



Detailed Flora and Vegetation Survey Wonnerup North M70/1396 & M70/1368

Prepared for Tronox Southwest Operations
28 January 2022



Document Status						
Rev No.	Authors	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
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EXECUTIVE SUMMARY

Tronox Southwest Operations (Tronox) currently undertakes minerals sands mining at Wonnerup, situated approximately 200 km south of Perth in south-west Western Australia. Tronox is proposing to expand mining operations to the Wonnerup North deposit which lies predominantly on cleared agricultural land. To support environmental approvals for the proposed extension of mining, Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned to undertake a single season detailed flora and vegetation survey of two new tenements, M70/1396 and M70/1368, herein referred to as the study area.

The field survey was completed by a Principal Botanist from Onshore Environmental under very good seasonal conditions in mid September (Spring) 2021. A total number of 86 plant taxa (including varieties and subspecies) from 24 families and 58 genera was recorded from the study area. The dominant families were Myrtaceae, Poaceae, Proteaceae, Fabaceae, Asteraceae, Cyperaceae and Iridaceae. The most speciose genera were *Eucalyptus*, *Melaleuca*, *Banksia* and *Hakea*.

None of the plant taxa recorded from the study area were gazetted as Threatened Flora (T) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the State *Biodiversity Conservation Act (2016)* (BC Act). Additionally, none of the native taxa recorded were listed as Priority flora by the Department of Biodiversity, Conservation and Attractions (DBCA), or identified as naturally occurring range extensions or potentially new taxa.

A total of 37 introduced species were recorded from the study area, of which two taxa were listed as Declared Plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act); **Asparagus asparagoides* (Bridal Creeper) - s22(2) and **Zantedeschia aethiopica* (Arum Lily) - s22(2).

Native vegetation within the study area was described as five vegetation types. Field assessment confirmed there were no Commonwealth or State listed Threatened Ecological Communities (TECs) or State listed Priority Ecological Communities (PECs) represented within the study area.

Vegetation condition across the entire study area was rated as *degraded* or *completely degraded*, with the primary disturbances resulting from historical clearing for agriculture and subsequent grazing by domestic stock. This included the road reserve vegetation.

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1.0 INTRODUCTION

1.1 Preamble

As part of future expansion of mining operations at the Wonnerup North Mine in southwest Western Australia, Tronox requested a baseline flora and vegetation survey of native vegetation situated on otherwise cleared farmland within two new tenements, M70/1396 and M70/1368, herein referred to as the study area (Figure 1).

1.2 Previous Surveys

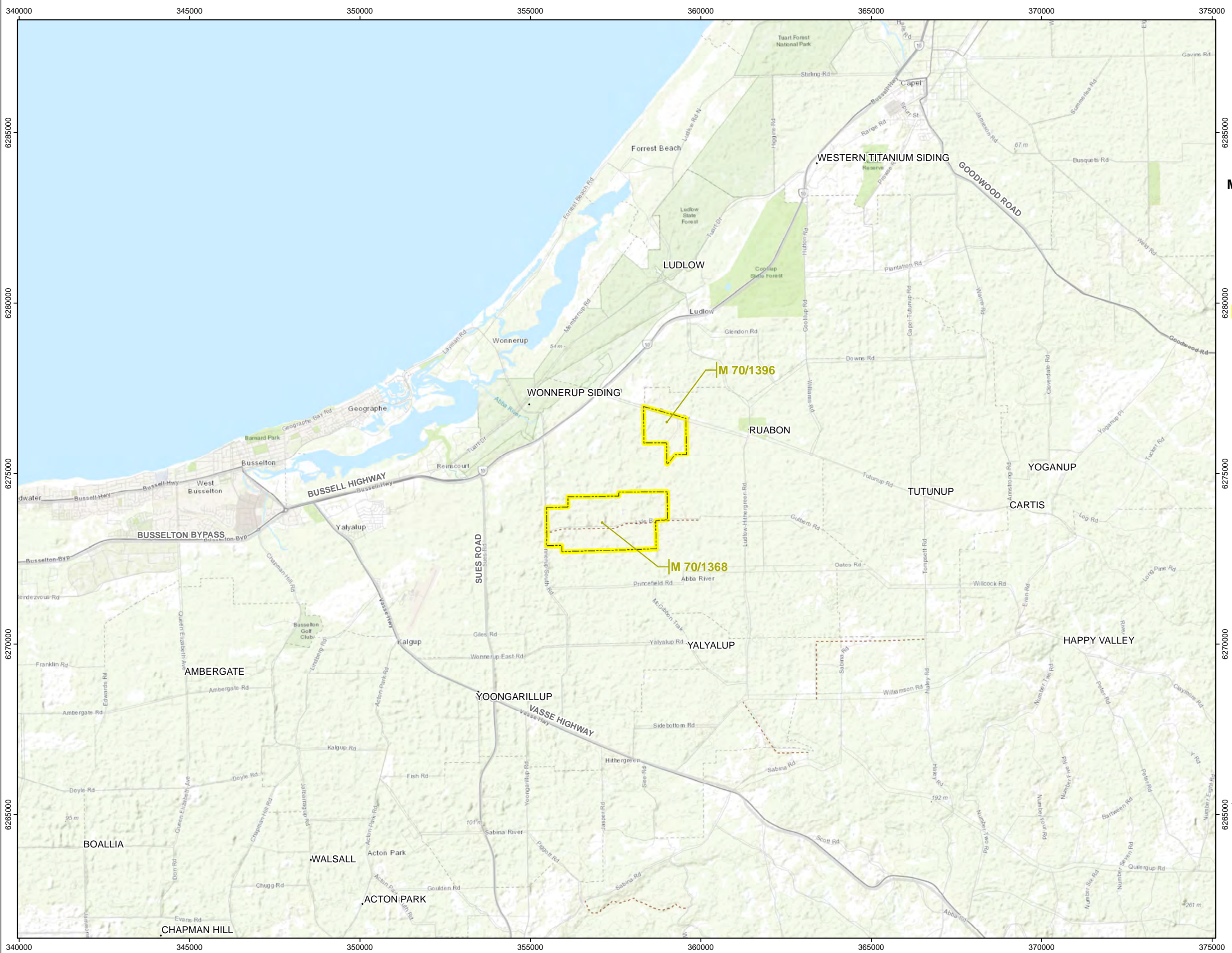
A two season flora and vegetation survey was previously completed over the Wonnerup North mineral sands tenements by Astron Environmental (2013). Native vegetation remnants forming the northern sector of the study area were mapped as “paddock trees”, and there was no significant flora recorded from within, or adjacent to, the native remnants.

A follow up reconnaissance flora and vegetation survey covering the northern sector of the current study area was undertaken by Onshore Environmental in October 2018 (Onshore Environmental 2018). The survey confirmed remnant native vegetation was highly disturbed from prolonged grazing by domestic stock, with vegetation condition rated as completely degraded. The total flora reflected very low diversity and there were no conservation significant flora taxa present.

1.3 Climate

The study area occurs within the dry Mediterranean region which experiences six dry months per year (Beard 1981). The Wonnerup region is typified by cool wet winters and hot dry summers. Annual rainfall for the nearby town of Busselton averages 685.4 mm (Bureau of Meteorology [BOM] 2021), with the majority of falls occurring during the winter months of June and July associated with cold fronts moving across the south-west of Western Australia. The annual average maximum temperature is 23.1°C, while the annual average minimum is 10.3°C (BOM 2021).

Annual rainfall for 2021 was 102 mm above the long term average, totalling 787.0 mm. Seven of ten months prior to the October 2021 field survey recorded above average monthly falls, resulting in very good seasonal conditions.

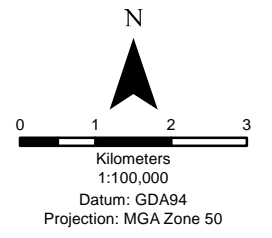
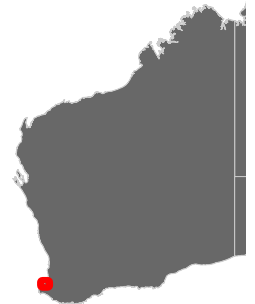


TRONOX

FIGURE 1
Location Map
M 70/1396 & M 70/1368

Legend

- Tronox Tenements (Study Area)**
- M 70/1396 & M 70/1368



Date: 25/01/2022
 Status: Draft
 Figure: 1
 Sheet Size: A3
 Internal Reference: FS_WON_Loc_20220125
 Drawn by: GSM
 Requested by: DB



1.4 Biogeographic Regions

The latest version of the Interim Biogeographic Regionalisation for Australia (IBRA7) divides Australia into 89 bioregions based on climate, geology, landform, native vegetation and species information, and includes 419 sub-regions (Department of Environment 2013). The bioregions and sub-regions are the reporting unit for assessing the status of native ecosystems and their level of protection in the National Reserve System.

The study area occurs within the Perth subregion (SWA2) of the Swan Coastal Plain Bioregion. The subregion runs along the coast from north of Perth down to Cape Naturaliste and covers 1,333,901 hectares. The Swan Coastal Plain is described as low lying coastal plains dominated by woodlands of *Banksia* and Tuart (*Eucalyptus gomphocephala*) on sandy soils. *Casuarina obesa* occurs on outwash plains and swampy areas support paperbarks (*Melaleuca* spp). The climate is warm Mediterranean and three phases of marine sand dunes provide relief (Mitchell *et al* 2002). The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats, and coastal limestone. Heath and/or Tuart woodlands occur on limestones, with *Banksia* and Jarrah/*Banksia* woodlands on Quaternary marine dunes of various ages, and Marri on colluvial and alluvials. The area contains a complex series of seasonal wetlands (Mitchell *et al* 2002).

1.5 Land Use

The dominant land use within the study area is dry land agriculture (dairy farming), with other nearby land uses including irrigated horticulture, forestry-plantations, conservation, unallocated crown lands and crown reserves, rural residential development, and mining.

1.6 Soils and Landforms

The study area occurs within the Darling System. Soils and landforms have been mapped by Churchward and McArthur (1980) and more recently revised by Tille and Lantzke (1990a). The study area occurs at the interface between the Ludlow Unit and depositional areas of the Abba Plain. The dominant landform pattern is an intricate patchwork of slight depressions and slight rises. The depressions tend to become waterlogged in winter, while the rises tend to suffer subsoil waterlogging. The soils on the depressions and rises are generally similar with sandy grey-brown gradational (Busselton) and duplex (Abba) soils occurring on both (Tille and Lantzke 1990a).

1.7 Flora and Vegetation

The study area occurs in the Drummond Subdistrict of the Darling Botanical District, in the Southwest Botanical Province (Beard 1981). Vegetation is dominated by an open woodland comprising Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata*) and *Banksia* (*Banksia attenuata*), with the proportion of *Banksia* increasing on the drier sand dunes. Along the drainage lines, flats and depressions *Eucalyptus rudis* occurs with *Melaleuca raphiophylla*.

2.0 METHODOLOGY

2.1 Legislation and Guidance Statements

The single season detailed flora and vegetation survey was carried out in a manner that was compliant with Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of flora and vegetation in Western Australia:

- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a); and
- Environmental Factor Guideline: Flora and Vegetation (EPA 2016b).

2.2 Desktop Assessment

2.2.1 Literature Review

Previous survey reports relevant to the survey area were reviewed to provide a local and regional perspective on flora and vegetation values. The main contextual (regional) report relevant to the survey area was:

- The flora and vegetation of the Busselton Plain (Swan Coastal Plain): a report for the Department of Environment and Conservation as part of the Swan Bioplan Project (Webb, Keighery, Keighery and Longman 2009).

There were four site specific flora and vegetation surveys sourced from work completed either within, or nearby to, the study area (Onshore Environmental 2006, 2013, 2018; Astron Environmental 2013). The relevant results have been summarised in more detail in Section 3.1.1.

2.2.2 Database Searches

The desktop assessment included databases relating to significant flora, TECs and PECs previously collected or described within, or in close proximity to, the study area. For this report the search was extended beyond the study area boundary to place flora values into a local and regional context. The following databases were searched:

- NatureMap1: This database represents the most comprehensive source of information on the distribution of Western Australia's flora, comprising records from the DBCA Threatened Flora database, and the Western Australian Herbarium (WAH) Specimen Database;
- DBCA's Threatened and Priority flora database was searched to confirm the NatureMap results;
- DBCA's TEC, PEC and Environmentally Sensitive Areas (ESAs) database was searched to identify significant communities;
- EPBC Act Protected Matters database; and
- International Union for Conservation of Nature (IUCN) database.

2.2.3 Assessment of Likelihood of Occurrence in the study area

A list of conservation significant flora species occurring within a 10 km radius of the study area was compiled during the literature review and database searches. The likelihood of each taxon occurring within the study area was assessed using a set of rankings and criteria (Table 1) based on presence of suitable landform (inferred from aerial imagery with contours overlaid and from knowledge of the adjacent areas) and distance to known records.

Table 1 Ranking system used to assign the likelihood that a species would occur in the study area.

Rank	Criteria
Recorded	The species has been recorded in the study area.
Likely to occur	The species has previously been recorded from a landform which is present within the study area, and there are previous records within a 5 km radius of the study area.
Possible to occur	The species has previously been recorded from a landform which is present within the study area, and there are previous records within a 10 km radius of the study area.
Unlikely to occur	The landform from which the species has previously been recorded is absent within the study area, and/or there are no previous records within a 10 km radius of the study area.

2.3 Field Survey Methodology

2.3.1 Timing and Personnel

The single season detailed flora and vegetation survey was completed by Principal Botanist Dr Darren Brearley working between the 20th and 23rd of September 2021.

2.3.2 Sampling of Study Sites

The field survey involved systematic sampling using quadrats supported by relevé vegetation descriptions and targeted searches for conservation significant flora species and weeds. The study sites (quadrats) sampled were 10 m by 10 m in dimension which is standard for the Swan Coastal Plain. A total of 15 quadrats were formally assessed.

The sampling sites were assessed to provide a list of the total flora occurring within the study area and a description of the vegetation structure. Data collected covered a range of environmental parameters including:

- Landform and habitat;
- Aspect;
- Soil colour and soil type;
- Rock type;
- Slope (angle);
- Vegetation condition;
- Disturbance (caused by fire, clearing, grazing etc.);
- Age since fire;

- Broad floristic formation;
- Vegetation association description; and
- Height and percentage ground cover provided by individual plant taxa.

Vegetation condition for each remnant was determined using a recognised rating scale (based on Keighery 1994, see Appendix 1).

2.3.3 Targeted Surveys for Conservation Significant Species

Targeted searches for species of conservation significance were completed within the study area. Ground truthing provided an opportunity to record opportunistic locations for conservation significant flora and to undertake closer examination of specific landforms where significant flora would be expected to occur.

2.3.4 Weed Survey and Mapping

Introduced species were recorded from the quadrats formally assessed within the study area. Opportunistic collections were also made while moving throughout the study area, with targeted weed searches completed in high moisture habitats.

2.3.5 Floristic Analysis

A multivariate statistical analysis of the floristic quadrat data (15 quadrats) was completed to assist in understanding the vegetation-habitat relationships within the study area. Statistical analysis of quadrat data can support delineation of vegetation types within the study area and provide comparison against locally significant communities (TECs and PECs) where quadrat data is available.

A two-way classification (Agglomerative Hierarchical Fusion) of the presence/absence quadrat data was carried out on the 31 taxa (natives) x 15 quadrat dataset using the program PATN (Belbin 2003). The flexible unweighted pair group method with arithmetic mean (UPGMA) classification strategy was used ($\beta = -0.1$), together with the Bray-Curtis site similarity measure. The number of groups to be determined was set at four. The primary output of the classification was in the form of a dendrogram (Appendix 2).

The results from the statistical analysis need to be appropriately analysed by an experienced botanist, and effects such as fire disturbance, ephemeral taxa, and spatial distribution of quadrats taken into consideration when interpreting the results. Plant taxa that occupy a range of vegetation types can obscure vegetation patterning and influence statistical outputs. It must be acknowledged that the results of multivariate statistical analysis may not always align with the delineated vegetation types given that the procedure is based on presence or absence of plant taxa at specific sampling points (with no weighting of species dominance), and acknowledgement that floristic community types are specific to a sampling point (i.e. they provide no spatial context).

The vegetation mapping utilised high-resolution aerial photography of the study area at a scale of 1:10,000. Ground-truthing was undertaken across native vegetation remnants to confirm dominant structural layers and associated plant taxa within vegetated polygons identified from the aerial photography.

Description of vegetation structure follows the height, life form and density classes of Muir (1977) (see Appendix 3). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account.

2.3.6 Field Survey Constraints

The EPA Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2016a) list seven potential limitations that field surveys may encounter. These limitations are addressed in Table 2.

Table 2 Relevance of limitations to the flora and vegetation survey, as identified by EPA (2016a).

Constraint	Relevance
Availability of contextual information at a regional and local scale	Previous flora and vegetation survey work has been completed in the northern sector of the study area by Astron (2013) and Onshore Environmental (2018). Other previous flora and vegetation surveys completed in close proximity to the study area include the Wonnerup Mine (Onshore Environmental 2006) and Wonnerup South Road (Onshore Environmental 2013).
Proportion of flora recorded and/or collected, any identification issues	A large proportion of the study area had been cleared for annual pasture and was actively being grazed by dairy cows. The native remnant vegetation was restricted to highly disturbed narrow road reserves, and also occurred as parkland cleared groves within unfenced paddocks. The reduced area within the study area supporting native vegetation ensured good coverage and a very high proportion of the total flora present likely being recorded.
Survey timing, rainfall, season of survey	The survey was completed by an experienced Principal Botanist in late September 2021. Seasonal conditions were determined to be optimum (rated as very good), with above average annual rainfall experienced during the entire year.
Disturbance that may have affected the results of survey such as fire, flood or clearing	There were no disturbances that influenced survey outcomes. It is noted that the study area had been subjected to an extensive grazing history by domestic stock, and supported a dense ground cover of introduced annual grasses. Vegetation condition was rated as 'degraded' or 'completely degraded' for all 15 quadrats formally assessed.
Was the appropriate area fully surveyed (effort and extent)	The Principal Botanist assessed 15 quadrats within remnant native vegetation to ensure thorough survey coverage and facilitate vegetation type mapping.
Access restrictions within the survey area	The study area was accessed by vehicle and on foot. There were no access restrictions encountered.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	The Principal Botanist, Dr Darren Brearley, has 25 years' experience working extensively on the Swan Coastal Plain. He has worked actively undertaking local baseline surveys at nearby Busselton, Ludlow, Wonnerup, Tutunup, Ruabon and on the Whicher Scarp.

2.3.7 Assessment of Conservation Significance

The conservation significance of flora and ecological communities are classified at a Commonwealth, State and Local level on the basis of various Acts and Agreements, including:

International Level:

- IUCN: The IUCN 'Red List' lists species at risk under nine categories (status codes) (Appendix 4).

Commonwealth Level:

- EPBC Act: The Department of Agriculture, Water and the Environment (DAWE) lists Threatened flora and ecological communities, which are determined by the Threatened Species Scientific Committee according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of six categories (Appendix 4).

State Level:

- BC Act: At a State level, native flora species are protected under the BC Act - Wildlife Conservation Notice. A number of species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations (Appendix 4); and
- DBCA Priority list: DBCA produces a list of Priority species and ecological communities that have not been assigned statutory protection under the BC Act. Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added under Priorities 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been removed from the threatened species list for other taxonomic reasons, are placed in Priority 4. These species require regular monitoring (see Appendix 4). The list of PECs identifies those that need further investigation before nomination for TEC status at a State level.

Local Level:

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally protected by legislation, such species are acknowledged to be in decline as a result of threatening processes, primarily habitat loss through land clearing.

3.0 RESULTS

3.1 Desktop Review

3.1.1 Previous Flora Surveys within the study area

The results from three previous flora and vegetation surveys completed within, or in close proximity to, the study area are presented in Table 3.

The local surveys confirm the occurrence of two Threatened Flora taxa along Wonnerup South Road, *Chamelaucium roycei*, and Ruabon Road, *Verticordia densiflora* var. *pedunculata*. There are an additional five Priority flora taxa that have been recorded along the verge of Ruabon Road; *Isopogon formosus* subsp. *dasylepis*, *Jacksonia gracillima* and *Verticordia attenuata* (Priority 3), and *Tripterococcus* sp. *Brachylobus* (A.S. George 14234) and *Calothamnus quadrifidus* subsp. *teretifolius* (Priority 4). A two season flora and vegetation survey of remnant vegetation remaining on farmland between these two roads failed to record any significant flora (Astron Environmental 2013).

The extensive historical clearing of native vegetation for annual pasture to support dairy herds has contributed to the introduction of a significant variety of pasture grasses and associated weeds into the local area. The previous surveys have identified in excess of 40 introduced species including four species listed as declared pests under the BAM Act; Bridal Creeper (**Asparagus asparagoides*), Narrowleaf Cotton Bush (**Gomphocarpus fruticosus*), Apple of Sodom (**Solanum linnaeanum*) and Arum Lily (**Zantedeschia aethiopica*).

Vegetation occurring on deep grey sand on low sandy rises fringing Ruabon Road has been determined to be closely aligned with the State listed PEC 'Southern *Banksia attenuata* woodlands (community type 21b)', which is a component of the Endangered 'Banksia Woodlands of the Swan Coastal Plain' EPBC listed TEC. These vegetation types supporting consolidated areas where vegetation condition is rated as good or better are considered to have high conservation significance.

A flora and vegetation survey of the Wonnerup North Mineral Sands Project (Astron Environmental 2013) identified past records of two Threatened Flora taxa and three Priority flora taxa within the boundary of the survey area. However, despite targeted searches none of these flora were confirmed. Contributing factors were determined to be the age of the records and inaccuracy in the coordinates.

There was one historical record from within the current study area (M 70/1368); *Chamelaucium erythrochlorum* (Priority 4). Targeted searches confirmed the recorded point occurred within a cleared paddock. Further searches from the nearest remnant native vegetation along the Lyle Road verge did not record the taxon.

Table 3 Results from flora and vegetation surveys previously completed within, or in close proximity to, the study area.

Survey	Consultant	Year	Field Survey Date	Significant Flora	Introduced (Weed) Taxa
Ruabon Road Reserve Extension - Vegetation Survey	Onshore Environmental Consultants	2019a	November 2018	Not assessed The three vegetation types were also aligned with the State listed PEC 'Southern <i>Banksia attenuata</i> woodlands (community type 21b)', which is a component of the Endangered <i>Banksia</i> Woodlands of the Swan Coastal Plain EPBC listed TEC.	Not assessed
Detailed Flora and Vegetation Survey Ruabon Road Reserve	Onshore Environmental Consultants	2019b	September and December 2018	One Threatened Flora taxon; <i>Verticordia densiflora</i> var. <i>pedunculata</i> Four Priority flora taxa; <i>Isopogon formosus</i> subsp. <i>dasylepis</i> , <i>Jacksonia gracillima</i> and <i>Verticordia attenuata</i> (Priority 3), and <i>Calothamnus quadrifidus</i> subsp. <i>teretifolius</i> (Priority 4)	41 introduced taxa including one species listed as a declared pest under the BAM Act 2007; Arum Lily (<i>*Zantedeschia aethiopica</i>)
Wonnerup North Banksia Woodland Mapping	Onshore Environmental Consultants	2018	January 2018	Not assessed The two vegetation associations were closely aligned with the EPBC-listed 'Banksia Woodlands' ecological community, and DBCA listed PEC 'Southern Banksia attenuata woodlands (FCT 21b)' (Priority 3)	Not assessed
Wonnerup North Mineral Sands Project Flora and Vegetation Assessment	Astron Environmental	2013	June and October 2013	One Threatened Flora taxon; <i>Chamelaucium roycei</i> Four Priority flora taxa; <i>Isopogon formosus</i> subsp. <i>dasylepis</i> , <i>Jacksonia gracillima</i> and <i>Verticordia attenuata</i> (Priority 3), and <i>Tripterococcus</i> sp. <i>Brachylobus</i> (A.S. George 14234) (Priority 4)	38 introduced taxa including four species listed as declared pests under the BAM Act 2007; Bridal Creeper (<i>*Asparagus asparagoides</i>), Narrowleaf Cotton Bush (<i>*Gomphocarpus fruticosus</i>), Apple of Sodom (<i>*Solanum linnaeanum</i>), and Arum Lily (<i>*Zantedeschia aethiopica</i>)

Survey	Consultant	Year	Field Survey Date	Significant Flora	Introduced (Weed) Taxa
Flora and Vegetation Survey Wonnerup South Road - Road Verge	Onshore Environmental Consultants	2013	November 2012	One Threatened Flora taxon; <i>Chamelaucium roycei</i>	24 introduced taxa including two species listed as declared pests under the BAM Act 2007; Bridal Creeper (<i>*Asparagus asparagoides</i>) and Arum Lily (<i>*Zantedeschia aethiopica</i>)
Flora and Vegetation Survey Grice and Location 7	Onshore Environmental Consultants	2006	April, May, October 2006	None	44 introduced taxa including four species listed as declared pests under the BAM Act 2007; Bridal Creeper (<i>*Asparagus asparagoides</i>), Narrowleaf Cotton Bush (<i>*Gomphocarpus fruticosus</i>), Apple of Sodom (<i>*Solanum linnaeanum</i>), and Arum Lily (<i>*Zantedeschia aethiopica</i>)

3.1.2 Threatened Flora listed under the EPBC Act and BC Act

A search of the EPBC Act Protected Matters database was undertaken for a 10 km radius around the study area (DAWE 2021). A total of 25 Threatened Flora taxa listed under both the EPBC Act and BC Act have been recorded as occurring or having suitable habitat within the search radius (Table 4). Four of these taxa were determined as being *likely* to occur within the study area, with the remainder considered *unlikely* to occur (Table 4). The majority of the Threatened Flora taxa identified during the database searches are restricted to the ironstone landforms present further inland at the Tutunup locality.

Table 4 Conservation significant flora listed under the Commonwealth EPBC Act and State BC Act, and the likelihood of each taxon occurring within the study area.

Taxon	Conservation Code		Habitat	Potential to occur within the study area
	BC Act	EPBC Act		
<i>Andersonia gracilis</i>	T	E	Occurs in winter-wet areas and near swamps, in white-grey sand, sandy clay and gravelly loam.	Unlikely
<i>Banksia nivea</i> subsp. <i>uliginosa</i>	T	E	Occurs in sandy clay and gravel.	Unlikely
<i>Banksia squarrosa</i> subsp. <i>argillacea</i>	T	V	Occurs in winter-wet flats and clay flats in white-grey sand, gravelly clay and loam.	Unlikely
<i>Brachyscias verecundus</i>	T	CE	Occurs on a granite outcrop in a moss sward.	Unlikely
<i>Caladenia hoffmanii</i>	T	E	Occurs in rocky outcrops and hillsides, ridges, swamps and gullies in clay, loam, laterite and granite.	Unlikely
<i>Caladenia huegelii</i>	T	E	Occurs in grey or brown sand and clay loam.	Unlikely
<i>Caladenia procera</i>	T	CE	Occurs in alluvial loamy flats, jarrah, marri and peppermint woodland, dense heath and sedges.	Unlikely
<i>Chamelaucium roycei</i>	T	V	Winter-wet flats, wetlands. Red sandy clays and loams, grey sands.	Likely
<i>Darwinia foetida</i>	T	CE	Occurs on flats. Dark grey sands.	Unlikely
<i>Darwinia whicherensis</i>	T	E	Occurs on wet flats with dark brown and black clayey sands.	Unlikely
<i>Diuris micrantha</i>	T	V	Occurs in winter-wet swamps and in shallow water in brown loamy clay.	Unlikely
<i>Drakaea elastica</i>	T	E	Occurs in low-lying situations adjoining winter-wet swamps.	Unlikely
<i>Drakaea micrantha</i>	T	V	Occurs in white-grey sand.	Unlikely
<i>Gastrobium papilio</i>	T	E	Occurs in flat plains in sandy clay over ironstone and laterite.	Unlikely
<i>Grevillea elongata</i>	T	V	Occurs in swamps, creek banks and road verges in gravelly clay, sandy clay and sand.	Likely
<i>Grevillea maccutcheonii</i>	T	E	Occurs in seasonally inundated sites in clay and shallow soils over laterite.	Unlikely

Taxon	Conservation Code		Habitat	Potential to occur within the study area
	BC Act	EPBC Act		
<i>Isopogon uncinatus</i>	T	E	Occurs in swampy depressions and hillslopes in peaty sand, loam or sand on granite.	Unlikely
<i>Lambertia echinata</i> subsp. <i>occidentalis</i>	T	E	Occurs on flats to foothills and winter-wet areas in white sandy soils over laterite and orange, brown-red clay over limestone.	Unlikely
<i>Petrophila latericola</i>	T	E	Occurs in winter-wet flats.	Unlikely
<i>Sphenotoma drummondii</i>	T	E	Occurs on steep rocky slopes and crevices of rocks in stony or shallow soils over granite or quartzite.	Unlikely
<i>Synaphea stenoloba</i>	T	E	Occurs in winter-wet flats and granite in gravelly sand, sandy or sandy clay soils.	Unlikely
<i>Tetralia australiensis</i>	T	V	Occurs on flats and low sand dunes. White and grey sand, sandy loams and clays.	Unlikely
<i>Verticordia densiflora</i> var. <i>pedunculata</i>	T	E	Occurs in winter-wet low-lying areas in grey-yellow sand and sandy loam.	Likely
<i>Verticordia plumosa</i> var. <i>ananeotes</i>	T	E	Occurs in seasonally inundated plains in sandy loam.	Unlikely
<i>Verticordia plumosa</i> var. <i>vassensis</i>	T	E	Occurs in winter-wet flats in white-grey sand.	Possible

3.1.3 Priority Flora listed under the BC Act

The database searches identified 27 Priority flora taxa, including one Priority 1 taxa, three Priority 2 taxa, 12 Priority 3 taxa and eleven Priority 4 taxa (Table 5). None of the known Priority flora records occur within the study area, and a number of nearby records were not present when targeted searches were completed by botanists in 2013 (Astron Environmental 2013) and 2018 (Onshore Environmental 2019a). Additionally, many of the significant flora recorded during the desktop searches are known to be habitat specific and occur on soils and landforms that are not found within the study area, e.g. seasonal wetlands on ironstone at shallow depth. Of the 27 Priority flora taxa identified from the database searches, seven species were determined as *likely* to occur within the study area, and a further five taxa were determined as *possible* occurrences (Table 5).

Table 5 Priority flora as listed by DBCA, and the likelihood of each taxon occurring within the study area.

Taxon	Priority Level	Habitat	Potential to occur within the study area
<i>Stylidium ferricola</i>	P1	Occurs on seasonal wet, poorly-drained slopes. Shallow red-brown clay loams over ironstone.	Unlikely
<i>Amperea micrantha</i>	P2	Occurs in sandy soils.	Unlikely
<i>Cardamine paucijuga</i>	P2	Occurs in moist to dry habitat, winter-wet swamps, mainly in black peaty sands.	Unlikely
<i>Stylidium korijekup</i>	P2	Occurs on upland ridges with well-drained grey-brown sandy loam with laterite.	Unlikely

Taxon	Priority Level	Habitat	Potential to occur within the study area
<i>Blennospora doliiformis</i>	P3	Occurs in seasonally wet flats in red or grey clays soils over ironstone.	Unlikely
<i>Chamaescilla gibsonii</i>	P3	Occurs in winter-wet flats and shallow water-filled claypans in sandy clay to clay.	Unlikely
<i>Eryngium</i> sp. Ferox (G.J. Keighery 16034)	P3	Occurs in seasonally wet flats. Moist brown and grey clay.	Possible
<i>Grevillea brachystylis</i> subsp. <i>brachystylis</i>	P3	Occurs in swampy situations in black sand and sandy clay.	Unlikely
<i>Hakea oldfieldii</i>	P3	Occurs in seasonally wet flats in red clay or sand over laterite.	Likely
<i>Isopogon formosus</i> subsp. <i>dasylepis</i>	P3	Occurs often in swampy areas in sand, sandy clay and gravelly sandy soils over laterite.	Likely
<i>Jacksonia gracillima</i>	P3	Grey or orange sandy soils in seasonally wet areas.	Likely
<i>Lasiopetalum membranaceum</i>	P3	Occurs in sand over limestone.	Unlikely
<i>Loxocarya magna</i>	P3	Occurs in seasonally inundated or damp habitats in sand, loam, clay and ironstone.	Unlikely
<i>Schoenus pennisetis</i>	P3	Occurs in swamps and winter-wet depressions in grey or peaty sand and sandy clay.	Likely
<i>Synaphea petiolaris</i> subsp. <i>simplex</i>	P3	Occurs on flats and wetland areas with moist grey soils.	Possible
<i>Verticordia attenuata</i>	P3	Occurs in winter-wet depressions on white or grey sands.	Likely
<i>Acacia flagelliformis</i>	P4	Occurs in winter-wet areas in sandy soils.	Possible
<i>Acacia semitrullata</i>	P4	Occurs in sandplains and swampy areas, in white- grey sand, sometimes over laterite and clay.	Possible
<i>Aponogeton hexatepalus</i>	P4	Occurs in freshwater ponds, rivers and claypans.	Unlikely
<i>Banksia meisneri</i> subsp. <i>ascendens</i>	P4	Occurs in swampy flats in white or grey sand.	Possible
<i>Calothamnus quadrifidus</i> subsp. <i>teretifolius</i>	P4	Wetlands and open plains and flats. Grey sands and red-brown clays.	Likely
<i>Chamaelaucium erythrochlorum</i>	P4	Occurs on slopes. White sands and clayey sands, sandy loams	Unlikely
<i>Eucalyptus rudis</i> subsp. <i>cratyantha</i>	P4	Occurs on flats and hillsides in loam.	Likely
<i>Ornduffia submersa</i>	P4	Occurs in wetlands and seasonally wet areas. Wet black sands, brown sandy loams	Unlikely
<i>Schoenus natans</i>	P4	Occurs winter-wet depressions. Brown sandy-clays, peaty clays.	Unlikely
<i>Stylidium longitubum</i>	P4	Occurs in seasonal wetlands, with sandy clay or clay.	Unlikely
<i>Stylidium striatum</i>	P4	Jarrah/Marri forest and Wandoo woodlands, hillslopes. Brown clay-loam over laterite.	Unlikely

3.1.4 TECs listed under Commonwealth and State Legislation

There were five EPBC listed TECs known to occur from a 10 km radius of the study area:

- Banksia Woodlands of the Swan Coastal Plain' - listed as Endangered;
- Shrublands on southern Swan Coastal Plain ironstones - listed as Endangered;
- Clay Pans of the Swan Coastal Plain - listed as Critically Endangered;
- Subtropical and Temperate Coastal Saltmarsh - listed as Vulnerable; and
- Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain - listed as Critically Endangered.

The following three State listed TECs were known to occur within a 10 km radius of the study area:

- Swan Coastal Plain (SCP) 1b - Southern *Eucalyptus (Corymbia) calophylla* woodlands on heavy soils of the southern Swan Coastal Plain - listed as Vulnerable;
- SCP10a - Shrublands on dry clay flats - listed as Endangered; and
- SCP10b - Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) - listed as Critically Endangered.

3.1.5 PECs listed by DBCA

The following two State listed PECs were known to occur within a 10 km radius of the study area:

- *Eucalyptus cornuta*, *Agonis flexuosa* and *Eucalyptus decipiens* forest on deep yellowbrown siliceous sands over limestone ('Busselton Yate community') - Priority 1;
- Quindalup *Eucalyptus gomphocephala* and / or *Agonis flexuosa* woodlands ('floristic community type 30b') - Priority 3(i); and
- Southern *Banksia attenuata* woodlands ('community type 21b') - Priority 3(i).

3.2 Flora Species

A total number of 86 plant taxa (including varieties and subspecies) from 24 families and 58 genera were recorded from the study area (Table 6, Appendix 5). This total included plant taxa recorded from the 15 formal study sites as well as opportunistic records made from throughout the study area. Species representation was greatest among the Myrtaceae (20 taxa), Poaceae (11 taxa), Proteaceae (9 taxa), Fabaceae (8 taxa), Asteraceae (7 taxa), Cyperaceae (6 taxa) and Iridaceae (5 taxa) families (Table 6). The most speciose genera were *Eucalyptus* (11 taxa), *Melaleuca* (5 taxa), *Banksia* (4 taxa) and *Hakea* (3 taxa).

A species by site matrix and raw data for the 15 study sites is presented in Appendices 6 and 7 respectively. The species accumulation curve demonstrates that the study area was adequately sampled, with the curve reaching an asymptote (Figure 2).

Table 6 Statistics for total flora recorded from the study area.

Overview	No. Taxa
Families	24
Genera	58
Taxa (species, subspecies, varieties)	86
Native Taxa	49
Introduced Taxa	37
Threatened Flora	0
Priority Flora	0
Range Extensions	0
Species of Interest	0
Speciose Families	No. Taxa
Myrtaceae	20
Poaceae	11
Proteaceae	9
Fabaceae	8
Asteraceae	7
Asteraceae	7
Cyperaceae	6
Iridaceae	5
Speciose Genera	No. Taxa
<i>Eucalyptus</i>	11
<i>Melaleuca</i>	5
<i>Banksia</i>	4
<i>Hakea</i>	3

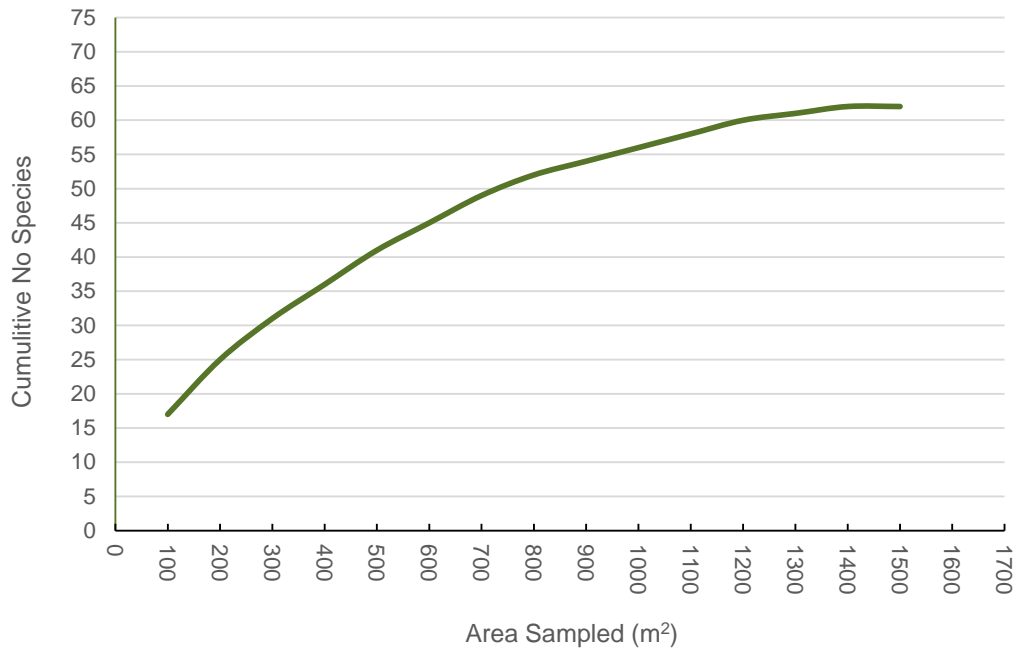


Figure 2 Species accumulation curve for the 15 study sites formally assessed within the study area.

3.3 Conservation Significant Flora Species

3.3.1 *Threatened Flora listed under the WC Act and EPBC Act*

None of the plant taxa recorded from the study area were gazetted as Threatened Flora (T) under the EPBC Act or the BC Act.

3.3.2 *Priority Flora*

None of the plant taxa recorded from the study area are listed as Priority flora by the DBCA.

3.3.3 *Range Extensions*

None of the plant taxa recorded from the study area are considered to be natural range extensions. It is noted that a number of tree species within the shelterbelts were sourced from nurseries and introduced to the site as seedling trees.

3.4 Introduced Flora

A total of 37 introduced plant species were recorded from the study area (Appendix 5), of which two species were listed as Declared Pests under the BAM Act:

- **Asparagus asparagoides* (Bridal Creeper) - s22(2); and
- **Zantedeschia aethiopica* (Arum Lily) - s22(2).

The diversity of weeds within the study area is relatively high and reflects the large areas of cleared agricultural land, long farming history of the site, and heavily disturbed nature of the remnant native vegetation.

3.5 Vegetation

Native vegetation within the study area was described as five vegetation types (Table 7, Figure 3), noting heavy disturbance and significant alteration of vegetation structure and reduced native composition throughout. Vegetation types were defined primarily by the upper strata (tree and tall shrub layers), with the understorey either completely removed or significantly altered by clearing, prolonged grazing and/or other disturbances. Introduced weed species including annual and perennial grasses and woody weeds formed the dominant ground cover for all five vegetation types described. The significant alteration to all five vegetation types consistently within the study area contributed to the degraded or completely degraded vegetation condition rating.

None of the vegetation types described and mapped from the study area were found to be aligned with any Commonwealth or State listed TECs or State listed PECs from the Swan Coastal Plain.

Table 7 Vegetation types mapped within the study area.

Code	Broad Floristic Formation	Description	Condition
Bi(Ba) KgKs(Ba) MtHa	<i>Banksia</i> Open Low Woodland A	Open Low Woodland A of <i>Banksia ilicifolia</i> (<i>Banksia attenuata</i>) over Open Scrub of <i>Kunzea glabrescens</i> and <i>Kunzea spathulata</i> (<i>Banksia attenuata</i>) over Scattered Low Shrubs of <i>Melaleuca thymoides</i> and <i>Hypocalymma angustifolium</i> over Dense Tall Grass of <i>*Ehrharta calycina</i> and <i>*Ehrharta longiflora</i> on grey sand on sandplain	Completely Degraded
CcAf Af	<i>Corymbia</i> Forest	Forest of <i>Corymbia calophylla</i> and <i>Agonis flexuosa</i> over Open Low Woodland B of <i>Agonis flexuosa</i> over Dense Low Grass of <i>*Ehrharta longiflora</i> and <i>*Cynodon dactylon</i> on grey sand on low sandy rises	Completely Degraded
Cc Ka	<i>Corymbia</i> Forest	Forest (to Open Woodland) of <i>Corymbia calophylla</i> over Open Scrub of <i>Kingia australis</i> , <i>Xylomelum occidentale</i> and <i>Nuytsia floribunda</i> (<i>Xanthorrhoea preissii</i>) over Dense Tall Grass of <i>*Ehrharta longiflora</i> , <i>*Cynodon dactylon</i> , <i>*Eragrostis curvula</i> and <i>*Lolium perenne</i> on grey sand on floodplains	Degraded to Completely Degraded
Mp	<i>Melaleuca</i> Low Forest A	Low Forest A of <i>Melaleuca preissiana</i> (<i>Corymbia calophylla</i>) over Dense Tall Grass of <i>*Ehrharta longiflora</i> , <i>*Lolium perenne</i> , <i>*Ehrharta calycina</i> and <i>*Cynodon dactylon</i> on grey sand of floodplains and drainage depressions	Completely Degraded
Er MpMr	<i>Eucalyptus</i> Woodland	Woodland of <i>Eucalyptus rudis</i> subsp. <i>rudis</i> over Low Woodland B of <i>Melaleuca preissiana</i> and/or <i>Melaleuca raphiophylla</i> over Dense Low Grass of <i>*Lolium perenne</i> and <i>*Ehrharta longiflora</i> on grey sand in drainage lines and depressions	Completely Degraded

3.6 Vegetation Condition

The majority of the study area has been historically cleared of native vegetation and replaced with introduced annual pasture grasses to support primarily dairy cows. Shelterbelt trees comprising species that were largely outside their normal range of occurrence have been strategically planted in rows along paddock boundaries.

Remnant native vegetation is restricted to narrow road reserves and localised groves of parkland cleared taller trees primarily along the major flow lines. All areas of remnant native vegetation shows evidence of prolonged multiple disturbances that have significantly altered vegetation structure and reduced species diversity. Vegetation across the entire study area was primarily rated as *completely degraded*, with localised areas rated as *degraded* (Figure 4).

Code	Bi(Ba) KgKs(Ba) MtHa
Broad Floristic Formation	<i>Banksia</i> Open Low Woodland A
Vegetation Type	Open Low Woodland A of <i>Banksia ilicifolia</i> (<i>Banksia attenuata</i>) over Open Scrub of <i>Kunzea glabrescens</i> and <i>Kunzea spathulata</i> (<i>Banksia attenuata</i>) over Scattered Low Shrubs of <i>Melaleuca thymoides</i> and <i>Hypocalymma angustifolium</i> over Dense Tall Grass of <i>*Ehrharta calycina</i> and <i>*Ehrharta longiflora</i> on grey sand on sandy flats



Quadrats Sampled	WN-05
Soils	Grey sand
Land Form	Sandy flats
Priority Ecological Community	No
Conservation Significant Flora	None
Introduced Species	<i>*Arctotheca calendula</i> , <i>*Asparagus asparagoides</i> , <i>*Cotula turbinata</i> , <i>*Crassula glomerata</i> , <i>*Cynodon dactylon</i> , <i>*Ehrharta calycina</i> , <i>*Ehrharta longiflora</i> , <i>*Eragrostis curvula</i> , <i>*Freesia alba x leichtlinii</i> , <i>*Gladiolus undulatus</i> , <i>*Hypochaeris glabra</i> , <i>*Lotus subbiflorus</i> , <i>*Romulea rosea</i> , <i>*Zantedeschia aethiopica</i>
Vegetation Condition	Completely Degraded
Disturbances	Clearing for agriculture, grazing by domestic stock, road reserve
Average Fire Age	Old (6+ years)
Vegetation Structure & Floristics	
Trees 5-15 m	<i>Banksia ilicifolia</i> (<i>Banksia attenuata</i>)
Tall Shrubs >2 m	<i>Kunzea glabrescens</i> , <i>Kunzea spathulata</i> (<i>Banksia attenuata</i>)
Low Shrubs 0.5-1 m	<i>Melaleuca thymoides</i> , <i>Hypocalymma angustifolium</i>
Tall Grass <1 m	<i>*Ehrharta calycina</i> , <i>*Ehrharta longiflora</i> , <i>*Cynodon dactylon</i>
Low Sedges <0.5 m	<i>Lyginea imberbis</i>
Herbs	<i>*Gladiolus undulatus</i>

Code	CcAf Af
Broad Floristic Formation	<i>Corymbia</i> Forest
Vegetation Type	Forest of <i>Corymbia calophylla</i> and <i>Agonis flexuosa</i> over Open Low Woodland B of <i>Agonis flexuosa</i> over Dense Low Grass of * <i>Ehrharta longiflora</i> and * <i>Cynodon dactylon</i> on grey sand on low sandy flats



Quadrats Sampled	WN-12, WN-13
Soils	Grey sand
Land Form	Sandy flats
Priority Ecological Community	No
Conservation Significant Flora	None
Introduced Species	* <i>Briza maxima</i> , * <i>Cynodon dactylon</i> , * <i>Ehrharta longiflora</i> , * <i>Eragrostis curvula</i> , * <i>Freesia alba x leichtlinii</i> , * <i>Gladious undulatus</i> , * <i>Rumex crispus</i> , * <i>Sonchus asper</i> , * <i>Zantedeschia aethiopica</i>
Vegetation Condition	Degraded to Completely Degraded
Disturbances	Clearing for agriculture, grazing by domestic stock, road reserve
Average Fire Age	Old (6+ years)
Vegetation Structure & Floristics	
Trees >15 m	<i>Corymbia calophylla</i> , <i>Agonis flexuosa</i>
Trees <5 m	<i>Agonis flexuosa</i>
Low Shrubs 0.5-1 m	<i>Gastrolobium praemorsum</i>
Low Grass <0.5 m	* <i>Ehrharta longiflora</i> , * <i>Cynodon dactylon</i> , * <i>Eragrostis curvula</i> , * <i>Briza maxima</i>
Herbs	* <i>Freesia alba x leichtlinii</i>

Code	Cc Ka
Broad Floristic Formation	<i>Corymbia</i> Forest
Vegetation Type	Forest (to Open Woodland) of <i>Corymbia calophylla</i> over Open Scrub of <i>Kingia australis</i> , <i>Xylomelum occidentale</i> and <i>Nuytsia floribunda</i> (<i>Xanthorrhoea preissii</i>) over Dense Tall Grass of <i>*Ehrharta longiflora</i> , <i>*Cynodon dactylon</i> , <i>*Eragrostis curvula</i> and <i>*Lolium perenne</i> on grey sand on floodplains



Quadrats Sampled	WN-01, WN-02, WN-06, WN-07, WN-08, WN-14
Soils	Grey sand
Land Form	Floodplains
Priority Ecological Community	No
Conservation Significant Flora	None
Introduced Species	<i>*Arctotheca calendula</i> , <i>*Asparagus asparagoides</i> , <i>*Briza maxima</i> , <i>*Cynodon dactylon</i> , <i>*Ehrharta calycina</i> , <i>*Ehrharta longiflora</i> , <i>*Eragrostis curvula</i> , <i>*Euphorbia helioscopia</i> , <i>*Ferraria crispa</i> , <i>*Freesia alba x leichtlinii</i> , <i>*Gladiolus undulatus</i> , <i>*Hypochaeris glabra</i> , <i>*Lolium perenne</i> , <i>*Lotus subbiflorus</i> , <i>*Lysimachia arvensis</i> , <i>*Romulea rosea</i> , <i>*Rumex acetosella</i> , <i>*Rumex crispus</i> , <i>*Solanum nigrum</i> , <i>*Sonchus asper</i> , <i>*Sonchus oleraceus</i> , <i>*Trifolium fragiferum</i> , <i>*Vicia sativa</i> , <i>*Watsonia meriana var. bulbifera</i> , <i>*Zantedeschia aethiopica</i>
Vegetation Condition	Degraded to Completely Degraded
Disturbances	Clearing, grazing by domestic stock, road reserve
Average Fire Age	Old (6+ years)

Vegetation Structure & Floristics	
Trees >15 m	<i>Corymbia calophylla</i>
Tall Shrubs >2 m	<i>Kingia australis</i> , <i>Xylomelum occidentale</i> , <i>Nuytsia floribunda</i>
Shrubs 1-2 m	<i>Xanthorrhoea preissii</i> , <i>Hakea sulcata</i>
Tall Grass >0.5 m	<i>*Ehrharta longiflora</i> , <i>*Cynodon dactylon</i> , <i>*Eragrostis curvula</i> , <i>*Lolium perenne</i>
Sedges <0.5 m	<i>Cyathochaeta avenacea</i> , <i>Hypolaena exsulca</i> , <i>Hypolaena caespitosa</i>
Herbs	<i>*Freesia alba x leichtlinii</i> , <i>*Lotus subbiflorus</i> , <i>*Romulea rosea</i>

Code	Mp
Broad Floristic Formation	<i>Melaleuca</i> Low Forest A
Vegetation Type	Low Forest A of <i>Melaleuca preissiana</i> (<i>Corymbia calophylla</i>) over Dense Tall Grass of <i>*Ehrharta longiflora</i> , <i>*Lolium perenne</i> , <i>*Ehrharta calycina</i> and <i>*Cynodon dactylon</i> on grey sand of floodplains and drainage depressions
	
Quadrats Sampled	WN-03, WN-04, WN-09, WN-10
Soils	Grey sand
Land Form	Floodplains and drainage depressions
Priority Ecological Community	No
Conservation Significant Flora	None
Introduced Species	<i>*Anthoxanthum odoratum</i> , <i>*Arctotheca calendula</i> , <i>*Asparagus asparagoides</i> , <i>*Briza maxima</i> , <i>*Cenchrus clandestinus</i> , <i>*Cotula coronopifolia</i> , <i>*Cynodon dactylon</i> , <i>*Ehrharta calycina</i> , <i>*Ehrharta longiflora</i> , <i>*Freesia alba × leichtlinii</i> , <i>*Gladiolus undulatus</i> , <i>*Hypochaeris glabra</i> , <i>*Lolium perenne</i> , <i>*Lotus subbiflorus</i> , <i>*Lythrum hyssopifolia</i> , <i>*Romulea rosea</i> , <i>*Rumex acetosella</i> , <i>*Solanum nigrum</i> , <i>*Sonchus asper</i> , <i>*Vicia sativa</i> , <i>*Zantedeschia aethiopica</i>
Vegetation Condition	Completely Degraded
Disturbances	Clearing, grazing by domestic stock, road reserve
Average Fire Age	Old (6+ years)
Vegetation Structure & Floristics	
Trees 5-15 m	<i>Melaleuca preissiana</i> , <i>Corymbia calophylla</i>
Tall Shrubs >2 m	<i>Kunzea glabrescens</i> , <i>Melaleuca viminea</i>
Tall Grass >0.5 m	<i>*Ehrharta longiflora</i> , <i>*Lolium perenne</i> , <i>*Ehrharta calycina</i> , <i>*Cynodon dactylon</i> , <i>*Cenchrus clandestinus</i> , <i>*Lolium perenne</i>
Herbs	<i>*Freesia alba × leichtlinii</i> , <i>*Asparagus asparagoides</i> , <i>*Lotus subbiflorus</i>

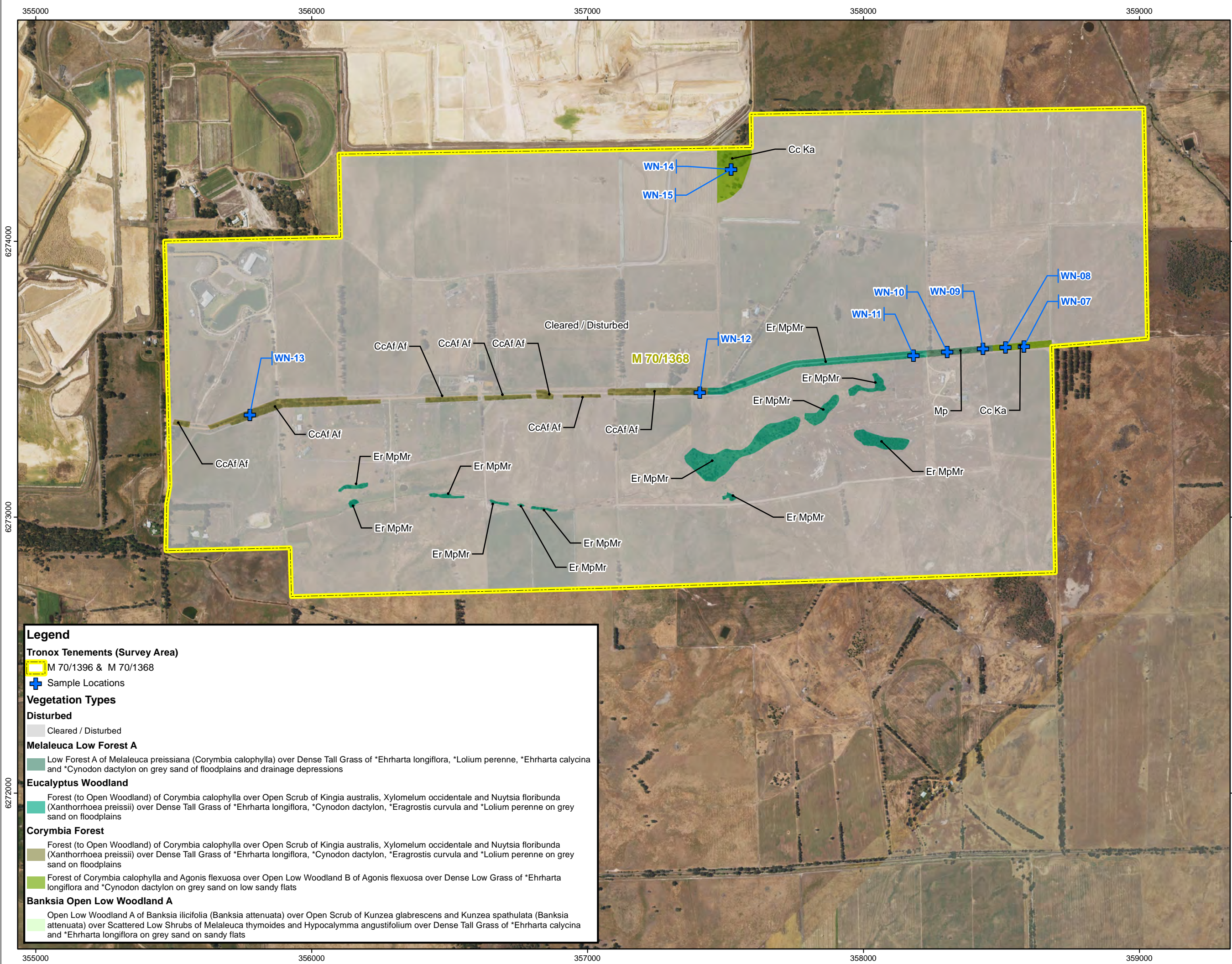
Code	Er MpMr
Broad Floristic Formation	<i>Eucalyptus</i> Woodland
Vegetation Type	Woodland of <i>Eucalyptus rudis</i> subsp. <i>rudis</i> over Low Woodland B of <i>Melaleuca preissiana</i> and/or <i>Melaleuca raphiophylla</i> over Dense Low Grass of <i>*Lolium perenne</i> and <i>*Ehrharta longiflora</i> on grey sand in drainage lines and depressions



Quadrats Sampled	WN-11, WN-15
Soils	Grey sand
Land Form	Drainage lines and depressions
Priority Ecological Community	No
Conservation Significant Flora	None
Introduced Species	<i>*Arctotheca calendula</i> , <i>*Cynodon dactylon</i> , <i>*Ehrharta calycina</i> , <i>*Ehrharta longiflora</i> , <i>*Freesia alba x leichtlinii</i> , <i>*Lolium perenne</i> , <i>*Lotus subbiflorus</i> , <i>*Rumex crispus</i> , <i>*Solanum nigrum</i> , <i>*Zantedeschia aethiopica</i>
Vegetation Condition	Completely Degraded
Disturbances	Clearing, grazing by domestic stock, road reserve
Average Fire Age	Old (6+ years)
Vegetation Structure & Floristics	
Trees 15-30 m	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>
Trees <5 m	<i>Melaleuca preissiana</i> , <i>Melaleuca raphiophylla</i>
Low Grass <0.5 m	<i>*Lolium perenne</i> , <i>*Ehrharta longiflora</i> , <i>*Cynodon dactylon</i>
Herbs	<i>*Arctotheca caledula</i>

TRONOX

FIGURE 4
Vegetation Types
M 70/1368



Legend

Tronox Tenements (Survey Area)

- M 70/1396 & M 70/1368
- Sample Locations

Vegetation Types

Disturbed

- Cleared / Disturbed

Melaleuca Low Forest A

- Low Forest A of Melaleuca preissiana (Corymbia calophylla) over Dense Tall Grass of *Ehrharta longiflora, *Lolium perenne, *Ehrharta calycina and *Cynodon dactylon on grey sand of floodplains and drainage depressions

Eucalyptus Woodland

- Forest (to Open Woodland) of Corymbia calophylla over Open Scrub of Kingia australis, Xylomelum occidentale and Nuytsia floribunda (Xanthorrhoea preissii) over Dense Tall Grass of *Ehrharta longiflora, *Cynodon dactylon, *Eragrostis curvula and *Lolium perenne on grey sand on floodplains

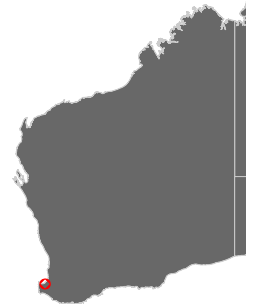
Corymbia Forest

- Forest (to Open Woodland) of Corymbia calophylla over Open Scrub of Kingia australis, Xylomelum occidentale and Nuytsia floribunda (Xanthorrhoea preissii) over Dense Tall Grass of *Ehrharta longiflora, *Cynodon dactylon, *Eragrostis curvula and *Lolium perenne on grey sand on floodplains
- Forest of Corymbia calophylla and Agonis flexuosa over Open Low Woodland B of Agonis flexuosa over Dense Low Grass of *Ehrharta longiflora and *Cynodon dactylon on grey sand on low sandy flats

Banksia Open Low Woodland A

- Open Low Woodland A of Banksia ilicifolia (Banksia attenuata) over Open Scrub of Kunzea glabrescens and Kunzea spathulata (Banksia attenuata) over Scattered Low Shrubs of Melaleuca thymoides and Hypocalymma angustifolium over Dense Tall Grass of *Ehrharta calycina and *Ehrharta longiflora on grey sand on sandy flats

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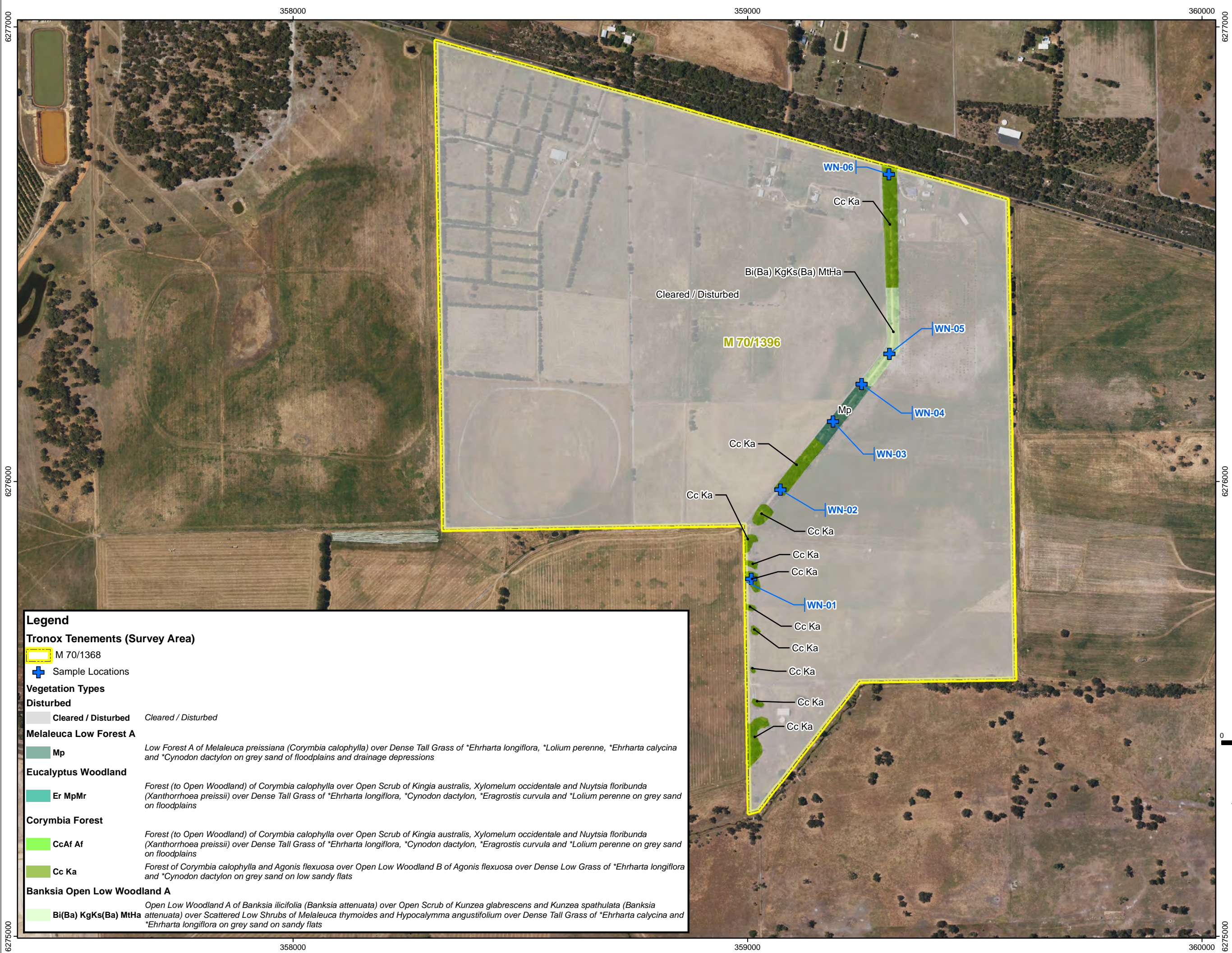
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TRONOX

FIGURE 4

Vegetation Types

M 70/1396



Legend

Tronox Tenements (Survey Area)

- M 70/1368
- Sample Locations

Vegetation Types

Disturbed

- Cleared / Disturbed

Melaleuca Low Forest A

- Mp
*Low Forest A of Melaleuca preissiana (Corymbia calophylla) over Dense Tall Grass of *Ehrharta longiflora, *Lolium perenne, *Ehrharta calycina and *Cynodon dactylon on grey sand of floodplains and drainage depressions*

Eucalyptus Woodland

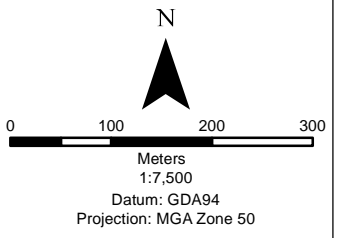
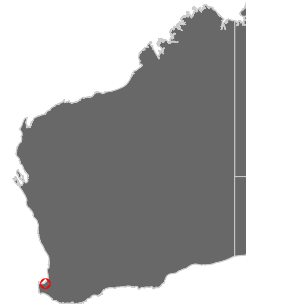
- Er MpMr
*Forest (to Open Woodland) of Corymbia calophylla over Open Scrub of Kingia australis, Xylomelum occidentale and Nuytsia floribunda (Xanthorrhoea preissii) over Dense Tall Grass of *Ehrharta longiflora, *Cynodon dactylon, *Eragrostis curvula and *Lolium perenne on grey sand on floodplains*

Corymbia Forest

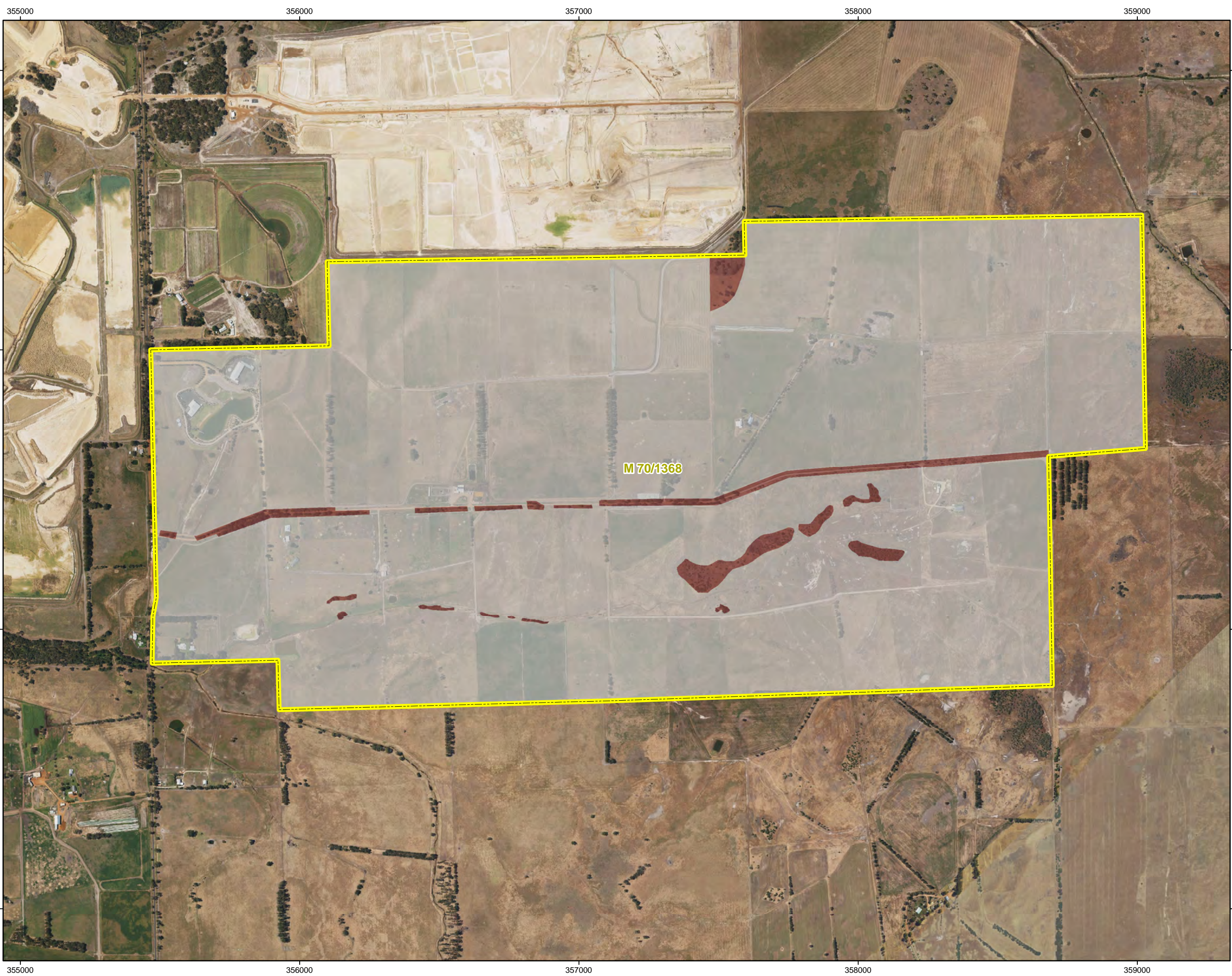
- CcAf Af
*Forest (to Open Woodland) of Corymbia calophylla over Open Scrub of Kingia australis, Xylomelum occidentale and Nuytsia floribunda (Xanthorrhoea preissii) over Dense Tall Grass of *Ehrharta longiflora, *Cynodon dactylon, *Eragrostis curvula and *Lolium perenne on grey sand on floodplains*
- Cc Ka
*Forest of Corymbia calophylla and Agonis flexuosa over Open Low Woodland B of Agonis flexuosa over Dense Low Grass of *Ehrharta longiflora and *Cynodon dactylon on grey sand on low sandy flats*

Banksia Open Low Woodland A

- Bi(Ba) KgKs(Ba) MtHa
*Open Low Woodland A of Banksia ilicifolia (Banksia attenuata) over Open Scrub of Kunzea glabrescens and Kunzea spathulata (Banksia attenuata) over Scattered Low Shrubs of Melaleuca thymoides and Hypocalymma angustifolium over Dense Tall Grass of *Ehrharta calycina and *Ehrharta longiflora on grey sand on sandy flats*



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TRONOX

FIGURE 5

Vegetation Condition

M 70/1368

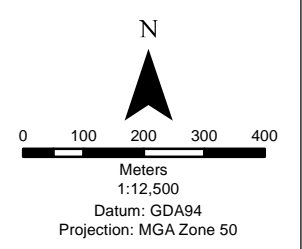
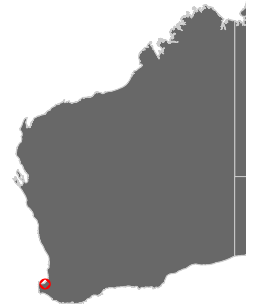
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Tronox Tenements (Study Area)

M 70/1396 & M 70/1368

Vegetation Condition

- Cleared / Completely Degraded
- Degraded to Completely Degraded



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TRONOX

FIGURE 5

Vegetation Condition

M 70/1396

Legend

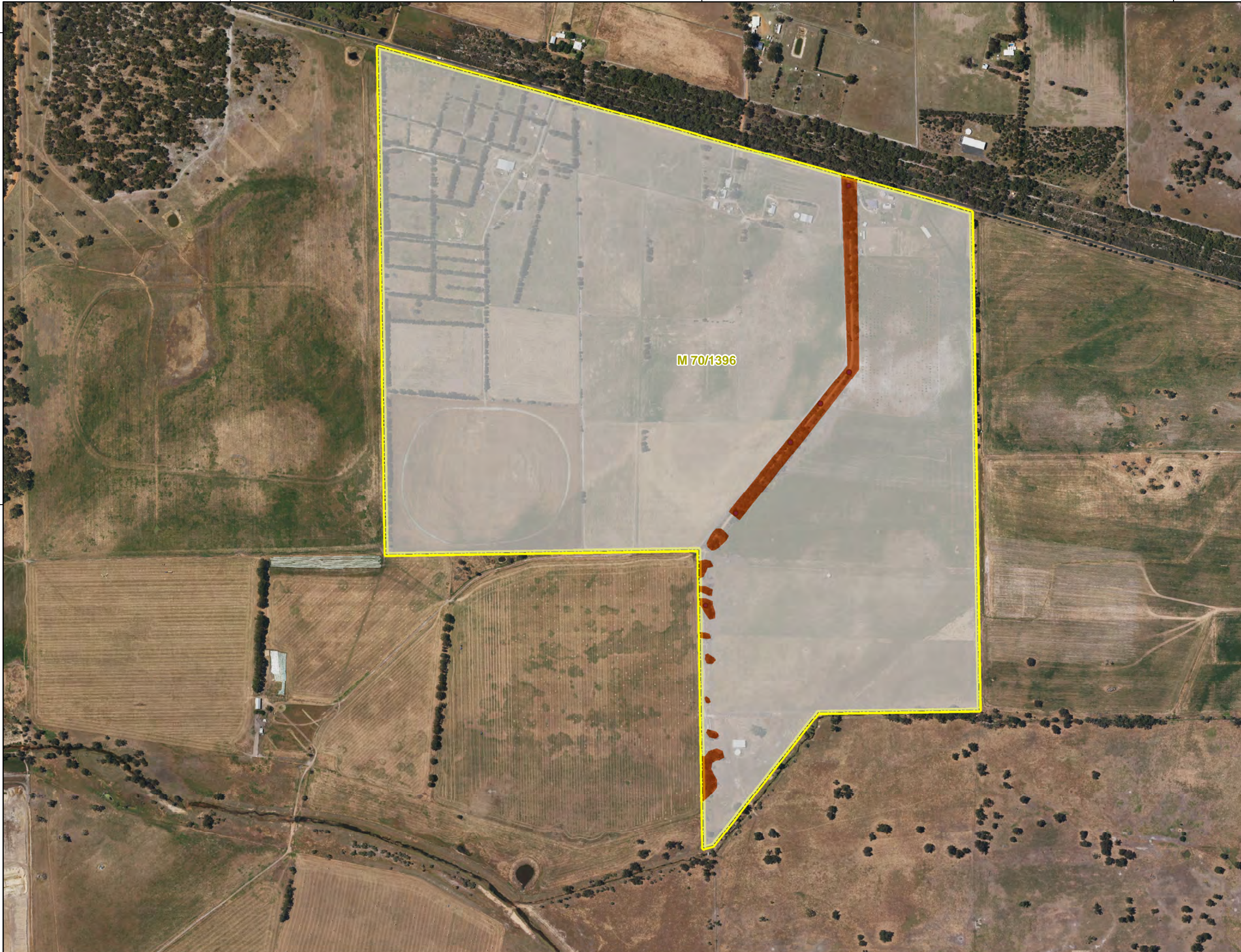
Tronox Tenements (Study Area)

M 70/1368

Vegetation Condition

Cleared / Completely Degraded

Degraded to Completely Degraded



N



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3.7 Representation & Reservation of Vegetation

3.7.1 Beard (1981) Vegetation Associations

The study area occurs in the Drummond Subdistrict of the Darling Botanical District, in the South-West Botanical Province (Beard 1981). It lies within the Bassendean Dunes (Beard 1981) and at a scale of 1: 1,000,000 is mapped as the following two vegetation associations (Figure 5):

- 1136 - Medium woodland; marri with some jarrah, wandoo, river gum, and casuarina; and
- 973 - Low forest; paperbark (*Melaleuca raphiophylla*).

In terms of representation, the Western Australian Government is committed to the National Objectives Targets for Biodiversity Conservation which includes a target that prevents clearance of ecological communities with an extent below 30% of that present at pre-European settlement (Department of Natural Resources and Environment 2002, EPA 2000). When determining representation and reservation of vegetation, vegetation association 973 was determined to be well represented at the State level with 37% of the Pre-European extent remaining (Table 8). However, at the and bioregional (IBRA and IBRA subregion) and local government authority levels, approximately 16% of the Pre-European extent remains intact (Table 8). Vegetation association 1136 was determined to be poorly represented at all three levels, with less than 7% of the Pre-European extent remaining (Table 8).

In terms of reservation, there is a benchmark for a minimum of 15% of each Beard vegetation association to be protected in Class I-IV reserves (Commonwealth of Australia 1997). Both vegetation associations were determined to be poorly reserved at the statewide level, noting that a larger proportion of vegetation association 973 is currently protected within the reserve system in comparison to vegetation association 1136 (Table 8). Less than 2% of the current extent of vegetation association 1136 is formally reserved.

3.7.2 Matisse and Havel (1998) Vegetation Complexes

The pre-1750 distribution of vegetation complexes of the South West Forest Region of Western Australia has been mapped at 1:50,000 scale by Matisse and Havel (1998) as part of the biodiversity assessment for the comprehensive regional assessment for the South West Forest Region. Interrogation of this database confirmed there were three vegetation complexes (as described and mapped by Matisse and Havel 1998) intersecting the study area:

- AB (Abba) - flats & low rises of the Abba Plain, dominated by woodland and open forest of Marri (*Corymbia calophylla*);
- AF (Abba) - terraces and valley floors of the Abba Plain, dominated by marri-peppermint and a tall shrubland of myrtaceous-proteaceous species; and
- Aw - broad depressions of the Abba Plain, dominated by tall shrubland of *Melaleuca viminea* and woodland of flooded gum and paperbark (*Eucalyptus rudis* – *Melaleuca raphiophylla*) with the occasional marri.

All three of the Abba vegetation complexes currently have less than 2% of the pre-European extent remaining within the South West Forest Region, and none are formally protected for conservation (Table 8). On this basis vegetation is determined to be poorly represented and poorly reserved.

Table 8 Pre-European extent of vegetation represented on the basis of identified datasets.

Vegetation System / Association	Pre-European Extent (ha)	Current Extent (ha)	% Pre-European Extent Remaining	Current Extent in Class I-IV Reserves (ha)	% Current Extent in Class I-IV Reserves	Current Extent DBCA Managed Lands (ha)	% Current Extent DBCA Managed Lands
Statewide							
973 - Low forest; paperbark (<i>Melaleuca raphiophylla</i>)	5,003.27	1,895.60	37.89	249.17	13.14	250.22	13.20
1136 - Medium woodland; marri with some jarrah, wandoo, river gum and casuarina	48,124.57	3,345.50	6.95	45.88	1.37	128.83	3.85
Bioregional (IBRA)							
973 - Swan Coastal Plain	2,510.53	410.22	16.34	172.95	42.16	172.95	42.16
1136 - Swan Coastal Plain	48,118.01	3,341.18	6.94	45.88	1.37	128.83	3.86
Bioregional (IBRA sub-region)							
973 - SWA02 Perth	2,510.53	410.22	16.34	172.95	42.16	172.95	42.16
1136 - SWA02 Perth	48,118.01	3,341.18	6.94	45.88	1.37	128.83	3.86
Local Government Area							
973 - City of Busselton	2,534.27	415.78	16.41	175.52	42.22	175.52	42.22
1136 - City of Busselton	38,946.49	2,640.77	6.78	45.88	1.74	82.34	3.12
Mattiske & Havel Complexes							
AB (Abba) - flats & low rises of the Abba Plain, dominated by woodland and open forest of Marri (<i>Corymbia calophylla</i>)	7,971	134	1.68	0.00	0.00	0.00	0.00
AF (Abba) - terraces & valley floors of the Abba Plain, dominated by marri-peppermint and a tall shrubland of myrtaceous-proteaceous species	1,901	8	0.42	0.00	0.00	0.00	0.00
Aw – broad depressions of the Abba Plain, dominated by tall shrubland of <i>Melaleuca viminea</i> and woodland of flooded gum and paperbark (<i>Eucalyptus rudis</i> – <i>Melaleuca raphiophylla</i>) with the occasional marri	9,111	140	1.54	0.00	0.00	0.00	0.00

TRONOX

FIGURE 6
Beard (1981)
vegetation complexes
within the study area

M 70/1396 & M 70/1368

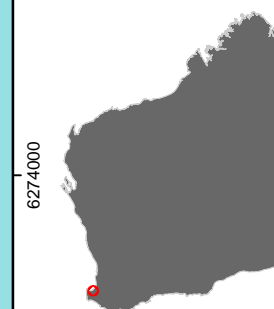
Legend

Tronox Tenements (Study Area)

M 70/1396 & M 70/1368

Pre-European Vegetation (Beard 1975)

- BASSENDEAN, 1000
- BASSENDEAN, 1136
- BASSENDEAN, 4
- BASSENDEAN, 949
- BASSENDEAN, 973
- BASSENDEAN, 990
- PINJARRA, 1136
- SPEARWOOD, 1000
- SPEARWOOD, 2

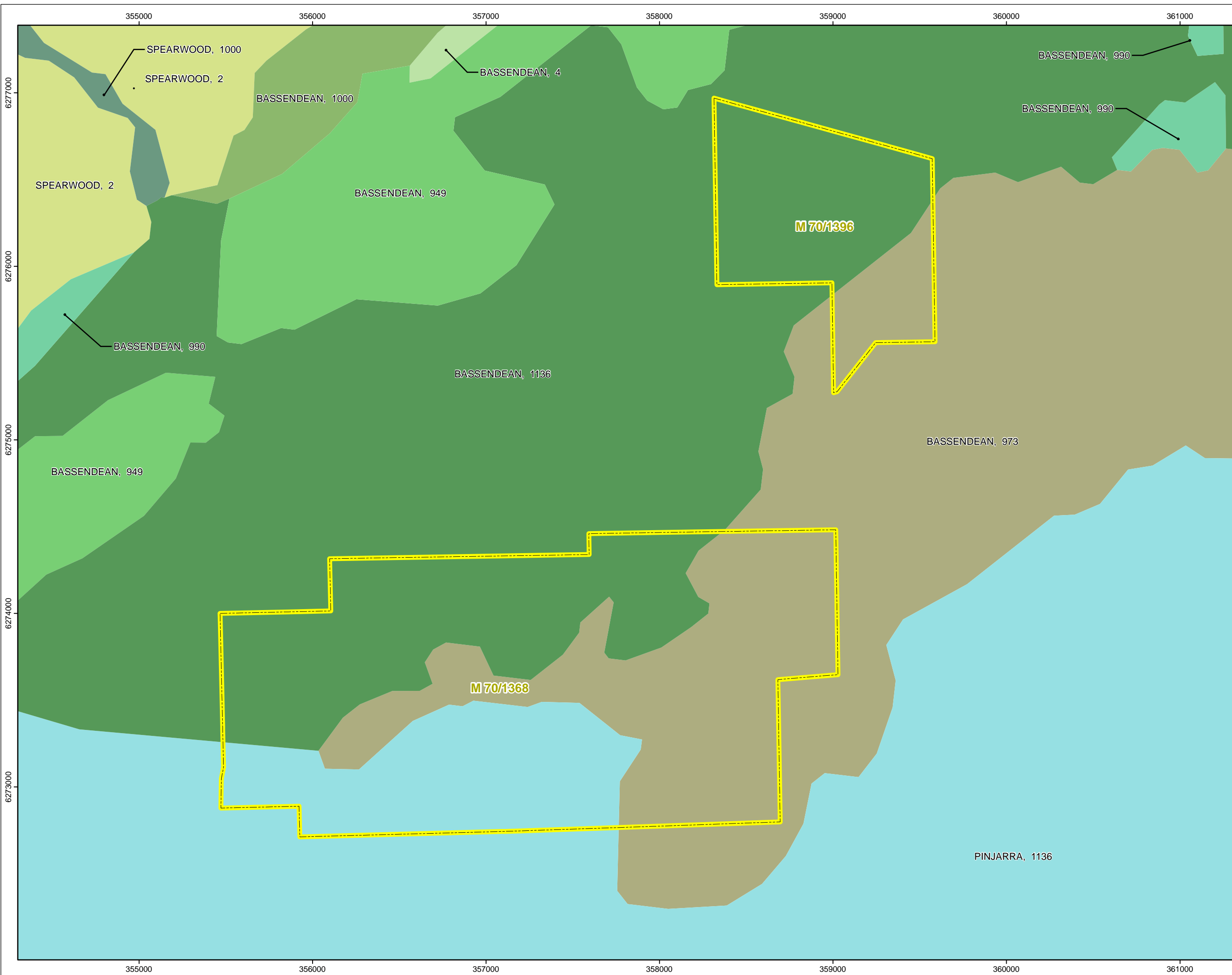


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3.8 Conservation Significance of Vegetation

3.8.1 National Significance

None of the vegetation types recorded from the study area support Threatened Flora listed under the EPBC Act, or are aligned with any Commonwealth listed TECs. Therefore, vegetation within the study area was not considered to be of national conservation significance.

3.8.2 State Significance

None of the vegetation types recorded from the study area support Threatened Flora listed under the BC Act or are aligned with any state listed TECs. Similarly none of the vegetation associations were determined to be aligned with known PECs, noting vegetation condition was rated as *degraded* to *completely degraded* across the entire study area. Therefore, vegetation within the study area was not considered to be of state conservation significance.

3.8.3 Local Significance

None of the vegetation types recorded from the study area supported plant taxa considered to represent a range extension or potential new species and hence, were determined not to be of local conservation significance.

4.0 SUMMARY

The field survey was completed by Principal Botanist Dr Darren Brearley under very good seasonal conditions in mid September (Spring) 2021. A total number of 86 plant taxa (including varieties and subspecies) from 24 families and 58 genera was recorded from the study area. The dominant families were Myrtaceae, Poaceae, Proteaceae, Fabaceae, Asteraceae, Cyperaceae and Iridaceae, and the most speciose genera were *Eucalyptus*, *Melaleuca*, *Banksia* and *Hakea*.

None of the plant taxa recorded from the study area were determined to be Threatened Flora (T) under the EPBC Act or the BC Act, Priority flora as listed by the DBCA, or represent range extensions or potentially new taxa. The total flora included 37 introduced species, of which two taxa were listed as Declared Plants under the BAM Act; *Asparagus asparagoides* (Bridal Creeper) - s22(2) and *Zantedeschia aethiopica* (Arum Lily) - s22(2).

Native vegetation within the study area was described and mapped as five vegetation types. Field assessment confirmed that vegetation was not aligned with any Commonwealth or State listed TECs or State listed PECs. Vegetation types were defined primarily by the upper strata (tree and tall shrub layers), with the understorey either completely removed or significantly altered by clearing, prolonged grazing and/or other disturbances. Introduced weed species including annual and perennial grasses and woody weeds formed the dominant ground cover for all five vegetation types described. The significant alteration to all five vegetation types consistently within the study area contributed to the degraded or completely degraded vegetation condition rating.

The Pre-European vegetation complexes that occurred on the Abba Plains that form the study area were determined to be poorly represented and poorly reserved due to extensive clearing of private land for dairy farming. The conservation significance of the remaining *in situ* remnant native vegetation within the study area has been significantly reduced by multiple and extensive disturbances over an extended period. Native remnants are highly fragmented and retained groves of native vegetation persist in a degraded and completely degraded condition.

5.0 STUDY TEAM

The single season detailed flora and vegetation survey was planned, co-ordinated and executed by the following personnel:

Onshore Environmental Consultants P/L

ABN 41 095 837 120

PO Box 227

YALLINGUP WA 6282

pf 08 9756 6206 m 0427 339 842

Email: info@onshoreenvironmental.com.au

Project Staff

Dr Darren Brearley

PhD Principal Botanist

Mr Todd Griffin

BSc GIS and Mapping Specialist

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APPENDIX 1

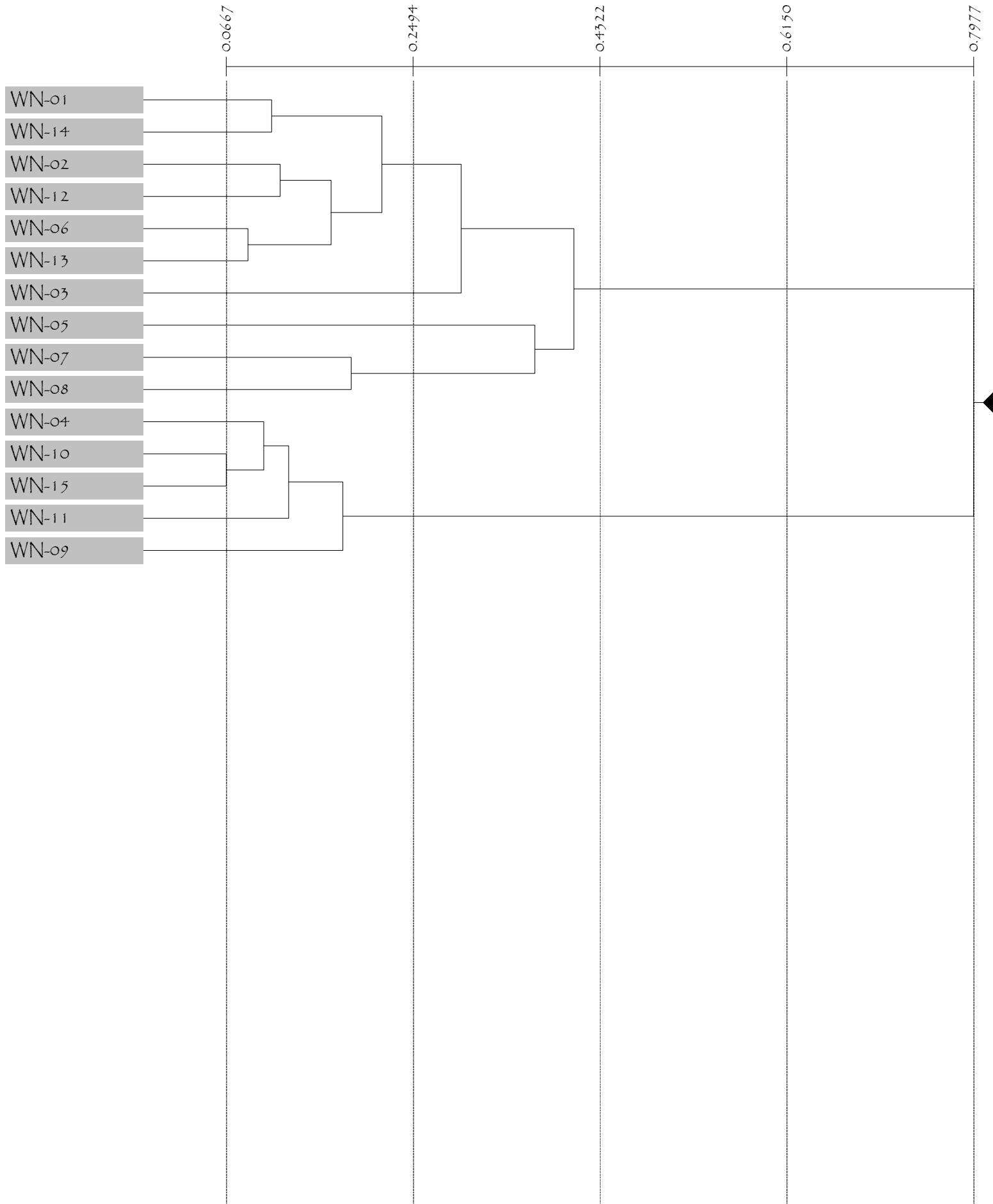
Vegetation condition scale
(as developed by Keighery 1994)

Condition	Scale	Description
Pristine	1	Pristine or nearly so, no obvious signs of disturbance.
Excellent	2	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	3	Vegetation structure altered; obvious signs of disturbance.
Good	4	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
Degraded	5	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching Very Good condition without intensive management.
Completely Degraded	6	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

APPENDIX 2

Column Fusion Dendrogram
15 quadrats by 31 native plant taxa

Column Fusion Dendrogram



APPENDIX 3

Vegetation Classifications following Muir (1997)

LIFE FORM / HEIGHT	Canopy Cover			
	DENSE 70 % - 100%	MID DENSE 30% - 70%	SPARSE 10% - 30%	VERY SPARSE 2% - 10%
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 - 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 - 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass > 0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

APPENDIX 4

Conservation Codes

Conservation codes for Western Australian Flora and Fauna



Department of Biodiversity,
Conservation and Attractions

CONSERVATION CODES

For Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora¹ are species² which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the Biodiversity Conservation Act 2016.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened species

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR **Critically endangered species**

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN **Endangered species**

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU **Vulnerable species**

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

¹ The definition of flora includes algae, fungi and lichens

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

Conservation categories for flora described under the EPBC Act

Category	Description
Extinct (Ex)	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	A species is categorised as extinct in the wild if it is only known to survive in cultivations, in captivity, or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	The species is facing an extremely high risk of extinction in the wild and in the immediate future.
Endangered (EN)	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable (VU)	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent (CD)	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Conservation categories for species described under the IUCN

Category	Description
Extinct (Ex)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CE)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

APPENDIX 5

Total flora list from the study area

Family	Species
Anarthraceae	<i>Lyginia imberbis</i>
Araceae	* <i>Zantedeschia aethiopica</i>
Asparagaceae	* <i>Asparagus asparagoides</i>
Asparagaceae	<i>Lomandra sonderi</i>
Asteraceae	* <i>Arctotheca calendula</i>
Asteraceae	* <i>Cotula coronopifolia</i>
Asteraceae	* <i>Cotula turbinata</i>
Asteraceae	* <i>Dittrichia graveolens</i>
Asteraceae	* <i>Hypochaeris glabra</i>
Asteraceae	* <i>Sonchus asper</i>
Asteraceae	* <i>Sonchus oleraceus</i>
Casuarinaceae	<i>Casuarina obesa</i>
Crassulaceae	* <i>Crassula glomerata</i>
Cyperaceae	<i>Cyathochaeta avenacea</i>
Cyperaceae	<i>Cyathochaeta equitans</i>
Cyperaceae	<i>Isolepis marginata</i>
Cyperaceae	<i>Lepidosperma longitudinale</i>
Cyperaceae	<i>Lepidosperma squamatum</i>
Cyperaceae	<i>Mesomelaena tetragona</i>
Dasygogonaceae	<i>Kingia australis</i>
Droseraceae	<i>Drosera glanduligera</i>
Euphorbiaceae	* <i>Euphorbia helioscopia</i>
Fabaceae	* <i>Lotus subbiflorus</i>
Fabaceae	* <i>Trifolium fragiferum</i>
Fabaceae	* <i>Vicia sativa</i>
Fabaceae	<i>Acacia saligna</i>
Fabaceae	<i>Acacia stenoptera</i>
Fabaceae	<i>Daviesia preissii</i>
Fabaceae	<i>Gastrolobium praemorsum</i>
Fabaceae	<i>Hardenbergia comptoniana</i>
Iridaceae	* <i>Ferraria crispa</i>
Iridaceae	* <i>Freesia alba x leichtlinii</i>
Iridaceae	* <i>Gladiolus undulatus</i>
Iridaceae	* <i>Romulea rosea</i>
Iridaceae	* <i>Watsonia meriana</i> var. <i>bulbillifera</i>
Juncaceae	<i>Juncus pallidus</i>
Loranthaceae	<i>Nuytsia floribunda</i>
Lythraceae	* <i>Lythrum hyssopifolia</i>
Myrtaceae	* <i>Eucalyptus globulus</i>
Myrtaceae	* <i>Eucalyptus grandis</i>
Myrtaceae	* <i>Eucalyptus leucoxydon</i>
Myrtaceae	<i>Agonis flexuosa</i> var. <i>flexuosa</i>
Myrtaceae	<i>Corymbia calophylla</i>
Myrtaceae	<i>Eucalyptus camaldulensis</i>
Myrtaceae	<i>Eucalyptus diversicolor</i>
Myrtaceae	<i>Eucalyptus gomphocephala</i>
Myrtaceae	<i>Eucalyptus marginata</i> subsp. <i>marginata</i>
Myrtaceae	<i>Eucalyptus occidentalis</i>
Myrtaceae	<i>Eucalyptus platypus</i>
Myrtaceae	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>

Family	Species
Myrtaceae	<i>Eucalyptus torquata</i>
Myrtaceae	<i>Hypocalymma angustifolium</i>
Myrtaceae	<i>Kunzea glabrescens</i>
Myrtaceae	<i>Melaleuca lateritia</i>
Myrtaceae	<i>Melaleuca preissiana</i>
Myrtaceae	<i>Melaleuca raphiophylla</i>
Myrtaceae	<i>Melaleuca thymoides</i>
Myrtaceae	<i>Melaleuca viminea</i> subsp. <i>viminea</i>
Poaceae	* <i>Anthoxanthum odoratum</i>
Poaceae	* <i>Avena fatua</i>
Poaceae	* <i>Briza maxima</i>
Poaceae	* <i>Briza minor</i>
Poaceae	* <i>Cenchrus clandestinus</i>
Poaceae	* <i>Cynodon dactylon</i>
Poaceae	* <i>Ehrharta calycina</i>
Poaceae	* <i>Ehrharta longiflora</i>
Poaceae	* <i>Eragrostis curvula</i>
Poaceae	* <i>Lolium perenne</i>
Poaceae	<i>Microlaena stipoides</i>
Polygonaceae	* <i>Rumex acetosella</i>
Polygonaceae	* <i>Rumex crispus</i>
Primulaceae	* <i>Lysimachia arvensis</i>
Proteaceae	<i>Adenanthos meisneri</i>
Proteaceae	<i>Banksia attenuata</i>
Proteaceae	<i>Banksia grandis</i>
Proteaceae	<i>Banksia ilicifolia</i>
Proteaceae	<i>Banksia littoralis</i>
Proteaceae	<i>Hakea multilineata</i>
Proteaceae	<i>Hakea sulcata</i>
Proteaceae	<i>Hakea varia</i>
Proteaceae	<i>Xylomelum occidentale</i>
Restionaceae	<i>Hypolaena caespitosa</i>
Restionaceae	<i>Hypolaena exsulca</i>
Solanaceae	* <i>Solanum nigrum</i>
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>
Zamiaceae	<i>Macrozamia riedlei</i>

APPENDIX 6

Species by site matrix

Taxon	WN-01	WN-02	WN-03	WN-04	WN-05	WN-06	WN-07	WN-08	WN-09	WN-10	WN-11	WN-12	WN-13	WN-14	WN-15
*Anthoxanthum odoratum									x	x					
*Arctotheca calendula	x	x	x	x	x	x			x	x	x			x	x
*Asparagus asparagoides		x	x	x	x	x									
*Briza maxima						x			x	x			x		
*Cenchrus clandestinus				x											
*Cotula coronopifolia									x						
*Cotula turbinata					x										
*Crassula glomerata					x										
*Cynodon dactylon		x	x	x	x	x	x	x			x	x	x	x	
*Ehrharta calycina		x	x	x	x		x				x				
*Ehrharta longiflora	x	x	x	x	x	x					x	x	x		
*Eragrostis curvula		x			x	x							x		
*Euphorbia helioscopia		x													
*Ferraria crispa						x									
*Freesia alba x leichtlinii		x	x		x		x	x	x	x	x	x	x		
*Gladiolus undulatus		x	x		x	x			x			x			
*Hypochaeris glabra		x	x	x	x	x			x	x					
*Lolium perenne								x	x	x	x			x	x
*Lotus subbiflorus		x		x	x		x	x	x	x	x				
*Lysimachia arvensis						x									
*Lythrum hyssopifolia			x												
*Romulea rosea		x			x		x	x	x	x					
*Rumex acetosella		x								x					
*Rumex crispus											x	x		x	
*Solanum nigrum			x			x								x	x
*Sonchus asper			x			x							x		
*Sonchus oleraceus						x									
*Trifolium fragiferum														x	
*Vicia sativa			x	x		x									

Taxon	WN-01	WN-02	WN-03	WN-04	WN-05	WN-06	WN-07	WN-08	WN-09	WN-10	WN-11	WN-12	WN-13	WN-14	WN-15
* <i>Watsonia meriana</i> var. <i>bulbillifera</i>							x	x							
* <i>Zantedeschia aethiopica</i>	x	x	x	x	x	x	x			x	x		x	x	
<i>Acacia saligna</i>											x				
<i>Acacia stenoptera</i>		x													
<i>Agonis flexuosa</i>												x			
<i>Banksia attenuata</i>					x										
<i>Banksia ilicifolia</i>					x										
<i>Corymbia calophylla</i>	x	x	x			x						x	x	x	
<i>Cyathochaeta avenacea</i>		x	x												
<i>Daviesia preissii</i>					x										
<i>Drosera glanduligera</i>		x			x										
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>											x				x
<i>Gastrolobium praemorsum</i>													x		
<i>Hakea sulcata</i>		x													
<i>Hardenbergia comptoniana</i>												x			
<i>Hypocalymma angustifolium</i>				x	x										
<i>Hypolaena caespitosa</i>							x	x	x						
<i>Hypolaena exsulca</i>								x							
<i>Juncus pallidus</i>												x	x		
<i>Kingia australis</i>	x						x	x						x	
<i>Kunzea glabrescens</i>			x		x										
<i>Kunzea spathulata</i>					x										
<i>Lepidosperma longitudinale</i>							x								
<i>Lomandra sonderi</i>												x			
<i>Lyginia imberbis</i>					x										
<i>Melaleuca preissiana</i>			x	x					x	x	x				x
<i>Melaleuca raphiophylla</i>											x				
<i>Melaleuca thymoides</i>					x										
<i>Melaleuca viminea</i> subsp. <i>viminea</i>										x					

Taxon	WN-01	WN-02	WN-03	WN-04	WN-05	WN-06	WN-07	WN-08	WN-09	WN-10	WN-11	WN-12	WN-13	WN-14	WN-15
<i>Mesomelaena tetragona</i>		x													
<i>Nuytsia floribunda</i>														x	
<i>Xanthorrhoea preissii</i>		x	x			x	x					x	x		
<i>Xylomelum occidentale</i>						x							x	x	

APPENDIX 7

Raw data for the 15 study sites

Study Sites

Site	Vegetation Type	Condition	Aspect	Slope	Soil Type	Soil Colour	Last Fire	Disturbance	Easting	Northing
WN-01	Dense Tall Grass of *Ehrharta longiflora with Forest of Corymbia calophylla and Scattered Tall Shrubs of Kingia australis	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	359008	6275786
WN-02	Dense Tall Grass of *Cynodon dactylon and *Ehrharta longiflora with Forest of Corymbia calophylla over Open Low Scrub A of Xanthorrhoea preissii and Scattered Tall Shrubs of Kingia australis	Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	359072	6275982
WN-03	Dense Tall Grass of *Ehrharta longiflora and *Cynodon dactylon with Forest of Corymbia calophylla over Low Woodland B of Melaleuca preissiana and Kunzea glabrescens and Scattered Tall Shrubs of Xanthorrhoea preissii	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	359188	6276132
WN-04	Dense Tall Grass of *Ehrharta longiflora and *Ehrharta calycina with Low Forest A of Melaleuca preissiana (Corymbia calophylla)	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	359251	6276214
WN-05	Dense Tall Grass of *Ehrharta calycina and *Ehrharta longiflora with Open Low Woodland A of Banksia ilicifolia (Banksia attenuata) over Open Scrub of Kunzea glabrescens and Kunzea spathulata (Banksia attenuata) over Scattered Low Shrubs of Melaleuca thymoides and Hypocalymma angustifolium	Completely Degraded	North	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	359312	6276281

Site	Vegetation Type	Condition	Aspect	Slope	Soil Type	Soil Colour	Last Fire	Disturbance	Easting	Northing
WN-06	Dense Tall Grass of *Ehrharta longiflora, *Cynodon dactylon and *Eragrostis curvula with Forest of Corymbia calophylla and Open Low Scrub A of Xanthorrhoea preissii	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	359311	6276676
WN-07	Dense Herbs of *Romulea rosea, *Freesia alba × leichtlinii and *Lotus subbiflorus with Scattered Tall Shrubs of Kingia australis and Xanthorrhoea preissii and Scattered Low Sedges of Hypolaena caespitosa and Lepidosperma longitudinale	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	358581	6273618
WN-08	Dense Herbs of *Watsonia meriana var. bulbifera, *Romulea rosea, *Lotus subbiflorus and *Freesia alba × leichtlinii with Very Open Low Sedges of Hypolaena exsulca and Hypolaena caespitosa and Scattered Tall Shrubs of Kingia australis	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	358514	6273615
WN-09	Dense Low Grass of *Lolium perenne with Scrub of Melaleuca preissiana and Scattered Low Sedges of Hypolaena caespitosa	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	358433	6273610
WN-10	Dense Low Grass of *Lolium perenne with Low Woodland B of Melaleuca preissiana and Melaleuca viminea subsp. viminea	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	358303	6273599
WN-11	Dense Low Grass of *Ehrharta longiflora and *Lolium perenne with Woodland of Eucalyptus rudis subsp. rudis over Low Woodland B of Melaleuca raphiophylla and Melaleuca preissiana	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	358181	6273586

Site	Vegetation Type	Condition	Aspect	Slope	Soil Type	Soil Colour	Last Fire	Disturbance	Easting	Northing
WN-12	Dense Low Grass of *Ehrharta longiflora and *Cynodon dactylon with Forest of Corymbia calophylla and Agonis flexuosa over Open Low Woodland B of Agonis flexuosa	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	357407	6273451
WN-13	Forest of Corymbia calophylla over Dense Low Grass of *Ehrharta longiflora over Open Dwarf Scrub C of Gastrolobium praemorsum with Open Herbs of *Freesia alba x leichtlinii	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	355776	6273371
WN-14	Open Woodland of Corymbia calophylla over Open Scrub of Kingia australis, Xylomelum occidentale and Nuytsia floribunda over Dense Low Grass of *Cynodon dactylon and *Lolium perenne on grey sand on sandy flats	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	357520	6274260
WN-15	Dense Low Grass of *Lolium perenne with Open Woodland of Eucalyptus rudis subsp. rudis and Open Scrub of Melaleuca preissiana	Completely Degraded	Flat	Flat	Sand	Grey	Old (6+ yr)	Cattle Grazing	357520	6274260

Flora

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-01	Quadrat	*Arctotheca	calendula			<1	<0.2
WN-01	Quadrat	*Ehrharta	longiflora			>70	<1
WN-01	Quadrat	*Zantedeschia	aethiopica			0.5	0.5
WN-01	Quadrat	Corymbia	calophylla			65	20-30
WN-01	Quadrat	Kingia	australis			<1	3.5
WN-02	Quadrat	*Arctotheca	calendula			1	0.2
WN-02	Quadrat	*Asparagus	asparagoides			<1	Cl
WN-02	Quadrat	*Cynodon	dactylon			60	0.5
WN-02	Quadrat	*Ehrharta	calycina			2	0.6
WN-02	Quadrat	*Ehrharta	longiflora			35	0.7
WN-02	Quadrat	*Eragrostis	curvula			<1	1.6
WN-02	Quadrat	*Euphorbia	helioscopia			<1	0.1
WN-02	Quadrat	*Freesia	alba × leichtlinii			<1	0.3
WN-02	Quadrat	*Gladiolus	undulatus			2	0.6
WN-02	Quadrat	*Hypochaeris	glabra			<1	0.5
WN-02	Quadrat	*Lotus	subbiflorus			0.5	0.1
WN-02	Quadrat	*Romulea	rosea			<1	0.2
WN-02	Quadrat	*Rumex	acetosella			<1	0.1
WN-02	Quadrat	*Zantedeschia	aethiopica			1	1
WN-02	Quadrat	Acacia	stenoptera			<1	0.6
WN-02	Quadrat	Corymbia	calophylla			60	15-30
WN-02	Quadrat	Cyathochaeta	avenacea			2	0.8
WN-02	Quadrat	Drosera	glanduligera			<1	0.05
WN-02	Quadrat	Hakea	sulcata			2	1.8
WN-02	Quadrat	Mesomelaena	tetragona			<1	0.6
WN-02	Quadrat	Xanthorrhoea	preissii			7	1.5-2
WN-02	Opportunistic	*Solanum	nigrum			-	-
WN-02	Opportunistic	Banksia	grandis			-	-

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-02	Opportunistic	Banksia	ilicifolia			-	-
WN-02	Opportunistic	Eucalyptus	marginata	subsp.	marginata	-	-
WN-02	Opportunistic	Lepidosperma	squamatum			-	-
WN-02	Opportunistic	Melaleuca	preissiana			-	-
WN-02	Opportunistic	Nuytsia	floribunda			-	-
WN-03	Quadrat	*Arctotheca	calendula			<1	0.3
WN-03	Quadrat	*Asparagus	asparagoides			2	Cl
WN-03	Quadrat	*Cynodon	dactylon			30	<
WN-03	Quadrat	*Ehrharta	calycina			2	0.7
WN-03	Quadrat	*Ehrharta	longiflora			60	<1
WN-03	Quadrat	*Freesia	alba × leichtlinii			4	0.6
WN-03	Quadrat	*Gladiolus	undulatus			1	0.6
WN-03	Quadrat	*Hypochaeris	glabra			1	0.5
WN-03	Quadrat	*Lythrum	hyssopifolia			0.5	0.3
WN-03	Quadrat	*Solanum	nigrum			0.5	0.5
WN-03	Quadrat	*Sonchus	asper			<1	0.7
WN-03	Quadrat	*Vicia	sativa			2	0.5
WN-03	Quadrat	*Zantedeschia	aethiopica			<1	1
WN-03	Quadrat	Corymbia	calophylla			40	15-30
WN-03	Quadrat	Cyathochaeta	avenacea			0.5	1
WN-03	Quadrat	Kunzea	glabrescens			5	5
WN-03	Quadrat	Melaleuca	preissiana			20	5
WN-03	Quadrat	Xanthorrhoea	preissii			2	1.6
WN-04	Quadrat	*Arctotheca	calendula			1	0.3
WN-04	Quadrat	*Asparagus	asparagoides			<1	Cl
WN-04	Quadrat	*Cenchrus	clandestinus			10	1
WN-04	Quadrat	*Cynodon	dactylon			10	0.5
WN-04	Quadrat	*Ehrharta	calycina			15	<1
WN-04	Quadrat	*Ehrharta	longiflora			50	<1

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-04	Quadrat	*Hypochaeris	glabra			<1	0.1
WN-04	Quadrat	*Lotus	subbiflorus			<1	0.1
WN-04	Quadrat	*Vicia	sativa			<1	0.5
WN-04	Quadrat	*Zantedeschia	aethiopica			1	1
WN-04	Quadrat	Hypocalymma	angustifolium			<1	0.5
WN-04	Quadrat	Melaleuca	preissiana			60	4-8
WN-05	Quadrat	*Arctotheca	calendula			1	0.1
WN-05	Quadrat	*Asparagus	asparagoides			1	Cl
WN-05	Quadrat	*Cotula	turbinata			<1	0.1
WN-05	Quadrat	*Crassula	glomerata			<1	0.1
WN-05	Quadrat	*Cynodon	dactylon			5	0.5
WN-05	Quadrat	*Ehrharta	calycina			>5	<1
WN-05	Quadrat	*Ehrharta	longiflora			50	<1
WN-05	Quadrat	*Eragrostis	curvula			<1	1
WN-05	Quadrat	*Freesia	alba × leichtlinii			1	0.4
WN-05	Quadrat	*Gladiolus	undulatus			2	1
WN-05	Quadrat	*Hypochaeris	glabra			1	0.1
WN-05	Quadrat	*Lotus	subbiflorus			1	0.1
WN-05	Quadrat	*Romulea	rosea			<1	0.2
WN-05	Quadrat	*Zantedeschia	aethiopica			<1	1
WN-05	Quadrat	Banksia	attenuata			1	3.5
WN-05	Quadrat	Banksia	ilicifolia			8	5-10
WN-05	Quadrat	Daviesia	preissii			<1	1
WN-05	Quadrat	Drosera	glanduligera			<1	0.05
WN-05	Quadrat	Hypocalymma	angustifolium			<1	1
WN-05	Quadrat	Kunzea	glabrescens			7	2-6
WN-05	Quadrat	Kunzea	spathulata			2	>2
WN-05	Quadrat	Lyginia	imberbis			1	1.2
WN-05	Quadrat	Melaleuca	thymoides			1	1.5

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-05	Opportunistic	Adenanthos	meisneri			-	-
WN-05	Opportunistic	Hakea	varia			-	-
WN-05	Opportunistic	Macrozamia	riedlei			-	-
WN-05	Opportunistic	Xylomelum	occidentale			-	-
WN-06	Quadrat	*Arctotheca	calendula			<1	-
WN-06	Quadrat	*Asparagus	asparagoides			2	-
WN-06	Quadrat	*Briza	maxima			1	-
WN-06	Quadrat	*Cynodon	dactylon			40	-
WN-06	Quadrat	*Ehrharta	longiflora			45	-
WN-06	Quadrat	*Eragrostis	curvula			5	-
WN-06	Quadrat	*Ferraria	crispa			2	-
WN-06	Quadrat	*Gladiolus	undulatus			2	-
WN-06	Quadrat	*Hypochaeris	glabra			<1	-
WN-06	Quadrat	*Lysimachia	arvensis			<1	-
WN-06	Quadrat	*Solanum	nigrum			<1	-
WN-06	Quadrat	*Sonchus	asper			<1	-
WN-06	Quadrat	*Sonchus	oleraceus			<1	-
WN-06	Quadrat	*Vicia	sativa			<1	-
WN-06	Quadrat	*Zantedeschia	aethiopica			<1	-
WN-06	Quadrat	Corymbia	calophylla			65	-
WN-06	Quadrat	Xanthorrhoea	preissii			3	-
WN-06	Quadrat	Xylomelum	occidentale			<1	-
WN-07	Quadrat	*Cynodon	dactylon			5	0.1
WN-07	Quadrat	*Ehrharta	calycina			2	0.5
WN-07	Quadrat	*Freesia	alba × leichtlinii			37	0.3
WN-07	Quadrat	*Lotus	subbiflorus			10	0.2
WN-07	Quadrat	*Romulea	rosea			45	0.4
WN-07	Quadrat	*Watsonia	meriana	var.	bulbillifera	<1	1
WN-07	Quadrat	*Zantedeschia	aethiopica			<1	1

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-07	Quadrat	Hypolaena	caespitosa			1	0.8
WN-07	Quadrat	Kingia	australis			1	1.5-2
WN-07	Quadrat	Lepidosperma	longitudinale			<1	1
WN-07	Quadrat	Xanthorrhoea	preissii			<1	1.5
WN-07	Opportunistic	Cyathochaeta	equitans			-	-
WN-07	Opportunistic	Microlaena	stipoides			-	-
WN-08	Quadrat	*Cynodon	dactylon			5	0.5
WN-08	Quadrat	*Freesia	alba × leichtlinii			5	0.2
WN-08	Quadrat	*Lolium	perenne			1	0.4
WN-08	Quadrat	*Lotus	subbiflorus			10	0.1
WN-08	Quadrat	*Romulea	rosea			65	0.3
WN-08	Quadrat	*Watsonia	meriana	var.	bulbillifera	5	1.6
WN-08	Quadrat	Hypolaena	caespitosa			2	<1
WN-08	Quadrat	Hypolaena	exsulca			3	0.6
WN-08	Quadrat	Kingia	australis			<2	1-2
WN-09	Quadrat	*Anthoxanthum	odoratum			5	<0.3
WN-09	Quadrat	*Arctotheca	calendula			<1	0.1
WN-09	Quadrat	*Briza	maxima			2	0.3
WN-09	Quadrat	*Cotula	coronopifolia			<1	0.1
WN-09	Quadrat	*Freesia	alba × leichtlinii			2	0.3
WN-09	Quadrat	*Gladiolus	undulatus			<1	0.6
WN-09	Quadrat	*Hypochaeris	glabra			1	0.2
WN-09	Quadrat	*Lolium	perenne			70	0.7
WN-09	Quadrat	*Lotus	subbiflorus			5	0.3
WN-09	Quadrat	*Romulea	rosea			1	0.3
WN-09	Quadrat	Hypolaena	caespitosa			1	<1
WN-09	Quadrat	Melaleuca	preissiana			20	2-4
WN-10	Quadrat	*Anthoxanthum	odoratum			5	0.3
WN-10	Quadrat	*Arctotheca	calendula			5	0.3

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-10	Quadrat	*Briza	maxima			5	0.3
WN-10	Quadrat	*Freesia	alba × leichtlinii			10	0.5
WN-10	Quadrat	*Hypochaeris	glabra			<1	0.2
WN-10	Quadrat	*Lolium	perenne			70	<1
WN-10	Quadrat	*Lotus	subbiflorus			5	0.2
WN-10	Quadrat	*Romulea	rosea			5	0.3
WN-10	Quadrat	*Rumex	acetosella			<1	1.3
WN-10	Quadrat	*Zantedeschia	aethiopica			<1	1
WN-10	Quadrat	Melaleuca	preissiana			5	>2
WN-10	Quadrat	Melaleuca	viminea	subsp.	viminea	10	>2
WN-10	Opportunistic	Melaleuca	lateritia			-	-
WN-10	Opportunistic	Melaleuca	preissiana			-	-
WN-11	Quadrat	*Arctotheca	calendula			<1	0.2
WN-11	Quadrat	*Cynodon	dactylon			5	0.5
WN-11	Quadrat	*Ehrharta	calycina			2	0.6
WN-11	Quadrat	*Ehrharta	longiflora			75	0.5
WN-11	Quadrat	*Freesia	alba × leichtlinii			2	0.3
WN-11	Quadrat	*Lolium	perenne			5	0.5
WN-11	Quadrat	*Lotus	subbiflorus			<1	0.1
WN-11	Quadrat	*Rumex	crispus			<1	1.2
WN-11	Quadrat	*Zantedeschia	aethiopica			<1	1
WN-11	Quadrat	Acacia	saligna			<1	1
WN-11	Quadrat	Eucalyptus	rudis	subsp.	rudis	20	15-30
WN-11	Quadrat	Melaleuca	preissiana			5	3-6
WN-11	Quadrat	Melaleuca	rhapsiophylla			10	2-5
WN-11	Opportunistic	Xanthorrhoea	preissii			-	-
WN-12	Quadrat	*Cynodon	dactylon			5	0.5
WN-12	Quadrat	*Ehrharta	longiflora			70	0.6
WN-12	Quadrat	*Freesia	alba × leichtlinii			5	0.6

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-12	Quadrat	*Gladiolus	undulatus			<1	1
WN-12	Quadrat	*Rumex	crispus			<1	0.5
WN-12	Quadrat	Agonis	flexuosa			10	2-20
WN-12	Quadrat	Corymbia	calophylla			60	15-30
WN-12	Quadrat	Hardenbergia	comptoniana			<1	0.6
WN-12	Quadrat	Juncus	pallidus			1	1.2
WN-12	Quadrat	Lomandra	sonderi			<1	0.5
WN-12	Quadrat	Xanthorrhoea	preissii			0.5	1.2
WN-12	Opportunistic	Banksia	littoralis			-	-
WN-13	Quadrat	*Briza	maxima			2	0.6
WN-13	Quadrat	*Cynodon	dactylon			2	0.5
WN-13	Quadrat	*Ehrharta	longiflora			30	0.6
WN-13	Quadrat	*Eragrostis	curvula			5	0.8
WN-13	Quadrat	*Freesia	alba × leichtlinii			15	0.5
WN-13	Quadrat	*Sonchus	asper			<1	1
WN-13	Quadrat	*Zantedeschia	aethiopica			<1	1
WN-13	Quadrat	Corymbia	calophylla			60	15-30
WN-13	Quadrat	Gastrolobium	praemorsum			15	0.6
WN-13	Quadrat	Juncus	pallidus			<1	1
WN-13	Quadrat	Xanthorrhoea	preissii			<1	1.2
WN-13	Quadrat	Xylomelum	occidentale			<1	1
WN-14	Quadrat	*Arctotheca	calendula			2	0.2
WN-14	Quadrat	*Cynodon	dactylon			65	0.3
WN-14	Quadrat	*Lolium	perenne			3	0.5
WN-14	Quadrat	*Rumex	crispus			<1	0.7
WN-14	Quadrat	*Solanum	nigrum			<1	0.5
WN-14	Quadrat	*Trifolium	fragiferum			1	0.3
WN-14	Quadrat	*Zantedeschia	aethiopica			<1	0.6
WN-14	Quadrat	Corymbia	calophylla			3	20

Site	Sampling	Genus	Species	Infra Rank	Infra Name	% Foliar Cover	Height (m)
WN-14	Quadrat	Kingia	australis			<1	3
WN-14	Quadrat	Nuytsia	floribunda			<1	3
WN-14	Quadrat	Xylomelum	occidentale			<1	2.5
WN-15	Quadrat	*Arctotheca	calendula			5	0.3
WN-15	Quadrat	*Lolium	perenne			65	0.5
WN-15	Quadrat	*Solanum	nigrum			<1	0.3
WN-15	Quadrat	Eucalyptus	rudis	subsp.	rudis	5	20
WN-15	Quadrat	Melaleuca	preissiana			3	6

WN-01



WN-02



WN-03



WN-04



WN-05



WN-06



WN-07



WN-08



WN-09



WN-10



WN-11



WN-12



WN-13



WN-14



WN-15



Basic and Targeted Fauna Survey

Ruabon Road Stage 1, Ruabon

DECEMBER 2021



Version control

Project number:	SW352			
Project file path:	SW368 Ruabon Rd Stage 1 fauna survey 20211223.docx			
Client:	Tronox			
Revision	Date	Prepared by (name)	Reviewed by (name)	Approved by (name)
Rev 0	23/12/21	Shane Priddle SW Environmental	Shane Priddle SW Environmental	Shane Priddle SW Environmental

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Statement of limitations

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Common terms/acronyms

BC Act	WA <i>Biodiversity Conservation Act 2016</i>
DAWE	Federal Department of Agriculture, Water and the Environment
DBCA	WA Department of Biodiversity, Conservation and Attractions
DBH	Diameter at Breast Height in centimetres
DWER	WA Department of Water and Environmental Regulation
EP Act	WA <i>Environmental Protection Act 1986</i>

EPBC Act	Federal <i>Environment Protection and Biodiversity Conservation Act 1999</i>
FRTBC	Forest Red-tailed Black Cockatoo
Locality	A 5 km buffer around the Study area
Project	The proposed action
Study area	Lots 834 and 2689, Ruabon Road
Suitable DBH tree	Tree of a suitable size to develop large hollows (> 50cm DBH most trees in the southwest or > 75cm for Karri).
WA	Western Australia

Executive summary

Tronox is progressing the environmental approvals required to the mine mineral sands on Lots 834 and 2689, south of Ruabon Road, Ruabon, within the City of Busselton. The 'study area' includes 85 ha of mostly cropped paddock with intentionally planted belts of trees, west of Teale Road, excluding the road reserve. Tronox required a fauna survey to the support relevant applications.

SW Environmental was commissioned to carry out a basic survey comprising of habitat assessment and likelihood of occurrence assessment of conservation significant fauna, along with a targeted black cockatoo survey. The targeted black cockatoo survey was required to identify black cockatoo habitat values, including potential and actual breeding habitat, foraging habitat and roost sites. Black cockatoos collectively refers to

- Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii subsp. naso*) (Vulnerable)
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) (Endangered)
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) (Endangered)

Field work consisted of site reconnaissance visit on 21st December 2021 by SW Environmental Principal, Shane Priddle. The study area consists of cropped and grazed paddocks with intentionally planted belts of trees (planted circa 2013), several sheds and two houses with some older planted trees around the buildings. The study area occurs over sandy soils without any drainage lines, dams or watercourses. There are two habitat types, neither associated with remnant native vegetation. Fauna habitat quality was Poor over the entire site:

- Planted - Planted belts of predominately exotic trees (up to 15 species) but with some native species *Corymbia calophylla* and *Eucalyptus rudis*, <50cm DBH or multi-stemmed. Occasional older planted paddock trees particularly around the buildings (4.54 ha),
- Cleared - Cleared, crops, tracks and other infrastructure (80.81 ha).

Twenty-five species of fauna were recorded from the 210 that may occur locally based on desktop assessment - 19 birds and six mammals (five of which are introduced). All are common species. No target species were observed, though 21 fauna of conservation significance may occur locally.

Targeted black cockatoo surveys identified the following

- The study area occurs within the breeding range of all three black cockatoo species (SEWPaC 2012).
- Thirteen suitable DBH trees (species likely to develop large hollows >50cm DBH) were recorded within the study area, none of which contained hollows. Only two trees were native - one Marri and one Jarrah. The remaining trees were planted eastern States eucalypts not likely to develop large hollows in the short or medium term.
- No roost trees were identified during the field work.
- No feed residue was observed within the study area. Foraging habitat within the study area is limited to planted Marri trees, which may be less than 10% of the total mix of plantings. Most of the remaining trees are non-native. Whilst the other species may have some feed potential the vegetation within the study area would not be considered 'high quality' black cockatoo foraging habitat.

- The site may also provide *Marginal foraging – supporting habitat* for Peregrine Falcon and Masked Owl (southern sub sp), given a small component of the planting are native species. Direct impacts on target fauna are unlikely.
- There are 23 State reserves within 12 km of the study area, with the most significant being the Ludlow State Forest and Tuart Forest National Park located approximately 1.3 km west of the project.
- The study area is not located within any mapped SWREL buffers or axis lines (Molloy et al 2009).

The following recommendations are made:

- Vegetation should be retained where possible.
- Clearing should be conducted outside of spring to minimise impacts to breeding fauna.

1 Introduction

1.1 Background

Tronox is progressing the environmental approvals required to the mine mineral sands on Lots 834 and 2689, south of Ruabon Road, Ruabon, within the City of Busselton. The 'study area' includes 85 ha, west of Teale Road, excluding the road reserve. It consists of mostly cropped paddock with intentionally planted belts of trees. The study area and locality are shown in Figures A.1 and A.2 (Appendix A).

Tronox required a fauna survey to the support environmental impact assessment (EIA) and a Clearing Permit application. This fauna survey report identifies baseline fauna and habitat values within the study area and will be used to guide the project design and to inform the Clearing Permit application.

1.2 Scope of work

SW Environmental was commissioned to carry out a basic survey comprising of habitat assessment and likelihood of occurrence of conservation significant fauna, along with a targeted black cockatoo survey¹. The targeted black cockatoo survey was required to identify black cockatoo habitat values, including potential and actual breeding habitat, foraging habitat and roost sites. The fauna survey is restricted to terrestrial vertebrate fauna. Threatened aquatic fauna and invertebrates were considered through desktop assessment only.

The survey is in accordance with EPA Technical Guidance and other relevant State and Commonwealth guidelines. The survey report also identifies whether any Matters of National Environmental Significance afforded protection under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are present or likely to occur within the area.

The survey includes

- Desktop study,
- Field survey - validation of the desktop study and habitat assessment,
- Consultation, reporting, mapping, and recommendations.

¹ Black cockatoos collectively refers to

- Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii subsp. naso*) (Vulnerable)
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) (Endangered)
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) (Endangered)

1.3 Regulatory context

1.3.1 Key legislation

Key environmental legislation that may be relevant to the fauna survey is outlined in Table 1-1. Refer to Appendix B for further detail and conservation code descriptions.

Table 1-1 Environmental legislation that may be relevant to the Project

Legislation	Government Department	Aspect
<i>Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	Federal Department of Agriculture, Water, and the Environment (DAWE)	Matters of National Environmental Significance including threatened fauna.
<i>Biodiversity Conservation Act 2016 (BC Act)</i>	WA Department of Biodiversity, Conservation and Attractions (DBCA)	Threatened species habitats, threatening processes, environmental pests and weeds.
<i>Biosecurity and Agricultural Management Act 2007 (BAM Act)</i>	WA Department of Primary Industries and Regional Development	Weeds, feral animals and other pests.
<i>Environmental Protection Act 1986 (EP Act)</i>	Environmental Protection Authority or DWER	Environmental impact assessment and management and offsets.

Fauna in WA may be afforded protection under the WA BC Act and or federal EPBC Act. Species listed as threatened or migratory are referred to collectively in this document as being 'conservation significant' or 'target' species. These terms include species under the DBCA Priority lists.

1.3.2 Guidelines

The survey methodologies were developed with consideration of:

- Environmental Protection Authority (2020) Technical Guidance – Terrestrial Guidance for Fauna Surveys for Environmental Impact Assessment. Perth, Western Australia
- Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3, EPA (2002).
- Commonwealth Matters of National Environmental Significance – *Significant impact guidelines 1.1 Environmental Protection and Biodiversity Conservation Act 1999*, Department of the Environment, Water, Heritage and the Arts (DEWHA)', (2009).
- Commonwealth of Australia (2017) Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo.
- Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) (2012) *Commonwealth EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered), Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable), Calyptorhynchus baudinii, and Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso.*

2 Methods

2.1 Desktop study

A desktop study of fauna within and near the study area was undertaken. A key aim of the study was to determine the likelihood of any species of conservation significance (target species) occurring within the study area and the importance of the study area to them. Common (non-target) species are also considered more generally.

Database searches using Western Australian Museum Nature Map and the Protected Matters Search Tool (Appendix C) were carried out within approximately five kilometres of the study area. This was supplemented by Atlas of Living Australia (ALA, 2021), Birddata Important Bird Areas (BirdLife Australia, 2021), Index of Biodiversity Surveys for Assessment (IBSA, 2021) species lists within five kilometres where available. Aerial photography (Landgate, 2021), data from the Government of WA's Shared Land Information Platform (SLIP, 2021) was also viewed along with management plans, recovery plans, books, scientific journals and other publications, previous survey reports and expert consultation as required.

Soil mapping from Tille and Lantzke (1990) was used to identify soil types and vegetation associations and complexes were reviewed to identify potential vegetation and therefore habitat types occurring within and near the study area (SLIP 2021).

A brief review of the ecology, habitat and range of target species were used in an evaluation matrix to determine the likelihood of occurrence of conservation significant fauna (Appendix D). Fauna of conservation significance that may occur locally are listed in Sections 3.3.2 and 4.3.

2.2 Field surveys

2.2.1 Study area, timing, and personnel

The 'study area' included 85 ha of private land west of Teale Road, excluding the road reserve. Field work consisted of a reconnaissance visit on 21st December 2021 by SW Environmental Principal, Shane Priddle. The field visit was undertaken to validate the desktop study and ground truth fauna habitat. Fauna habitat type was documented based on structural vegetation and soil mapping where significant changes occurred. Evidence of fauna (e.g., scat searches, diggings or feed residue) and fauna sightings were also noted. Fauna habitat quality was based on Tables 2-1 to 2-3.

Table 2-1 Vegetation structure (Keighery 1994).

Life Form/Height Class	Canopy cover			
	100% to 70%	70%to 30%	30%to 10%	10% to 2%
Trees over 30 m	Tall Closed Forest	Tall Open Forest	Tall Woodland Woodland	Tall Open Woodland
Trees 10-30 m	Closed Forest	Open Forest		Open Woodland
Trees under 10 m	Low erased Forest	Low Open Forest	Low Woodland	Low Open Woodland ..
Mallee over 8 m (Tree Mallee)	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree. Mallee
Mallee under 8 m (Shrub Mallee)	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub
Shrubs over 2 m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland Shrubland	Tall Open Shrubland
Shrubs 1 2 m	Closed Heath	Open Heath	Low Shrubland	Open Shrubland
Shrubs under 1 m	Closed Low Heath	Open Low Heath		Very Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Table 2-2 Vegetation condition scale (EPA 2016).

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact, and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

Table 2-3 Fauna habitat quality categories and descriptions (SW Environmental, undated).

Quality	Description
Good	<ul style="list-style-type: none"> • Native vegetation with intact and diverse habitat structure. Different vegetation age classes present at most stratum levels (ground, understorey, midstorey, canopy). • Forest/woodland: abundant hollow-bearing trees, including those with or likely to develop large hollows. Mature trees offer more foraging resources (nectar/seed). • Presence of shelter/refuges at ground level (dense understorey plants, tussock, rocky outcrop, hollow logs). • High habitat complexity (ecotones between vegetation types or habitat mosaic). This increases the range of foraging and shelter opportunities within a habitat. • Presence of key foraging and microhabitat components for target species. • Little to no obvious weed invasion or evidence of grazing. • May be large patch and/or connected to other areas of native vegetation.
Moderate	<ul style="list-style-type: none"> • Native flora species dominant with moderate habitat structure complexity appropriate to vegetation type. Ground litter intact or slightly disturbed. More than one age class present. • Forest/woodland: low to moderate abundance of hollow-bearing trees or trees likely to develop hollows. • Some shelter and refuge present for ground dwelling fauna. • Some habitat complexity (ecotones between vegetation types or areas forming a habitat mosaic). • Marginal presence of key microhabitat components for target species. • May be small or large in scale, and isolated or well connected.
Poor	<ul style="list-style-type: none"> • Habitat highly disturbed and simplified with low structural complexity. Ground litter layer absent or highly modified. Complexity reduced by only one age class present. • Little or no shelter and refuge for ground dwelling fauna. • Forest/woodland: not likely to support hollow-bearing trees. • Lack of key foraging and microhabitat components for target species. • May have evidence of weed invasion or grazing. • May be narrow or small area and substantially influenced by edge effects, isolated from other areas of native vegetation.

2.3 Black cockatoo habitat assessment

The field survey methodology was based on the Commonwealth referral guidelines for black cockatoos (Commonwealth of Australia 2017, SEWPaC 2012) and the black cockatoo species profiles provided in the desktop study (Section 3.4). The species profiles are based on literature review and consultation with Tony Kirby, a recognised black cockatoo expert. Black cockatoo habitat surveys included:

- **Foraging habitat assessment:** The quality of potential black cockatoo foraging habitat was noted based on structural vegetation mapping, with presence or absence of feed residue.

- **Roosting habitat survey:** Direct and indirect evidence of black cockatoos roosting within trees was noted if observed.
- **Suitable DBH tree and hollow survey:** The hollows were assessed based on the likelihood of black cockatoos using the hollows for breeding. Criteria included:
 - *Tree with suitable DBH without hollows* – describes trees with a 50 cm DBH (or 75 cm for Karri) that do not have hollows.
 - *Tree with suitable DBH with unsuitable hollow* – describes trees with a 500 mm DBH (or 75 cm for Karri) that have hollows that are not suitable due to the size of its entry, internal dimensions, height off ground or angle.
 - *Tree with potentially suitable size hollow with no signs of use (confirmed).*
 - *Tree with potentially suitable size hollow with no signs of use (not confirmed).*
 - *Tree with suitable size hollow with no signs of use (confirmed).*
 - *Tree with potentially suitable size hollow with signs of use (not confirmed).*
 - *Tree with suitable size hollow with signs of use (confirmed).*
 - *Known nesting tree.*

Suitability of the hollow for black cockatoo breeding also considered orientation, access, chamber size, and use by other animals. Confirmed / not confirmed indicates whether closer inspection has been carried out by drone or camera.

Twelve kilometres is referenced broadly within this document as a nominal distance in considering wider local vegetation and habitat values due to that distance being the maximum that black cockatoos will travel from their nesting site to forage (Commonwealth of Australia 2017).

2.4 Survey method considerations

Publications

Publications consulted for general distribution of fauna included, but was not limited to:

- A Complete Guide to Reptiles of Australia (Wilson and Swan, 2017)
- A Field Guide to the Mammals of Australia (Menkhorst and Knight, 2013)
- Field guide to frogs of Western Australia (Doughty and Tyler, 2009)
- Frogs of Western Australia (Thomson-Dans and Wardell-Johnson, 2002)
- Handbook Western Australian Birds Vol I (Johnstone and Storr, 1998)
- Michael Morcombe's Birds of Australia eGuide, (Michael Morcombe, 2011)
- Reptiles and Frogs in the Bush: Southwestern Australia (Bush et al., 2007)
- Scats, Tracks and Other Traces: A field guide to Australian mammals (Triggs, 2008)
- The Field Guide to the Birds of Australia (Pizzey and Knight, 2012)
- Waterbirds of South-west Wetlands (Thomson-Dans and Halse, 2001)
- Numerous online publications, journal articles and other general species references (see References section).

Taxonomy and nomenclature

The taxonomy and nomenclature used in this report follows several sources, depending on the faunal group. It primarily follows Naturemap (2021) but also the following:

- Amphibians: Bush et al. (2007)
- Aves: Pizzey and Knight (2007)
- Mammals: Menkhorst and Knight (2013)
- Reptiles: Wilson and Swan (2017)

Animal ethics

The survey conformed to Section 4 of the *Australian code of practice for the care and use of animals for scientific purposes* (National Health and Medical Research Council 2004). No animals were captured or collected during the survey.

2.5 Limitations

In accordance with relevant *Technical Guidance* (EPA 2020) survey limitations are shown below.

Table 2-4 Assessment of survey limitations

Aspect	Constraint	Comment
Competency / experience of the survey team	No	Suitably qualified individuals carried out the work. Shane Priddle (Ba Science; CEnvP No. 310) has over 20 years' experience conducting fauna surveys throughout NSW and WA.
Scope, e.g. where faunal groups were excluded from the survey	Negligible	The scope is adequate to provide information required to support a clearing assessment. Fish and invertebrates were not sampled in the field but were considered in the desktop assessment.
Adequacy of the survey intensity and proportion of survey achieved	No	Suitable survey effort has been adopted to identify the fauna constraints associated with the study area. A precautionary approach has also been adopted.
The proportion of the task achieved and further work	No	The surveys were completed adequately, to a sufficient level with respect to the scope.
Timing/weather/season	No	The surveys were completed in summer 2021. The survey timing and weather conditions were suitable to detect most target species. Breeding black cockatoos may have been present, however older hollow chews and feed residue would still have been present and observable.
Disturbances that may have affected results of survey	No	There were no disturbances that affected the survey.
Intensity	No	Based on the results the survey is considered adequate to meet the project scope.
Completeness	No	The entire study area was surveyed.

Aspect	Constraint	Comment
Resources	No	The surveys were completed adequately.
Access problems;	No	The study area was on private land and accessible.
Identification of hollows	Low	<p>Ground-based counts of hollows are subjective, it is not possible to be certain that the feature is a hollow as seen from the ground. Limitations include the likelihood that some hollows may be missed, may not be observable or may be obscured, particularly hollows in branches and vertical hollows.</p> <p>Known limitations inherent in the ground survey of hollows include bias between different surveyors / survey times due to differing familiarity with tree types, levels of training / expertise, survey conditions such as weather and time of day, and survey technique (Gorrod & Keith 2008, Rayner et al. 2011). Poor visibility (such as overcast weather) is known to affect results also (Rayner et al. 2011).</p> <p>As well as providing inaccurate counts of hollow abundance, ground-based surveys provide incomplete or inaccurate information on hollow dimensions and use of hollows by fauna (Koch 2008). Generally, ground-based surveys lead to overestimation of hollows (Rayner et al. 2011, Author pers obs).</p> <p>The suitability of hollow may change over time. There is some risk, though low, that black cockatoos may be breeding in a hollow where evidence of use was not visible or hollow characteristics were atypical.</p> <p>It is also noted that not all active cockatoo hollows show signs of heavy chewing, and active or past breeding hollows therefore may be missed.</p>

3 Desktop study

3.1 Local and regional context

3.1.1 Land use

The study area consists of paddock with intentionally planted belts of trees, several sheds and two houses with some older planted trees around the buildings. The trees over most of the study area appear to have been planted around 2013, as shown in Figure 3-1 below, in the north west of the study area (SLIP 2021).



Figure 1 Public aerial imagery from 2013 showing the study area (blue) largely devoid of vegetation (SLIP 2021).

3.1.2 Interim Biogeographic Regionalisation of Australia (IBRA) values

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies Australia's landscapes into 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. IBRA also provides a planning framework for the systematic

development of a comprehensive, adequate and representative National Reserve System, endorsed by all levels of government as a key tool for identifying land for conservation under Commonwealth's Australia's Strategy for the National Reserve System 2009-2030 (DE, 2017).

The Project occurs within the Swan Coastal Plain Sub-region (SWA02) of the Swan Coastal Plain IBRA region. This bioregion consists of a low lying coastal plain, mainly covered with woodland. Woodlands are dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *C. obesa*-Marri woodlands and Melaleuca shrublands, are extensive only in the south (Mitchell et al 2002) (Williams et al 2002).

3.1.3 DBCA managed lands

There are 23 State reserves within 12 km of the study area, with the most significant being the Ludlow State Forest and Tuart Forest National Park located approximately 1.3 km west of the project. The Ruabon Townsite Nature Reserve is located approximately 1.8 km east. These are linked to the study area by the mostly vegetated Ruabon Road reserve. Extensive areas of vegetation associated with the Jarrah Forest (Millbrook and Jarrahwood State Forests and Whicher Scarp National Park) are present approximately nine kilometres to the east.

3.1.4 Habitat connectivity, linkage, or corridor values

In a local context there is approximately 9,522 ha of remnant native vegetation mapped (or 19%) remaining within 12 km of the study area (49,700 ha) (Government of Western Australia 2020).

Linkages (SWREL) project identifies regional scale ecological linkages and aims to respond to the issues of fragmentation and climate change through land use planning policy and procedures. It also seeks to retain native vegetation and fauna habitat and reduce the loss of biodiversity and ecological function in the South West. The SWREL axis lines can be summarised as a series of vegetation patches which due to their proximity, act as habitat stepping stones thereby facilitating ecological processes and movement of organisms within and across the landscape (i.e. at the landscape scale) (Molloy et al 2009).

Lacking remnant native vegetation, the study area is not located within any mapped SWREL buffers or axis lines (Molloy et al 2009). The adjacent Ruabon Road is mapped as *a: with and edge touching or <100m from a linkage* and Teale Road is mapped as *2a: with an edge touching or <500m from a linkage* (Molloy et al 2009) but these areas fall outside of the study area. The study area therefore has low value in terms of habitat connectivity, linkage and corridor importance at the patch and landscape scales.

3.2 Environmental values of the study area

3.2.1 Climate, landform and soils

The southwest of WA has a moderate Mediterranean climate with mild wet winters and hot dry summers. The following summary is based on data from the nearby Busselton Aero data station (Weatherzone 2021). The temperature ranges from an average maximum of 30.2°C in the hottest month of January to an average minimum of 7°C in July with an average annual rainfall of 672 mm, with most of the rain falling between May and July (Weatherzone, 2021).

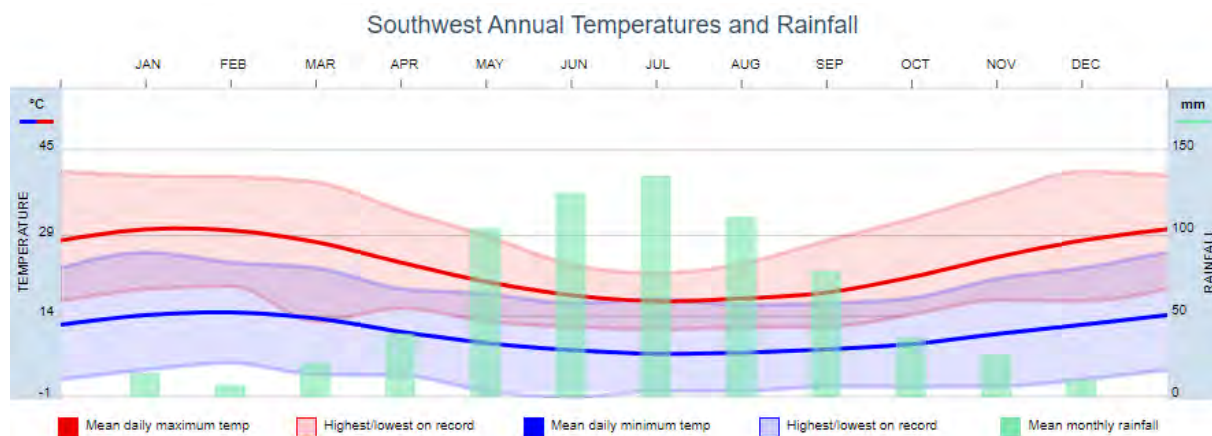


Figure 1 Annual temperatures and rainfall near the study area (Busselton Aero) (Weatherzone 2021)

The study area occurs over low rolling topography and passes through two soil units, as described by Department of Agriculture and Food (Tille and Lantzke 1990):

- 213AbABw Abba wet flats: Phase Winter wet flats and slight depressions with sandy grey brown duplex (Abba) and gradational (Busselton) soils.
- 213AbAB1 Abba Flats Phase: Flats and low rises with sandy grey brown duplex (Abba) and gradational (Busselton) soils.

3.2.2 Wetlands and watercourses

The term 'wetlands' refers to damplands, estuary-peripheral and water body, floodplains, palusplain and sumplands. The wetland categories are recognised by the EPA, DBCA, DWER and other decision making authorities. Guidance on protecting the environment during planning and development is set out in the *Environmental Protection Authority's Guidance Statement 33 - Environmental Guidance for Planning and Development* (EPA 2008) Chapter B4 describes the requirements for the protection of wetlands. The EPA considers wetlands in terms of the three broad wetland management categories: Conservation (0-5% disturbed), Resource Enhancement (5-90%) and Multiple Use (90-100% disturbed).

The project occurs over sandy soils without any drainage lines or watercourses. The study area is mapped as a Multiple Use palusplain wetland (Government of Western Australia, 2021). The study area

does not contain any wetlands listed under the Directory of Important Wetlands in Australia or RAMSAR (List of Wetlands of International Importance) (Government of Western Australia, 2021).

3.2.3 *Vegetation*

There is no remnant vegetation mapped within the study area. Adjacent road verge vegetation is mapped as 1136 - Medium woodland; marri with some jarrah, wandoo, river gum and casuarina Vegetation Association, by Beard (1981).

3.3 Fauna records

3.3.1 *Fauna recorded locally*

The south west has generally been well surveyed for fauna. Recent surveys within approximately five kilometres of the study area (Index of Biodiversity Surveys for Assessment, 2021) include

- Biologic (2013) Wonnerup North Vertebrate Fauna Survey. Unpublished report to Cristal Mining Australia Ltd. (Adjacent property to the west).
- Ecosystem Solutions (2019) Flora and Fauna Significance Assessment Capel Tutunup Road, Tutunup. Unpublished report to City of Busselton.
- Ecoedge and Harewood (2019) Fauna Assessment (CPS 8424/1) Wonnerup South Road (SLK 1.40 to SLK 8.88) Abba River. Unpublished report to City of Busselton.

The results of the surveys above were amalgamated with desktop searches (Naturemap, 2021 and ALA, 2021) within approximately five kilometres from the study area. This yielded 210 vertebrate terrestrial fauna species (Appendix C.1):

- 29 mammals: 21 non-volant, 8 volant (bats),
- 151 birds,
- 22 reptiles, and
- 9 amphibians.

Twelve fauna species are introduced or naturalised species. Invertebrates, marine or aquatic dependant species (fish) are not included. Some near coastal or wetland taxa may be included in the list even though they may not occur within the study area.

3.3.2 *Fauna of conservation significance*

Based on the evaluation provided in Appendix D, there are 21 terrestrial vertebrate fauna of conservation significance that may occur locally, though not necessarily within the study area. An additional 19 birds are listed a Migratory though these generally would not occur at the study area. Additionally, three fish and one invertebrate of conservation significance may also potentially occur.

The Busselton Wetlands Important Bird Area occurs approximately 3.7 km to the west and is identified by Birdlife International as a conservation priority (Birdlife International, 2021). The Busselton Wetlands IBA regularly holds large numbers of waterbirds, including more than 1% of the global populations of Banded Stilt and Red-necked Avocet, occasionally more than 1% of the global populations of Australian Shelduck and Sharp-tailed Sandpiper, and regularly more than 1% of the Australian population of Black-winged Stilt (White-headed Stilt) (Birdlife International, 2021).

The study area occurs within the breeding range of all three black cockatoo species (SEWPaC 2012). Detailed species profiles are provided below.

3.4 Black cockatoo species profiles

The black cockatoo species profiles and breeding requirements are provided to inform the assessment and provide context around the assessment results.

3.4.1 Black cockatoo profiles

Baudin's cockatoo (*Calyptorhynchus baudinii*)

EN (EPBC Act), EN (BC Act)

Baudin's cockatoo is a large, iconic forest cockatoo endemic to the south west corner of WA. The species is likely to breed locally (SEWPaC 2012). It has suffered a substantial decline in number in the past 50 years. Direct causes of this decline include large numbers shot by orchardists, fragmentation of habitat and the impact of hollow competitors (Johnstone and Kirkby 2008). Depending on their region of origin, Baudin's cockatoo is a resident, a post nuptial nomad or migrant with the bulk of the population vacating the coldest parts of their range (i.e. the Karri forest block) in the autumn and migrating northwards during the non-breeding season. Small numbers also appear resident in a few places including Leeuwin – Naturaliste Ridge and Manjimup (Johnstone and Kirkby 2008). Flock sizes vary from small family groups to large aggregations at roosting sites. Breeding mainly takes place in forested areas from August to November (egg laying dates) (Tony Kirkby pers comm).

In the non-breeding season, Baudin's cockatoo is mainly an inhabitant of the Jarrah Marri Forest but is also frequently seen in farmland and orchards. It feeds on a variety of foods including nectar and seeds from hakeas and banksia spp. Also apples, persimmons, and macadamias. Overall, its main food is Marri from which it takes seeds, grubs, and nectar. Its long bill is adapted to removing seeds from Marri fruit capsules.

Roost sites are usually in smooth barked eucalypts (occasionally rough barked eucalypts, i.e. Marri, Jarrah and Blackbutt) including Wandoo, Flooded Gum, Bullich and smooth barked exotic eucalypts including plantations (Johnstone and Kirkby 2008).

Carnaby's cockatoo (*Calyptorhynchus latirostris*)

EN (EPBC Act), EN (BC Act)

The species has been recorded breeding locally (SEWPaC 2012) (SLIP 2021). It is a postnuptial nomad, tending to move west after breeding. Carnaby's cockatoo mainly occurs in or near eucalypt woodlands, especially those dominated by Wandoo or Salmon Gum, and sometimes reported in forests of Marri, Jarrah, Karri and Tuart. Nesting hollows may be located anywhere over two metres from ground, mainly in the Wheatbelt (Cale 2003, SPRAT 2019, WA Museum 2010).

It is known to forage in native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as *Banksia* spp. *Hakea* spp. And *Grevillea* spp. It forages in pine plantations, eucalypt woodland and forest that contains foraging species, individual trees and small stands of these species (SEWPAC 2012).

This species is currently expanding its breeding range westward and south into the Jarrah Marri Forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain. This may be due to climate change. Breeding occurs mainly from early July to mid-December. Breeding success is largely dependent on suitable feeding habitat adjacent to the nest site to provide the necessary food for the survival of the chick, for example adjacent pine forest or remnant vegetation (Johnstone and Kirkby, Undated). Carnaby's cockatoo is also known to breed in Karri Forest at Porongurup, Walpole, Albany, Denmark and Mount Manypeaks.

Carnaby's cockatoos are known to roost in Jarrah, Marri, Blackbutt, Bullich, exotic eucalypt species and pines.

Forest Red-tailed Black Cockatoo (FRTBC) (*Calyptorhynchus banksii naso*)

VU (EPBC Act), VU (BC Act)

The FRTBC is a large, iconic forest cockatoo, endemic to the south-west corner of Western Australia. The species may breed locally (SEWPac 2012). Formerly common, but now rare to uncommon and patchily distributed, it has disappeared from about 30% of its former range. It has suffered a marked decline in numbers over the past 60 years. The main reasons for this decline include the destruction and fragmentation of habitat (especially Jarrah Marri Forest), the apparent decline in Marri along the eastern side of the Darling Scarp, logging, the impact of hollow competitors, fire and possibly climate change (Johnstone, Kirkby and Sarti 2013a, b). FRTBC occurs throughout the Jarrah Marri Karri forested areas but in recent years has been foraging out on to the Swan Coastal Plain feeding on the seeds of Cape Lilac. Group sizes vary from small family groups and pairs to larger gatherings at roost sites.

FRTBC nest in hollows Jarrah, Marri, Blackbutt, Bullich and Wandoo. Hollows have been recorded from 6.5 – 33 m above ground (Johnstone Kirkby and Sarti 2015). FRTBC have been recorded breeding in all months but with peaks in Spring and Autumn. There are also years when very little if any breeding takes place i.e. 2008 and 2009 (Johnstone and Kirkby unpublished data).

FRTBC feed mainly on the seeds of Jarrah and Marri but also Blackbutt, Albany Blackbutt, Sheoak, Snottygobble and introduced native and non-native species such as Lemon-scented Gum, Spotted Gum, Ilyarrie and Cape Lilac (SPRAT 2019).

FRTBC are known to roost in Jarrah, Marri, Blackbutt, Bullich and introduced eucalypt species.

3.4.2 Black cockatoo breeding requirements

All three black cockatoos rely on large hollows for breeding, typically >20 cm in diameter. Hollows take many years to form. The onset of hollow-formation is dependent on damage to the tree, from fire, animals (vertebrates or invertebrates), or dropping branches. Young and healthy trees can quickly heal after damage and subsequently trees less than 100 years old are unlikely to contain hollows.

SW Environmental and Kirkby (2019) note that for nesting, black cockatoos show a preference for:

- large senescing trees,
- hollows not angled more than 45 degrees,
- entrances of at least 12 cm but usually much larger (20-30 cm),
- deep or well sheltered hollows in main trunk or large branches which are able to provide a floor space of at least 30cm diameter or more.

All three species of black cockatoo are of similar size and utilise similar types of tree hollows when breeding. The actual species of tree is probably unimportant to each individual species, for example Carnaby's cockatoo use Marri, when in the Marri Forest and Wandoo when in the Wheatbelt. All three species are known to use the same individual hollows when not occupied in the breeding season by another black cockatoo species (Kirkby pers comm, 2019). Hollows suitable for use by black cockatoos are usually in trees at least 150 years old (Koch 2009).

Marri and Jarrah are considered by Commonwealth of Australia (2017) to be large enough to develop hollows once they are >50 cm DBH. Wheatbelt species such as Wandoo and Salmon Gum may develop hollows at 30 cm DBH. Multi-stemmed or exotic tree species are much less likely to develop hollows at these sizes.

While breeding, black cockatoos will generally forage within a 6–12 km radius of their nesting site. Following breeding, birds assemble into flocks and move through the landscape searching for food, usually foraging within six kilometres of a night roost (Commonwealth of Australia 2012).

4 Results

4.1 Fauna habitat

4.1.1 *General fauna habitat*

Key fauna habitat types are listed in Table 4-1 and mapped in Figure A.3 (Appendix A). There are two habitat types within the 85 ha study area, neither associated with remnant native vegetation. Fauna habitat quality was Poor across the entire site due to a lack of native vegetation, limited structural and species diversity.

Table 4-1 Fauna habitat types over the study area

Code	Fauna habitat type	Structural vegetation description	Fauna habitat quality	Area (ha)	Photo
P	Planted	Planted belts of predominately exotic trees (up to 15 species) but with some native species <i>Corymbia calophylla</i> and <i>Eucalyptus rudis</i> . Generally, all under 50cm DBH or multi-stemmed. Occasional older planted paddock trees particularly around the buildings.	Poor	4.54	

C	Cleared	Cleared, crops, tracks and other infrastructure.	Poor	80.81
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4.1.2 Suitable DBH trees and hollows

Only 13 suitable DBH trees (species likely to develop large hollows >50cm DBH) were recorded within the study area, none of which contained hollows. Only two trees were native -one Marri and one Jarrah. The remaining trees were planted eastern States eucalypts and whilst relatively large are not likely to develop large hollows in the short or medium term. Suitable DBH trees are mapped in Figure A.4, Appendix A, with the full dataset provided in Appendix E.

4.2 Fauna recorded

Twenty-five species of fauna were observed within the study area (Table 4-2). The fauna recorded included 19 birds and six mammals (five of which are introduced). All are common species. Other faunal groups are likely to occur but are more cryptic, nocturnal or would not have been detected during the brief diurnal reconnaissance visit (such as bats, many reptiles – lizards and snakes, and frogs which may not have been calling). In addition, numerous species may use the study area as a part of a larger area of occupancy, such as other birds.

Table 4-2 Fauna recorded within the study area

Class	Family	Species Name	Vernacular Name	
Aves	ACANTHIZIDAE	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	
	ARTAMIDAE	<i>Artamus cinereus</i>	Black-faced Woodswallow	
	ARTAMIDAE	<i>Gymnorhina tibicen</i>	Australian Magpie	
	CACATUIDAE	<i>Eolophus roseicapilla</i>	Galah	
	CAMPEPHAGIDAE	<i>Coracina novaehollandiae</i>	Black-faced cuckoo-shrike	
	COLUMBIDAE	<i>Ocyphaps lophotes</i>	Crested Pigeon*	
	CORVIDAE	<i>Corvus coronoides</i>	Australian Raven	
	FALCONIDAE	<i>Falco cenchroides</i>	Nankeen Kestrel	
	HIRUNDINIDAE		<i>Hirundo neoxena</i>	Welcome Swallow
			<i>Petrochelidon ariel</i>	Fairy Martin
	MALURIDAE	<i>Malurus splendens</i>	Splendid Fairy-wren	
	MELIPHAGIDAE	<i>Anthochaera carunculata</i>	Red wattlebird	
	MEROPIDAE	<i>Merops ornatus</i>	Rainbow Bee-eater	
	MONARCHIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	
	MOTACILLIDAE	<i>Anthus novaeseelandiae</i>	Australian Pipit	
	PARDALOTIDAE	<i>Pardalotus striatus</i>	Striated Pardalote	
	PSITTACIDAE	<i>Barnardius zonarius</i>	Australian Ringneck	
	RHIPIDURIDAE		<i>Rhipidura albiscapa</i>	Grey Fantail
			<i>Rhipidura leucophrys</i>	Willie Wagtail
Mammalia	BOVIDAE	<i>Bos taurus</i>	European Cattle*	
	CANIDAE	<i>Canis lupus</i>	Dog*	
		<i>Vulpes vulpes</i>	Fox*	
	EQUIDAE	<i>Equus caballus</i>	Horse*	
	LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit*	
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		

4.3 Fauna of conservation significance

4.3.1 Local records

The desktop assessment identified 21 fauna of conservation significance, recorded or likely to occur within five kilometres of the study area (see Appendix C.2). A threatened fauna evaluation table was prepared for conservation significant fauna based on the desktop assessment and site reconnaissance (Appendix D). It excludes marine, marine migratory and regionally extinct species and has been updated with other records where the species may occur. Fauna of conservation significance that possibly occur or were encountered within the study area are summarised in Table 4-3. Taxa that may occur within the study area are considered further in Section 4.3.2.

Table 4-3 Conservation significant fauna that may occur within the study area, based on habitat suitability.

Family <i>Genus species</i>	Vernacular	Status Federal	Stat. WA	Presence of habitat	Likelihood of occurrence
CACATUIDAE <i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	Marginal foraging - supporting	Possible
<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	EN	EN		
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN		
FALCONIDAE <i>Falco peregrinus</i>	Peregrine Falcon	-	OS		
STRIGIDAE <i>Tyto novaehollandiae sub sp. novaehollandiae</i>	Masked Owl (southern sub sp)	-	P3		

4.3.2 Species profiles and study area values

The following sections considers the value of the study area to fauna of conservation significance that possibly occur or were encountered within the study area. The study area is considered unlikely to provide any core or supporting habitat for target fauna, as defined below.

- *Present - core: Potential or known habitat present within the study area. Consists of "habitat critical to the survival of a species" which refers to core areas that are necessary for activities such as foraging, breeding, roosting, or dispersal, necessary for the long-term maintenance of the species to maintain genetic diversity and long term evolutionary development (Department of the Environment 2013) or habitat types recognised in recovery plans or guidelines.*
- *Present - supporting: Likely to provide dispersal, transitory or supporting habitat that may support core / critical habitat areas, such as small areas of lesser quality habitat where an animal has a large home range.*

The site may provide *Marginal foraging – supporting habitat* for several target species, given a small component of the planting are native species.

Black cockatoos

BREEDING HABITAT AND ROOST SITES

No hollows were observed within the study area and only two suitable DBH trees were native. These are insignificant in a local context. For example, even the adjacent Ruabon Road provides considerably better habitat quality than the study area, with native remnant Jarrah Marri Woodland containing numerous large trees and hollows. None of the remaining 11 exotic Eucalypts over 50cm DBH contained hollows. The planted belts of trees were all less than 20 years old and subsequently also too young to be of a suitable size to support large hollows.

No roost trees were identified during the field work.

FORAGING HABITAT

Foraging habitat within the study area is limited to planted Marri trees, which occur amongst up to 12-15 exotic species, most of which are eastern states eucalypts. Estimates of Marri abundance within the study area may be less than 10% of the total mix. No feed residue was observed within the study area. Whilst the other species may have some feed potential the vegetation within the study area would not be considered 'high quality' black cockatoo foraging habitat.

In addition to the adjacent road reserves with relative intact Jarrah Marri communities, the desktop study identified 23 State reserves within 12 km of the study area, with significant tracts of contiguous National Park and State Forest located 1.3 km west of the study area. Approximately 19% of the land within 12 km of the study area is mapped as native vegetation (Government of Western Australia 2020). These areas outside of the study area are likely to provide the majority of local black cockatoo feed resources.

Peregrine Falcon (*Falco peregrinus*) OS

Peregrine Falcons occur in woodland, plains, gorges, wetlands but tend to breed either in stick-nests in trees or nest on cliff ledges. It appears that hollows and large abandoned nests of other birds may be used where cliff ledges are limited. Where good habitat occurs, and the density of Peregrine Falcons is high, active nests may occur within 2.5km of each other. The diet of the Peregrine Falcon includes wood duck, pigeons and doves, galahs, rosellas and cockatoo, starlings and larks (Olsen et al. 2006).

Recorded locally but from forested areas (Naturemap 2021). Peregrine Falcons are wide ranging, with abundant habitat locally. They weren't observed during the site visit, and the planted vegetation may contribute to low quality habitat and part of a broader area of occupancy (supporting habitat). Clearing is unlikely to result in any direct impacts given no nests were observed.

Masked Owl (southern sub sp) (*Tyto novaehollandiae subsp. novaehollandiae*) P3

Inhabits forests, open woodlands and farmlands with large trees, including timber watercourses paperbark woodlands. Widespread but very sparse, they breed any time of the year when conditions are favourable with a nesting period of about three months (Pizzey and Knight 2007).

Recorded locally but with limited habitat within the study area (marginal foraging and no breeding) (Naturemap 2021). Wide ranging but sparse. Given the lack of hollows within the study area and that any habitat locally could be potentially considered part of a broader area of occupancy (feeding grounds), clearing is unlikely to result in any direct impact to this species.

5 Conclusions and Recommendations

The following points summarise the fauna values of the study area:

- The study area consists of cropped and grazed paddocks with intentionally planted belts of trees (planted circa 2013), several sheds and two houses with some older planted trees around the buildings.
- There are two habitat types within the 85 ha study area, neither associated with remnant native vegetation. Fauna habitat quality was Poor:
 1. Planted - Planted belts of predominately exotic trees (up to 15 species) but with some native species *Corymbia calophylla* and *Eucalyptus rudis*. Generally, all under 50cm DBH or multi-stemmed. Occasional older planted paddock trees particularly around the buildings (4.54 ha),
 2. Cleared - Cleared, crops, tracks and other infrastructure (80.81 ha).
- The study area occurs over sandy soils without any drainage lines or watercourses.
- Twenty-five species of fauna were recorded from the 210 that may occur based on desktop assessment. This included 19 birds and six mammals (five of which are introduced). All are common species. No target species were observed, though 21 fauna of conservation significance may occur locally.
- Targeted black cockatoo surveys identified the following
 1. The study area occurs within the breeding range of all three black cockatoo species (SEWPaC 2012).
 2. Only 13 suitable DBH trees (species likely to develop large hollows >50cm DBH) recorded within the study area, none of which contained hollows. Only two trees were native -one Marri and one Jarrah. The remaining trees were planted eastern States eucalypts not likely to develop large hollows in the short or medium term.
 3. No roost trees were identified during the field work.
 4. Foraging habitat within the study area is limited to planted Marri trees, which occur amongst up to 12- 15 exotic species, most of which are eastern states eucalypts. Estimates of Marri abundance within the study area may be less than 10% of the total mix. No feed residue was observed within the study area. Whilst the other species may have some feed potential the vegetation within the study area would be not considered 'high quality' black cockatoo foraging habitat.
- The site may also provide *Marginal foraging – supporting habitat* for Peregrine Falcon and Masked Owl (southern sub sp), given a small component of the planting are native species. Direct impacts on target fauna are unlikely.

- There are 23 State reserves within 12 km of the study area, with the most significant being the Ludlow State Forest and Tuart Forest National Park located approximately 1.3 km west of the project.
- Generally lacking remnant native vegetation, the study area is not located within any mapped SWREL buffers or axis lines (Molloy et al 2009).

The following recommendations are made:

- Vegetation should be retained where possible.
- Clearing should be conducted outside of spring to minimise impacts to breeding fauna.

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Appendix A Figures

Figure A.1 Study area

Figure A.2 Locality

Figure A.3 Fauna habitats and suitable DBH trees



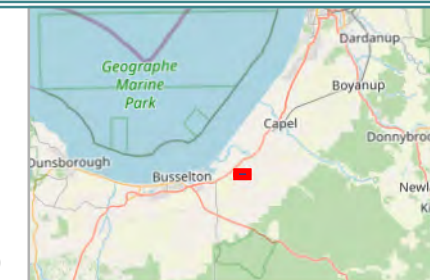
FIGURE 1 STUDY AREA

BASIC AND TARGETED FAUNA SURVEY
 RUABON ROAD STAGE 1
 (LOTS 834 AND 2689), RUABON

- Road
- Study area

Ref: SW350 F1
 Date: 20/12/2021 Author: SP

Source: Base map © Esri and its data suppliers. SLIP Landgate (2021)



A3 @ 1:6000

0 25 50 100m

GRID: GDA zone 50





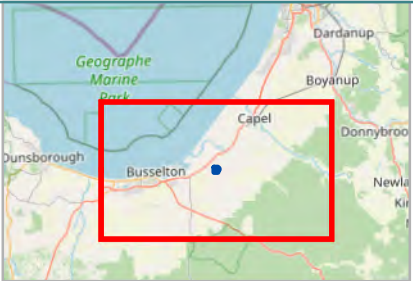
FIGURE 2 LOCALITY

**BASIC AND TARGETED FAUNA SURVEY
RUABON ROAD STAGE 1
(LOTS 834 AND 2689), RUABON**

- Road
- Major watercourse
- Minor drainage line
- Study area
- DBCA managed land
- 12 km buffer
- Locality (5 km)

Ref: SW350 F1
Date: 20/12/2021 Author: SP

Source: Base map © Esri and its data suppliers. SLIP Landgate (2021)



A3 @ 1:115000

0 0.5 1 2 km

GRID: GDA zone 50





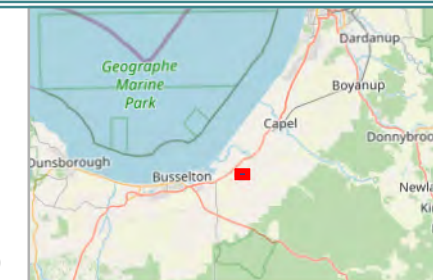
FIGURE 3 FAUNA HABITATS AND SUITABLE DBH TREES

BASIC AND TARGETED FAUNA SURVEY
 RUABON ROAD STAGE 1
 (LOTS 834 AND 2689), RUABON

- Suitable DBH tree
- ▭ Study area
- Planted
- Road

Ref: SW350 F4
 Date: 21/12/2021 Author: SP

Source: Base map © Esri and its data suppliers. SLIP Landgate (2021)



A3 @ 1:5000
 0 25 50 100 m
 GRID: GDA zone 50

Appendix B Conservation codes

Fauna in WA may be afforded protection under the WA BC Act and or federal EPBC Act. Species listed as threatened or migratory under the above legislation are referred to collectively in this document as being 'conservation significant' or 'target' species. These terms include species and communities listed under the DBCA Priority lists.

BC Act

The WA BC Act and associated Regulations provide for the licensing and management of activities that affect biodiversity. The BC Act provides for the listing of threatened native animals (fauna) that need protection as critically endangered, endangered or vulnerable species because they are under identifiable threat of extinction (species).

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* contain the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act. These are described below.

Threatened species and communities

- PD: Presumed totally destroyed (TECs only)
- CR: Critically endangered species
- EN: Endangered species
- VU: Vulnerable species

Extinct species

- EX: Extinct species
- EW: Extinct in the wild species

Specially protected species

- MI: Migratory species
- CD: Species of special conservation interest (conservation dependent fauna)
- OS: Other specially protected species

Priority species and communities

- Priority 1: Poorly-known species
- Priority 2: Poorly-known species
- Priority 3: Poorly-known species
- Priority 4: Rare, Near Threatened and other species in need of monitoring
- Priority Ecological Community (PEC): Where communities are considered rare but not (currently) threatened or there is insufficient information available for the community to be considered a TEC, communities can be listed as priority ecological communities (PECs).

A full description of conservation codes is provided in Appendix B.

EPBC Act

In accordance with Commonwealth legislation, the EPBC Act provides a list of 'Matters of National Environmental Significance' (NES), which includes significant fauna. Under the EPBC Act fauna matters of NES may be listed in any one of the following categories as defined in *Section 179* of the Act:

- Extinct,
- *Extinct in the wild,
- *Critically endangered,
- *Endangered,
- *Vulnerable,
- Conservation dependent.

*Only these categories are matters of NES under the Act.

The EPBC Act also lists migratory species that are recognized under international treaties including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA) and the Bonn Convention (The Convention on the conservation of Migratory Species of Wild Animals). The EPBC Act is regulated by the DAWE.

IUCN Red List

The IUCN Red List is an inventory of the global conservation status of species and used to assist DBCA and other agencies in attributing a given threatened species status. It does not have any statutory authority and is not considered in detail in this assessment.



CONSERVATION CODES

For Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora¹ are species² which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR **Critically endangered species**

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN **Endangered species**

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU **Vulnerable species**

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where “*there is no reasonable doubt that the last member of the species has died*”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that “*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

¹ The definition of flora includes algae, fungi and lichens

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

Appendix C Potential fauna list and fauna recorded

Appendix C.1 Fauna within 5 km ALA (2021), (Naturemap (2021), Biologic (2013), Ecosystem Solutions (2019), Ecoedge and Harewood (2019).

Class	Family	Species Name	Vernacular Name	Cons. status	Recorded Study area
Amphibia	HYLIDAE	<i>Litoria adelaidensis</i>	Slender Tree Frog		
Amphibia	HYLIDAE	<i>Litoria moorei</i>	Moore's Frog		
Amphibia	LIMNODYNASTIDAE	<i>Heleioporus eyrei</i>	Moaning Frog		
Amphibia	LIMNODYNASTIDAE	<i>Heleioporus inornatus</i>	Whooping Frog		
Amphibia	LIMNODYNASTIDAE	<i>Limnodynastes dorsalis</i>	Sand Frog		
Amphibia	MYOBATRACHIDAE	<i>Crinia georgiana</i>	Quacking Froglet		
Amphibia	MYOBATRACHIDAE	<i>Crinia glauerti</i>	Clicking Froglet		
Amphibia	MYOBATRACHIDAE	<i>Crinia insignifera</i>	Squelching Froglet		
Amphibia	MYOBATRACHIDAE	<i>Geocrinia leai</i>	Ticking Frog		
Aves	ACANTHIZIDAE	<i>Acanthiza apicalis</i>	Inland Thornbill		
Aves	ACANTHIZIDAE	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill		x
Aves	ACANTHIZIDAE	<i>Acanthiza inornata</i>	Western Thornbill		
Aves	ACANTHIZIDAE	<i>Gerygone fusca</i>	Western Gerygone		
Aves	ACANTHIZIDAE	<i>Sericornis frontalis</i>	White-browed Scrubwren		
Aves	ACANTHIZIDAE	<i>Smicronis brevirostris</i>	Weebill		
Aves	ACCIPITRIDAE	<i>Accipiter fasciatus</i>	Brown Goshawk		
Aves	ACCIPITRIDAE	<i>Aquila audax</i>	Wedge-tailed Eagle		
Aves	ACCIPITRIDAE	<i>Circus approximans</i>	Swamp harrier		
Aves	ACCIPITRIDAE	<i>Elanus axillaris</i>	Black-shouldered Kite		
Aves	ACCIPITRIDAE	<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle		
Aves	ACCIPITRIDAE	<i>Haliaeetus sphenurus</i>	Whistling Kite		
Aves	ACCIPITRIDAE	<i>Hieraaetus morphnoides</i>	Little Eagle		
Aves	ACCIPITRIDAE	<i>Lophoictinia isura</i>	Square-tailed Kite		
Aves	ACCIPITRIDAE	<i>Pandion haliaetus</i>	Osprey	IA	
Aves	ACROCEPHALIDAE	<i>Acrocephalus australis</i>	Australian Reed Warbler		
Aves	ALCEDINIDAE	<i>Dacelo novaeguineae</i>	Kookaburra*		
Aves	ALCEDINIDAE	<i>Todiramphus sanctus</i>	Sacred Kingfisher		
Aves	ANATIDAE	<i>Anas castanea</i>	Chestnut Teal		
Aves	ANATIDAE	<i>Anas gracilis</i>	Grey teal		
Aves	ANATIDAE	<i>Anas platyrhynchos</i>	Mallard		
Aves	ANATIDAE	<i>Anas rhynchotis</i>	Australasian Shoveler		
Aves	ANATIDAE	<i>Anas superciliosa</i>	Pacific Black Duck		
Aves	ANATIDAE	<i>Aythya australis</i>	Hardhead		
Aves	ANATIDAE	<i>Biziura lobata</i>	Musk Duck		
Aves	ANATIDAE	<i>Chenonetta jubata</i>	Australian Wood Duck		
Aves	ANATIDAE	<i>Cygnus atratus</i>	Black Swan		
Aves	ANATIDAE	<i>Malacorhynchus membranaceus</i>	Pink-eared Duck		
Aves	ANATIDAE	<i>Oxyura australis</i>	Blue-billed Duck	P4	
Aves	ANATIDAE	<i>Tadorna tadornoides</i>	Australian Shelduck		

Class	Family	Species Name	Vernacular Name	Cons. status	Recorded Study area
Aves	ANHINGIDAE	<i>Anhinga novaehollandiae</i>	Australasian Darter		
Aves	ARDEIDAE	<i>Ardea alba</i>	Great Egret		
Aves	ARDEIDAE	<i>Ardea ibis</i>	Cattle Egret		
Aves	ARDEIDAE	<i>Ardea modesta</i>	Eastern Great Egret		
Aves	ARDEIDAE	<i>Ardea pacifica</i>	White-necked Heron		
Aves	ARDEIDAE	<i>Egretta garzetta</i>	Little Egret		
Aves	ARDEIDAE	<i>Egretta novaehollandiae</i>	White-faced Heron		
Aves	ARDEIDAE	<i>Nycticorax caledonicus</i>	Rufous Night Heron		
Aves	ARTAMIDAE	<i>Artamus cinereus</i>	Black-faced Woodswallow		x
Aves	ARTAMIDAE	<i>Artamus cyanopterus</i>	Dusky Woodswallow		
Aves	ARTAMIDAE	<i>Cracticus torquatus</i>	Grey Butcherbird		
Aves	ARTAMIDAE	<i>Gymnorhina tibicen</i>	Australian Magpie		x
Aves	CACATUIDAE	<i>Cacatua pastinator</i>	Western Long-billed Corella		
Aves	CACATUIDAE	<i>Cacatua sanguinea</i>	Little Corella		
Aves	CACATUIDAE	<i>Calyptorhynchus banksii subsp. naso</i>	Forest Red-tailed Black Cockatoo	T	
Aves	CACATUIDAE	<i>Calyptorhynchus baudinii</i>	Baudin's Cockatoo	T	
Aves	CACATUIDAE	<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	T	
Aves	CACATUIDAE	<i>Eolophus roseicapilla</i>	Galah		x
Aves	CAMPEPHAGIDAE	<i>Coracina novaehollandiae</i>	Black-faced cuckoo-shrike		x
Aves	CASUARIIDAE	<i>Dromaius novaehollandiae</i>	Emu		
Aves	CHARADRIIDAE	<i>Charadrius bicinctus</i>	Double-banded Plover	IA	
Aves	CHARADRIIDAE	<i>Charadrius leschenaultii</i>	Greater Sand Plover	T	
Aves	CHARADRIIDAE	<i>Charadrius ruficapillus</i>	Red-capped Dotterel		
Aves	CHARADRIIDAE	<i>Elseyornis melanops</i>	Black-fronted Dotterel		
Aves	CHARADRIIDAE	<i>Pluvialis fulva</i>	Pacific golden plover	IA	
Aves	CHARADRIIDAE	<i>Pluvialis squatarola</i>	Grey plover	IA	
Aves	CHARADRIIDAE	<i>Vanellus miles</i>	Masked Lapwing		
Aves	CHARADRIIDAE	<i>Vanellus tricolor</i>	Banded Lapwing		
Aves	COLUMBIDAE	<i>Columba livia</i>	Domestic Pigeon*		
Aves	COLUMBIDAE	<i>Ocyphaps lophotes</i>	Crested Pigeon*		x
Aves	COLUMBIDAE	<i>Phaps chalcoptera</i>	Common Bronzewing		
Aves	COLUMBIDAE	<i>Streptopelia senegalensis</i>	Laughing Turtle-dove		
Aves	CORVIDAE	<i>Corvus coronoides</i>	Australian Raven		x
Aves	CUCULIDAE	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo		
Aves	CUCULIDAE	<i>Cacomantis pallidus</i>	Pallid Cuckoo		
Aves	CUCULIDAE	<i>Chrysococcyx lucidus</i>	Shining Bronze Cuckoo		
Aves	FALCONIDAE	<i>Falco cenchroides</i>	Nankeen Kestrel		x
Aves	FALCONIDAE	<i>Falco longipennis</i>	Australian Hobby		
Aves	FALCONIDAE	<i>Falco peregrinus</i>	Peregrine Falcon	S	
Aves	HAEMATOPODIDAE	<i>Haematopus longirostris</i>	Australian Pied Oystercatcher		
Aves	HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow		x
Aves	HIRUNDINIDAE	<i>Petrochelidon ariel</i>	Fairy Martin		x
Aves	HIRUNDINIDAE	<i>Petrochelidon nigricans</i>	Tree Martin		
Aves	LARIDAE	<i>Anous stolidus</i>	Common noddy	IA	
Aves	LARIDAE	<i>Chlidonias hybrida</i>	Whiskered tern		
Aves	LARIDAE	<i>Chroicocephalus novaehollandiae</i>	Silver Gull		
Aves	LARIDAE	<i>Hydroprogne caspia</i>	Caspian Tern	IA	
Aves	LARIDAE	<i>Larus pacificus</i>	Pacific Gull		
Aves	LARIDAE	<i>Thalasseus bergii</i>	Crested Tern	IA	

Class	Family	Species Name	Vernacular Name	Cons. status	Recorded Study area
Aves	MALURIDAE	<i>Malurus splendens</i>	Splendid Fairy-wren		x
Aves	MALURIDAE	<i>Stipiturus malachurus</i>	Southern Emu-wren		
Aves	MEGALURIDAE	<i>Cincloramphus cruralis</i>	Brown Songlark		
Aves	MELIPHAGIDAE	<i>Acanthorhynchus superciliosus</i>	Western Spinebill		
Aves	MELIPHAGIDAE	<i>Anthochaera carunculata</i>	Red wattlebird		x
Aves	MELIPHAGIDAE	<i>Epthianura albifrons</i>	White-fronted Chat		
Aves	MELIPHAGIDAE	<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater		
Aves	MELIPHAGIDAE	<i>Lichmera indistincta</i>	Brown Honeyeater		
Aves	MELIPHAGIDAE	<i>Melithreptus lunatus</i>	White-naped Honeyeater		
Aves	MELIPHAGIDAE	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater		
Aves	MEROPIIDAE	<i>Merops ornatus</i>	Rainbow Bee-eater		x
Aves	MONARCHIDAE	<i>Grallina cyanoleuca</i>	Maggpie-lark		x
Aves	MONARCHIDAE	<i>Myiagra inquieta</i>	Restless Flycatcher		
Aves	MOTACILLIDAE	<i>Anthus novaeseelandiae</i>	Australian Pipit		x
Aves	NEOSITTIDAE	<i>Daphoenositta chrysoptera</i>	Varied Sittella		
Aves	PACHYCEPHALIDAE	<i>Colluricincla harmonica</i>	Grey Shrike-thrush		
Aves	PACHYCEPHALIDAE	<i>Pachycephala occidentalis</i>	Western Whistler		
Aves	PACHYCEPHALIDAE	<i>Pachycephala pectoralis</i>	Golden Whistler		
Aves	PACHYCEPHALIDAE	<i>Pachycephala rufiventris</i>	Rufous Whistler		
Aves	PARDALOTIDAE	<i>Pardalotus punctatus</i>	Spotted Pardalote		
Aves	PARDALOTIDAE	<i>Pardalotus striatus</i>	Striated Pardalote		x
Aves	PELICANIDAE	<i>Pelecanus conspicillatus</i>	Australian Pelican		
Aves	PETROICIDAE	<i>Eopsaltria georgiana</i>	White-breasted Robin		
Aves	PETROICIDAE	<i>Eopsaltria griseogularis</i>	Western Yellow Robin		
Aves	PETROICIDAE	<i>Petroica boodang</i>	Scarlet Robin		
Aves	PHALACROCORACIDAE	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant		
Aves	PHALACROCORACIDAE	<i>Phalacrocorax carbo</i>	Great Cormorant		
Aves	PHALACROCORACIDAE	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		
Aves	PHALACROCORACIDAE	<i>Phalacrocorax varius</i>	Pied Cormorant		
Aves	PHASIANIDAE	<i>Coturnix pectoralis</i>	Stubble Quail		
Aves	PODARGIDAE	<i>Podargus strigoides</i>	Tawny Frogmouth		
Aves	PODICIPEDIDAE	<i>Podiceps cristatus</i>	Crested Grebe		
Aves	PODICIPEDIDAE	<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe		
Aves	PODICIPEDIDAE	<i>Tachybaptus novaehollandiae</i>	Australasian Little Grebe		
Aves	PROCELLARIIDAE	<i>Pterodroma macroptera</i>	Great-winged Petrel		
Aves	PSITTACIDAE	<i>Barnardius zonarius</i>	Australian Ringneck		x
Aves	PSITTACIDAE	<i>Neophema elegans</i>	Elegant Parrot		
Aves	PSITTACIDAE	<i>Parvipsitta porphyrocephala</i>	Purple-crowned Lorikeet		
Aves	PSITTACIDAE	<i>Platycercus icterotis</i>	Western Rosella		
Aves	PSITTACIDAE	<i>Polytelis anthopeplus</i>	Regent Parrot		
Aves	PSITTACIDAE	<i>Purpureicephalus spurius</i>	Red-capped Parrot		
Aves	RALLIDAE	<i>Fulica atra</i>	Eurasian Coot		
Aves	RALLIDAE	<i>Gallinula tenebrosa</i>	Dusky Moorhen		
Aves	RALLIDAE	<i>Gallirallus philippensis</i>	Buff-banded rail		
Aves	RALLIDAE	<i>Porphyrio porphyrio</i>	Purple Swamphen		
Aves	RALLIDAE	<i>Porzana tabuensis</i>	Spotless Crake		
Aves	RECURVIROSTRIDAE	<i>Cladorhynchus leucocephalus</i>	Banded Stilt		
Aves	RECURVIROSTRIDAE	<i>Himantopus himantopus</i>	Black Winged Stilt		
Aves	RECURVIROSTRIDAE	<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet		

Class	Family	Species Name	Vernacular Name	Cons. status	Recorded Study area
Aves	RHIPIDURIDAE	<i>Rhipidura albiscapa</i>	Grey Fantail		x
Aves	RHIPIDURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail		x
Aves	SCOLOPACIDAE	<i>Actitis hypoleucos</i>	Common Sandpiper	IA	
Aves	SCOLOPACIDAE	<i>Arenaria interpres</i>	Turnstone	IA	
Aves	SCOLOPACIDAE	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	IA	
Aves	SCOLOPACIDAE	<i>Calidris ferruginea</i>	Curlew Sandpiper	T	
Aves	SCOLOPACIDAE	<i>Calidris melanotos</i>	Pectoral Sandpiper	IA	
Aves	SCOLOPACIDAE	<i>Calidris ruficollis</i>	Red-necked Stint	IA	
Aves	SCOLOPACIDAE	<i>Calidris subminuta</i>	Long-toed Stint	IA	
Aves	SCOLOPACIDAE	<i>Limosa limosa</i>	Black-tailed Godwit	IA	
Aves	SCOLOPACIDAE	<i>Numenius phaeopus</i>	Whimbrel	IA	
Aves	SCOLOPACIDAE	<i>Tringa glareola</i>	Wood Sandpiper	IA	
Aves	SCOLOPACIDAE	<i>Tringa nebularia</i>	Greenshank	IA	
Aves	SCOLOPACIDAE	<i>Tringa stagnatilis</i>	Marsh Sandpiper	IA	
Aves	STRIGIDAE	<i>Ninox novaeseelandiae</i>	Southern Boobook		
Aves	THRESKIORNITHIDAE	<i>Platalea flavipes</i>	Yellow-billed Spoonbill		
Aves	THRESKIORNITHIDAE	<i>Plegadis falcinellus</i>	Glossy Ibis	IA	
Aves	THRESKIORNITHIDAE	<i>Threskiornis moluccus</i>	Australian White Ibis		
Aves	THRESKIORNITHIDAE	<i>Threskiornis spinicollis</i>	Straw-necked Ibis		
Aves	TIMALIIDAE	<i>Zosterops lateralis</i>	Silvereeye		
Aves	TURNICIDAE	<i>Turnix varius</i>	Painted Button-quail		
Aves	TYTONIDAE	<i>Tyto javanica</i>	Eastern Barn Owl		
Aves	TYTONIDAE	<i>Tyto novaehollandiae</i>	Masked Owl	P3	
Fish	GALAXIIDAE	<i>Galaxias occidentalis</i>	Western Minnow		
Fish	GALAXIIDAE	<i>Galaxiella munda</i>	Mud Minnow	T	
Fish	GALAXIIDAE	<i>Galaxiella nigrostriata</i>	Black-stripe minnow	T	
Fish	PERCICHTHYIDAE	<i>Nannatherina balstoni</i>	Balston's Pygmy Perch	T	
Invertebrate	HYRIIDAE	<i>Westralunio carteri</i>	Carter's Freshwater Mussel	T	
Mammalia	BOVIDAE	<i>Bos taurus</i>	European Cattle*		x
Mammalia	BOVIDAE	<i>Ovis aries</i>	Sheep*		
Mammalia	BURRAMYIDAE	<i>Cercartetus concinnus</i>	Western Pygmy-possum		
Mammalia	CANIDAE	<i>Canis lupus</i>	Dog*		x
Mammalia	CANIDAE	<i>Vulpes vulpes</i>	Fox*		x
Mammalia	DASYURIDAE	<i>Dasyurus geoffroi</i>	Chuditch, Western Quoll	T	
Mammalia	DASYURIDAE	<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	CD	
Mammalia	EQUIDAE	<i>Equus caballus</i>	Horse*		x
Mammalia	FELIDAE	<i>Felis catus</i>	Cat*		
Mammalia	LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit*		x
Mammalia	MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		x
Mammalia	MACROPODIDAE	<i>Notamacropus irma</i>	Western Brush Wallaby	P4	
Mammalia	MACROPODIDAE	<i>Setonix brachyurus</i>	Quokka	T	
Mammalia	MOLOSSIDAE	<i>Mormopterus planiceps</i>	Southern Freetail-bat		
Mammalia	MOLOSSIDAE	<i>Tadarida australis</i>	White-striped Freetail-bat		
Mammalia	MURIDAE	<i>Hydromys chrysogaster</i>	Water-Rat	P4	
Mammalia	MURIDAE	<i>Mus musculus</i>	House Mouse*		
Mammalia	MURIDAE	<i>Rattus fuscipes</i>	Western Bush Rat		
Mammalia	MURIDAE	<i>Rattus rattus</i>	Black Rat*		
Mammalia	PERAMELIDAE	<i>Isodon fusciventer</i>	Southern Brown Bandicoot	P4	
Mammalia	PHALANGERIDAE	<i>Trichosurus vulpecula</i>	Common Brushtail Possum		
Mammalia	PSEUDOCHEIRIDAE	<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	T	
Mammalia	TARSIPEDIDAE	<i>Tarsipes rostratus</i>	Honey Possum		
Mammalia	VESPERTILIONIDAE	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		

Class	Family	Species Name	Vernacular Name	Cons. status	Recorded Study area
Mammalia	VESPERTILIONIDAE	<i>Chalinolobus morio</i>	Chocolate Wattled Bat		
Mammalia	VESPERTILIONIDAE	<i>Falsistrellus mackenziei</i>	Western False Pipistrelle	P4	
Mammalia	VESPERTILIONIDAE	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		
Mammalia	VESPERTILIONIDAE	<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat		
Mammalia	VESPERTILIONIDAE	<i>Vespadelus regulus</i>	Southern Forest Bat		
Reptilia	ELAPIDAE	<i>Elapognathus coronatus</i>	Western Crowned Snake		
Reptilia	ELAPIDAE	<i>Parasuta nigriceps</i>	Mitchell's Short-tailed Snake		
Reptilia	ELAPIDAE	<i>Pseudonaja affinis</i>	Dugite		
Reptilia	GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko		
Reptilia	PYGOPODIDAE	<i>Aprasia pulchella</i>	Pretty Worm-lizard		
Reptilia	PYTHONIDAE	<i>Morelia spilota subsp. imbricata</i>	Carpet Python		
Reptilia	SCINCIDAE	<i>Acritoscincus trilineatum</i>	South-western Cool Skink		
Reptilia	SCINCIDAE	<i>Cryptoblepharus buchananii</i>	Buchanans Snake-eyed Skink		
Reptilia	SCINCIDAE	<i>Ctenotus impar</i>	Odd-striped Ctenotus		
Reptilia	SCINCIDAE	<i>Ctenotus labillardieri</i>	Common South-west Ctenotus		
Reptilia	SCINCIDAE	<i>Ctenotus ora</i>	Coastal Plains Skink	P3	
Reptilia	SCINCIDAE	<i>Egernia kingii</i>	King's Skink		
Reptilia	SCINCIDAE	<i>Egernia napoleonis</i>	South-western Crevice-skink		
Reptilia	SCINCIDAE	<i>Hemiernis gracilipes</i>	South-western Mulch-skink		
Reptilia	SCINCIDAE	<i>Hemiernis peronii</i>	Lowlands Earless Skink		
Reptilia	SCINCIDAE	<i>Lerista distinguenda</i>	South-Western Orange-Tailed Slider		
Reptilia	SCINCIDAE	<i>Lerista elegans</i>	Elegant Slider		
Reptilia	SCINCIDAE	<i>Menetia greyii</i>	Common Dwarf Skink		
Reptilia	SCINCIDAE	<i>Morethia lineocellata</i>	West Coast Morethia Skink		
Reptilia	SCINCIDAE	<i>Tiliqua rugosa</i>	Bobtail		
Reptilia	TYPHLOPIDAE	<i>Anilius australis</i>	Southern Blind Snake		
Reptilia	VARANIDAE	<i>Varanus rosenbergi</i>	Heath Monitor		

Appendix C.2 Naturemap and PMST database results



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 15/12/21 13:35:00

[Summary](#)

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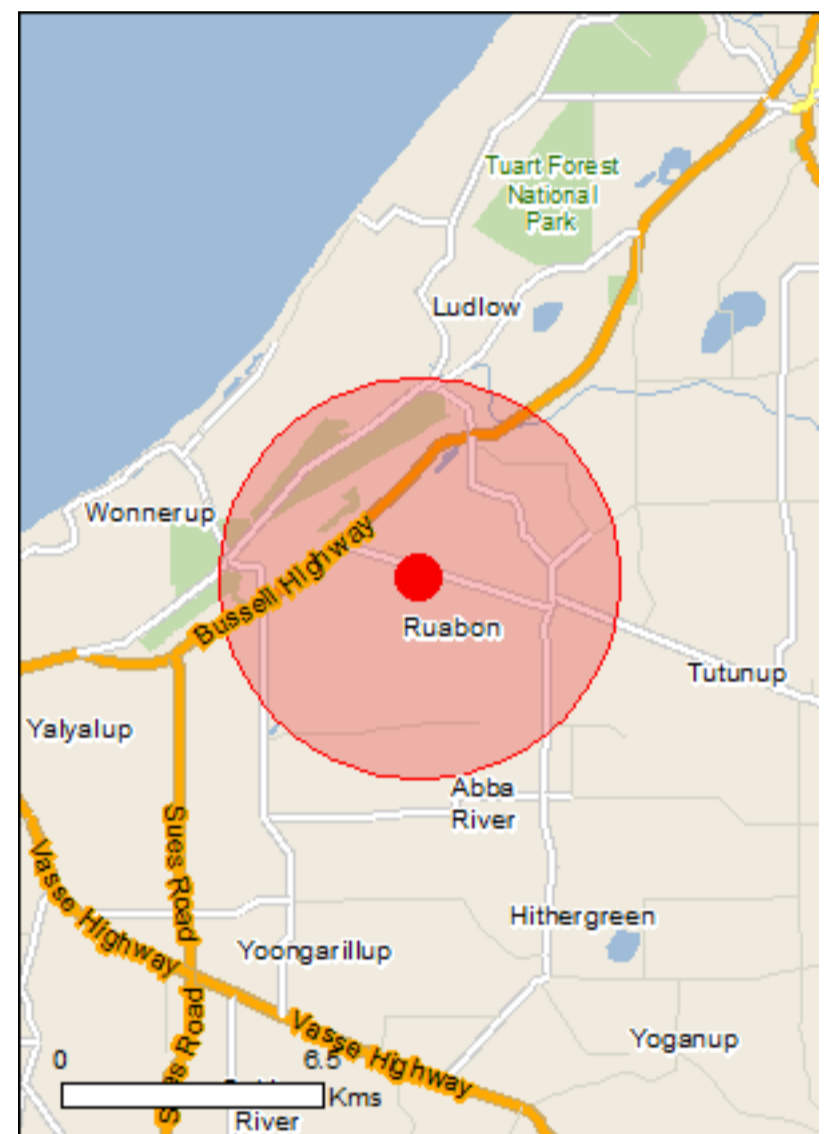
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[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

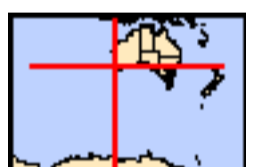
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	51
Listed Migratory Species:	33

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	40
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	3
Regional Forest Agreements:	None
Invasive Species:	25
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Vasse-wonnerup system	Within Ramsar site

Listed Threatened Ecological Communities [\[Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Tuart (<i>Eucalyptus gomphocephala</i>) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [\[Resource Information \]](#)

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Breeding known to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence within area
Plants		
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	Endangered	Species or species habitat known to occur within area
Banksia squarrosa subsp. argillacea Whicher Range Dryandra [82769]	Vulnerable	Species or species habitat known to occur within area
Brachyscias verecundus Ironstone Brachyscias [81321]	Critically Endangered	Species or species habitat may occur within area
Caladenia busselliana Bussell's Spider-orchid [24369]	Endangered	Species or species habitat likely to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Chamelaucium sp. S coastal plain (R.D.Royce 4872) Royce's Waxflower [87814]	Vulnerable	Species or species habitat known to occur within area
Darwinia whicherensis Abba Bell [83193]	Endangered	Species or species habitat likely to occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat may occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leaved Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area
Grevillea elongata Ironstone Grevillea [64578]	Vulnerable	Species or species habitat likely to occur within area
Grevillea maccutcheonii McCutcheon's Grevillea [64522]	Endangered	Species or species habitat likely to occur within area
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Petrophile latericola Laterite Petrophile [64532]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat may occur within area
Tetraria australiensis Southern Tetraria [10137]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence within area
Verticordia densiflora var. pedunculata Long-stalked Featherflower [55689]	Endangered	Species or species habitat known to occur within area
Verticordia plumosa var. vassensis Vasse Featherflower [55804]	Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	habitat likely to occur within area Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [\[Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name

Commonwealth Land -

Listed Marine Species [\[Resource Information \]](#)

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Charadrius bicinctus Double-banded Plover [895]		Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species

Name	Threatened	Type of Presence
Thalassarche cauta Shy Albatross [89224]	Endangered	habitat known to occur within area Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Mammals		
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Extra Information

State and Territory Reserves [\[Resource Information \]](#)

Name	State
Ruabon Townsite	WA
Tuart Forest	WA
Unnamed WA44838	WA

Invasive Species [\[Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
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Birds

Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area

Mammals

Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area

Plants

Name	Status	Type of Presence
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Nationally Important Wetlands		[Resource Information]
Name		State
Vasse-Wonnerup Wetland System		WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-33.64092 115.47553

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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NatureMap Species Report

Created By Guest user on 15/12/2021

Kingdom Animalia
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 28' 37" E, 33° 38' 33" S
Buffer 5km
Group By Kingdom

Kingdom	Species	Records
Animalia	24	251
TOTAL	24	251

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Animalia				
1.	41323 <i>Actitis hypoleucos</i> (Common Sandpiper)		IA	
2.	24788 <i>Calidris ruficollis</i> (Red-necked Stint)		IA	
3.	24731 <i>Calyptorhynchus banksii</i> subsp. <i>naso</i> (Forest Red-tailed Black Cockatoo)		T	
4.	24733 <i>Calyptorhynchus baudinii</i> (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)		T	
5.	24734 <i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)		T	
6.	48400 <i>Calyptorhynchus</i> sp. (white-tailed black cockatoo)		T	
7.	25575 <i>Charadrius leschenaultii</i> (Greater Sand Plover)		T	
8.	25624 <i>Falco peregrinus</i> (Peregrine Falcon)		S	
9.	24215 <i>Hydromys chrysogaster</i> (Water-rat, Rakali)		P4	
10.	48587 <i>Hydroprogne caspia</i> (Caspian Tern)		IA	
11.	48588 <i>Isoodon fusciventer</i> (Quenda, southwestern brown bandicoot)		P4	
12.	24168 <i>Macrotis lagotis</i> (Bilby, Dalgyte, Ninu)		T	
13.	48022 <i>Notamacropus irma</i> (Western Brush Wallaby)		P4	
14.	24328 <i>Oxyura australis</i> (Blue-billed Duck)		P4	
15.	48591 <i>Pandion cristatus</i> (Osprey, Eastern Osprey)		IA	
16.	48070 <i>Phascogale tapoatafa</i> subsp. <i>wambenger</i> (South-western Brush-tailed Phascogale, Wambenger)		S	
17.	24843 <i>Plegadis falcinellus</i> (Glossy Ibis)		IA	
18.	24166 <i>Pseudocheirus occidentalis</i> (Western Ringtail Possum, ngwayir)		T	
19.	24240 <i>Pseudomys occidentalis</i> (Western Mouse)		P4	
20.	48597 <i>Thalasseus bergii</i> (Crested Tern)		IA	
21.	24806 <i>Tringa glareola</i> (Wood Sandpiper)		IA	
22.	24808 <i>Tringa nebularia</i> (Common Greenshank, greenshank)		IA	
23.	24809 <i>Tringa stagnatilis</i> (Marsh Sandpiper, little greenshank)		IA	
24.	34113 <i>Westralunio carteri</i> (Carter's Freshwater Mussel)		T	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix D Threatened Fauna Evaluation

Table E.1 provides an evaluation of the presence of habitat and the likelihood of occurrence for conservation significant (target) fauna species. The species list was derived from database searches (ALA, Naturemap and PMST reporting tool, 2021), literature and expert consultation, and assessed against habitat observed within the study area. The potential to be impacted depends on the final nature of the final impacts proposed, habitat utilised by the target species and the likelihood of occurrence. The presence of habitat is broken into four categories:

- **Present - core:** Potential or known habitat present within the study area. Consists of "habitat critical to the survival of a species" which refers to core areas that are necessary for activities such as foraging, breeding, roosting, or dispersal, necessary for the long-term maintenance of the species to maintain genetic diversity and long term evolutionary development (Department of the Environment 2013) or habitat types recognised in recovery plans or guidelines.
- **Present - supporting:** Likely to provide dispersal, transitory or supporting habitat that may support core / critical habitat areas, such as small areas of lesser quality habitat where an animal has a large home range.
- **Marginal:** Habitat present is not typical but may be suitable, or habitat is typical, but condition and microhabitat requirements of species are not present.
- **Absent:** No potential or known habitat is present within the project area.

There are four categories for likelihood of occurrence:

- **Nil:** Species known or predicted to occur within the locality but no suitable habitat within the project area.
- **Unlikely:** Species known or predicted within the locality. Suitable habitat may be present in the project area, but the proximity of nearest records suggests it is unlikely to occur.
- **Possible:** Suitable habitat present and the species could occur in the project area based on the proximity of nearest records.
- **Present:** Species was recorded during the field investigations.

Some fauna have been excluded as they are not relevant to the proposal or would not be impacted:

- Marine (e.g. seals, dolphins, whales, penguins).
- Marine migratory species (e.g. Albatrosses) or where breeding is in the northern hemisphere, e.g. those from the family Scolopacidae: Shorebirds and waders, e.g. *Charadrius leschenaultia* (Greater Sand Plover).
- Species considered regionally extinct (e.g. Malleefowl, Woylie, Noisy Scrub-bird, Heath Mouse).
- Aquatic (Blue-billed Duck) where there are no large waterbodies.

Conservation status is as per the (federal) EPBC Act and (WA) DBCA Parks and Wildlife Service's Threatened and Priority Fauna List last updated 10/04/2019, under the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* made by the Minister for Environment under section 14(4) Part 2 of *Biodiversity Conservation Regulations 2018*. Refer to Appendix B for Conservation Codes.

Table E.1 Evaluation of the presence of habitat and the likelihood of occurrence for conservation significant fauna within the study area

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
AVES	CACATUIDAE <i>Calyptrorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	The Forest Red-tailed Black Cockatoo inhabits the dense Jarrah, Karri and Marri forests receiving more than 600 mm rainfall annually (SPRAT 2018). The FRTBC occurs within the same habitat as the Baudin's Cockatoo. FRTBC nest in Jarrah, Karri, Marri and Wandoo favouring large top entry hollows with entrances ranging over 12 cm in diameter and hollow depth one to five metres (SEWPaC, 2012) (Johnson and Kirkby, Undated). It breeds between February to December with a peak between October and December, also a peak in some years in April–May, probably every two years. On the Swan Coastal Plain breeding has been recorded in November–December (Johnson and Kirkby, Undated). The species predominately feeds on seeds from Marri and Jarrah fruits and Blackbutt, Albany Blackbutt, Forest Sheoak, Snottygobble and the non-indigenous native Spotted Gum and Cape Lilac within its home range of about 116-187 ha (SPRAT 2018).	Marginal foraging - supporting	Possible
	<i>Calyptrorhynchus baudinii</i>	Baudin's Cockatoo	EN	EN	Baudin's Cockatoo is mainly found in eucalypt forests, especially Jarrah-Marri Forest, Karri Forest, and less frequently in woodlands of Wandoo, Blackbutt, Flooded Gum. Yate, partly cleared farmlands including roadside trees and gardens. It forages at all levels of the forest from the canopy to the ground, often feeding in the understorey on proteaceous trees and shrubs, especially Banksia, and in orchards both in trees (Johnson and Kirkby, Undated). Preferred roosts are in areas with a dense canopy close to permanent sources of water (SPRAT 2018). The range of the species during the non-breeding season (breeds in August though to late December) may be determined by the distribution of Marri, and nesting might be confined to areas in which Karri occurs (SPRAT 2018). It is known to nest in hollows of Eucalypts usually at some height (Pizzey and Knight 2007),	Marginal foraging - supporting	Possible

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
					often 30-50m above ground (Jupp 2000). Tree hollows usually have an entrance of 30-40cm, >30cm deep and are mostly vertical (SPRAT 2018) (Johnson and Kirkby, Undated).		
	<i>Calyptrorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	<p>This species is a postnuptial nomad, moving west after breeding. Carnaby's Cockatoo mainly occurs in or near eucalypt woodlands, especially those dominated by Wandoo or Salmon Gum, and sometimes reported in forests of Marri, Jarrah, Karri and Tuart. Nesting hollows may be located anywhere from over 2 m from ground, mainly in the Wheatbelt (Cale 2003, SPRAT 2009, WA Museum 2010).</p> <p>It is known to forage in native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as Banksia spp. (including Dryandra spp.), Hakea spp. and Grevillea spp. Forages in pine plantations, eucalypt woodland and forest that contains foraging species. Also individual trees and small stands of these species (SEWPAC 2012).</p> <p>This species is currently expanding its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain, due to climate change. Breeding occurs mainly from early July to mid-December. Breeding success is largely dependent on suitable feeding habitat adjacent to the nest site to provide the necessary food for the survival of the chick, e.g. adjacent pine forest or remnant vegetation (Johnson and Kirkby, Undated).</p>	Marginal foraging - supporting	Possible
	FALCONIDAE <i>Falco peregrinus</i>	Peregrine Falcon	-	OS	Peregrine Falcons occur in woodland, plains, gorges, wetlands but tend to breed either in stick-nests in trees or nest on cliff ledges. It appears that hollows and large abandoned nests of other birds may be used where cliff ledges are limited. Breeds Aug-Dec. Where good habitat occurs, and the density of Peregrine Falcons is high, active nests may occur within 2.5km of each other. The diet of the Peregrine Falcon includes wood	Marginal – supporting (potential feeding)	Possible

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
					duck, pigeons and doves, galahs, rosellas and cockatoo, starlings and larks (Olsen et al. 2006).		
	STRIGIDAE <i>Tyto novaehollandiae</i> <i>subsp. novaehollandiae</i>	Masked Owl (southern sub sp)	-	P3	Inhabits forests, open woodlands and farmlands with large trees, including timber watercourses paperbark woodlands. Widespread but very sparse, they breed any time of the year when conditions are favourable with a nesting period of about three months (Pizzey and Knight 2007).	Marginal – supporting (potential feeding)	Possible
MAMMALS	DASYURIDAE <i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	VU	VU	Quolls may occupy a range of habitats including forest, woodland and desert, though in the SW they are largely restricted to Jarrah forest or scattered through the southern and eastern wheat belt (DEC 2010). Habitat critical to Quoll are large areas of undisturbed habitat which a sufficient variety of key food and other resources such as large hollow logs, burrows or small caves at ground level for denning. To be suitable as den sites, logs must have a diameter of at least 30 cm but usually greater than 50 cm, a hollow diameter of 7–20 cm and generally 1m long (Orell & Morris 1994). Annually, an adult female Chuditch will utilise an estimated average of 66 logs and 110 burrows within her home range. A large amount of den sites is required for both sexes. They occupy relatively large home ranges, with males utilizing over 15 km ² and females, 3-4 km ² (Orell & Morris 1994). No nearby records (Naturemap 2021).	Absent	Unlikely
	<i>Phascogale tapoatafa</i>	Southern Brush-tailed Phascogale	-	S	This arboreal species is found in a variety of forest types. Ideal habitat for this species consists of dry sclerophyll forest and open woodland (Jarrah, Marri, and mixed Jarrah Karri) that contain hollow bearing trees and sparse ground cover. Their many nesting sites include hollow tree limbs, rotten stumps and even birds' nests. Lactating females prefer a large tree cavity with a small entrance with a nest made of bark, feathers and fur. A female's home range covers 20 to 70 hectares, a male's home ranges over laps females and increases during breeding	Marginal – supporting (potential feeding)	Unlikely

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
					season. It is predominantly carnivorous, foraging on arthropods, invertebrates, small vertebrates and nectar (Strahan 1995). Observed in woodland in adjacent lot (Biologic 2013), however no hollows or nesting habitat within the study area.		
	MACROPODIDAE <i>Notamacropus irma</i>	Western Brush Wallaby		P4	Optimum habitat for the Western Brush Wallaby includes open Jarrah forest or woodland and seasonally wet flats with low grasses and scrubby thickets, but also areas of mallee and heathland. Common dietary flora includes <i>Carpobrotus edulis</i> , <i>Cynodon dactylon</i> and <i>Nuytsia floribunda</i> . Old 1995 record in lot to the west (Naturemap 2021).	Absent	Nil
	<i>Setonix brachyurus</i>	Quokka	VU	VU	The understorey structure of the habitats currently used by Quokka consist of dense, low vegetation that provides refuge from predation (Hayward 2002). The mainland habitats include dense riparian vegetation (Hayward et al. 2005). Nearby records (over 6 km away) are associated with Muddy Lakes drainage line (DBCA database 2021).	Absent	Nil
	MURIDAE <i>Hydromys chrysogaster</i>	Water Rat	-	P4	The Water rat is usually found in permanent fresh or brackish water but can be found in marine environments. Fresh water habitats include swamps, lakes, dams even urban drainage swamps. Typically forages close to the shoreline, restricting its movements to shallow water (up to 2 m in depth) (CSIRO, 2004). One record within 5 km (Naturemap 2021).	Absent	Nil
	PERAMELIDAE <i>Isoodon obesulus fusciventer</i>	Southern Brown Bandicoot	-	P4	Bandicoot habitat consists of dense scrubby, often swampy vegetation with a dense cover up to one metre high particularly near watercourses/wetlands. It often feeds in adjacent forest (Jarrah and Wandoo) and woodlands that are burnt on a regular basis. Nests can be concealed next to or under old logs, shrubs or piles of debris and are made up of ground litter piled up over a shallow depression providing internal chambers. Home ranges vary with population density and range from 5-8.6 ha for males and 1-6 ha for females (DEC 2010). Feed on a	Absent	Nil

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
					variety of ground-dwelling invertebrates and the fruit-bodies of hypogeous fungi. Their searches for food often create distinctive conical holes in the soil (DECC 2010). Several nearby records (Naturemap 2021). No evidence observed.		
	PSEUDOCHEIRIDAE <i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	CR	CR	In dense, coastal Peppermint forest, home ranges are about 0.5 hectares to 1.5 ha and in eucalypt forests about 2.5 ha. In the northern jarrah forests, home ranges are larger and have been recorded to at least 5.6 ha. Peppermint leaves form the basis of the WRP diet in coastal areas (between 79-100% based on a study of WRP near Busselton by Jones et al. 1994), but when unavailable, the dominant myrtaceous species are preferred. In the inland forest, Jarrah and Marri the main food source. Garden plant varieties are also exploited in urban areas. WRP use a range of nest and shelter sites to avoid predators and exposure to the weather. Dreys are constructed in the canopy if hollows are not available. Adequate nest and shelter sites are necessary components of good quality habitat (Jones 1994, Shedley and Williams 2014). Numerous local records in native vegetation (Naturemap 2021). No scats or evidence observed.	Marginal	Unlikely
	VESPERTILIONIDAE <i>Falsistrellus mackenziei</i>	Western False Pipistrelle	-	P4	It occurs in wet sclerophyll forest dominated by Karri, and in the high rainfall zones of the Jarrah and Tuart forests. It has also been recorded in mixed Tuart-Jarrah tall woodlands on the adjacent coastal plain. Marri, Sheoak and Peppermint trees are often co-dominant at its collection localities (DotEE, 2018). This species roosts in tree hollows (Phillips & Inwards 1985) in colonies of 5 to 30 bats. The species feed on flying insects between below the forest canopy.	Nil	Absent
REPTILES	<i>Ctenotus ora</i>	Coastal Plains Skink	-	P3	<i>Ctenotus ora</i> is a recently described species of medium sized (6cm) skink with a restricted range within the southern Swan Coastal Plain and Cape Naturaliste area, as far north as Pinjarra and south as far as Yallingup (Kay & Keogh 2012) and Dunsborough (Ecoscape 2012). It has previously been recorded	Nil	Absent

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
					in areas with sandy substrates and low vegetation (including heath) in open Eucalyptus/Corymbia woodland over Banksia in the sandy coastal plain and coastal dunes (Kay & Keogh 2012).		
FISH	GALAXIIDAE <i>Galaxiella munda</i>	Mud minnow, Western dwarf galaxias	-	VU	Occur in slow-running, tea-coloured streams usually in sandy areas. Also found in swamps, small ponds and roadside ditches. Also lives in the vegetated shallows of some freshwater lakes. Water is typically acidic (pH 4.5-6.5) and darkly tannin-stained. An inhabitant of temporary waters, capable of aestivating in damp bottom sediments over summer (Allen et al 2002) (Smith et al 2002).	Nil	Absent
	<i>Galaxiella nigrostriata</i>	Black-stripe minnow	-	EN	Largely restricted to near-coastal wetlands from Augusta to Albany, although populations are also known near Bunbury and in the Ellen Brook catchment north of Perth. The existence of these satellite populations suggests that the minnow previously occurred in other wetlands along the Swan Coastal Plain, and perhaps were displaced as wetlands have been lost or degraded as the area was developed (e.g. salinisation, eutrophication, sedimentation, water abstraction), and in response to invasion of exotic species and due to a drying climate. Occupies the same ephemeral habitats as the salamanderfish and, like that species, is also capable of burrowing and aestivating (a state of dormancy similar to hibernation, characterised by inactivity and a lowered metabolic rate) to survive the dry summer (DWER 2020)..	Nil	Absent
	PERCICHTHYIDAE <i>Nannatherina balstoni</i>	Balston's Pygmy Perch	VU	VU	Balston's Pygmy Perch is a small freshwater fish that grows to a maximum length of around 90 mm (commonly 60 mm). This species is brownish dorsally and silver below, usually with a prominent brown mid-lateral stripe and a series of vertical brown bars on sides giving a cross-hatched pattern Balston's Pygmy Perch inhabits acidic, tannin-stained freshwater pools, streams and lakes in peat flats within 30 km of the coast of south-west WA, preferring shallow water, and commonly	Nil	Absent

Class	Family Genus species	Vernacular	Status Federal	Stat. WA	Requirements	Presence of habitat	Likelihood of occurrence
					associated with tall sedge thickets and inundated riparian vegetation (SPRAT 2018) (Bray et al. 2018). Associated with slow-flowing, low salinity, acidic and tannin-stained waters, and complex instream habitat – recorded locally (DWER 2020).		
INVERTEBRATES	HYRIIDAE <i>Westralunio carteri</i>	Carters Freshwater Mussel	VU	VU	Carters Freshwater Mussel is the only freshwater mussel found in southwest WA. It is found in freshwater streams, rivers, ponds, wetlands and lakes inland from the coast mostly areas with muddy, silty and sandy bottoms and flowing permanent water. Tracks can be seen along banks and sandy/muddy patches of stream bed where they are present. Native fish are critical to the Mussel's lifecycle. Larval mussels attach to native fish to develop into juvenile mussels. Unlike their marine and estuarine cousins, they do not attach to structures. This allows them to move with receding water levels and position themselves to the best feeding spots (Murdoch University, 2010).	Nil	Absent

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Note not all references appear in the text.

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Appendix E Habitat Tree Survey Results

ID	Tree	Comment	Easting	Northing	DBH (cm)
1	Marri	Suitable_DBH_no_hollows	358775	6276838	50_75
2	Unknown	Suitable_DBH_no_hollows	359066	6276658	75_100
3	Unknown	Suitable_DBH_no_hollows	359074	6276707	75_100
4	Unknown	Suitable_DBH_no_hollows	359075	6276713	>100
5	Unknown	Suitable_DBH_no_hollows	359075	6276719	75_100
6	Unknown	Suitable_DBH_no_hollows	359075	6276728	>100
7	Unknown	Suitable_DBH_no_hollows	359080	6276755	50_75
8	Unknown	Suitable_DBH_no_hollows	359005	6276761	>100
9	Unknown	Suitable_DBH_no_hollows	359006	6276735	75_100
10	Jarrah	Suitable_DBH_no_hollows	359043	6276701	50_75
11	Unknown	Suitable_DBH_no_hollows	358643	6276844	50_75
12	Unknown	Suitable_DBH_no_hollows	358640	6276828	50_75
13	Unknown	Suitable_DBH_no_hollows	358620	6276771	50_75