

Flora Survey and Fauna Habitat Assessment,
Proposed Sand Quarry, Jandabup

Holcim (Australia) Pty Ltd

H04 – J06

14 September 2015





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REPORT DETAILS

Project Number: H04 – J06	
Report Name: Flora Survey and Fauna Habitat Assessment, Proposed Sand Quarry, Jandabup	
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AUTHORISATION FOR ISSUE

Report Version Date			
Author Review	Name: Stephen Connell	Signature: 	Date: 11/09/2015
Approved for Issue Director	Name: Laura Todd	Signature: 	Date: 14/09/2015

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EXECUTIVE SUMMARY

Holcim (Australia) Pty Ltd proposes to establish a sand quarry in an area approximately 2 km South East of Pinjar, Western Australia. The vegetation within this area includes Banksia – Melaleuca Woodlands, *Pinus pinaster* plantation and areas of regrowth previously covered by pine plantation which has been cleared. As part of the approvals process a flora study, involving database searches, a desktop review and on-site floristic surveys, was undertaken in Autumn and Spring 2015 (field visits occurred 13th May, 7th, 8th and 10th September) in accordance with Environmental Protection Authority (EPA) Guidance Statement Number 51 (2004) *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*.

The surveys involved traversal of the study area during which plant specimens were collected for later identification. Field studies focused on determining the type of plant communities present, compilation of comprehensive plant species lists, assessment for threatened and priority flora and description of fauna habitat. Mapping of native vegetation was based on aerial photograph interpretation with the field studies providing details of community floristics and structure. Fauna habitat assessment involved determination of the range of habitats present and assessment of potential nesting and shelter locations (e.g. nests, hollows, burrows, fallen tree limbs, etc.) and food resources.

The study area is located within the banksia woodland belt of the Swan Coastal Plain (SCP). Areas of native vegetation were cleared approximately 85 years ago to establish the Gnangara Pine Plantation. Most of the area making up the tenement was harvested recently, as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Environment and Conservation and Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009).

Two native vegetation community types were identified locally:

- The first community (a low woodland of *Banksia attenuata* – *Banksia menziesii* in degraded-very good ecological condition) occurs in small uncleared southern sections of the tenement outside the proposed clearing footprint. The community occupies 24.8ha and is most similar floristically to SCP23a Central *Banksia attenuata*-*Banksia menziesii* Woodlands
- The second community (open woodland of *Eucalyptus rudis* over a low woodland of *Melaleuca preissiana* over wetlands in degraded-good ecological condition) is found as a small area (20ha) of wetland vegetation on seasonally wet sands near the eastern edge of the tenement, outside the proposed clearing footprint. It is most similar floristically to SCP4 *Melaleuca preissiana* Woodlands.

It is understood that the proposed exploration and future quarry will not result in any clearing of the above two native vegetation communities. Much of the survey area consists of cleared pine plantation (424 ha). One small area of Pine plantation remains (11 ha). It is understood that the proposed quarry activities will be limited to occurring within the old pine plantation areas. The native plant communities present within the study area range from degraded to very good in condition while within the pine and cleared areas ecological condition was assessed as completely degraded-degraded.

No Threatened or Priority Ecological Communities (TEC's/PEC's) were identified within the study area via the Department of Parks and Wildlife (DPAW) database search or through field visits – this is to be expected given the study area is predominantly cleared pine plantation. The native plant communities present (SCP4 and SCP23a) are not considered to be at risk and are well conserved.

155 native plant species representing 110 genera and 39 families were recorded within the study area. The most common plant families included Proteaceae, Myrtaceae and Fabaceae. Species of *Eucalyptus*, *Banksia*, *Melaleuca* and *Nuytsia floribunda* dominate the tree and taller shrub flora while Myrtaceae and Fabaceae species are most common within the lower shrubs. *Macrozamia fraseri* and *Xanthorrhoea preissii* occur

occasionally. The ground flora is species rich with Cyperaceae, Haemodoraceae and Asteraceae being the most common. Weeds were extensive in the Pine Plantation and cleared areas; 61 species being recorded.

No conservation significant plant taxa were recorded within the study areas.

No threatened or priority fauna were observed. Fauna habitat within the study area is limited due to the sparse nature of the understorey and small stature of the re-growth/rehabilitated vegetation.

Given the proposed exploration and future quarry disturbance is limited to pine plantation areas, no native vegetation clearing will occur. Provided appropriate environmental management controls are put in place, the proposed quarry is unlikely to have a significant impact on flora, vegetation and fauna habitat values in the area. Proposed clearing is unlikely to be at variance with the 10 Clearing Principles, as listed under Schedule 5 of the *Environment Protection Act (1986)* (EP Act).

1 INTRODUCTION

Holcim Australia proposes to establish a sand quarry in an area approximately 2 km south east of Pinjar (Figures 1 and 2). Initial exploratory drilling is proposed to be conducted as shown in Figures 3 and 4.

As part of the approvals process for initial exploratory drilling and the future quarry, a flora study is required to determine the nature of the vegetation present and the presence of threatened species / communities and significant fauna habitat.

The objectives of the survey were to:

- Develop an inventory of the flora occurring within the survey area and to determine the presence of any flora of conservation significance.
- Undertake an assessment of vegetation communities and fauna habitat present, their condition and potential conservation significance.
- Provide an assessment of the potential impacts of activity to flora and vegetation in the areas surveyed.
- Provide a statement against the 10 Clearing Principles, as listed under Schedule 5 of the EP Act.

2 METHODS

The potentially significant species and associations of flora expected to occur within the vicinity of the project area were identified and compiled by searching Department of Parks and Wildlife (DPaW) databases using a 10 x 10 km (x,y) search buffer for flora and fauna species around the clearing footprint. Databases searched included the following:

- The Threatened Flora Database.
- The Threatened Fauna Database.
- The WA Herbarium.
- The Declared Rare Flora and Priority Flora List.
- The Threatened and Priority Ecological Community Database.

The on-site floristic survey was undertaken in Autumn and Spring (visits occurred 13th May, 7th, 8th and 10th September) in accordance with Environmental Protection Authority (EPA) Guidance Statement Number 51 (2004) *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*.

The surveys involved traversal of the study area during which plant specimens were collected for later identification. During traversal, particular attention was paid to determining the extent of Rare and Priority species and, if found, the status of any populations of these species. Plant specimens were identified and verified using the resources of the State Herbarium and on-line State Herbarium database 'Florabase'.

Floristic community types are assemblages as defined by Gibson *et al.* (1994). The presence or absence of individual taxa in standard areas (quadrats) is used to define floristic groupings (or community types) based on shared species. A total of eight 100 m² floristic quadrats were established within the native vegetation and cleared portions of the study area. Within each quadrat all plant species were identified and their cover determined. Mapping of plant communities was based on aerial photograph interpretation with the field studies providing details of community floristics and structure. Ecological condition was assessed according to Keighery (1994). The vegetation condition rating scale used is included as Appendix A. Plant structural formation definitions follow Muir (1977) as outlined in Appendix B.

Vegetation was mapped at the community level and is based on floristics and land systems as per EPA Guidance Statement No. 51 (EPA 2004). The 8 study quadrats were compared statistically against the 1098 quadrats of the Swan floristic database available from Naturemap. This database combines the results of a number of floristic studies conducted on plant communities of the IBRA Swan Coastal Plain Bioregion south of the Moore River (Keighery *et al.* 2012). It incorporates the studies by Gibson *et al.* (1994) and various quadrats established by Perth Biodiversity Project and others. Quadrats were classified by creating a dendrogram based on Sorensen's index of similarity (equivalent to Bray-Curtis index, with species presence-absence data only). The dendrogram was created using the Group Average Method ('UPGMA'), implemented in Primer v6 (Clarke and Gorley 2006, Legendre & Legendre 2012). It should be noted that the comparative Swan dataset does not include cover information. Hence only binary (species presence/absence) comparison is possible.

Fauna habitat assessment involved determination of the extent, type and quality of the vegetation present, including the presence and extent of plants known to be used by black cockatoos. The habitat assessment included searching for signs of use by black cockatoos. Signs of use include suitable nest hollows, feeding signs or feeding debris, and sighting records. The presence of cockatoo droppings and feathers, or 'chewed' banksia or pine cones or marri nuts, can indicate feeding by black cockatoos (including, if possible, the identification of bite patterns to indicate which black cockatoo species fed there).

All maps and data are in GDA94 Zone 50 coordinates.

3 ASSESSMENT OF CONSERVATION SIGNIFICANCE

The conservation status of both flora and fauna species is assessed under Commonwealth and State legislation such as the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999 and the *WA Wildlife Conservation Act 1950* (WC Act). The significance levels for species used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources. The WC Act uses a set of Schedules but also classifies species using IUCN categories.

In Western Australia, the Department of Environment and Regulation (DER) has also produced a supplementary list of Priority Flora and Fauna, being species that are not considered threatened under the WC Act but for which there is cause for concern. Some priority species however are also assigned an IUCN Conservation category. The following levels of conservation significance are recognised in this report.

WA Wildlife Conservation Act (1950) Classification

Under the WC Act, specially protected species are listed under one of four schedules:

- Schedule 1 – Species that are rare or likely to become extinct. Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection. Species listed under Schedule 1 are also referred to as Threatened Species for fauna or Declared Rare Flora (DRF) for flora.
- Schedule 2 – Species that are presumed to be extinct. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
- Schedule 3 – Birds protected under an international agreement.
- Schedule 4 – Other specially protected fauna.

IUCN Classifications

The DPaW in WA also classifies species into one of five IUCN categories:

- Extinct (EX) - also listed on Schedule 2 above.
- Extinct in the wild (EW) - also listed on Schedule 1 above.
- Critically endangered (CR) - also listed on Schedule 1 above.
- Endangered (EN) - also listed on Schedule 1 above.
- Vulnerable (VU) - also listed on Schedule 1 above.

These categories are determined by the total distribution of the species, and not just their distribution within WA.

Priority Species

If a species does not meet the criteria for listing as Threatened Fauna or DRF (e.g. due to lack of information) and is poorly known and/or conservation dependent, it may then be classified as Priority species. Priority species are placed into one of five categories of priority and are managed by DPaW accordingly.

- Priority One: Taxa with few, poorly known populations (generally <5) on threatened lands.
- Priority Two: Taxa with few, poorly known populations (generally <5) on conservation lands (at least some of which are not believed to be under immediate threat).
- Priority Three: Taxa with several, poorly known populations, some on conservation lands (at least some of which are not believed to be under immediate threat).
- Priority Four: Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

- Priority Five: Taxa that are conservation dependent (i.e. their conservation status is dependent on ongoing active management).

In summary the following categories (Table 1) and criteria are used to define the status of species at international, national and state levels and where relevant have been used within this report.

Table 1: Categories Used to Define the Conservation Status of Species.

Level	Governing Body, Legislation (if relevant)	Conservation Categories
International	International Union for Conservation of Nature and natural resources (IUCN)	Extinct (EX) Extinct in the Wild (EW) Critically Endangered (CR) Endangered (EN) Vulnerable (VU) Near Threatened (NT) Least Concern (LC) Data Deficient (DD) Not Evaluated (NE)
National	Commonwealth Department of Environment (DoE), EPBC Act	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent
State of WA	DPaW, WC Act	Threatened Fauna/DRF (Schedule 1) Extinct in the Wild Critically Endangered Endangered Vulnerable Extinct (Schedule 2) Schedule 3 (Fauna) Birds protected under an international agreement Schedule 4 (Fauna)
State of WA	DPaW supplementary priority list (not listed under legislation)	Priority species: Priority One Priority Two Priority Three Priority Four Priority Five

4 RESULTS

The study area is located within the banksia woodland belt of the Swan Coastal Plain (SCP). Areas of the tenement were cleared approximately 85 years ago to establish the Gnangara Pine Plantation. Some sections of the plantation have been harvested recently as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Environment and Conservation and Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009).

4.1 PRE-EUROPEAN VEGETATION

The study area is found over three pre-european vegetation complexes as mapped by Heddle *et al.* (1980), see Table 2 and Figure 1. These complexes are broadly circumscribed and include a range of vegetation communities.

Table 2: Circa 1997 Aerial Extent of the Associated Vegetation Complex in the Swan Coastal Plain (Heddle *et al.* 1980, BushForever 2000, del Marco *et al.* 2004))

Name	Description	Original Extent (ha)	Extent (1997) (ha)
Bassendean Complex–North	Low open forest and low woodland of <i>Banksia</i> spp.- <i>Eucalyptus tottiana</i> to a low woodland of <i>Melaleuca</i> spp. and sedgeland in moister areas.	74,147	53,384 (72%)
Bassendean Complex–North Transition	Low open forest and low woodland of <i>Banksia</i> spp.- <i>Eucalyptus tottiana</i> differing from Bassendean Complex–North in understory floristics	17,675	16,308 (92%)
Pinjar	Woodland of <i>Banksia</i> spp. – <i>Eucalyptus marginata</i> on dune slopes to a woodland of <i>E. rudis</i> – <i>Melaleuca preissiana</i> and sedgeland in depressions.	4,893	1,294 (26%)

The composition of the native species flora within the study area is consistent with Bassendean Complex–North and Bassendean Complex–North Transition descriptions. Plant communities mapped across the study area are shown in Figure 3 and described below.

4.2 WETLANDS

Categorisation of wetlands has been undertaken by Hill *et al.* (1996) for the SCP into a series of “Geomorphic Wetlands” as follows:

- “Conservation Category Wetlands” are those which support high levels of ecological attributes and hydrologic functions.
- “Resource Enhancement Wetlands” are those that have been partly modified but still support substantial functions and attributes.
- “Multiple Use Wetlands” are classified as those wetlands with few ecological attributes but which still provide important hydrologic functions.

A wetland may be classed as Conservation category if it:

- Is a representative wetland type (i.e., representative of its consanguineous suite).
- Exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting).
- Is an important breeding, feeding or watering site for migratory populations (local and international).
- Exhibits unaltered wetland vegetation and fauna.

Jandabup Lake is located approximately 500 m to the west of the proposed quarry (Figure 1). Water levels in this lake have been artificially maintained in summer since 1999 with water from the Leederville confined aquifer in order to prevent recurring acidification events (Sommer, 2007). In fact all of the monitored Bassendean wetlands on the Gnangara mound are now acidic (Clark, J; Horwitz, P, 2005), apart from Lake Jandabup. The reason for the acidification of the Bassendean wetlands is likely to be the steadily dropping groundwater table, combined with the low buffering capacity of the leached sandy sediments. Lake Jandabup has been impacted by drought and acidification. Monitoring detected serious impacts on aquatic macroinvertebrate community structure (including local extinctions) at Lake Jandabup following the prolonged summer drought of 1997/1998 (Sommer & Horwitz, 2001). The Lake and the surrounding area is a Nature Reserve and listed on the Register of the National Estate (RNE), being an important drought refuge for diverse populations of water birds (Department of the Environment, Water, Heritage and the Arts, 2012).

Hawkins Road Swamp is located immediately north of Tenement M70/1248 and will not be directly disturbed. It is in degraded ecological condition, and is used as a horse exercise area by neighbours, which is supported by the numerous tracks circling the swamp visible on aerial photography.

Both Jandabup Lake and Hawkins Road Swamp described above are classed as Conservation Category under the Geomorphic Wetlands Classification system.

An un-named Resource Enhancement wetland occurs in part on Tenement M70/1250 (Figure 1).

It is understood that the proposed quarry will maintain a buffer distance of 100 m from all naturally vegetated geomorphic wetlands.

4.3 DRAINAGE

Local topography slopes towards the wetlands.

There are no significant surface drainage lines or creeks within 5 km of the proposed quarry. Therefore all runoff is assumed to be via shallow dispersed flow.

The shallow geology of the project area consists predominantly of Bassendean sands. High infiltration is therefore expected. The lack of visible surface channelisation suggests that percolation of rainfall to groundwater is more significant than surface runoff.

4.4 CONSERVATION AREAS

A number of Bush Forever sites occur locally (Figure 1). Bush Forever Sites 141, 146 and 399 occur entirely or partly within the study area as shown in Figure 1. Summary descriptions of these Bush Forever Sites are detailed below (Government of Western Australia, 2000). It is understood that the proposed quarry will maintain a buffer distance of 50 m from all Bush Forever Sites.

BushForever Site 141 146: NUMBAT ROAD BUSHLAND, MARIGINIUP

Sites 141 and 146 are part of proposed Gngangara Park, State Forest 65. Floristic Community Types have not been assessed. Structural Units present include uplands of: *Banksia attenuata*, *B. ilicifolia*, *B. menziesii* Low Woodland; *Banksia menziesii*, *B. attenuata* Low Open Woodland. Wetlands include *Melaleuca preissiana* Low Open Forest over *Astartea* aff. *fascicularis* Open Shrubland; *Melaleuca preissiana* Low Open Woodland. Vegetation Condition is >40% Excellent, >40% Very Good, <15% Good, with areas of severe localised disturbance. There is no adjacent native vegetation.

BushForever Site 324: JANDABUP LAKE AND ADJACENT BUSHLANDS, JANDABUP/MARIGINIUP

Part of proposed Gngangara Park. Floristic Community Types have not been assessed. Structural Units present include uplands of *Eucalyptus marginata* Closed Forest; *Banksia attenuata* and *B. menziesii* Low Open Forest; *Banksia attenuata*, *B. menziesii* and *Allocasuarina fraseriana* Low Open Forest; *Acacia saligna* Tall Open Scrub.. Wetlands include *Eucalyptus rudis* Woodland to Open Forest; *Melaleuca raphiophylla* Low Woodland to Low Open Forest; *Viminaria juncea* Tall Open Scrub; *Astartea* aff. *fascicularis* and *Regelia ciliata* Open Heath with emergent scattered *Melaleuca preissiana*; *Villarsia* sp. Herbland; Closed Sedgeland to Sedgeland dominated by *Baumea articulata*, *B. preissii*, *B. juncea*, *Lepyrodia muirii* and *Meeboldinia scariosa*. Vegetation Condition is <70-80% Excellent - Very Good, 20-30% Good to Degraded, with areas of severe localised disturbance. Part of a regionally significant contiguous and fragmented bushland/wetland linkage. A number of conservation significant flora and fauna have been recorded for the site.

BushForever Site 326: HAWKINS RD BUSHLANDS, JANDABUP/GNANGARA

Part of proposed Gngangara Park. Floristic Community Types have been assessed in part - SCP23a (Central *Banksia attenuata* — *B. menziesii* woodlands) being recorded. Structural Units present include uplands of *Banksia attenuata*, *B. menziesii*, *Eucalyptus tottiana* and *Allocasuarina fraseriana* Low Woodland/ Low Open Forest; *Banksia attenuata* and *B. ilicifolia* Low Woodland; *Adenanthos cygnorum* Tall Open Shrubland; Low Shrublands to Open Heaths dominated by *Stirlingia latifolia*, *Leucopogon conostephioides*, *Acacia pulchella*, *Conospermum stoechadis*, *Hibbertia hypericoides*, *Calytrix fraseri* and *Xanthorrhoea preissii* and combinations of these Wetlands include *Eucalyptus rudis* Woodland; *Melaleuca preissiana* and *Banksia ilicifolia* Low Woodland to Open Forest; Mixed Tall Shrubland; *Astartea* aff. *fascicularis* Open Heath to Closed Tall Scrub; *Pultenaea reticulata* Open Scrub, *Pericalymma ellipticum* Shrubland; *Hypocalymma angustifolium* Low Open Heath; *Cyathochaeta avenacea* Sedgeland. Vegetation Condition is >30% Excellent to Pristine, <40% Very Good to Good and <30% Degraded, with areas of severe localised disturbance. Part of a regionally significant contiguous and fragmented bushland/wetland linkage. It is part of the catchment for local mound springs. Brown *et al.* (2009) note the bushland as being part of a regional ecological linkage within the Gngangara Groundwater System.

4.5 LOCAL NATIVE VEGETATION PLANT COMMUNITIES

Figures 2, 3 and 4 show the history of the plantation and its removal, the ecological condition and vegetation communities present within the survey area.

Two native vegetation community types were identified locally which are broadly consistent with the corresponding vegetation units mapped by Heddlé et al. (1980), see Table 2:

- The first community (low woodland of *Banksia attenuata* – *Banksia menziesii*) occurs in localised uncleared southern sections of the tenement (Figure 3).
- The second community (low woodland of *Melaleuca preissiana* over wetlands) occurs as a small eastern intrusion of wetland vegetation on seasonally wet sands (Figure 3)

Each of these communities is described below.

4.5.1 COMMUNITY 1: LOW WOODLAND OF BANKSIA ATTENUATA – BANKSIA MENZIESII

Area: 24.8 ha

Landscape: slopes and crests, flat areas

Substrate: grey, white sands

Species richness (100m²): 56

Plant Cover: 40%

Weed Frequency: 2

Vegetation Condition: very good 5.5ha, degraded-good 19.3ha

Structure: Open Scrub over very/open herbland

Structural units:

- Low woodland

- Scrub, open scrub

- Heath, low heath

- Herbs, open herbs

Floristic Communities: SCP23a

Illustration: Plates 1 and 2

Description: *Banksia attenuata*, *B. menziesii*, *Allocasuarina fraseriana* Woodland to 7m in height. The understorey consists of shrubs (*Jacksonia furcellata*, *Xanthorrhoea preissii*, *Scholtzia involucrata*, *Hibbertia hypericoides*) over a species rich ground layer of low shrubs, herbs, lilies and sedge-like species (e.g. *Anarthria prolifera*, *Calytrix fraseri*, *Conostylis aculeata*, *Dasypogon bromellifolius*, *Hibbertia subvaginata*, *Patersonia occidentalis*, *Pithocarpa pulchella*). Exotic species (e.g. Capeweed, Galdiulus, Veldt Grass) are confined to the edges and disturbed areas. The community is mostly in very good ecological condition within Bushforever Site 326 and is in degraded/good condition below power lines elsewhere. Figure 2 shows this degraded area as “Banksia Woodland – Modified”. Weed invasion and physical damage are the main disturbances



Plate 1: Low *Banksia attenuata* – *B. menziesii* Woodland



Plate 2: *Adenanthos cygnorum* shrubland below power lines

4.5.2 COMMUNITY 2: LOW WOODLAND OF *MELALEUCA PREISSIANA* OVER WETLANDS.

Area: 20 ha

Landscape: slopes and flat areas

Substrate: grey, white sands

Species richness (100m²): 23

Plant Cover: 30%

Weed Frequency: 3

Vegetation Condition: degraded-good 20ha

Structure: Open Scrub over very open /herbland

Structural units:

- Woodland, low woodland

- Scrub, open scrub

- Heath, low heath

- Herbs, open herbs

Floristic Communities: elements of SCP4, SCP22, SCP23a, SCP23b

Illustration: Plate 3

Description: Open Low woodland (to 10m) of *Eucalyptus rudis* over *Melaleuca preissiana* (to 5m) over low shrubs (*Hypocalymma angustifolium*, *Pultenaea reticulata*, *Hakea varia*, *Xanthorrhoea preissii*), over a groundlayer of *Anigozanthos humilis*, *Lyginia barbata*, *Dasypogon bromelifolius* and exotic grasses and herbs. Native spring ephemerals were absent at the time of the field visit. This community occurs in a small area on poorly drained areas of grey sand (Figure 2). The community is in degraded ecological condition and was originally cleared for plantation. Weeds are common



Plate 3: *Melaleuca preissiana* Open Woodland

4.6 PINE PLANTATION

Much of the native vegetation in the study area was cleared approximately 85 years ago to establish the Gnangara Pine Plantation. Parts of the plantation within the tenement were harvested recently, as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Environment and Conservation and Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009). Harvest times were determined by review of historical aerial photographs.

4.6.1 PINE PLANTATION

Existing pine plantation occupies 11 hectares (Figure 3, Plate 6). Native plant species occur sporadically within the plantations with obvious recolonisation occurring within harvested and thinned plantation areas. The vegetation consists of self-sown scattered individual plants of *Nuytsia floribunda*, *Xanthorrhoea preissii*, *Jacksonia* spp. and low woody shrubs such as *Hypocalymma robustum* and *Acacia pulchella*. Weeds (especially grasses) are common. The vegetation condition within these areas is degraded.



Plate 4: Thinned plantation with a sparse native understorey.

4.6.2 CLEARED PINE PLANTATION

Sections of the pine plantation have been harvested within the last 20 years (Figure 3, Plates 5 - 7). These areas occupy 424 ha within the tenements. Small areas were rehabilitated via direct seeding and planting. Native vegetation present consists of scattered individual plants of *Nuytsia floribunda*, *Xanthorrhoea preissii*, *Jacksonia* spp. and low woody shrubs (e.g. *Acacia puchella*, *Daviesia divaricata*, *D. physodes*, *Hibbertia subvaginata*, *Hypocalymma robustum*). The ground layer typically consists of annual herbs (e.g. *Podotrochea* sps.) and geophytes (e.g. species of Cyperaceae, Restionaceae). Annual weeds are very common.

Clearing of the plantation may involve complete removal of the pine tree (Plate 5) or gradual thinning (Plate 4). Native species richness increases and vegetation structure becomes more similar to remnant native vegetation over time. Ecological condition varies from being completely degraded in recently cleared areas to degraded in older regrowth.



Plate 5: Plantation Cleared 2013.



Plate 6: Native regrowth (cleared 2006)



Plate 7: Rehabilitation planting

4.7 FLORISTIC ANALYSIS

Dendrogram 1 shows the final results of the classification of the 1098 quadrats in the Swan floristic dataset and the 8 quadrats established in this study. The highlighted divisions indicate the positions of the floristic quadrats. Division A identifies the 6 quadrats established within the cleared pine plantation (Quadrats 1, 4, 5, 6, 7 and 8). Division B identifies the *Banksia* woodland quadrat (#2) while Division C indicates the *Eucalyptus rudis-Melaleuca preissii* quadrat (#3)

The results of the Similarity Comparisons are shown below in Table 3. Each of the 8 floristic quadrats established within the study area was compared with the 1098 Floristic quadrats of the Swan dataset. For each quadrat a list of the 10 most similar floristic quadrats is displayed. These quadrats are listed in order of decreasing similarity; i.e. the most similar site is the first in each list.

One Sandplain community (Community type SCP23a – Central *Banksia attenuata*-*Banksia menziesii* woodlands) dominates the list for the undisturbed *Banksia* woodland quadrat (#2). SCP23a extends from the southern parts of the Shire of Chittering to the Shire of Serpentine-Jarrahdale. The average species richness of Sandplain Community type 23a is 62.8 per 100m² respectively (Gibson *et al.* 1994). Fifty six species were recorded in Quadrat 2. Though less, this number is considered to be normal for good/very good condition remnant vegetation.

Floristic Community 23a is not considered to be threatened - the community is not currently listed as a TEC or PEC. Gibson *et al.* (1994) determined that SCP23a is well reserved and at low conservation risk. Locally SCP23a is recorded from Bushforever Site 326 (Hawkins Rd Bushland). The community type is not associated closely with wetlands.

One Sandplain community (Community type SCP4) dominates the list for the *E.rudis-M.preissiana* open woodland quadrat (#3). SCP4 extends from the southern parts of the Shire of Gingin to the Shire of Busselton.

The average species richness of Sandplain Community type 4 is 36.9 per 100m² respectively (Gibson *et al.* 1994). Twenty Three species were recorded in Quadrat 3. This number is considered to be indicative of disturbed remnant vegetation.

Floristic Community 4 is not considered to be threatened - the community is not currently listed as a TEC or PEC. Gibson *et al.* (1994) determined that SCP4 is well reserved and at low conservation risk. Locally SCP4 is recorded from Bushforever Site 399 (Melaleuca Park). The community type is associated closely with wetlands.

Comparison of the Floristic quadrats established within the cleared plantations areas (quadrats 1, 4 to 8) reveal no clear patterns of similarities. They indicate a general resemblance to *Banksia* woodland communities (types 21a, 21b, 21c, 23a, 24 and 28). This is due to the presence of species common to *Banksia* woodlands and found across all floristic community types. Native species richness within these Quadrats (mean 21 species) is low compared with the Gibson *et al.* sites and reflects the fact that these areas are regenerating and are in completely degraded-degraded ecological condition.

Table 3: Similarity Comparisons of floristics Quadrats.

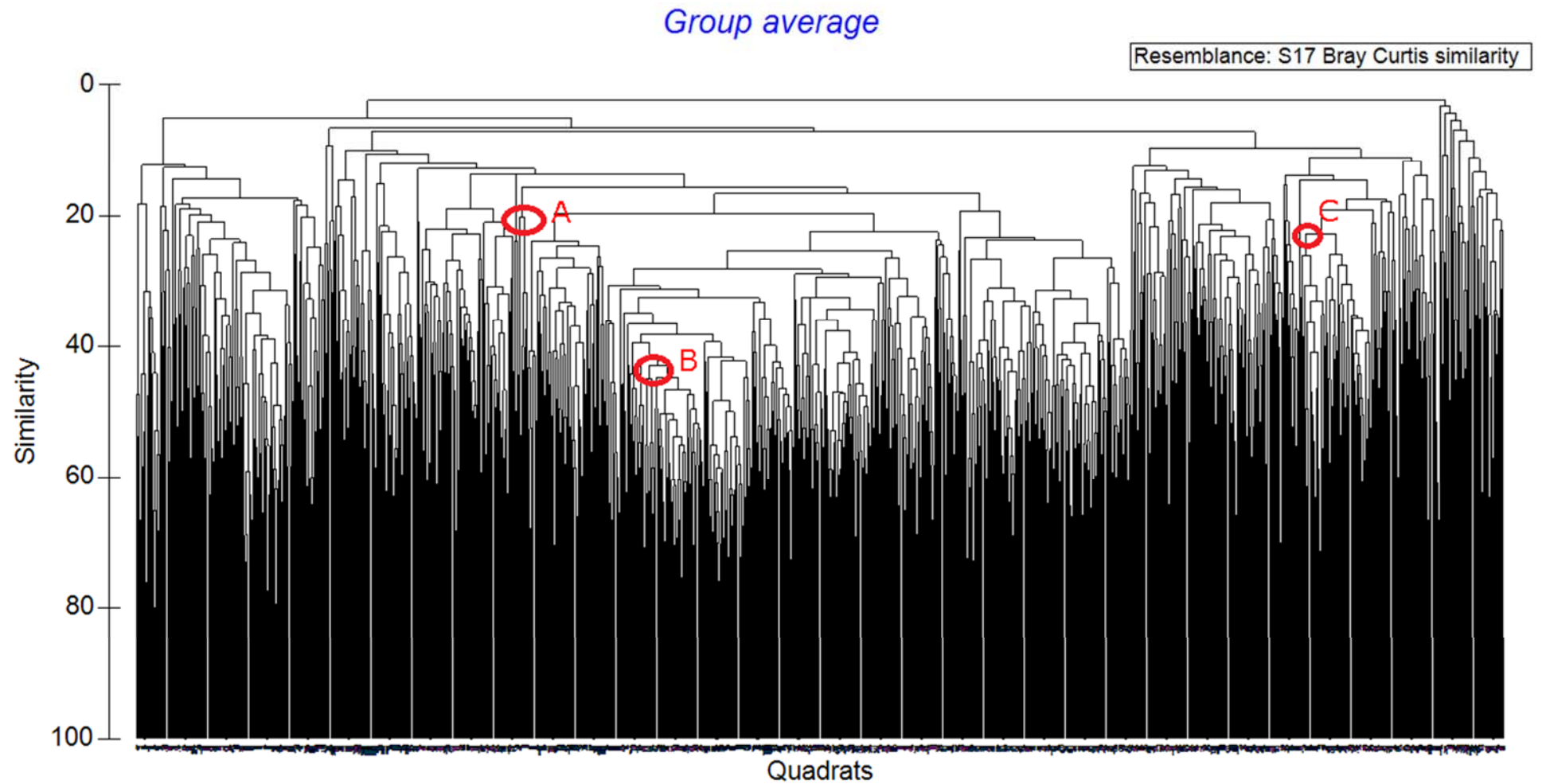
Quadrat 1 – cleared Pine			Quadrat 2 – Banksia woodland		
Floristic Quadrat	Community Type	Similarity	Floristic Quadrat	Community Type	Similarity
jand02	23a	43	WIRR-2	23a	57
FL-6	21c	40	WIRR-1	23a	56
THOM-2	24	39	WHITE-1	23a	54
bibra01	23a	38	ELE03	23b	54
WIRR-2	23a	38	ELE16	23b	52

Quadrat 1 – cleared Pine			Quadrat 2 – Banksia woodland		
Cavs11	21a	37	WARB-3	23a	52
FL-5	21c	37	ELE08	23b	51
TRIG-3	28	36	ELE02	21c	51
perth08	23a	35	perth08	23a	50
cas03	23a	35	WARB-1	23a	50

Quadrat 3 – <i>E.rudis</i> – <i>M.preissiana</i> woodland			Quadrat 4 – cleared Pine		
Floristic Quadrat	Community Type	Similarity	Floristic Quadrat	Community Type	Similarity
ELE32	4	37	FL-5	21c	29
MODO-6	4	36	jand02	23a	28
MUK02	4	35	gnan03	23a	28
cas04	4	34	Tele01	23a	28
ELE07	4	34	bibra01	23a	28
WHITE-2	4	34	Cavs10	21a	27
KOOLJ-1	4	33	THOM-2	24	27
MODO-1	4	32	Light01	23a	26
perth10	4	31	C71-3	21a	26
C58-1	4	31	DEJONG02	21c	26

Quadrat 5 – cleared Pine			Quadrat 6 – cleared Pine		
Floristic Quadrat	Community Type	Similarity	Floristic Quadrat	Community Type	Similarity
wire02	28	30	THOM-2	24	39
SHENT-1	28	29	jand02	23a	36
WN100WNR	23b	26	Cavs11	21a	33
5A01	23b	25	bibra01	23a	33
FL-5	21c	25	hurst04	23a	32
raven05	22	24	ELE24	23b	31
sand01	28	24	ELE03	23b	30
NEER-3	28	23	WN086CHE	23b	30
Light01	23a	23	WIRR-2	23a	30
bibra01	23a	23	WHITE-1	23a	30

Quadrat 7– cleared Pine			Quadrat 8– cleared Pine		
Floristic Quadrat	Community Type	Similarity	Floristic Quadrat	Community Type	Similarity
ELE22	21c	37	KING-2	28	28
Cavs11	21a	35	TRIG-6	24	28
ELE21	S09	33	sand01	28	28
ELE03	23b	32	THOM-2	24	27
ELE11	21a	32	FL-6	21c	27
ELE29	21c	31	TRIG-2	29a	27
ELE28	23b	31	ELE11	21a	27
perth10	4	31	jand05	21c	27
ELE02	21c	30	wire02	28	26
wire02	28	30	Cavs02	21a	26



Dendrogram 1: Floristic Analysis of 1102 Floristic Quadrats

4.8 CONSERVATION SIGNIFICANT NATIVE VEGETATION COMMUNITIES

A Threatened or Priority Ecological Community (TEC or PEC) is one that has been endorsed by WA's Environment Minister as being subject to processes that threaten to destroy or significantly modify it across much of its range. A search of the DPaW TEC/PEC database indicated 17 TECs / PECs occur within the search area which included a 10 km buffer around the study area (Table 4), however none of these TEC / PEC records occur within the proposed project area (Figure 1).

Analysis of the floristic quadrats indicated that the quadrat within the *Banksia* woodland area was most similar to SCP23a while the quadrat within the *Melaleuca* woodland area was most similar to SCP4. It is concluded that the native bushlands within the tenement (predominantly coinciding with Bush Forever Sites) include areas of extensive common floristic communities which are not at risk (e.g. SCP23a, SCP4)

The areas of cleared pine plantation are similar to completely degraded-degraded *Banksia* woodland community types.

Table 4: DPaW TEC / PEC Records within 10 km Buffer of Study Area

Name	ID	Conservation Status
Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain	CAVES SCP01	Critically Endangered
<i>Banksia attenuata</i> woodland over species rich dense shrublands	SCP20a	Endangered
<i>Banksia ilicifolia</i> woodlands	SCP22	Priority 3
Coastal shrublands on shallow sands	SCP29a	Priority 3
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	Mound Springs SCP	Critically Endangered
<i>Eucalyptus calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain	SCP3c	Critically Endangered
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	SCP15	Vulnerable
Herb rich saline shrublands in clay pans	SCP07	Vulnerable
Herb rich shrublands in clay pans	SCP08	Vulnerable
Low lying <i>Banksia attenuata</i> woodlands or shrublands	SCP21c	Priority 3
<i>Melaleuca huegelii</i> - <i>Melaleuca acerosa</i> (currently <i>M. systema</i>) shrublands on limestone ridges (Gibson et al. 1994 type 26a)	Limestone ridges (SCP 26a)	Endangered
Northern Spearwood shrublands and woodlands	SCP24	Priority 3
Shrublands and woodlands on Muchea Limestone	Muchea Limestone	Endangered
Shrublands on calcareous silts of the Swan Coastal Plain	SCP18	Vulnerable
Shrublands on dry clay flats	SCP10a	Endangered
Southern <i>Eucalyptus gomphocephala</i> - <i>Agonis flexuosa</i> woodlands	SCP25	Priority 3
Swan Coastal Plain <i>Banksia attenuata</i> - <i>Banksia menziesii</i> woodlands	SCP23b	Priority 3

4.9 ECOLOGICAL CONDITION

The native vegetation within the study area is generally in completely degraded-degraded ecological condition, according to the rating scale outlined in Keighery (1994) – see Figure 4, Table 5. Much of the area has had a long history as a *Pinus pinaster* plantation. Parts of the plantation have been removed within the last 20 years and the native vegetation which is present is re-growth and young rehabilitation. Uncleared native vegetation is generally in good-very good ecological condition apart from localised disturbances and weed invasion associated with tracks and human activities.

Table 5: Ecological Condition

Ecological Condition	Area (ha)
Very Good	5.5
Degraded - Good	36.6
Completely degraded/degraded	221.1
Completely degraded	206.7
Plantation	11.0
road	25.1
TOTAL	506.1

4.10 NATIVE FLORA

155 native plant species representing 110 genera and 39 families were recorded within the study area (Table 6). The most common native plant families included Proteaceae, Myrtaceae and Fabaceae. Species of *Eucalyptus*, *Banksia*, *Melaleuca* and *Nuytsia floribunda* dominate the tree and taller shrub flora while Myrtaceae, Ericaceae and Fabaceae species are most common within the lower shrubs. *Macrozamia fraseri* and *Xanthorrhoea preissii* plants are common. The native ground flora is species rich with Cyperaceae, Restionaceae, Haemodoraceae and Asteraceae being the most common families.

Table 6: Native Plant Species

Species	Author	Family
<i>Acacia huegii</i>	Benth.	Fabaceae
<i>Acacia pulchella</i>	R.Br.	Fabaceae
<i>Acacia saligna</i>	(Labill.) Wendl.	Fabaceae
<i>Acacia sessilis</i>	Benth.	Fabaceae
<i>Adenanthos cygnorum</i> var <i>cygnorum</i>	Diels	Proteaceae
<i>Adenanthos obovatus</i>	Labill.	Proteaceae
<i>Alexgeorgea nitens</i>	(Nees) L.A.S.Johnson & B.G.Briggs	Restionaceae
<i>Allocasuarina fraseriana</i>	(Miq.) LAS .Johnson	Casuarinaceae
<i>Allocasuarina humilis</i>	(Otto & Dietr.) LAS.Johnson	Casuarinaceae
<i>Anarthria prolifera</i>	R.Br.	Anarthriaceae
<i>Anigozanthos humilis</i>	Lindl.	Haemodoraceae
<i>Anigozanthos manglesii</i>	D.Don	Haemodoraceae
<i>Aotus gracillima</i>	Meisn.	Fabaceae
<i>Astartea fascicularis</i>	(Labill.)DC	Myrtaceae
<i>Astroloma macrocalyx</i>	Sond.	Ericaceae
<i>Astroloma xerophyllum</i>	(DC) Sonder	Ericaceae

Species	Author	Family
<i>Austrostipa compressa</i>	(R.Br.) S.W.L.Jacobs & J.Everett	Poaceae
<i>Banksia attenuata</i>	R.Br.	Proteaceae
<i>Banksia grandis</i>	Willd.	Proteaceae
<i>Banksia ilicifolia</i>	R.Br.	Proteaceae
<i>Banksia menziesii</i>	R.Br.	Proteaceae
<i>Bossiaea eriocarpa</i>	Benth.	Fabaceae
<i>Burchardia congesta</i>	(Turner) J.Agardh	Colchicaceae
<i>Caesia micrantha</i>	Lindl.	Hemerocallidaceae
<i>Caladenia flava</i>	R.Br.	Orchidaceae
<i>Caladenia</i> sps. (indet.)		Orchidaceae
<i>Calandrinia linifolia</i>	Fenzl.	Portulacaceae
<i>Calectasia narragara</i>	R.L.Barret & K.L.Dixon	Dasypogonaceae
<i>Calothamnus sanguineus</i>	Labill.	Myrtaceae
<i>Calytrix angulata</i>	Lindl.	Myrtaceae
<i>Calytrix fraseri</i>	Cunn.	Myrtaceae
<i>Cartonema philydroides</i>	F.Muell.	Commelinaceae
<i>Cassytha glabella</i>	R.Br.	Lauraceae
<i>Caustis dioica</i>	R.Br.	Cyperaceae
<i>Chamelaucium uncinatum</i>	Schauer	Myrtaceae
<i>Comesperma calymega</i>	Labill.	Polygalaceae
<i>Conospermum incurvum</i>	Lind.	Proteaceae
<i>Conospermum triplinervum</i>	R.Br.	Proteaceae
<i>Conostephium pendulum</i>	Benth.	Ericaceae
<i>Conostylis aculeata</i>	R.Br.	Haemodoraceae
<i>Conostylis juncea</i>	Endl.	Haemodoraceae
<i>Corynotheca micrantha</i>	(Lindley) J.F. Macbride	Hemerocallidaceae
<i>Crassula colorata</i>	(Nees.)Ostenf.	Crassulaceae
<i>Dampiera lavandulacea</i>	Lindl.	Goodeniaceae
<i>Dampiera linearis</i>	de Vriese	Goodeniaceae
<i>Dasypogon bromelifolius</i>	R.Br.	Dasypogonaceae
<i>Daucus glochidiatus</i>	(Labill.)Fisch,Mey,Ave-Lall	Apiaceae
<i>Daviesia divaricata</i>	Benth.	Fabaceae
<i>Daviesia physodes</i>	Cunn ex. Don	Fabaceae
<i>Daviesia triflora</i>	M.D. Crisp	Fabaceae
<i>Desmocladius flexuosa</i>	(R.Br.)B.G.Briggs & L.A.A.Johnson	Restionaceae
<i>Dianella divaricata</i>	R.Br.	Hemerocallidaceae
<i>Dielsia stenostachya</i>	(W.Fitzg.) B.G.Briggs & L.A.S.Johnson	Restionaceae
<i>Diuris</i> sp (indet.)		Orchidaceae
<i>Drosera erythrorhiza</i>	Lindl.	Droseraceae
<i>Drosera menziesii</i> subsp. <i>menziesii</i>	R. Br. ex DC	Droseraceae
<i>Drosera</i> sps (indet.)		Droseraceae
<i>Eremaea pauciflora</i>	(Endl.) Druce	Myrtaceae
<i>Eriochilus dilatatus</i>	Lindl.	Orchidaceae
<i>Eucalyptus erythrocorys</i>	F.Muell.	Myrtaceae
<i>Eucalyptus marginata</i>	Donn ex Smith	Myrtaceae

Species	Author	Family
<i>Eucalyptus rudis</i>	Endl.	Myrtaceae
<i>Eucalyptus tottiana</i>	F.Muell.	Myrtaceae
<i>Euchilopsis linearis</i>	(Benth.) F. Muell.	Fabaceae
<i>Gastrolobium capitatum</i>	(Benth.) G.Chandler & Crisp	Fabaceae
<i>Gompholobium tomentosum</i>	Labill.	Fabaceae
<i>Haemodorum spicatum</i>	R.Br.	Haemodoraceae
<i>Hakea prostrata</i>	R.Br.	Proteaceae
<i>Hakea varia</i>	R.Br.	Proteaceae
<i>Hardenbergia comptoniana</i>	(Andrews) Benth.	Fabaceae
<i>Hemiandra pungens</i>	R.Br.	Lamiaceae
<i>Hibbertia huegii</i>	(Endl.) F. Muell.	Dilleniaceae
<i>Hibbertia hypericoides</i>	(DC)Benth.	Dilleniaceae
<i>Hibbertia subvaginata</i>	(Steudel) F. Muell.	Dilleniaceae
<i>Hibbertia vaginata</i>	(Benth.)F.Muell.	Dilleniaceae
<i>Hovea pungens</i>	Benth.	Fabaceae
<i>Hyalosperma cotula</i>	(Benth.)P.G.Wilson	Asteraceae
<i>Hybanthus calycinus</i>	(DC ex Ging.) F. Muell.	Violaceae
<i>Hypocalymma angustifolium</i>	(Endl.)Schauer	Myrtaceae
<i>Hypocalymma robustum</i>	(Endl.)Lindl.	Myrtaceae
<i>Hypocalymma xanthopetalum</i>	F.Muell.	Myrtaceae
<i>Hypolaena exsulca</i>	R.Br.	Restionaceae
<i>Jacksonia floribunda</i>	Endl.	Fabaceae
<i>Jacksonia furcellata</i>	(Bonpl.)DC	Fabaceae
<i>Jacksonia sternbergiana</i>	Huegel	Fabaceae
<i>Kunzea glabrescens</i>	Tolken	Myrtaceae
<i>Lagenophora huegii</i>	Benth.	Asteraceae
<i>Laxmannia ramosa</i>	Lindl.	Asparagaceae
<i>Laxmannia squarrosa</i>	Lindl.	Asparagaceae
<i>Lechenaultia biloba</i>	Lindl.	Goodeniaceae
<i>Lechenaultia floribunda</i>	Benth.	Goodeniaceae
<i>Lepidosperma longitudinale</i>	Labill.	Cyperaceae
<i>Lepidosperma squamatum</i>	Labill.	Cyperaceae
<i>Leucopogon australis</i>	R.Br.	Ericaceae
<i>Leucopogon conostephioides</i>	DC	Ericaceae
<i>Leucopogon polymorphus</i>	Sonder	Ericaceae
<i>Leucopogon squarrosus</i>	Benth.	Ericaceae
<i>Levenhookia stipitata</i>	(Sonder)F.Muell.	Stylidiaceae
<i>Lobelia tenuior</i>	R.Br.	Campanulaceae
<i>Lomandra hermaphrodita</i>	(Andrews)Gardner	Asparagaceae
<i>Loxocarya cinerea</i>	R.Br.	Restionaceae
<i>Lyginia barbata</i>	R.Br.	Restionaceae
<i>Macarthuria australis</i>	Huegel ex Endl.	Molluginaceae
<i>Macrozamia fraseri</i>	Miq.	Zamiaceae
<i>Meeboldina coangustata</i>	(Nees.)Briggs&Johnson	Restionaceae
<i>Melaleuca preissiana</i>	Schauer	Myrtaceae

Species	Author	Family
<i>Melaleuca seriata</i>	Lindl.	Myrtaceae
<i>Mesomelaena pseudostygia</i>	(Kurek.)K.L.Wilson	Cyperaceae
<i>Microtis media</i>	R.Br.	Orchidaceae
<i>Millotia myosotidifolia</i>	(Benth.)Steetz	Asteraceae
<i>Neurachne alopecuroides</i>	R.Br.	Poaceae
<i>Nuytsia floribunda</i>	(Labill.) R.Br. ex Fenzl	Loranthaceae
<i>Patersonia juncea</i>	Lindl.	Iridaceae
<i>Patersonia occidentalis</i>	R.Br.	Iridaceae
<i>Pericalymma elliptica</i>	(Endl.) Schauer	Myrtaceae
<i>Persoonia saccata</i>	R.Br.	Proteaceae
<i>Petrophile linearis</i>	R.Br.	Proteaceae
<i>Philothea spicatus</i>	(A Rich)P.Wilson	Rutaceae
<i>Phlebocarya ciliata</i>	R.Br.	Haemodoraceae
<i>Phyllanthus calycinus</i>	Labill.	Phyllanthaceae
<i>Pimelea imbricata var piligera</i>	(Benth.) Diels	Thymeleaceae
<i>Pithocarpa pulchella</i>	Lindl.	Asteraceae
<i>Podotheca chrysantha</i>	(Steetz)Benth.	Asteraceae
<i>Podotheca gnaphalioides</i>	R.A.Graham	Asteraceae
<i>Poranthera microphylla</i>	Brongn	Phyllanthaceae
<i>Pultenaea reticulata</i>	Smith(Benth.)	Fabaceae
<i>Pyrorchis sp (indet.)</i>		Orchidaceae
<i>Quinetia urvillei</i>	Cass.	Asteraceae
<i>Regelia ciliata</i>	Schauer	Myrtaceae
<i>Rytidosperma occidentale</i>	(Vickery) Connor & Edgar	Poaceae
<i>Scaevola canescens</i>	Benth.	Goodeniaceae
<i>Scaevola repens var angustifolia</i>	de Vriese	Goodeniaceae
<i>Schoenus curvifolius</i>	(R.Br.)Roem&Schult	Cyperaceae
<i>Scholtzia involucrata</i>	(Endl.)Druce	Myrtaceae
<i>Siloxeros humifusus</i>	Labill.	Asteraceae
<i>Sowerbaea laxiflora</i>	Lindl.	Asparagaceae
<i>Stirlingia latifolia</i>	(R.Br.) Steudel	Proteaceae
<i>Stylidium brunonianum</i>	Benth.	Stylidiaceae
<i>Stylidium calcaratum</i>	R.Br.	Stylidiaceae
<i>Stylidium repens</i>	R.Br.	Stylidiaceae
<i>Stylidium schoenoides</i>	DC	Stylidiaceae
<i>Taxandria linearifolia</i>	(DC) Schauer	Myrtaceae
<i>Thysanotus manglesianus</i>	Kunth	Asparagaceae
<i>Trachymene pilosa</i>	Smith	Araliaceae
<i>Tribonanthes australis</i>	Endl.	Haemodoraceae
<i>Tribonanthes longipetala</i>	Lindl.	Haemodoraceae
<i>Tricoryne elatior</i>	R.Br.	Hemerocallidaceae
<i>Tripterococcus brunonis</i>	Endl.	Celastraceae
<i>Verticordia densiflora var. densiflora</i>	Lindl.	Myrtaceae
<i>Verticordia nitens</i>	(Lindley)Endlicher	Myrtaceae
<i>Wahlenbergia preissii</i>	de Vriese	Campanulaceae

Species	Author	Family
<i>Waitzia suaveolens</i>	(Benth.) Druce	Asteraceae
<i>Xanthorrhoea preissii</i>	Endl.	Xanthorrhoeaceae
<i>Xanthosia huegii</i>	(Benth.) Steudl.	Apiaceae

4.11 CONSERVATION SIGNIFICANT FLORA

A significant flora search requested from DPaW for a 10 km buffer of the study area found 37 species of conservation significance. None of these DPaW records occur within the proposed project area. The recorded location of *Pimelea calcicola* is from Hepburn Heights and has been incorrectly placed within the Jandabup search area likely due to data entry or recording errors. All significant flora species from the DPaW search are listed in Table 7, along with their conservation significance and an assessment of the likely presence within the tenements.

No conservation significant flora species were located during field studies. It is unlikely that conservation significant flora species occur within the pine plantation areas, however they could be present within the Bush Forever Sites. Field studies were considered to be optimal in timing for the detection of conservation significant flora.

Table 7: DPaW Significant Flora Records within 10 km Buffer of Study Area

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
<i>Acacia anomala</i>	Threatened	August to September	Slender, rush-like shrub, 0.2-0.5 m high, yellow flowers	Lateritic soils. Slopes.	Not recorded from the City of Wanneroo. A species occurring on laterite which is not present in the tenements
<i>Acacia benthamii</i>	Priority 2	August to September	shrub growing to 1m, producing yellow flowers	Brown/grey sand on limestone breakaways	A conspicuous coastal species. Unlikely to be present. Field studies corresponded to flowering times
<i>Anigozanthos humilis</i> subsp. <i>chrysanthus</i>	Priority 4	July to October	Rhizomatous, perennial, herb, 0.2-0.4(-0.8) m high. Fl. yellow	Grey or yellow sand.	Not recorded from the City of Wanneroo. A conspicuous species. Field studies corresponded to flowering times. Unlikely to be present.
<i>Baeckea</i> sp. <i>Limestone</i> (N. Gibson & M.N. Lyons 1425)	Priority 1		A woody shrub	grey sand on limestone breakaways	<i>Baeckea</i> sps are generally conspicuous – this species is unlikely to be present
<i>Caladenia huegelii</i>	Threatened	September to October	Tuberous, perennial, herb, 0.25-0.6 m high. Fl. green & cream & red	Grey or brown sand, clay loam	Possibly present in the undisturbed banksia woodland, unlikely to be present in plantation or regrowth areas. Field studies corresponded to flowering time
<i>Calectasia</i> sp. <i>Pinjar</i> (C. Tauss 557)	Priority 1		Perennial, herb, to 0.4 m high, with multiple stems and roots.	Deep grey quartz soils. Gentle slopes, above damplands.	A conspicuous species. Damplands are limited within the tenements. Unlikely to be present.
<i>Chamaescilla gibsonii</i>	Priority 3	Spring ephemeral	Small lily, Blue flowers		Not recorded from the City of Wanneroo. Unlikely to be present.
<i>Conostylis bracteata</i>	Priority 3	August to September	perennial, rhizomatous, tufted or shortly proliferous grass like herb, yellow flowers	Sand over limestone on coastal dunes	A conspicuous coastal species. Unlikely to be present. Field studies corresponded to flowering times.
<i>Cyathochaeta teretifolia</i>	Priority 3	September	Clumped tuberous, herb. Fl. blue	Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.	A conspicuous species. Damplands are limited within the tenements. Field studies corresponded to flowering times. Unlikely to be present.
<i>Dampiera triloba</i>	Priority 3	August to December	Erect perennial, herb or shrub, to 0.5 m high, Flowers blue		Unlikely to be present. Field studies corresponded to flowering times.

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
<i>Darwinia foetida</i>	Threatened	October to November	Shrub to 1m, flowers red-green	grey-black sandy rises in winter-damp to wet clay flats	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present.
<i>Dasymalla axillaris</i>	Threatened	Spring	Grey shrub to 80cm. Flowers pink/red	Grey sands, damplands	A conspicuous species unlikely to be present. Field studies corresponded to flowering times.
<i>Drosera occidentalis</i> subsp. <i>occidentalis</i>	Priority 4	November to December	Fibrous-rooted, rosetted perennial, herb, to 0.01 m high. Fl. pink/white,	Sandy & clayey soils. Swamps & wet depressions.	Damplands are limited within the tenements. Unlikely to be present.
<i>Drosera x sidjamesii</i>	Priority 1	November to March	Fibrous-rooted perennial, herb, to 0.06 m high. Fl. green-pink	Peaty sand. Along lake margins, close to winter high-water line	Damplands are limited within the tenements. Unlikely to be present.
<i>Eleocharis keigheryi</i>	Threatened	August to November	Rhizomatous, clumped perennial, grass-like or herb (sedge), to 0.4 m high. Fl. green	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Not recorded from the City of Wanneroo. No standing water is present within the tenements.
<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)	Priority 3	Spring	Spring ephemeral	damplands	Not recorded from the City of Wanneroo. A distinctive species unlikely to be present. Field studies corresponded to flowering times.
<i>Grevillea curviloba</i> subsp. <i>curviloba</i>	Threatened	October	Prostrate to erect shrub, 0.1-2.5 m high. Fl. white-cream	Grey sand. Winter-wet heath	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times
<i>Grevillea curviloba</i> subsp. <i>incurva</i>	Threatened	August to September	Prostrate to erect shrub, 0.1-2.5 m high. Fl. white-cream	Sand, sandy loam. Winter-wet heath.	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times
<i>Guichenotia tuberculata</i>	Priority 3	August to October	Erect, open shrub, (0.25-)0.6-0.9 m high. Fl. purple-pink	Sand clay over laterite, sand.	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times
<i>Hibbertia helianthemoides</i>	Priority 4	July to October	spreading to erect, low or prostrate shrub growing to 0.3 m high. It produces yellow flowers	Clayey sand over sandstone or loam over quartzite on hills and scree slopes	Unlikely to be present. Field studies corresponded to flowering times. Unlikely to be present.

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
<i>Hydrocotyle lemnoides</i>	Priority 4	August to October	Aquatic, floating annual, herb	Swamps	Not recorded from the City of Wanneroo. No standing water is present within the tenements. Unlikely to be present.
<i>Hypolaena robusta</i>	Priority 4	September to October	Dioecious rhizomatous, perennial, herb, ca 0.5 m high	White sand. Sandplains	Not recorded from the City of Wanneroo. Field studies corresponded to flowering times. Unlikely to be present.
<i>Jacksonia sericea</i>	Priority 4	December to February	Low spreading shrub, to 0.6 m high. Fl. orange	Calcareous & sandy soils	A conspicuous species unlikely to be present
<i>Phlebocarya pilosissima</i> subsp. <i>pilosissima</i>	Priority 3	August to December	Shortly rhizomatous, compactly tufted perennial, grass-like or herb, 0.15-0.4 m high. Fl. cream-white	White or grey sand, lateritic gravel	Not recorded from the City of Wanneroo. Field studies corresponded to flowering times. Unlikely to be present.
<i>Pimelea calcicola</i>	Priority 3	September to November	erect to spreading shrub growing to 1m high, producing pink flowers	Sand over limestone in coastal areas	A conspicuous coastal species. Unlikely to be present. Field studies corresponded to flowering times
<i>Pithocarpa corymbulosa</i>	Priority 3	January to April.	erect to scrambling perennial herb growing to 1 m high, producing white flowers	Gravelly or sandy loam amongst granite outcrops near the coast	A coastal species unlikely to be present
<i>Platysace ramosissima</i>	Priority 3	October to November	Perennial, herb, to 0.3 m high. Fl. white-cream	Sandy soils	Not recorded from the City of Wanneroo. Unlikely to be present
<i>Poranthera moorokatta</i>	Priority 2	September to November	annual herb to 5cm, flowers pink/white	Damplands, sandy soils	Not recorded from the City of Wanneroo. Damplands are limited within the tenements. Unlikely to be present
<i>Schoenus griffinianus</i>	Priority 3	September to October	Small, tufted perennial, grass-like or herb (sedge), to 0.1 m high.	White sand	Not recorded from the City of Wanneroo. Unlikely to be present
<i>Stenanthemum sublineare</i>	Priority 2	October to December	Erect shrub, to 0.1 m high. Fl. green	Littered white sand. Coastal plain	A coastal species unlikely to be present
<i>Stylidium longitubum</i>	Priority 3	October to December	Erect annual (ephemeral), herb, 0.05-0.12 m high. Fl. pink	Sandy clay, clay. Seasonal wetlands	Damplands are limited within the tenements. Unlikely to be present

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
<i>Stylidium trudgenii</i>	Priority 3		Caespitose perennial, herb, 0.05-0.5 m high	Grey sand, dark grey to black sandy peat. Margins of winter-wet swamps, depressions	Not recorded from the City of Wanneroo. Damplands are limited within the tenements. Unlikely to be present
<i>Tetraria</i> sp. <i>Chandala</i> (G.J. Keighery 17055)	Priority 2		A sedge	Grey sand, Margins of winter-wet swamps, depressions	Damplands are limited within the tenements. Unlikely to be present
<i>Thelymitra variegata</i>	Priority 3	June to September	Tuberous, perennial, herb, 0.1-0.35 m high. Fl. orange & red & purple & pink	Sandy clay, sand, laterite.	Possibly present in the undisturbed banksia woodland, unlikely to be present in plantation or regrowth areas. Field studies corresponded to flowering time
<i>Trichocline</i> sp. <i>Treeton</i> (B.J. Keighery & N. Gibson 564)	Priority 2		Tuberous, perennial, herb, to 1.6 m high.	Sand over limestone, sandy clay over ironstone. Seasonally wet flats.	Not recorded from the City of Wanneroo. Unlikely to be present.
<i>Tripterococcus paniculatus</i>	Priority 4	Spring	Spring ephemeral, flowers green-yellow		Possibly present in the undisturbed woodland, unlikely to be present in plantation or regrowth areas. Field studies corresponded to flowering time
<i>Verticordia serrata</i> var. <i>linearis</i>	Priority 3	September to October	Shrub, to 1 m high, yellow flowers	White sand, gravel. Open woodland	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times.

4.12 WEEDS

During the field survey 61 weed species were recorded as outlined below in Table 8. All species are common weeds associated with disturbance and agriculture. One species *Emex australis* (Doublegee) is a Priority 1 Declared Plant within some W.A. local government areas under the *Agriculture and Related Resources Act 1976*. Weeds were most common within the plantation areas and along tracks. The majority of species are not considered to be serious environmental problems – DPaW Swan Region - Environmental Weed List - (DPaW, 2013).

Table 8: Weed Species Recorded in Field Survey

Species	Author	Family
<i>Acacia iteaphylla</i>	Benth.	Fabaceae
<i>Acacia longifolia</i> var <i>sophorae</i>	(Labill.)Court	Fabaceae
<i>Agave americana</i>	L.	Asparagaceae
<i>Aira caryophylloides</i>	L.	Poaceae
<i>Arctotheca calendula</i>	(L.) Levyns	Asteraceae
<i>Asphodelus fistulosus</i>	L.	Asphodelaceae
<i>Brassica tournefortii</i>	Gouan	Brassicaceae
<i>Briza maxima</i>	L.	Poaceae
<i>Carpobrotus edulis</i>	(L.)N.E.Br.	Aizoaceae
<i>Centaurea melitensis</i>	L.	Asteraceae
<i>Coronopus didymus</i>	(L.)Smith	Brassicaceae
<i>Crassula glomerata</i>	P.J.Bergius	Crassulaceae
<i>Dimorphotheca ecklonius</i>	DC	Asteraceae
<i>Diplotaxis muralis</i>	(L.) DC.	Brassicaceae
<i>Dittrichia viscosa</i>	(L.) Greuter	Asteraceae
<i>Ehrharta calycina</i>	Smith	Poaceae
<i>Emex australis</i>	Steinh.	Polygonaceae
<i>Eragrostis curvula</i>	(Schrud.) Nees	Poaceae
<i>Erodium botrys</i>	(Cav.)Bertol.	Geraniaceae
<i>Erodium moschatum</i>	(L.) L'Her.	Geraniaceae
<i>Eucalyptus saligna</i>	Sm.	Myrtaceae
<i>Eucalyptus</i> sp (indet.)		Myrtaceae
<i>Euphorbia australis</i>	Boiss.	Euphorbiaceae
<i>Euphorbia terracina</i>	L.	Euphorbiaceae
<i>Foeniculum vulgare</i>	Mill.	Apiaceae
<i>Freesia</i> sp.	N.A.	Iridaceae
<i>Gazania linearis</i>	(Thunb.) Druce	Asteraceae
<i>Gladiolus caryophyllaceus</i>	(N.L. Burman) Poiret	Iridaceae
<i>Hypochaeris glabra</i>	L.	Asteraceae
<i>Ipomoea cairica</i>	(L.) Sweet	Convolvulaceae
<i>Lagurus ovatus</i>	L.	Poaceae
<i>Leptospermum laevigatum</i>	(Gaertn.)F.Muell.	Myrtaceae
<i>Lotus angustissimus</i>	L.	Fabaceae
<i>Lupinus consentinii</i>	Guss.	Fabaceae

Species	Author	Family
<i>Lysimachia minima</i>	(L.) U.Manns & Anderb	Primulaceae
<i>Melilotus indicus</i>	(L.)All.	Fabaceae
<i>Oenothera drummondii</i>	Hook.	Onagraceae
<i>Ornithopus compressus</i>	L.	Fabaceae
<i>Orobanche minor</i>	Smith	Orobanchaceae
<i>Oxalis pes-caprae</i>	L.	Oxalidaceae
<i>Pelargonium capitatum</i>	(L.) L.'Her.	Geraniaceae
<i>Petrorhagia velutina</i>	(Guss.)Bail.&Heywood	Caryophyllaceae
<i>Phytolacca octandra</i>	L.	Phytolaccaceae
<i>Pinus pinaster</i>	Aiton	Pinaceae
<i>Plantago lanceolata</i>	L.	Plantaginaceae
<i>Polycarpon tetraphyllum</i>	(L.)L.	Caryophyllaceae
<i>Raphanus raphanistrum</i>	L.	Brassicaceae
<i>Ricinis communis</i>	L.	Euphorbiaceae
<i>Romulea rosea</i>	(L.) Ecklon	Iridaceae
<i>Solanum nigrum</i>	L.	Solanaceae
<i>Sonchus asper</i>	Hill	Asteraceae
<i>Sonchus oleraceus</i>	L.	Asteraceae
<i>Spergularia diandra</i>	(Guss.) Heldr.	Caryophyllaceae
<i>Tolpis barbata</i>	(L.)Gaertn.	Asteraceae
<i>Trachyandra divaricata</i>	(Jacq.)Kunth	Asphodelaceae
<i>Trifolium hirtum</i>	All.	Fabaceae
<i>Ursinia anthemoides</i>	(L.) Poiret	Asteraceae
<i>Verbascum virgatum</i>	Stokes	Scrophulariaceae
<i>Verbesina encelioides</i>	(Cav.) A.Gray	Asteraceae
<i>Wahlenbergia capensis</i>	(L.)A.D.C.	Campanulaceae
<i>Yucca aliofolia</i>	L.	Agavaceae

4.13 CONSERVATION SIGNIFICANT FAUNA AND HABITAT

A significant fauna search requested from DPaW for a 10 km buffer around the study area, showed 28 species of conservation significance recorded previously within the search area as listed in Table 9 below. However none of these DPaW records occur within the proposed project area.

No threatened fauna were observed during field studies. There was little evidence of fauna presence apart from kangaroos and birds.

The pine plantation vegetation and regrowth areas provide limited shelter and nesting locations and food resources (flowers, fruit, leaves) for terrestrial, arboreal and aerial species. The lack of large trees means the area does not contain habitat for large arboreal or aerial species. There is no breeding habitat for significant bird species (such as tree hollows). The low species richness of the native flora and the sparseness of this vegetation limits the habitat values of these areas.

The area of native wetland vegetation may provide some seasonal fauna habitat. The Banksia woodland community and existing Pine Plantation may provide foraging resources for Carnaby's Cockatoo (Valentine, and Stock 2008).

Table 9: DPaW Significant Fauna Records within 10 km Buffer of Study Area

Species Name	Common Name	Status
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Threatened
<i>Calidris ferruginea</i>	Curlew Sandpiper	Threatened
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo (long-billed black-cockatoo), Baudin's Cockatoo	Threatened
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo	Threatened
<i>Dasyurus geoffroyi</i>	Chuditch, Western Quoll	Threatened
<i>Falco peregrinus</i>	Peregrine Falcon	Schedule Priority 4 (Specially Protected)
<i>Falco peregrinus subsp. macropus</i>	Australian Peregrine Falcon	Schedule Priority 4 (Specially Protected)
<i>Actitis hypoleucos</i>	Common Sandpiper	International Agreement (Migratory)
<i>Ardea modesta</i>	Eastern Great Egret	International Agreement (Migratory)
<i>Calidris ruficollis</i>	Red-necked Stint	International Agreement (Migratory)
<i>Glareola maldivarum</i>	Oriental Pratincole	International Agreement (Migratory)
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	International Agreement (Migratory)
<i>Limosa lapponica</i>	Bar-tailed Godwit	International Agreement (Migratory)
<i>Merops ornatus</i>	Rainbow Bee-eater	International Agreement (Migratory)
<i>Plegadis falcinellus</i>	Glossy Ibis	International Agreement (Migratory)
<i>Pluvialis squatarola</i>	Grey Plover	International Agreement (Migratory)
<i>Tringa glareola</i>	Wood Sandpiper	International Agreement (Migratory)
<i>Tringa nebularia</i>	Common Greenshank	International Agreement (Migratory)
<i>Tringa stagnatilis</i>	Marsh Sandpiper	International Agreement (Migratory)
<i>Xenus cinereus</i>	Terek Sandpiper	International Agreement (Migratory)
<i>Hylaeus globuliferus</i>	Native Bee	Priority 3
<i>Leioproctus contrarius</i>	Native Bee	Priority 3
<i>Neelaps calonotos</i>	Black-striped Snake	Priority 3
<i>Tyto novaehollandiae subsp. novaehollandiae</i>	Masked Owl (southern subsp)	Priority 3
<i>Ardeotis australis</i>	Australian Bustard	Priority 4
<i>Ixobrychus minutus</i>	Little Bittern	Priority 4
<i>Macropus irma</i>	Western Brush Wallaby	Priority 4
<i>Isodon obesulus subsp. fusciventer</i>	Quenda, Southern Brown Bandicoot	Priority 5

5 ASSESSMENT AGAINST TEN CLEARING PRINCIPLES

Table 10 summarises the ecological attributes of the vegetation in the study area against the 10 Clearing Principles as listed under Schedule 5 of the EP Act.

Table 10: Assessment of Proposed Quarry Against Ten Clearing Principles

Clearing Principle Native Vegetation should not be cleared if....	Site Assessment: Proposed Sand Quarry, Holcim (Australia)
1) It comprises a high level of biological diversity.	<p>Much of the area to be cleared, is already cleared pine plantation, containing self-sown or trial seeded small plants. Uncleared native vegetation is in good to very good ecological condition. 155 native species were recorded and this is considered to be a normal complement for the vegetation communities present.</p> <p>Given the proposed mine will only occur in pine plantation, it will not affect vegetation of high biological diversity.</p>
2) It comprises the whole or part of, or is necessary for the maintenance of a significant habitat for fauna indigenous to WA.	<p>No significant fauna or fauna habitats were observed within the regrowth areas or the plantation. Seasonal wetlands occur which may provide fauna habitat values. The Banksia woodland may provide foraging resources for Carnaby's Cockatoo.</p> <p>Given the proposed mine will only occur in pine plantation, it will not affect significant fauna habitat.</p>
3) It includes, or it is necessary for the continued existence of rare flora.	<p>No conservation significant flora species were located in the study area. The timing of the survey is considered to be optimal for detection of conservation priority species. It is unlikely they would occur within pine plantation, but could be present within the Bush Forever Sites.</p> <p>Given the proposed mine will only occur in pine plantation, it is unlikely to affect significant flora.</p>
4) It comprises the whole or a part of, or is necessary for the maintenance of a TEC.	<p>No TEC's were identified Two native bushlands within the tenement were identified as being most similar to SCP4 and SCP23a which are not risk.</p> <p>Given the proposed mine will only occur in pine plantation, it is unlikely to affect any TEC or PEC.</p>
5) It is significant as a remnant of native vegetation in an area that has been extensively cleared.	<p>The native communities with the survey area coinciding with Bush Forever Sites are locally extensive. Pine plantation areas are not considered significant remnant vegetation.</p>
6) It is growing in, or in association with, an environment associated with a watercourse or wetland.	<p>A seasonal wetland intrudes on the eastern boundary of the tenements. Appropriate quarry management measures should avoid impacts (such as runoff, erosion and weed transport) to wetlands. A 100 m buffer will be maintained from all naturally vegetated geomorphic wetlands, therefore the project is unlikely to affect wetland vegetation.</p>
7) The clearing of the vegetation is likely to cause appreciable land degradation.	<p>Quarry management measures methods should ensure that runoff and erosion are contained.</p>

Clearing Principle Native Vegetation should not be cleared if....	Site Assessment: Proposed Sand Quarry, Holcim (Australia)
8) The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Quarry environmental management measures should ensure that indirect impacts (such as runoff, erosion and weed transport) to local conservation areas (such as conservation category wetlands and Bushforever Sites) are avoided.
9) The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	It is unlikely that there will be a significant impact on ground or surface water quality. Quarry management methods should ensure that runoff, spills and erosion are contained. Mining is unlikely to extend below the groundwater table.
10) The clearing of the vegetation is likely to cause or exacerbate the incidence or intensity of flooding.	Quarry management measures should address impacts of surface runoff and minimise the risk of flooding.

6 LIMITATIONS

There are a number of limitations that may arise during flora and vegetation surveying. These survey limitations are addressed in Table 11 below.

Table 11: Consideration of Study Limitations

Limitation	Comment
Survey Intensity (In retrospect, was the intensity adequate?)	Survey intensity (desktop research followed by site visits in Autumn and Spring) follows EPA (2004) recommendations.
Competency/experience of the consultant(s) carrying out the survey.	The author has had significant experience in flora and vegetation surveys including desktop reviews, site inspections and report writing.
Scope. (life forms sampled etc).	All flora species observed during the site visits were identified, with a focus on searching for any significant species or TEC/PEC's during the survey.
Proportion of flora collected and identified (based on sampling, timing and intensity).	Only species which were not identifiable in the field were collected for further identification. This was deemed suitable for the type of survey undertaken.
Timing/weather/season/cycle.	Survey intensity (desktop research followed by a site visit in Autumn and Spring) follows EPA (2004) recommendations.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No disturbances affected the survey.
Completeness (e.g. was relevant area fully surveyed) and further work which might be needed.	Desktop study covered proposed clearing area. Site inspection covered all areas of proposed disturbance. No further work is currently deemed necessary.
Resources (e.g. degree of expertise available in flora identification to taxon level).	Appropriate resources were used. Most specimens identified to species level.
Mapping reliability.	All mapping completed is deemed reliable. Hand held GPS used to record coordinates and mapping done using professional GIS system.
Access problems.	No access problems encountered.
Sources of information and availability of contextual information (i.e. pre- existing background versus new material).	Extensive regional and local information was available and was consulted. DPaW Threatened Flora, Fauna and TEC Databases were searched and the author had conducted several previous studies in the region.

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8 GIS DATASET CITATIONS

Table 12: GIS Dataset Citations.

Reference No.	Dataset (short name)	Citation
4A	Australia TOPO250K Layers	GEODATA TOPO 250K Series 3 Topographic Data, Geoscience Australia. Publication date June 2006.
10A	(ESA) Environmentally Sensitive Areas	Clearing Regulations – Environmentally Sensitive Areas (ESA), Department of Environment and Conservation Western Australia. Publication date 12/05/2011.
10F	DPaW Managed Lands	DPaW Managed Lands and Waters, Department of Environment and Conservation Western Australia. Publication date 05/10/2013.
17C	Roads (LGATE-012)	WA Road Network, Geographic Services, Landgate. Access date 25/07/2013.
21AF	DoW Linear Hydrography	DoW Linear Hydrography, Department of Water, WA. Download date 04/10/2013.

Notes: Citations are sourced from the metadata that accompanies the dataset. If no metadata is available, the citation appears in grey text.

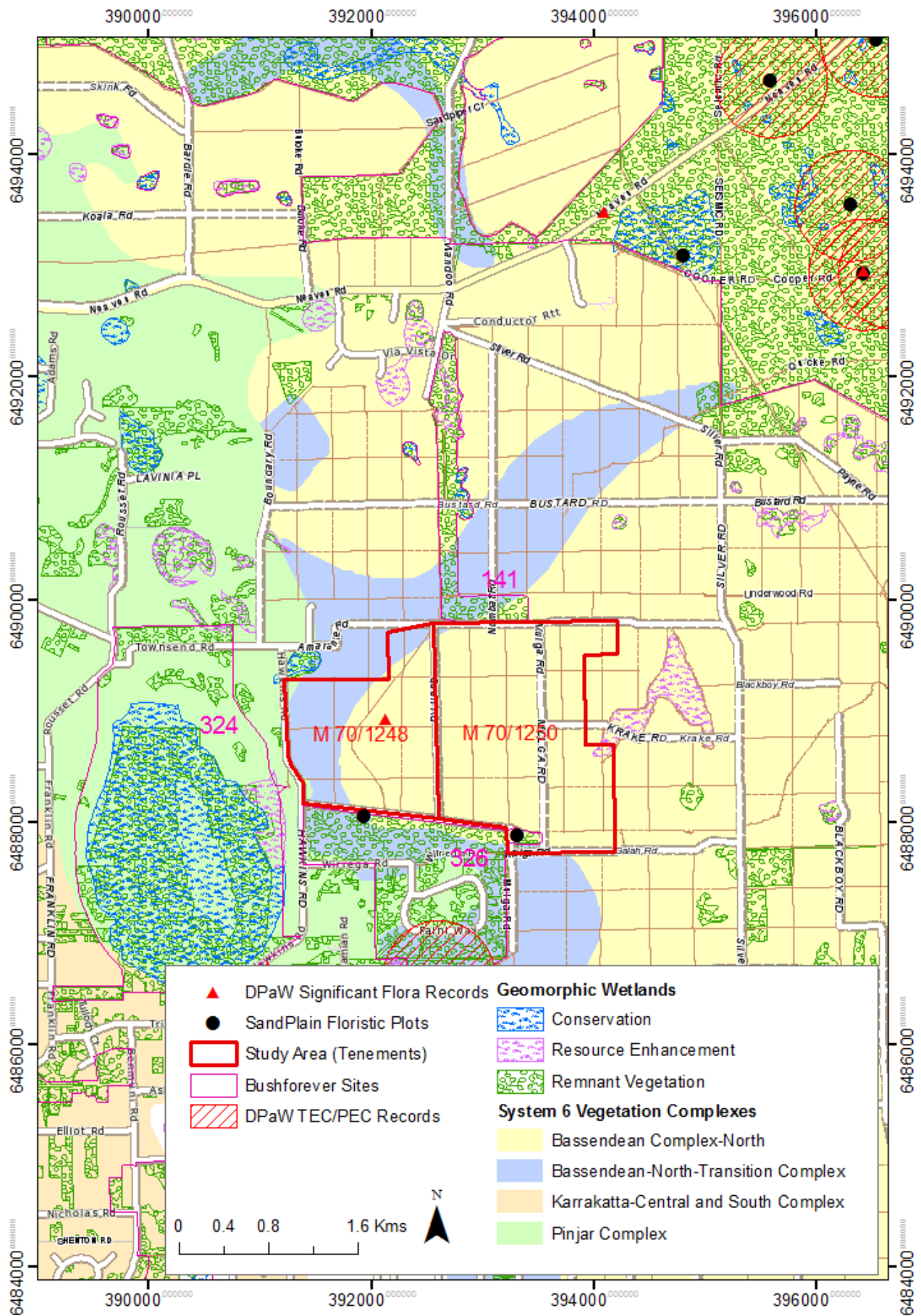


Figure 1: Location of Tenements and Ecological Context.

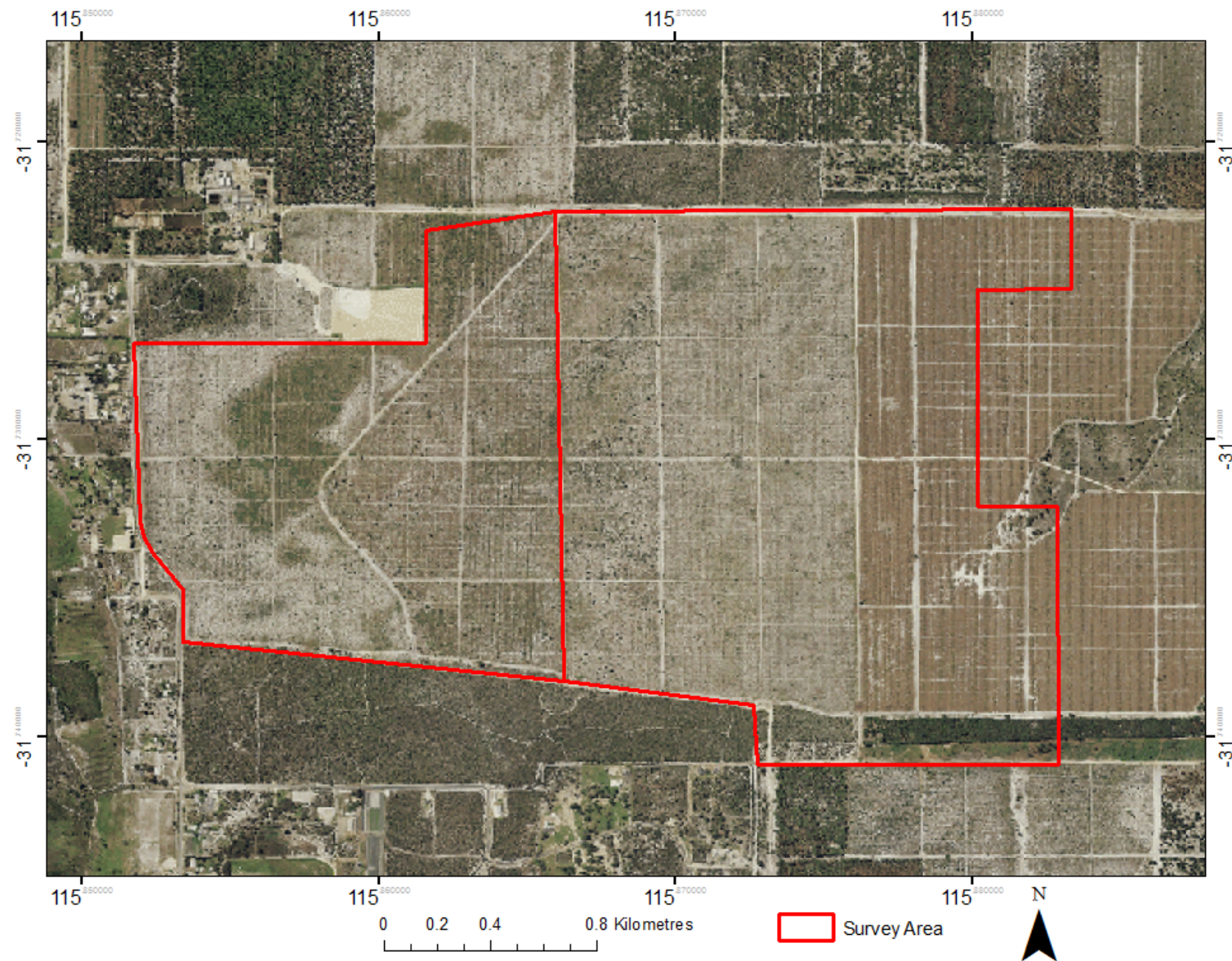


Figure 2: Regional Aerial Photography, September 2013.

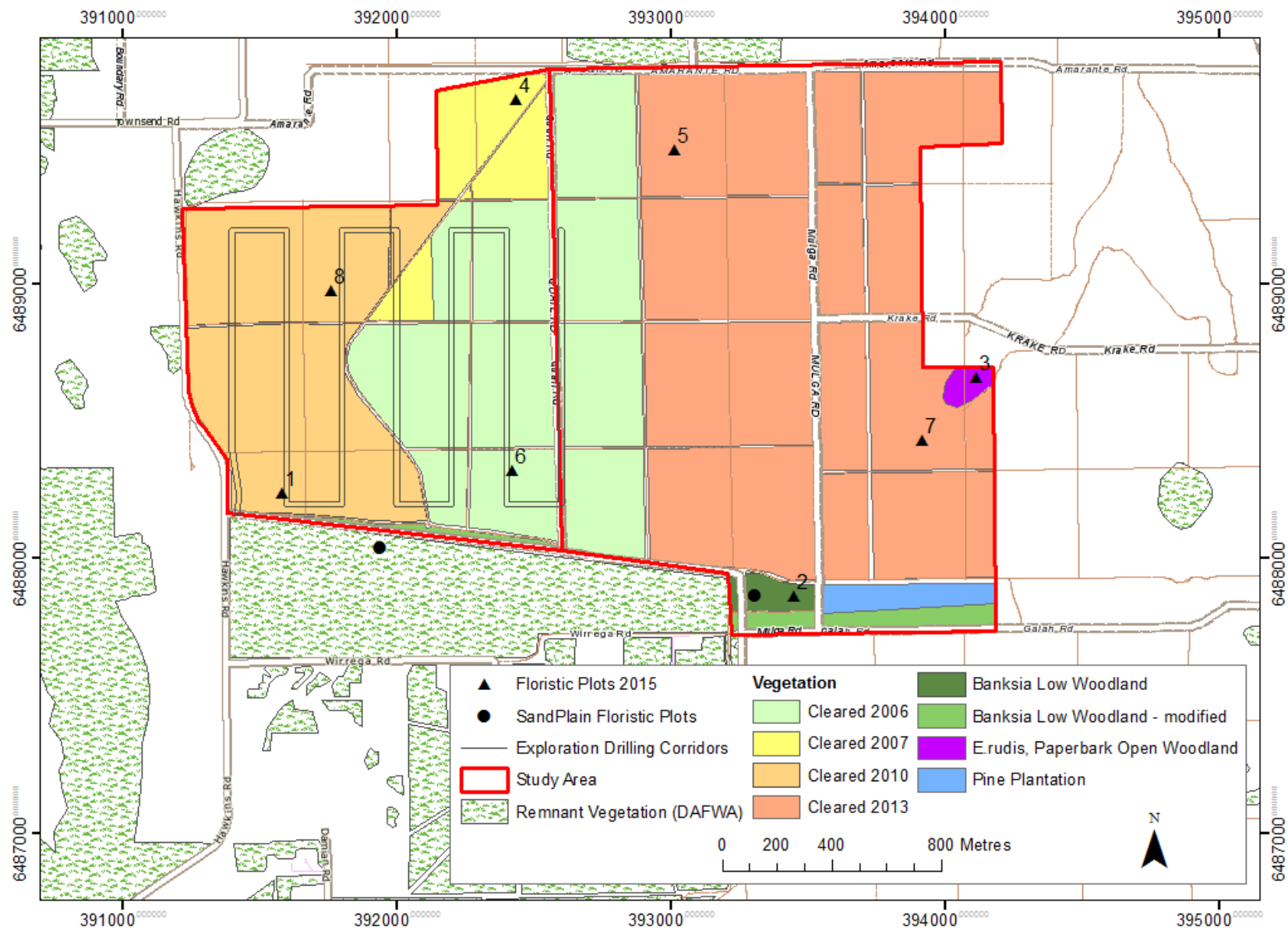


Figure 3: Plant Community Mapping.

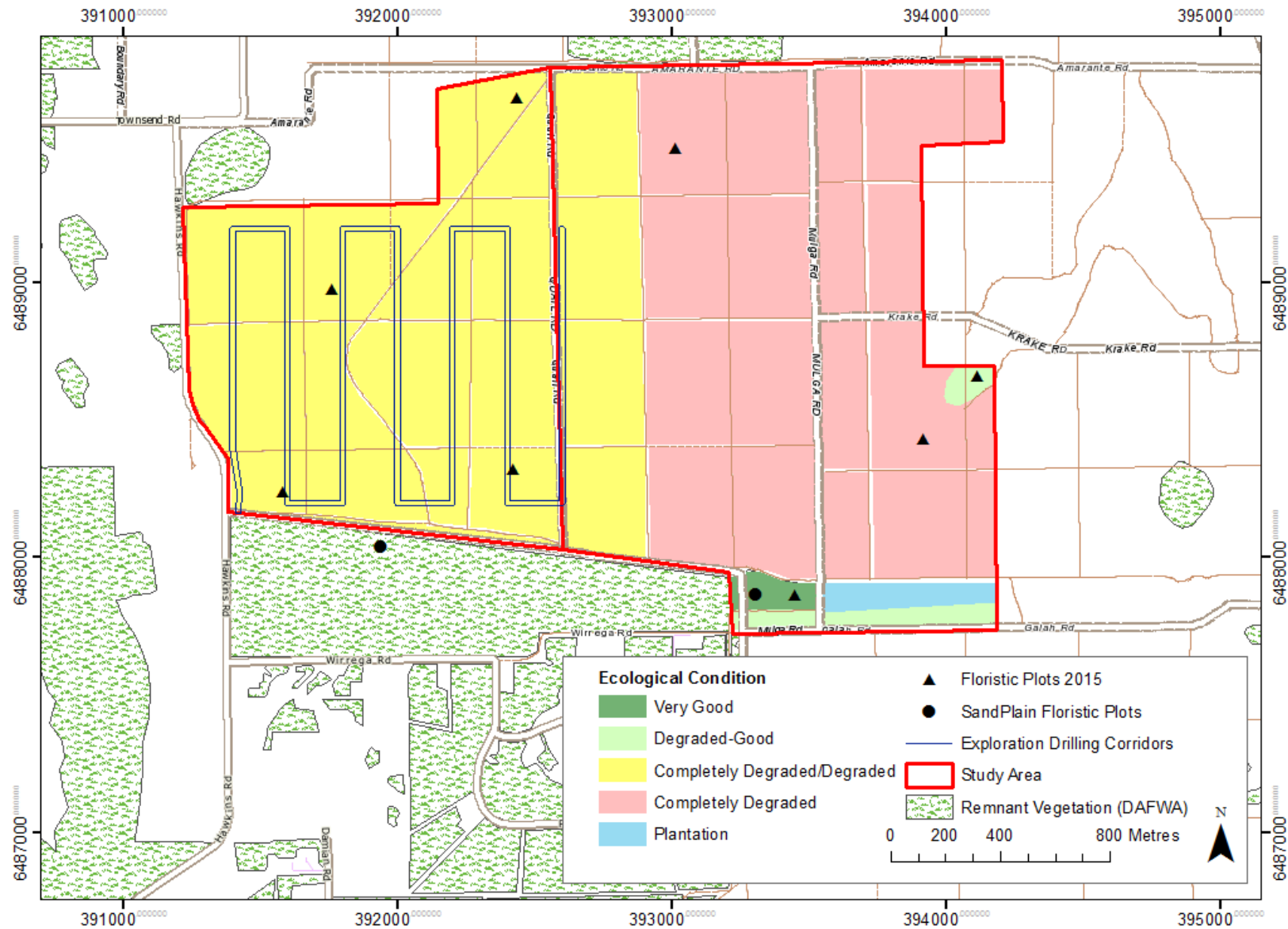


Figure 4: Ecological Condition.

APPENDIX A. CRITERIA USED FOR THE ASSESSMENT OF REMNANT VEGETATION CONDITION (KEIGHERY, 1994)

Rating	Criteria
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact; disturbance affecting individual species; 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; 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; 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; 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.

APPENDIX B. PLANT COMMUNITY STRUCTURAL FORMATION AND HEIGHT CLASSES (MUIR, 1977)

LIFE FORM/ HEIGHT CLASS	CANOPY COVER			
	Dense 70% - 100%	Mid-Dense 30% - 70%	Sparse 10% - 30%	Very Sparse 2% - 10%
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee Tree Form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee Shrub Form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 – 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 – 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat Plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock	Dense Hummock	Mid-dense Hummock	Hummock	Open Hummock
Grass	Grass	Grass	Grass	Grass
Bunch grass >0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < .5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

APPENDIX C. QUADRAT LOCATIONS

Quadrat	Easting	Northing
1	391586	6488241
2	393453	6487863
3	394118	6488663
4	392439	6489673
5	393016	6489491
6	392425	6488321
7	393918	6488431
8	391762	6488978

APPENDIX D. SPECIES LIST

Family	Species	1	2	3	4	5	6	7	8
Agavaceae	*Yucca aliofolia								
Aizoaceae	*Carpobrotus edulis		1	1				1	
Anarthriaceae	Anarthria prolifera			1					
Apiaceae	Daucus glochidiatus								1
	*Foeniculum vulgare								
	Xanthosia huegii		1	1	1				
Araliaceae	Trachymene pilosa		1	1	1			1	1
Asparagaceae	*Agave americana								
	Laxmannia ramosa								
	Laxmannia squarrosa			1		1			
	Lomandra hermaphrodita		1	1					
	Sowerbaea laxiflora			1		1			1
	Thysanotus manglesianus								
Asphodelaceae	*Asphodelus fistulosus								
	*Trachyandra divaricata								
Asteraceae	*Arctotheca calendula		1				1	1	1
	*Centaurea melitensis								
	*Dimorphotheca ecklonius								
	*Dittrichia viscosa								
	*Gazania linearis								
	Hyalosperma cotula			1				1	
	*Hypochaeris glabra								
	Lagenophora huegii			1				1	
	Millotia myosotidifolia								
	Pithocarpa pulchella			1					
	Podotheca chrysantha								1

Family	Species	1	2	3	4	5	6	7	8
	Podotheca gnaphalioides			1		1		1	1
	Quinetia urvillei		1	1					
	Siloxeros humifusus								
	*Sonchus asper								
	*Sonchus oleraceus							1	1
	*Tolpis barbata								
	*Ursinia anthemoides		1			1		1	1
	*Verbesina encelioides								
	Waitzia suaveolens								
Brassicaceae	*Brassica tournefortii								
	*Coronopus didymus						1	1	1
	*Diplotaxis muralis								
	*Raphanus raphanistrum					1	1		1
Campanulaceae	Lobelia tenuior						1		1
	*Wahlenbergia capensis					1	1		
	Wahlenbergia preissii								
Caryophyllaceae	*Petrohragia velutina								
	*Polycarpon tetraphyllum								
	*Spergularia diandra								
Casuarinaceae	Allocasuarina fraseriana								
	Allocasuarina humilis					1		1	
Celastraceae	Tripterococcus brunonis								
Colchicaceae	Burchardia congesta			1					
Commelinaceae	Cartonema philydroides								
Convolvulaceae	*Ipomoea cairica								
Crassulaceae	Crassula colorata					1		1	1
	*Crassula glomerata		1			1	1	1	1
Cyperaceae	Caustis dioica								
	Lepidosperma longitudinale				1				
	Lepidosperma squamatum		1	1					
	Mesomelaena pseudostygia		1		1		1		

Family	Species	1	2	3	4	5	6	7	8
Dasypogonaceae	Schoenus curvifolius		1					1	
	Calectasia narragara								
	Dasypogon bromelifolius			1	1		1		1
Dilleniaceae	Hibbertia huegii								
	Hibbertia hypericoides	1	1				1	1	1
	Hibbertia subvaginata		1						
	Hibbertia vaginata	1							
Droseraceae	Drosera erythrorhiza			1					
	Drosera menziesii subsp. menziesii				1				
	Drosera sps (indet.)								
Ericaceae	Astroloma macrocalyx								
	Astroloma xerophyllum			1					
	Conostephium pendulum			1					
	Leucopogon australis								
	Leucopogon conostephioides			1					
	Leucopogon polymorphus								
	Leucopogon squarrosus								
	Styphelia tenuiflora			1					
Euphorbiaceae	*Euphorbia australis								
	*Euphorbia terracina		1					1	
	*Ricinis communis								
Fabaceae	Acacia huegii		1						
	*Acacia iteaphylla								
	*Acacia longifolia var sophorae								
	Acacia pulchella	1	1				1		
	Acacia saligna	1				1		1	
	Acacia sessilis								
	Aotus gracillima								
	Bossiaea eriocarpa			1		1		1	1
	Daviesia divaricata					1	1	1	
	Daviesia physodes	1							1

Family	Species	1	2	3	4	5	6	7	8
Fabaceae	Daviesia triflora			1					
	Euchilopsis linearis								
	Gastrolobium capitatum			1			1		1
	Gompholobium tomentosum		1	1		1			
	Hardenbergia comptoniana		1			1		1	1
	Hovea pungens			1					
	Jacksonia floribunda			1		1	1	1	
	Jacksonia furcellata		1					1	
	Jacksonia sternbergiana		1						1
	*Lotus angustissimus								
	*Lupinus consentinii		1			1			1
	*Melilotus indicus								
	*Ornithopus compressus								
	Pultenaea reticulata								
	*Trifolium hirtum								
Geraniaceae	*Erodium botrys		1				1		
	*Erodium moschatum								
	*Pelargonium capitatum		1					1	1
Goodeniaceae	Dampiera lavandulacea								
	Dampiera linearis		1	1				1	
	Lechenaultia biloba								1
	Lechenaultia floribunda								
	Scaevola canescens								
Haemodoraceae	Scaevola repens var angustifolia			1					
	Anigozanthos humilis								1
	Anigozanthos manglesii			1		1			
	Conostylis aculeata		1	1			1	1	
	Conostylis juncea								
	Haemodorum spicatum		1	1				1	1
	Phlebocarya ciliata				1			1	1
	Tribonanthes australis					1			

Family	Species	1	2	3	4	5	6	7	8
Hemerocallidaceae	Tribonanthes longipetala				1				
	Caesia micrantha								
	Corynotheca micrantha					1			1
	Dianella divaricata							1	1
	Tricoryne elatior			1					
Iridaceae	*Freesia sp.								
	*Gladiolus caryophyllaceus		1	1	1			1	1
	Patersonia juncea								
	Patersonia occidentalis		1	1		1		1	1
	*Romulea rosea								
Lamiaceae	Hemiandra pungens								
Lauraceae	Cassytha glabella								
Loranthaceae	Nuytsia floribunda		1	1		1		1	
Molluginaceae	Macarthuria australis						1	1	1
	Astartea fascicularis								
	Calothamnus sanguineus								
	Calytrix angulata			1					
	Calytrix fraseri		1	1					
	Chamelaucium uncinatum								
	Eremaea pauciflora			1					
	Eucalyptus erythrocorys								
	Eucalyptus marginata								
	Eucalyptus rudis				1				
	*Eucalyptus saligna								
	*Eucalyptus sp (indet.)								
	Eucalyptus tottiana			1				1	1
	Hypocalymma angustifolium				1				1
	Hypocalymma robustum			1		1		1	1
	Hypocalymma xanthopetalum								
	Kunzea glabrescens				1				1
	*Leptospermum laevigatum								

Family	Species	1	2	3	4	5	6	7	8
Myrtaceae	Melaleuca preissiana				1				
	Melaleuca seriata							1	
	Pericalymma eliptica				1				
	Regelia ciliata								
	Scholtzia involucrata			1					
	Taxandria linearifolia								
	Verticordia densiflora var. densiflora								
	Verticordia nitens								
Onagraceae	*Oenothera drummondii								
Orchidaceae	Caladenia flava								
	Caladenia sps. (indet.)								
	Diuris sp (indet.)								
	Eriochilus dilatatus				1				
	Microtis media								
	Pyrorchis sp (indet.)								
Orobanchaceae	*Orobanche minor							1	
Oxalidaceae	*Oxalis pes-caprae						1		
Phyllanthaceae	Phyllanthus calycinus								
	Poranthera microphylla								
Phytolaccaceae	*Phytolacca octandra							1	
Pinaceae	*Pinus pinaster		1		1	1			
Plantaginaceae	*Plantago lanceolata								
Poaceae	*Aira caryophylloides								
	Austrostipa compressa								
	*Briza maxima		1		1	1	1		1
	*Ehrharta calycina		1			1		1	1
	*Eragrostis curvula								
	*Lagurus ovatus								
	Neurachne alopecuroides						1		1
	Rytidosperma occidentale		1						
	Comesperma calymega								
Polygalaceae									

Family	Species	1	2	3	4	5	6	7	8
Polygonaceae	*Emex australis								
Portulacaceae	Calandrinia linifolia								
Primulaceae	*Lysimachia minima								
Proteaceae	Adenanthos cygnorum var cygnorum		1	1			1		1
	Adenanthos obovatus								
	Banksia attenuata			1			1		1
	Banksia grandis								
	Banksia ilicifolia								
	Banksia menziesii			1					1
	Conospermum incurvum								
	Conospermum triplinervum								
	Hakea prostrata								
	Hakea varia				1				
	Persoonia saccata								
	Petrophile linearis			1			1		
	Stirlingia latifolia			1		1		1	1
Restionaceae	Alexgeorgea nitens			1					
	Desmocladius flexuosa			1					
	Dielsia stenostachya				1				
	Hypolaena exsulca								
	Loxocarya cinerea				1				
	Lyginia barbata		1	1	1				
	Meeboldina coangustata								
Rutaceae	Philotheca spicatus					1			1
Scrophulariaceae	*Verbascum virgatum								
Solanaceae	*Solanum nigrum		1				1	1	1
Stylidiaceae	Levenhookia stipitata			1					
	Stylidium brunonianum			1					
	Stylidium calcaratum								
	Stylidium repens				1				
	Stylidium schoenoides			1					

Family	Species	1	2	3	4	5	6	7	8
Thymeleaceae	Pimelea imbricata var piligera								
Violaceae	Hybanthus calycinus								
Xanthorrhoeaceae	Xanthorrhoea preissii		1	1	1	1	1	1	1
Zamiaceae	Macrozamia fraseri		1					1	