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Ad unit

BUSSELTON DEPOSIT,

WILLMOTT PROPERTY.

REMNANT VEGETATION,

ECOLOGICAL APPRAISAL 2.

Prepared by

Hart, Simpson and Associates Pty Ltd

for

Westralian Sands Limited

December 1997

CONTENTS.

1. SUMMARY.

Westralian Sands Limited is mining the Busselton Deposit approximately 5km south-east of Busselton. The property includes small areas of remnant vegetation near the mining area. An ecological appraisal of this remnant vegetation was carried out in September 1996, with further studies of the main remnant in September and November 1997. The surveys examined the landforms, flora, vegetation and vertebrate fauna to look at the conservation values of the remnant vegetation, and to provide information for environmental management of the mining and remnant vegetation.

The remnant vegetation is on private property and was open to the surrounding paddocks and grazing. The main block of remnant vegetation is roughly triangular and occupies approximately 20ha. It is surrounded by cleared pasture except for the southern end where there is some adjoining parkland cleared native vegetation of little value. The study was virtually restricted to this main remnant of good vegetation.

The main remnant is a very low dune with a wetland in the centre. The vegetation consists of Banksia woodland and Jarrah-Marri-Banksia woodland on sand, and myrtaceous trees and shrubs in the wetland. These vegetation units are common and well conserved, although there has been extensive clearing locally and regionally. The vegetation, particularly the Banksia woodland, has been affected by grazing which has reduced the density of the vegetation, and caused loss of species and weed invasion. The wetland area is affected by dieback due to *Phytophthora cinnamomi*, and there has been a high impact around the edge of the wetland. Quantitative studies were carried out in September 1997 to provide information on species diversity and plant density. The vegetation is numerically dominated by perennial herbaceous species.

Much of the flora has been identified or collected, and a partial field herbarium was established. A total of 159 native species from 105 genera and 38 families was found. A previously unknown population of the Declared Rare Flora species *Drakaea elastica* (a small orchid) was found. This population is larger than all other known populations combined, and gives the remnant a very high conservation value. Three other rare plant species were found but none of these are of great significance.

A list of the vertebrate fauna which may occur was drawn up from the habitats, and an opportunistic survey of the fauna was carried out in November 1997. One Schedule 1 rare mammal is present (the Ring-tailed Possum) and various other rare species may be present, but most are birds which would make occasional use of the property.

The remnant has a very high conservation value on the basis of the presence of the rare orchid alone. It has now been fenced off, and is being protected. The parkland cleared area at the southern end has little value and does not need to be protected.

The quantitative results provide information which will be useful in rehabilitation.

2. INTRODUCTION.

Westralian Sands Limited is mining the Busselton Deposit approximately 5km south-east of Busselton, on the Willmott property. The property includes small areas of remnant vegetation near the mining area. An ecological appraisal of this remnant vegetation was commissioned in September 1996, and more detailed studies of the main remnant were carried out in September and November 1997. These surveys examined the landforms, flora, vegetation and vertebrate fauna to look at the conservation values of the remnant vegetation, and to provide information for environmental management of mining.

Specifically the surveys were designed to:

- Examine the flora of the remnant vegetation.
- Determine if any rare plant species are present or likely to be present.
- Identify the landform and vegetation units present.
- Record the condition of the vegetation, including the presence of *Phytophthora* dieback.
- Provide quantitative information on species diversity and the density of plants for use in rehabilitation.
- List the vertebrate fauna species which are actually present, or might be present on the basis of the habitats.
- Determine the conservation values of the remnants in both a local and regional context, and their impact on the mining.

The results of all the work to date are given here.

3. METHODS.

A listing of rare flora species known from the region was obtained from the Department of Conservation and Land Management rare flora database and other information, and the habitats of species which might be present were examined from collections in the W.A. Herbarium.

The remnant vegetation was examined by making extensive traverses on foot. The landforms and vegetation were described in general terms in the initial study. The condition of the vegetation was recorded by looking at disturbance, the diversity of species, dieback, weeds, grazing and other factors, and rated on the scale of Keighery (1994) which is a scale of 1 to 6:

1. Pristine or nearly so.

2. Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.

3. Vegetation structure altered, obvious signs of disturbance.

4. Vegetation structure significantly altered by very obvious signs of multiple disturbance, retains basic vegetation structure or ability to regenerate it.

5. Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.

6. The structure of the vegetation is no longer intact and the area is completely or almost without native species.

The entire native flora was collected as far as possible, concentrating on possible rare species. Species were identified in the field or collected and identified from keys and reference to material in the W.A. Herbarium. A partial field herbarium was also set up. Weeds were only recorded if they were actually within the native vegetation.

The vertebrate fauna species which could be expected to occur in the vegetation were listed from the habitats, local knowledge and general information on the habitat preferences of the species. This list was drawn up conservatively to detect all species of interest which might be present.

The first field survey was carried out over one and a half days in spring (19-20/8/96) at a time when the vegetation was in good condition and many species were flowering.

In September 1997 further flora collecting was carried out in the main remnant, and a quantitative study of this vegetation was carried out over four days (4-7/9/97). The quantitative survey was carried out by listing all species in plots of 10m x 10m, counting the trees in the 10m x 10m plots, and counting all individuals except trees in sub-plots of $20m^2$ except weeds. These sub-plots were either 2m x 10m down one side of the larger plots or two sub-plots of 1m x 10m down two opposite sides, depending on the density of the vegetation. The narrower plots were eventually adopted as the standard because of the practical problems of counting individuals in wider plots. Trees were recorded as seedlings if they had a woody stem and were less than 2m tall. Small seedlings which had not yet survived a summer season were not counted as these were judged to have a small chance of establishment.

In November 1997 an opportunistic survey of the vertebrate fauna was carried out over parts of four days. This included raking leaf litter, turning over logs, listening for calls, searching for droppings or other signs, and direct observation.

4. RESULTS.

4.1 Landforms and vegetation.

The site lies on the coastal plain (Figure 1, next page) and the main remnant vegetation area consists of very low sand dunes and a small wetland in the centre (Figure 2, page 7). One other remnant was very degraded and was not examined in any detail (a block north-west of the main study area shown in Figure 2). The main study area is a remnant on private property which has not been cleared but was partly open to the surrounding paddocks and was used for grazing. The block is roughly triangular and occupies approximately 20ha. It is surrounded by cleared pasture except for the southern end where there is some adjoining parkland cleared native vegetation of little value. This parkland cleared area is the southern strip of about 4ha of the study area shown in Figure 2. It has almost no understorey and was not examined further.

The soils are all sandy but range from grey sand on the more elevated parts to peaty sand in the wetland. The vegetation was divided into three natural areas:

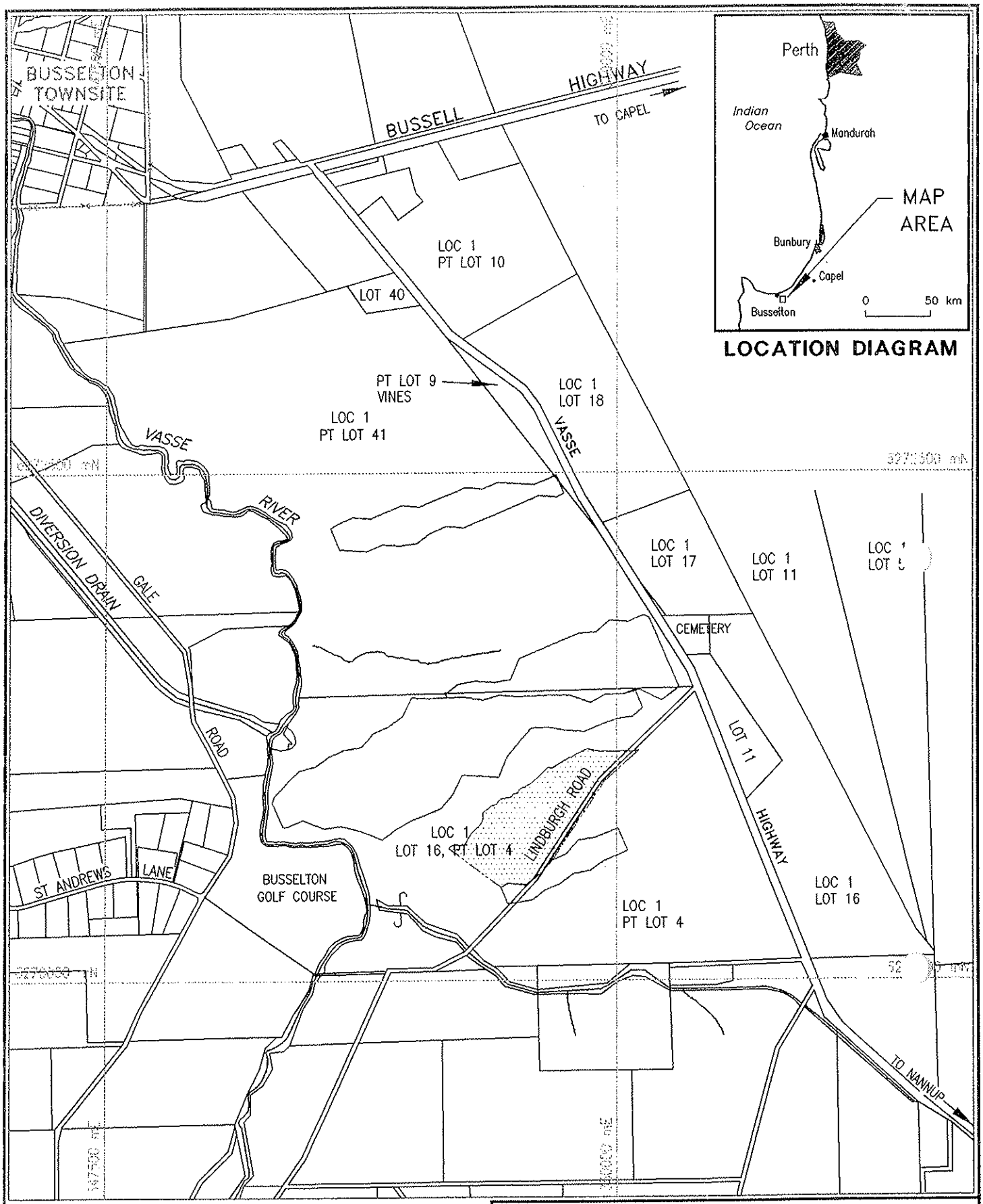
1. A Banksia woodland dominated by *Banksia attenuata* and *Banksia ilicifolia*, with occasional individuals of *Nuytsia floribunda* and *Agonis flexuosa*, over a diverse but sparse and variable shrub and ground stratum The understorey of shrubs, sedges and herbs has been greatly affected by grazing. This vegetation occurs on a very low sandy dune surface which is almost flat. *Banksia ilicifolia* is most common in the low-lying parts.

2. A wetland with scattered trees of *Melaleuca preissiana* over a myrtaceous shrub stratum dominated by *Pericalymma ellipticum*, with a ground stratum of small shrubs, sedges and herbs. Extensive water was present in spring. The soil is peaty sand. This unit grades into the Banksia woodland but the boundary has been severely affected by dieback.

3. A Jarrah-Marri-Banksia woodland with trees up to 20m. The tallest trees are Jarrah and Marri, with a lower tree stratum of *Banksia attenuata*, *Xylomelum occidentale*, *Nuytsia floribunda*, *Banksia grandis* and *Persoonia longifolia*. There is a sparse but diverse shrub and ground stratum. This unit occurs on grey sand but is slightly more elevated than the adjacent Banksia woodland.

The vegetation changes towards the northern end with more *Agonis flexuosa*, but this has not yet been studied.

Typical photographs of the vegetation are given in Plates 1-4 (pages 8 and 9)



LOCATION DIAGRAM

LEGEND

ORE ZONE

REPORT STUDY AREA

0 500 1000

METRES

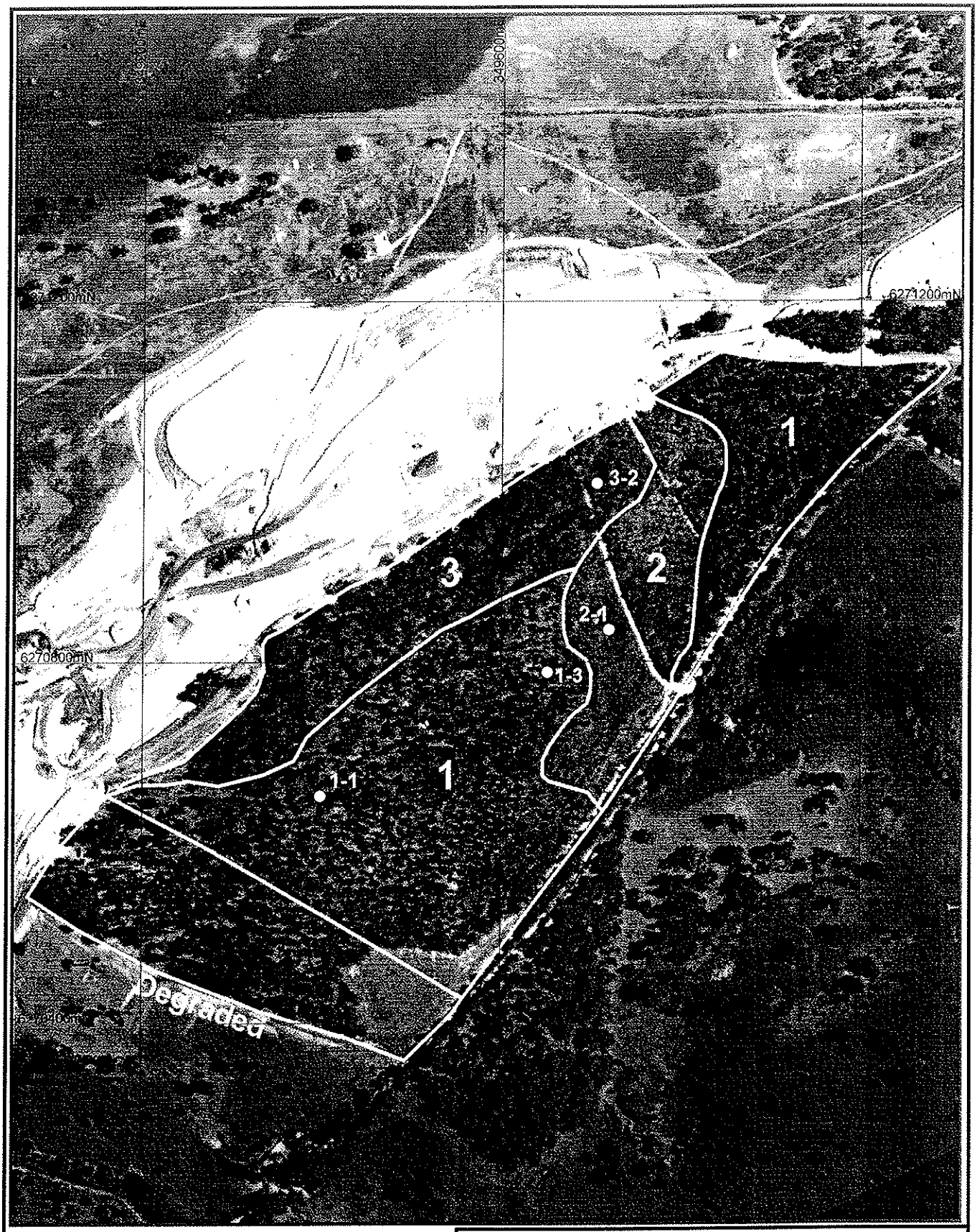
Westralian Sands Limited

BUSSELTON

PROJ AREA :

TITLE : **REPORT STUDY AREA**

DESIGN : N.McMULKIN	SCALE 1: 25 000	**FIGURE 1**
DRAWN : J.C.H.	DATE : 5 FEB 1997	DRG.No: BSR0013A



Vegetation Units

○ Vegetation Plots

N

0 100 200 300 Meters

Westralian Sands Limited

BUSSELTON

TITLE :

VEGETATION STUDY AREAS

DESIGN : N.McMULKIN	SCALE : 1 : 6000	REF:
DRAWN : D.G.S.	DATE : 19 March 1998	DWG No :BSR0028A

PLATE 1. Typical Banksia woodland (Plot 1-1).

PLATE 2. A variant of the Banksia woodland with many *B. ilicifolia* (Plot 1-3).

PLATE 3. The wetland vegetation (Plot 2-1).

PLATE 4. The Jarrah-Marri-Banksia woodland (Plot 3-2).

The results of the quantitative vegetation study plots are given in Appendix 1 and the plots are illustrated in Plates 1-4. Eight plots were laid out but only four of these were recorded. Their locations are given in Figure 2. Two plots were recorded in the Banksia woodland to cover the normal Banksia woodland and a variant with large numbers of *Banksia ilicifolia*. Single plots were recorded in the wetland and Jarrah-Marri-Banksia. The other plots were set up to provide some replication and study of the variation within the vegetation, but these were not monitored for lack of time.

The plots monitored were:

1-1 Typical *Banksia attenuata* woodland.

1-3 *Banksia attenuata* woodland in a relatively low area with numerous *Banksia ilicifolia*.

2-1 Wetland.

3-2 Jarrah-Marri-Banksia woodland.

4.2 Flora.

All plant species recorded are listed in Appendix 2. The weed species are also identified. One additional species, the common prostrate creeper *Kennedia prostrata*, was found in the badly degraded remnant to the north-west but is not listed in Appendix 2 although it is likely to occur in the main remnant considered here.

If a specimen was collected the field herbarium number is also given. The species are listed as occurring in the three vegetation units defined above.

Appendix 1 lists a native flora of 159 species in 105 genera and 38 families. In addition there are 16 weed species listed in 16 genera and 9 families, giving a total flora of 176 species in 121 genera and 42 families. In the native flora the most diverse groups are the orchids (21 species), and the woody trees and shrubs of the Proteaceae (16 species), Papilionaceae (15 species) and Myrtaceae (12 species). These are the typical dominant families of the coastal plain woodlands. The largest genera are *Stylidium* (7 species), *Acacia* and *Lomandra* (6 species each) and *Drosera* (5 species).

Appendix 2 is not a complete list of the flora, but probably includes the great majority of the perennial flora and most of the ephemeral flora.

Most of the species in Appendix 2 are common or widespread. There were previously known occurrences of a variety of rare flora species in the general area, but not on the property considered here. Specific searches were made for rare species which might occur in the remnant vegetation.

The rare species found were:

- *Drakaea elastica*, a small orchid which is a Declared Rare Flora species, previously known from small and scattered populations from Busselton to Gingin. The population found here is larger than all other populations combined, and is a find of major significance.

- *Synaphea hians* (Priority 3), a recently described small shrub known from Ludlow to Collie.

- *Acacia semitrullata* (Priority 3), a small shrub known from the Yallingup, Donnybrook to Yarloop area. It is widespread in the Busselton area.

- Jacksonia sparsa (Priority 3), a tall shrub known from the Busselton area.

Stachystemon aff. *axillaris* (4583) is an undescribed species represented in the W.A. Herbarium by a specimen collected previously from Whiteman Park, and is probably poorly collected rather than rare. *Stachystemon axillaris* is a Priority 4 known from Perth northward.

Declared Rare Flora species have specific legal protection, and cannot be disturbed in any way without a special licence. Priority 3 species are defined by CALM as "Poorly known taxa. Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (ie. not currently endangered), either due to the number of populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey".

Both the first two priority 3 species were present as scattered plants over much of the main remnant, while Jacksonia sparsa was common and widespread.

Weeds were a major element of the flora, with 16 species recorded although others were present. The weeds are herbaceous and grass species which are all common locally and regionally. Many other weeds were present on the fringe and in the adjacent pasture areas, and the total number of species present in and around the remnant is much larger than shown in Appendix 2. These weed species are all common and widespread in the region and cannot be controlled locally or in small sites.

4.3 Condition and dieback.

Dieback due to *Phytophthora cinnamomi* was clearly present in the wetland where it has caused a very high impact. The disease has altered the vegetation around the edge of the wetland by moving back the boundary of the Banksia individuals. Some shrub species would have also been affected in the same way. The extent of the disease was not mapped but it did not appear to have spread far from the wetland. There are few susceptible species in the wetland proper but the fringe is highly susceptible. There are numerous highly susceptible species in the Banksia woodland and to a lesser extent in the mixed woodland. There was no evidence of dieback in the *Banksia attenuata* woodland or the Jarrah-Marri-Banksia woodland except on the fringes, although it could be present.

The vegetation, particularly the Banksia woodland, has been severely affected by grazing, with a reduction in the density of the vegetation and probably a selective loss of species. The grazing has been by stock and rabbits. There has also been minor physical disturbance including pipe laying and track making.

Weeds are a significant component of the vegetation, and are present as a result of the grazing and other disturbances. Within the good native vegetation the weeds tend to be scattered or concentrated in small disturbed sites, and they are often stunted.

In total the conditon of the vegetaton units was rated as

Banksia woodland	2-3
Wetland	3-4
Jarrah-Marri woodland	2-3.

The parkland cleared area to the south has almost no understorey, and is in poor condition.

A small part of the site in the southern corner was mined and rehabilitated in 1997 (see Figure 2)..

4.4 Fauna.

Appendix 2 lists all the vertebrate fauna species which may occur in the remnant vegetation or were actually found in November 1997. The total number of species which actually occurs there is not known. The remnant has been affected by grazing and the understorey has been reduced, and this condition of the vegetation reduces the value of the habitat for fauna. The main remnant is isolated and this will also reduce the chance of finding some of the terrestrial species.

Most of the species listed in Appendix 3 are common or widespread. The following species with a classified conservation status are or may be present:

- Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), which is gazetted under Schedule 1 of the Wildlife Act as "Rare or likely to become extinct". This species breeds primarily in the northern and eastern parts of its range and tends to move to the coastal belt when not breeding where it feeds on native shrubs and trees (particularly proteaceous species) as well as pine trees. It is threatened primarily by loss of tree hollows for breeding, particularly in the wheatbelt. This species is probably present on the property considered here as a casual visitor, but the remnants cannot be considered as essential to its survival.

- Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*), which is gazetted under Schedule 1 of the Wildlife Act as "Rare or likely to become extinct". This species is primarily a forest dwelling species which eats the seeds of Marri and other eucalypts. It is not common and has declined due to destruction as a pest in orchards, but appears to be secure since much of its forest habitat is still available. This species would be a regular visitor to the property considered here.

- Western Ringtail Possum (*Pseudocheirus occidentalis*) which is gazetted under Schedule 1 of the Wildlife Act as "Rare or likely to become extinct". This species is widespread in the South-West but very rare in almost all areas. The Busselton region is one of the few areas where it is still common. It is primarily associated with Peppermint trees, and can survive in even severely degraded native vegetation as long as the critical habitat features are present. It was found to be present in both the Banksia woodland and the Jarrah-Marri-Banksia woodland vegetation on the basis of its droppings, but it is not known how many individuals are present.

- The Carpet Python (*Morelia spilota imbricata*) which is gazetted under Schedule 4 of the Wildlife Act as "Other specially protected fauna". This species is widespread in the South-West of W.A., where it occurs in a variety of habitats. It is usually found under logs or rocks and may even be found around human settlements (Wilson and Knowles 1988). It could be present in the site considered here, but the area is probably too developed and isolated for it to survive as a long-term resident. This species is not endangered in total and is mainly gazetted to protect it from illegal killing and capture, particularly where it is mistaken for large venomous species.

- The Peregrine Falcon (*Falco peregrinus*), which is gazetted under Schedule 4 of the Wildlife Act as "In need of special protection". The Peregrine Falcon is a widespread although uncommon species which is threatened by egg-shell thinning due to pesticides, illegal hunting as a pest, and capture for falconry and the cage trade (Kennedy 1990, Garnett 1992). Pesticides are a problem in only restricted areas and in Western Australia this species is uncommon but secure (Garnett 1992a). It would make regular but only incidental use of the property considered here, probably using the large trees as a convenient hunting platform when chasing other birds.

In addition to these species which have a formal gazetted conservation status, the Department of Conservation and Land Management also lists Priority species which are restricted, vulnerable or too poorly known to be considered for gazetting. These species have no special protection, but their presence is normally considered.

The only Priority species which might occur on the property is a Priority 4:

- The Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii*) which occurs primarily in the forest country to the east but would make regular use of the property for feeding.

Priority 4 species are defined as "Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands".

Introduced species are restricted to the Kookaburra and a suite of mammals found in all areas. No control of these is possible on a local scale.

5. DISCUSSION.

Conservation values.

The conservation values which could be given to the remnant vegetation derive from:

- The presence of rare species.
- The rarity and conservation status of the landforms, vegetation units and fauna habitats provided by the remnants.
- The value of the remnant vegetation in a local and regional context because of its position and regardless of its intrinsic value.

There were no previously known occurrences of rare plant species on the property, but a new and very important population of the Declared Rare Flora species *Drakaea elastica* was found in the main remnant vegetation. This species has specific legal protection, and the population should be protected. Three Priority 3 species were also found. These do not require any specific management as they are common enough, and would not in themselves be sufficient to stop any development of the block.

The number of orchid species was a feature of the flora. These have probably survived despite the grazing because orchids are bulbous and tolerate grazing relatively well. The thinning of the understorey by grazing may have favoured the orchids. The exact habitat requirements of *Drakaea elastica* are not understood as it is widespread but very rare and occurs in habitats which appear to be common and widespread but rarely support the orchid.

Rare fauna species are present or likely to be present on the property. The Western Ringtail Possum (*Pseudocheirus occidentalis*) is gazetted as a Schedule 1 species. This species is very rare in total but common locally. It appears to be able to persist as long as there are Peppermint trees, although its long term future locally is uncertain. It is threatened by habitat loss and predation. The predation is thought to be particularly serious when the animals are forced to the ground by breaking of the canopy as the trees are thinned out. The other rare species are mainly birds which would make occasional use of the property, and the remnant cannot be regarded as critical habitat for them.

The landforms and vegetation units are common and widespread in the region. The vegetation is the southern end of the Bassendean Dunes as used by Beard (1981) with a characteristic vegetation of Jarrah-Marri-Banksia woodland, Banksia woodlands or Melaleuca swamps. More recently Gibson *et al.* (1994) have further refined the divisions of the regional vegetation by looking at floristics. In their analysis the vegetation as described above and in Appendices 1 and 2 would probably represent Community Type 21b (Southern *Banksia attenuata* woodlands) for the Banksia woodland, and doubtfully a transition between 1b (Southern Marri woodland on heavy soils) and 21a (Central *Banksia attenuata* and Jarrah woodlands) for the mixed woodland, and Type 4 (*Melaleuca preissiana* damplands) for the wetland. All of these are well reserved in total, although not necessarily locally. Much of the native vegetation has been cleared locally and regionally for agricultural use.

At this stage it is not possible to identify smaller divisions of the vegetation with confidence and to assess their conservation status definitively.

The fauna habitats represented by these units are common, and accordingly there are few rare species.

The fauna species found to be actually present in the survey (Appendix 3) are all common locally and regionally. Although the survey was opportunistic rather than quantitative, relatively few terrestrial individuals were caught for the effort. This probably results from the small area, degree of isolation and poor condition of much of the vegetation with a reduced understorey. Many terrestrial species would be limited by the poor cover and limited feeding habitat given by the sparse understorey in places. The only important habitat component present is the Peppermint trees which are associated with the Western Ringtail Possum.

The remnant vegetation considered here is isolated and on private property, and has been partly degraded by grazing and dieback. It has and has never had any specific conservation purpose. Taken together these factors reduce its local and regional value to low.

The presence of the large population of the Declared Rare Flora species *Drakaea elastica* gives the main remnant a very high conservation value. The presence of the Schedule 1 mammal the Western Ringtail Possum also gives the remnant a high conservation value regionally. The other conservation values are less, and would not in themselves be sufficient to prevent any development of the remnant vegetation. The parkland cleared vegetation in the south does not have the same value because it has virtually no understorey, and it does not need to be protected.

Quantitative vegetation studies.

The quantitative results can be examined in various ways. The simplest and most useful summary is given in Table 1 (next page). This examines the numbers of individuals in the life form categories. The results have been adjusted to individuals/20m^2, with the trees calculated from the entire plot of 100m^2 and the unknowns added to the most likely categories (dicots to shrubs and monocots to perennial herbs). The trees include seedlings except those which have not yet survived a summer. The number of tree species shown in Table 1 is on over-estimate because the number from the whole plot has been taken.

The plots have not been replicated and there are differences between them (see Plates 1-4). Plot 1-1 has been heavily grazed but plot 1-3 has not and has a much denser understorey. Dieback may also have affected the results, with for example a deficiency of the Proteaceae in the wetland plot 2-1. The results in Appendix 1 contain much information about individual species, but this needs to be treated cautiously without replication.

Taking the results at face value, Table 1 shows that:

- The total density of plants is very high with the values of plants/m^2 varying from 18 in the Jarrah-Marri-Banksia woodland to 116 in the low-lying Banksia woodland.

- The tree species, although they are dominant structurally except in the wetland, are represented by few species or individuals.

- The shrubs are both less numerous and fewer in species than the perennial herbs, but are visually more conspicuous in the total vegetation.

- The perennial herbs dominate in both the number of species and the density of individuals, and they provide more than half of all the species and individuals in every plot.

- The perennial herbs are dominated by a small number of very common species including the small lily *Chamaescilla corymbosa*, two orchids (*Leporella fimbriata* and *Pyrorchis nigricans*), a small sundew, three sedges and rushes, *Lomandra hermaphrodita*, *Phlebocarya ciliata* and one triggerplant. These very high numbers obscure some of the summary results.

- The annual herbs and native grasses contribute little to the total vegetation in either species or numbers of individuals. The two most common species, *Trachymene pilosa* and *Quinetia urvillei*, are very small herbs.

TABLE 1. Numbers of individuals and minimum number of species (in brackets) in $20m^2$ by life form category in the quantitative plots, and the numbers of individuals of the most common species in each category.

	Plot 1-1	Plot 1-3	Plot 2-1	Plot 3-2
Life form				
Trees	3 (1)	9 (4)	0	4 (4)
Shrubs	88 (12)	169 (12)	166 (7)	53 (14)
Perennial herbs	705 (23)	2115 (31)	349 (20)	299 (23)
Annual herbs	128 (2)	11 (2)	82 (4)	11 (3)
Perennial grasses	23 (2)	8 (1)	2 (1)	0
Total plants/$20m^2$	947 (40)	2312 (50)	599 (32)	367 (44)
Total plants/m^2	47	116	30	18
Most common species:				
A. Shrubs.				
Calytrix flavescens		76		
Kunzea micrantha	30			
Hibbertia racemosa	10			
Melaleuca thymoides	10	48		
Pericalymma ellipticum			131	
Xanthorrhoea preissii				17
B. Perennial herbs.				
Chamaescilla corymbosa	90	1140		
Drosera sp. rosette		109		
Hypolaena exsulca			99	
Lepidosperma squamatum				42
Leporella fimbriata	151	184		
Lomandra hermaphrodita				56
Phlebocarya ciliata			77	
Pyrorchis nigricans		122		
Stylidium brunonianum	251	88		
Tetraria octandra				31

- The wetland is the least diverse vegetation type although not the least dense in numbers of individuals.

- The Jarrah-Marri-Banksia woodland has the least density of plants but is not species poor, with the second highest total of species.

- The two Banksia woodland units are similar, but also show clear differences in the density of individuals, species diversity and actual species present. Plot 1-1 has been grazed heavily while plot 1-3 has not, and this was clear in the density of the understorey (Plates 1 and 2).

- The sedges and rushes are most common in the wetland plot, but they are common in all plots and actually provide a higher proportion of the total number of individuals in the Jarrah-Marri-Banksia woodland plot than in the wetland plot:

	Plot 1-1	Plot 1-3	Plot 2-1	Plot 3-2
Plants of Cyperaceae and Restionaceae	72	71	159	114
% of all plants	8%	3%	27%	31%

- The results with the sedges and rushes need to be interpreted cautiously because they tend to occur in clumps of particular species and there are great differences between plots in which species are common. This is a diverse group of species which are only superficially similar and it is simplistic to assume that there is much in common between the species

- The *Lomandra* have six species in the plots but they are generally inconspicuous in the total vegetation. They are in fact a significant component of the flora in some cases:

	Plot 1-1	Plot 1-3	Plot 2-1	Plot 3-2
Plants of Lomandra	4	73	2	96
% of all plants	0.4%	3%	0.3%	26%

These results are of significance for rehabilitation and the following summary can be made:

- The high density of plants and species diversity provides some measure of what might be appropriate success criteria in revegetation with such communities. More information is needed on variability if the criteria are to be realistic, practical and attainable on a reasonable time scale.

- In general the tree and shrub strata contain fewer species and individuals than the perennial herbs, and these species are more readily established by seeding or planting of nursery stock.

- The perennial herbs are the most common and diverse but contain numerous species which are not readily regenerated by existing methods. Most of the common perennial herb species listed in Table 1 are in this category. There are 17 species of Cyperaceae, *Lomandra* and Restionaceae in Appendix 2, all of which are likely to be difficult to regenerate.

- The annual herbs and native grasses contribute little to the total vegetation but are likely to be readily regenerated.

Care is needed in setting any rehabilitation success criteria in relation to the total vegetation and more difficult components.

Management of the remnant vegetation.

The main remnant has now been protected from stock grazing, but requires continuing environmental management to maintain its values. This management needs to address:

- Long term protection.
- Grazing by rabbits.
- Dieback.
- Weed invasion.
- Fire management.

Consideration should be given to the presence of the Western Ringtail Possum by ensuring that the Peppermint is maintained, and is common in the small area rehabilitated after mining. Peppermint trees could also be planted anywhere that shelter belts are restored on the property or where any tree planting is carried out. The ultimate survival of the Possum will depend on the trees in the entire area including on other properties beyond the Company's control.

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APPENDIX 1. Plant species, numbers and the cover of strata recorded as:

1. Cover of strata in plots of 10m x 10m
2. Number of trees in plots of 10m x 10m.
3. List of all species recorded in plots of 10m x 10m.
4. Numbers of individuals of all species except trees recorded in sub-plots of $20m^2$, with the species in life form groups.

PLOT 1-1, SEPTEMBER 1997.

A. 10m x 10m	
Species	Number of individuals
TREES	
Banksia attenuata	6 + 8 seedlings
SHRUBS	
Acacia pulchella	
Allocasuarina humilis	
Astroloma ciliatum	
Bossiaea eriocarpa	
Calytrix flavescens	
Cassytha sp.	
Gompholobium tomentosum	
Hemiandra pungens	
Hibbertia hypericoides	
Hibbertia racemosa	
Hovea trisperma	
Jacksonia sparsa	
Kunzea micrantha	
Leucopogon propinquus	
Melaleuca thymoides	
Scaevola calliptera	
Stirlingia latifolia	
Synaphea hians	
Xanthorrhoea preissii	
PERENNIAL HERBS	
Burchardia congesta	
Caladenia flava	
Caladenia sp.	
Chamaescilla corymbosa	
Conostylis aculeata	
Desmocladus fascicularis	
Drosera pallida	
Eriochilus sp.	
Hypolaena exsulca	
Johnsonia pubescens	
Lagenifera huegelii	
Lepidosperma squamatum	
Leporella fimbriata	
Lomandra ?odora	
Luzula meridionalis	
Monotaxis occidentalis	
Patersonia occidentalis	
Pyrorchis nigricans	
Schoenus curvifolius	
Schoenus sp.	
Stylidium brunonianum	
Stylidium piliferum	
Stylidium repens	
Tetraria octandra	
?Thysanotus sp.	
Xanthosia huegelii	
ANNUAL HERBS	
Trachymene pilosa	

Quinetia urveillei	
PERENNIAL GRASSES	
Amphipogon turbinatus	
Austrostipa campylachne	
Tetrarrhena laevis	
WEEDS	
* Briza maxima	
* Hypochaeris glabra	
* Lolium sp.	
* Romulea rosea	
* Ursinia anthemoides	
Cover	
Banksia attenuata to 7m	10-30%
Tall shrubs 1-2m	10-30%
Shrubs <1m	10-30%
Sedges	1%
Grass (mainly weeds)	2-10%
Herbs	2-10%
B. 2m x 10m	
SHRUBS	
Acacia pulchella	2
Allocasuarina humilis	1
Cassytha sp.	4
Gompholobium tomentosum	2
Hemiandra pungens	7
Hibbertia hypericoides	5
Hibbertia racemosa	10
Hovea trisperma	3
Kunzea micrantha	30
Melaleuca thymoides	10
Stirlingia latifolia	3
Xanthorrhoea preissii	8
PERENNIAL HERBS	
Burchardia congesta	3
Caladenia flava	10
Caladenia sp. large	1
Chamaescilla corymbosa	90
Conostylis aculeata	4
Desmocladus fascicularis	41
Drosera pallida	46
Eriochilus sp.	1
Hypolaena exsulca	6
Lagenifera huegelii	7
Lepidosperma squamatum	19
Leporella fimbriata	151
Lomandra ?odora	4
Luzula meridionalis	2
Monotaxis occidentalis	1
Pyrorchis nigricans	3
Schoenus curvifolius	3
Stylidium brunonianum	251

Stylidium piliferum	28
Stylidium repens	7
Tetraria octandra	3
?Thysanotus sp.	12
Xanthosia huegelii	8
ANNUAL HERBS	
Trachymene pilosa	57
Quinetia urveillei	71
PERENNIAL GRASSES	
Amphipogon turbinatus	10
Austrostipa campylachne	6
Tetrarrhena laevis	7
UNKNOWN DICOTYLEDONS	3
UNKNOWN MONOCOTYLEDONS	4

A. 10m x 10m	
Species	
TREES	Number of individuals
Banksia ilicifolia	4 + 9 seedlings
Banksia attenuata	1 +28 seedlings
Agonis flexuosa	2 seedlings
Banksia grandis	1 seedling
SHRUBS	
Acacia huegelii	
Acacia pulchella	
Acacia semitrullata	
Andersonia caerulea	
Calytrix flavescens	
Dampiera linearis	
Dillwynia uncinata	
Eriostemon spicatus	
Gompholobium capitatum	
Hibbertia racemosa	
Jacksonia sparsa	
Leucopogon conostephioides	
Leucopogon glabellus	
Melaleuca thymoides	
Persoonia saccata	
Petrophile linearis	
Platytheca galioides	
Stachystemon aff. axillaris	
PERENNIAL HERBS	
Baxteria australis	
Burchardia congesta	
Caesia micrantha	
Caladenia flava	
Chamaescilla corymbosa	
Conostylis setigera	
Dasypogon bromeliifolius	
Drakaea sp.	
Drosera pallida	
Drosera sp. rosette	
Elythranthera brunonis	
Hypolaena exsulca	
Isotropis cuneifolia	
Johnsonia pubescens	
Leporella fimbriata	
Lomandra hermaphrodita	
Lomandra nigricans	
Lomandra suaveolens	
Lyginia barbata	
Monotaxis occidentalis	
Patersonia occidentalis	
Phlebocarya ciliata	
Pterostylis aff. nana	
Pterostylis sp.	
Pyrorchis nigricans	
Schoenus curvifolius	

Stylidium carnosum	
Stylidium brunonianum	
Stylidium piliferum	
Stylidium repens	
Thelymitra sp.	
Thysanotus ?manglesii	
Xanthosia huegelii	
ANNUAL HERBS	
Trachymene pilosa	
Quinetia urvillei	
PERENNIAL GRASSES	
Amphipogon turbinatus	
WEEDS	
* Hypochaeris glabra	
* grasses	
Cover	Cover (%)
Trees to 8m	30-70%
Tall shrubs 1-2m	10-20%
Shrubs <1m	30-40%
Sedges	2-10%
Grass (mainly weeds)	<1%
Herbs	2-10%
B. 1m x 20m	Number of individuals
SHRUBS	
Acacia huegelii	4
Calytrix flavescens	76
Dillwynia uncinata	1
Eriostemon spicatus	1
Hibbertia racemosa	2
Jacksonia sparsa	2
Leucopogon conostephioides	21
Leucopogon glabellus	6
Melaleuca thymoides	48
Persoonia saccata	1
Platytheca galioides	4
Stachystemon aff. axillaris	3
PERENNIAL HERBS	
Baxteria australis	2
Burchardia congesta	80
Caesia micrantha	7
Caladenia flava	46
Chamaescilla corymbosa	1140
Dasypogon bromeliifolius	3
Drakaea sp.	1
Drosera pallida	30
Drosera sp. rosette	109
Elythranthera brunonis	7
Hypolaena exsulca	22
Isotropis cuneifolia	5
Johnsonia pubescens	3
Leporella fimbriata	184

Lomandra hermaphrodita	17
Lomandra nigricans	51
Lomandra suaveolens	5
Lyginia barbata	40
Patersonia occidentalis	11
Phlebocarya ciliata	45
Pterostylis aff. nana	14
Pterostylis sp.	1
Pyrorchis nigricans	122
Schoenus curvifolius	6
Stylidium carnosum	9
Stylidium brunonianum	88
Stylidium piliferum	33
Stylidium repens	7
Thelymitra sp.	4
Thysanotus ?manglesii	1
Xanthosia huegelii	10
ANNUAL HERBS	
Trachymene pilosa	8
Quinetia urvillei	3
PERENNIAL GRASSES	
Amphipogon turbinatus	8
UNKNOWN DICOTYLEDONS	
UNKNOWN MONOCOTYLEDONS	12

A. 10m x 10m	
Species	
TREES	Number of individuals
None	
SHRUBS	
Acacia semitrullata	
Calothamnus quadrifidus	
Calytrix flavescens	
Cassytha sp.	
Dillwynia uncinata	
Jacksonia sparsa	
Kunzea glabrescens	
Kunzea micrantha	
Legume unknown	
Pericalymma ellipticum	
PERENNIAL HERBS	
Anigozanthos viridis	
Baxteria australis	
Chamaescilla corymbosa	
Conostylis setigera	
Cytogonidium leptocarpoides	
Dasypogon bromeliifolius	
Drakaea glyptodon.	
Drosera sp. rosette	
Elythranthera brunonis	
Hypolaena exsulca	
Johnsonia pubescens	
Lepidiosperma squamatum	
Lomandra nigricans	
Lomandra suaveolens	
Lyginia barbata	
Patersonia occidentalis	
Phlebocarya ciliata	
?Prasophyllum sp.	
Pterostylis aff. vittata	
Schoenus curvifolius	
Stylidium brunonianum	
Stylidium piliferum	
Stylidium repens	
Thelymitra pauciflora	
Xanthosia huegelii	
ANNUAL HERBS	
Drosera glanduligera	
Rhodanthe citrina	
Trachymene pilosa	
Quinetia urvillei	
PERENNIAL GRASSES	
Amphipogon turbinatus	
WEEDS	
* Hypochaeris glabra	
* Ornithopus sp.	
* Romulea rosea	
* Trifolium sp.	

* Ursinia anthemoides	
Cover	Cover (%)
Trees nil	
Tall shrubs 1-3m	1-2%
Shrubs <1m	30-70%
Sedges	10-30%
Grass (mainly weeds)	<1%
Herbs	10%
B. 1m x 20m	Number of individuals
SHRUBS	
Acacia semitrullata	4
Calothamnus quadrifidus	5
Calytrix flavescens	2
Cassytha sp.	9
Kunzea glabrescens	7
Kunzea micrantha	8
Pericalymma ellipticum	131
PERENNIAL HERBS	
Anigozanthos viridis	2
Baxteria australis	2
Chamaescilla corymbosa	6
Conostylis setigera	2
Cytogonidium leptocarpoides	22
Drakaea glyptodon	4
Drosera sp. rosette	15
Hypolaena exsulca	99
Johnsonia pubescens	2
Lomandra nigricans	2
Lyginia barbata	5
Patersonia occidentalis	4
Phlebocarya ciliata	77
?Prasophyllum sp.	14
Pterostylis aff. vittata	2
Schoenus curvifolius	33
Stylidium brunonianum	6
Stylidium repens	23
Thelymitra pauciflora	6
Xanthosia huegelii	1
ANNUAL HERBS	
Drosera glanduligera	3
Rhodanthe citrina	1
Trachymene pilosa	30
Quinetia urvillei	48
PERENNIAL GRASSES	
Amphipogon turbinatus	2
UNKNOWN DICOTYLEDONS	
UNKNOWN MONOCOTYLEDONS	22

A. 10m x 10m	
Species	Number of individuals
TREES	
Eucalyptus marginata	3
Eucalyptus calophylla	3 + 6 seedlings
Banksia grandis	3 + 1 seedling
Xylomelum occidentale	1 + 2 seedlings
SHRUBS	
Acacia applanata	
Acacia pulchella	
Acacia semitrullata	
Astroloma ciliatum	
Astroloma pallidum	
Billardiera variifolia	
Bossiaea eriocarpa	
Dampiera linearis	
Daviesia physodes	
Gompholobium polymorphum	
Gompholobium tomentosum	
Hardenbergia comptoniana	
Hibbertia hypericoides	
Hovea crorizemifolia	
Hovea trisperma	
Jacksonia sparsa	
Logania serpyllifolia	
Petrophile linearis	
Platytheca galioides	
Scaevola calliptera	
Xanthorrhoea preissii	
PERENNIAL HERBS	
Burchardia congesta	
Caesia micrantha	
Caladenia flava	
Chamaescilla corymbosa	
Conostylis aculeata	
Cyrtostylis robusta	
Dasypogon bromeliifolius	
Desmocladus fascicularis	
Drosera erythrorhiza	
Drosera pallida	
Eriochilus sp.	
Hypolaena exsulca	
Lagenifera huegelii	
Lepidosperma squamatum	
Lomandra hermaphrodita	
Lomandra preissii	
Lomandra sericea	
Lomandra sonderi	
Luzula meridionalis	
Mesomelaena tetragona	
Pterostylis aff. vittata	
Pterostylis recurva	
Pyrorchis nigricans	

Stylidium brunonianum	
Stylidium carnosum	
Tetraria octandra	
Thysanotus ?manglesii	
Xanthosia huegelii	
ANNUAL HERBS	
Drosera glanduligera	
Trachymene pilosa	
Quinetia urveillei	
WEEDS	
* Briza maxima	
* Hypochaeris glabra	
* Lolium sp.	
* Romulea rosea	
Cover	
Trees - eucalypts	10-30%
Trees - others	2-10%
Tall shrubs 1-2m	2-5%
Shrubs <1m	10-30%
Sedges	2-10%
Grass (weeds)	<1%
Herbs	2-10%
B. 2m x 10m	
SHRUBS	
Acacia applanata	1
Astroloma ciliatum	4
Astroloma pallidum	6
Billardiera variifolia	3
Bossiaea eriocarpa	1
Dampiera linearis	4
Gompholobium polymorphum	1
Gompholobium tomentosum	2
Hovea trisperma	4
Lagenifera huegelii	1
Petrophile linearis	6
Platytheca galioides	1
Scaevola calliptera	2
Xanthorrhoea preissii	17
PERENNIAL HERBS	
Burchardia congesta	7
Caladenia flava	15
Chamaescilla corymbosa	7
Dasypogon bromeliifolius	14
Desmocladus fascicularis	9
Drosera erythrorhiza	10
Drosera pallida	6
Hypolaena exsulca	7
Lagenifera huegelii	1
Lepidosperma squamatum	42
Lomandra hermaphrodita	56
Lomandra ?odora	6

Lomandra preissii	6
Lomandra sericea	11
Lomandra sonderi	17
Mesomelaena tetragona	25
Pterostylis aff. vittata	3
Pterostylis recurva	1
Pyrorchis nigricans	4
Stylidium brunonianum	2
Tetraria octandra	31
Thysanotus ?manglesii	2
Xanthosia huegelii	6
ANNUAL HERBS	
Drosera glanduligera	1
Trachymene pilosa	8
Quinetia urveillei	2
UNKNOWN MONOCOTYLEDONS	11

APPENDIX 2. List of the flora recorded in the remnants, with:

Collection No. where a specimen was collected.

Occurrence in:
1. Banksia woodland on sand.
2. Wetland.
3. Jarrah-Marri-Banksia woodland on sand.

Life form coded as:
T = Tree
S = Shrub, including climbers, small sub-shrubs and large perennial trunked herbs >1m
PH = Perennial herb, including all bulbous species
AH = Annual herb
PG = Perennial grass
W = Weed of any form

Introduced species are identified by an asterisk (*).

BUSSELTON DEPOSIT, WILLMOTT'S, 1997.

	Collection No.	1	2	3	Life form
CYCADS					
ZAMIACEAE					
Macrozamia riedlei		X	X	X	S
GYMNOSPERMS					
PODOCARPACEAE					
Podocarpus drouynianus		X		X	S
DICOTYLEDONS					
APIACEAE					
Trachymene pilosa	19	X	X	X	AH
Xanthosia huegelii	56	X	X	X	PH
ASTERACEAE					
*Arctotheca calendula			X		W
Cotula coronopifolia	44		X		AH
* Cotula turbinata	4563		X		W
Craspedia variabilis	4559			X	PH
* Hypochaeris glabra		X	X	X	W
Lagenifera huegelii		X	X	X	PH
Quinetia urvillei	4553	X	X	X	AH
Rhodanthe citrina	25		X		AH
* Sonchus oleraceus			X		W
* Ursinia anthemoides		X	X	X	W
CARYOPHYLLACEAE					
* Cerastium glomeratum	32	X			AH
CASUARINACEAE					
Allocasuarina humilis		X			S
CRASSULACEAE					
Crassula colorata var. colorata	27	X			AH
Crassula decumbens	18, 4557, 4575	X			AH
DILLENIACEAE					
Hibbertia huegelii	50		X		S
Hibbertia hypericoides		X		X	S
Hibbertia racemosa	2	X		X	S
Hibbertia stellaris	45		X		S
DROSERACEAE					
Drosera erythrorhiza		X		X	PH
Drosera glanduligera		X	X	X	AH
Drosera menziesii		X	X		PH
Drosera pallida		X	X	X	PH
Drosera sp. (rosette)		X	X		PH

	Collection No.	1	2	3	Life form
EPACRIDACEAE					
Andersonia caerulea	48	X	X	X	S
Astroloma ciliatum	53	X		X	S
Astroloma pallidum	54			X	S
Leucopogon australis	38		X	X	S
Leucopogon conostephioides	5	X	X		S
Leucopogon glabellus	4	X	X		S
Leucopogon propinquus	34, 55	X		X	S
Lysinema ciliatum	6	X	X	X	S
EUPHORBIACEAE					
Monotaxis occidentalis	12	X			PH
Phyllanthus calycinus	4558			X	S
Stachystemon aff. axillaris [Keighery]	4583	X			S
GERANIACEAE					
* Erodium botrys	80			X	W
GOODENIACEAE					
Dampiera linearis	37	X	X	X	S
Scaevola calliptera	60	X		X	S
LAMIACEAE					
Hemiandra pungens	3	X	X	X	S
LAURACEAE					
Cassytha sp.		X	X		S
LOGANIACEAE					
Logania serpyllifolia subsp. angustifolia	64			X	S
LORANTHACEAE					
Nuytsia floribunda		X	X	X	T
MIMOSACEAE					
Acacia applanata	57			X	S
Acacia extensa	1	X	X	X	S
Acacia huegelii	9	X	X	X	S
Acacia pulchella		X		X	S
Acacia semitrullata	33	X	X	X	S
Acacia stenoptera				X	S
MOLLUGINACEAE					
Macarthuria apetala	4556	X			S
MYRTACEAE					
Agonis flexuosa		X		X	T
Calothamnus quadrifidus	22		X		S
Calothamnus sanguineus	4565	X			S
Calytrix flavescens	13	X	X		S
Eucalyptus calophylla		X		X	T
Eucalyptus marginata		X		X	T

	Collection No.	1	2	3	Life form
Kunzea glabrescens	40		X		S
Kunzea micrantha	41	X	X		S
Melaleuca preissiana			X		T
Melaleuca thymoides	8	X	X	X	S
Pericalymma ellipticum	42		X		S
Regelia ciliata	39		X		S
PAPILIONACEAE					
Bossiaea eriocarpa		X		X	S
Bossiaea ornata	67, 72			X	S
Brachysema praemorsum	59			X	S
Daviesia physodes	58			X	S
Dillwynia uncinata	10, 36	X	X		S
Euchilopsis linearis	46		X		S
Gompholobium capitatum	49	X	X	X	S
Gompholobium polymorphum	4568			X	S
Gompholobim tomentosum		X		X	S
Hardenbergia comptoniana	73			X	S
Hovea chorizemifolia	75			X	S
Hovea trisperma		X		X	S
Isotropis cuneifolia		X			PH
Jacksonia sparsa ms	7, 4577	X	X	X	S
Kennedia coccinea	66		X	X	S
* Ornithopus sp.	30	X	X		W
* Trifolium sp.		X	X	X	W
PITTOSPORACEAE					
Billardiera variifolia	4567			X	S
PROTEACEAE					
Adenanthos meisneri	49		X	X	S
Adenanthos obovatus			X		S
Banksia attenuata		X	X	X	T
Banksia grandis		X		X	T
Banksia ilicifolia		X	X	X	T
Conospermum flexuosum subsp. laevigatum	69			X	S
Conospermum teretifolium	63			X	S
Dryandra lindleyana subsp. lindleyana	23	X		X	S
Hakea ruscifolia				X	S
Petrophile linearis		X		X	S
Persoonia elliptica				X	S
Persoonia longifolia		X		X	S
Persoonia saccata	68	X		X	S
Stirlingia latifolia		X		X	S
Synaphea hians	31	X		X	S
Xylomelum occidentale		X		X	T
RUBIACEAE					
Opercularia apiciflora	65			X	S

	Collection No.	1	2	3	Life form
RUTACEAE					
Eriostemon nodiflorus subsp. lasiocalyx	4564		X		S
Eriostemon spicatus		X	X		S
SOLANACEAE					
* Solanum nigrum		X			W
STACKHOUSIACEAE					
Tripterococcus brunonis	0	X			PH
STYLIDIACEAE					
Stylidium brunonianum		X	X	X	PH
Stylidium carnosum	28	X		X	PH
Stylidium piliferum		X	X	X	PH
Stylidium repens		X	X	X	PH
Stylidium scandens	24	X	X		PH
Stylidium sp. large green				X	PH
TREMANDRACEAE					
Platytheca galioides	11	X	X	X	S
MONOCOTYEDONS					
ANTHERICACEAE					
Caesia micrantha	4560	X		X	PH
Chamaescilla corymbosa	15	X	X	X	PH
Johnsonia pubescens	14	X	X	X	PH
Sowerbaea laxiflora				X	PH
Thysanotus manglesii		X		X	PH
ARACEAE					
* Zantedeschia aethiopica		X	X	X	W
COLCHICACEAE					
Burchardia congesta		X	X	X	PH
Burchardia multiflora	4555		X		PH
CENTROLEPIDACEAE					
Centrolepis drummondiana	29B	X			AH
CYPERACEAE					
Isolepis marginata	29A	X	X		PH
Lepidosperma squamatum	70	X	X	X	PH
Mesomelaena tetragona	71			X	PH
Schoenus curvifolius	16, 4579	X	X	X	PH
Schoenus sp. [Rye]	4574	X			PH
Tetraria octandra	62	X		X	PH
DASYPOGONACEAE					
Baxteria australis	4576	X	X		PH
Dasypogon bromeliifolius		X	X	X	PH
Lomandra hermaphrodita	4572	X		X	PH

	Collection No.	1	2	3	Life form
Lomandra nigricans	21	X	X	X	PH
Lomandra ?odora	20	X			PH
Lomandra preissii		X		X	PH
Lomandra sericea	4573			X	PH
Lomandra sonderi	4569, 4571			X	PH
Lomandra suaveolens	26	X	X		PH
HAEMODORACEAE					
Anigozanthos manglesii			X	X	PH
Anigozanthos viridis			X		PH
Conostylis aculeata	17	X		X	PH
Conostylis setigera		X	X		PH
Phlebocarya ciliata	4578	X	X		PH
IRIDACEAE					
* Freesia sp.		X	X	X	W
Patersonia occidentalis		X		X	PH
* Romulea rosea		X	X	X	W
JUNCACEAE					
Luzula meridionalis	52	X		X	PH
ORCHIDACEAE					
Caladenia chapmanii	77	X		X	PH
Caladenia flava		X	X	X	PH
Caladenia reptans subsp. reptans	4561			X	PH
Cyanicula sericea	79	X			PH
Cyrtostylis robusta	4566			X	PH
Diuris corymbosa			X	X	PH
Drakaea elastica		X	X		PH
Drakaea glyptodon		X	X		PH
Elythranthera brunonis		X	X	X	PH
Eriochilus sp.		X		X	PH
Leporella fimbriata		X	X		PH
Lyperanthus serratus				X	PH
* Monadenia bracteata			X		W
Paracaleana nigrita		X	X		PH
Prasophyllum sp.			X		
Pterostylis aff. nana [Limestone]	4582	X			PH
Pterostylis barbata	76			X	PH
Pterostylis recurva	78			X	PH
Pterostylis aff. vittata			X	X	PH
Pyrorchis nigricans		X	X	X	PH
Thelymitra pauciflora			X	X	PH
Thelymitra sp.		X		X	PH
POACEAE					
Amphipogon turbinatus		X	X		PG
Austrostipa campylachne	4562	X		X	PG
* Briza maxima		X		X	W
* Lolium sp.		X		X	W
Tetrarrhena laevis	4554	X		X	PG

	Collection No.	1	2	3	Life form
RESTIONACEAE					
Cytogonidium leptocarpoides	51, 4580		X		PH
Desmocladus fascicularis	61	X		X	PH
Hypolaena exsulca	35, 4570, 4581	X	X	X	PH
Lyginia barbata		X	X	X	PH
XANTHORRHOEACEAE					
Xanthorrhoea preissii		X	X	X	S

APPENDIX 3. List of the vertebrate fauna species which may occur in the main remnant (X) or have been recorded (P). The habitats are identified as:

1. Banksia woodland on sand

2. Wetland.

3. Jarrah-Marri-Banksia woodland on sand.

Introduced species are identified by an asterisk (*).

		1	2	3
A. FROGS				
LEPTODACTYLIDAE				
Crinia georgiana			X	
Geocrinia leai			X	
Heleioporus eyrei			X	
Limnodynastes dorsalis			X	
Myobatrachus gouldii		X	X	X
Pseudophryne guentheri			X	
Ranidella insignifera		P	P	
HYLIDAE				
Litoria adelaidensis			X	
L. moorei			X	
B. REPTILES				
GEKKONIDAE	Geckos			
Phyllodactylus marmoratus		P	P	P
PYGOPODIDAE	Legless Lizards			
Aprasia repens		X	X	P
Lialis burtonis		X	X	X
Pygopus lepidopodus		X	X	X
AGAMIDAE	Dragon Lizards			
Pogona m. minor		X	X	X
SCINCIDAE	Skinks			
Bassiana trilineata			X	
Cryptoblepharus plagiocephalus		P	X	P
Ctenotus impar		X	X	X
Egernia kingii			X	
E. napoleonis		X	X	X
Glaphyromorphus australis			X	
Hemiergis peronii		X	X	X
Lerista distinguenda		P	X	P
Menetia greyii		X	X	X
Morethia lineocellata		P	P	P
M. obscura			X	X
Tiliqua r. rugosa		X	P	P

		1	2	3
VARANIDAE	Monitors			
Varanus gouldii		X	X	X
V. rosenbergi		X	X	X
TYPHLOPIDAE	Blind Snakes			
Ramphotyphlops australis		X	X	X
BOIDAE	Pythons			
Morelia spilota imbricata		X	X	X
ELAPIDAE	Elapid Snakes			
Drysdalia coronata		X	X	X
Echiopsis curta		X	X	X
Elapognathus minor			X	
Neelaps bimaculatus		X	X	X
Notechis scutatus occidentalis		X	X	X
Pseudonaja affinis affinis		X	X	X
Rhinoplocephalus bicolor		X	X	X
R. gouldii		X	X	X
R. nigriceps		X	X	X
Simoselaps bertholdi				
C. BIRDS				
PHASIANIDAE				
Coturnix pectoralis	Stubble Quail	X	X	X
ANATIDAE				
Tadorna tadornoides	Australian Shelduck		X	
Chenonetta jubata	Australian Wood Duck		X	
Anas superciliosa	Pacific Black Duck		X	
A. gibberifrons	Grey Teal		X	
PHALACROCORACIDAE				
Phalacrocorax melanoleucos	Little Pied Cormorant		X	
ARDEIDAE				
Ardea novaehollandiae	White-faced Heron		X	
A. pacifica	White-necked Heron		X	

		1	2	3
THRESKIORNITHIDAE				
Threskiornis spinicollis	Straw-necked Ibis	P	X	
Platalea regia	Royal Spoonbill		X	
P. flavipes	Yellow-billed Spoonbill		X	
ACCIPITRIDAE				
Elanus axillaris	Black-shouldered Kite	X	X	X
Haliastur sphenurus	Whistling Kite	X	X	X
Circus approximans	Swamp Harrier	X	X	X
Accipiter fasciatus	Brown Goshawk	X	X	X
A. cirrhocephalus	Collared Sparrowhawk	X	X	X
Aquila audax	Wedge-tailed Eagle	X	X	X
Hieraaetus morphnoides	Little Eagle	X	X	P
FALCONIDAE				
Falco berigora	Brown Falcon	X	X	X
F. longipennis	Australian Hobby	X	X	X
F. peregrinus	Peregrine Falcon	X	X	X
F. cenchroides	Nankeen Kestrel	X	X	X
RALLIDAE				
Gallirallus philippensis	Buff-banded Rail		X	
Porzana pusilla	Baillon's Crake		X	
P. fluminea	Australian Spotted Crake		X	
P. tabuensis	Spotless Crake		X	
Porphyrio porphyrio	Purple Swamphen		X	
Gallinula tenebrosa	Dusky Moorhen		X	
Fulica atra	Eurasian Coot		X	
TURNICIDAE				
Turnix varia	Painted Button-quail	X	X	X
COLUMBIDAE				
Phaps chalcoptera	Common Bronzewing	X	P	X
CACATUIDAE				
Calyptorhynchus banksii	Red-tailed Black-Cockatoo	X		X
C. latirostris	Short-billed Black-Cockatoo	X		X
C. baudinii	Long-billed Black-Cockatoo	X		X

		1	2	3
PSITTACIDAE				
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	X	X	X
Polytelis anthopeplus	Regent Parrot	X	X	X
Platycercus icterotis	Western Rosella	X	X	X
Barnardius zonarius	Australian Ringneck	P	X	P
Purpureicephalus spurius	Red-capped Parrot	P	X	P
Neophema elegans	Elegant Parrot	X	X	X
CUCULIDAE				
Cuculus pallidus	Pallid Cuckoo	X	X	X
Cacomantis flabelliformis	Fan-tailed Cuckoo	X	X	X
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	X	X	X
C. lucidus	Shining Bronze-Cuckoo	X	X	P
STRIGIDAE				
Ninox novaeseelandiae	Southern Boobook	X	X	X
TYTONIDAE				
Tyto alba	Barn Owl	X	X	X
PODARGIDAE				
Podargus strigoides	Tawny Frogmouth	X	X	X
CAPRIMULGIDAE				
Eurostopodus argus	Spotted Nightjar	X		X
AEGOTHELIDAE				
Aegotheles cristatus	Australian Owlet-nightjar	X		X
APODIDAE				
Apus pacificus	Fork-tailed Swift	X	X	X
HALCYONIDAE				
* Dacelo novaeguineae	Laughing Kookaburra	X	X	P
Todiramphus sanctus	Sacred Kingfisher	P	X	X
MEROPIDAE				
Merops ornatus	Rainbow Bee-eater	P	X	P
MALURIDAE				
Malurus splendens	Splendid Fairy-wren		X	X
M. elegans	Red-winged Fairy-wren		X	X

		1	2	3
PARDALOTIDAE				
Pardalotus punctatus	Spotted Pardalote	X	X	X
P. striatus	Striated Pardalote	X	X	P
Sericornis frontalis	White-browed Scrubwren		X	X
Smicrornis brevirostris	Weebill	X	X	X
Gerygone fusca	Western Gerygone	P	X	P
Acanthiza apicalis	Inland Thornbill		X	X
A. inornata	Western Thornbill	X	X	X
A. chrysorrhoa	Yellow-rumped Thornbill	X	X	X
MELIPHAGIDAE				
Anthochaera carunculata	Red Wattlebird	X	X	P
A. chrysoptera	Little Wattlebird	X	X	X
Manorina flavigula	Yellow-throated Miner	X	X	X
Lichenostomus virescens	Singing Honeyeater	X	X	X
Melithreptus lunatus	White-naped Honeyeater	X	X	X
Lichmera indistincta	Brown Honeyeater	P	P	P
Phylidonyris novaehollandiae	New Holland Honeyeater	X	X	X
Acanthorhynchus superciliosus	Western Spinebill	P	X	X
Ephthianura albifrons	White-fronted Chat		X	
PETROICIDAE				
Petroica multicolor	Scarlet Robin	X		P
NEOSITTIDAE				
Daphoenositta chrysoptera	Varied Sittella			X
PACHYCEPHALIDAE				
Pachycephala pectoralis	Golden Whistler		X	
P. rufiventris	Rufous Whistler	X		P
Colluricincla harmonica	Grey Shrike-thrush	X	X	X
DICRURIDAE				
Grallina cyanoleuca	Magpie-lark		X	
Rhipidura fuliginosa	Grey Fantail	P		P
R. leucophrys	Willie Wagtail	X	X	X
CAMPEPHAGIDAE				
Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	X	X
Lalage sueurii	White-winged Triller	X	X	X

		1	2	3
ARTAMIDAE				
Artamus cinereus	Black-faced Woodswallow	X	X	X
A. cyanopterus	Dusky Woodswallow	X	X	X
Cracticus torquatus	Grey Butcherbird	P	X	X
Gymnorhina tibicen	Australian Magpie	X	X	P
CORVIDAE				
Corvus coronoides	Australian Raven	P	X	P
MOTACILLIDAE				
Anthus novaeseelandiae	Richard's Pipit		X	
DICAEIDAE				
Dicaeum hirundinaceum	Mistletoebird	X		X
HIRUNDINIDAE				
Hirundo neoxena	Welcome Swallow	X	X	X
H. nigricans	Tree Martin	X	X	X
H. ariel	Fairy Martin	X	X	X
SYLVIIDAE				
Megalurus gramineus	Little Grassbird		X	
Cinclorhamphus mathewsi	Rufous Songlark	X	X	
ZOSTEROPIDAE				
Zosterops lateralis	Silvereye	X	X	X

		1	2	3
D. MAMMALS				
BURRAMYIDAE				
Cercartetus concinnus	Western Pygmy-possum	X		X
PSEUDOCHEIRIDAE				
Pseudocheirus occidentalis	Western Ringtail Possum	P		P
TARSIPEDIDAE				
Tarsipes rostratus	Honey Possum		X	
PHALANGERIDAE				
Trichosurus vulpecula	Common Brushtail Possum			X
MACROPODIDAE				
Macropus fuliginosus	Western Grey Kangaroo	P	X	P
MOLOSSIDAE				
Mormopterus planiceps	Southern Freetail-bat	X	X	X
Nyctinomus australis	White-striped Freetail-bat	X	X	X
VESPERTILIONIDAE				
Nyctophilus geoffroyi	Lesser Long-eared Bat	X	X	X
N. gouldi	Gould's Long-eared Bat	X	X	X
N. timoriensis	Greater Long-eared Bat	X	X	X
Chalinolobus gouldii	Gould's Wattled Bat	X	X	X
C. morio	Chocolate Wattled Bat	X	X	X
Falsistrellus mackenziei	Western False Pipistrelle	X	X	X
Vespadelus regulus	Southern Forest Bat	X	X	X
MURIDAE				
* Mus musculus	House Mouse	X	X	X
* Rattus rattus	Black Rat		X	
CANIDAE				
* Vulpes vulpes	Fox	P	X	X
FELIDAE				
* Felis catus	Feral Cat	X	X	X
LEPORIDAE				
* Oryctolagus cuniculus	Rabbit	P	X	X