

Level 1 fauna risk assessment and Black-Cockatoo habitat assessment for Lot 15 Barfield Road, Hammond Park



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Front Cover: Burton's Legless Lizard (*Lialis burtonis*)

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EXECUTIVE SUMMARY

Gold Estates Holdings Pty Ltd proposes to clear and develop Lot 15 Barfield Road, Hammond Park (i.e. project area). The project area is 24km south of the Perth CBD and is separated from the Kwinana Freeway by a Western Power high voltage power line easement approximately 180m wide (Figure 1). The project area is approximately 1.86ha (Figure 1).

There are four fauna habitats in the project area. Vegetation in the project area is regrowth and generally in very poor condition and of low value. The site does not form part of an important ecological linkage for fauna.

The very small quantity of *Lomandra hermaphrodita* in the project area suggests that it is unlikely Graceful Sun-Moths (*Synemon gratiosa*) are present. The lack of suitable vegetation in the project area would also indicate that Southern Brown Bandicoots (*Isodon obesulus fusciventer*) are not present.

The impact of clearing less than 2ha of low or very low quality Black-Cockatoo foraging habitat is not significant on these species, and does not warrant a referral to the Commonwealth Government under the EPBC Act (1999).

There is a very low possibility that the project area contains the Jewelled South-west Skink (*Ctenotus gemmula*), Black-striped snake (*Neelaps calonotus*) or Lined Skink (*Lerista lineata*), however, they were not caught or seen when the much larger adjacent Vivente project area was cleared. If present, these reptiles will be lost during vegetation clearing. There is cumulative effect of progressively clearing most of the *Banksia* and Jarrah woodland in the general area.

Conservation significant Rainbow Bee-eater (*Merops ornatus*), if they are in the project area, will move to adjacent areas once vegetation clearing commences and would not be significantly impacted.

It is recommended that a fauna salvage program by a suitably qualified zoologist is implemented during the vegetation clearing program.

1 INTRODUCTION

1.1 Background

Gold Estates Holdings Pty Ltd (Gold Estates) proposes to clear and develop Lot 15 Barfield Road, Hammond Park (i.e. project area). The project area is 24km south of the Perth CBD and is separated from the Kwinana Freeway by a Western Power high voltage power line easement that is approximately 180m wide (Figure 1). The project area is approximately 1.86ha (Figure 2).

1.2 Project objectives and scope of work

Terrestrial Ecosystems was commissioned by Gold Estates to undertake a Level 1 fauna risk assessment. The purpose of this Level 1 fauna risk assessment is to provide information to the appropriate government regulators to enable them to assess the potential impact of vegetation clearing on the fauna assemblage in the project area. The methodology broadly follows that described in the Environmental Protection Authority (EPA) *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002), *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004) and the EPA/Department of Environment and Conservation (DPAW) *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA / DEC 2010).

A Level 1 fauna risk assessment involves undertaking a desktop review and site inspection. The objectives of this fauna risk assessment were to:

- provide an indication of the vertebrate fauna assemblage (reptiles, amphibians, small mammals and birds) on and in the vicinity of the project area;
- identify the presence and/or potential risks of impacting on species of conservation significance that are present or likely to be present in the project area during vegetation clearing;
- determine if any additional surveys are required to assess the potential impact on fauna assemblages in the project area, in particular, impacts on species of conservation significance; and
- make recommendations that mitigate or minimise potential impacts on resident fauna.

As Black-Cockatoos are known to forage the banksia and eucalypt woodlands in the adjacent areas, an assessment of the potential for Black-Cockatoo species to breed and forage in the project area was also undertaken.

To achieve these objectives, Terrestrial Ecosystems has:

- reviewed Terrestrial Ecosystems fauna survey database [includes Western Australian Museum (WAM), Atlas of Living Australia (AoLA) and DPaW records] to identify potential vertebrate fauna within the area;
- reviewed DPaW listed Threatened and Priority species as recorded in NatureMap that are likely to be in the area;
- searched the Commonwealth government's on-line database to identify fauna species of national environmental significance that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) potentially occurring in the area;
- reviewed previous fauna surveys conducted in the region;
- undertaken a site visit to identify available fauna habitat types and condition;
- mapped potential foraging habitat for Black-Cockatoos and recorded all potential Black-Cockatoo breeding trees with a diameter of 50cm or greater;
- undertaken an assessment of the potential risks to the fauna associated with clearing additional areas of native vegetation;
- provided a discussion of the likelihood of EPBC Act 1999 and Western Australian (WA) *Wildlife Conservation Act 1950* listed species being present in the project area; and
- provided management recommendations to mitigate and minimise potential impacts on the fauna in the project area.

2 EXISTING ENVIRONMENT

2.1 Survey area

Lot 15 Barfield Road, Hammond Park (1.86ha) is approximately 24km south of the Perth CBD, in an area that is rapidly being developed for urban housing. Immediately to the west, the vegetation has been cleared and residential development is underway for the Vivente project. Other lots of land to the north and west of the project area have also been recently cleared for residential housing.

2.2 Topography

The project area is a very gently undulating sand plain on the western section of the Bassendean Dune System. There are no wetlands in the project area or nearby.

2.3 Vegetation

PGV Environmental's (2014) flora and vegetation assessment indicated the area had previously been cleared and the current vegetation is regrowth. PGV Environmental (2014) reported the following three flora and vegetation communities in the project area in addition to the cleared area:

Low open Woodland of *Banksia attenuata*/B. *menziesii* over open shrubland of *Xanthorrhoea preissii*

This vegetation type occurred in the north-east corner of the site. The *Banksia* trees were up to 4m high and in low densities. *Xanthorrhoea preissii* was the most dominant native understorey species at around 1m high and 10% cover. All other native species had very low coverage. *Gladiolus caryophyllaceus*, *Ursinia anthemoides* and Flat Weed (*Hypochaeris glabra*) were the most prevalent weed species. The soil was grey-brown sand.

Open shrubland of *Xanthorrhoea preissii*

A small section of *Xanthorrhoea preissii* shrubland occurred in the north central part of the site. The *Xanthorrhoea* shrubs were up to 1.2m high and 20% density. Very few native species were recorded in this vegetation type and no trees except several WA Christmas Trees (*Nuytsia floribunda*). Presumably the *Banksia* and possibly Jarrah trees that occurred previously in this area did not regenerate after clearing in the early 1970s. Introduced species were common, particularly *Ursinia anthemoides*, Veldtgrass (*Ehrharta longiflora*) and Flat Weed. The soil was grey sand.

Low woodland of *Eucalyptus marginata*/ *Banksia attenuata*/B. *menziesii* over weeds

Two stands of this vegetation type occurred, one in the north-west corner and the other in the south-west corner. Jarrah (*Eucalyptus marginata*) was the most common tree species up to 6m high and varying in density while *Banksia attenuata* and *B. menziesii* also occurred but in very low numbers. Few native understorey species were present while introduced species such as Veldtgrass and *Ursinia* were common. The soil was light grey sand.

2.4 Climate

The Perth bioregion experiences a Mediterranean climate with hot summers from December to March and mild winters from May to August (Gentili 1972). Chart 1 shows the average mean monthly maximum and minimum temperatures and rainfall for Jandakot airport. Temperatures are highest in January – February. Perth receives the majority of its annual rainfall in winter (Chart 1). This rain is usually the result of low pressure cells moving in a westerly direction which bring moisture bearing clouds over the south-west of Western Australia.

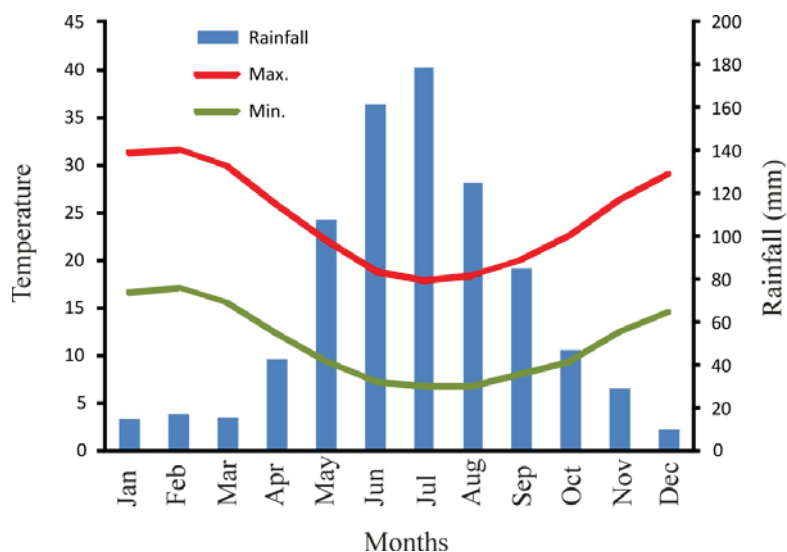


Chart 1. Mean monthly maximum and minimum temperatures and rainfall for Jandakot Airport (BOM November 2014; http://www.bom.gov.au/climate/averages/tables/cw_009172.shtml)

2.5 Land use

The dominant land use in the general area was large, semi-rural blocks mostly retaining much of the original native vegetation. The Southern Suburbs District Structure Plan – Stage 3 has rezoned this area from ‘Urban Deferred’ to ‘Urban’ under the Metropolitan Regional Scheme. The area has now been subdivided and the vegetation is being cleared for housing and urban development. Residential housing development has been rapid over the last 10 years in adjacent areas to the west and north of the project area.

2.6 Biological context for the project area

The frogs, reptiles, mammals and birds on the Swan Coastal Plain south of the Swan River have been surveyed on numerous occasions for a variety of purposes. Surveys in the vicinity of the project area which have been reviewed for this assessment include:

- 360 Environmental (2008) *Lot 9 Abernethy Road, Byford Spring Flora and Fauna Report*. Unpublished report for Australand Property Group, Perth.
- ATA Environmental (2006) *Vertebrate Fauna Assessment Brookdale Redevelopment Area*. Unpublished report for the Armadale Redevelopment Authority, Perth.
- Bamford Consulting Ecologists (2009) *Keane Road Strategic Link, Armadale Fauna Assessment*. Unpublished report for EnviroWorks Consulting, Perth.
- Ecoscape (Australia) Pty Ltd (2009) *Fauna Survey for Lots 13, 14 and 18 Barfield Road and Lots 48-51 Rowley Road, Hammond Park*. Unpublished report for Gold Estate and the Department of Housing, Perth.
- ENV (2009) *Jandakot Airport Fauna Survey*. Unpublished report for Jandakot Airport Holdings Pty Ltd, Perth.
- GHD (2006) *Fiona Stanley Heath Precinct Site Investigation Fauna Assessment March 2006*. Unpublished report for Department of Housing and Works, Perth.
- Gole C.A. (2003) *Bird Survey in selected Perth Metropolitan Reserves. A Joint Biodiversity Conservation Project between Birds Australia WA and Perth Biodiversity Project*. Unpublished report Birds Australia and Perth Biodiversity Project, Perth.
- Harvey M.S., Dell J., How R.A. and Waldock J.M. (1997) *Ground Fauna of Bushland Remnants on the Ridge Hill Shelf and Pinjarra Plain Landforms Perth*. Unpublished report for the Australian Heritage Commission NEP Grant N95/49, Perth.
- How R. A., Harvey M.S., Dell J. and Waldock J.M. (1999) *Ground Fauna of Urban Bushland Remnants in Perth*. Unpublished report to the Australian Heritage Commission; NEP Grant N93/04, Perth.

- Phoenix Environmental Sciences (2011) *Vertebrate Fauna Survey for the Roe Highway Extension Project*. Unpublished report for South Metro Connect, Perth.
- Terrestrial Ecosystems' (2015) vertebrate fauna trapping and fauna salvage program data.
- Western Wildlife (2010) *Wetland and Migratory Bird Survey*. Unpublished report for South Metro Connect, Perth.

The most relevant data are from Terrestrial Ecosystems trapping and vertebrate fauna salvage program conducted prior to and during the clearing of vegetation in the Vivente Estate which is located immediately to the west of the project area. Ecoscape (2009) reported on a fauna survey for the Vivente Estate that was undertaken sometime (date not disclosed) before the approval for that development. The Phoenix Environmental Sciences (2011) and Western Wildlife (2010) undertook fauna surveys to support an application to clear vegetation for the Roe Highway extension. The 360 Environmental (2008), ATA Environmental (2006) and Bamford Consulting Ecologists (2009) reports are for projects to the east of the project area but on the Swan Coastal Plain. The Western Australian Museum (Harvey et al. 1997, How et al. 1999) and Gole (2003) reports are for remnant habitats in the region. The Fiona Stanley Hospital (GHD 2006) and the Jandakot airport surveys (ENV Australia 2009) are for other large scale projects on the Swan Coastal Plain in the vicinity of the project area.

In addition to the above reports, Terrestrial Ecosystems fauna survey database contains records from NatureMap, AoLA and the WAM collection for this area. These records include the results of historical surveys and incidental records that very often remain unreported.

3 METHODOLOGY

3.1 Desktop assessment

3.1.1 Conservation significant species

A search of the Department of the Environment's (DotE) Matters of National Environmental Significance (MNES) search tool (search coordinates 32.17459°S, 115.85403°E with a 10km buffer) was undertaken. The DPaW threatened and priority species database was searched via the records in NatureMap. In addition, a desktop search of the Terrestrial Ecosystems' fauna survey database was used to develop an appreciation of the vertebrate fauna assemblages in the relevant section of the bioregion in the vicinity of the project area.

Other more general texts were also used to provide supplementary information on vertebrates in the bioregion, including Tyler *et al.* (2000) for frogs; Storr *et al.* (1983, 1990, 1999, 2002) for reptiles; Johnstone and Storr (1998, 2004) for birds; and Van Dyck and Strahan (2008) for mammals.

Collectively these sources of information were used to create lists of species expected to utilise the project area and the adjacent areas. It should be noted that these lists will include species that have been recorded in the general region but are possibly vagrants and they will not generally be found in the project area due to a lack of suitable habitat (e.g. wetland and shore birds). Vagrants can be recorded almost anywhere. Many of the bird, mammal, reptile and amphibian species have specific habitat requirements that may be present in the general area but not in the specific project area. Also, the ecology of many of these species is often not well understood and it can sometimes be difficult to indicate those species whose specific habitat requirements are not present in the survey area. As a consequence many species will be included in the lists produced from database searches but will not be present in the actual project area.

3.2 Site assessment and reporting

Dr Scott Thompson undertook the reconnaissance survey and fauna habitat assessment with the assistance of Edward Swinhoe on 19 April 2016. Dr Graham Thompson prepared the report and Dr Scott Thompson reviewed the report before it was issued to the client. Both senior scientists have appropriate relevant post-graduate qualifications, extensive experience in conducting fauna assessments on the Swan Coastal Plain, have published research articles on biodiversity, fauna assemblages, conservation significant species, trapping techniques and temporal variations in trapped fauna assemblages and are therefore appropriately trained and experienced for the task of preparing this assessment. Both scientists were involved with the work at Vivente Estate and are familiar with the fauna assemblage present in the area.

3.2.1 Black-Cockatoo habitat assessment

As adjacent areas have been foraged by Black-Cockatoos, an assessment of the suitability of the habitat in the project area as a breeding and foraging site for Black-Cockatoos was undertaken. This assessment mapped Black-Cockatoo foraging habitat based on the rating system in Table 1.

Table 1. Rating system to be used for mapping foraging habitat for black-cockatoos

Rating	Description of vegetation		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
1	No or negligible foraging value. Examples: <ul style="list-style-type: none"> Scattered food plants with foliage cover[†] of <5%. Open pasture with limited scattered foraging trees. Area largely devoid of any foraging species. 	No or negligible foraging value. Examples: <ul style="list-style-type: none"> Scattered food plants with foliage cover[†] of <5%. Open pasture with limited scattered foraging trees. Area largely devoid of any foraging species. 	No or negligible foraging value. Examples: <ul style="list-style-type: none"> Scattered food plants with foliage cover[†] of <5%. Open pasture with limited scattered foraging trees. Area largely devoid of any foraging species.

Rating	Description of vegetation		
	Carnaby's Black-Cockatoo	Baudin's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
2	<p>Very low foraging value. Examples:</p> <ul style="list-style-type: none"> Woodland or shrubland of banksias with 5-10%[#] foliage cover[‡]; or Eucalypt woodland/mallee of small-fruited species; or Eucalypt woodland/forest with 5-10%[#] marri foliage cover[‡]. 	<p>Very low foraging value. Examples:</p> <ul style="list-style-type: none"> Marri, shrubby banksias with 5-10%[#] foliage cover[‡]; or Open pasture with scattered foraging trees or clumps of foraging trees. 	<p>Very low foraging value. Examples:</p> <ul style="list-style-type: none"> Marri and/or sheoak and/or jarrah and/or other potential sources of food with 5-10%[#] foliage cover[‡]; or Open pasture with scattered foraging trees or clumps of foraging trees.
3	<p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> Woodland or shrubland of banksias with 10-20%[#] foliage cover[‡]. Eucalypt woodland/forest with 10-20%[#] marri foliage cover[‡]. 	<p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> Marri, and/or shrubby banksias with 10-20%[#] foliage cover[‡]; Open pasture with numerous scattered foraging trees or clumps of foraging trees. 	<p>Low foraging value. Examples:</p> <ul style="list-style-type: none"> Marri and/or sheoak and/or jarrah and/or other potential sources of food with 10-20%[#] foliage cover[‡]. Open pasture with numerous scattered foraging trees or clumps of foraging trees.
4	<p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Woodland or shrubland of banksias with 20-40%[#] foliage cover[‡]; Eucalypt woodland/forest with 20-40%[#] marri foliage cover[‡]; or May have evidence of foraging by <i>C. latirostris</i>. 	<p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Marri, banksia and other foraging species with 20-40%[#] foliage cover[‡]; or May have evidence of foraging by <i>C. baudinii</i>. 	<p>Moderate foraging value. Examples:</p> <ul style="list-style-type: none"> Marri and/or sheoak and/or jarrah and/or other foraging species with 20-40%[#] foliage cover[‡]; or May have evidence of foraging by <i>C. banksia naso</i>.
5	<p>High foraging value. Examples:</p> <ul style="list-style-type: none"> Woodland or shrubland of banksias with 40-60%[#] foliage cover[‡]; Eucalypt woodland/forest with 40-60%[#] marri foliage cover[‡] and evidence of foraging by <i>C. latirostris</i>; or Thinned pine plantation with considerable evidence of foraging by <i>C. latirostris</i>. 	<p>High foraging value. Examples:</p> <ul style="list-style-type: none"> Marri, banksia and other foraging species with 40-60%[#] foliage cover[‡]. Evidence of foraging by <i>C. baudinii</i>. 	<p>High foraging value. Examples:</p> <ul style="list-style-type: none"> Marri and/or sheoak and/or jarrah and/or other foraging species with 40-60%[#] foliage cover[‡]. Evidence of foraging by <i>C. banksia naso</i>.
6	<p>Very high foraging value. Examples:</p> <ul style="list-style-type: none"> Eucalypt woodland/forest with >60%[#] marri foliage cover[‡] and evidence of foraging by <i>C. latirostris</i>; Banksia woodlands of key species (e.g. <i>B. attenuata</i>, <i>B. menziesii</i>, <i>B. prionotes</i>, <i>B. sessilis</i>) with foliage cover[‡] >60%; Intact pine plantation with the majority of cones foraged by <i>C. latirostris</i>; or Majority of food plants showing evidence of foraging by <i>C. latirostris</i>. 	<p>Very high foraging value. Examples:</p> <ul style="list-style-type: none"> Marri and/or banksia and/or other foraging species with >60% foliage cover[‡]; or Majority of food plants showing evidence of foraging by <i>C. baudinii</i>. 	<p>Very high foraging value. Examples:</p> <ul style="list-style-type: none"> Marri and/or sheoak and/or jarrah and/or cape lilac and/or other foraging species with >60% foliage cover[‡]; or Majority of food plants showing evidence of foraging by <i>C. banksii</i>.

[‡] Foliage cover refers to the percentage of ground surface shaded by vegetation, excluding litter and vegetation within 50mm of the ground, at midday. It can be estimated based on linear transects or plots. For the purpose of a black-cockatoo habitat assessment, it is estimated.

[#] If an area is degraded or under stress (e.g. dieback, water stress, drought, etc) the foraging value of the foliage cover (and seeds and nectar) may be lower than the percentage cover that is still present. In this case a lower rating than the percentage foliage cover is appropriate (i.e. 40-60% degraded foliage cover may be equivalent to 20-40% normal foliage cover). This issue should be discussed in the results.

Rating scales in Table 1 are a judgement made by Dr Scott Thompson, a zoologist with substantial experience in black-cockatoo habitat assessments. The project area was also investigated for the evidence of foraging activity,

e.g. chewed banksia infructescences, marri and sheoak nuts, and all eucalypts with a diameter at breast height of 50cm or over were recorded.

3.3 Limitations

This Level 1 fauna risk assessment is based on information contained in the Commonwealth Government threatened species database, other published and unpublished fauna survey data for the bioregion and a site visit. It is acknowledged that multiple surveys conducted in different seasons, repeated over several years are necessary to fully appreciate the fauna assemblage in the project area.

The EPA *Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*, No. 56 (2004) suggested that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 2.

Table 2. Fauna survey limitations and constraints

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comment
Competency and experience of the consultant carrying out this assessment	No	The environmental scientists that undertook the field assessment and prepared this report are familiar with the vertebrate fauna of this bioregion.
Scope	No	All aspects of the scope of works have been addressed.
Proportion of fauna identified, recorded and/or collected	No	Not applicable.
Accuracy of previous survey work	Yes, negligible	Terrestrial Ecosystems has reported fauna survey data recorded by various authors, but is not in a position to vouch for the accuracy of this information. It is acknowledged that the taxonomy of Western Australian vertebrates is continually being revised and the nomenclature of some of the species listed in the appendices may have changed since publication by the authors.
Sources of information	Yes, negligible	Vertebrate fauna information was available from an on-line database and unpublished and published reports of surveys conducted in the bioregion in a variety of habitat types. Many of these surveys employed a low level of trapping effort which significantly impacts on the capacity of these data to represent the fauna assemblages in the areas surveyed.
Timing/weather/season/ cycle	No	Weather was suitable during the site visit.
Disturbances which affected results of the survey	No	The project area had been cleared at an earlier date and most of the vegetation was regrowth. This was factored into this assessment.
Intensity of survey effort	No	No trapping surveys were undertaken.
Resources	No	Adequate resources were available.
Remoteness and/or access problems	No	There were no problems with access.

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comment
Availability of contextual information on the region	No	Fauna survey data are available for the general area.

Negligible – less than 20%; moderate -20-60%; significant – greater than 80%

4 RESULTS

4.1 Fauna habitats and condition

There are four fauna habitats present in the project area. One was largely devoid of vegetation and the vegetated area can be divided into three fauna habitat types based on the vegetation types, namely:

- Low Open Woodland of *Banksia attenuata*/B. *menziesii* over Open Shrubland of *Xanthorrhoea preissii*
- Open Shrubland - *Xanthorrhoea preissii*
- Low Woodland over weeds - *Eucalyptus marginata*/ *Banksia attenuata*/B. *menziesii*

Details of the vegetation in these three habitat types is contained in section 2.3 above.



Plate 1. Open unvegetated area



Plate 1. Open unvegetated area



Plate 3. Low Open woodland of *Banksia attenuata*/B. *menziesii* over open Shrubland of *Xanthorrhoea preissii*



Plate 4. Low open woodland of *Banksia attenuata*/B. *menziesii* over open shrubland of *Xanthorrhoea preissii*



Plate 5. Open shrubland of *Xanthorrhoea preissii*

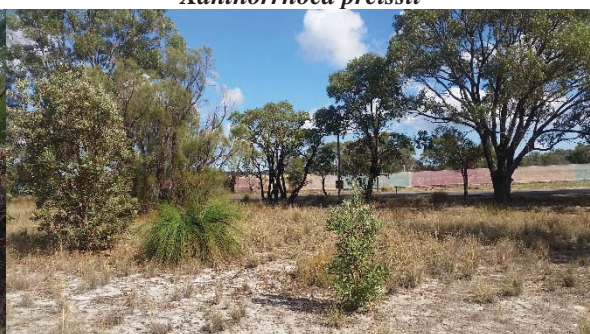


Plate 6. Low woodland of *Eucalyptus marginata*/ *Banksia attenuata*/B. *menziesii* over weeds

Habitat quality is mapped in Figure 2. The vast majority of the project area (1.86 ha) is either highly degraded or disturbed and therefore of very low value for fauna.

Black-Cockatoo foraging habitat has been mapped and is shown in Figure 3. There are two different foraging habitats that are rated as 2 (i.e. very low foraging value; 1.49ha) and 3 (low foraging value; 0.37ha; see Table 1 for details). There were seven trees in or immediately adjacent to the project area (Figure 3; Table 3). None of these trees had hollows suitable as a nesting site for a Black Cockatoo.

Table 3. Black-Cockatoo tree assessment

Tree N ^o	Tree type	Diameter at breast height	Hollow present
1	Jarra	600	No
2	Jarra	600	No
3	Jarra	800	No
4	Jarra	1300	No
5	Jarra	700	No
6	Jarra	800	No
7	Jarra	500	No

4.2 Bioregional vertebrate fauna

Appendix B provides a summary of the fauna survey data that are available in the vicinity of the project area. The most relevant information is the results of the trapping and fauna salvage program that Terrestrial Ecosystems undertook for the Vivente project area. These are shown in Table 4.

Table 4. Vertebrate fauna caught in the trapping and fauna salvage program for the Vivente project area

Species	Number
Mammals	
Cat <i>Felis catus</i>	1
Southern Brown Bandicoot <i>Isodon obesulus fusciventer</i>	11
House Mouse <i>Mus musculus</i>	3
Brushtail Possum <i>Trichosurus vulpechula</i>	1
Amphibians	
<i>Limnodynastes dorsalis</i>	1
<i>Litoria adelaidensis</i>	16
Reptiles	
<i>Ctenotus australis</i>	1
Marbled Gecko <i>Christinus marmoratus</i>	1
<i>Cryptoblepharus buechananii</i>	23
<i>Delma fraseri</i>	2
<i>Hemiergis quadrilineata</i>	5
<i>Lialis burtonis</i>	17
<i>Menetia greyii</i>	1
<i>Pletholax gracilis</i>	1
Bearded Dragon <i>Pogona minor</i>	3
Dugite <i>Pseudonaja affinis</i>	3
Bobtail <i>Tiliqua rugosa</i>	62

There are appreciable differences among recorded fauna assemblages recorded in the vicinity of the project area shown in Appendix B. These differences are partially due to the low survey effort often deployed and they also reflect variations in soils and vegetation as well as temporal variations in the fauna assemblages.

Tables 5-8 provide a list of vertebrate species potentially found in the vicinity of the project area that have been compiled based on the fauna survey report results shown in Appendix B. Lists in these Tables are a significant over estimate of the actual species likely to be present as many of these species (e.g. water and shore birds) have specific habitat requirements not available in the project area, the project area is small, adjacent to new housing developments on the western and northern sides and it is immediately adjacent to a school. The highly degraded nature of the project area means that only a small subset of the vertebrate fauna assemblage that once was present is still present in the area.

Table 5. Birds potentially found in the vicinity of the project area

Family	Species	Common Name
Accipitridae	<i>Pandion cristatus</i>	Eastern Osprey
	<i>Elanus axillaris</i>	Black-shouldered Kite
	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle
	<i>Haliastur spheurnus</i>	Whistling Kite
	<i>Accipiter fasciatus</i>	Brown Goshawk
	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk
	<i>Circus approximans</i>	Swamp Harrier
	<i>Aquila audax</i>	Wedge-tailed Eagle
	<i>Hieraaetus morphnoides</i>	Little Eagle
Anatidae	<i>Pandion haliaetus</i>	Osprey
	<i>Biziura lobata</i>	Musk Duck
	<i>Stictonetta naevosa</i>	Freckled Duck
	<i>Cygnus atratus</i>	Black Swan
	<i>Tadorna radjah</i>	Radjah Shelduck
	<i>Tadorna tadornoides</i>	Australian Shelduck
	<i>Chenonetta jubata</i>	Australian Wood Duck
	<i>Malacorhynchus membranaceus</i>	Pink-eared Duck
	<i>Anas rhynchotis</i>	Australasian Shoveler
	<i>Anas gracilis</i>	Grey Teal
	<i>Anas castanea</i>	Chestnut Teal
	<i>Anas platyrhynchos</i>	Northern Mallard
	<i>Anas superciliosa</i>	Pacific Black Duck
	<i>Aythya australis</i>	Hardhead
	<i>Oxyura australis</i>	Blue-billed Duck
Aegothelidae	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth
Charadriidae	<i>Pluvialis fulva</i>	Pacific Golden Plover
	<i>Pluvialis squatarola</i>	Grey Plover
	<i>Charadrius dubius</i>	Little Ringed Plover
	<i>Charadrius ruficapillus</i>	Red-capped Plover
	<i>Elseyornis melanops</i>	Black-fronted Dotterel
	<i>Thinornis rubricollis</i>	Hooded Plover
	<i>Erythronyx cinctus</i>	Red-kneed Dotterel
	<i>Vanellus tricolor</i>	Banded Lapwing
	<i>Vanellus miles</i>	Masked Lapwing
	<i>Laridae</i>	Fairy Tern
Laridae	<i>Gelochelidon nilotica</i>	Gull-billed Tern
	<i>Chlidonias hybridus</i>	Whiskered Tern
	<i>Chlidonias leucopterus</i>	White-winged Black Tern
	<i>Chroicocephalus novaehollandiae</i>	Silver Gull
Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt
	<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet
	<i>Cladorhynchus leucocephalus</i>	Banded Stilt
Scolopacidae	<i>Limosa limosa</i>	Black-tailed Godwit
	<i>Limosa haemastica</i>	Hudsonian Godwit
	<i>Actitis hypoleucos</i>	Common Sandpiper
	<i>Tringa brevipes</i>	Grey-tailed Tattler
	<i>Tringa nebularia</i>	Common Greenshank
	<i>Tringa stagnatilis</i>	Marsh Sandpiper
	<i>Tringa glareola</i>	Wood Sandpiper
	<i>Calidris tenuirostris</i>	Great Knot
	<i>Calidris canutus</i>	Red Knot

Family	Species	Common Name
	<i>Calidris ruficollis</i>	Red-necked Stint
	<i>Calidris subminuta</i>	Long-toed Stint
	<i>Calidris melanotos</i>	Pectoral Sandpiper
	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper
	<i>Calidris ferruginea</i>	Curlew Sandpiper
	<i>Philomachus pugnax</i>	Ruff
Stercorariidae	<i>Stercorarius longicauda</i>	Long-tailed Jaeger
Turnicidae	<i>Turnix varius</i>	Painted Button-quail
	<i>Turnix velox</i>	Little Button-quail
Ardeidae	<i>Botaurus poiciloptilus</i>	Australasian Bittern
	<i>Ixobrychus dubius</i>	Australian Little Bitten
	<i>Ardea alba</i>	Great Egret
	<i>Ardea pacifica</i>	White-necked Heron
	<i>Ardea modesta</i>	Eastern Great Egret
	<i>Ardea intermedia</i>	Intermediate Egret
	<i>Ardea ibis</i>	Cattle Egret
	<i>Egretta novaehollandiae</i>	White-faced Heron
	<i>Egretta garzetta</i>	Little Egret
	<i>Nycticorax caledonicus</i>	Nankeen Night Heron
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican
Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis
	<i>Threskiornis molucca</i>	Australian White Ibis
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis
	<i>Platalea regia</i>	Royal Spoonbill
	<i>Platalea flavipes</i>	Yellow-billed Spoonbill
Columbidae	<i>Columba livia</i>	Rock Dove
	<i>Streptopelia senegalensis</i>	Laughing Dove
	<i>Streptopelia chinensis</i>	Spotted Dove
	<i>Phaps chalcoptera</i>	Common Bronzewing
	<i>Ocyphaps lophotes</i>	Crested Pigeon
Alcedinidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra
	<i>Todiramphus sanctus</i>	Sacred Kingfisher
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater
Cuculidae	<i>Chalcites basalus</i>	Horsfield's Bronze-Cuckoo
	<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo
	<i>Cacomantis pallidus</i>	Pallid Cuckoo
	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo
	<i>Eurostopodus argus</i>	Spotted Nightjar
Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel
	<i>Falco berigora</i>	Brown Falcon
	<i>Falco longipennis</i>	Australian Hobby
	<i>Falco subniger</i>	Black Falcon
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen
	<i>Gallirallus philippensis</i>	Buff-banded Rail
	<i>Porzana pusilla</i>	Baillon's Crake
	<i>Porzana fluminea</i>	Australian Spotted Crake
	<i>Porzana tabuensis</i>	Spotless Crake
	<i>Tribonyx ventralis</i>	Black-tailed Native-hen
	<i>Gallinula tenebrosa</i>	Dusky Moorhen
	<i>Fulica atra</i>	Eurasian Coot
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren

Family	Species	Common Name
	<i>Smicrornis brevirostris</i>	Weebill
	<i>Gerygone fusca</i>	Western Gerygone
	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill
	<i>Acanthiza inornata</i>	Western Thornbill
	<i>Acanthiza apicalis</i>	Inland Thornbill
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler
	<i>Megalurus gramineus</i>	Little Grassbird
	<i>Cinclocephalus mathewsi</i>	Rufous Songlark
Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow
	<i>Artamus cyanocephalus</i>	Dusky Woodswallow
	<i>Cracticus torquatus</i>	Grey Butcherbird
	<i>Cracticus tibicen</i>	Australian Magpie
	<i>Strepera versicolor</i>	Grey Currawong
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-Shrike
	<i>Lalage sueurii</i>	White-winged Triller
Climacteridae	<i>Climacteris rufa</i>	Rufous Treecreeper
Corvidae	<i>Corvus coronoides</i>	Australian Raven
	<i>Corvus splendens</i>	House Crow
Estrildidae	<i>Stagonopleura oculata</i>	Red-eared Firetail
Hirundinidae	<i>Cheramoeca leucosterna</i>	White-backed Swallow
	<i>Hirundo neoxena</i>	Welcome Swallow
	<i>Petrochelidon nigriceps</i>	Tree Martin
	<i>Petrochelidon ariel</i>	Fairy Martin
Maluridae	<i>Malurus splendens</i>	Splendid Fairy-wren

Family	Species	Common Name
	<i>Malurus elegans</i>	Red-winged Fairy-wren
Meliphagidae	<i>Acanthorhynchus superciliosus</i>	Western Spinebill
	<i>Lichenostomus virescens</i>	Singing Honeyeater
	<i>Manorina flavigula</i>	Yellow-throated Miner
	<i>Anthochaera lunulata</i>	Western Wattlebird
	<i>Anthochaera chrysoptera</i>	Little Wattlebird
	<i>Anthochaera carunculata</i>	Red Wattlebird
	<i>Epthianura albifrons</i>	White-fronted Chat
	<i>Glyciphila melanops</i>	Tawny-crowned Honeyeater
	<i>Lichmera indistincta</i>	Brown Honeyeater
	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater
	<i>Phylidonyris niger</i>	White-cheeked Honeyeater
	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater
	<i>Melithreptus lunatus</i>	White-naped Honeyeater
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-Lark
Motacilidae	<i>Anthus novaeseelandiae</i>	Australasian Pipit
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird
	<i>Daphoenositta chrysoptera</i>	Varied Sittella
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler
	<i>Pachycephala rufiventris</i>	Rufous Whistler
	<i>Colluricincla harmonica</i>	Grey Shrike-thrush
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote
	<i>Pardalotus striatus</i>	Striated Pardalote
Petroicidae	<i>Petroica multicolor</i>	Pacific Robin

Table 6. Amphibians potentially found in the vicinity of the project area

Family	Species	Common Name
Hylidae	<i>Litoria adelaidensis</i>	Slender Tree Frog
	<i>Litoria moorei</i>	Motorbike Frog
Limnodynastidae	<i>Heleioporus eyrei</i>	Moaning Frog
	<i>Heleioporus psammophilus</i>	Sand Frog
	<i>Limnodynastes dorsalis</i>	Western Banjo Frog

Family	Species	Common Name
Myobatrachidae	<i>Crinia georgiana</i>	Quacking Frog
	<i>Crinia glauerti</i>	Clicking Frog
	<i>Crinia insignifera</i>	Squelching Froglet
	<i>Myobatrachus gouldii</i>	Turtle Frog
	<i>Pseudophryne guentheri</i>	Crawling Toadlet

Table 7. Mammals potentially found in the vicinity of the project area

	Species	Common Name
Canidae	<i>Canis lupus</i>	Dog
	<i>Vulpes vulpes</i>	Red Fox
Felidae	<i>Felis catus</i>	House Cat
Molossidae	<i>Austronomus australis</i>	White-striped Freetail Bat
	<i>Mormopterus species 4</i>	Southern Freetail Bat
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat
	<i>Nyctophilus geoffroyi</i>	Lesser Longeared Bat
	<i>Nyctophilus major</i>	Western Longeared Bat
	<i>Vespadelus regulus</i>	Southern Forest Bat
Dasyuridae	<i>Antechinus flavipes</i>	Yellow-footed Antechinus
	<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale

	Species	Common Name
Macropodidae	<i>Macropus fuliginosus</i>	Western Grey Kangaroo
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum
Tarsipedidae	<i>Tarsipes rostratus</i>	Honey Possum
Leporidae	<i>Oryctolagus cuniculus</i>	European Rabbit
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna
Peramelidae	<i>Isodon obesulus</i>	Southern Brown Bandicoot
Muridae	<i>Hydromys chrysogaster</i>	Water Rat
	<i>Mus musculus</i>	House Mouse
	<i>Rattus fuscipes</i>	Bush Rat
	<i>Rattus rattus</i>	Black Rat

Table 8. Reptiles potentially found in the vicinity of the project area

Family	Species
Agamidae	<i>Ctenophorus adalaidensis</i>
	<i>Pogona minor</i>
Diplodactylidae	<i>Diplodactylus polyophthalmus</i>
	<i>Strophurus spinigerus</i>
Elapidae	<i>Acanthophis antarcticus</i>
	<i>Brachyuropsis fasciolata</i>
	<i>Brachyuropsis semifasciata</i>
	<i>Demansia psammophis</i>
	<i>Echiopsis curta</i>
	<i>Elapognathus coronatus</i>
	<i>Neelaps bimaculatus</i>
	<i>Neelaps calonotos</i>
	<i>Notechis scutatus</i>
	<i>Parasuta gouldii</i>
	<i>Parasuta nigriceps</i>
	<i>Pseudonaja affinis</i>
	<i>Simoselaps bertholdi</i>
Gekkonidae	<i>Christinus marmoratus</i>
Pygopodidae	<i>Aprasia pulchella</i>
	<i>Aprasia repens</i>
	<i>Delma fraseri</i>
	<i>Delma grayii</i>
	<i>Lialis burtonis</i>
	<i>Pletholax gracilis</i>

Family	Species
	<i>Pygopus lepidopodus</i>
Scincidae	<i>Acriscincus trilineatus</i>
	<i>Cryptoblepharus buehneri</i>
	<i>Ctenotus australis</i>
	<i>Ctenotus fallens</i>
	<i>Ctenotus gemmula</i>
	<i>Ctenotus impar</i>
	<i>Ctenotus labillardieri</i>
	<i>Egernia napoleonis</i>
	<i>Hemiergis initialis</i>
	<i>Hemiergis quadrilineata</i>
	<i>Lerista distinguenda</i>
	<i>Lerista elegans</i>
	<i>Lerista lineata</i>
	<i>Lerista lineopunctulata</i>
	<i>Menetia greyii</i>
	<i>Morethia lineocellata</i>
	<i>Morethia obscura</i>
	<i>Tiliqua occipitalis</i>
	<i>Tiliqua rugosa</i>
Typhlopidae	<i>Ramphotyphlops australis</i>
Varanidae	<i>Varanus gouldii</i>
	<i>Varanus rosenbergi</i>
	<i>Varanus tristis</i>

4.3 Conservation significant fauna

Conservation significant fauna are protected by the Commonwealth *EPBC Act 1999*, and this list includes species covered by international treaties such as the Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) and the Western Australia (WA) *Wildlife Conservation Act 1950*. The WA *Wildlife Conservation Act 1950* provides for the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* that lists species under multiple categories. In addition, the DPaW maintains a list of fauna that require monitoring under four priorities based on DPaW's knowledge of their distribution, abundance and threatening processes. The *EPBC Act 1999* and *Wildlife Conservation Act 1950* imply legislative requirements for the management of anthropogenic impacts to minimise the effects of disturbances on species and their habitats. Priority species have no statutory protection, other than the DPaW wishes to monitor potential impacts on these species. Environmental consultants and proponents of developments are encouraged to avoid and minimise impacts on these species. Definitions of the significant fauna under the WA *Wildlife Conservation Act* are provided in Appendix C.

Appendix D shows the results of a search of the EPBC threatened species online database for adjacent areas. In the analysis below, marine, wetland and shorebirds have been excluded due to a lack of suitable habitat in or near the project area.

Thirteen threatened species of fauna and nine migratory/marine species of birds identified under the *EPBC Act 1999* potentially occur in the vicinity of the project area. There are nine species listed on the DPaW's Priority Fauna List that potentially occur in the vicinity of the project area. The following is an assessment of the likelihood of each of the species being impacted in the project area. Table 9 is a summary of this information.

Table 9. Species that are potentially found in the vicinity of the project area and that are listed as being of conservation significance under state or commonwealth government legislation or with DPAW

Species	Status under the Wildlife Conservation Act / DPAW	Status under the EPBC Act	Comment on potential impact that vegetation clearing will have on conservation significant species
<i>Neopasiphae simplicior</i> Native bee	Schedule 2	Critically Endangered	Unlikely to be found in the project area. Low potential impact.
<i>Leioproctus douglasiellus</i> Short-tongued bee	Schedule 2	Critically Endangered	Unlikely to be found in the project area. Low potential impact.
<i>Calyptrorhynchus latirostris</i> Carnaby's Black-Cockatoo	Schedule 2	Endangered	Could be seen foraging in the vicinity of the project area. Low potential impact.
<i>Bettongia penicillata ogilbyi</i> Woylie	Schedule 1	Critically Endangered	Not present in the project area. Low potential impact.
<i>Calyptrorhynchus banksii naso</i> Forest Red-tailed Black-Cockatoo	Schedule 3	Vulnerable	Could be seen foraging in the vicinity of the project area. Low potential impact.
<i>Calyptrorhynchus baudinii</i> Baudin's Black-Cockatoo	Schedule 2	Vulnerable	May infrequently be seen in the vicinity of the project area. Low potential impact.
<i>Dasyurus geoffroii</i> Chuditch	Schedule 3	Vulnerable	Not present in the project area. Low potential impact.
<i>Phascogale calura</i> Red-tailed Phascogale	Schedule 6	Endangered	Not present in the project area. Low potential impact.
<i>Myrmecobius fasciatus</i> Numbat	Schedule 2	Vulnerable	Not present in the project area. Low potential impact.
<i>Setonix brachyurus</i> Quokka	Schedule 3	Vulnerable	Not present in the project area. Low potential impact.
<i>Pseudocheirus occidentalis</i> Western Ringtail Possum	Schedule 2	Vulnerable	Not present in the project area. Low potential impact.
<i>Phascogale tapoatafa</i> Southern Brush-tailed Phascogale	Schedule 3	Vulnerable	Not present in the project area. Low potential impact.
<i>Leipoa ocellata</i> Malleefowl	Schedule 3	Vulnerable	Unlikely to be found in the project area. Low potential impact.
<i>Apus pacificus</i> Fork-tailed Swift	Schedule 5	Migratory	May infrequently fly over the project area. Low potential impact.
<i>Pandion haliaetus</i> Osprey	Schedule 5	Migratory	Not present in the project area. Low potential impact.
<i>Merops ornatus</i> Rainbow Bee-eater	Schedule 5	Migratory	May be found in the vicinity of the project area. Low potential impact.
<i>Ardea modesta</i> Great Egret	Schedule 5	Migratory Wetland	Unlikely to be found in the project area. Low potential impact.
<i>Ardea ibis</i> Cattle Egret	Schedule 5	Migratory Wetland	Unlikely to be found in the project area. Low potential impact.
<i>Motacilla cinerea</i> Grey Wagtail	Schedule 5	Migratory	Not present in the project area. Low potential impact.
<i>Haliaeetus leucogaster</i> White-bellied Sea-eagle		Marine	May infrequently fly over the project area. Low potential impact.
<i>Ctenotus gemmula</i>	Priority 3		Very low possibly in the project area. There is a low possibility that some individuals could be lost during vegetation clearing.
<i>Neelaps calonotos</i> Black-striped Snake	Priority 3		Very low possibly in the project area. There is a low possibility that some individuals could be lost during vegetation clearing.
<i>Lerista lineata</i> Lined Skink	Priority 3		Very low possibly in the project area. There is a low possibility that some individuals could be lost during vegetation clearing.
<i>Synemon gratiosa</i> Graceful Sun-Moth	Priority 4		Low possibly in the project area. There is a low possibility that some individuals could be lost during vegetation clearing.
<i>Macropus irma</i> Western Brush Wallaby	Priority 4		Not present in the project area. Low potential impact.
<i>Hydromys chrysogaster</i> Water Rat	Priority 4		Not present in project area. Low potential impact.
<i>Falsistrellus mackenziei</i> Western False Pipistrelle	Priority 4		Unlikely to be found in the project area. Low potential impact.
<i>Isodon obesulus fusciventer</i> Southern Brown Bandicoot	Priority 4		Unlikely to be found in the project area. Low potential impact.

Native Bee (*Neopasiphae simplicior*) – Critically Endangered under the *EPBC Act 1999* and Schedule 2 under the *Wildlife Conservation Act 1950*

This critically endangered bee has been found at multiple locations including Port Gregory, Cannington, Forrestdale and Kooljerrenup Nature Reserve near Lake Clifton. It has been collected from the flowers of Thread-leaved Goodenia (*Goodenia filiformis*), Slender Lobelia (*Lobelia tenulor*), *Angianthus preissianus* and *Velleia* sp. (Houston 2000).

Terrestrial Ecosystems' assessment is that the proposed vegetation clearing is unlikely to impact on this species, as there is no suitable habitat and it is outside the species known geographic distribution.

Short-tongue bee (*Leioproctus douglasiellus*) – Critically Endangered under the *EPBC Act 1999* and Schedule 2 under the *Wildlife Conservation Act 1950*

This small black bee occurs at four locations in the Perth metropolitan area, with each location considered a separate population. This bee is found on clay-based wetlands and vegetation that is subject to seasonal inundation. Terrestrial Ecosystems' assessment is that the proposed vegetation clearing is unlikely to impact on this species, as there is no suitable habitat and it is outside the species known geographic distribution.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) – Endangered under the *EPBC Act 1999* and Schedule 2 under the *Wildlife Conservation Act 1950*

Carnaby's (or Short-billed) Black-Cockatoo (*Calyptorhynchus latirostris*) is a large, pied, cockatoo. Garnett et al. (2011) and the DSEWPac (2011) reported that Carnaby's Black-Cockatoo inhabits the south-west of Western Australia, from Kalbarri to as east on the south coast as Esperance. It breeds inland and moves to the coastal areas when chicks have fledged (Saunders et al. 1985). Carnaby's Black-Cockatoos are highly gregarious, usually seen in trios, small parties or large flocks (up to 5000 birds; Perry 1948). These flocks usually contain males, females and immature birds.

In some locations, breeding populations have decreased or become locally extinct (Saunders 1986, Saunders and Ingram 1987). For example, in the Coomallo Creek area north of Perth, Black-Cockatoos laid 74 clutches in 1973, 75 in 1974, 82 in 1975 but only 20 in 1994 and 19 in 1996 (Saunders and Ingram 1987). Saunders (1986) reported finding 13 nests at Manmanning in 1969 but by 1977, the species had stopped breeding in the area. Saunders (1990) reported failed nestings due to predation by a cat, galahs broke Carnaby's Black-Cockatoo eggs and took over nests, while other adult birds were killed by vehicles and Wedge-tailed Eagles (*Aquila audax*).

Carnaby's Black-Cockatoos are partly migratory and partly sedentary (Higgins 1999). In the drier regions of their geographic range where most of the native vegetation has been cleared (e.g. wheatbelt), Carnaby's Black-Cockatoos are postnuptial migrants (Saunders 1980, Saunders and Ingram 1995). After breeding, individuals in these areas migrate to feed in higher rainfall areas including the Swan Coastal Plain, and to a lesser extent, forests dominated by *E. marginata* (Jarrah), *C. calophylla* (Marri) and *E. diversicolor* (Karri; Saunders 1980). On the Swan Coastal Plain, Carnaby's Black-Cockatoos have been recorded foraging in most suburbs and in pine plantations within the greater Perth metropolitan area (Perry 1948). Vagrants have been recorded on Rottnest Island (Winnett 1989) and Garden Island (Wykes et al. 1999). These later two sightings clearly indicate that Carnaby's Black-Cockatoo will fly considerable distances over non-vegetated areas to forage.

Garnett et al. (2011) estimated there were between 10,000 and 60,000 birds in the population.

Saunders (1980) recorded non-breeding cockatoos at Coomallo Creek foraging within a 50km radius of their breeding area, whereas, cockatoos at Manmanning moved a much greater distance to the coastal plain during their non-breeding season. These data suggest that Carnaby's Black-Cockatoo move from areas where there is little food to southern and western coastal areas where food is presumably more plentiful during summer and autumn (Davies 1966, Saunders 1980).

Carnaby's Black-Cockatoo breed between July and November mostly in eucalypt woodland (Saunders 1980, 1986). Carnaby's Black-Cockatoo nest in tree hollows that are created by fire, fungi, termites or old age, with hollows between 2.5 and 12m above the ground (Saunders 1979a, Higgins 1999). Hollows are large, ranging from 10 to over 250cm in depth (Higgins 1999). These hollows are usually in live or dead smooth-barked *Eucalyptus salmonophloia* (Salmon Gum) or *Eucalyptus wandoo* (Wandoo). However, Carnaby's Black-Cockatoo will also nest in *E. longicornis* (Red Morrell), *E. loxophleba* (York Gum), *E. gomphocephala* (Tuart), *E. rudis* (Flooded Gum), *E. salubris* (Gimlet), *E. occidentalis* (Swamp Yate) and *C. calophylla* (Higgins 1999, Cale 2003). When

breeding, they most often forage in the surrounding shrubland and kwongan heath (Higgins 1999). On the Swan Coastal Plain, breeding could occur in *E. gomphocephala*, *E. rudis*, *E. occidentalis* and *C. calophylla*. Adults return to the same breeding area each year (Saunders 1977) and some use the same tree hollow for many years in succession to raise their chicks, others shift their nests among a number of trees in the same area (Saunders and Ingram 1998).

Eggs are laid on a mat of wood chips chewed from the sides of the hollow. Clutches are 1-2, but most often only one chick is raised. Incubation takes 29 days, and only the female incubates and broods (Johnstone and Kirkby 2011). Initially the female will return to the nest mid-morning to feed the chick, but after about 2-3 weeks both parents leave in the early morning and return late evening.

Young remain with their parents until the parents return to the breeding area in the following year (Saunders 1980). Immature birds probably do not move into the breeding areas until they are ready to breed, although little is known of the movements of immature Carnaby's Black-Cockatoo until they are ready to breed (Saunders 1977).

The breeding success of Carnaby's Black-Cockatoo is believed to be strongly influenced by the availability of food at breeding sites (Saunders et al. 1985). Saunders (1977) found that birds that foraged within one or two kilometres from nesting sites had greater fledgling success than those from populations that had to travel up to four kilometres to obtain food. In a study that monitored Carnaby's Black-Cockatoo's breeding over 25 years at Coomallo Creek, Saunders and Ingram (1998) showed that the number of breeding attempts halved by the end of the study. During this period, native vegetation cover was reduced from 90% in 1959 to 25% in 1996. Their study revealed that although there was a surplus of trees with hollows of sufficient sizes, clearing of adjacent foraging habitat had adversely impacted on the success of breeding birds. Therefore, breeding sites typically have nearby areas of scrub and heath where birds forage on seeds and flowers of numerous trees and shrubs including *Banksia*, *Hakea*, *Dryandra*, *Grevillea* and *Callistemon* spp. (Robinson 1965, Saunders 1980, Higgins 1999). Unlike other cockatoo species, Carnaby's Black-Cockatoo will not utilise cereal crops (Saunders et al. 1985), but will feed on *Erodium* seed (Saunders 1980).

At Coomallo Creek, Carnaby's Black-Cockatoo travelled on average 1.4km from their nests to forage, whereas at Manmanning they foraged more widely and travelled an average of 2.5km from their nest to forage (Saunders 1980). At Manmanning, road and railway reserves were extensively used for foraging, presumably as this was the closest food source to their nests. The availability of food near the nest influenced the time spent incubating eggs and fledgling body mass (Saunders 1980). At Manmanning, Carnaby's Black-Cockatoo traversed agricultural land to forage in remnant plots of uncleared land.

The social organisation of breeding Carnaby's Black-Cockatoo is known (Saunders 1974, 1977, 1979b, 1980, Saunders et al. 1985, Saunders 1986, Higgins 1999). Carnaby's Black-Cockatoo start reproducing at about four years of age and continue for at least 15 years (Cale 2003). Strong pair bonds are then formed, often for life. Females lay one or two eggs asynchronously with an average of 8 days (range 1-12) between the laying of the first and second egg. Egg laying usually occurs in early July to mid-October, with inland birds laying approximately three weeks later than those closer to the coast. Females incubate their 1-2 eggs for 28-29 days (Saunders 1982). When two eggs are laid, it is extremely rare for both nestlings to successfully fledge. The female alone broods and feeds the young birds. Initially, the female, and later the chick, rely on the male for food during the brooding and hatching of the eggs (Saunders 1977, Saunders 1982). After two to three weeks, both parents forage and return at mid-morning and dusk to feed the young (Saunders 1977, Saunders 1982). The young are dependent on parents for several months after fledgling. Fledglings are independent after about 10-11 weeks (Saunders 1977).

Although flocks of Carnaby's Black-Cockatoo are seen foraging in the Perth metropolitan area during summer and autumn there are no published data of any breeding taking place in the greater Perth metropolitan area. It is also interesting that Carnaby's Black-Cockatoo will nest in the Moora town site (Davies 2005) but have not nested in the Perth metropolitan area. It is not known if they bred in the Perth area before European settlement.

Saunders (1980) reported Carnaby's Black-Cockatoo at Coomallo Creek (breeding area) foraged mostly on native plants, with the only exception being *Erodium* sp.. Higgins (1999) reported the habitat of Carnaby's Black-Cockatoo was uncleared or remnant woodlands dominated by *Eucalyptus*, particularly *E. wandoo* and *E. salmonophloia* and often in shrubland or kwongan heathland dominated by *Hakea*, *Dryandra*, *Banksia* and *Grevillea* and seasonally in *Pinus* plantations and less often in *C. calophylla*, *E. diversicolor* or *E. marginata*.

Since the 1930s, pine plantations have become an important feeding resource during the summer months (Perry 1948, Saunders 1974, 1980). The utilisation of pine plantations by cockatoos is likely to reflect the high energetic return of pine seeds, the concentrated food source and the loss of native habitat that has occurred on the Swan Coastal Plain since the 1930s.

The belief that Carnaby's Black-Cockatoo numbers are in serious decline has led to a recovery plan being released in 2012 (DEC 2013). This plan details the current status of the cockatoo and provides conservation measures to increase the population. The five broad recovery actions in this plan are:

- Protect and manage important habitat – identify, protect and manage habitat critical for survival (nesting, foraging and roosting) for Carnaby's Black-Cockatoos across their breeding and non-breeding range;
- Conduct research to inform management – undertake research into the biology, ecology, and conservation management of Carnaby's Black-Cockatoo;
- Undertake regular monitoring – monitor population parameters, habitat, threats and status of the Carnaby's Black-Cockatoo;
- Manage other impacts – monitor the impacts and implement strategies to reduce other factors detrimentally affecting Carnaby's Black-Cockatoo, and support rehabilitation programs;
- Undertake information and communication activities – develop and distribute awareness raising and guidance materials for decision makers, establish joint management agreements and provide for improved sharing of information between agencies; and
- Engage with the broader community – engage with and involve people across the community in the conservation of Carnaby's Black-Cockatoo.

There is a very limited foraging opportunities for Carnaby's Black-Cockatoo in the project area. If it did forage it is unlikely to return frequently due to the lack of foraging resource. Clearing of the vegetation is unlikely to significantly impact on Baudin's Black-Cockatoo.

Woylie (*Bettongia penicillata ogilbyi*) – Critically Endangered under the *EPBC Act 1999* and Schedule 1 under the *Wildlife Conservation Act 1950*

Woylie numbers have significantly reduced in recent years after it was removed from the conservation significant species lists. The Woylie was once abundant in the south-west forest areas. Fox and cat predation, along with habitat destruction were thought to have significantly reduced its numbers (De Tores and Start 2008). The Woylie diet consists of underground fungi, tubes, bulbs and seeds.

They have not been recorded in the vicinity of the project area in recent years. They were not seen during the site visit. It is Terrestrial Ecosystems' assessment that they are not present in the project area.

Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable under the *EPBC Act 1999* and Schedule 3 under the *Wildlife Conservation Act 1950*

The Forest Red-tailed Black-Cockatoo is one of three large black-cockatoos found in Western Australia. *Calyptorhynchus banksii naso* frequents the humid to sub-humid south-west of Western Australia from Gingin in the north, to Albany in the south and west to Cape Leeuwin and Bunbury (Department of Sustainability Environment Water Population and Communities 2011). It was mostly seen in the hill interior, but small numbers of birds were seen at Mundijong, Baldivis, Karnup, Stakehill, Pinjarra, Coolup and in the Lake Clifton area (Johnstone and Kirkby 2011). In 2011, there was an increase in the number of Forest Red-tailed Black-Cockatoo on the coastal strip north from Rockingham to the northern metropolitan suburbs. The reason for the recent increase in abundance is unknown.

The Forest Red-tailed Black-Cockatoo nests in tree hollows with a depth of 1-5m that are predominately *C. calophylla*, *E. marginata* and *E. diversicolor*. The nest entrance is 12-41 cm, and similar to other black-cockatoos, it lays two eggs on wood chips in October and November, but most often only one survives. Incubation period is 29-31 days and only the female incubates and broods (Johnstone and Storr 1998).

Johnstone and Kirkby (2011) reported the Forest Red-tailed Black-Cockatoo to feed mostly on seeds from *C. calophylla*, *E. marginata*, but also on *Allocasuarina fraseriana* (Sheoak), *Persoonia longifolia* (Snottygobble),

Eucalyptus patens (Blackbutt) and introduced species such as *M. azedarach* (Cape Lilac) and *Corymbia citriodora* (Lemon-scented Gum).

Loss of breeding habitat in the form of suitable hollows and adequate feeding resources in the vicinity of nesting hollows to enable adults to feed chicks is a primary threat. Abbott (1998) reported that trees within its known breeding distribution was not a factor in limiting breeding. He estimated there were about 15,000 birds and Garnett et al. (2011) thought about 10% of these birds bred each year. Competition for nesting hollows by other cockatoos, Wood Ducks, Galahs and feral Honey Bees appears to also be a significant threat (Garnett et al. 2011).

There is very limited foraging habitat for Forest Red-tailed Black-Cockatoos with the consequence that they are unlikely to be seen regularly foraging in the project area, and if they do then they will move on quickly. Clearing of the vegetation is unlikely to significantly impact on Forest Red-tailed Black-Cockatoos.

Baudin's Black-Cockatoo (*Calyptrorhynchus baudinii*) – Vulnerable under the *EPBC Act 1999* and Schedule 2 under the *Wildlife Conservation Act 1950*

Baudin's Black-Cockatoo occurs in the humid and sub-humid forests of Western Australia, an area within the 750mm isohyet (Chapman 2007). Its range extends from Gidgegannup and Clackline in the north to about 50km east of Albany and all the forest to the south-west coast (Chapman 2007).

Baudin's Black-Cockatoo is typically found in vagrant flocks and utilises the taller, more open *E. marginata*, Marri and Karri forests, where it feeds mainly on Marri seeds and various Proteaceous species. Johnstone and Kirkby (2008) reported Baudin's Black-Cockatoo feeding on the seeds of *C. calophylla*, *E. marginata*, *A. fraseriana*, *Banksia grandis*, *B. quercifolia*, *B. littoralis*, *B. ilicifolia*, *Hakea erinacea*, *H. prostrata*, *H. stenocarpa*, *H. trifurcata*, *H. lasianthoides*, *H. ruscifolia*, *H. lissocarpha*, *H. varia*, *H. cristata*, *H. marginata*, *Dryandra sessilis*, *D. squarrosa*, *D. praemorsa*, *Grevillea wilsonii*, *Xanthorrhoea preissii*, *Kingia australis*, *Reedia spathacea*, *Pinus radiata*, *Erodium* spp., *Jacaranda* spp., *Macadamia* spp., *Carya illinoensis*, *Malus* spp., *Pyrus* spp., *Diospyros* spp. and *Quercus* spp.; and the nectar, buds and flowers of *C. calophylla*, *C. citriodora*, *E. marginata*, *E. wandoo*, *B. grandis*, *D. sessilis*, *D. lindleyana*, *D. squarrosa*, *Darwinia citriodora* and *Callistemon* spp. They also eat insect larvae and insects from under the bark. Baudin's Black-Cockatoo damages apples and pears in domestic and commercial orchards, and for this reason has been shot by orchardists (Chapman 2007).

Johnstone and Kirkby (2008) suggested that once chicks had fledged, birds leave the nesting area and family groups amalgamate to form larger flocks. These large flocks arrive in the non-breeding central and northern parts of the Darling Scarp in early February and March. This postnuptial nomad is seen in Collie, Bannister, North Dandalup, Serpentine, Jarrahdale, Wungong, Mundaring and Chidlow, and sometimes venture on to the adjacent coastal plain at Maida Vale, Kelmscott, Armadale, Byford, Mundijong, Lake Clifton, Bunbury, Capel, Busselton and Dunsborough (Johnstone and Kirkby 2008, Johnstone and Kirkby 2011). During the non-breeding period, Baudin's Black-Cockatoo utilises a number of roosts on a regular basis. Johnstone and Kirkby (2008) have recorded some of the larger roosts at Gidgegannup, Piesse Brook, Nangur, Mundaring, Araluen, Wungong, North Dandalup and Serpentine. Other roosts are at Chidlow, Parkerville, Kalamunda, Kelmscott, Roleystone, Bedfordale, Gleneagle, Mundijong, Jarrahdale, Bannister and Crossman. Most of these roost sites are tall emergent eucalypts or Blackbutt and they are often near watercourses and in sheltered gullies. They seldom venture as far west as the project area.

It is known to breed in the southern forests north to Collie and east to near Kojonup in large vertical hollows of *E. diversicolor*, *C. calophylla* and *E. wandoo* (Johnstone and Kirkby 2008). Johnstone and Storr (1998) reported eggs are laid in August to December, with a clutch of 1-2, but normally only a single chick is fledged. Only the female incubates and broods.

Garnett et al. (2011) estimated the population to be around 10,00-15,000, with only 10% breeding in any year.

Garnett et al. (2011) reported the primary threat to this species is a lack of suitable hollows. Competition for hollows comes from other cockatoos, Galahs, Australian Shelducks, Wood Ducks and feral Honey Bees (Johnstone and Kirkby 2008, Garnett et al. 2011). Inadequate feeding resources in the vicinity of nesting hollows to enable adults to feed chicks are also a threat.

The Recovery Plan for Baudin's and Forest Red-tailed Black-Cockatoos (Chapman 2007) seeks to:

- develop and promote non-lethal means of stopping Baudin's damaging fruit in orchards;
- eliminate illegal shooting;

- develop and implement strategies to allow for the use of noise emitting devices in orchards;
- develop and implement as protocol for the easy removal of honeybees from nesting hollows;
- determine and implement ways to minimise the effects of mining on habitat loss;
- identify factors affecting the number of breeding attempts and breeding success and manage nest hollows to increase recruitment reduce habitat loss;
- map feeding and breeding habitat critical to the survival of this species;
- determine the population and distribution and patterns of movement for both species; and
- maintain the Cockatoo Care program.

Baudin's Black-Cockatoo may infrequently be seen foraging in the vicinity of the project area, but it is mostly seen on the Swan Coastal Plain much closer to the Darling Scarp. Clearing of the vegetation is unlikely to significantly impact on Baudin's Black-Cockatoo.

Chuditch, Western Quoll (*Dasyurus geoffroii*) – Vulnerable under the *EPBC Act 1999* and Schedule 3 under the *Wildlife Conservation Act 1950*

The Chuditch was originally found in over 70% of Australian woodlands; however, since European settlement its range has diminished to a patchy distribution throughout the Jarrah forest and mixed Karri - Marri - Jarrah forest of south-west WA. They have been known to occupy a wide range of habitats including woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. The Chuditch creates dens in hollow logs or burrows and have also been recorded in tree hollows and cavities. They are opportunistic feeders, and forage on the ground at night, feeding on invertebrates, small mammals, birds and reptiles.

Chuditch were not seen during the site visit and there is no suitable habitat in the project area. Terrestrial Ecosystems' believes that the Chuditch is not present in the project area due to a lack of suitable habitat and there are no recent records in the vicinity.

Western Ringtail Possum (*Pseudocheirus occidentalis*) - Vulnerable under the *EPBC Act 1999* and Schedule 2 under the *Wildlife Conservation Act 1950*

The Western Ringtail Possums distribution is patchy across its current range. The closest known population is south of Mandurah. It has a preference for Peppermint woodlands, but is also found in Jarrah/Marri forests and woodlands with adequate hollows, coastal heath, myrtaceous heaths and shrublands and karri forests.

Terrestrial Ecosystems' believes that the Western Ringtail Possum is not present in the project area due to a lack of suitable habitat and there are no recent records in the vicinity of the project area.

Red-tailed Phascogale (*Phascogale calura*) – Endangered under the *EPBC Act 1999* and Schedule 6 under the *Wildlife Conservation Act 1950*

This species was formerly widespread in woodland habitat through much of inland southern and central Australia. It is now restricted to remnants of mature Wandoo or Rock Oak woodland in the southern wheatbelt.

The Red-tailed Phascogale was not seen on site during surveys or caught during the trapping program of the Vivente project area. Terrestrial Ecosystems' assessment is that given the lack of recent records of this species in the vicinity of the project area and a lack of suitable habitat, the Red-tailed Phascogale is not present in the project area.

Numbat (*Myrmecobius fasciatus*) – Vulnerable under the *EPBC Act 1999* and Schedule 2 under the *Wildlife Conservation Act 1950*

The Numbat was originally widespread across southern semi-arid and arid Australia, from western NSW through SA and southern NT to the south-west of WA (Maxwell et al. 1996). There are currently two remnant native populations at Dryandra and Perup, WA and several reintroduced populations including Boyagin Nature Reserve, Tutanning Nature Reserve, Battalling block and Karroun Hill Nature Reserve (Friend and Thomas 1995).

The Numbat was not seen during the site visit nor caught during the trapping program of the Vivente project area and there are no recent records of this species in the general area. Terrestrial Ecosystems' assessment is that it is not present in the project area.

Southern Brush-tailed Phascogale (*Phascogale tapoatafa*) – Vulnerable under the *EPBC Act 1999* and Schedule 3 under the *Wildlife Conservation Act 1950*

Southern Brush-tailed Phascogales are arboreal marsupials which require tree hollows in suitable woodland or forest and rely on abundant invertebrate prey to sustain populations. They are rarely detected in vertebrate fauna surveys as they are arboreal and trap shy. They are generally not found on the coastal plain south of the Swan River and there are no recent records for this Phascogale in the vicinity of the project area.

The Southern Brush-tailed Phascogale was not seen during the site visit or caught during the Vivente trapping program and given the recent lack of records of this species in the vicinity of the project area and a lack of suitable habitat in the project area, it Terrestrial Ecosystems' assessment that the Southern Brush-tailed Phascogale is not present in the project area.

Quokka (*Setonix brachyurus*) – Vulnerable under the *EPBC Act 1999* and Schedule 3 under the *Wildlife Conservation Act 1950*

Quokkas were originally very common on the Swan Coastal Plain, however, their distribution is now limited to Rottnest Island and a few isolated areas in the south-west of WA. On the mainland, they prefer densely vegetated areas around wetlands and streams, whereas on Rottnest Island they inhabit low scrubby coastal vegetation where water is not readily available year-round. They are herbivorous, and feed on leaves, bark, succulent plants and grasses. There are no recent records of Quokka being found in the vicinity of the project area.

Quokkas were not seen during the site visit nor caught during the Vivente trapping program. Terrestrial Ecosystems' believes that Quokkas are not present in the project area due to lack of suitable habitat and the presence of introduced predators.

Malleefowl (*Leipoa ocellata*) - Schedule 3 under the *Wildlife Conservation Act 1950* and Vulnerable under the *EPBC Act 1999*.

Malleefowl are large, ground-dwelling birds that rarely fly unless alarmed or are perching for the night. Historically, Malleefowl have been found in mallee regions of southern Australia from approximately the 26th parallel of latitude southwards. Recently their range has contracted due to fox predation and land clearance. They have not been recorded in the Perth metropolitan area for many years. Malleefowl build distinctive nests that comprise a large mound of soil/rock covering a central core of leaf litter. These nest mounds range in diameter but can span more than five metres and may be up to one metre high. Malleefowl are generally monogamous and, once breeding commences, they pair for life. The presence of nest mounds provides an indication of the presence of Malleefowl in the area.

Malleefowl are not in the project area and it is Terrestrial Ecosystems' assessment that the proposed clearing in the project area will not have a significant impact on this species.

Fork-tailed Swift (*Apus pacificus*) - Migratory under the *EPBC Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*

The Fork-tailed Swift breeds in north-east and mid-east Asia and winters in Australia and south New Guinea (Johnstone and Storr 1998). They arrive in the Kimberley in late September and in the Pilbara in November and the south-west in December, leaving late in April. Johnstone and Storr (1998) reported them as common in the Kimberley and uncommon to moderately common along the north-west, west and south-east coasts and scarce elsewhere. They are often seen in large flocks and can be attracted to thunderstorms or cyclonic events in the northern parts of the state.

As this is an aerial migratory species, ground disturbance activities on a localised scale are unlikely to significantly impact on Fork-tailed Swifts. They could infrequently be seen flying over the project area.

Rainbow Bee-eater (*Merops ornatus*) - Migratory under the *EPBC Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*

Rainbow Bee-eaters are abundant in Australia, and found in many parts of Western Australia except the sandy deserts and dry arid interior. Johnstone and Storr (1998) described them as resident, breeding visitors and

postnuptial nomads. They are generally migratory, moving south in late September and early October, having wintered from the Gascoyne to Indonesia.

Rainbow Bee-eaters are regularly seen across most of the wetter areas of Western Australia including around the project area. Given their abundance and wide spread distribution, ground disturbance activities on a localised scale are unlikely to significantly impact on Rainbow Bee-eaters.

Great Egret (*Ardea modesta*) - Migratory under the *EPBC Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*

Hérons and egrets all depend to some extent upon surface water for hunting. The Great Egret is the largest of the Australian egrets, and is an elegant, white wader dependent upon floodwaters, rivers, shallow wetlands and intertidal mudflats. Its diet consists of a range of small, aquatic invertebrates and small vertebrates (Frith 1976).

Given the dependence of the Great Egret upon wetlands and waterways, it is unlikely to be seen in the project area.

Cattle Egret (*Ardea ibis*) - Migratory under the *EPBC Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*

The smallest of the Australian egrets, this species has undertaken an invasion of Australia from the north, where it was originally more common in the Indonesian archipelago than Australia (Simpson and Day 2004). This invasion may have been assisted by the opening up of farming land and irrigation schemes, providing the pasturelands and shallow wetlands in which it prefers to forage. Johnstone and Storr (1998) noted the species distribution in Western Australia as being confined to the irrigation areas surrounding Kununurra, however, its migratory nature and current invasive tendencies suggest that it may occur elsewhere in the state, and may still be expanding its distribution.

Given the dependence of the Cattle Egret upon wetlands, waterways and pastures, it is unlikely to be seen in the project area.

Osprey (*Pandion haliaetus*) - Migratory under the *EPBC Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*

Osprey are a large bird of prey that is found along the coast of Western Australia. They are typically found close to the coast, river and occasionally large wetlands. They feed mainly on fish and sea snakes and occasionally on large coastal lizards.

Osprey may infrequently be seen flying over the project area, but clearing the vegetation is unlikely to have a significant impact on this species.

Grey Wagtail (*Motacilla cinerea*) - Migratory under the *EPBC Act 1999* and Schedule 5 under the *Wildlife Conservation Act 1950*

The Grey Wagtail is a small yellow breasted bird with a grey back and head. Johnstone and Storr (2004) reported this migratory species as breeding in Palearctic from western Europe and north-west Africa to eastern Asia and wintering in Africa, south-east Asia, Indonesia, the Philippines, New Guinea and Australia. Its preferred habitat in Australia is banks and rocks in fast-running fresh water including rivers, streams and creeks where it feeds on insects. The Atlas of Living Australia records two sightings on the south-coast of Western Australia and none around the project area. It is highly unlikely to be seen in the project area due to a lack of suitable habitat.

Ctenotus gemmula – Priority 3 with DPAW

There are three geographic populations for this small skink. One is on the sand plain north of Perth, one is on the sand plain around the greater metropolitan area and the largest geographic distribution is along the south coast of Western Australia. Storr et al. (1999) reported its habitat as white sand plains, mainly in semi arid and sub-humid zones. There are two records in Terrestrial Ecosystems' fauna survey database for a *C. gemmula* in the vicinity of the project area, but since the project area had been previously cleared, there is a very low possibility that it could still occur in the project area. It was not recorded during vegetation clearing of Vivente.

Terrestrial Ecosystems' assessment is that there is a very low possibility this species could occur in the project area.

Black-striped Snake (*Neelaps calonotos*) – Priority 3 with DPaW

This species occurs on dunes and sand-plains vegetated with heaths and eucalypt/banksia woodlands. It feeds largely on skinks and its distribution is restricted and threatened by urban development. In its natural state, the project area would have been typical habitat for the Black-striped snake, but not since the project area has been cleared. It was not recorded during vegetation clearing in the Vivente project area.

Terrestrial Ecosystems' assessment is that there is a very low possibility this species could occur in the project area.

Lined Skink (*Lerista lineata*) – Priority 3 with DPaW

This species is found in coastal heaths and shrub lands on the lower west coast between Perth and Mandurah, including Rottnest Island, with isolated populations on the mid-west coast and Busselton. It has been caught on the sand plain south of the Swan River and could be found in the project area before it was cleared. It was not recorded during vegetation clearing in the Vivente project area, and is therefore unlikely to occur in the project area.

Graceful Sun-moth (*Synemon gratiosa*) – Priority 4 with DPaW

This species has brightly coloured orange hind-wings, and is similar in appearance to a butterfly. The breeding season is late February to early April, during which time adults are active during the day and they are thought to breed exclusively on *Lomandra* species, in particular *L. hermaphrodita* and *L. maritima*. PGV Environmental (2014) listed *L. hermaphrodita* as being present in the project area. Graceful Sun-moths occur along the Swan Coastal Plain between Moore River and Preston Beach and the species is under threat due to vegetation clearing and damage to the environment.

As there is a small quantity of *L. hermaphrodita* in the project area, there is a low possibility that the Graceful Sun-moth is present in the project area.

Western Brush Wallaby (*Macropus irma*) – Priority 4 with DPaW

This species was very common in the early days of settlement, however, its range has been seriously reduced and fragmented due to clearing for agriculture and there is a significant decline in abundance within most remaining habitat. It is now distributed across the south-west of WA from north of Kalbarri to Cape Arid. The optimum habitat is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets.

It was not seen during the site visit and Terrestrial Ecosystems' believes that it is not present in the project area because of a lack of suitable habitat.

Water Rat (*Hydromys chrysogaster*) – Priority 4 with DPaW

The water rat is found mainly near permanent bodies of freshwater, occasionally at temporary waterholes. It is also found in the streams, wetland, lakes and estuaries on the Swan Coastal Plain.

As there is no wetland on or near the project area, Terrestrial Ecosystems' believes the Water Rat it is not present in the project area.

Western False Pipistrelle (*Falsistrellus mackenziei*) – Priority 4 with DPaW

This insectivorous species is the largest vespertilinoid in WA and is confined to south-west WA, south of Perth and east to the wheatbelt. It is known to utilise the mature Karri forests but has also been recorded in Jarrah and Tuart woodland on the Swan Coastal Plain.

Terrestrial Ecosystems' believes it is unlikely to be recorded in a Banksia woodland on the Swan Coastal Plain.

Quenda or Southern Brown Bandicoot (*Isodon obesulus fusciventer*) – Priority 4 with DPaW

Quenda prefer dense scrub, with swampy vegetation but are found in a variety of other habitats. They will often feed in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and crop land lying close to dense cover. This species was caught in the Vivente project area prior to the vegetation clearing program but due to a lack of suitable habitat in the project area it is highly unlikely to be present.

Threatened marine, wetland or shore birds

Anous tenuirostris melanops (Australian Lesser Noddy), *Botaurus poiciloptilus* (Australasian Bittern), *Calidris ferruginea* (Curlew Sandpiper), *Diomedea epomophora epomophora* (Southern Royal Albatross), *Diomedea epomophora sanfordi* (Northern Royal Albatross), *Diomedea exulans amsterdamensis* (Amsterdam Albatross), *Diomedea exulans exulans* (Tristan Albatross), *Diomedea exulans* (Wandering Albatross), *Macronectes giganteus* (Southern Giant Petrel), *Macronectes halli* (Northern Giant Petrel), *Pachyptila turtur subantarctica* (Fairy Prion), *Rostratula australis* (Australian Painted Snipe), *Sternula nereis nereis* (Australian Fairy Tern), *Thalassarche cauta cauta* (Shy Albatross), *Thalassarche cauta steadi* (White-capped Albatross), *Thalassarche melanophris* (Black-browed Albatross), *Thalassarche melanophris impavida* (Campbell Albatross), *Puffinus carneipes* (Flesh-footed Shearwater), *Sterna anaethetus* (Bridled Tern), *Charadrius rubricollis* (Hooded Plover), *Sterna caspia* (Caspian Tern), *Sterna dougallii* (Roseate Tern), *Thalassarche melanophris* (Black-browed Albatross), *Calidris acuminata* (Sharp-tailed Sandpiper), *Calidris canutus* (Red Knot), *Calidris melanotos* (Pectoral Sandpiper), *Calidris ruficollis* (Red-necked Stint), *Calidris subminuta* (Long-toed Stint), *Charadrius dubius* (Little Ringed Plover), *Charadrius ruficapillus* (Red-capped Plover), *Gallinago megala* (Swinhoe's Snipe), *Gallinago stenura* (Pin-tailed Snipe), *Haliaeetus leucogaster* (White-bellied Sea-Eagle), *Himantopus himantopus* (Black-winged Stilt), *Larus pacificus* (Pacific Gull), *Limosa lapponica* (Bar-tailed Godwit), *Limosa limosa* (Black-tailed Godwit) and *Philomachus pugnax* (Ruff) were recorded in the EPBC threatened species database search in the vicinity of the project area, but they are marine, wetland or shore birds and therefore unlikely to be seen in the project area due to a lack of suitable habitat.

4.4 Risk assessment

Fauna surveys to support Environmental Impact Assessments (EIA) are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on the biodiversity in a particular area and region. Potential impacts on fauna from the proposed development are identified and briefly described above. Tables 9, 10 and 11 provide a summary of the risk assessment associated with this project.

The assessment contained in Table 11 is supported by more detailed discussion in sections above and the management recommendations below.

Table 10: Fauna impact risk assessment descriptors

Any risk assessment is a product of the likelihood of an impact occurring and the consequences of that impact. Likelihood and consequences are categorised and described below. These criteria do not fit all circumstances (e.g. adequacy of fauna survey data); however, they are useful in providing the reader with an appreciation of the level of likelihood and consequences of an event. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the events or impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 12.

Likelihood		Criteria
Level	Description	Criteria
A	Rare	The environmental event may occur or one or more conservation significant species may be present in exceptional circumstances.
B	Unlikely	The environmental event could occur or one or more conservation significant species could be present at sometime.
C	Moderate	The environmental event should occur or one or more conservation significant species should be present at sometime.
D	Likely	The environmental event will probably occur or one or more conservation significant species will be present in most circumstances.
E	Almost certain	The environmental event is expected to occur or one or more conservation significant species is expected to be present in most circumstances.
Consequences		Criteria
Level	Description	Criteria
1	Insignificant	Insignificant impact on fauna of conservation significance or regional biodiversity, and the loss of individuals will be insignificant in the context of the availability of similar fauna or fauna assemblages in the area.
2	Minor	Impact on fauna localised and no significant impact on species of conservation significance in the project area. Loss of species at the local scale.
3	Moderate	An appreciable loss of fauna in a regional context or a limited impact on species of conservation significance in the project area.
4	Major	Significant impact on conservation significant fauna or their habitat in the project area and/or regional biodiversity and/or a significant loss in the biodiversity at the landscape scale.
5	Catastrophic	Loss of species at the regional scale and/or a significant loss of species categorised as 'vulnerable' or 'endangered' under the <i>EPBC Act (1999)</i> at a regional scale.
		Acceptability of Risk
Level of risk	Management of risk	
Low	No action required.	
Moderate	Avoid if possible, routine management with internal audit and review of monitoring results annually.	
High	Externally approved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually. Will require a referral to the Commonwealth under the <i>EPBC Act 1999</i> .	
Extreme	Unacceptable, project should be redesigned or not proceed.	

Table 11. Levels of acceptable risk

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequences	Insignificant (1)	Low	Low	Low	Low	Low
	Minor (2)	Low	Low	Low	Moderate	Moderate
	Moderate (3)	Low	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

Table 12. Risk assessment

Factor	Potential Impact	Before Management			Risk Controls / Management			With Management		
		Likelihood	Consequence	Significance				Likelihood	Consequence	Significance
Inadequate fauna survey data.	Unknown loss of fauna, fauna of conservation significance, fauna assemblage(s) in development site.	A	1	Low						
Inadequate knowledge of potential impacts.	Unknown or poorly assessed impact(s) on fauna assemblage and conservation significant species.	A	2	Low						
Inadequate bioregional data for contextual purposes.	Incomplete analysis of data and appreciation of impacts on biodiversity values in a regional context.	C	2	Low						
Removal of habitat – site scale.	Almost complete loss of terrestrial fauna in cleared areas, severe impact on local fauna assemblage.	E	2	Moderate						
Significant reduction of habitats – local scale.	Loss of fauna and fauna habitat and impacts on local fauna assemblage (excluding conservation significant species).	A	2	Low						
Significant reduction of habitats – landscape scale.	Loss of fauna and fauna habitat and impacts on fauna in a landscape context (excluding conservation significant species).	A	1	Low						
Significant reduction of habitats – regional scale.	Loss of fauna and fauna habitat and impacts on fauna in a bioregional context (excluding conservation significant species).	A	1	Low						

Factor		Before Management			With Management		
Potential Impact		Inherent Risk			Residual Risk		
		Likelihood	Consequence	Significance	Risk Controls / Management	Likelihood	Consequence
Impact on resident or visiting conservation significant terrestrial species.	Loss of a localised population or a few individuals – <i>Calyptrorhynchus banksii naso</i> .	A	1	Low			Significance
	Loss of a localised population or a few individuals – <i>Calyptrorhynchus latirostris</i> .	A	1	Low			
	Loss of a localised population or a few individuals – <i>Calyptrorhynchus baudinii</i> .	A	1	Low			
	Loss of a localised population or a few individuals – <i>Synemon gratiosa</i> .	B	1	Low			
	Loss of a localised population or a few individuals – <i>Neelaps calonotus</i> .	B	2	Low			
	Loss of a localised population or a few individuals – <i>Lerista lineata</i> .	B	2	Low			
	Loss of a localised population or a few individuals – <i>Ctenotus gemmula</i> .	B	2	Low			
	Loss of a localised population or a few individuals – <i>Merops ornatus</i> .	A	1	Low			
	Loss of a localised population or a few individuals – <i>Isodon obesulus</i> .	A	1	Low			

5 DISCUSSION

5.1 Adequacy of available vertebrate fauna data

The EPA *Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3* (EPA 2002), *Guidance Statement for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56* (EPA 2004) and the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA / DEC 2010) are the three relevant documents to assess the adequacy of the available information and reporting for vertebrate fauna surveys in Western Australia.

Trapping and relocation data for the Vivente project area and reports by Phoenix Environmental Sciences (2011), Western Wildlife (2010), 360 Environmental (2008), ATA Environmental (2006), Bamford Consulting Ecologists (2009), GHD (2006) and ENV Australia (2009) in conjunction with data extracted from NatureMap, Atlas of Living Australia and the Western Australian Museum records and reports by the Western Australian Museum (Harvey et al. 1997, How et al. 1999) and Gole (2003) for remnant vegetation plots provide an adequate indication of the fauna likely to be in the vicinity of the project area.

5.2 Biodiversity values of the site

5.2.1 Condition of fauna habitat and extent of habitat degradation

There are four fauna habitat types present on the site (see section 2.3). Vegetation in the project area is regrowth and generally in very poor condition and of low value.

5.2.2 Ecological linkages

There are three substantial areas set aside as Bush Forever sites nearby; Thompsons Lake Nature Reserve (BFS 391), Harry Waring Marsupial Reserve (BFS 392) and Forrestdale Lake (BFS 345). In addition, there are three smaller areas; Mandogalup Road Bushland (BFS 268), Banjup Bushland (BFS 263) and Lyon Road Bushland (BFS 492) that would support a fauna assemblage similar to that in the project area. Birds can easily move between these sites, however, terrestrial mammals, reptiles and amphibians are mostly restricted by major roads, urban residential, agriculture and industrial developments. The project area was originally connected to the Vivente project area, but has been separated by the Barfield Road for many years, which has now been cleared.

The site does not form part of an important ecological linkage for fauna in the general area.

5.2.3 Size and scale of the proposed disturbance and potential impacts

The project area is less than 2ha and the vegetation is in poor condition, so potential impacts on vertebrate fauna, including threatened species is very low.

5.2.4 Conservation significant species

Given the area had previously been cleared and the project supports low quality habitat, the potential for the Black-striped Snake (*Neelaps calonotus*), *Ctenotus gemmula* and the Lined Skink (*Lerista lineata*) to be recorded in the project area is low. These species were not recorded when Vivente was cleared. Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) and the Rainbow Bee-eater (*Merops ornatus*) may infrequently forage in the project area, however, clearing of the vegetation is unlikely to have a significant impact on any of these species due to the low value of the habitat.

No tree hollows with the potential to be used as nesting sites by Black-Cockatoos are in the project area. Johnstone and Kirkby (2011) indicated that there were no records of Carnaby's Black-Cockatoo breeding in the vicinity of the project area. Forest Red-tailed Black-Cockatoos are known to breed in the grounds of Murdoch University to the north and in farmland around Baldivis to the south.

The very small quantity of *Lomandra hermaphrodita* would suggest that it is unlikely that Graceful Sun-Moths (*Synemon gratiosa*) were present in the project area. Southern Brown Bandicoots were trapped and relocated prior to vegetation clearing in the Vivente project area and in the Catholic Primary School grounds to the west of the project area, but the lack of suitable habitat in the project area would indicate that they are not present.

5.3 Potential environmental impacts

Clearing of vegetation will potentially affect vertebrate fauna in a number of ways, including:

- death/injury of fauna during vegetation clearing and development;
- loss of habitat; and
- fragmentation of fauna habitat.

5.3.1 Impacts on the fauna assemblage and fauna habitat

Level 1 fauna assessments are, in essence, an assessment of the risks associated with the proposed disturbance on the fauna either known or potentially in the area. Table 13 is a summary of that risk assessment for clearing vegetation and developing the project area.

Table 13. A summary of the assessed risk of impact on the fauna and fauna habitat at the project area

Issues	Assessment				
Formal conservation status for the area:	No		Yes		
Specifically for fauna	X				
Level of alteration to the original faunal habitat	Very High		Very Low		
	1	2	3	4	5
surface soil				X	
vegetation		X			
by salinity					X
by non-farmed exotic species				X	
by farmed species					X
level of habitat fragmentation		X			
Knowledge of:	Very High		Very Low		
	1	2	3	4	5
species in each biotope		X			
assemblage structure per biotope		X			
presence of rare and protected species		X			
presence of range restricted species		X			
presence of short range endemic invertebrates					?
presence of stygofauna					?
ecosystem values		X			
regional species and regional assemblages		X			
regional ecosystems		X			
Capacity to assess biodiversity values for each biotope at:	Very High		Very Low		
	1	2	3	4	5
species level	X				
ecosystem levels	X				
ecological functional values	X				
regional significance of faunal assemblage	X				
Consequences of the proposed disturbance in the context of the:	Very High		Very Low		
	1	2	3	4	5
level of existing disturbance	X				
size of area to be disturbed					X
scale of the disturbance				X	
significance of fauna habitat in a regional context					X
extent to which the area is a refuge for fauna					X
extent to which the disturbance will impact on rare or protected fauna					X
extent to which the fauna habitat is an ecologically important					X

Issues	Assessment				
remnant					
extent to which the habitat provides an ecological linkage(s) or corridor(s)					X
heterogeneity of habitat				X	
abundance of the habitat in the bioregion			X		

5.3.2 Impacts on Black-Cockatoos

Carnaby's Black-Cockatoo may infrequently forage in the areas of *Banksia* sp. and Forest Red-tailed Black-Cockatoos would forage in the *E. marginata*. However, there is a very low abundance of *Banksia* sp. and *E. marginata* in the project area.

Table 14 provides a summary of the assessed potential impact on Black-Cockatoos associated with the action of clearing the vegetation based on the criteria set out in the Department of Sustainability, Environment, Water, Population and Communities (2012) referral guidelines for Black-Cockatoos. This is followed by a more detailed assessment to support this summary table. Commonwealth referral guidelines (Department of Sustainability Environment Water Population and Communities 2011) do not define what is quality foraging habitat for Black-Cockatoos, so the criteria outlined in Table 1 have been used.

The Eco Logical Australia (2013) assessment of Carnaby's Black-Cockatoo foraging habitat in the Perth-Peel region used a measure of the number of *Banksia* trees or pods/hectare to estimate the foraging resource characteristics of particular areas. No indication of quality was provided in this report, however, tree and pod densities are provided for numerous sites, some in close proximity to the project area (i.e. Thomsons Lake Reserve, Harry Warring Marsupial Reserve, Beeliar Regional Park). *Banksia* tree and pod density were not measured in this assessment, but are likely to be much lower than those recorded for Thomson Lake Reserve and Harry Waring Marsupial Reserve.

Table 14. Summary assessment of whether an action will have a significant impact on the two species of Black-Cockatoos

High risk of significant impacts: referral recommended	Carnaby's Black-Cockatoo	Forest Red-tailed Black-Cockatoo
Clearing of any known nesting tree.	No nesting trees were recorded on the project area.	No nesting trees were recorded on the project area.
Clearing or degradation of any part of a vegetation community known to contain breeding habitat.	The project is outside the DPaW mapped potential breeding habitat.	Is within the vicinity of a known breeding location.
Clearing of more than 1ha of quality foraging habitat.	Will not clear more than 1ha of quality foraging habitat.	Will not clear more than 1ha of quality foraging habitat.
Clearing or degradation (including pruning the top canopy) of a known night roosting site.	Clearing will not impact on a known roosting site.	Clearing will not impact on a known roosting site.
Creating a gap of greater than 4 km between patches of black cockatoo habitat (Breeding, foraging or roosting).	Clearing will not create a gap of greater than 4km between patches of Black-Cockatoo habitat.	Clearing will not create a gap of greater than 4km between patches of Black-Cockatoo habitat.
Uncertainty: referral recommended or contact the department		
Degradation (such as through altered hydrology or fire regimes) of more than 1 ha of foraging habitat. Significance will depend on the level and extent of degradation and the quality of the habitat.	Clearing will not impact on more than 1ha of foraging habitat.	Clearing will not impact on more than 1ha of foraging habitat.
Clearing or disturbance in areas surrounding black-cockatoo breeding, foraging or night roosting habitat that has the potential to degrade habitat through introduction of invasive species, edge effect, hydrological changes, increased human visitation or fire.	Based on the recent Great Cocky count (Byrne et al. 2015), there are roost sites to the west of the project area. The exact locations of these roosts are not shown so the distance from the project area cannot be determined	Based on the recent Great Cocky count (Byrne et al. 2015), there are roost sites to the north-west of the project area. The exact locations of these roosts are not shown and thus the distance from the project area cannot be

	from the report, but is a considerable distance away.	determined from the report, but is a considerable distance away.
Actions that do not directly affect the listed species but that have a potential for indirect impacts such as increasing competitors for nest hollows.	The project area contains no trees with hollows.	The project area contains no trees with hollows.
Actions with the potential to introduce known plant disease such as <i>Phytophthora</i> spp. To an area where the pathogen was not previously known.	With the implementation of appropriate hygiene standards during vegetation clearing, diseases are unlikely to be introduced to the site.	With the implementation of appropriate hygiene standards during vegetation clearing, diseases are unlikely to be introduced to the site.
Low risk of significant impacts: referral may not be required.		
Actions that do not affect black-cockatoo habitat or individuals.		
Actions whose impacts occur outside the modelled distribution of the three black-cockatoos.		

Clearing of any known nesting tree (high risk)

Forest Red-tailed Black-Cockatoos are known to nest in farm land, rural residential, rural remnants and eucalypt woodland near Baldy and at Murdoch University. The project area is between Baldy and Murdoch University, but it contains no trees with hollows that may provide a suitable nesting site. The project area is outside the known potential area of nesting sites for Carnaby's Black-Cockatoo as shown on the DPaW maps.

Clearing of any part or degradation of breeding habitat (high risk)

Breeding habitat for Carnaby's Black-Cockatoo is defined as woodland or forest, but also breeds in former woodland or forest now present as isolated trees. Carnaby's Black-Cockatoo nests in hollows in live or dead trees of *E. salmonophloia*, *E. wandoo*, *E. gomphocephala*, *E. marginata*, *E. rudis*, *E. loxophleba*, *E. accedens*, *C. calophylla*, *E. diversicolor* and for Forest Red-tailed Cockatoos in woodland or forest, but may also breed in former woodland or forest now present as isolated trees. Nests are found in hollows in live or dead trees of *C. calophylla*, *E. diversicolor*, *E. wandoo*, *E. megacarpa*, *E. patens*, *E. gomphocephala* and *E. marginata* (Department of Sustainability Environment Water Population and Communities 2012; p.15). It is Terrestrial Ecosystems assessment that Carnaby's Black-Cockatoo are unlikely to nest in the vicinity of the project area as they have not nested in the project area thus far and the area is outside that defined by DPaW as a potential breeding site. However, with the recent increase in Forest Red-tailed Black-Cockatoos on the Swan Coastal Plain both south and north of the Swan River, and known breeding activity at Murdoch University and Baldy, it is possible that this species may breed in the vicinity of the project area in the future. However, there are no suitable tree hollows in the project area.

Clearing of more than 1ha of quality foraging habitat (high risk)

The definition of what is 'quality habitat' is unknown, but based on the rating system provided in Table 1, the foraging habitat is assessed as poor or very poor. Therefore less than 1ha of quality foraging habitat will be cleared.

Clearing or degradation including pruning the top canopy of a known roosting site (high risk)

There is no evidence to indicate that Carnaby's or Forest Red-tailed Black-Cockatoos roost in the project area. However, Forest Red-tailed Black-Cockatoos regularly shift their roosting sites, and could periodically roost in the project area for a short period. The recently released 2015 Great Cocky Count (Byrne et al. 2015) indicates a roosting sites for Carnaby's Black-Cockatoo to the west and Forest Red-tailed Black-Cockatoos to the north-west, but both are a considerable distance away.

Degradation (such as through altered hydrology or fire regimes) of more than 1ha of foraging habitat. Significance will depend on the level and extent of degradation and the quality of the habitat (uncertainty)

It is proposed that less than 1ha of Black-Cockatoo foraging habitat will be cleared.

Clearing or disturbance in areas surrounding black cockatoo habitat that has the potential to degrade habitat through the introduction of invasive species, edge effects, hydrological changes, increased human visitation or fire (uncertainty)

The area to be cleared will be used for residential housing in a similar manner to other adjacent developments. So, this development will increase human visitation to the area.

Actions that do not directly affect the listed species but that have the potential for indirect impacts such as increasing competitors for nest hollows (uncertainty)

There was no other obvious indirect impact that clearing the vegetation might have on Black-Cockatoos and no suitable nesting hollows in the project area.

Action with the potential to introduce known plant diseases such as Phytophthora spp. (uncertainty)

Clearing of the vegetation is only likely to spread diseases such as *Phytophthora* spp., if appropriate standards of hygiene are not maintained in the equipment used to clear the vegetation. This aspect is able to be effectively managed and controlled by the land developer.

5.4 Native vegetation clearing principles

The *Environmental Protection Act (1986)* provides criteria to judge the potential impact of a development on clearing native vegetation. These criteria have been listed in Table 15 with a response to indicate how clearing of the vegetation in the project area might be judged against these principles.

Table 15. Assessment of impact on fauna using the Native Vegetation Clearing Principles

Principle	Response
It comprises a high level of biological diversity.	Clearing vegetation will not compromise a high level of biodiversity.
It comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Clearing the vegetation will not result in the loss of significant habitat necessary for the maintenance of fauna indigenous to Western Australia.
It includes, or is necessary for the continued existence of, rare flora.	Not applicable.
It comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	The area does not contain a threatened ecological fauna community, but could support a number of conservation significant species.
It is significant as a remnant of native vegetation in an area that has been extensively cleared.	The area is not a remnant and similar habitat exists in adjacent areas.
It is growing in, or in association with, an environment associated with a watercourse or wetland.	The area is not a wetland.
The clearing of the vegetation is likely to cause appreciable land degradation.	Not applicable.
The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Clearing of vegetation is unlikely to impact on the environmental values of the bioregion.
The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	Not applicable.
The clearing of the vegetation is likely to cause, or exacerbate the incidence of flooding.	Not applicable.

6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Gold Estates is seeking to develop Lot 15 Barfield Road, Hammond Park, adjacent to the recently cleared Vivente project area. The project area has a substantial area that is devoid of native trees and shrubs and the remaining area is regrowth. The project area has been assessed as low value fauna habitat and low or very low Black-Cockatoo foraging habitat. Although, there is a small quantity of *L. hermaphrodita* present on site, it is unlikely that Graceful Sun-moths are present.

The impact of clearing less than 2ha of low or very low quality foraging habitat on Black-Cockatoos is not significant, and does not warrant a referral to the Commonwealth Government under the EPBC Act (1999).

There is a very low possibility that the area contains the Jewelled South-west Skink (*Ctenotus gemmula*), Black-striped snake (*Neelaps calonotus*) or Lined Skink (*Lerista lineata*), however, they were not caught or seen when the much larger Vivente project area, which is located directly to the west of the project area, was cleared. If present, these reptiles will be lost during vegetation clearing. The cumulative effect of progressively clearing most of the *Banksia* and jarrah woodland in the general area may have an effect in the long term.

Conservation significant Rainbow Bee-eater (*Merops ornatus*), if they are in the project area, will move to adjacent bush land once vegetation clearing commences and would not be significantly impacted.

6.1 Recommendations

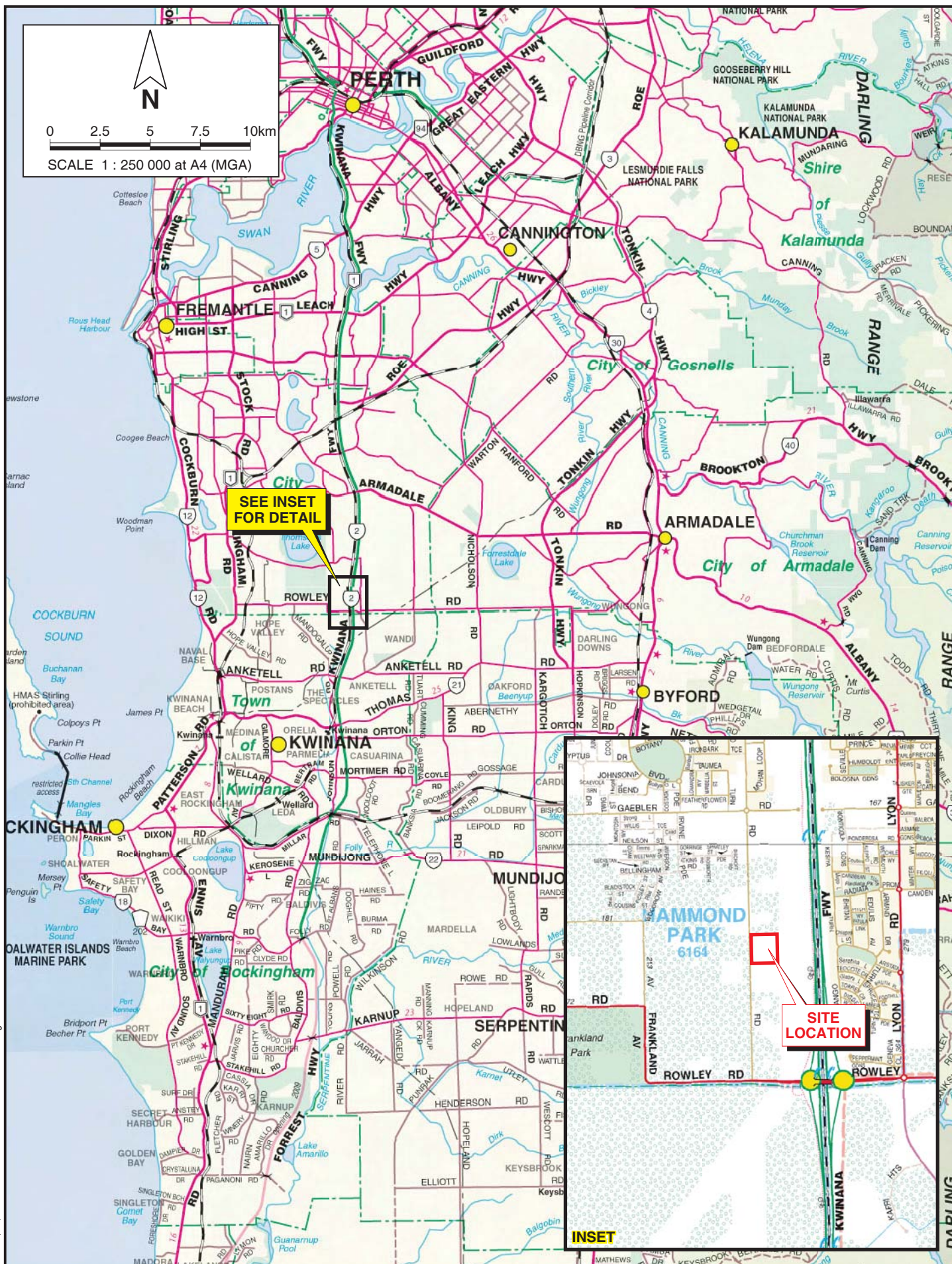
It is recommended that a fauna salvage program is implemented during the vegetation clearing program by a suitably qualified zoologist.

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Figure 1

REGIONAL LOCATION

TERRESTRIAL ECOSYSTEMS

Drawn: S. Thompson Date: 27 Apr 2016

Job: 2016-0020



