

Lot 5 Wellesley Rd Wellesley Flora and Vegetation Survey



PREPARED FOR LUNDSTROM ENVIRONMENTAL CONSULTANTS



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Executive Summary

Plantecology Consulting was commissioned by Lundstrom Environmental Consultants Pty Ltd in August 2019 to undertake a detailed flora and vegetation survey of a part of Lot 5 Wellesley Rd, Wellesley, in the Shire of Harvey. Part of the broader site is currently used for resource extraction and an expansion to the operations has been proposed.

The purpose of the survey was to provide a detailed assessment of botanical values within the site, which could then inform the development process regarding future expansion of resource extraction.

The field survey was conducted by two botanists from Plantecology Consulting on the 24th September 2019. The site was traversed on foot in parallel lines approximately 10 m apart and a search made for conservation significant flora. A detailed survey of the vegetation was undertaken at five 100 m² sampling plots (10m x 10m quadrats), selected to adequately sample the flora within a stand (Figure 2). Plots were positioned to sample a representative and homogeneous (i.e. not located in transitional areas between communities) area of each community. The location of each corner of a plot was recorded with a hand-held GPS unit and a photograph of the plot taken looking inward to the quadrat. All vascular plant species were recorded and an estimate of the Foliage Projective Cover (FPC) percentage was made for each species.

A total of 61 native and 14 non-native (exotic) taxa were recorded within the site, representing 33 families and 58 genera. The dominant families containing mostly native taxa were Fabaceae (6 native taxa, 3 exotic taxa), Asteraceae (6 native taxa, 4 exotic taxa), and Orchidaceae (5 native taxa). For a complete species list and the individual site data refer to Appendix A and Appendix B, respectively.

No Threatened Flora pursuant to the Biodiversity Conservation Act (2016) nor the EPBC Act (1999) were recorded during the survey. One species listed as Priority Flora by the PWS was recorded during the survey: *Lasiopetalum membranaceum* (P3).

The survey identified two plant communities within the site:

Eucalyptus marginata - *Banksia attenuata* woodland (Plates 1:4)

Open Woodland of *Eucalyptus marginata* and *Banksia attenuata* with *Agonis flexuosa* over *Banksia grandis* and a shrubland of *Xanthorrhoea gracilis* and *Hibbertia hypericoides* over a herbland of *Dasypogon bromeliifolius*, *Anarthria prolifera* and *Desmocladius fasciculatus* on grey sands.

Agonis flexuosa Woodland (Plate 5)

Woodland of *Agonis flexuosa* with *Eucalyptus marginata* over open shrubland of *Xanthorrhoea gracilis*, *Macrozamia riedlei* and *Hibbertia hypericoides* over a herbland of *Dasypogon bromeliifolius* in grey sands.

Eucalyptus marginata - *Banksia attenuata* woodland has an open overstorey with *Banksia attenuata* as a co-dominant, which is a key diagnostic characteristic for the Commonwealth-listed TEC 'Banksia-dominated woodlands of the Swan Coastal Plain IBRA Region'. For this TEC to be present, the condition of the vegetation needs to be 'Good' or better, which is the case for the *Eucalyptus marginata* - *Banksia attenuata* woodland. as the extent of the community within the site exceeds 2 ha, it is likely that this community meets the criteria for inclusion in the 'Banksia-dominated woodlands of the Swan Coastal Plain IBRA Region' TEC.

Most of the site is in an 'Degraded' condition or worse and retains only some of its original botanical value. This is mainly in the *Agonis flexuosa* woodland where the vegetation structure has been highly modified from past grazing activity, especially in the understorey, where native herbaceous species have largely been replaced by exotic species. The shrub mid-storey has also been largely lost.

The *Eucalyptus marginata* - *Banksia attenuata* woodland is rated mostly as 'Good' or better with much of the original vertical structure intact as well as the original shrub and tree density. The native herbaceous understorey has been somewhat modified in some areas.

The site is located within the McLarty/ Kemerton/Twin Rivers/Preston River/Gwindinup Ecological Linkage as identified in the Greater Bunbury Region Scheme (EPA 2003). Naturally vegetated areas (in

particular the larger relatively intact remnants) in the area of the linkages are priorities for retention and protection. Also, as the site is outside the constrained area as identified in the Greater Bunbury Region Scheme (EPA 2003). The two vegetation complexes mapped as occurring within the site (the Bassendean Complex – Central and South, and the Karrakatta Complex – Central and South) both have less than 30% of their original extent remaining, which may present an impediment to development.

Fourteen of the taxa recorded during the survey are exotics (weeds). The most significant weed in the site is **Zantedeschia aethiopicum* (Arum Lily), which is a Declared Pest under the Biosecurity and Agriculture Management Act 2007.

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1 Introduction

Plantecology Consulting was commissioned by Lundstrom Environmental Consultants Pty Ltd in August 2019 to undertake a detailed flora and vegetation survey of a part of Lot 5 Wellesley Rd, Wellesley, in the Shire of Harvey (Figure 1). Part of the broader site is currently used for resource extraction and an expansion to the operations has been proposed.

1.1 Purpose

The purpose of the survey was to provide a detailed assessment of botanical values within the site, which could then inform the development process regarding future expansion of resource extraction.

The objectives of the survey were to:

- Undertake a detailed flora and vegetation survey in accordance with the Environmental Protection Authority's (EPA) *Technical Guidance: Flora and Vegetation Survey for Environmental Impact Assessment* (2016).
- Identify the presence of any Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs);
- Undertake a systematic search for all vascular plant taxa present; and
- Record the locations and numbers present of any Threatened Flora and Priority Flora.

1.2 Existing Environment

The property is currently being used for resource extraction and has also previously supported stock grazing. As a result, the vegetation varies in condition and structure with some areas retaining intact native vegetation, while most of the site has lost much of the original native midstorey and ground layer.

1.3 Climate

The Wellesley area experiences a dry Mediterranean climate of hot dry summers and cool wet winters. Long-term climatic averages indicate the site is located in an area of moderate to high rainfall, receiving 726 mm on average annually (data for Bunbury, station number 9965, the nearest currently reporting station) (Bureau of Meteorology 2019) with the majority of rainfall received between May and August. The area experiences rainfall on an average of 122 days per year. Mean maximum temperatures range from 17.3 °C in July to 29.8 °C in January. Mean minimum temperatures range from 7.1 °C in July to 15.8 °C in February.

1.4 Soils

The Atlas of Australian Soils maps the soils for the site as Map Unit Cb39, which is a subdued swale terrain. The chief soils are leached sands (Uc2.33) with smaller areas of other sands (Natural Resource Information Centre 1991).

1.5 Ecological Linkages

Ecological linkages are important conservation tools 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 improves the viability of those remnants by allowing greater access to breeding partners, food sources, refuge from disturbances such as fire and maintains the genetic diversity of plant communities and populations. Regional ecological linkages serve to link regionally significant areas via the best condition patches that are available as stepping stones (Molloy et al. 2009). The remnant vegetation within the site is within 100m of a regional ecological linkage axis line and forms part of a core asset of this linkage connecting vegetation to the southeast and

northwest of the site (Molloy et al. 2009). This linkage is identified as the McLarty/ Kemerton/Twin Rivers/Preston River/Gwindinup Ecological Linkage in the Greater Bunbury region Scheme.

1.6 Conservation Significant Flora

Under the Biodiversity Conservation Act 2016 ('BC Act'), the Minister for the Environment produces a gazetted list of Threatened Flora under three categories: Critically Endangered, Endangered and Vulnerable. The Parks and Wildlife Service (PWS) also produces a list of Priority Flora that have not been assigned statutory protection under the BC Act but may be under some degree of threat (PWS 2019a). The PWS recognises four Priority Flora levels. The definitions for each category of Threatened and Priority Flora are shown in Appendix E.

As well as protection under State legislation, selected flora are also afforded statutory protection at a Federal level pursuant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act provides for the protection of Threatened species, pursuant to Schedule 1 of the Act, and are defined as "Critically Endangered", "Endangered", "Vulnerable" or "Conservation Dependent" under Section 179. Definitions of these categories are shown in Appendix E. Any action likely to have a significant impact on a species listed under the EPBC Act requires approval from the Commonwealth Minister for Environment and Energy.

Searches of the State databases identified 26 taxa with the potential to occur within the site (Table 1). Of these taxa, six are listed as Threatened under the BC Act, five of which are orchids. *Diuris drummondii*, *Diuris micrantha* are orchids of winter-wet swamps and *Drakaea elastica* occurs in sands of low-lying areas adjacent to damp areas. These species are unlikely to occur within the site.

1.7 Conservation Significant Communities

The PWS defines an ecological community as "a naturally occurring assemblage that occurs in a particular type of habitat" (PWS 2019b). A Threatened Ecological Community (TEC) is one that has declined in area or was originally limited in distribution. Uncommon ecological communities that do not strictly meet TEC defined criteria, or are inadequately defined, are listed by the PWS as a Priority Ecological Community (PEC). Definitions of the categories of Threatened and Priority Ecological Communities are given in Appendix E.

As well as protection under State legislation, selected ecological communities are also afforded statutory protection at a Federal level pursuant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act provides for the protection of TECs, which are listed under section 181 of the Act, and are defined as "Critically Endangered", "Endangered" or "Vulnerable" under Section 182. Similar to flora listed under the EPBC Act, any action likely to have a significant impact on a TEC listed under the EPBC Act requires Commonwealth approval.

Two terrestrial TECs endorsed under State legislation are recorded as occurring near the site:

- Floristic Community Type (FCT) 9 - 'Dense shrublands on clay flats'; and
- 'Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain'.

Seven other terrestrial FCTs listed as PECs are recorded as occurring within or near the site:

- FCT 25 - 'Southern Eucalyptus gomphocephala - Agonis flexuosa woodlands' (Priority 3);
- FCT 21c - 'Low-lying Banksia attenuata woodlands or shrublands' (Priority 3);
- FCT 24 - 'Northern Spearwood shrublands and woodlands' (Priority 3);
- FCT 30b - 'Quindalup Eucalyptus gomphocephala and/or Agonis flexuosa woodlands' (Priority 3);
- Subtropical and Temperate Coastal Saltmarsh' (Priority 3);
- 'Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain' (Priority 3); and

- 'Banksia dominated woodlands of the Swan Coastal Plain IBRA Region' (Priority 3).

The 'Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community' is also categorised as 'Critically Endangered' by the Commonwealth and includes FCTs 25 and 30b. The 'Subtropical and Temperate Coastal Saltmarsh' community is listed as 'Vulnerable' by the Commonwealth and the 'Banksia-dominated woodlands of the Swan Coastal Plain IBRA Region', which is listed as an 'Endangered' TEC by the Commonwealth and includes FCT 21c, is mapped as occurring within the site.

1.8 Vegetation Complexes

Vegetation complexes are a series of plant communities forming a regularly repeating pattern associated with a particular soil unit (Government of Western Australia 2000). Two vegetation complexes have been mapped as occurring within the site. The Bassendean Complex – Central and South occupies the majority of the site and has 25% of its original 87 300 ha pre-European extent remaining and 1.8% of its current extent has some level of protection (Government of Western Australia 2017). The Karrakatta Complex – Central and South occupies approximately 0.5 ha at the western end of the site. This complex has 23.6% of its original 53 000 ha extent remaining with 3.9% of its current extent having some level of protection (Government of Western Australia 2017).

Table 1: Threatened and Priority Flora potentially occurring within the survey area based on database searches. (VU = Vulnerable; EN = Endangered; CR = Critically Endangered; T = Threatened; 1 – 4 = Priority Flora Category)

Taxa	PWS Ranking	EPBC Act Category	Flowering Period
<i>Acacia flagelliformis</i>	4		May-Sep
<i>Acacia semitrullata</i>	4		May - Oct
<i>Acacia</i> sp. Binningup (G. Cockerton et al. WB 37784)	1		
<i>Austrostipa bronwenae</i>	T	EN	
<i>Boronia capitata</i> subsp. <i>gracilis</i>	3		Jun - Nov
<i>Boronia juncea</i> subsp. <i>juncea</i>	1		Apr
<i>Caladenia procera</i>	T	CR	Sep-Oct
<i>Caladenia speciosa</i>	4		Sep-Oct
<i>Cyathochaeta teretifolia</i>	3		DEC
<i>Dillwynia dillwynioides</i>	3		Aug - Dec
<i>Diuris drummondii</i>	T	VU	Nov-Jan
<i>Diuris micrantha</i>	T	VU	Sep-Oct
<i>Drakaea elastica</i>	T	EN	Oct-Nov
<i>Drakaea micrantha</i>	T	EN	Sep-Oct
<i>Lasiopetalum membranaceum</i>	3		Sep-Dec
<i>Myriophyllum echinatum</i>	3		Nov
<i>Pterostylis frenchii</i>	2		
<i>Puccinellia vassica</i>	1		
<i>Pultenaea skinneri</i>	4		Jul-Sep
<i>Schoenus</i> sp. Waroona (G.J. Keighery 12235)	3		Oct - Nov
<i>Styphelia filifolia</i>	3		
<i>Tripterococcus</i> sp. <i>Brachylobus</i> (A.S. George 14234)	4		
<i>Verticordia attenuata</i>	3		Dec-May

2 Methods

2.1 Field Survey

The field survey was conducted by two botanists from Plantecology Consulting on the 24th September 2019. The site was traversed on foot in parallel lines approximately 10 m apart and a search made for conservation significant flora. A detailed survey of the vegetation was undertaken at five 100 m² sampling plots (10m x 10m quadrats), selected to adequately sample the flora within a stand (Figure 2). Plots were positioned to sample a representative and homogeneous (i.e. not located in transitional areas between communities) area of each community. The location of each corner of a plot was recorded with a hand-held GPS unit and a photograph of the plot taken looking inward to the quadrat. All vascular plant species were recorded and an estimate of the Foliage Projective Cover (FPC) percentage was made for each species.

Environmental data recorded included topographic position, aspect, slope, soil colour and texture class, rock outcropping, litter cover as well as the degree of disturbance and an estimate of the time since the last fire event. The condition of the vegetation of the site was assessed to assist in determining the conservation values of the site. The vegetation condition was rated according to Keighery (1994), a vegetation condition scale commonly used in the metropolitan and southwest regions. The categories are listed and defined in Table 2. Data on the vegetation structure was also recorded and included the height of the three main strata and the dominant species within each stratum. The vegetation structural description follows that of the National Vegetation Information System (Thackway et al. 2006).

All plant specimens collected during the field survey were dried, pressed and then sorted in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Taxonomic determinations were made using reference material at the Western Australian State Herbarium. Taxa names utilise the current terminologies from FloraBase (2019). Family names utilise the revised phylogeny of the Angiosperm Phylogeny Group - APGIII (FloraBase 2019).

Table 2: Vegetation Condition Scale (Keighery 1994)

Vegetation Condition	Definition
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, 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. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, 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 or shrubs.

2.2 Data Analysis

The remnant vegetation of the southern Swan Coastal Plain (SCP) was surveyed by Gibson et al. (1994) to provide an understanding of the major floristic gradients across the region. The major plant communities (or FCTs) were defined by classifying the data according to the similarities in species composition between plots. When determining the FCT of a new record, a floristic analysis of species composition provides the most robust method that is consistent with the original classification. Presently, a single consistent method for the determination of FCTs for vegetation data in the Swan Coastal Plain is not available. Therefore, it is preferable to use a few different methods and compare the output for the most likely result. All analyses described below were undertaken using R packages Cluster, Vegclust and Vegan.

2.2.1 Hierarchical Clustering

Hierarchical agglomerative clustering is the usual first stage in classifying vegetation data into community types. This involves calculating the similarity (or more often, the dissimilarity) between plots within the dataset and then sequentially fusing the plots into groups according to their similarity. This type of method was used in the analysis of the original Swan Coastal Plain dataset (Gibson et al. 1994), but its use as the basis for assigning new plot data to the regional classification has some drawbacks. Firstly, a hierarchical clustering only applies to the relationships between plots, and the relative distances between them, within that particular dataset. The addition of new data often alters the relative distances and disrupts the clustering output. Secondly, as an unsupervised method, hierarchical clustering does not define rules for the membership of the defined groups, and so the addition of new plots requires the rebuilding of the entire hierarchy (De Cáceres and Wiser 2012).

The data for the Swan Coastal Plain regional survey (Gibson et al. 1994) was downloaded from the NatureMap website. This is largely similar to the original survey except for one site (OATES-1), which has now been excluded. The species nomenclature of the original dataset was updated to be consistent with current usage. Where original names could not be matched clearly to the updated usage, those taxa were removed from the analysis. The new data from the Ludlow Rd survey was added to the matrix one plot at a time to remove any effect of spatial correlation between the new plots. Each new dataset was then analysed calculating the Bray-Curtis distance coefficient (or resemblance measure) and the flexible beta linkage method ($\beta = -0.1$). Assignment of the Ludlow Rd plots was to the nearest distinct group by inspection of the resulting dendrogram.

2.2.2 Non-hierarchical clustering

Non-hierarchical clustering methods often allow new plot data to be added to previous classifications because they are based on the concept that each group or cluster is represented by a prototype i.e. either a centroid or a medoid (a 'type' plot) (De Cáceres and Wiser 2012). Therefore, new observations can be assigned to an existing classification by calculating the distance to the nearest prototype (which may be considered a membership criterion). This approach is to be preferred to the hierarchical reconstruction approach because it defines numerical rules that can be consistently applied. However, it also means the original classification needs to be reanalysed using a different method, which can be problematic because not all sites from the original classification may be diagnostic for their respective clusters.

For the analysis of the Ludlow Rd data, the same updated SCP dataset was used as for the hierarchical clustering analysis. The dataset was then analysed using Fuzzy C-Means clustering in the R package 'Vegclust'. A fuzziness coefficient of 1.1 was chosen to minimise influence from noisy data points. FCTs with too few plots to reliably define or determine a prototype (e.g. FCT 14 with two plots) were removed from the analysis. Similarly, some plots that were regularly being misclassified (such as those from clusters with large internal heterogeneity) were also removed. The final dataset consisted of 344 plots with 1316 taxa representing 38 FCTs. Each site of the Ludlow Rd data was then assigned a FCT using function 'vegclass' in the Vegclust package.

It should be noted that this approach for FCT assignment is preliminary and will need to be refined further before it can be used consistently.

2.3 Study Limitations and Survey Effort

Various factors can limit the effectiveness of a vegetation survey. Pursuant to EPA Technical Guidance: Flora and Vegetation Survey for Environmental Impact Assessment (EPA 2016), these factors have been identified and their potential impact on the effectiveness of the survey has been assessed (Table 3).

The initial survey was undertaken September 2019 and would likely have intercepted the flowering period of annuals of conservation concern with the potential to occur within the site. However, the spring of 2019 was much drier than normal, which may have affected the flowering of some species.

Table 3: Potential limitations affecting the vegetation survey

Potential limitations	Constraint	Comment
Availability of contextual information	No	Sufficient regional and local information was available to place the survey site in its environmental context.
Competency and experience of the botanists undertaking the survey	No	The survey was undertaken by botanists with a comprehensive knowledge of Swan Coastal Plain vegetation, with at least 15 years experience in vegetation surveys in Western Australia.
Seasonality	Minor	The survey was undertaken in spring 2019. The rainfall in the three months prior to the survey were well below average for the area. Maximum and minimum temperatures were approximately 1 ^o higher than the mean.
Adequate ground coverage and intensity of survey effort	No	The survey area was traversed on foot. It is considered the survey quadrats and mapping points provided adequate coverage given the degraded nature of most of the site.
Proportion of Flora identified	No	The survey recorded an estimated 77% of the plant taxa present, although this still represents fewer species than could be expected from an intact system.
Disturbance	Constrained	The area has previously been used for stock grazing and the poor condition of much of the vegetation has limited the confidence in conclusions that can be drawn regarding some of the vegetation types present.
Resources	No	Adequate resources were available to conduct the survey.
Access restrictions	No	All parts of the site were accessible

3 Results

3.1 Flora

3.1.1 Floristic Summary

A total of 61 native and 14 non-native (exotic) taxa were recorded within the site, representing 33 families and 58 genera. The dominant families containing mostly native taxa were Fabaceae (6 native taxa, 3 exotic taxa), Asteraceae (6 native taxa, 4 exotic taxa), and Orchidaceae (5 native taxa). For a complete species list and the individual site data refer to Appendix A and Appendix B, respectively.

3.1.2 Threatened and Priority Flora

No Threatened Flora pursuant to the Biodiversity Conservation Act (2016) nor the EPBC Act (1999) were recorded during the survey. One species listed as Priority Flora by the PWS was recorded during the survey. *Lasiopetalum ?membranaceum* (P3) is a low multi-stemmed shrub growing up to 1 m in height (Table 4). The uncertain identification is due to all specimens observed being sterile, but the vegetative features indicate that this is most likely the correct result.

Table 4: Locations of priority flora within the surveyed area.

Taxon Name	Abundance	Latitude	Longitude
<i>Lasiopetalum ?membranaceum</i>	1	-33.15011	115.75493
<i>Lasiopetalum ?membranaceum</i>	1	-33.15042	115.75632
<i>Lasiopetalum ?membranaceum</i>	1	-33.15049	115.75681
<i>Lasiopetalum ?membranaceum</i>	1	-33.150426	115.75702
<i>Lasiopetalum ?membranaceum</i>	1	-33.15039	115.75721
<i>Lasiopetalum ?membranaceum</i>	1	-33.15038	115.75751
<i>Lasiopetalum ?membranaceum</i>	1	-33.1504	115.75794

3.2 Vegetation

3.2.1 Plant Associations

The survey identified two plant communities within the site (Figure 2):

Eucalyptus marginata - *Banksia attenuata* woodland (Plates 1:4)

Open Woodland of *Eucalyptus marginata* and *Banksia attenuata* with *Agonis flexuosa* over *Banksia grandis* and a shrubland of *Xanthorrhoea gracilis* and *Hibbertia hypericoides* over a herbland of *Dasypogon bromeliifolius*, *Anarthria prolifera* and *Desmocladius fasciculatus* on grey sands.

Agonis flexuosa Woodland (Plate 5)

Woodland of *Agonis flexuosa* with *Eucalyptus marginata* over open shrubland of *Xanthorrhoea gracilis*, *Macrozamia riedlei* and *Hibbertia hypericoides* over a herbland of *Dasypogon bromeliifolius* in grey sands.

3.2.2 Conservation Significance

The results of the FCT assignment were inconsistent between the hierarchical clustering and non-hierarchical clustering. Much of this inconsistency is likely to be due to the high proportion of exotic species in the Wellesley Rd dataset.

The hierarchical clustering assignments indicated that Plots W01, W02 and W04 were part of FCT 21a – ‘Central *Banksia attenuata* – *Eucalyptus marginata* woodlands’, with some similarity to FCT 28 – ‘Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands’ (Appendix D). This result would be consistent with the locality and position on the Swan Coastal Plain. Plots W03 and W05 nearest fusions were with sites from FCTs 5 and 11, respectively, which are wetland community

types and are not likely correct results. These types of assignments are often seen where there is a high proportion of exotic species and low native species richness.

The non-hierarchical clustering produced different results to the hierarchical clustering and no assignment could be made with confidence (Table 5). For all plots there was little difference in strengths of memberships for the first three nearest groups, indicating an equivocal result. The influence of the high proportion of weeds is seen in the similarity to FCT 6 – ‘Weed dominated wetlands on heavy soils’.

Table 5: Results of non - hierarchical analysis for plots from the Ludlow Rd survey (Strength of membership shown in brackets).

Plot	FCT of nearest group	FCT of 2 nd nearest group	FCT of 3 rd nearest group	Possible FCT
W01	21c (18.5%)	6 (12.4%)	5 (10.2%)	undetermined
W02	6 (23.4%)	5 (11.1%)	21c (10.7%)	undetermined
W03	6 (20.8%)	5 (17.1%)	13,15,16,17 (14.2%)	undetermined
W04	6 (21.9%)	13,15,16,17 (10.7%)	29a/30a (10.2%)	undetermined
W05	29a/30a (29.0%)	6 (28.9%)	13,15,16,17 (25.9%)	undetermined

Eucalyptus marginata - *Banksia attenuata* woodland has an open overstorey with *Banksia attenuata* as a co-dominant, which is a key diagnostic characteristic for the Commonwealth-listed TEC ‘*Banksia*-dominated woodlands of the Swan Coastal Plain IBRA Region’. For this TEC to be present, the condition of the vegetation needs to be ‘Good’ or better, which is the case for the *Eucalyptus marginata* - *Banksia attenuata* woodland. as the extent of the community within the site exceeds 2 ha, it is likely that this community meets the criteria for inclusion in the ‘*Banksia*-dominated woodlands of the Swan Coastal Plain IBRA Region’ TEC.

3.2.3 Vegetation Condition

Most of the site is in an ‘Degraded’ condition or worse and retains only some of its original botanical value (Figure 3). This is mainly in the *Agonis flexuosa* woodland where the vegetation structure has been highly modified from past grazing activity, especially in the understorey, where native herbaceous species have largely been replaced by exotic species. The shrub mid-storey has also been largely lost.

The *Eucalyptus marginata* - *Banksia attenuata* woodland is rated mostly as ‘Good’ or better with much of the original vertical structure intact as well as the original shrub and tree density. The native herbaceous understorey has been somewhat modified in some areas.

3.2.4 Weeds

Fourteen of the taxa recorded during the survey are exotics (weeds). The most significant weed in the site is **Zantedeschia aethiopicum* (Arum Lily), which is a Declared Pest under the Biosecurity and Agriculture Management Act 2007.

4 Discussion

The site retains some significant botanical values including the presence of Priority Flora, a Commonwealth-listed TEC, vegetation complexes that have been significantly cleared and is situated within a regionally significant ecological linkage.

4.1 Flora

No species of Threatened Flora were recorded during the survey.

One species of Priority Flora was recorded within the site. *Lasiopetalum ?membranaceum* was recorded at seven locations within the *Eucalyptus marginata* - *Banksia attenuata* woodland. This species is ranked as Priority 3 and occurs in sand over limestone mainly from the Perth region to the Busselton area.

4.2 Plant Communities

The results of the FCT analysis indicate that the *Eucalyptus marginata* - *Banksia attenuata* woodland is part of FCT 21a 'Central *Banksia attenuata* – *Eucalyptus marginata* woodlands'. This community is not listed as conservation significant pursuant to state legislation or policy, but is part of the Commonwealth-listed TEC 'Banksia-dominated woodlands of the Swan Coastal Plain IBRA Region'. As such, impacts on this com will likely require assessment by the Commonwealth.

The *Agonis flexuosa* woodland is in a 'Degraded' condition, most likely from past grazing of the site. Due to the community's condition, it is not possible to assign a floristic community type, and therefore conservation category, with any degree of confidence. As *Agonis flexuosa* is a prominent part of the overstorey within the adjacent *Eucalyptus marginata* - *Banksia attenuata* woodland, it is possible this area also formed part of that same community. In the FCT analysis, some plots showed a similarity to plots from FCT 25 'Southern *Eucalyptus gomphocephala* – *Agonis flexuosa* woodlands' but this could also be due to the presence of *Agonis flexuosa* and a high proportion of weeds as that FCT also supports a high weed frequency (Gibson et al. 1994).

The site is located within the McLarty/ Kemerton/Twin Rivers/Preston River/Gwindinup Ecological Linkage as identified in the Greater Bunbury Region Scheme (EPA 2003). Naturally vegetated areas (in particular the larger relatively intact remnants) in the area of the linkages are priorities for retention and protection. Also, as the site is outside the constrained area as identified in the Greater Bunbury Region Scheme (EPA 2003). The two vegetation complexes mapped as occurring within the site (the Bassendean Complex – Central and South, and the Karrakatta Complex – Central and South) both have less than 30% of their original extent remaining, which may present an impediment to development.

4.3 Weeds

One weed recorded within the site is a Declared Pest pursuant to the Biosecurity and Agriculture Management Act 2007: **Zantedeschia aethiopicum*. Listing as a Declared Pest places restrictions on the importation of a species, but **Zantedeschia aethiopicum* does not require active management.

5 Summary

One species of Priority Flora was recorded within the site. *Lasiopetalum ?membranaceum* was recorded at seven locations within the *Eucalyptus marginata* - *Banksia attenuata* woodland. The vegetation condition of the site varies between 'Degraded' to 'Excellent'. The *Eucalyptus marginata* - *Banksia attenuata* woodland in the north of the site meets criteria to be considered part of the Commonwealth-listed TEC 'Banksia-dominated woodlands of the Swan Coastal Plain IBRA Region'. The site contains vegetation complexes that have been cleared extensively on the Swan Coastal Plain and is situated within a regional ecological linkage, factors that may need to be considered as part of any development and rehabilitation plans.

6 References

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Figures

Figure 1: Locality Plan Lot 5 Wellesley Road Flora and Vegetation Survey

Figure 2: Plant Communities Lot 5 Wellesley Road Flora and Vegetation Survey

Figure 3: Vegetation Condition Lot Wellesley Road Flora and Vegetation Survey



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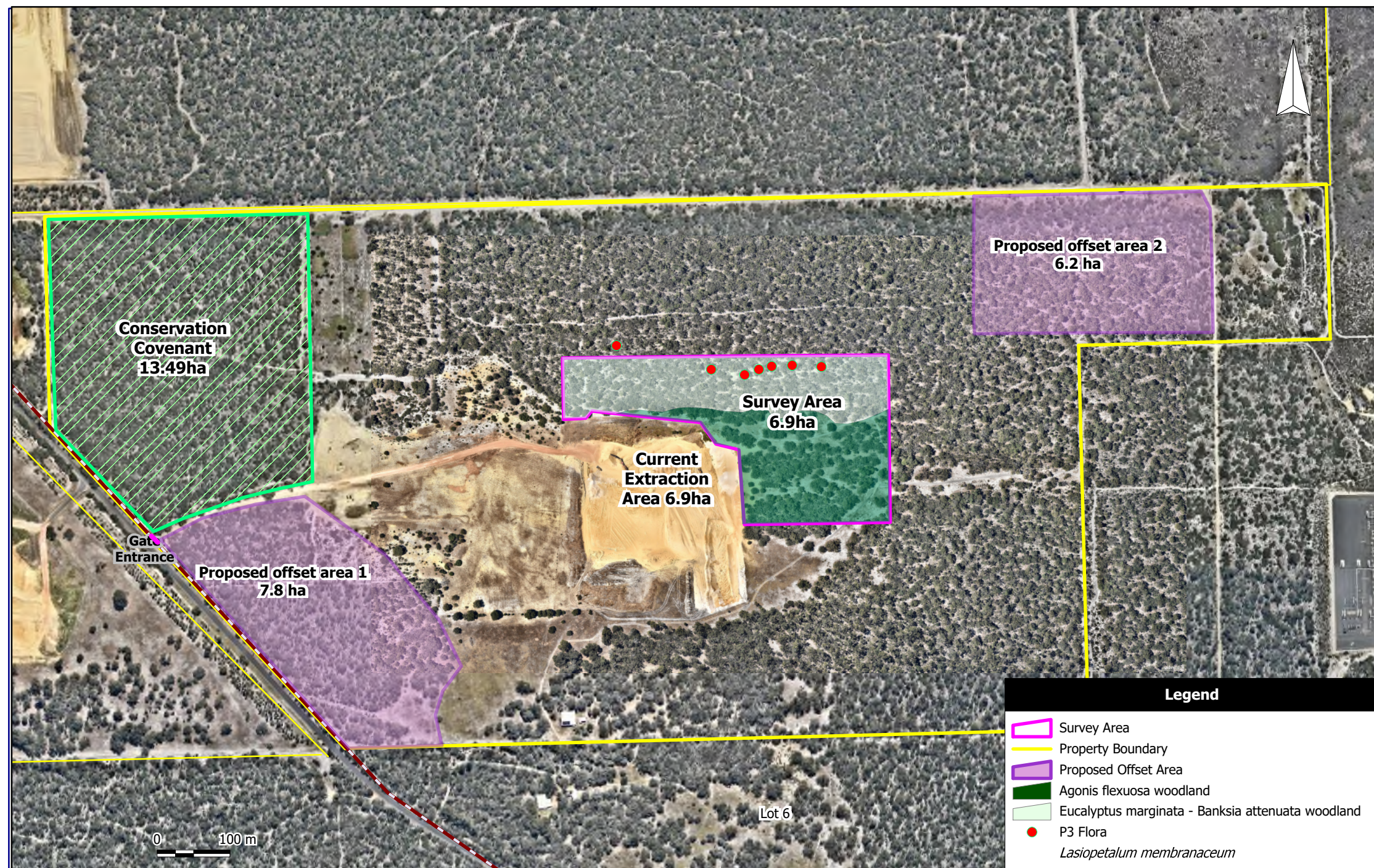
21, Sellen Court, LEEMING WA 6149
Mobile: 0417934863
Email: mikelund1@bigpond.com

Scale: 1:3100
Original Size: A4
Air Photo Date: Natmap Digital Maps 2008
Datum: World Geodetic 1984 (WGS84)

**Carbone Bros
Lot 5 Wellesley Rd
Wellesley
Sand Extraction**

Locality

Figure 1

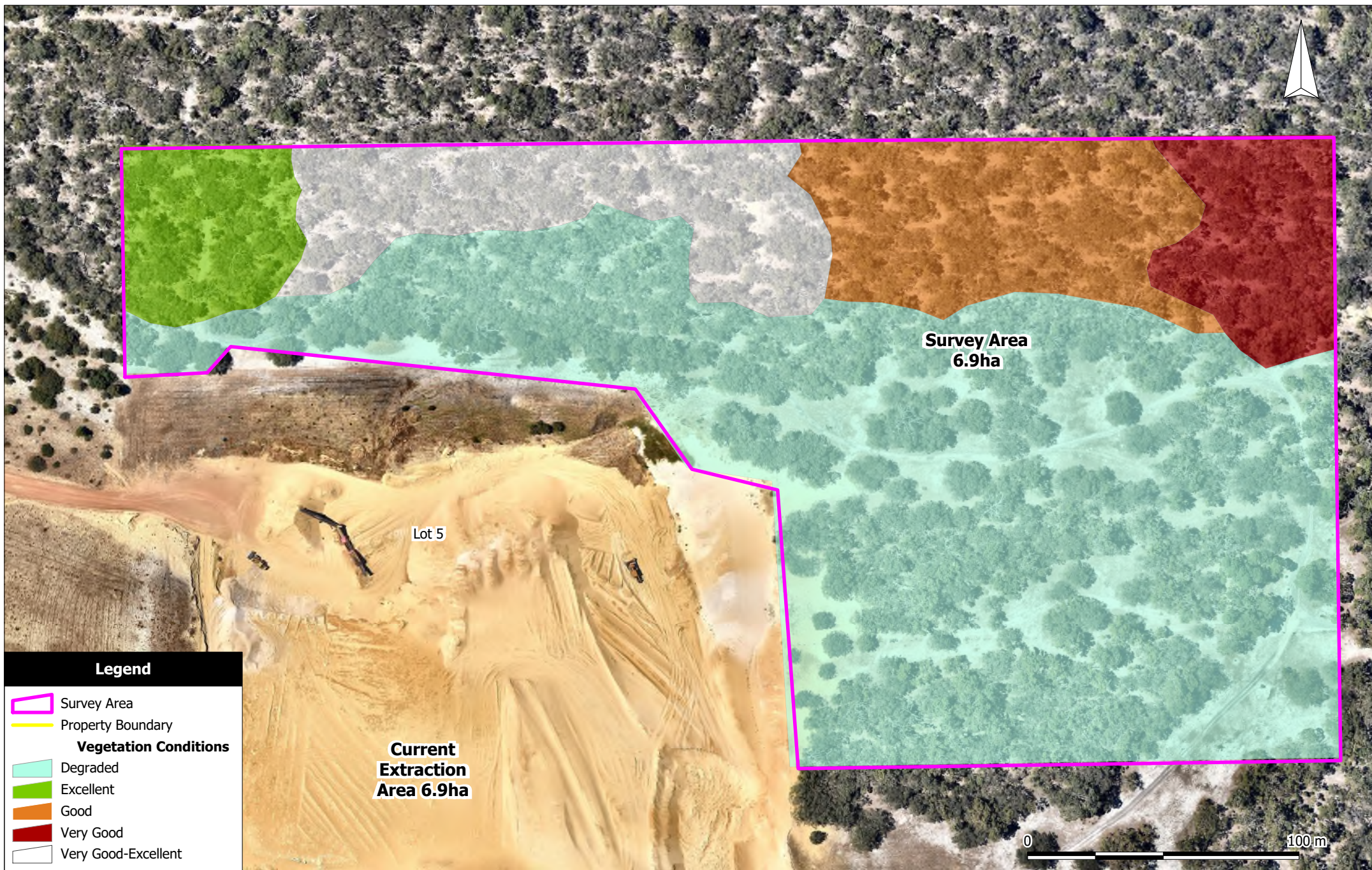


**Lundstrom Environmental
Consultants Pty Ltd**
Leeming WA 6149
Mob: 0417934863
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Scale: 1:6400
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Air Photo Date: Nearmap Dec 2019
Datum: GDA94
Projection: Australia MGA94 (50)

Client: Carbone Bros Pty Ltd
Project: Flora and Vegetation
Assessment
Location: Lot 5 Wellesley Rd
Wellesley

Figure 2
Plant Communities



**Lundstrom Environmental
Consultants Pty Ltd**
Leeming WA 6149
Mob: 0417934863
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Scale: 1:1800
Original Size: A4
Air Photo Date: Nearmap Dec 2019
Datum: GDA94
Projection: Australia MGA94 (50)

Client: Carbone Bros Pty Ltd
Project: Flora and Vegetation
Assessment
Location: Lot 5 Wellesley Rd
Wellesley

**Figure 3:
Vegetation Condition**

Plates



Plate 1: View of sampling plot W01: *Eucalyptus marginata* – *Banksia attenuata* woodland



Plate 2: View of sampling plot W02: *Eucalyptus marginata* – *Banksia attenuata* woodland



Plate 3: View of sampling plot W03: *Eucalyptus marginata* – *Banksia attenuata* woodland



Plate 4: View of sampling plot W04: *Eucalyptus marginata* – *Banksia attenuata* woodland



Plate 5: View of sampling plot W05: *Agonis flexuosa* woodland

Appendix A

List of flora recorded within the survey area

NB: * indicates introduced flora

Family	Taxon Name
Zamiaceae	<i>Macrozamia riedlei</i>
Araceae	* <i>Zantedeschia aethiopica</i>
Colchicaceae	<i>Burchardia congesta</i>
Orchidaceae	<i>Caladenia flava</i> <i>Caladenia reptans</i> subsp. <i>reptans</i> <i>Elythranthera brunonis</i> <i>Pterostylis</i> sp. crinkled leaf (G.J. Keighery 13426) <i>Pyrorchis nigricans</i>
Xanthorrhoeaceae	<i>Chamaescilla corymbosa</i> <i>Xanthorrhoea gracilis</i>
Asparagaceae	<i>Lomandra caespitosa</i> <i>Lomandra sericea</i> <i>Sowerbaea laxiflora</i>
Hemerocallidaceae	<i>Caesia micrantha</i>
Haemodoraceae	<i>Conostylis aculeata</i> <i>Conostylis juncea</i>
Dasypogonaceae	<i>Dasypogon bromeliifolius</i>
Cyperaceae	<i>Isolepis marginata</i> <i>Lepidosperma squamatum</i> <i>Lepidosperma tetraquetrum</i>
Anarthriaceae	<i>Anarthria prolifera</i> <i>Lyginia imberbis</i>
Restionaceae	<i>Desmocladius fasciculatus</i> <i>Desmocladius flexuosus</i> <i>Hypolaena exsulca</i>
Poaceae	* <i>Briza maxima</i> * <i>Briza minor</i> * <i>Ehrharta longiflora</i>
Ranunculaceae	<i>Clematis pubescens</i>
Proteaceae	<i>Banksia attenuata</i> <i>Banksia grandis</i> <i>Petrophile linearis</i>

Family	Taxon Name
Dilleniaceae	<i>Hibbertia hypericoides</i> <i>Hibbertia racemosa</i>
Crassulaceae	<i>Crassula colorata</i> var. <i>colorata</i> <i>Crassula exserta</i>
Fabaceae	<i>Bossiaea eriocarpa</i> <i>Daviesia divaricata</i> subsp. <i>divaricata</i> <i>Daviesia physodes</i> <i>Hardenbergia comptoniana</i> <i>Isotropis cuneifolia</i> <i>Kennedia prostrata</i> * <i>Trifolium campestre</i> var. <i>campestre</i> * <i>Trifolium repens</i> var. <i>repens</i> * <i>Trifolium subterraneum</i>
Elaeocarpaceae	<i>Tetradlea hirsuta</i> subsp. <i>viminea</i>
Phyllanthaceae	<i>Phyllanthus calycinus</i>
Violaceae	<i>Hybanthus calycinus</i>
Geraniaceae	* <i>Geranium molle</i>
Myrtaceae	<i>Agonis flexuosa</i> <i>Eucalyptus marginata</i>
Rutaceae	<i>Philothea spicata</i>
Malvaceae	<i>Lasiopetalum ?membranaceum</i> (P3)
Droseraceae	<i>Drosera ?pallida</i> <i>Drosera erythrorhiza</i> <i>Drosera pallida</i> <i>Drosera stolonifera</i>
Primulaceae	* <i>Lysimachia arvensis</i>
Ericaceae	<i>Leucopogon ?capitellatus</i> <i>Leucopogon propinquus</i>
Rubiaceae	* <i>Galium murale</i> <i>Opercularia echinocephala</i>
Lamiaceae	<i>Hemiandra pungens</i>

Family	Taxon Name
Stylidiaceae	<i>Stylidium piliferum</i>
Asteraceae	<ul style="list-style-type: none"> * <i>Arctotheca calendula</i> * <i>Cotula turbinata</i> <i>Craspedia variabilis</i> <i>Hyalosperma cotula</i> * <i>Hypochaeris glabra</i> <i>Lagenophora huegelii</i> <i>Quinetia urvillei</i> <i>Senecio</i> sp. * <i>Ursinia anthemoides</i>
Araliaceae	<i>Trachymene pilosa</i>

Appendix B

Site x species matrix of flora recorded within plots in the survey area.

Taxon Name	W01	W02	W03	W04	W05
<i>Agonis flexuosa</i>	15	4	7	15	30
<i>Anarthria prolifera</i>	0.1	0.1	0.1	0.1	0
<i>Arctotheca calendula</i>	0	0	0	0	0.2
<i>Caesia micrantha</i>	0.1	0.1	0	0.1	0
<i>Banksia attenuata</i>	4	0	7	0	0
<i>Banksia grandis</i>	0.5	0	0.3	0	0
<i>Briza maxima</i>	0.1	0.1	0	0.1	0
<i>Briza minor</i>	0	0	0.1	0	0
<i>Burchardia congesta</i>	0.1	0.1	0.1	0.1	0
<i>Caladenia flava</i>	0.1	0.1	0.1	0.1	0.1
<i>Caladenia reptans</i> subsp. <i>reptans</i>	0	0	0	0	0.1
<i>Chamaescilla corymbosa</i>	0.1	0.1	1	0	0
<i>Clematis pubescens</i>	0	0.2	0	0	0
<i>Trifolium subterraneum</i>	0	0	0	0	0.1
<i>Conostylis aculeata</i>	0.1	0.1	0	0	0
<i>Conostylis juncea</i>	0	0.1	0	0.1	0
<i>Craspedia variabilis</i>	0.1	0.1	0	0	0
<i>Crassula colorata</i> var. <i>colorata</i>	0	0	0.1	0	0.1
<i>Crassula exserta</i>	0	0	0	0.1	0.1
<i>Cotula turbinata</i>	0	0	0	0	0.1
<i>Dasypogon bromeliifolius</i>	0.1	0.2	1	1	0
<i>Daviesia divaricata</i> subsp. <i>divaricata</i>	0.3	0.2	0	0	0
<i>Daviesia physodes</i>	0	0.5	0	0	0
<i>Desmocladus fasciculatus</i>	0.1	0.1	0.1	0.1	0
<i>Desmocladus flexuosus</i>	0	0.1	0.1	0.1	0
<i>Drosera erythrorhiza</i>	0.1	0.1	0.1	0	0
<i>Drosera pallida</i>	0	0	0	0.1	0
<i>Drosera stolonifera</i>	0.1	0.1	0.2	0.1	0
<i>Ehrharta longiflora</i>	0	0	0	0	2
<i>Elythranthera brunonis</i>	0	0	0	0.1	0
<i>Geranium molle</i>	0	0	0	0	0.1
<i>Eucalyptus marginata</i>	12	10	0	4	0
<i>Hardenbergia comptoniana</i>	0.1	0.1	0.1	0.1	0.1
<i>Hemianandra pungens</i>	0.1	0	0	0	0
<i>Hibbertia hypericoides</i>	1	0.3	0.2	0.2	0
<i>Hibbertia racemosa</i>	0.1	0.1	0	0.2	0
<i>Hybanthus calycinus</i>	0.1	0.1	0	0	0
<i>Hypochaeris glabra</i>	0.1	0.1	0.1	0	0.1
<i>Hypolaena exsulca</i>	0	0.2	0	0	0
<i>Isolepis marginata</i>	0	0	0	0.1	0
<i>Isotropis cuneifolia</i>	0.1	0.1	0.1	0.1	0
<i>Kennedia prostrata</i>	0	0.2	0	0.1	0
<i>Lagenophora huegelii</i>	0.1	0.1	0.1	0.1	0
<i>Lepidosperma squamatum</i>	0	0	0	0.1	0
<i>Lepidosperma tetraquetrum</i>	0.1	0.1	0.1	0.1	0.1
<i>Leucopogon propinquus</i>	0.2	0	0.3	0	0.1
<i>Galium murale</i>	0	0	0	0	0.1
<i>Hyalosperma cotula</i>	0.1	0.1	0	0	0
<i>Lomandra sericea</i>	0	0	0	0.1	0
<i>Lomandra caespitosa</i>	0.1	0	0.1	0	0
<i>Lyginia imberbis</i>	0	0	0	0.1	0
<i>Lysimachia arvensis</i>	0.1	0	0	0	5
<i>Macrozamia riedlei</i>	0.5	0	0	0.9	0.3
<i>Opercularia echinocephala</i>	0.1	0.1	0	0.1	0
<i>Petrophile linearis</i>	0.1	0	0	0	0
<i>Philothea spicata</i>	0	0.3	0	0	0
<i>Phyllanthus calycinus</i>	0	0	0	0.3	0
<i>Pterostylis</i> sp. crinkled leaf (G.J. Keighery 13426)	0	0	0	0.1	0.1
<i>Pyrorchis nigricans</i>	0.1	0	0	0	0
<i>Quinetia urvillei</i>	0.1	0	0.1	0	0
<i>Sowerbaea laxiflora</i>	0.1	0.1	0.1	0.1	0
<i>Stylidium piliferum</i>	0.1	0	0	0	0
<i>Leucopogon propinquus</i>	0	0	0.2	0	0
<i>Trachymene pilosa</i>	0.1	0.1	0.1	0.1	0
<i>Trifolium campestre</i> var. <i>campestre</i>	0	0	0	0	0.1
<i>Trifolium repens</i> var. <i>repens</i>	0	0	0.1	0	0
<i>Ursinia anthemoides</i>	0.1	0.1	0.1	0.1	0.1
<i>Xanthorrhoea gracilis</i>	5	5	5	6	0
<i>Zantedeschia aethiopica</i>	0.1	0.1	0	0	0
<i>Tetratheca hirsuta</i> subsp. <i>viminea</i>	0	0	0	0.1	0

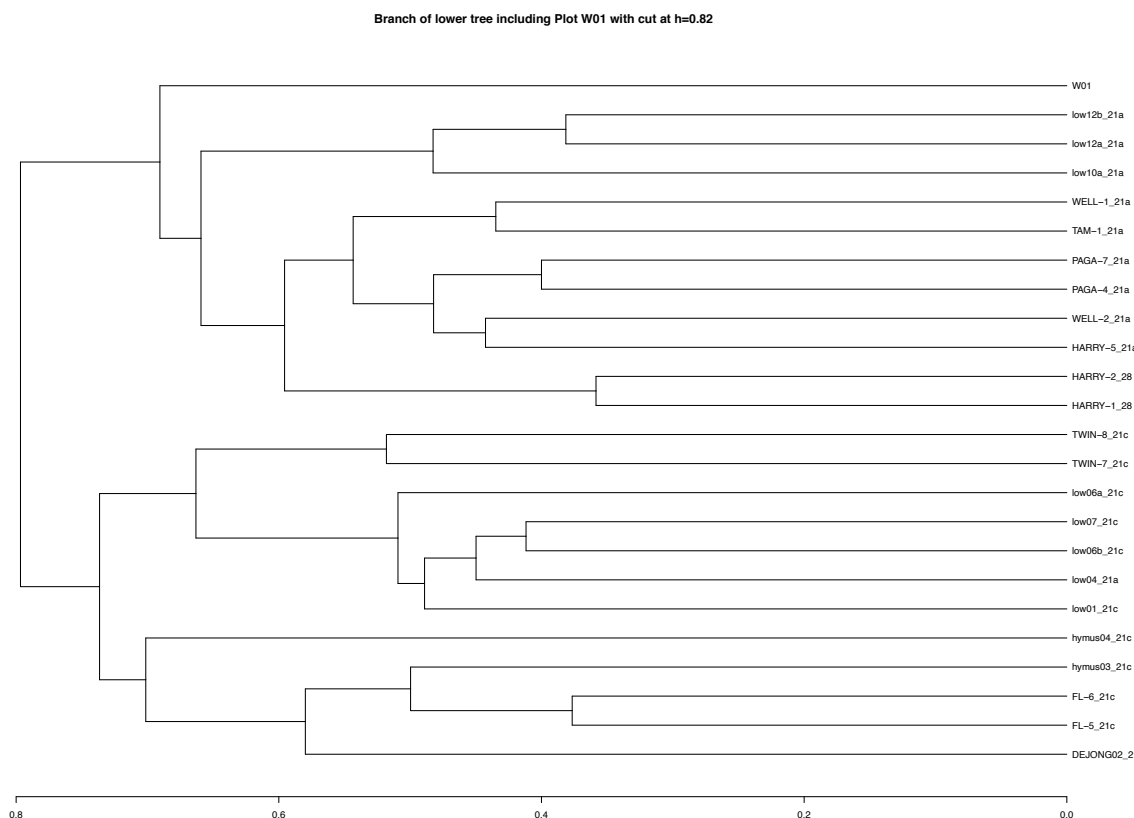
Appendix C

Sampling plot environmental data

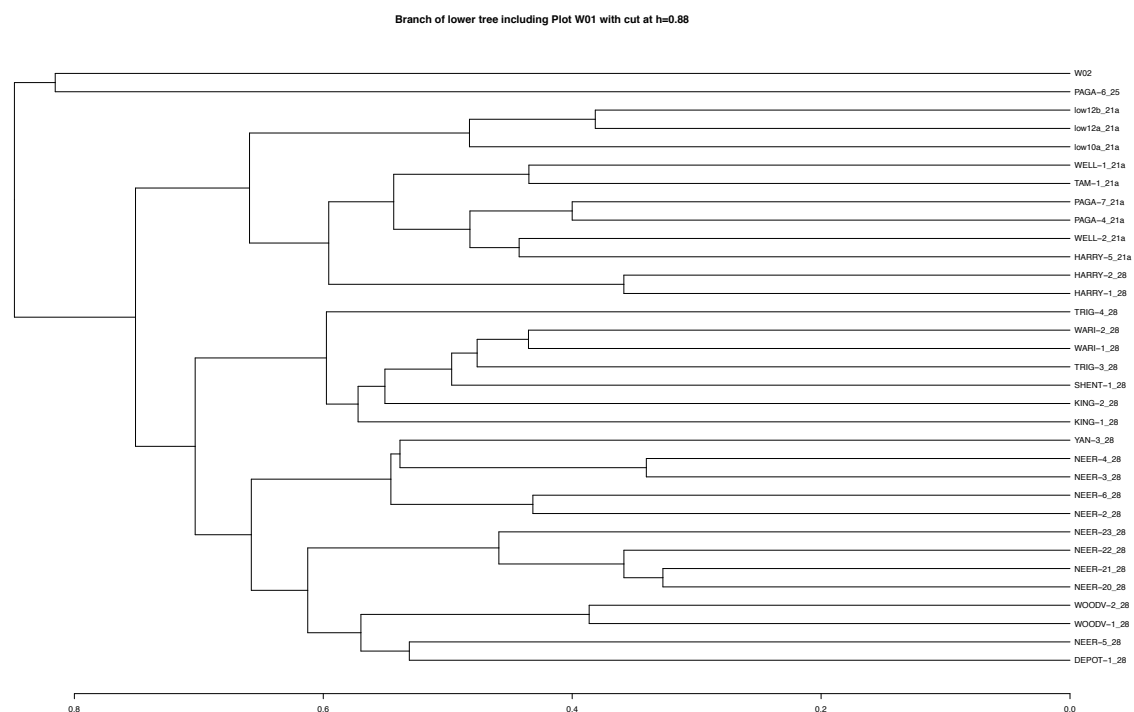
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Aspect (classes)	W	S	N/A	S	SE
Slope (°)	4	3	0	2	2
Plot Shape	Quadrat	Quadrat	Quadrat	Quadrat	Quadrat
Plot Size (m ²)	100	100	100	100	100
Plot Width (m)	10	10	10	10	10
Plot Length (m)	10	10	10	10	10
Placement strategy	Preferential	Preferential	Preferential	Preferential	Preferential
Date	24/9/19	24/9/19	24/9/19	24/9/19	24/9/19
Time since fire	>10	>10	>10	>10	>10
Bare Ground (%)	20	5	50	3	2
Bare Rock (%)	0	N/A	N/A	N/A	N/A
Litter (%)	70	70	35	85	75
Landform	mid slope	upper slope	crest	crest	upper slope
Soil Colour	Grey	grey	grey	grey	grey
Soil Texture	Sand	Sand	sand	sand	sand
Rock Outcrop Type	N/A	N/A	N/A	N/A	N/A
Vegetation Condition	Very good	Excellent	Good	Good- Very good	Degraded - Good
Cover Trees (%)	20	20	20	25	30
Cover Shrubs (%)	10	6	10	10	0.3
Cover Ground Layer (%)	10	8	5	10	15

Appendix D

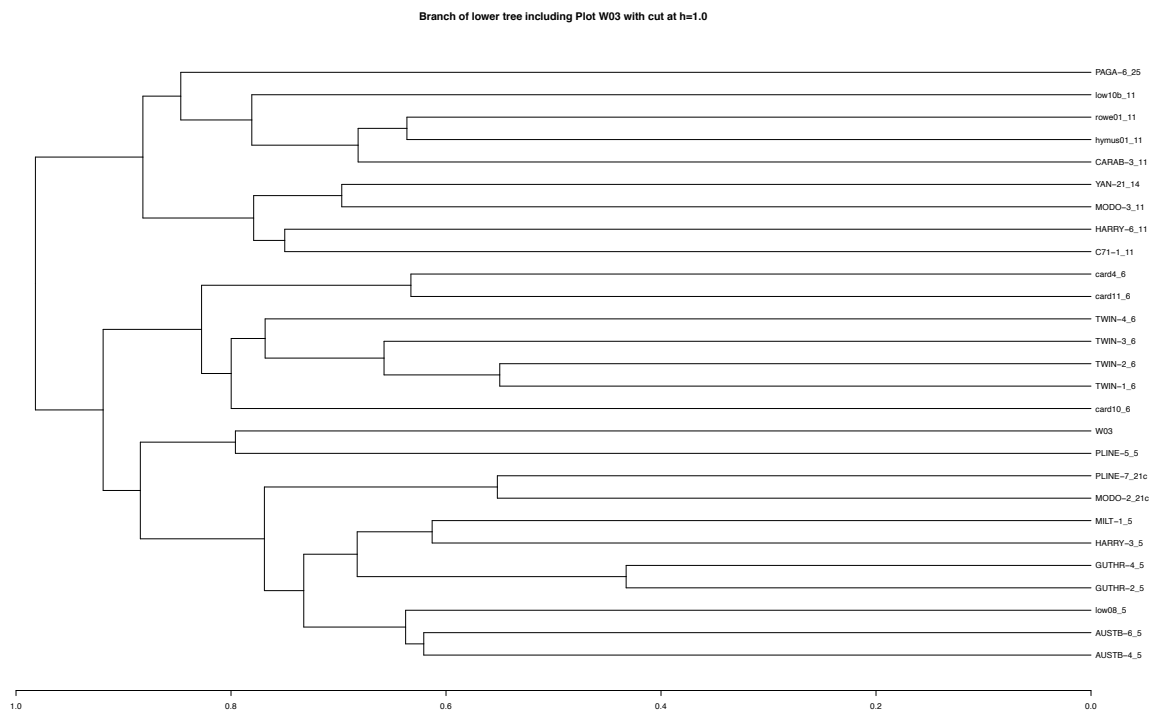
Partial dendrograms from hierarchical clustering assignment of plot floristics to the Swan Coastal Plain classification (Gibson et al. 1994)



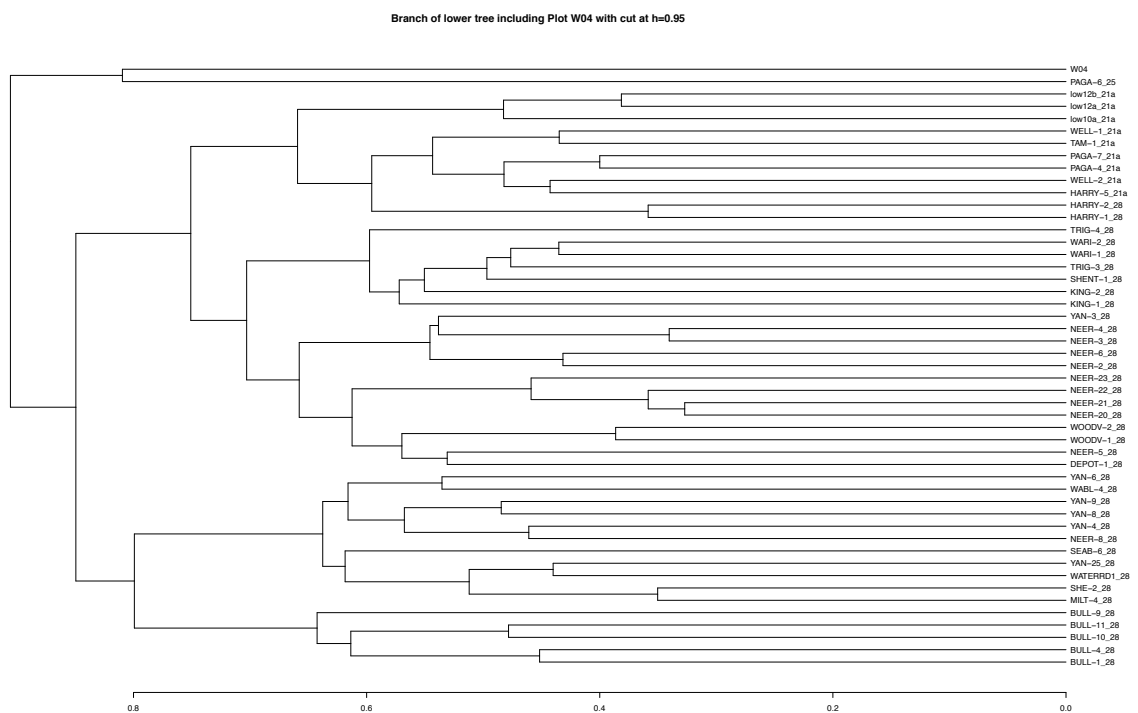
Partial Dendrogram for Plot W01



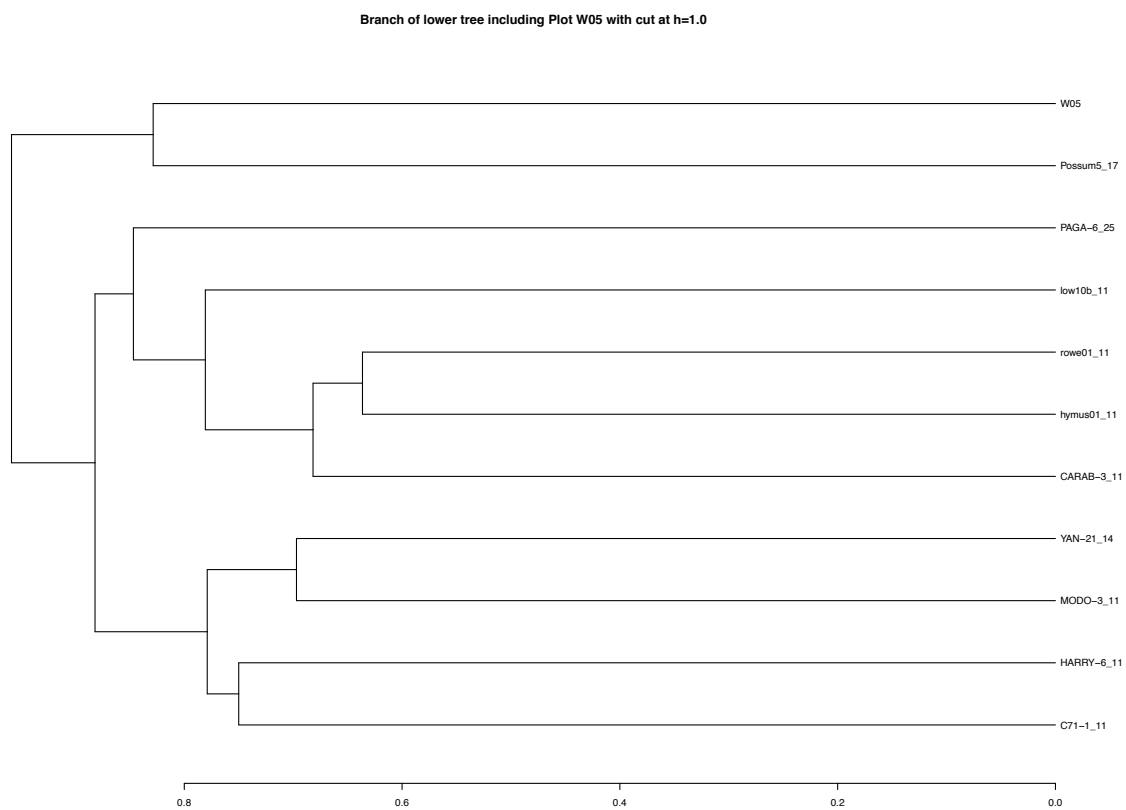
Partial Dendrogram for Plot W02



Partial Dendrogram for Plot W03



Partial Dendrogram for Plot W04



Partial Dendrogram for Plot W05

Appendix E

Definitions of Threatened and Priority Flora and Communities



CONSERVATION CODES

For Western Australian Flora and Fauna

Specially protected fauna or flora¹ are species² which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

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 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) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct 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 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.

¹ The definition of flora includes algae, fungi and lichens

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

DEFINITIONS, CATEGORIES AND CRITERIA FOR THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1. GENERAL DEFINITIONS

Ecological Community

A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or “vulnerable”.

Possible threatened ecological communities that do not meet survey criteria are added to DEC’s Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities 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, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:

“An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts.”

Community structure is defined as follows:

“The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage” (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: “changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a

direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention.”

Destruction: “modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention.”

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be brought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:

“Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community.”

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE 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 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.

C) 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 (within approximately 50 years) 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.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community List under priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of $\leq 100\text{ha}$). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of $\leq 200\text{ha}$). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: 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 with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), 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, inappropriate fire regimes, clearing, hydrological change etc.

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 a higher threat category.
- (iii) Ecological communities that have been removed from the list of threatened communities 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.