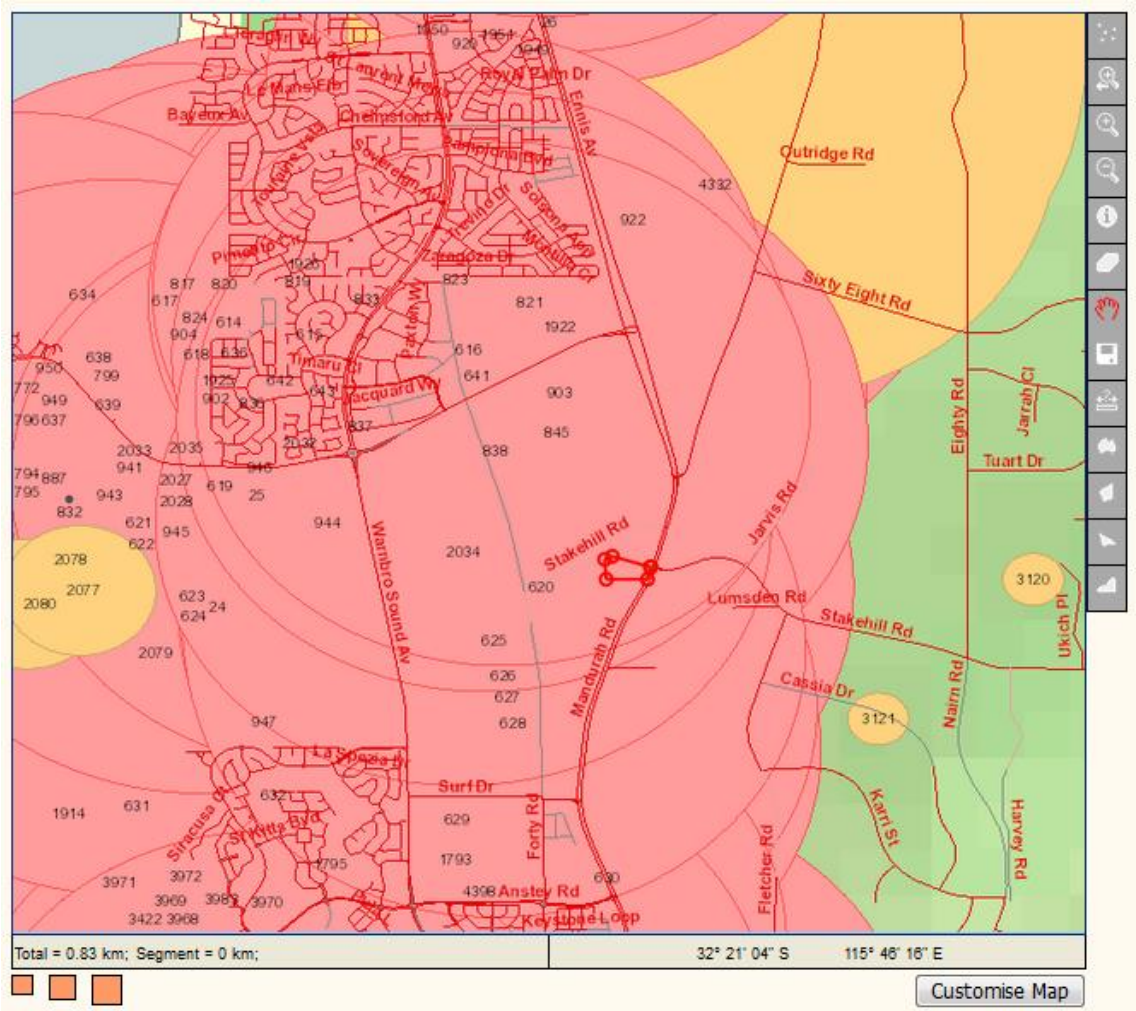

Figure 3: *NatureMap* (DBCA 2017b) search showing TEC (pink) and PEC (orange) buffers in relation to the study area location

Ecoscape's floristic analysis indicated that, of the FCTs identified in Gibson *et al.* (1994), the most similar was SCP 29b, with SCP 29a also showing similarity. However, the low species richness in comparison to these FCTs, low number of FCT species (acknowledging that some taxonomic changes since the Gibson *et al.* survey that are difficult to trace backwards may have slightly lowered this number) and poor (Degraded and Completely Degraded) condition of the vegetation indicates that the similarity is low. Additionally, as Degraded and Completely Degraded vegetation is generally not considered as extant native vegetation, Ecoscape considers the vegetation within the study area should not be considered representative of either of these.

5.3 BUSH FOREVER

The study area is included in Bush Forever site 356 Lake Cooloongup, Lake Walyungup and adjacent bushland, Hillman to Port Kennedy (Government of Western Australia 2000; Western Australian Planning Commission 2000). The approximate extent of the study area in relation to Bush Forever lands is shown in **Figure 4** and, on a larger scale indicating connectivity, in **Figure 5**. The study area is part of a large corridor connecting the coast and coastal lakes (Lake Walyungup and Lake Cooloongup), and bushland further to the north and east. However, its position is not central to the corridor as it occupies an edge corner that is unlikely to be integral to maintaining the intactness of the corridor, nor is it likely to play a large role in the biological function of a corridor, which includes its use by fauna to move through the landscape and for gene flow for plants and animals. Of itself, the study area provides little in the way of habitat for, or biological diversity of, native flora or fauna.

The inclusion of an area in a Bush Forever site is generally taken into consideration during the environmental approvals process. However, Bush Forever sites do not have statutory protection although they do have statutory recognition under the *Perth Metropolitan Regional Scheme Amendment 1082/33 for Bush Forever and Related Lands* (MRS 1082/33, Department of Planning Lands and Heritage & Western Australian Planning Commission 2012b). The study area is not listed as being a proposed 'special control area' within MRS 1082/33.

While there is generally a presumption against clearing within Bush Forever lands, it is acknowledged that essential public infrastructure may need to be located within Bush Forever sites (Department of Planning Lands and Heritage & Western Australian Planning Commission 2012a).

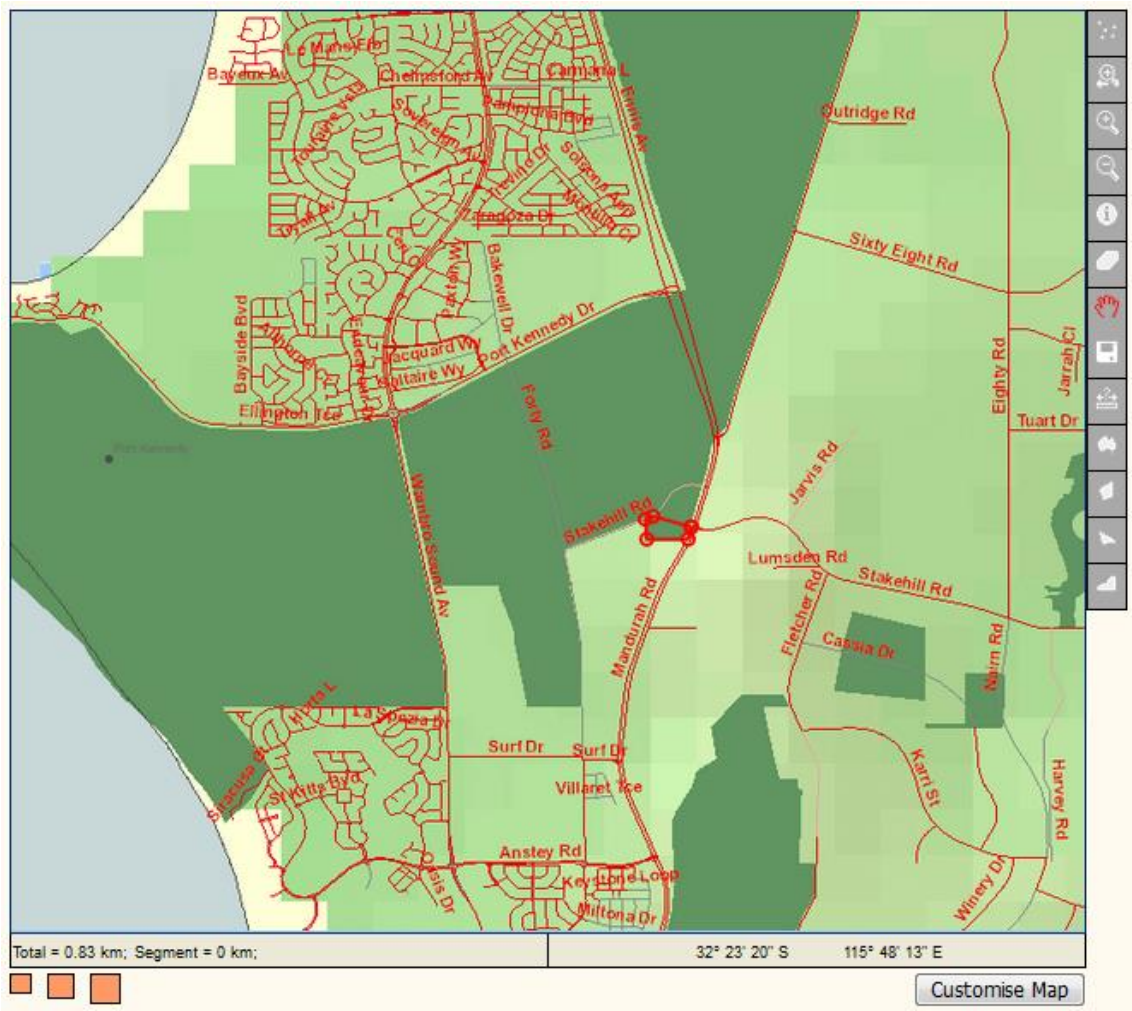

Figure 4: *NatureMap* (DBCA 2017b) search showing Bush Forever sites (dark green)

Perth's Bush Forever Areas (South)

Figure 5: Bush Forever sites (Urban Bushland Council WA Inc 2017); study area location indicated by a red circle

6 CONCLUSIONS

6.1 EPA (2016A) ENVIRONMENTAL FACTOR GUIDELINE: FLORA AND VEGETATION

The EPA's environmental objective for the factor Flora and Vegetation (EPA 2016a) is:

> *To protect flora and vegetation so that biological diversity and ecological integrity are maintained."*

The flora and vegetation factors in this document that have been assessed for the study area are discussed below.

6.1.1 FLORA

No significant flora species, as defined in this *Factor Guideline*, were recorded from the study area. No TF species are considered likely to occur within the study area.

6.1.2 VEGETATION

The significant factors affecting vegetation listed in this Factor Guideline, and how they relate to the vegetation of the study area are:

- *being identified as threatened or priority ecological communities*. There is little doubt that, had the vegetation of the study area been in better condition (it was all assessed as being in Degraded or Completely Degraded condition), it would have been included in an FCT listed as a PEC. However, Degraded and Completely Degraded condition vegetation is generally not considered as extant native vegetation.
- *restricted distribution*. Similar near-coastal vegetation is generally restricted in distribution to the coastal sands over limestone of the Quindalup dune system. This area has largely been cleared, hence its listing as several PECs (including SCP29a and SCP29b that the study area is most similar to) or TECs, however, the poor condition of the vegetation indicates that it is not considered as extant native vegetation.
- *degree of historical impact from threatening processes*: the study area is in poor condition, and may have been cleared or historically grazed, and is heavily invaded by weeds
- *a role as a refuge*: the study area may be a refuge for some fauna species (e.g. Quenda), however, its species-poor native vegetation that is heavily weed invaded indicates that it would be considered as poor quality habitat for most fauna species (and also as poor quality habitat for native flora species)
- *providing an important function required to maintain ecological integrity of a significant ecosystem*: the poor condition of the vegetation indicates low ecological integrity.

Overall, the vegetation of the study area is considered to not be representative of ecologically significant areas, and provides poor quality habitat in its potential role as a refuge.

6.2 BUSH FOREVER

The study area is included as part of Bush Forever site 356 Lake Cooloongup, Lake Walyungup and adjacent bushland, Hillman to Port Kennedy (Government of Western Australia 2000; Western Australian Planning Commission 2000).

Bush Forever site 356 is largely associated with wetlands, and the study area's inclusion is most likely a factor if being included in a vegetated linkage between these lakes (Lake Cooloongup and Lake Walyungup) and the coast, including Port Kennedy Scientific Park that is in DBCA tenure, and being in Local Government tenure, as well as being representative of coastal vegetation.

6.3 OVERALL CONCLUSION

Overall, the study area of itself (i.e. when not taking other factors into consideration) does not hold any significant flora or vegetation values due to its poor condition.

Its value lies in its role as part of the larger vegetated area. Its role as a corridor for use by fauna to move through the landscape, or for gene flow for plants and animals, is small due it being isolated from larger bushland areas by roads, being on the edge of a corridor rather than a part of the connected vegetation, and its poor condition.

The site provides little habitat value or contribution to genetic diversity or gene flow for both plants and animals.

6.4 RECOMMENDATION

Based on the results of the field survey, Ecoscape does not consider the study area to have high conservation value. Its inclusion in a Bush Forever site may restrict DFES's opportunities to develop the area. Ecoscape recommends DFES discuss this aspect with regulatory authorities.

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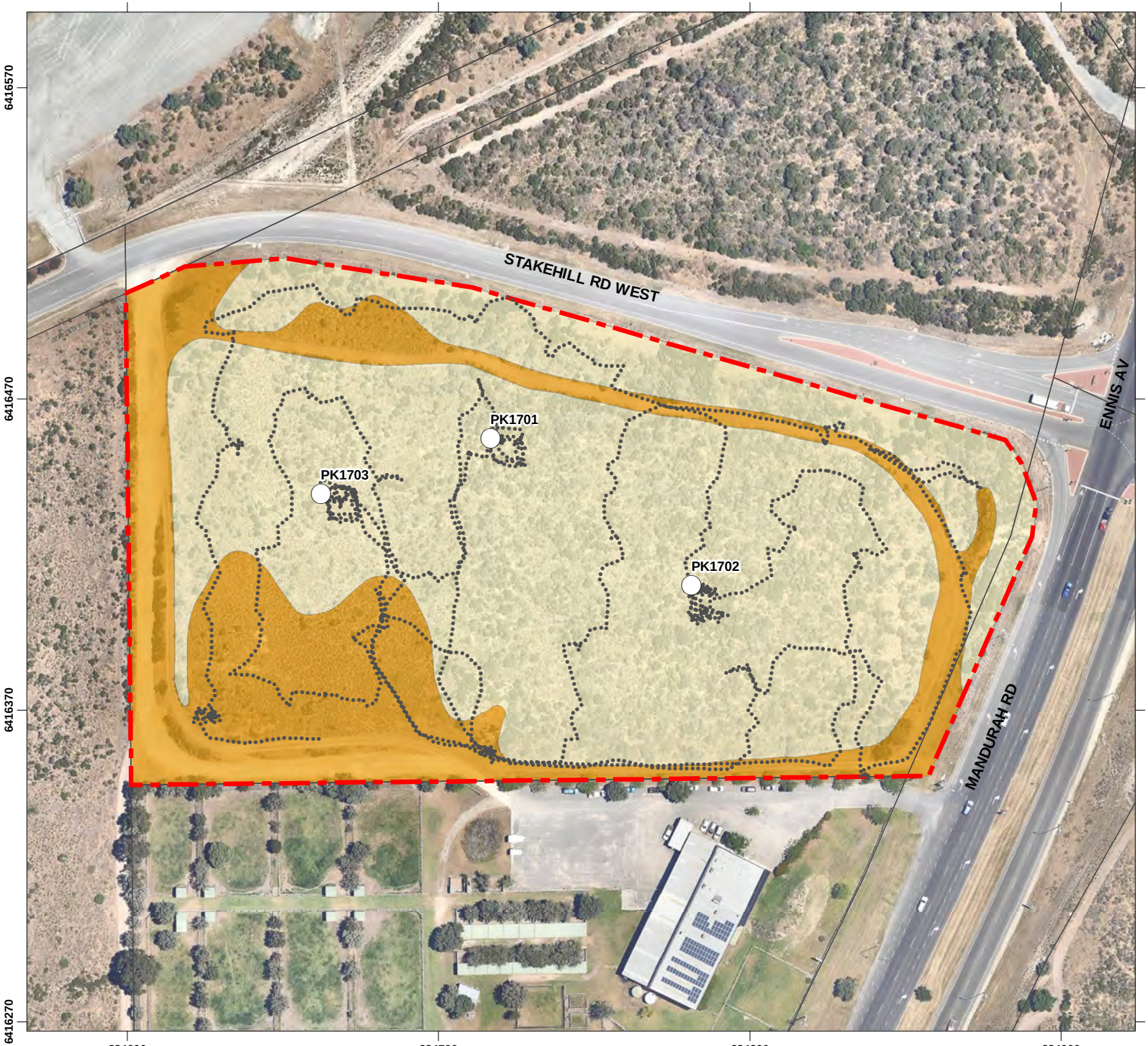
MAPS



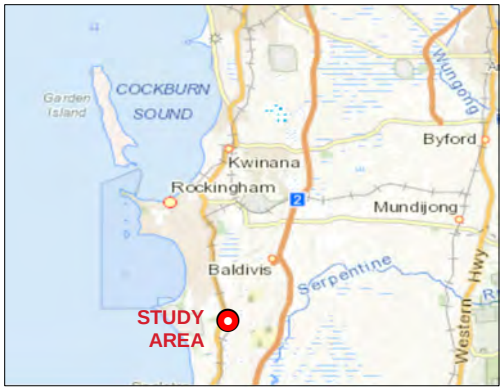
LEGEND

- Quadrats
- Survey Tracks
- Study Area
- Cadastral Boundary

Vegetation Condition

- Degraded
- Completely Degraded

DATASOURCES :
AERIAL: NEARMAP
SERVICE LAYERS: TOPOGRAPHIC BASEMAP - GEOSCIENCE AUSTRALIA



ecoscape

VEGETATION CONDITION QUADRATS AND SURVEY TRACKS

PORT KENNEDY BOTANICAL SURVEY

CLIENT: DEPARTMENT OF FIRE AND EMERGENCY SERVICES

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

SCALE: 1:1,750 @ A4

N

0 10 20 30 40 50 Meters

PROJECT NO: 3968-17

REV	AUTHOR	APPROVED	DATE
0	JN	LA	21/09/2017

MAP

01

APPENDIX ONE DEFINITIONS AND CRITERIA

Table 3: EPBC Act categories for flora and fauna

EPBC ACT 1999 category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 4: Conservation codes for Western Australian flora and fauna (DPaW 2017)

Conservation Codes for Western Australian Flora and Fauna	
T	**Threatened species*** Published as Specially Protected under the *Wildlife Conservation Act 1950*, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). • ***Threatened fauna*** is that subset of 'Specially Protected Fauna' declared to be ' likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act. • ***Threatened flora*** is flora that has been declared to be 'likely to become extinct or is rare, or is otherwise in need of special protection' pursuant to section 23F(2) of the Wildlife Conservation Act. 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. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EN	**Endangered species** Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
VU	**Vulnerable species** Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EX	**Presumed extinct species** Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
IA	**Migratory birds protected under an international agreement** 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 the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.
CD	**Conservation Dependent fauna** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice
OS	**Other specially protected fauna** Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice
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 flora or fauna. • 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 list 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.
P1	**Priority One: 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 or 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 localities 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.
P2	**Priority Two: 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 localities 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.
P3	**Priority Three: 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 localities 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 localities 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.

Conservation Codes for Western Australian Flora and Fauna	
P4	**Priority Four: 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.
*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).	

Table 5: DBCA definitions and criteria for TECs and PECs (DEC 2013)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being

Criteria	Definition
	substantially restored or rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.
Priority ecological communities	
Priority One	*Poorly known ecological communities* Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	*Poorly known ecological communities* Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	*Poorly known ecological communities* i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. i. Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. ii. Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities

Criteria	Definition
	during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table 6: NVIS structural formation terminology, terrestrial vegetation (ESCAVI 2003)

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

Table 7: NVIS height classes (ESCAVI 2003)

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

Table 8: Vegetation Condition Scale for the South West and Interzone Botanical Provinces (EPA 2016b)

Condition rating	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.

APPENDIX TWO FLORA INVENTORY

Table 9: Site by species/species inventory

Species/Quadrat	PK1701	PK1702	PK1703	Opportunistic observations
Acacia rostellifera	x	x	x	
Acanthocarpus preissii	x	x		
**Arctotheca calendula*				x
**Asphodelus fistulosus*				x
Austrostipa flavescens	x	x	x	
**Avena barbata*				x
**Brassica tournefortii*				x
**Bromus diandrus*		x		
**Cenchrus clandestinus*				x
**Chloris gayana*				x
Clematis linearifolia	x	x	x	
Conostylis aculeata subsp. *aculeata*	x	x		
Crassula sp.				x
**Cynodon dactylon*				x
Desmocladus asper			x	
Dianella revoluta				x
**Ehrharta calycina*				x
**Ehrharta longiflora*				x
**Eragrostis curvula*				x
Eremophila glabra subsp. *albicans*				x
**Euphorbia peplus*	x	x		
**Euphorbia terracina*	x	x		
**Fumaria capreolata*		x	x	
**Fumaria muralis*	x	x	x	
Hardenbergia comptoniana	x			
Introduced herbs	x	x	x	
**Lagurus ovatus*	x			
Leucopogon parviflorus				x
**Lolium rigidum*				x
Lomandra maritima	x			
Lepidosperma calcicola	x	x		
Melaleuca systena	x			
**Oenothera* sp.				
**Olea europaea*				x
Opercularia vaginata				x
**Orobanche minor*				x
**Oxalis pes-caprae*				x
**Pelargonium capitatum*				x
Phyllanthus calycinus				x
Rhagodia baccata			x	
**Ricinus communis*				x
**Sonchus oleraceus*		x		
Spyridium globulosum	x	x		
Senecio condylus			x	
**Urtica urens*				x
No. species	**14**	**13**	**8**	**44**

Note: number of species does not include 'introduced herbs'.

APPENDIX THREE FLORISTIC QUADRATS

Site: **PK1701**

Staff:	LJA	**Date:**	06/09/2017	**Season:**	Average
Type:	Quadrat				
MGA Zone:	50	384716.69	mE	6416457.37	mN
	Lat.	-32.38293	Long.	115.77441	
Habitat:	Flat	**Aspect:**	N/A	**Slope:**	N/A
Soil Type:	Grey sand	**Rock Type:**	Limestone	**Rock Cover:**	0
Litter:	20% cover				
Bare Ground:	5% cover	**Weeds:**	80% cover		

Vegetation: M ^*Acacia rostellifera*,^*Spyridium globulosum*\^shrub\4\i;G ^*Austrostipa flavescens*,^introduced herbs,*Acanthocarpus preissii*\^tussock grass,other grass,forb\2\d

Condition: Degraded

Disturbance: Rabbits

Species	Height (m)	Cover (%)
Acacia rostellifera	2.3	25
Acanthocarpus preissii	1	10
Austrostipa flavescens	0.5	10
Clematis linearifolia	2	5
Conostylis aculeata subsp. *aculeata*	0.3	<1
**Euphorbia peplus*	0.1	2
**Euphorbia terracina*	0.2	10
**Fumaria muralis*	0.2	20
Hardenbergia comptoniana	1	<1
Introduced herbs	0.3	60
**Lagurus ovatus*	0.2	10
Lepidosperma calcicola	0.3	<1
Lomandra maritima	0.3	<1
Melaleuca systena	1	1
Spyridium globulosum	2	5

Site: **PK1702**

Staff:	LJA	**Date:**	06/09/2017	**Season:**	Average
Type:	Quadrat				
MGA Zone:	50	384781.30	mE	6416410.21	mN
		Lat. -32.38337		Long. 115.77509	
Habitat:	Flat	**Aspect:**	N/A	**Slope:**	N/A
Soil Type:	Grey sand	**Rock Type:**	Limestone	**Rock Cover:**	0
Litter:	10% cover				
Bare Ground:	1% cover		**Weeds:**	70% cover	

Vegetation: M ^*Acacia rostellifera*\^shrub\4\c;G ^^*Acanthocarpus preissii,Austrostipa flavescens*,introduced herbs, \^forb,tussock grass,other grass\2\d

Condition: Degraded

Disturbance: Rabbits

Species	Height (m)	Cover (%)
Acacia rostellifera	2	45
Acanthocarpus preissii	0.6	10
Austrostipa flavescens	0.4	10
**Bromus diandrus*	0.4	20
Clematis linearifolia	1.5	<1
Conostylis aculeata subsp. *aculeata*	0.3	1
**Euphorbia peplus*	0.1	5
**Euphorbia terracina*	0.3	5
**Fumaria capreolata*	0.2	2
**Fumaria muralis*	0.2	5
Introduced herbs	0.3	60
Lepidosperma calcicola	0.3	2
**Sonchus oleraceus*	0.5	>1
Spyridium globulosum	1.8	1

Site: **PK1703**

Staff:	LJA	**Date:**	06/09/2017	**Season:**	Average
Type:	Quadrat				
MGA Zone:	50	384662.23	mE	6416439.67	mN
		Lat. -32.38309		Long. 115.77383	
Habitat:	Flat	**Aspect:**	N/A	**Slope:**	N/A
Soil Type:	Grey sand	**Rock Type:**	Limestone	**Rock Cover:**	0
Litter:	40% cover				
Bare Ground:	1% cover		**Weeds:**	60% cover	

Vegetation: M ^*Acacia rostellifera*,*Clematis linearifolia*\^shrub,vine\4\r;G ^*Austrostipa flavescens*,^introduced herbs\^tussock grass,other grass,forb\2\d

Condition: Degraded

Disturbance: Potentially previously cleared or grazed

Species	Height (m)	Cover (%)
Acacia rostellifera	1.5	5
Austrostipa flavescens	0.5	25
Clematis linearifolia	1.8	2
Desmocladus asper	0.1	<1
**Fumaria capreolata*	0.1	2
**Fumaria muralis*	0.2	1
Introduced herbs	0.2	50
Rhagodia baccata	1	1
Senecio condylus	0.3	<1

APPENDIX FOUR FLORISTIC ANALYSIS

Table 10: Floristic community type analysis

Quadrat	Quadrat Description	FCT	Typical Landform	Notes with reference to Gibson *et al.* (1994)	No. spp. in quad.	Species Richness			WA Cons. code	Comm. TEC
						No. FCT spp.	% of FCT spp.	Cumulative Frequency		
PK1701	*Acacia rostellifera* and *Spyridium globulosum* open tall shrubland over *Austrostipa flavescens,* *introduced herbs and *Acanthocarpus preissii* closed low tussock grassland/grassland/forbland	SCP29b Acacia shrublands on taller dunes	Quindalup	No consistent dominant species. Important species include *Acacia rostellifera*, *Acacia lasiocarpa* and *Melaleuca systena*. Species richness: 40.7.	14	7	19.66	346	PEC	-
		SCP29a Acacia shrublands on shallow sands	Quindalup	No clear dominant species. Important species include *Spyridium globulosum*, *Rhagodia baccata* and *Olearia axillaris*. Species richness 35.6.		7	17.2	344	PEC	-
PK1702	*Acacia rostellifera* tall shrubland over *Acanthocarpus preissii, Austrostipa flavescens* and *introduced herbs closed low tussock grassland/grassland/forbland	SCP29b Acacia shrublands on taller dunes	Quindalup	No consistent dominant species. Important species include *Acacia rostellifera*, *Acacia lasiocarpa* and *Melaleuca systena*. Species richness: 40.7.	13	6	16.85	285	PEC	-
		SCP29a Acacia shrublands on shallow sands	Quindalup	No clear dominant species. Important species include *Spyridium globulosum*, *Rhagodia baccata* and *Olearia axillaris*. Species richness 35.6.		6	14.74	312	PEC	-

Quadrat	Quadrat Description	FCT	Typical Landform	Notes with reference to Gibson *et al.* (1994)	No. spp. in quad.	Species Richness			WA Cons. code	Comm. TEC
						No. FCT spp.	% of FCT spp.	Cumulative Frequency		
PK1703	*Acacia rostellifera* and *Clematis linearifolia* open tall shrubland over *Austrostipa flavescens* and *introduced herbs closed low tussock grassland/grassland/forbland	SCP29b Acacia shrublands on taller dunes	Quindalup	No consistent dominant species. Important species include *Acacia rostellifera*, *Acacia lasiocarpa* and *Melaleuca systena*. Species richness: 40.7.	8	2	5.62	131	PEC	-
		SCP29a Acacia shrublands on shallow sands	Quindalup	No clear dominant species. Important species include *Spyridium globulosum*, *Rhagodia baccata* and *Olearia axillaris*. Species richness 35.6.		2	4.91	89	PEC	-