

**Biological Assessment
South Coast Highway
King River to Kalgan River, 7.16 to 18.12 SLK
Main Roads Western Australia**



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1 SUMMARY

Main Roads Western Australia (Main Roads) is proposing to conduct widening and reconstruction of South Coast Highway, between straight line kilometres (SLK) 7.16 to 18.12. A biological assessment of vegetation, flora and fauna values was undertaken to inform the environmental impact and approval process. The Survey Area included the full width of the road reserve that comprised 44.13 hectares (ha). The project footprint (clearing area) is still in design and will seek to avoid areas of high conservation values.

Vegetation:

- Seven native vegetation types were defined:- *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (0.57ha), Jarrah/Marri/Sheoak Laterite Forest (9.69ha), Jarrah/Sheoak/*E.staeri* Sandy Woodland (5.13ha), Marri/Jarrah Forest/Peppermint Woodland (3.07ha), *Taxandria parviceps* Transitional Shrubland (0.15ha), *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket and *Melaleuca preissiana* Low Woodland (latter two comprise 3.53ha including as a mosaic). Non-native vegetation, remnant trees or cleared areas accounted for 21.99ha.
- Vegetation condition varied from degraded (native understory very sparse or absent) to excellent (native understory present and minor disturbance) or as a mosaic of multiple categories.
- *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland is recognised as a locally restricted, Priority Ecological Community (Priority 1) and is also concordant with the Threatened Ecological Community “Proteaceae Dominated Kwongan Shrublands”.
- Three of the vegetation types described are wetlands or riparian, which comprise 3.68ha (*Taxandria parviceps* Transitional Shrubland, *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket and *Melaleuca preissiana* Low Woodland).
- Two of the wetland vegetation types are poorly reserved within the region (<30% in all reserve types) (*Homalospermum firmum*/*Callistemon glaucus* Peat Thicket and *Melaleuca preissiana* Low Woodland).
- The broad pre-European vegetation types (Association 3, 5 & 978) mapped in the Survey Area are above the 30% extent threshold for the state and Jarrah Forest IBRA Region.

Flora:

- A total of 397 taxa from 66 families (including 80 weed species) were recorded from the Survey Area. One Priority flora (*Astartea transversa* (P2)) was recorded in the Survey Area. Two Weeds of National Significance (WONS) were recorded; Bridal creeper (*Asparagus asparagoides*) and Blackberry (*Rubus* species complex).
- A likelihood of occurrence analysis determined that from 102 Priority and Threatened flora recorded from the vicinity (<20km) of the Survey Area, six were likely to occur, 34 could possibly occur and 61 were unlikely to occur.
- Two Threatened orchids were considered highly likely to occur and survey limitations (flowering period & fire interval) were identified that would have prevented their detection (*Drakaea micrantha* (T) and *Microtis globula* (T)).

- Four Priority flora were considered likely to occur and survey limitations (flowering period) were identified for two of the Priority flora that would have reduced their detectability.

Fauna:

- Six conservation significant fauna species were either present or considered likely to occur; Australasian Bittern (T;En), Carnaby's Cockatoo (T;En), Forest Red-tailed Black Cockatoo (T;Vu), Baudin's Cockatoo (T;Vu), Western Ringtail Possum (T;Vu), and Southern Brown Bandicoot (P5).
- A total of 435 significant fauna habitat trees were identified within the Survey Area (Table 4). Current or potential breeding hollows were identified in 60 trees.
- Western Ringtail Possums (scats and drays) were observed widely across the Survey Area, utilising multiple habitats including *Eucalyptus* or *Banksia* Woodland and Wetland Thickets. Inundated areas within wetland vegetation were identified as potential foraging or breeding habitat for Australasian Bittern. All *Eucalyptus* and *Banksia* woodlands were identified as foraging habitat for three Black Cockatoo species. Southern Brown Bandicoots (diggings & one sighting) were common in open areas adjacent to dense vegetation.
- The vegetation within the road reserve represents an ecological linkage between the King and Kalgan River. The road reserves in the eastern section are an important linkage between Bakers Junction Nature Reserve and the Kalgan River and are used extensively by Western Ringtail Possum. Many roadside thickets within the wetlands may also be used by Western Ringtail Possum as linkages between upland *Eucalyptus* Woodlands.

2 INTRODUCTION

2.1 Background

Main Roads is proposing to conduct widening and reconstruction of South Coast Highway, between SLK 7.16 to 18.12. A biological assessment of vegetation, flora and fauna values was undertaken to inform the environmental impact and approval process. The Survey Area included the full width of the road reserve that comprised 44.13 hectares (ha). The Survey Area extended from approximately the King River to the Kalgan River with a large proportion adjacent to Bakers Junction Nature Reserve.

The Survey Area is located in the southern half of the Jarrah Forest Interim Biogeographic Regionalisation of Australia (IBRA) Region (Department of the Environment [DotE] 2014a). Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) indicates that the native vegetation of the area is composed of a low forest of Jarrah (*Eucalyptus marginata*), Albany Blackbutt (*Eucalyptus staeri*) & Sheoak (*Allocasuarina fraseriana*) (Vegetation Association 978), medium forest of Jarrah-Marri (*Eucalyptus marginata-Corymbia calophylla*) (Vegetation Association 3) and Sedgeland; reed swamps, occasionally with heath (Vegetation Association 51).

The Survey Area occurs between two major drainage channels (King and Kalgan River) and is dissected by several seasonally running tributaries. The Survey Area occurs within six soil-landscapes mapped in South West Western Australia (Department of Agriculture and Food Western Australia [DAFWA] 2014):

- Minor Valleys S7 floor Phase - Footslopes and swampy valley floors of minor valleys.
- Dempster crest Phase - Sands and laterite on elongate crests; Jarrah-Albany Blackbutt-Marri forest.
- Minor Valleys 6 Subsystem - Narrow V-shaped valleys, in sedimentary rocks; <10 m relief. Sandy yellow duplex soils on slopes; Jarrah-Marri low forest. Deep sands on narrow swampy floor; sedges and reeds.
- Minor Valleys S7 slope Phase - Broad valleys in sedimentary rocks; 30 m relief; smooth slopes. Deep sands and iron podzols on slopes; Albany Blackbutt-jarrah-sheoak woodland. Podzols and yellow duplex soils on floors; paperbark woodland, teatree heath.
- Major Valleys 7h Phase - Broad valleys in sedimentary rocks; 30 m relief; smooth slopes. Deep sands and iron podzols on slopes; Albany Blackbutt-Jarrah-Sheoak woodland. Podzols and yellow duplex soils on floors; Paperbark woodland, Teatree heath.
- Major Valleys 7 terrace Phase - Terraces.

3 METHODS

The assessments were primarily conducted by Damien Rathbone (SL 011605), an ecologist with over 13 years of experience in southwest Western Australia. Assistance with the fauna component was provided by Dr Sandra Gilfillan, a zoologist with extensive local experience in vertebrate fauna surveys. All vegetation assessments, locations of significant flora, weeds and faunal habitat were recorded using a handheld GPS (Garmin 60).

3.1 Desktop Assessment

A desktop assessment of known or potential conservation significant vegetation, flora and fauna within a 20 km radius around the Survey Area was undertaken using the following sources:

- Previous reports: Albany Regional Vegetation Survey (Sandiford and Barrett 2010).
- Protected Matters Search Tool (PMST) (Department of the Environment and Energy [DotEE] 2016) to identify potential flora and fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- NatureMap (Department of Parks and Wildlife [DPaW] 2016a) to identify potential flora and fauna species listed under State and Federal legislation.
- DPaW database of Priority Ecological Communities (PECs) and Threatened Ecological Communities (TECs) (DPaW 2016b) to determine known occurrences in the vicinity of the assessment area.

3.2 Vegetation Assessment

A vegetation assessment using floristic quadrats was conducted to identify the vegetation type and condition. The following information was recorded in quadrats with dimensions of 100 m² in accordance with the “Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment” (Environmental Protection Authority [EPA] 2016):

- Location – GPS coordinate of NW corner, other corners measured using a vertex (Nikon 36) and compass.
- Recorder and date – personnel involved in sampling that location and survey date.
- Species – all vascular plant species present, including weed species. Species that were not confidently identified during the field survey were collected for later identification in the Albany regional herbarium, or at the Western Australian Herbarium where required.
- Foliar cover – the estimated percentage cover for each dominant species in each stratum.
- Vegetation description – according to the National Vegetation Information System (Executive Steering Committee for Australian Vegetation Information [ESCAVI] 2003).
- Vegetation condition – according to the most current vegetation condition classification (EPA 2016).
- Disturbance – records of any obvious disturbances such as symptoms of plant disease (i.e. caused by the presence of *Phytophthora* Dieback, aerial canker or *Armillaria* sp.), recent fire, tracks, weed infestation etc.
- Photographs – several photographs overlooking quadrat from various corners.

Quadrat information was used to define vegetation communities based on a comprehensive quadrat sampling regime (minimum of three quadrats per community). Species accumulation curves were assessed according to Drozd *et al.* (2010) to determine the adequacy of the overall number of quadrats within the Survey Area. Quadrat similarity was assessed using two way tables and field observations, no cladistics analysis was conducted.

3.3 Targeted Rare and Priority Flora Search

A targeted search for potential Threatened and Priority flora identified from the desktop assessment was conducted across the Survey Area. The search was conducted in the appropriate season to detect most of the Threatened or Priority species with a high likelihood of occurrence. The assessment area was initially surveyed via a meandering traverse to identify vegetation types and condition. Where vegetation types were identified as potential habitat for Threatened or Priority flora, an intensive grid of suitably spaced transects was surveyed. Population census and site information of any Threatened or Priority flora was recorded in accordance with the Threatened & Priority Flora (TPFL) Database Manual (Department of Environment and Conservation [DEC] 2010). Population size was determined by either direct counts, or by estimation of plant density using transects or suitably sized quadrats within population boundaries.

3.4 Fauna Habitat Assessment

A fauna habitat assessment was undertaken in accordance with the technical guidance documents for fauna surveys for environmental impact assessment in Western Australia (EPA and DEC 2010). The fauna assessment primarily focused on the identification of fauna habitat based on vegetation type and structure and the likelihood of occurrence determined from the desktop analysis. Opportunistic recording of faunal evidence (sightings, bird calls, tracks, scats, bones and feeding signs) was undertaken during the concurrent vegetation survey.

Identification and quantification of habitat for Black Cockatoo species was specifically undertaken within the Survey Area. Breeding, foraging and roosting habitat was assessed in accordance with the EPBC Act Referral guidelines for the three threatened Black Cockatoo species (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] 2012). This included recording the species, location, number and behaviour of any observed Black Cockatoos; recording the number, location and species of trees above a threshold diameter at breast height (DBH) and notes on whether they contain hollows; and the presence and extent of foraging habitat other than tree species (e.g. Proteaceous Shrubland). Trees were also recognised as significant when DBH was below the threshold size and hollows were present. The timing potentially coincided with the use of hollows by nesting cockatoos, however the assessment was made only from ground level therefore limiting the detectability of active, or recently active hollows.

3.5 Legislation and Conservation Significance

Flora, fauna and vegetation can be considered as conservation significant under Federal or State legislation or through listing by State Government Authorities. These are explained below with the definitions of conservation status relevant to the different Acts provided (Table 1).

The EPBC Act 1999 is administered by the Federal Government and provides protection to Threatened flora, fauna or vegetation communities that are recognised as Matters of National Environmental Significance (MNES). Impacts to MNES require approval from the Federal Minister for the Environment.

State Government legislation includes the *Wildlife Conservation Act 1950* (WC Act), which recognises Threatened flora, fauna and vegetation in need of special protection within Western Australia. The recently proclaimed *Biodiversity Conservation Act 2016* (BC Act) will eventually replace the WC Act. The DPaW also maintain a list of Priority flora, fauna and ecological communities that warrant monitoring or protection.

The *Environmental Protection Act 1986* (EP Act) provides regulations for clearing of vegetation or habitats through ten clearing principles (Schedule Five of the EP Act) relevant to the biological and environmental aspects of native vegetation. The EP Act also recognises Environmentally Sensitive Areas (ESA) that have specific values such as threatened species, certain conservation estate and wetlands.

Other State level measures of conservation significance other than statutory listing for vegetation and species, subspecies, varieties, hybrids or ecotypes relate to local distribution, range extensions, relictual characteristics, novel assemblages, degree of impact from threatening processes and the level of reservation (EPA 2016). Conservation targets also exist for the protection of certain vegetation above thresholds of pre-European extent (EPA 2016). Six overarching criteria relate to the assessment of regional conservation significance including representation of ecological communities, diversity, rarity, maintaining ecological process, evolutionary importance and wetlands (EPA 2016).

Table 1. Relevant Acts and conservation status definitions used in environmental impact assessment.

<i>Environment Protection and Biodiversity Conservation Act 1999</i>	http://www.environment.gov.au/epbc http://www.environment.gov.au/epbc/about/epbc-act-lists#species
<i>Wildlife Conservation Act 1950</i>	https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf (Also includes DPaW Priority species)
<i>Environmental Protection Act 1986</i>	https://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_304_homepage.html
<i>Biodiversity Conservation Act 2016</i>	https://www.dpaw.wa.gov.au/plants-and-animals/468-biodiversity-conservation-act-2016
Environmentally Sensitive Areas	https://www.der.wa.gov.au/your-environment/environmentally-sensitive-areas

4 FLORA RESULTS & DISCUSSION

4.1 Vegetation

Fifty-three floristic quadrats were established to identify the type and condition of the vegetation within the Survey Area. Four upland vegetation types were defined:- *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland, Jarrah/Marri/Sheoak Laterite Forest, Jarrah/Sheoak/*E.staeri* Sandy Woodland and Marri/Jarrah Forest/Peppermint Woodland. Three wetland vegetation types were defined:- *Taxandria parviceps* Transitional Shrubland, *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket and *Melaleuca preissiana* Low Woodland. The vegetation was represented in condition scales grading from degraded (native understory very sparse or absent) to excellent (no obvious disturbance) or as a mosaic of multiple categories. Vegetation descriptions (with corresponding Unit from Sandiford and Barrett (2010)) and the area of extent (Table 1) for each condition scale is provided below. Mapping of vegetation type and condition is provided in Appendix A.

Table 1. Extent (ha) and condition (EPA 2016) of native remnant and non-native vegetation within the South Coast Highway Survey Area.

Vegetation Type	Condition					Total:
	Degraded	Degraded/ Good	Good	Very Good	Very Good/ Excellent	
<i>Banksia coccinea</i> Shrubland/ <i>Eucalyptus staeri</i> /Sheoak Open Woodland					0.57	0.57
Jarrah/Marri/Sheoak Laterite Forest	1.42		2.66	3.50	2.12	9.69
Jarrah/Sheoak/ <i>E.staeri</i> Sandy Woodland	0.23	0.15		1.38	3.37	5.13
Marri/Jarrah Forest/Peppermint Woodland	1.58		0.16	1.33		3.07
<i>Taxandria parviceps</i> Transitional Shrubland					0.15	0.15
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket	0.08		0.19		0.97	1.25
<i>Melaleuca preissiana</i> Low Woodland	0.41		0.22	0.13		0.75
Mosaic <i>M. preissiana</i> Low Woodland / <i>H. firmum</i> / <i>C. glaucus</i> Peat Thicket	0.37			1.15		1.52
Cleared						21.99
Sub-total:	4.09	0.15	3.23	7.49	7.19	44.13

Banksia coccinea Shrubland/Eucalyptus staeri/Sheoak Open Woodland (Unit 14)



Shrublands of *Banksia coccinea* with *Eucalyptus staeri*/Sheoak Open Woodland were recorded on lower slopes on the margin of seasonally wet drainage lines in white/light grey sands.

Areas in excellent condition are described as an open woodland or isolated trees of *Eucalyptus staeri*, *Eucalyptus marginata* and *Allocasuarina fraseriana* over a tall shrubland of *Banksia coccinea* and *Taxandria parviceps* over a mid-open shrubland of *Jacksonia spinosa*, *Gompholobium scabrum*, *Melaleuca thymoides*, *Adenanthos cuneatus* and *Adenanthos obovatus* over a dense sedgeland of *Anarthria scabra* and *Anarthria prolifera*. A high proportion of the species within this vegetation type are susceptible to Phytophthora Dieback, which is prevalent in the Survey Area. In areas of high disease impact the shrubland of *Banksia coccinea* becomes sparse or absent and the diversity of lower shrub species reduces.

Jarrah/Marri/Sheoak Laterite Forest (Unit 12)



Woodlands or forest of Jarrah/Marri/Sheoak were recorded on upper slopes and hill crests with gravel or outcropping laterite and loam or sandy soils.

Areas in excellent condition are described as a woodland or forest of *Eucalyptus marginata*, *Corymbia calophylla*, *Eucalyptus staeri*, and *Allocasuarina fraseriana* over tall shrubland of *Banksia grandis*, *Hakea amplexicaulis* and *Persoonia longifolia* over a shrubland of *Agonis theiformis*, *Bossiaea linophylla*, *Beaufortia decussata*, *Taxandria parviceps*, and *Leucopogon verticillatus* over a low shrubland of *Xanthosia rotundifolia*, *Bossiaea ornata*, *Tetratheca setigera* and *Hovea chorizemifolia* over a sedgeland (including forbs) of *Anarthria prolifera*, *Tetraria octandra*, *Tetraria* sp. Jarrah Forest, *Desmocladius fascicularis* and *Patersonia umbrosa* var. *umbrosa*.



Jarrah/Sheoak/E.staeri Sandy Woodland (Unit 13)

Woodlands of Jarrah/Sheoak/*Eucalyptus staeri* were recorded on mid slopes on deep white/grey sandy soils.

Areas in excellent condition are described as a woodland of *Eucalyptus staeri*, *Eucalyptus marginata* and *Allocasuarina fraseriana* over tall shrubland of *Agonis theiformis*, *Hakea ruscifolia* and *Gompholobium scabrum* over diverse low shrubland of *Isopogon longifolia*, *Beaufortia anisandra*, *Adenanthos cuneatus*, *Leucopogon glabellus*, *Daviesia flexuosa*, *Daviesia incrassata*, *Hypocalymma strictum*, *Gompholobium venustum*, *Acacia browniana*, *Petrophile rigida*, *Boronia spathulata*, *Synaphea polymorpha* and *Hibbertia depressa* over a sedgeland of *Anarthria scabra*, *Cyathochaeta equitans*, *Tricostularia neesii*, *Anarthria prolifera* and *Schoenus caespititius*.

Marri/Jarrah Forest/Peppermint Woodland (Unit 10)



Woodlands to forests of Marri/Jarrah Forest/Peppermint were recorded on mid to lower slopes in grey/brown sandy loam soils, often in the vicinity of the major rivers bounding the Survey Area.

Areas in very good condition are described as a tall woodland or forest of *Corymbia calophylla* and *Eucalyptus marginata* over a tall shrubland of *Agonis flexuosa* and *Hakea oleifolia* over a mid shrubland of *Bossiaea linophylla*, *Hovea elliptica*, *Leucopogon verticillatus* and *Xanthorrhoea platyphylla* over a low shrubland of *Leucopogon obovatus*, *Xanthosia rotundifolia*, *Tremandra stelligera*, *T. diffusa* and *Opercularia hispidula* over a sedgeland (including forbs) of *Patersonia umbrosa* var. *umbrosa*, *Anarthria prolifera*, *Desmocladius flexuosus*, *Lepidosperma gracile*, *Tetrandra octandra*, *Tetraria* sp. Jarrah Forest.

***Taxandria parviceps* Transitional Shrubland (Unit 38)**



Shrublands to closed shrublands of *Taxandria parviceps* were recorded on the margins of wetlands and lower slopes in deep grey sands.

Areas in excellent condition are described as isolated trees of *Eucalyptus staeri*, *Banksia littoralis* or *Banksia quercifolia* over a closed shrub of *Taxandria parviceps* over a low shrubland of *Hakea ceratophylla*, *Adenanthos obovatus*, *Beaufortia decussata* and *Sphaerolobium grandiflorum* over a sedgeland of *Anarthria scabra*, *Anarthria laevis*, *Mesomelaena gracilipes*, *Schoenus efoliatus*, *Schoenus acuminatus* and *Chordifex laxus*. Herbs such as *Drosera* and *Stylidium* were common in this vegetation. Some long unburnt areas had a very tall and closed canopy. In more recently burnt areas, habitat for the Threatened orchid, *Drakaea micrantha* existed within this community.

***Homalospermum firmum*/Callistemon glaucus Peat Thicket (Unit 47)**



Shrublands to closed shrublands of *Homalospermum firmum* and *Callistemon glaucus* were recorded in seasonally wet lower areas of broad drainage channels in leached grey sand with a heavy peat layer. These sites are waterlogged in winter and usually moist in summer.

Areas in excellent condition are described as a closed shrubland of *Taxandria linearifolia*, *Homalospermum firmum*, *Callistemon glaucus*, *Aotus intermedia*, *Hakea linearis*, *Taxandria parviceps*, *Sphaerolobium fornicatum* and *Acacia hastulata* with a diverse sedgeland of *Evandra aristata*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Schoenus multiglumis*, *Leptocarpus tenax*, *Gahnia decomposita*, *Lepidosperma striatum* and *Xyris lanata*. Standing water occurs within this community in the very lowest part of the valley profile, where *Baumea rubiginosa*, *B. vaginalis* and *B. arthropophylla* become dominant.

Melaleuca preissiana Low Woodland (Unit 49)



Woodlands of *Melaleuca preissiana* were recorded from seasonally wet lower areas of broad drainage channels in leached grey sand and peat. These sites were usually lower in the profile or occurred as mosaic with *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket.

Areas in excellent condition are described as an low open woodland of *Melaleuca preissiana*, occasionally with *M. raphiophylla* and *M. cuticularis* over a spare tall shrub layer of *Taxandria linearifolia*, *Hakea linearis* and *Taxandria parviceps* over on open mid shrubland of *Astartea glomerulosa* and *Hakea ceratophylla*, over a sedgeland of *Anarthria laevis*, *Leptocarpus tenax*, *Anarthria prolifera*, *Cyathochaeta avenacea*, *Lepidosperma striatum* and *Baumea juncea*.

4.2 Priority and Threatened Ecological Communities

Banksia coccinea Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (Unit 14) is recognised as a locally restricted, Priority Ecological Community (Priority 1) (DPaW 2016c) and is also concordant with the Threatened Ecological Community “Proteaceae Dominated Kwongkan Shrublands” (Kwongkan TEC) (DotE 2014b).

The community is distinguished by a tall shrub layer of *Banksia coccinea* occurring on lower hillslopes in deep white/grey sands. This vegetation type is fire sensitive, with many shrub species being obligate seeders and has a high proportion of species susceptible to *Phytophthora cinnamomi*. It is likely to be largely restricted to the region (<35km radius around Albany) and based on soil and landform, most of its former habitat has been cleared (Sandiford and Barrett 2010). Its’ current extent is generally well reserved (85.9%), although few areas are not infested with *Phytophthora cinnamomi*. Due to the sand plain habitat and high cover of *Banksia* species and this community easily exceeds the 30% cover threshold of Proteaceae to align with the Kwongkan TEC. In some areas where heavily impacted by *Phytophthora cinnamomi* the present cover of Proteaceae is below 30%.

Three occurrences (total area 0.57 hectares) were mapped and numbered consecutively west to east within the Survey Area and are described in Table 2.

Table 2. Occurrences of the *Banksia coccinea* Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (Unit 14) within the Survey Area.

Occurrence Number	SLK	Area (ha)	Description
1	11.92	0.31	Lower east facing slope, long unburnt. Core of vegetation is in excellent condition with >70 cover of tall (4-5m) <i>Banksia coccinea</i> . Direct edge of road and surrounds are infested with <i>Phytophthora cinnamomi</i> where <i>B. coccinea</i> is absent.
2	13.92	0.12	Lower east facing slope. Mostly infested with <i>Phytophthora cinnamomi</i> , therefore <i>B. coccinea</i> is absent. Some <i>Jacksonia</i> , <i>Isopogon</i> and <i>Latrobea</i> are persisting.
3	14.12	0.14	Lower west facing slope, long unburnt. Dissected by vehicle access track. Core of vegetation is in excellent condition with >70 cover of tall (4-5m) <i>Banksia coccinea</i> . <i>Phytophthora cinnamomi</i> is present but expression is low.

4.3 Other Conservation Significant Vegetation

Vegetation clearing principals in the EP Act (No. 6 of Schedule Five) state that “native vegetation should not be cleared if it is growing in, or in association with an environment associated with a watercourse or wetland”. Three vegetation types described in the Survey Area are wetland or riparian, which together comprise 3.68ha (*Taxandria parviceps* Transitional Shrubland, *Homalospermum firmum/Callistemon glaucus* Peat Thicket and *Melaleuca preissiana* Low Woodland). The extent of two of these wetland units is also underrepresented in the reserve estate with the Albany Region (Table 3).

Table 3. Reservation status of the seven vegetation types described from the Survey Area. Includes IUCN I-IV and crown reserves with Albany Region (<35km radius).

Vegetation Type	Current Extent		Reserve		Non Reserve	
	ha	%	ha	%	ha	%
<i>Banksia coccinea</i> Shrubland/ <i>Eucalyptus staeri</i> /Sheoak Open Woodland (Unit 14)	1330	3	1,142.0	85.9	188	14.1
Jarrah/Sheoak/ <i>E.staeri</i> Sandy Woodland (Unit 13)	13,144.00	29.8	5,264.6	40.2	7,879.00	59.9
Jarrah/Marri/Sheoak Laterite Forest (Unit 12)	5,148.00	11.70	3,212.0	62.4	1,936.00	37.60
Marri/Jarrah Forest/Peppermint Woodland (Unit 10)	1,597.00	3.60	516.0	32.3	1,081.00	67.70
<i>Taxandria parviceps</i> Transitional Shrubland (Unit 38)	109.00	0.20	77.0	70.5	32.00	29.50
<i>Homalospermum firmum/Callistemon glaucus</i> Peat Thicket (Unit 47)	2,083.00	4.70	477.0	22.9	1,606.00	77.10
<i>Melaleuca preissiana</i> Low Woodland (Unit 49)	679	1.5	203.0	29.8	476	70.2

Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) is used in south west Western Australia to determine the significance of remnant vegetation. There is a presumption against clearing vegetation associations with less than 30% pre-European extent remaining and vegetation with less than 10% of their pre-European extent remaining are considered endangered (EPA 2016). The seven vegetation types described from the Survey Area can be aligned with three broad pre-European vegetation associations (Association 3, 5 & 978) (Table 4). These are all above the 30% extent threshold for the state (Table 4) and Jarrah Forest IBRA Region (data not shown).

Table 4. Extent of Pre-European vegetation associations in Western Australia (Government of Western Australia [GoWA] 2015) aligned to the seven vegetation types described from the Survey Area.

Vegetation Type	Vegetation Association	Pre-European Extent	Current Extent	% Remaining
<i>Banksia coccinea</i> Shrubland/ <i>Eucalyptus staeri</i> /Sheoak Open Woodland (Unit 14)	978 - Low forest; jarrah, <i>Eucalyptus staeri</i> & <i>Allocasuarina fraseriana</i>	53230.64	19017.07	35.73
Jarrah/Sheoak/ <i>E.staeri</i> Sandy Woodland (Unit 13)				
Jarrah/Marri/Sheoak Laterite Forest (Unit 12)				
Marri/Jarrah Forest/Peppermint Woodland (Unit 10)	3 - Medium forest; jarrah-marri	2661405.06	1810489.41	68.03
<i>Taxandria parviceps</i> Transitional Shrubland (Unit 38)				
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket (Unit 47)	51 - Sedgeland; reed swamps, occasionally with heath	59085.59	33000.98	55.85
<i>Melaleuca preissiana</i> Low Woodland (Unit 49)				

4.4 Flora

A total of 397 taxa from 66 families (including 80 weed species) were recorded from the Survey Area.

A species accumulation curve according to Drozd *et al.* (2010) was used to determine the adequacy of the quadrat sampling. From 53 quadrats, 299 species (excluding adjacent collections) were detected, which represents 75% of total flora inventory for the Survey Area. The species accumulation curve is beginning to plateau at 53 quadrats, although further species are predicted with increased sampling (Figure 1).

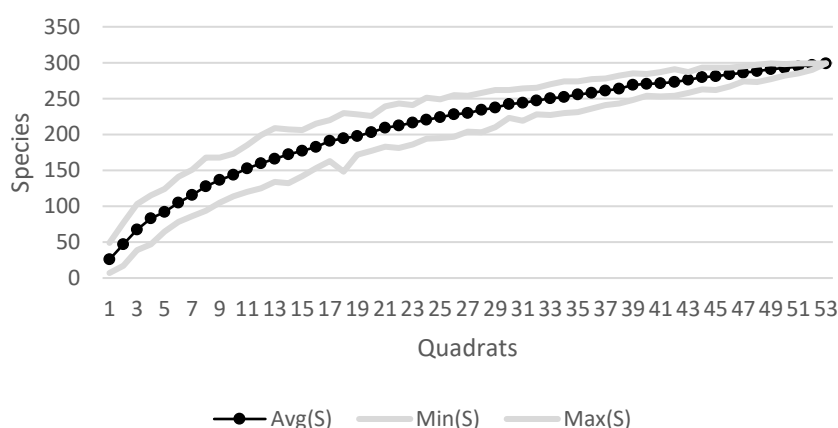


Figure 1. Species accumulation curve; the accumulative average, min and maximum number of species recorded in 53 quadrats (n=299, excluding species outside quadrats) using 100 random permutations. The logarithmic function of $y = 78.355\ln(x) - 24.196$

4.5 Flora Likelihood of Occurrence Assessment

The desktop assessment identified 102 conservation significant flora species that may occur in the Survey Area (Appendix C). A likelihood of occurrence was determined using reported habitat information in herbarium voucher labels, published descriptions, distribution records and knowledge from the author. The analysis determined that six species were likely to occur, 34 could possibly occur and 61 were unlikely to occur in the Survey Area.

Two Threatened flora, *Drakaea micrantha* (T) and *Microtis globula* (T), are known from the vicinity (<300m) and from habitats represented in the Survey Area (wetlands). Limitations to the survey method were identified that would have prevented their detection. *Drakaea micrantha* is an inconspicuous orchid that flowers for a short period in late September (Western Australian Herbarium [WAH] 2016). Suitable habitat for *Drakaea micrantha* was observed in the Survey Area. However, the timing of the field assessment (November) was inadequate to determine if the taxon was present or absent. Resurvey of these habitats at the appropriate time is recommended if road construction activities are likely to impact the wetland and adjacent lower slopes in Bakers Junction Nature Reserve. *Microtis globula* is an ephemeral orchid that flowers only in the first summer after fire and two records (1990 & 1998) are known from wetlands in Bakers Junction Nature Reserve adjacent to the Survey Area. The absence of fire is an unresolvable survey limitation for this taxon.

Four Priority flora were considered likely to occur in the Survey Area and survey limitations (flowering period) were identified for two of the Priority flora that would have reduced their detectability. *Lysinema lasianthum* (P4) and *Laxmannia jamesii* (P4) are inconspicuous species that flower in winter or early spring, which does not align with the timing of the field assessment (November).

4.6 Priority Flora

One population of a Priority flora, *Astartea transversa* (P2), was recorded in the Survey Area (Appendix A). A small patch of plants (approx. 25 individuals) occurred within a wetland adjacent to Bakers Junction Nature Reserve. The population is offset from the road edge by approximately 30m therefore is unlikely to be impacted by road construction activities. Extensive potential habitat occurs in Baker Junction Nature Reserve that was not surveyed.

4.7 Weeds

A total of 80 weed species were recorded from the Survey Area including two Weeds of National Significance (WONS), Bridal creeper (*Asparagus asparagoides*) and Blackberry (*Rubus* species complex). Golden Wattle (*Acacia pycnantha*), Pampas Grass (*Cortaderia selloana*), Sydney Wattle (*Acacia longifolia*) and Victorian Teatree (*Leptospermum laevigatum*) were also recorded and mapped in the survey area. These are currently not recognised as WoNS and are permitted (s11) under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (DAFWA 2016). However, they are recognised as problematic weeds by local government authorities and some may become listed under the BAM Act in the future. The location of these weed species are mapped in Appendix A.

5 FAUNA RESULTS & DISCUSSION

5.1 Fauna Assessment

The fauna assessment combined opportunistic field observations and the identification of habitats based on vegetation type, structure and the likelihood of occurrence. The likelihood of occurrence assessment is listed in Appendix D, which determined six conservation significant fauna species were present or likely to occur:- Australasian Bittern (*Botaurus poiciloptilus*)(T), Carnaby's Cockatoo (*Calyptorhynchus latirostris*)(T), Baudin's Cockatoo (*Calyptorhynchus baudinii*)(T), Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)(T), Western Ringtail Possum (*Pseudocheirus occidentalis*)(T), and Southern Brown Bandicoot (*Isodon obesulus* subsp. *fusciventer*)(P5). Field assessments confirmed that habitats within the Survey Area are currently or likely to be utilised by conservation significant fauna and are discussed in section 5.2.

Six conservation significant fauna species (excluding migratory birds) were considered to possibly occur:- Southern Brush-tailed Phascogale (*Phascogale tapoatafa* subsp. *tapoatafa*)(T), Quokka (*Setonix brachyurus*)(T), Western Bristlebird (*Dasyornis longirostris*)(T), Masked Owl (*Tyto novaehollandiae* subsp. *novaehollandiae*)(P3), Western Brush Wallaby (*Macropus irma*)(P4) and Water-rat (*Hydromys chrysogaster*)(P4). The occurrence of these species within the Survey Area is not confirmed and is discussed in Appendix D.

5.2 Priority and Threatened Fauna

Australasian Bittern (T)

Habitat for the Australasian Bittern is described as densely vegetated freshwater wetlands or rarely estuaries or tidal wetlands. In the southwest of Western Australia, the Australasian Bittern is usually found in beds of tall rush mixed with, or near, short fine sedge or open pools. It also occurs around swamps, lakes, pools, rivers and channels fringed with dense vegetation (Marchant & Higgins 1990). Occasionally it is known to venture into areas of open water or onto banks. Brackish water is tolerated in estuaries and tidal wetlands; sea coasts are avoided (Pickering 2013).

Potential suitable foraging habitat for this species occurred in low lying areas within the wetland systems in the road reserve adjacent to Baker Junction Nature Reserve (Plate 1&2). The habitat is described as tall *Baumea* sedgeland in standing water >30cm deep (November) surrounded by a 2-3m thicket of *Taxandria linearifolia* and *T. parviceps*. No individual were observed or heard during the reconnaissance field assessment. The Australasian Bittern has previously been recorded in the vicinity (<0.5km in 1993), although the spatial accuracy of this record is insufficient to determine the original location and the area has not been recently surveyed by DPaW. The mapped areas (Appendix A) are likely to be good foraging habitat, but may not be sufficiently large to provide good breeding habitat (Sarah Comer pers. comm. 2017). Further survey for this taxon may be warranted if significant impacts to this potential habitat are proposed.



Plate 1 & 2. Wetland habitats - potential foraging and breeding habitat for Australasian Bittern (T).

Western Ringtail Possum (T)

Preferred habitat for the Western Ringtail Possum (WRP) on the south coast of Western Australia is not well understood. The species has been recorded in coastal heath, Jarrah/Marri woodland and forest, Jarrah/Sheoak woodland, peppermint woodlands, myrtaceous heaths and shrublands, Bullich (*Eucalyptus megacarpa*) dominated riparian zones and Karri forest (*Eucalyptus diversifolia*). In the vegetation associations mapped in the Albany Region (35km radius from Albany in Sandiford and Barrett (2010)), most ringtail records were from coastal limestone heath vegetation unit 5b (DPaW 2014). Recent spotlight surveys have found high numbers in Coastal Hills Forest, Jarrah Woodland and Marri/Jarrah Forest/Peppermint Woodland on Mt Clarence/Adelaide and Mt Meville within the Albany town site (S. Gilfillan unpubl. data). Recent radio collaring of individuals determined home ranges of 0.88 ± 0.12 ha (mean \pm SE), and were commonly associated at night with Marri and Jarrah, suggesting a preference for these species as foraging trees. Daytime refuges included dreys, large trees, tree hollows (Marri only) and thick ground cover (Van Helden 2016).

The field assessment determined WRP utilised a wide range of vegetation types in various levels of condition. Several scat accumulations and dreys were found from road reserves adjacent to Bakers Junction Nature Reserve and extending east towards the Kalgan River. Habitats varied from Jarrah, Marri and Sheoak woodlands, *Banksia* Shrublands and *Taxandria parviceps* Thickets (within wetland vegetation units) that varied in condition from excellent to degraded (understory absent, single roadside row of Marri). An occupied hollow was also observed in a roadside Jarrah (potential WRP). Subsequently, all remnant native vegetation (including Marri with hollows) adjacent to Bakers Junction Nature Reserve and in the road reserves extending east to the Kalgan River are refuge, foraging and breeding habitat for WRP. Road reserves in the eastern section of the Survey Area are also a potentially important ecological linkage for WRT (See section 5.4).

Carnaby's Cockatoo

Uncleared or remnant native eucalypt woodlands or forests containing Marri, Jarrah or Karri (*Eucalyptus diversicolor*) and shrublands or Kwongan heathland dominated by *Hakea*, *Dryandra*, *Banksia* and *Grevillea* are considered habitat for this species (DSEWPac 2012). On the south coast they feed on Jarrah and Marri seeds and a wide variety of mainly proteaceous species. Breeding hollows generally have an entrance diameter >200mm and occur in trees that are 120–150 years

old; trees approaching 680 mm DBH are close to developing suitable hollows (Pittman *et. al.* 2007, Whitford 2002, DPaW 2013).

The Survey Area occurs within the known distribution and predicted breeding range of Carnaby's Cockatoo. One flock was observed flying in the vicinity and evidence of feeding on *Banksia grandis* was observed during the field assessment. All *Eucalyptus* woodland/forest and *Banksia* Shrublands are considered foraging and/or potential breeding habitat (mapped in Appendix A).

Baudin's Cockatoo

Baudin's Cockatoo occurs in high-rainfall areas, usually at sites that are heavily forested and dominated by Marri, Jarrah and Karri. It also occurs in woodlands of Wandoo (*E. wandoo*), Blackbutt (*E. patens*), Flooded Gum (*E. rudis*), and Yate (*E. cornuta*) (DSEWPac, 2012). Baudin's cockatoo feeds mainly on the seeds of Marri, but may also feed on the seed of *Banksia* spp., *Hakea* spp. and *Erodium botrys*. Additionally, Baudin's Cockatoo feeds on invertebrate larvae and on apple, pear and persimmon in domestic and commercial fruit orchards (Chapman 2008). Trees with hollows suitable for Baudin's Cockatoo are likely to be 500 mm or greater DBH and suitable hollows usually have a diameter of 300-400 mm (Johnstone & Storr 1998; Higgins 1999; Saunders 1974b, 1979).

The Survey Area occurs within the known distribution and known breeding range of Baudin's Cockatoo. No individuals were observed during the field survey. All *Eucalyptus* woodland/forest and *Banksia* Shrublands are considered foraging and/or potential breeding habitat (mapped in Appendix A).

Forest Red-tailed Black Cockatoo

Forest Red-tailed Black Cockatoo commonly occur in Jarrah, Karri and Marri forests and also in a range of other forest and woodland types, including Blackbutt, Wandoo and Tuart (*E. gomphocephala*), Albany Blackbutt, Yate and Flooded Gum (DSEWPac, 2012). Ninety percent of the Forest Red-tailed Black Cockatoo total diet consists of marri and jarrah seeds (Johnstone & Kirkby 1999), and it depends on both feed trees during breeding periods (Johnstone *et al.* 2013). Other feed trees include Blackbutt, Albany Blackbutt, Forest Sheoak (*Allocasuarina torulosa*), Snottygobble (*Persoonia* spp.) and Karri. A realistic minimum age for trees bearing suitable hollows is approximately 120–150 years (trees diameters of 500–600 mm). Most nest hollows occur in intermediate-sized trees (Whitford *et al.* 2015).

The survey area occurs within the modelled distribution of the Forest Red-tailed Black Cockatoo. The breeding range has not been modelled although it is recognised that it may breed anywhere within its occurrence range (DSEWPac 2012). Several flocks were observed perching or flying in the vicinity during the field assessment and destructive foraging on Marri capsules diagnostic of Forest Red-tailed Black Cockatoo was also observed frequently across the entire Survey Area. All *Eucalyptus* woodland/forest and *Banksia* Shrublands are considered foraging and/or potential breeding habitat (mapped in Appendix A).

Southern Brown Bandicoot (P5)

The Southern Brown Bandicoot occurs in wet or dry sclerophyll forest through to open woodland and scrubby, dense vegetation on sandy soils. The species often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Characteristic diggings and runnels of this species were observed throughout the Survey Area and were particularly abundant in sandy areas of *E. staeri* Woodlands and *Banksia* Shrublands. One individual was also observed crossing the South Coast Highway.

5.3 Significant Fauna Habitat Trees

Significant trees were specifically considered in the Fauna assessment as potential breeding habitat for the three Threatened Black Cockatoo species. Significant trees are those greater than 500 mm DBH for *Eucalyptus marginata*, *E. staeri*, *E. rudis* and *Corymbia calophylla* (DSEWPaC 2012). A total of 435 individual trees of five taxa were considered as significant within the Survey Area (Table 5). Current or potential breeding hollows were identified in 60 individuals of four tree species (mapped in Appendix A).

Table 5. Species, average diameter and presence of hollows in the significant trees within the Survey Area.

Taxon	Average DBH (mm)	Count	Hollows Present
<i>Corymbia calophylla</i>	685	228	8
<i>Eucalyptus marginata x staeri</i>	778	6	3
<i>Eucalyptus marginata</i>	646	130	28
<i>Eucalyptus rudis</i>	1910	1	
<i>Eucalyptus staeri</i>	629	70	21
Total:		435	60

5.4 Ecological linkages

The vegetation within the road reserve represents an ecological linkage between the King and Kalgan River. The road reserves in the eastern section are an important linkage between Bakers Junction Nature Reserve and the Kalgan River and is used extensively by Western Ringtail Possum. Many roadside thickets within the wetlands (adjacent to Baker Junction Nature Reserve) may also be used by Western Ringtail Possum as linkages between upland Eucalypt Woodlands.

6 SURVEY TIMING & LIMITATIONS

The assessment was conducted during November, 2016. Climatic characteristics of the site and the seasonal conditions preceding the field work may have favourably influenced the emergence of annual species and the flowering of perennial species. The Survey Area occurs within a high rainfall zone and the assessment was conducted in spring after good rainfall in the preceding year (Figure 2). Total rainfall for the 12 months prior to the survey was 909 mm, close to the historic average of 929 mm. Consequently, soil moisture conditions were not considered as a limitation for the emergence and flowering of Threatened or Priority species within the Survey Area.

Two Threatened orchids were considered highly likely to occur and survey limitations (flowering period & fire interval) were identified that would have prevented their detection. Four Priority flora were considered likely to occur and survey limitations (flowering period) were identified for two of the Priority flora that would have reduced their detectability.

Eight native taxa were not confidently identified to species level, five due to the absence of fertile material and three due to the ambiguity of some morphological characters. Three weeds taxa were not identified to species level. All unidentified taxa are not considered likely to be conservation significant or WoNS.

The information provided within this report is accurate and correct to the best of the author's knowledge. However, no liability is accepted for loss, damage or injury arising from its use. Plant populations can fluctuate over time, particularly after disturbance events such as fire and drought. Consequently, all mapping, vegetation descriptions and population estimates within this report should not be considered accurate indefinitely. The report was prepared for Main Roads and should be read, distributed and referred to in its entirety.

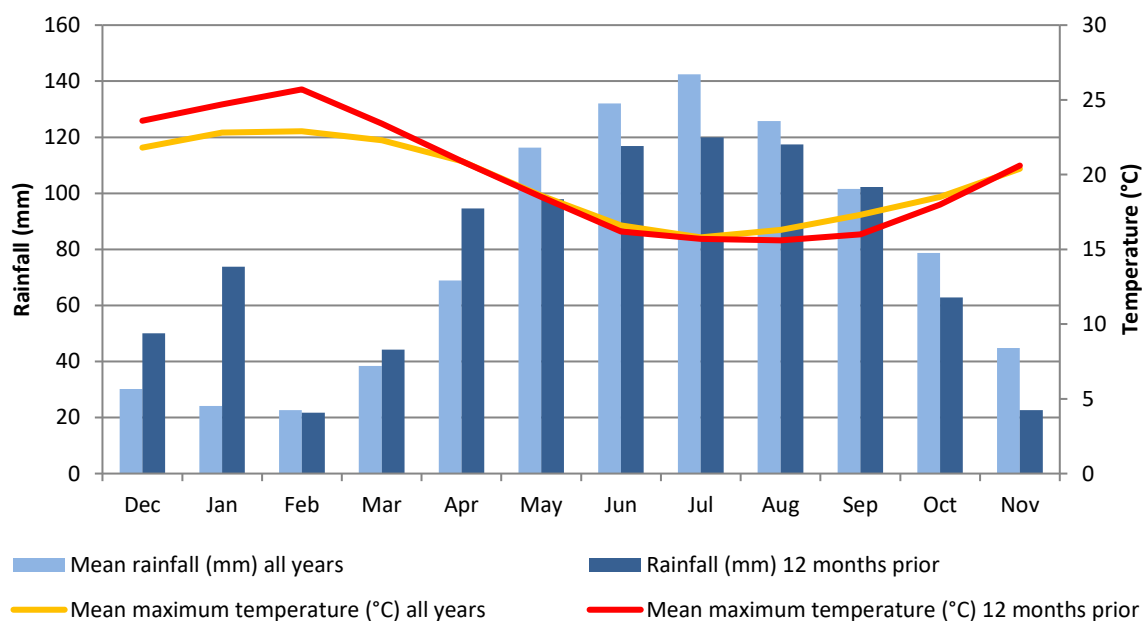


Figure 2. Climate statistics for 12 months prior to the assessment compared with historical averages (all years available) from the nearest weather station (Albany) (BOM 2016). Total rainfall for 2016 month period prior to the survey was 909 mm compared to the historic average of 929 mm.

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8 APPENDIX A – Locality, Index & Maps 1-4, A-D

