Appendix D
AECOM Ellenbrook Bus Rapid Transit Biological Assessment February 2016

Ellenbrook Bus Rapid Transit
Department of Transport
11-Feb-2016

Biological Assessment

Ellenbrook Bus Rapid Transit

Biological Assessment

Ellenbrook Bus Rapid Transit

Client: Department of Transport

ABN: N/A

Prepared by

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Quality Information

Document Biological Assessment

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Prepared by Lyn Van Gorp and Matthew Cann

Reviewed by Floora de Wit

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	24-Nov-2015	Draft	Linda Kirchner Associate Director - Environment	
B	03-Dec-2015	Draft for Internal Review	Linda Kirchner Associate Director - Environment	
C	04-Dec-2015	Draft for Client Review	Linda Kirchner Associate Director - Environment	
D	18-Dec-2015	Final Draft incorporating Client Comments	Linda Kirchner Associate Director - Environment	
0	11-Feb-2016	Final for Issue	Linda Kirchner Associate Director - Environment	

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Executive Summary

A dedicated Bus Rapid Transit (BRT) corridor is proposed between Ellenbrook Town Centre and Marshall Road in the City of Swan in order to meet the short to medium term travel demands of the region. This report presents the results of a biological assessment undertaken for the proposal, which will be used to inform any environmental approvals that may be required.

The biological assessment included desktop and field components to assess flora, vegetation and fauna values associated with the proposed BRT corridor (the Study Area) and was undertaken in accordance with relevant Environmental Protection Authority (EPA) and Department of the Environment guidelines.

Nine native vegetation communities were recorded and mapped during the field survey as well as an additional six significantly altered communities, which did not contain intact remnant native vegetation. Most of the remnant vegetation contained within the Study Area was in Completely Degraded condition. The majority of the Study Area is already cleared.

No Threatened or Priority Ecological Communities were recorded or are known to occur within the Study Area. No Threatened or Priority flora species were recorded within the Study Area during the survey.

The Threatened Forest Red-tailed Black Cockatoo and the Migratory Rainbow Bee-eater were recorded during the field survey. The Threatened Carnaby's Black Cockatoo and Baudin's Black Cockatoo as well as the Priority 5 Quenda were not recorded but are considered likely to occur. The Study Area contains suitable foraging habitat for the three listed Black Cockatoo species and a total of 291 potential breeding trees were recorded for these species.

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1.0 Introduction

1.1 Background

The Department of Transport (DoT) intends to progress a Bus Rapid Transit (BRT) system between Ellenbrook and Bassendean Train Station with the aim of meeting the short to medium term travel demands to and from Ellenbrook and the associated Swan Urban Growth Corridor. This report focuses on the proposed BRT corridor (the Study Area) which comprises a dedicated transit corridor from the Ellenbrook Town Centre to Marshall Road and includes three proposed Park and Ride sites at:

- Marshall Road
- Youle-Dean Road
- Gnangara Road.

AECOM Australia Pty Ltd (AECOM) was commissioned to conduct a biological assessment within the Study Area. The results of this assessment will be used to identify and update any environmental values that need to be considered by the project.

1.2 Location

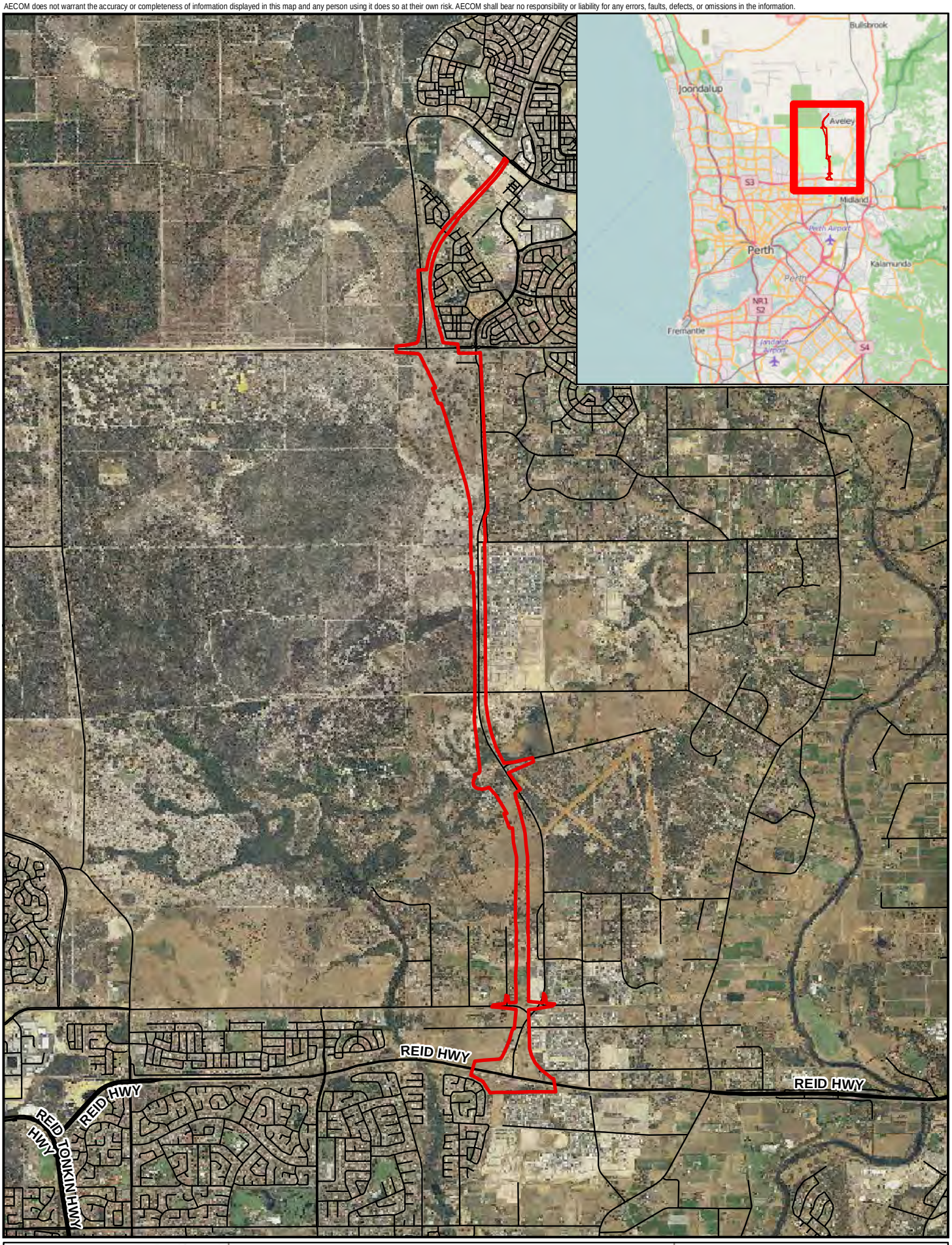
The northern section of the proposed BRT system extends southward from Ellenbrook Town Centre to Marshall Road in the City of Swan (Figure 1). It is located within the existing 'Public Purpose – Special Use (Transit)' and 'Primary Regional Roads' reservations in the Metropolitan Region Scheme.

In order to allow for flexibility in future design configurations, the area surveyed (the Study Area) was extended beyond the 'Primary Regional Roads' and 'Public Purpose – Special Use (Transit)' boundaries in some places. It is anticipated that the area of actual impact will be considerably less than the surveyed Study Area footprint.

1.3 Objectives

The overall purpose of this biological assessment was to identify the key flora, vegetation and fauna values of the Study Area. The biological assessment consisted of a desktop assessment, field survey and discussion of results in this technical report. Specific objectives of the assessment were to:

- Conduct a Level 1 Flora and Vegetation Assessment in accordance with Environmental Protection Authority (EPA) Guidance Statement 51, including:
    - assessment of riparian and wetland vegetation
    - assessment of relevant matters of national environmental significance
    - recording and mapping of vegetation communities and condition
    - undertaking of targeted searches for potential Threatened and Priority species
    - collection of floristic data from relevés.
- Conduct a Level 1 Fauna Assessment in accordance with EPA Guidance Statement 56 including assessment of relevant matters of national environmental significance.
- Undertake a Black Cockatoo survey in accordance with the *Referral guidelines for three species of Western Australian Black Cockatoo Species: Carnaby's Cockatoo (endangered), Baudin's Cockatoo (vulnerable), Forest Red-tailed Black Cockatoo (vulnerable)* (Commonwealth of Australia, 2012).



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LEGEND

- Study Area
- State Road
- Local Road

Project Location

ELLENBROOK BUS RAPID TRANSPORT

Figure

1

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\602X\60286738\16 - Ellenbrook\4. Tech work area\4.99 GIS\02_MXDs\Environmental Impact AssessmentEnvironmental Management Plan (EIA EMP)\ENV_Map1_ProjectLocation_DF_20160111.mxd (fotheringhamd) A4 size

2.0 Existing Environment

2.1 Climate

The Swan Coastal Plain has a warm Mediterranean climate (Mitchell et al., 2002), characterised by hot dry summers and cool to mild wet winters. The closest meteorological recording station to the Study Area with comprehensive data is the Perth Airport station (station 009021), located approximately 7 km to the south of the Study Area at its closest point. Perth Airport meteorological station is maintained by the Bureau of Meteorology (BoM) and commenced recording in 1944. Rainfall and temperature statistics for the station are presented in Figure 2.

Perth Airport has experienced an average annual rainfall of 770.1 mm since 1944, with the majority of rainfall occurring between May and September (BoM, 2015). Figure 2 shows the rainfall data for 2015 compared with the average rainfall for the site. Although higher than average rainfall was experienced between February and April, rainfall in the remaining months prior to the survey was below average. This has the potential to impact on the presence of climate sensitive species such as orchids and annuals.

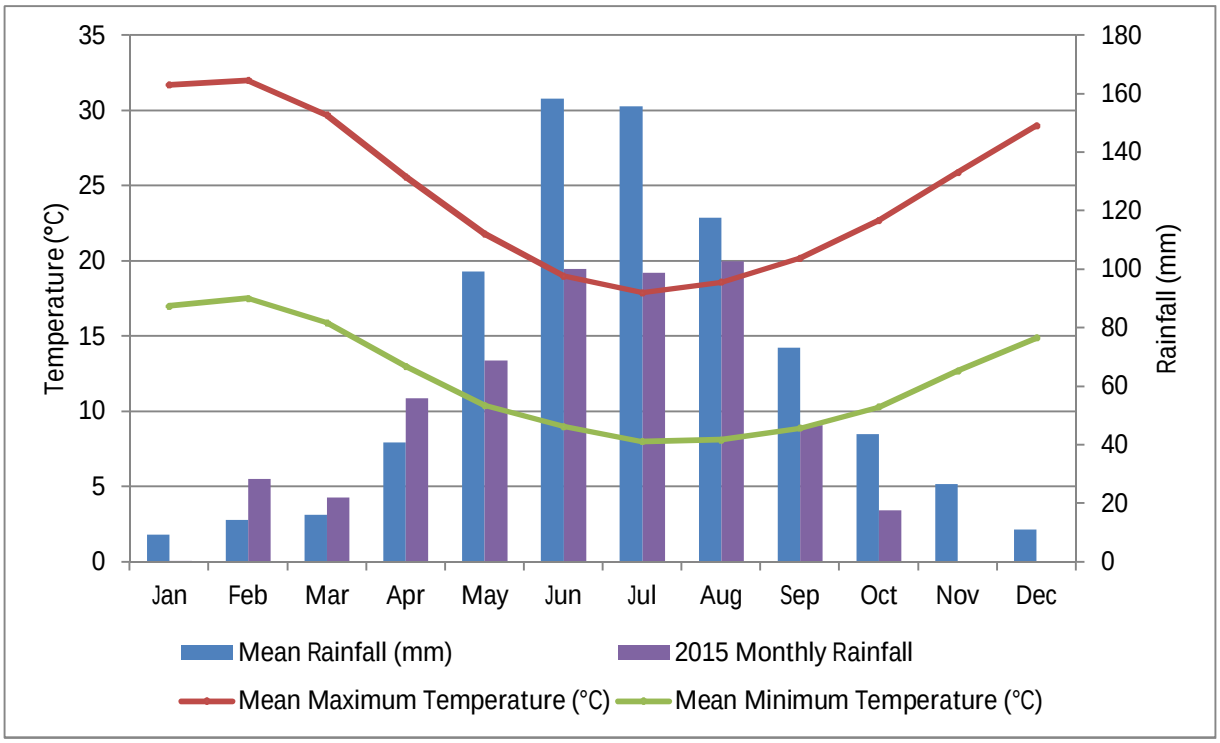


Figure 2 Rainfall and Temperature Statistics for Perth Airport (BoM, 2015)

2.2 Geology and Soils

The surface geology of the Study Area comprises the following three geological types:

- The majority of the Study Area is classified as Bassendean Sand, which is derived from aeolian sand and coastal sediments and is described as basal conglomerate overlain by dune quartz sand with heavy mineral concentrations.
- A small portion of the Study Area is underlain by lake deposits 38492, derived from lacustrine sediment. It is described as lacustrine or residual mud, clay, silt and sand, commonly gypsiferous and/or saline; playa, claypan, and swamp deposits; peat; peaty sand and clay; halitic and gypsiferous evaporites.
- The southern portion of the Study Area lies on the Guildford Formation, originating from alluvial and estuarine sediment. It is described as alluvial sand and clay with shallow marine and estuarine lenses and local basal conglomerate (Geological Survey of Western Australia and Geoscience Australia, 2008).

The underlying geology has given rise to the soils of the area. The majority of the Study Area occurs within the Cb39 soil type (Bureau of rural Science, 1991). These soils are described as subdued dune-swale terrain with the chief soils being leached sands.

A relatively small portion of the southern part of the Study Area lies over the Cb38 and Mw31 soil types. The Cb38 soil type is described as sandy dunes with intervening sandy and clayey swamp flats. The chief soils are leached sands, sometimes with a clay horizon on the dunes and sandy swamps. The Mw31 soils are deeply incised, steep scarp and valley side slopes of the Darling scarp and its more deeply incised tributary valleys. Chief soils of the steep scarp and valley side slopes, on which massive rock outcrops are a feature, seem to be acid red earths on the colluvial slope deposits (Bureau of Rural Science, 1991).

2.3 IBRA Regions

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia, 2013a). The Study Area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell et al., 2002).

The Perth subregion consists of alluvial river flats, colluvial and Aeolian sands, and coastal limestone (Mitchell et al., 2002). Vegetation of the subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands. The subregion includes Rottnest, Carnac and Garden Islands as well as a complex chain of seasonal wetlands.

2.4 Vegetation

The Study Area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990) into three Pre-European vegetation associations. Three Pre-European vegetation associations occur within the Study Area (Table 1).

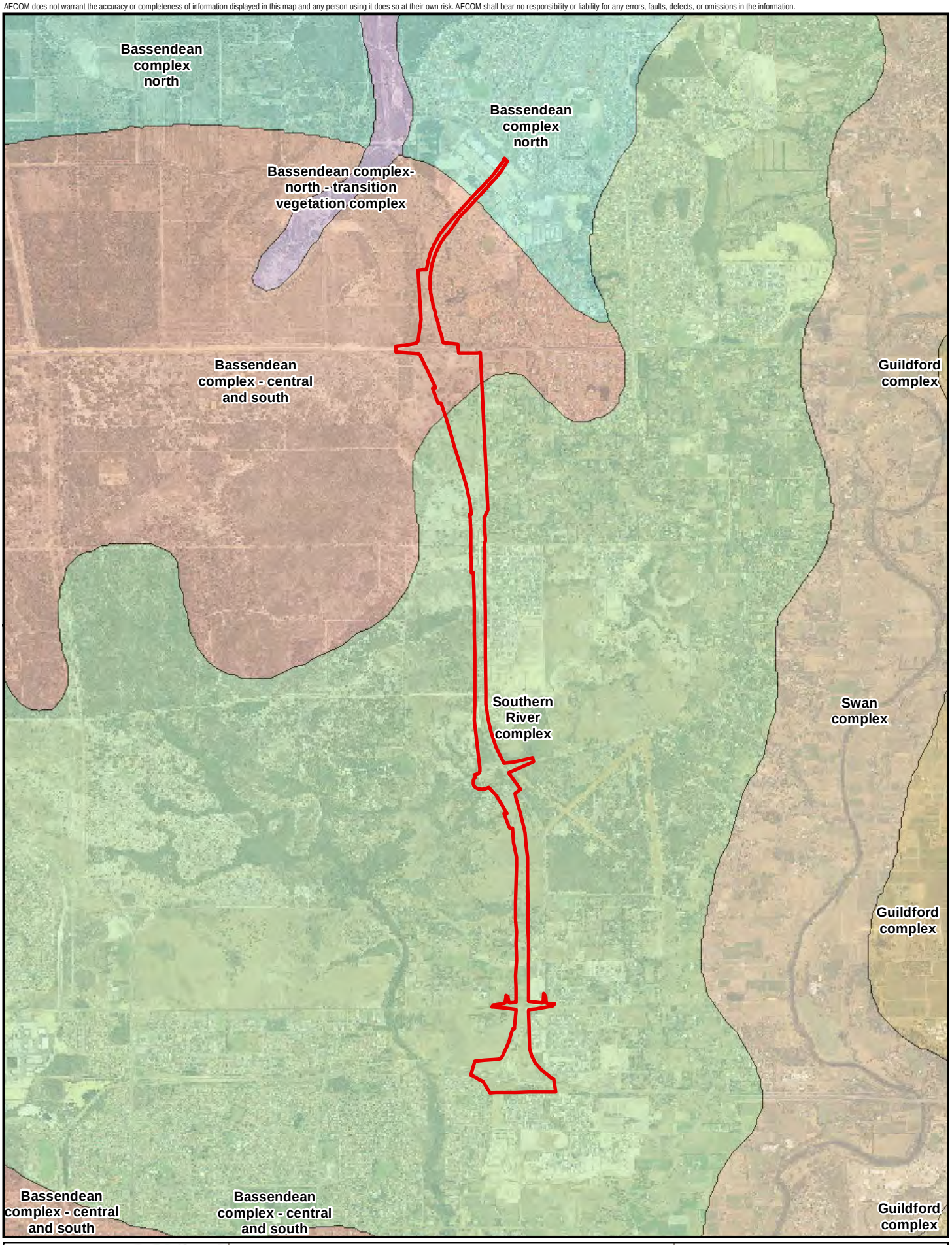
Vegetation complexes within the Study Area have been defined by Heddle et al. (1980) and are based on vegetation in association with landforms and underlying geology. Three vegetation complexes as described by Heddle et al. (1980) occur within the Study Area. The majority of the native vegetation occurring within the Study Area is Southern River Complex, with smaller areas of the two remaining complexes occurring within the northern extent of the Study Area. Vegetation complexes within the Study Area are described in Table 2 and spatially presented in Figure 3.

Table 1 Pre-European Vegetation (Beard, 1990)

Name	Vegetation Association No.	Original Map Code	Description
Bassendean	1001	E2Mb cbLi	Medium very sparse woodland; Jarrah, with low woodland; *Banksia* and *Casuarina*
Bassendean	1018	E2,3Mi/bLi/mLc/c6Li	Mosaic: Medium forest; Jarrah – Marri/Low woodland; Banksia /Low forest; teatree/Low woodland; *Casuarina obesa*
Bassendean	1009	E3,18Mr	Medium woodland; Marri and River Gum

Table 2 Heddle et al. (1980) Vegetation Complexes

Vegetation Complex	Description
Bassendean Complex - North	Low open-forest and low woodland of *Banksia* and Pricklybark to a low woodland of *Melaleuca* species, and sedgelands which occupy the moister sites
Bassendean Complex – Central and South	Ranges from woodland of *Eucalyptus marginata, Allocasuarina* and *Banksia* on sand dunes to a low woodland of *Melaleuca* species, and sedgelands on the low-lying depressions and swamps.
Southern River Complex	Open woodland of *Corymbia calophylla*, *Eucalyptus marginata*, *Banksia* species with fringing woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* along creek beds.



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LEGEND

Study Area

Vegetation Complexes

- Bassendean complex - central and south
- Bassendean complex north
- Bassendean complex- north - transition vegetation complex
- Guildford complex
- Southern River complex
- Swan complex

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Complexes

ELLENBROOK BUS RAPID TRANSPORT

Figure 3

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3.0 Methodology

3.1 Desktop Assessment

A desktop assessment was undertaken as part of the Ellenbrook Bus Rapid Transit Concept Design Study Report (AECOM, 2013). The desktop assessment incorporated a literature review of available information and searches from relevant government databases. These sources included:

- Database searches for conservation significant ecological communities, flora and fauna species maintained by the then Department of Environment and Conservation (DEC) (now the Department of Parks and Wildlife (DPaW)).
- The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool.
- Department of Agriculture and Food (DAF) Western Australian Organism list pursuant to the *Biosecurity and Agriculture Management Act 2007* (BAM Act).
- *Ellenbrook Public Transport Options Study: Workshop 1 Report* (SKM, 2011a).
- *Ellenbrook BRT Public Transport Options Study: Consolidated Final Summary Report* (SKM, 2011b).

Database searches were conducted based on a 3 km buffer area surrounding the Study Area.

To ensure currency of database search results, DPaW database searches for conservation significant ecological communities, flora and fauna species were re-run in January 2016 and the original desktop assessment was updated in accordance with these more recent results. Suitable buffers for the searches were determined by DPaW. Search buffers used were 5 km around the Study Area for both the flora and ecological community searches, and 2 km for the fauna search.

All flora and fauna species of conservation significance identified in database searches were investigated to determine the likelihood of their occurrence in the Study Area. Categories used for this assessment are provided in Table 3.

Table 3 Categories of Likelihood of Occurrence for Species of Conservation Significance identified in the Desktop Assessment

Likelihood Category	Flora	Fauna
Likely to occur	Habitat is present in the Study Area and it has been recorded in close proximity to the Study Area	Study Area is within the known distribution of the species, habitat is present in the Study Area and it has been recorded in close proximity
May occur	Habitat may be present and/or it has been recorded in close proximity to the Study Area	Study Area is within the known distribution of the species, marginal habitat may be present and/or it has been recorded in close proximity
Unlikely to occur	No suitable habitat is present and there have been no recorded locations in close proximity to the Study Area	Study Area is outside known distribution for that species or, no suitable habitat is present and there have been no recent recorded locations in close proximity to the Study Area.

3.2 Field Surveys

The flora, vegetation and fauna surveys were conducted simultaneously by Lyn Van Gorp (Environmental Scientist; Flora Collection Permit no. SL011558) and Matthew Cann (Zoologist) on 22 and 29 October, 2015. The field surveys were undertaken in accordance with:

- Environmental Protection Authority (EPA) Guidance Statement 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a).
- EPA Guidance Statement 56, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004b).
- EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species (Commonwealth of Australia, 2012).

3.2.1 Flora and Vegetation

Prior to the field assessment, results of the original desktop assessment were reviewed to determine the potential presence of conservation significant flora species occurring within the Study Area.

The Level 1 Flora and Vegetation survey was carried out by recording floristic data at various locations throughout the Study Area, wherever changes in floristic composition and structure were observed. Detailed information was recorded to enable characterisation of each vegetation community. The survey was conducted using relevés within each vegetation community. The following parameters were recorded at each relevé site:

- physical features of the survey area
- GPS location details
- vegetation condition
- a comprehensive flora species list including species height and foliage cover (recorded as a percentage).

All data was recorded using Apple iPads and mapped using ArcGIS software.

Species that were unable to be identified in the field were collected and pressed for identification using the AECOM in-house Herbarium or the Western Australian State Herbarium. Plant specimens were identified by Lyn Van Gorp (Environmental Scientist and Floora de Wit (Senior Botanist) of AECOM using a combination of taxonomic keys and comparison with pressed specimens. Nomenclature of the species recorded follows the protocol of the Western Australian Herbarium.

Vegetation community mapping was completed for all areas of native vegetation. Community descriptions were based on the National Vegetation Information System (NVIS) framework (Executive Steering Committee for Australian Vegetation Information, 2003). The NVIS framework is a comprehensive data system that allows for the comparison of Australia's native vegetation at an Australia-wide scale. The system is based on describing strata levels using the three dominant species in that stratum, and using the first letter of the genus and species as abbreviations for the code.

The condition of the Study Area was determined at designated recording sites and in between as necessary, where condition was observed to change. Vegetation condition was determined in relation to the (perceived) ability of the bushland to maintain itself (Keighery. 1994). This is commonly interpreted primarily on the ratio of visible introduced species to native species, however, disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure, site ecology and other factors are also considered. The categories of vegetation condition used were consistent with methods developed by Keighery (1994) (Table 4).

The Study Area was traversed on foot and any suitable habitat searched for Threatened or Priority flora species.

Table 4 Bushland Condition Rating (Keighery, 1994)

Descriptor	Explanation
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, 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 or shrubs.

3.2.2 Fauna

A Level 1 Fauna Assessment was conducted in accordance with Level 1 Surveys as per the EPA Guidance Statement 56 (EPA, 2004b). The fauna survey was conducted in conjunction with the Level 1 Flora and Vegetation Assessment. Conducting the two assessments concurrently enabled interpretation of the habitat value of each of the vegetation units described and mapped, and determination of each of these as suitable for significant fauna. Where habitat for conservation significant species was located, site details were recorded using Apple iPads with parameters including:

- GPS location
- species observed
- habitats present
- scats
- tracks
- linkage values.

In addition to recording all observed fauna and birds identified from distinctive calls, details of indirect evidence such as scats, tracks and diggings was documented. In particular, attention was given to conservation significant species identified in the desktop assessment as having the potential to occur in the area.

Opportunistic observations of fauna were recorded whilst traversing the Study Area. Furthermore, at each habitat, micro habitat searches were conducted. This included raking soil and leaf litter, inspecting dead logs and timber, inspecting burrows, lifting rocks and inspecting loose bark of trees.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians is in accordance with the Western Australian Museum's Checklist of Vertebrates of Western Australia (WA Museum, 2015) and for bird species the Bird's Australia Checklist of Australian Birds based on Christidis and Boles (2008).

3.2.3 Targeted Black Cockatoo Assessment

The three threatened species of Black Cockatoo are the most likely threatened species present and as such were surveyed as per:

- *Referral guidelines for three species of Western Australian black cockatoos species: Carnaby's Cockatoo (endangered), Baudin's Cockatoo (vulnerable), Forest Red-tailed Black Cockatoo (vulnerable*) (Commonwealth of Australia, 2012)
- *Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA & DEC, 2010).

The field assessment for fauna values included the following:

- recording opportunistic observations of fauna (chance sightings)
- recording secondary evidence such as scats, eggs, diggings, tracks, feathers, fur, calls and nests or burrows
- habitat assessment (reconnaissance) to assess fauna habitats present in the project and determine if a more detailed fauna assessment is required
- targeted searching of key habitat areas such as tree hollows, under logs, under scrubby bushes and inside/around burrows
- photographs of representative habitats
- recording GPS location for all significant fauna sightings.

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4.0 Survey Limitations

A number of limitations relating to the survey have been considered and are discussed below:

- Evidence of recent fire was observed in the section of Study Area between Charlton Way and Woollcott Avenue. Due to the recentness of the fire, this may have affected the results of the survey for this particular area because many of the plant species may be absent due to the fire.
- Below average rainfall for consecutive months prior to conducting the surveys may have influenced the presence of flora species such as annuals and orchids. In addition, drought is likely to continue to impact on condition of remnant vegetation.
- Below average rainfall in the five months preceding the survey may have resulted in some species not flowering, rendering them more difficult to identify in the field in and in the herbarium.
- Some plant species were not able to be confirmed due to lack of flowering material available at the time of survey. This may be attributed to the lack of rainfall in preceding months and the primarily degraded condition of remnant vegetation within the Study Area.
- Flora specimens that could not be identified to a high degree of certainty have been denoted by a question mark in front of the name. This can be the case, for example, when a collection of a flora species is made but no flowering and/or fruiting parts are available. In this instance it may not be possible to confidently attribute a particular species to the specimen.

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5.0 Results

5.1 Flora

5.1.1 Desktop Assessment

The desktop assessment identified the potential for 47 Threatened or Priority flora species to occur within the Study Area. It was determined that 41 conservation significant flora species were unlikely to occur and six may occur within the Study Area. The full results of the desktop assessment are provided in Appendix A and the database results are illustrated in Figure 4. Those species that may occur within the Study Area are listed in Table 5.

The likelihood of occurrence of each of the conservation significant species identified in the desktop assessment was determined based on a number of factors. These included locations of known records in the vicinity of the Study Area as well as interpretation of the preferred habitat and soil types in comparison with those supported by the Study Area.

Table 5 Threatened and Priority Flora species that may occur within Study Area

Species	Conservation Status		Preferred Habitat	Likelihood of Occurrence
	Commonwealth	State		
Poranthera moorokatta		Priority 2	Open *Banksia* woodland on white silica sands or shallow dampland on mixed grey and white sand	May occur
Cyathochaeta teretifolia	-	Priority 3	Grey sand, sandy clay. Swamps, creek edges	May occur
Haemodorum loratum		Priority 3	Grey or yellow sand, gravel	May occur
Stylidium trudgenii	-	Priority 3	Grey sand, dark grey to black sandy peat. Margins of winter wet swamps, depressions	May occur
Hypolaena robusta	-	Priority 4	White sand. Sandplains	May occur
Thysanotus glaucus		Priority 4	White, grey or yellow sand, sandy gravel	May occur

Note: Conservation Status codes are explained in Appendix B.

5.1.2 Field Assessment

A total of 129 vascular plant species from 43 families and 103 genera were recorded within the Study Area. This total includes 78 (60%) native species, 49 (38%) introduced (weed) species and two (2%) species that have been planted outside of their usual range.

The most highly represented families were Fabaceae (17 species: 13 native and four introduced), Myrtaceae (18 taxa: 15 native, one introduced and two planted) and Poaceae (16 species, 15 of which were introduced). A complete list of species recorded is provided in Appendix C.

5.1.2.1 Threatened and Priority Flora

No Threatened or Priority flora species were recorded within the Study Area.

5.1.2.2 Introduced Species

A total of 49 (38% of all species recorded) weed species were recorded within the Study Area. Of these, the following four species are categorised as Declared Pests in accordance with Section 22 of the BAM Act:

- **Asparagus asparagoides* (Bridal Creeper)
- **Echium plantagineum* (Paterson's Curse)
- **Moraea miniata* (Two-leaf Cape Tulip)
- **Zantedeschia aethiopica* (Arum Lily).

Under the BAM Act, all Declared Pests are placed into one of three management categories: C1 (Exclusion), C2 (Eradication) or C3 (Management). **Asparagus asparagoides* and **Zantedeschia aethiopica* require C3 management for the whole of the State. **Echium plantagineum* and **Moraea miniata* require C3 management in a variety of areas around the State but not within the Study Area (DAF, 2015).

Of the recorded weeds, **Asparagus asparagoides is* also listed amongst Weeds of National Significance (WoNS). Management of WoNS requires coordination among all levels of government, organisations and individual landowners. Individual landowners and managers are responsible for managing WoNS occurring on their properties (Department of the Environment, 2014).

A full list of weeds recorded within the Study Area is included in Appendix D alongside the environmental weed rating and SWAN Priority Rating defined by Bettink and Keighery (2008) for each species. The locations of recorded Declared Pests are shown in Figures 7.

5.2 Vegetation

5.2.1 Desktop Assessment

As discussed in Section 2.4, three vegetation complexes described by Heddle et al. (1980) occur within the Study Area. The remaining extents of all of these vegetation complexes (Table 6) exceeds the minimum 10% target for the retention of vegetation complexes in constrained areas in the Perth and Peel regions (EPA, 2015).

Table 6 Pre-European and Remaining extents of Vegetation Complexes (Source: EPA, 2015)

Vegetation Complex	Pre-Clearing Extent of the complex within the Perth and Peel regions (ha)	Remaining Area in Perth and Peel regions in 2015 (ha)	Percentage Remaining in Perth and Peel regions 2015
Bassendean Complex - North	35,389	23,859	67.4
Bassendean Complex – Central and South	63,451	13,486	21.3
Southern River Complex	41,192	6,936	16.8

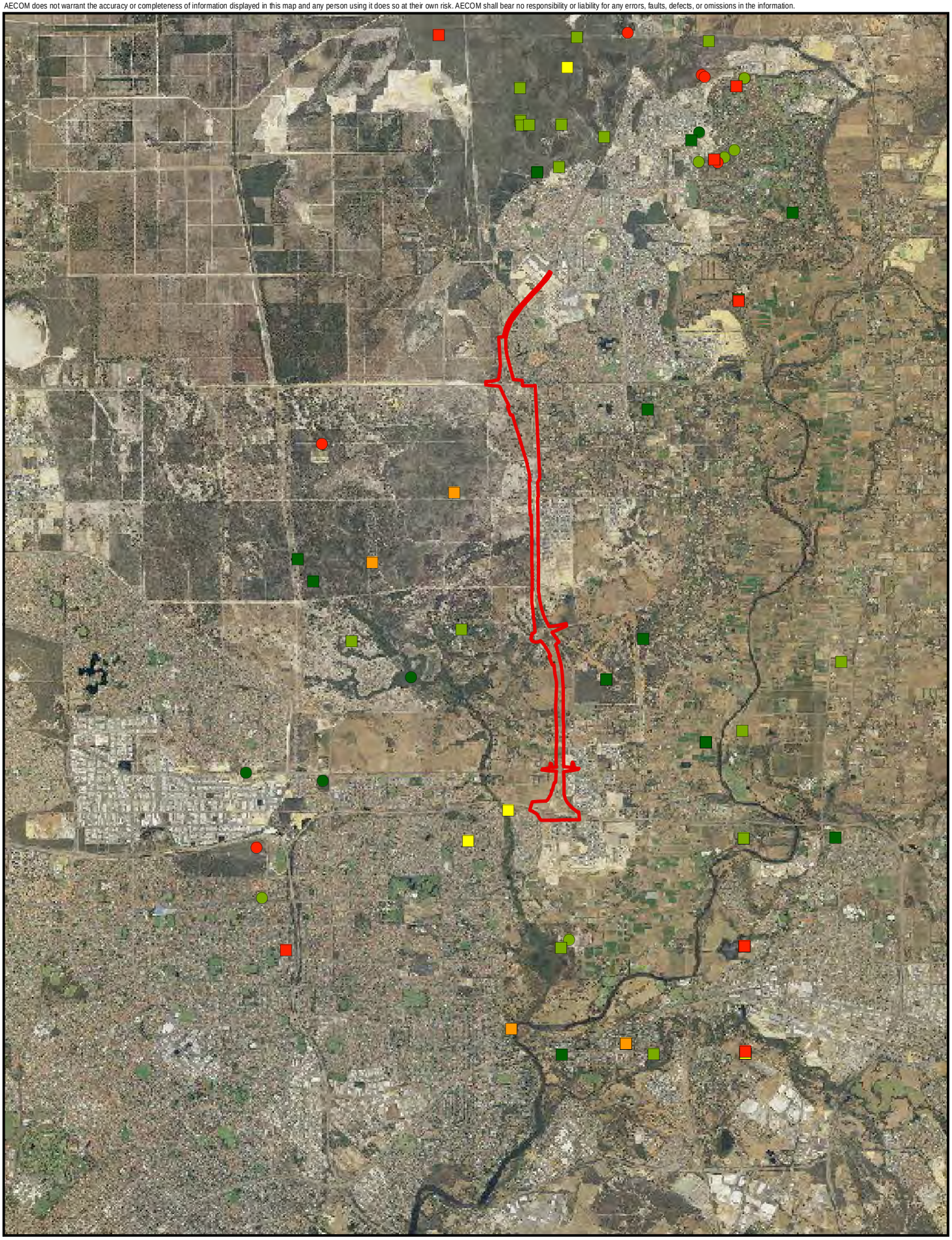
5.2.1.1 Threatened and Priority Ecological Communities

No Threatened or Priority Ecological Communities (TECs or PECs) have been previously identified within the Study Area boundary, however, the desktop assessment identified that one TEC and one PEC have been mapped within close proximity to the Study Area and have the potential to occur within the Study Area (Figure 5).

Table 7 Threatened and Priority Ecological Communities within close proximity to the Study Area

Description	Conservation Status		Distance from Study Area
	Commonwealth	State	
Mound Springs SCP – Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	Endangered	Critically Endangered	Buffer of TEC mapped as intersecting with the northern end of the Study Area
Muchea Limestone – Shrublands and woodlands on Muchea Limestone	Endangered	Endangered	Located approximately 1 km to the north-east of the Study Area
SCP22 – *Banksia ilicifolia* woodlands and *Banksia attenuata* woodlands	-	Priority 3	Located approximately 800 m west of the alignment

Note: Conservation Status codes are explained in Appendix B



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LEGEND

Study Area

Threatened Flora	DPaW Threatened Flora
T	T
1	1
2	2
3	3
4	4

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Threatened and Priority Flora

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Figure
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5.2.1.2 Bush Forever and Environmentally Sensitive Areas

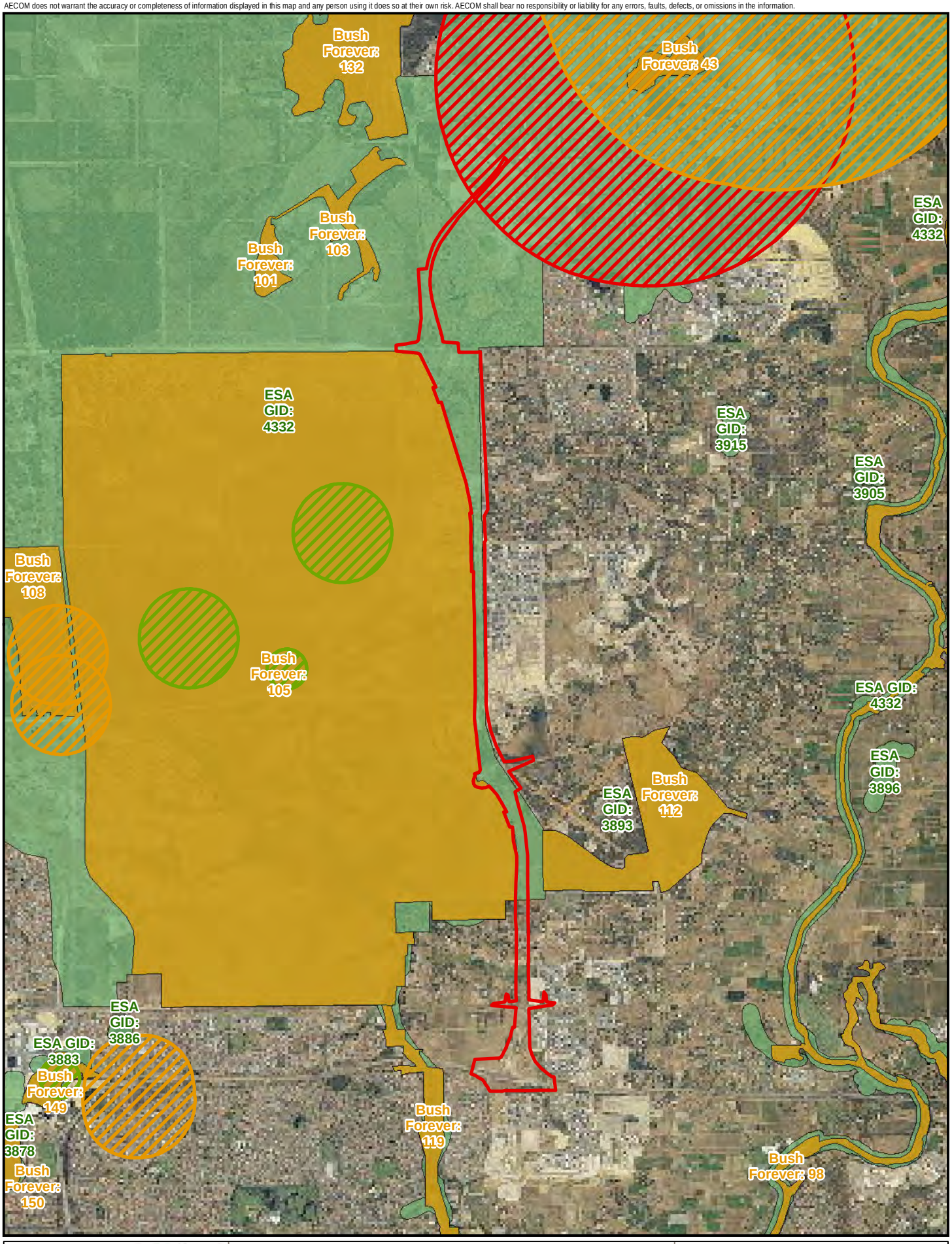
One Bush Forever Site, Whiteman Park, Whiteman/West Swan (Site 304), is located partially within the Study Area (Figure 5). This Bush Forever Site is 1,547.9 ha in size and is recognised for its representation of ecological communities, diversity, rarity as well as scientific or evolutionary importance. It also protects wetlands, estuarine fringing vegetation and coastal vegetation (Government of Western Australia, 2000). A total of 2.24 ha or 0.1% of this Bush Forever is located within the Study Area.

Almost the entire Study Area from approximately Harrow Street northward lies within an Environmentally Sensitive Area (ESA). This ESA boundary appears to coincide primarily with Bush Forever Site 304 as well as potentially being associated with mapped PEC to the north of the Study Area (Figure 5). A total of 124.62 ha of area mapped as ESA is intersected by the Study Area, although much of this is cleared.

5.2.2 Field Assessment

5.2.2.1 Vegetation Communities

A total of nine native vegetation communities were described and delineated during the field survey, comprising six woodlands and three wetland vegetation types. An additional six disturbed or non-native communities were mapped as well as open water and cleared areas. No TECs or PECs were recorded within the Study Area during the field survey. The surveyed vegetation communities are described in Table 8 and spatially represented in Figures 6A-E.



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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 400 800 1,200 1,600 2,000

metres

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LEGEND

- Study Area
- Bush Forever
- Environmentally Sensitive Areas

TEC/PEC

- Priority 3
- Endangered
- Critically Endangered

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Bush Forever, TECs and ESAs

ELLENBROOK BUS RAPID TRANSPORT

Figure

5

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\602X\60286738\16 - Ellenbrook\4. Tech work area\4.99 GIS\02_MXDs\EIA EMP\ENV_Map5_BushForeverTECsESAs_DF_20160209.mxd (fotheringhamd)

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Table 8 Vegetation Communities of the Study Area

Community Code	Vegetation Description	Area within Study Area (ha)	Percentage of Study Area (%)	Representative Photo
Woodlands				
CcXpBm	*Corymbia calophylla* and *Melaleuca preissiana* mid open forest over *Xanthorrhoea preissii, Dasypogon bromeliifolius* and *Patersonia occidentalis sparse shrubland over *Briza maxima, Alexgeorgea nitens, *Ehrharta longiflora* low to mid mixed tussock grassland and sedgeland. *Eucalyptus marginata, Nuytsia floribunda, Allocasuarina* sp. and *Banksia* species are intermittent. In degraded versions of this community the understorey is dominated by grasses.	32.29	17.0	
CcXpPe	*Corymbia calophylla, Melaleuca preissiana* and *Eucalyptus marginata* low to mid open forest over *Xanthorrhoea preissii* mid isolated shrubs over *Pteridium esculentum, Lepidosperma ?longitudinale* and *Dasypogon bromeliifolius* mid closed mixed fern and sedgeland	0.18	0.1	

Community Code	Vegetation Description	Area within Study Area (ha)	Percentage of Study Area (%)	Representative Photo
BaCePg	*Banksia attenuata, Banksia littoralis, Casuarina obesa* low woodland with emergent *Corymbia calophylla* over **Carpobrotus edulis*, *Patersonia occidentalis* and *Calytrix angulata* low open heathland over *Podotheca gnaphalioides*, **Ehrharta calycina* and **Ursinia anthemoides* low open mixed grass and herbland	0.26	0.1	
ErCd	*Eucalyptus rudis* and *Melaleuca rhaphiophylla* low to mid woodland over **Cynodon dactylon, Marsilea drummondii* and **Avena barbata* low closed grassland	0.26	0.1	

Community Code	Vegetation Description	Area within Study Area (ha)	Percentage of Study Area (%)	Representative Photo
CcAsAb	*Corymbia calophylla, Melaleuca rhaphiophylla* and *Casuarina obesa* low woodland over *Acacia saligna, Hakea prostrata* and **Solanum nigrum* mid to high shrubland over **Avena barbata, *Lolium rigidum* and **Ehrharta longiflora* closed grassland	1.96	1.0	
MpAsPp	*Melaleuca preissiana, Melaleuca rhaphiophylla* and *Eucalyptus rudis* low to mid woodland with emergent *Corymbia calophylla* over *Acacia saligna, *Lupinus angustifolius* and **Brassica* sp. low to high open shrubland over **Pentameris pallida, *Ehrharta longiflora and *Vulpia myuros* low to high open grassland	1.75	0.9	

Community Code	Vegetation Description	Area within Study Area (ha)	Percentage of Study Area (%)	Representative Photo
Wetlands				
MpXpCa	*Melaleuca preissiana* and *Melaleuca rhaphiophylla* low closed forest *over Xanthorrhoea preissii, Taxandria linearifolia* and *Aotus gracillima* high open shrubland over *Cyathochaeta avenacea, Dielsia stenostachya* and *Lepidosperma ?longitudinale* high sedgeland. In wetter areas, the understorey is dominated by sedges including *Baumea articulata, Ornduffia albiflora* and *?Schoenoplectus pungens*	3.02	1.6	
ErAbLl	*Eucalyptus rudis, Melaleuca preissiana* and *Melaleuca rhaphiophylla* mid closed forest over *Acacia blakelyi* and **Ficus carica* low *open shrubland* over *Lepidosperma ?longitudinale*, *Juncus pallidus* and **Zantedeschia aethiopica* high open sedgeland	0.09	0.05	

Community Code	Vegetation Description	Area within Study Area (ha)	Percentage of Study Area (%)	Representative Photo
MrAsCp	*Melaleuca rhaphiophylla* and *Eucalyptus rudis* low woodland over, *Acacia saligna* and *Viminaria juncea* low open shrubland over **Cyperus papyrus, *Cyperus polystachyos* and **Holcus lanatus* high closed sedgeland	1.83	1.0	
Disturbed Vegetation				
Mp/Mr	Isolated *Melaleuca preissiana* and/or *Melaleuca rhaphiophylla* trees over common pasture weeds	8.52	4.5	n/a
Native Eucalypts over paddock	*Corymbia calophylla*, *Eucalyptus rudis, Eucalyptus marginata,* and/or *Eucalyptus patens* isolated trees over common pasture weeds	23.9	12.6	
To	**Typha orientalis* tall closed rushland in artificial drainage infrastructure. Emergent *Acacia saligna* and Planted Eucalypts are present in places	0.22	0.1	
Pine Plantation	**Pinus pinaster* isolated trees over common pasture weeds	4.10	2.2	
Landscaping	Planted vegetation comprising predominantly non-native species	7.44	3.9	
Planted	Roadside planted common native rehabilitation species	2.41	1.3	

Community Code	Vegetation Description	Area within Study Area (ha)	Percentage of Study Area (%)	Representative Photo
Other				
Water	Inundated areas associated with wetlands	0.13	0.1	n/a
Cleared	Areas devoid of native vegetation including existing roads, tracks, infrastructure or cleared paddock areas comprising weeds	101.84	53.5	
Total		**190.22**	**100**	

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LEGEND

Study Area

Vegetation Communities

- BaCePg
- CCXpBm
- CcAsAb
- CcXpBm
- CcXpPe
- Cleared
- ErAbLi
- ErCd
- Landscaping
- Mp/Mr
- MpAsPp
- MpXpCa
- MrAsCp
- Native Eucalypts over paddock
- Pine Plantation
- Planted
- To
- Water

A B C D E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

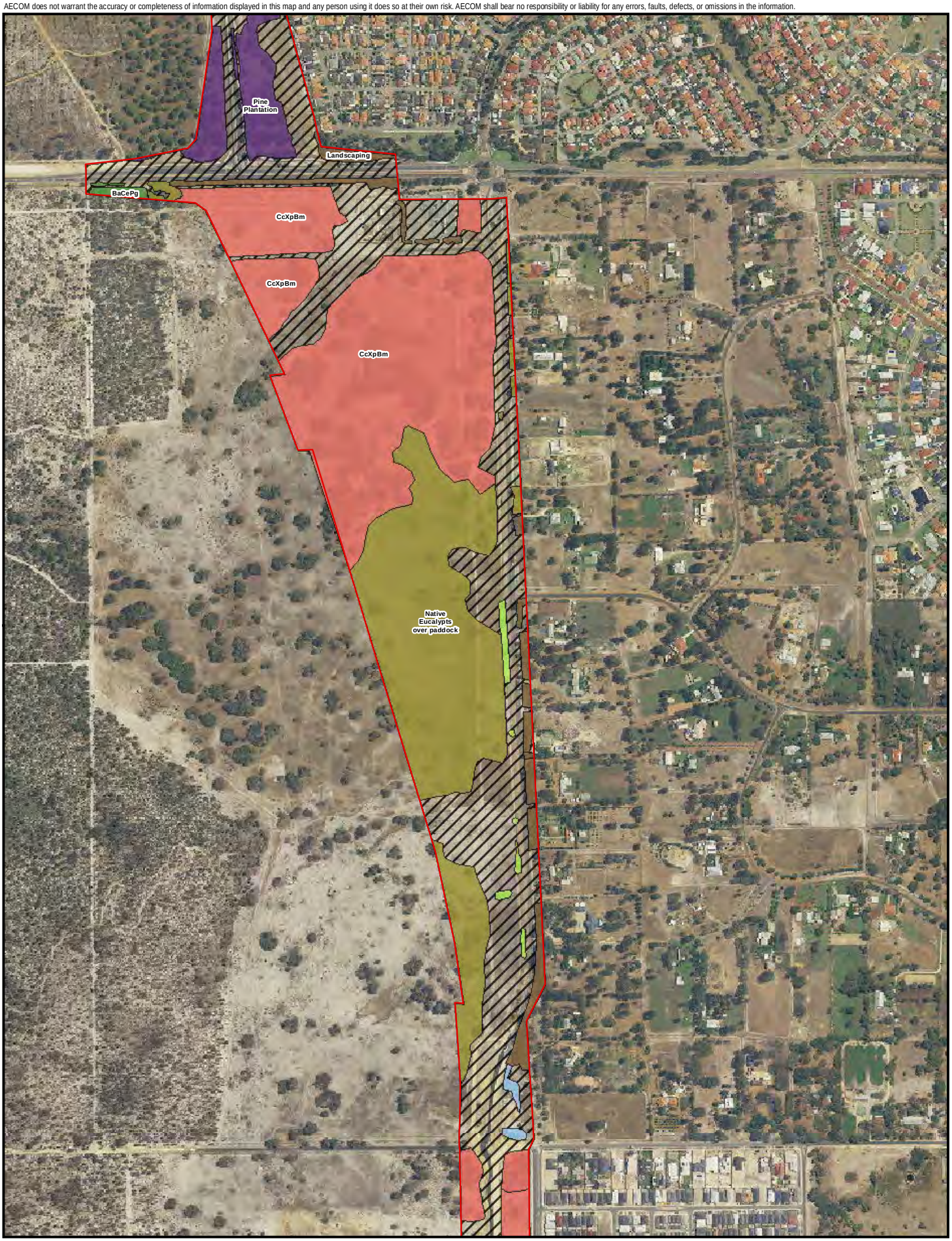
Vegetation Communities

ELLENBROOK BUS RAPID TRANSPORT

Figure

6A

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\602X\60286738\16 - Ellenbrook\4. Tech work area\4.99 GIS\02_MXDs\Environmental Impact AssessmentEnvironmental Management Plan (EIA EMP)\ENV_Map6_VegetationCommunities_DF_20160111.mxd (fotheringhamd) A4 size



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LEGEND

- Study Area

Vegetation Communities

- BaCePg
- CCXpBm
- CcAsAb
- CcXpBm
- CcXpPe
- Cleared
- ErAbLi
- ErCd
- Landscaping
- Mp/Mr
- MpAsPp
- MpXpCa
- MrAsCp
- Native Eucalypts over paddock
- Pine Plantation
- Planted
- To
- Water

A B C D E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Communities

ELLENBROOK BUS RAPID TRANSPORT

Figure 6B

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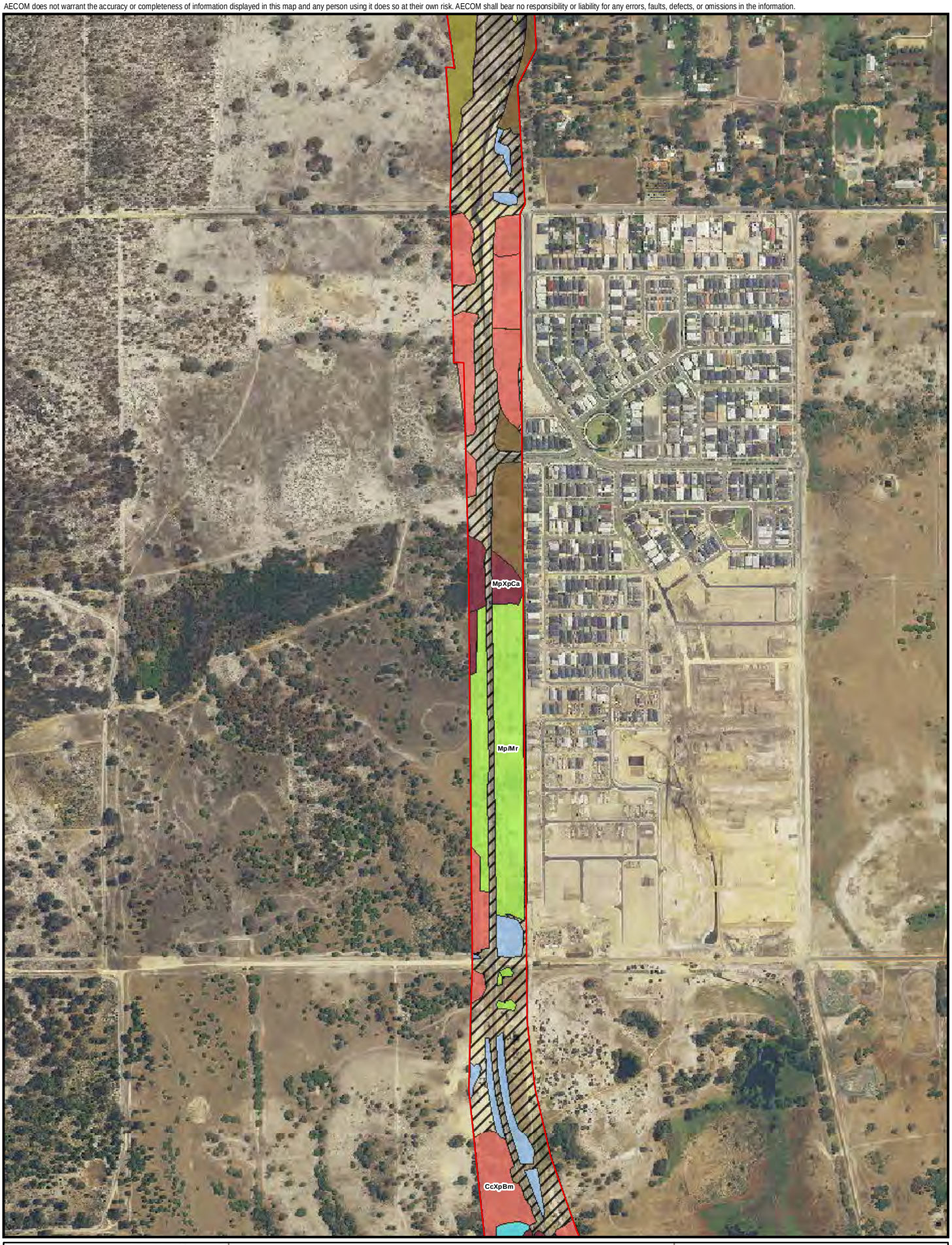

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metres

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LEGEND

- Study Area

Vegetation Communities

- BaCePg
- CCXpBm
- CcAsAb
- CcXpBm
- CcXpPe
- Cleared
- ErAbLi
- ErCd
- Landscaping
- Mp/Mr
- MpAsPp
- MpXpCa
- MrAsCp
- Native Eucalypts over paddock
- Pine Plantation
- Planted
- To
- Water

A B C D E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Communities

ELLENBROOK BUS RAPID TRANSPORT

Figure

6C

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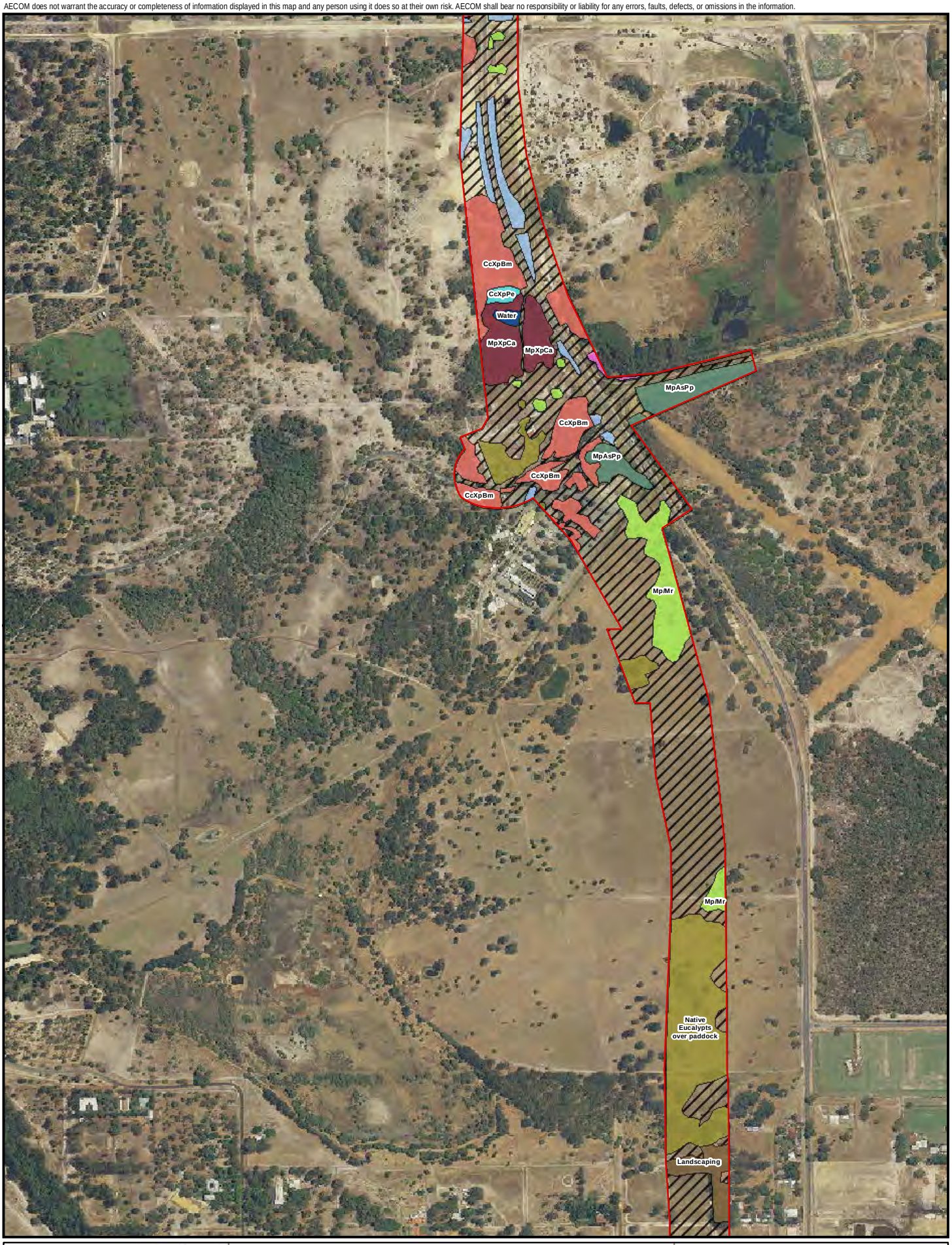

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LEGEND

Study Area

Vegetation Communities

- BaCePg
- CCXpBm
- CcAsAb
- CcXpBm
- CcXpPe
- Cleared
- ErAbLi
- ErCd
- Landscaping
- Mp/Mr
- MpAsPp
- MpXpCa
- MrAsCp
- Native Eucalypts over paddock
- Pine Plantation
- Planted
- To
- Water

A B C D E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Communities

ELLENBROOK BUS RAPID TRANSPORT

Figure 6D

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LEGEND

Study Area

Vegetation Communities

- BaCePg
- CCXpBm
- CcAsAb
- CcXpBm
- CcXpPe
- Cleared
- ErAbLi
- ErCd
- Landscaping
- Mp/Mr
- MpAsPp
- MpXpCa
- MrAsCp
- Native Eucalypts over paddock
- Pine Plantation
- Planted
- To
- Water

A B C D E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Communities

ELLENBROOK BUS RAPID TRANSPORT

Figure 6E

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5.2.2.2 Vegetation Condition

The condition of the vegetation within the Study Area ranged from 'Completely Degraded' to 'Very Good'. Despite the number of vegetation communities described (Section 5.2.2.1), the majority of the Study Area vegetation was in 'Completely Degraded' condition (37.4% of the Study Area), primarily reflecting the considerable level of human disturbance of the area and the presence of numerous weeds. The area and proportion of each vegetation condition contained within the Study Area are summarised in Table 9 and shown in Figures 7A-E.

More than half of the Study Area has already been cleared for existing infrastructure and paddocks (53.5%). Open water associated with wetlands comprised a further 0.1% of the Study Area.

Table 9 Vegetation Condition within the Study Area

Condition Rating	Area within Study Area (ha)	Percentage of Study Area (%)
Very Good	2.26	1.2
Good	3.72	2.0
Degraded	11.21	5.9
Completely Degraded	71.06	37.4
Cleared	101.84	53.5
Water	0.13	0.1
Total	**190.22**	**100**

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metres

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LEGEND

Study Area

Weeds

*Asparagus asparagoides

*Echium plantagineum

*Moraea miniata

*Zantedeschia aethiopica

Vegetation Condition

Very Good
Good
Degraded
Completely Degraded
Cleared
Water

A
B
C
D
E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Condition

ELLENBROOK BUS RAPID TRANSPORT

Figure

7A

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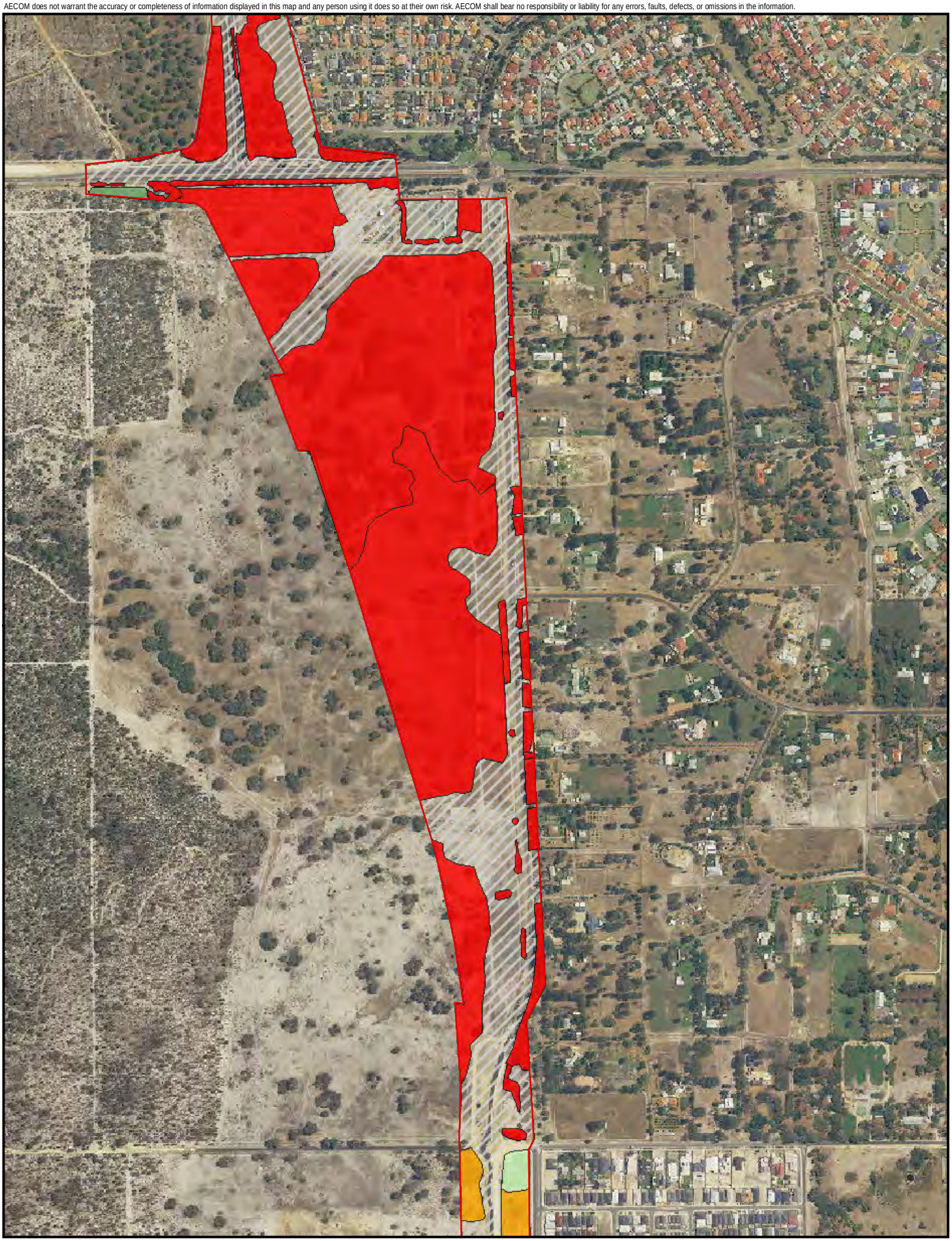

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LEGEND

Study Area

Weeds

*Asparagus asparagoides
*Echium plantagineum
*Moraea miniata
*Zantedeschia aethiopica

Vegetation Condition

Very Good
Good
Degraded
Completely Degraded
Cleared
Water

A
B
C
D
E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Condition

ELLENBROOK BUS RAPID TRANSPORT

Figure
7B

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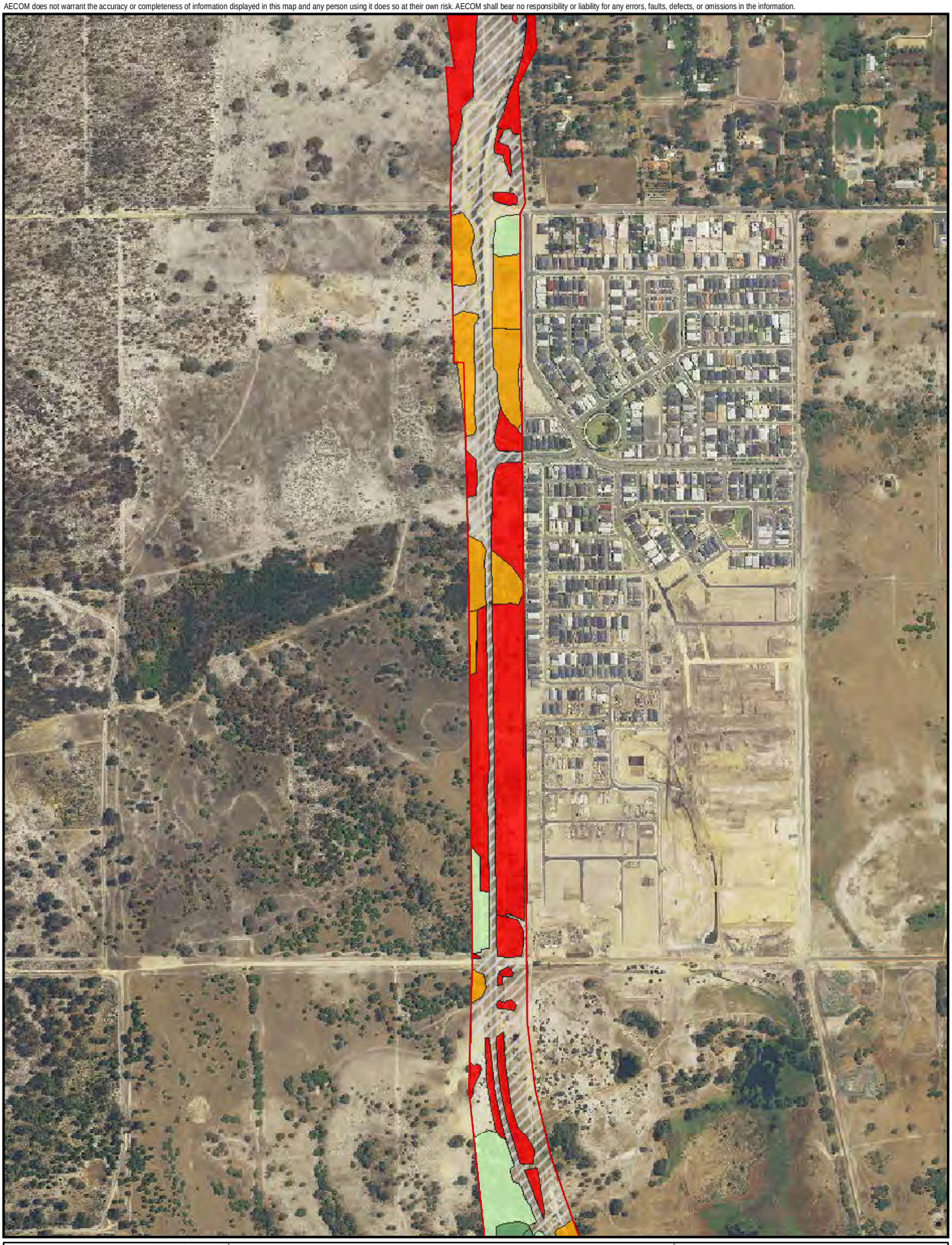

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metres

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LEGEND

Study Area

Weeds

*Asparagus asparagoides

*Echium plantagineum

*Moraea miniata

*Zantedeschia aethiopica

Vegetation Condition

Very Good
Good
Degraded
Completely Degraded
Cleared
Water

A
B
C
D
E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

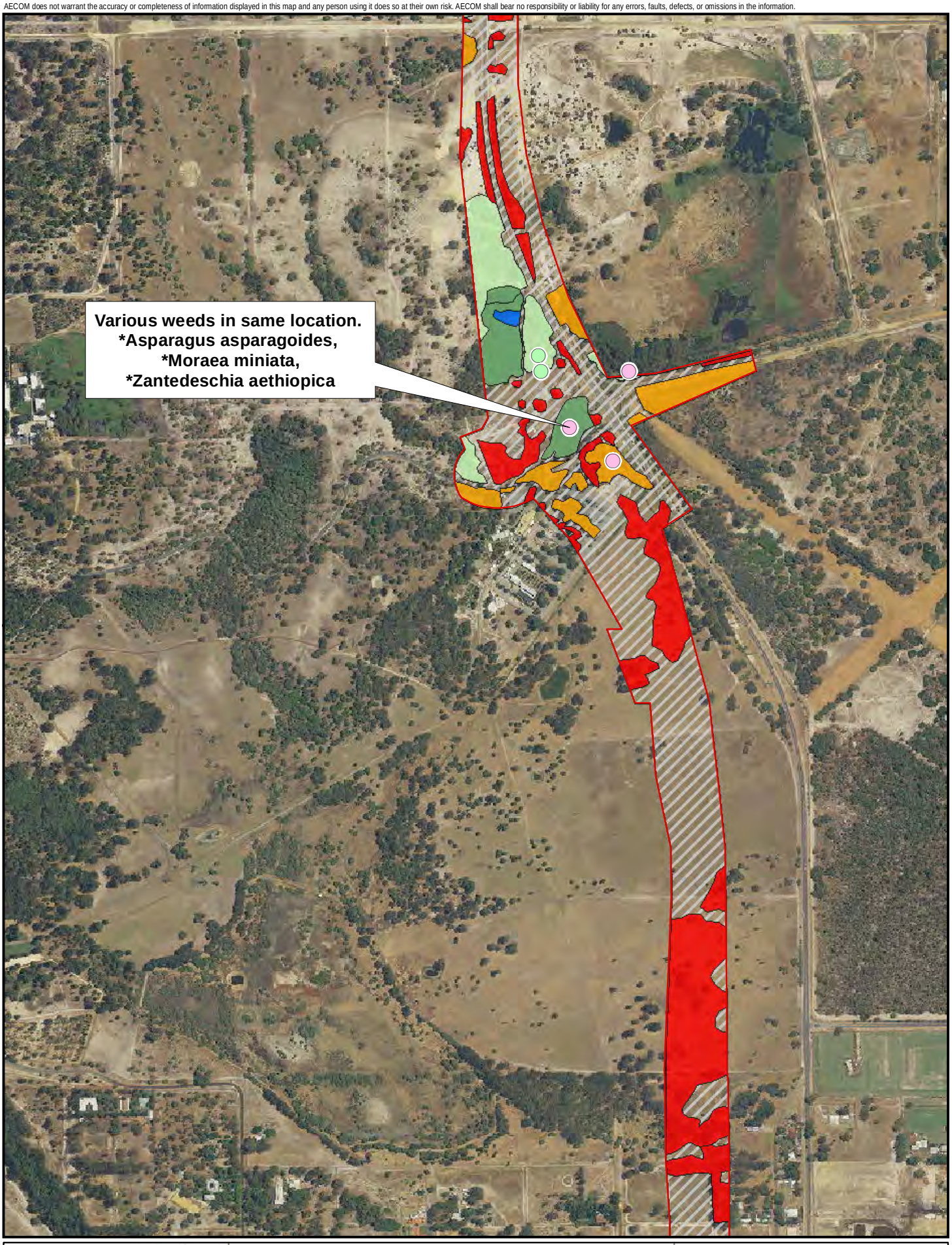
Vegetation Condition

ELLENBROOK BUS RAPID TRANSPORT

Figure

7C

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\602X\60286738\16 - Ellenbrook\4. Tech work area\4.99 GIS\02_MXDs\Environmental Impact AssessmentEnvironmental Management Plan (EIA EMP)\ENV_Map7_VegetationCondition_DF_20160111.mxd (fotheringhamd) A4 size



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LEGEND

Study Area

Weeds

*Asparagus asparagoides

*Echium plantagineum

*Moraea miniata

*Zantedeschia aethiopica

Vegetation Condition

Very Good
Good
Degraded
Completely Degraded
Cleared
Water

A
B
C
D
E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Condition

ELLENBROOK BUS RAPID TRANSPORT

Figure

7D

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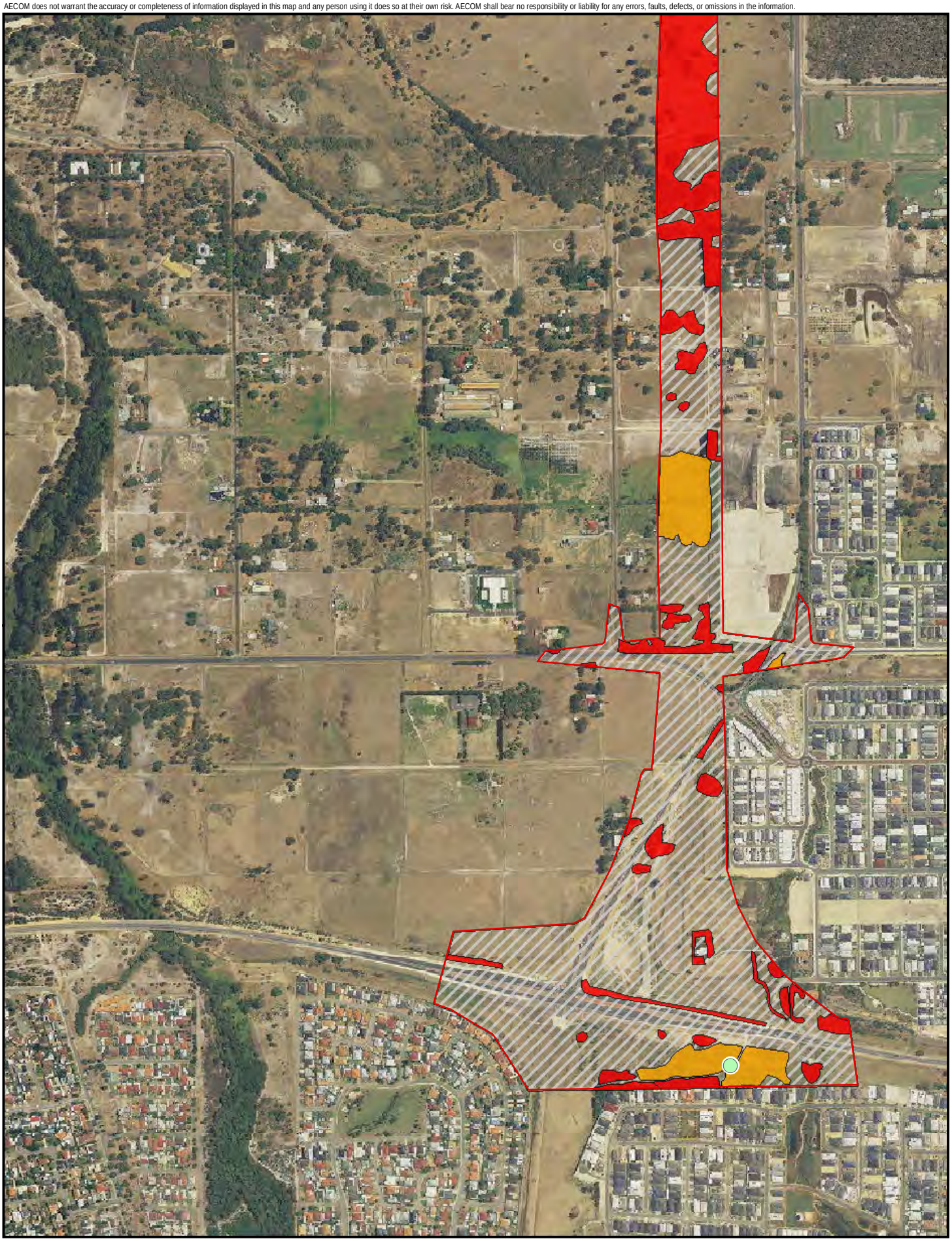

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LEGEND

Study Area

Weeds

*Asparagus asparagoides

*Echium plantagineum

*Moraea miniata

*Zantedeschia aethiopica

Vegetation Condition

Very Good
Good
Degraded
Completely Degraded
Cleared
Water

A
B
C
D
E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Vegetation Condition

ELLENBROOK BUS RAPID TRANSPORT

Figure
7E

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\602X\60286738\16 - Ellenbrook\4. Tech work area\4.99 GIS\02_MXDs\Environmental Impact AssessmentEnvironmental Management Plan (EIA EMP)\ENV_Map7_VegetationCondition_DF_20160111.mxd (fotheringhamd) A4 size

5.3 Fauna

5.3.1 Fauna Desktop

This section provides a summary of the fauna desktop results, extracted from Ellenbrook Bus Rapid Transit (AECOM, 2013) and updated with more recent database results; the Perth – Darwin National Highway Reid Highway to Maralla Road Section – Fauna Management Plan (Kinhill Engineers Pty Ltd, 1995) and from trapping undertaken in Whiteman Park by Conservation Officers employed by the Park.

5.3.1.1 Ellenbrook Bus Rapid Transit (AECOM, 2013)

The results of the desktop assessment are presented in Table 10.

A total of 20 fauna species of conservation significance were listed as potentially occurring in the area (Table 10). The field assessment in October was undertaken to assess whether these species, or their habitat, occurs within the alignment and those results are in Sections 5.3.2 to 5.3.5.

Table 10 Conservation significant fauna species that may or are likely to occur within the Study Area

Species	Vernacular	Conservation Status		Likelihood
		Commonwealth	State	
Birds				
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Schedule 2 - EN	Likely to occur
Calyptorhynchus baudinii	Baudin's Cockatoo (long-billed black-cockatoo)	Vulnerable	Schedule 2 - EN	Likely to occur
Calyptorhynchus banksii subsp. *naso*	Forest Red Tailed Black Cockatoo	Vulnerable	Schedule 3 - VU	Likely to occur
Leipoa ocellata	Malleefowl	Vulnerable	Schedule 3 - VU	Unlikely to occur
Sternula nereis subsp. *nereis*	Fairy tern	Vulnerable	NA	Unlikely to occur
Rostratula benghalensis australis	Australian Painted Snipe	Endangered, Migratory, Marine	Schedule 2 - EN	May occur
Ardea ibis	Cattle Egret	Migratory, Marine	Schedule 5 - IA	May occur
Ardea modesta	Eastern Great Egret	Migratory, Marine	Schedule 5 - IA	May occur
Apus pacificus	Fork-tailed swift	Migratory, Marine	Schedule 5 - IA	May occur
Falco peregrinus	Peregrine Falcon	NA	Schedule 7	May occur
Merops ornatus	Rainbow Bee-eater	Migratory, Marine	Schedule 5 - IA	May occur
Haliaeetus leucogaster	White Bellied Sea Eagle	Migratory	Schedule 5 - IA	May occur
Plegadis falcinellus	Glossy Ibis	Migratory	Schedule 5 - IA	May occur
Mammals				
Bettongia penicillata ogilbyi	Woylie, Brush-tailed Bettong	Endangered	Schedule 1 - CR	May occur
Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable	Schedule 3 - VU	Unlikely to occur
Hydromys chrysogaster	Water Rat	NA	Priority 4	Unlikely to occur
Isoodon obesulus subsp. *fusciventer*	Quenda, Southern Brown Bandicoot	NA	Priority 5	May occur

Species	Vernacular	Conservation Status		Likelihood
		Commonwealth	State	
Macropus eugenii derbianus	Tammar Wallaby	NA	Priority 4	May occur
Reptiles				
Neelaps calonotos	Black-striped Snake	NA	Priority 3	May occur
Invertebrates				
Synemon gratiosa	Graceful Sun-moth	NA	Priority 4	May occur

Note: Conservation Status codes are explained in Appendix B

5.3.1.2 Perth – Darwin National Highway Reid Highway to Maralla Road Section – Fauna Management Plan (Kinhill Engineers Pty Ltd, 1995)

A summary of fauna surveys conducted at Whiteman Park are provided in the 1995 Fauna Environmental Management Plan (Kinhill Engineers Pty Ltd, 1995). The authors noted that at Whiteman Park there were potentially at least six species of amphibians, 32 species of reptiles, 95 species of birds and eight species of native mammals. The plan highlighted that species of note included the Black Gloved Wallaby (*Macropus Irma*), now a Priority 4 species, Honey Possum and Southern Brown Bandicoot, the latter now a Priority 5 species.

A field survey was undertaken by Ecologia in May 1995 which recorded 34 bird species, one native and three introduced mammals, four amphibians and five reptiles. A variety of trapping, searching and observation techniques were employed and totalled 732 trap nights. This trapping effort would in today's practises equate to a Level 2 Fauna Survey.

The only native mammal recorded at Whiteman Park was the Western Grey Kangaroo. Introduced mammals recorded included the Feral Cat (*Felis catus*), European Rabbit (*Oryctolagus cuniculus*) and the Fox (*Vulpes vulpes*). Amphibians recorded were the Turtle Frog (*Myobatrachus gouldii*), Moaning Frog (*Helioporus eyrie*), *Helioporus* sp. and Gunthers Toadlet (Crawling Toadlet) (*Pseudophryne guentheri*).

The only rare fauna species, under the legislation of the day, was the Quenda or Southern Brown Bandicoot which at that time was a Schedule 1 ('fauna that is rare or likely to become extinct') species. After numerous records from surveys since 1995, the Quenda has been downgraded to a Priority 5. Baudin's Black Cockatoo, at the time a schedule 4 species, was also recorded at Whiteman Park, in the Pine Plantation. This species is now a Schedule 1 species under the *Wildlife Conservation Act 1950 (*WC Act) and Vulnerable under the EPBC Act.

5.3.1.3 Whiteman Park information

AECOM contacted Whiteman Park Conservation officers on the 5th of November, 2015 for more information on the conservation significant species that may occur at the Park. The Western Brush Wallaby (*Macropus irma*) and Quenda (*Isoodon obesulus* subsp. *fusciventer)* were confirmed to occur at the park, the latter in high numbers. This data has come from an annual trapping survey that is undertaken at the park (Pers. Comm. Kellie Morley– Senior Environmental Officer).

5.3.2 October 2015 Field Survey

5.3.2.1 Threatened, Migratory and Priority fauna species

Two conservation significant fauna species were directly observed during the October field survey. The Rainbow Bee-eater (Migratory) was recorded at two locations with several pairs observed feeding on insects between tree canopies. Forest Red-tailed Black Cockatoos were observed foraging in Marri trees and flying overhead at three locations. Indirect evidence of potential conservation significant species was also recorded. Numerous potential Quenda diggings were recorded inside the Study Area in one location, at the southern end of the Study Area (Figures 8A-E). Feeding signs from the Forest Red-tailed Black Cockatoo were observed throughout the Study Area under numerous Marri trees. No other conservation significant species were recorded within the Study Area. Details are provided in Table 11 and displayed in Figures 8A-E.

Table 11 Conservation significant species recorded during the October field survey

Species	Evidence	Location
Quenda, (Southern Brown Bandicoot)	Potential Diggings	Latitude:-31.862936, Longitude:115.966541,
Rainbow Bee-eater	Direct Observation	Longitude: 115.959307 Latitude:-31.801153
		Latitude:-31.849694, Longitude:115.966884,
Forest Red-tailed Black Cockatoo	Direct Observation	Latitude:-31.799715, Longitude:115.962265,
		Latitude: -31.798507 Longitude: 115.959397
		Latitude: -31.835454 Longitude: 115.964431
	Marri nut chewings	Numerous locations throughout Study Area

5.3.3 Habitat

A total of eight fauna habitats have been defined (Table 12) and mapped (Figures 8A-E) for the Study Area based on the results of the field assessment.

Table 12 Fauna habitats of the Study Area

Habitat	Description	Area / % of Study Area	Photo
Banksia woodland	*Banksia attenuata, Banksia littoralis, Casuarina obesa* low woodland with emergent *Corymbia calophylla* over **Carpobrotus edulis*, *Patersonia occidentalis* and *Calytrix angulata* low open heathland over *Podotheca gnaphalioides*, **Ehrharta calycina* and **Ursinia anthemoides* low open grassland	0.26 (0.14%)	
Eucalypt/Marri woodland	*Corymbia calophylla, Eucalyptus marginata, Eucalyptus patens* and *Eucalyptus rudis* over a mix of native shrubs including *Xanthorrhoea preissii, Dasypogon bromeliifolius*, *Nuytsia floribunda, Allocasuarina* sp., *Banksia* species and/or over a mix of introduced grasses.	58.71 (30.9%)	

Habitat	Description	Area / % of Study Area	Photo
Melaleuca over introduced grasses	Isolated *Melaleuca preissiana* and/or *Melaleuca rhaphiophylla* trees over common pasture grasses	8.32 (4.4%)	n/a
Melaleuca swampland	*Melaleuca rhaphiophylla* and *Eucalyptus rudis* low woodland over, *Acacia saligna* and *Viminaria juncea* low open shrubland over **Cyperus papyrus*, **Cyperus polystachyos* and **Holcus lanatus* high closed sedgeland	1.83 (1.0%)	
Melaleuca woodland	*Melaleuca preissiana, Melaleuca rhaphiophylla* and *Eucalyptus rudis* low to mid woodland over a mixture of native and introduced species including *Acacia saligna, *Lupinus angustifolius* and **Brassica sp*., *Xanthorrhoea preissii, Taxandria linearifolia* and *Aotus gracillima* low to high open shrubland over **Pentameris pallida, *Ehrharta longiflora* and **Vulpia myuros* low to high open grassland	4.96 (2.6%)	
Pine plantation	Pine Plantation over sandy grey sand.	4.10 (2.2%)	n/a
Planted/Landscaping	Planted vegetation comprising a mixture of native and/or non-native species.	9.84 (5.2%)	n/a
Swampland	Wet swampland of native and introduced shrubs and grasses.	0.35 (0.2%)	

5.3.3.1 Black Cockatoo habitat

A total of 291 trees within the Study Area are considered to be potential breeding habitat trees in accordance with the Commonwealth Guidelines (Australian Government, 2012), (Figures 8A-E and Appendix E). A total of 20 hollows with an opening diameter of 5 cm and above were recorded. Of these, four hollows had an opening diameter large enough (larger than 20 cm) to accommodate Black Cockatoos. Depths of these hollows were unable to be ascertained so suitability of these hollows can't be concluded. No tree hollows were in use by Black Cockatoo species.

A total of 63.07 ha within the Study Area may provide some foraging value to Black Cockatoos, mapped in Figures 8A-E. These areas did not have a high diversity of foraging species for Black Cockatoos. For example, 58.7 ha of this total comprises Eucalypts over grassland, with the grassland making up a much larger percentage of the area than the Eucalypts. Additionally, 4.1 ha of the total comprises introduced pine plantation which is a food source for Carnaby's Black Cockatoo and Baudin's Black Cockatoo. Suitable foraging species that were present were observed in low numbers.

5.3.4 Inventory of fauna species

A total of 42 vertebrate fauna species were recorded during the field survey. The total number comprised 33 birds, six mammals and three reptiles. These are listed in Table 13.

Table 13 Inventory of fauna species recorded in the Study Area during the October Field Survey 2015

Species	Vernacular	Conservation Status
Birds		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	Native
Anthochaera carunculata	Red Wattlebird	Native
Cacatua roseicapilla	Galah	Native
Cacatua sanguinea	Little Corella	Native
Calyptorhynchus banksii subsp. *naso*	Forest Red-tailed Black Cockatoo	Vulnerable (EPBC Act) and Schedule 1 (WC Act)
Chenonetta jubata	Australian Wood Duck (Wood Duck)	Native
Cincloramphus cruralis	Brown Songlark	Native
Cincloramphus mathewsi	Rufous Songlark	Native
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Native
Corvus coronoides	Australian Raven	Native
Cracticus tibicen	Australian Magpie	Native
Falco cenchroides	Australian Kestrel	Native
Gerygone fusca	Western Gerygone	Native
Grallina cyanoleuca	Magpie-lark	Native
Himantopus himantopus	Black-winged Stilt	Native, Marine
Hirundo neoxena	Welcome Swallow	Native, Marine
Lichmera indistincta	Brown Honeyeater	Native
Malurus splendens	Splendid Fairy-wren	Native
Merops ornatus	Rainbow Bee-eater	Migratory, Marine
Ocyphaps lophotes	Crested Pigeon	Native
Pachycephala rufiventris	Rufous Whistler	Native
Pardalotus striatus	Striated Pardalote	Native
Phaps chalcoptera	Common Bronzewing	Native

Species	Vernacular	Conservation Status
Phylidonyris novaehollandiae	New Holland Honeyeater	Native
Platycercus zonarius	Australian Ringneck (Ring-necked Parrot)	Native
Rhipidura fuliginosa	Grey Fantail	Native
Rhipidura leucophrys	Willie Wagtail	Native
Smicrornis brevirostris	Weebill	Native
Tadorna tadornoides	Australian Shelduck (Mountain Duck)	Native
Threskiornis molucca	Australian White Ibis	Native
Todiramphus sanctus	Sacred Kingfisher	Native
Trichoglossus haematodus	Rainbow Lorikeet	Introduced (Declared Pest s22)
Vanellus miles	Masked Lapwing	Native
Mammals		
Bos taurus	European Cattle	Introduced (Permitted s11)
Canis lupus familiaris	Dog	Introduced (Domestic Permitted s11 & Feral Declared Pest s22)
Felis catus	Cat	Introduced (Domestic Permitted s11 & Feral Declared Pest s22)
Isoodon obesulus subsp. *fusciventer*	Southern Brown Bandicoot, Quenda (Diggings)	Priority 5
Macropus fuliginosus	Western Grey Kangaroo	Native
Oryctolagus cuniculus	Rabbit	Introduced Declared Pest (s22)
Reptiles		
Cryptoblepharus buchananii	Fence Skink	Native
Menetia greyii	-	Native
Tiliqua rugosa subsp. *rugosa*	Bobtail	Native

5.3.5 Introduced species

Five introduced species were recorded within the Study Area during the field survey. The Rainbow Lorikeet has established a population in Perth since 1968. It is a Declared Pest under the BAM Act. Cattle are a permitted species under the BAM Act. The three other introduced mammal species are all (if feral) Declared Pests under the BAM Act.

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LEGEND

- Study Area

Significant Fauna

- Forest Red-tailed Black Cockatoo
- Quenda, (Southern Brown Bandicoot)
- Rainbow Bee-eater

Black Cockatoo Potential Breeding Habitat Tree

- Blackbutt
- Flooded Gum
- Jarrah
- Marri
- Stag
- Tuart

Black Cockatoo Potential Foraging Habitat

Fauna Habitat

- *Banksia* Woodland
- Cleared
- Eucalypt/Marri over introduced grasses
- *Melaleuca* Woodland
- *Melaleuca* over introduced grasses
- *Melaleuca* swampland
- Pine Plantation
- Planted/Landscaping
- Swampland

A B C D E

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Fauna Values of the Project Area

ELLENBROOK BUS RAPID TRANSPORT

Figure

8A

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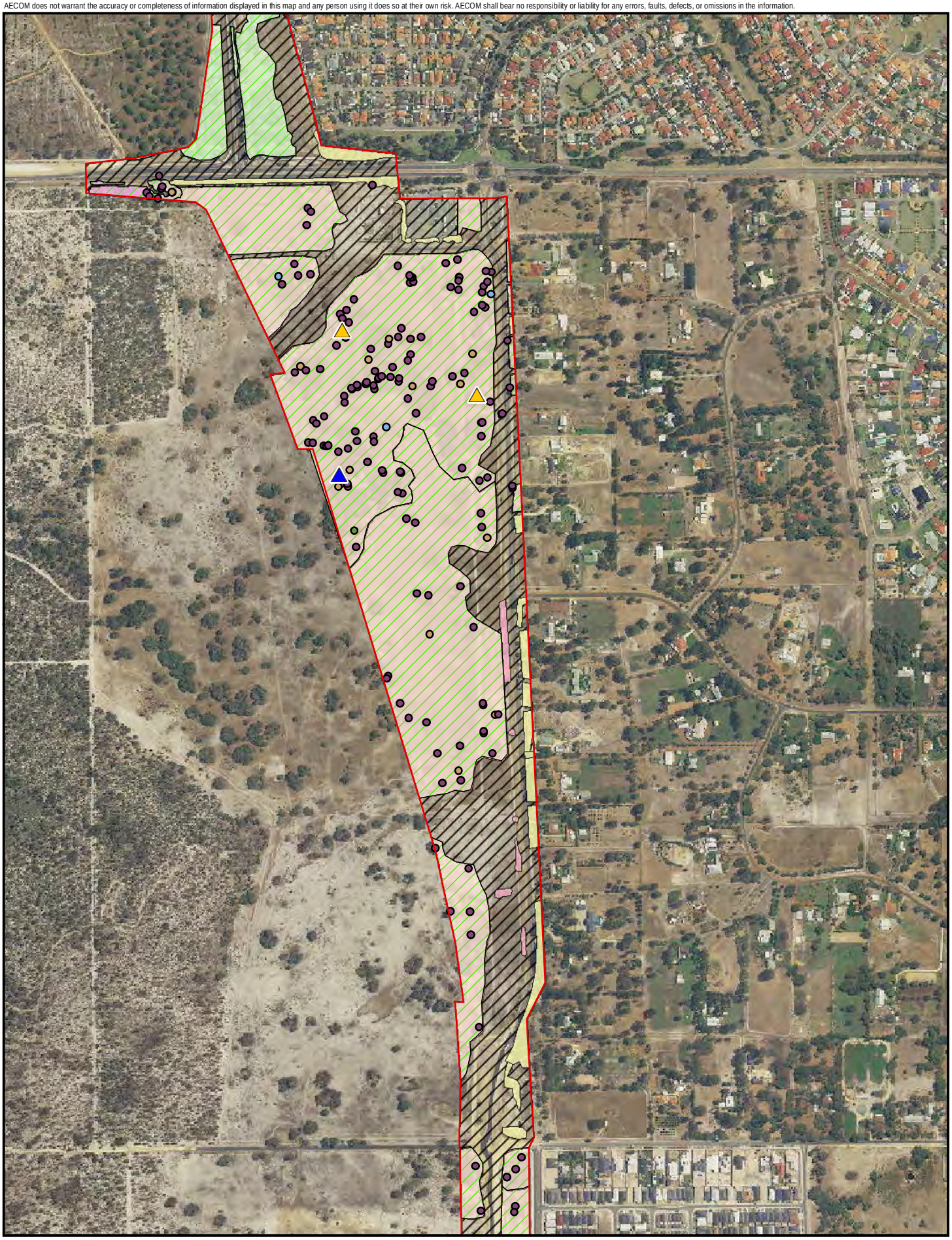

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Fauna Values of the Project Area

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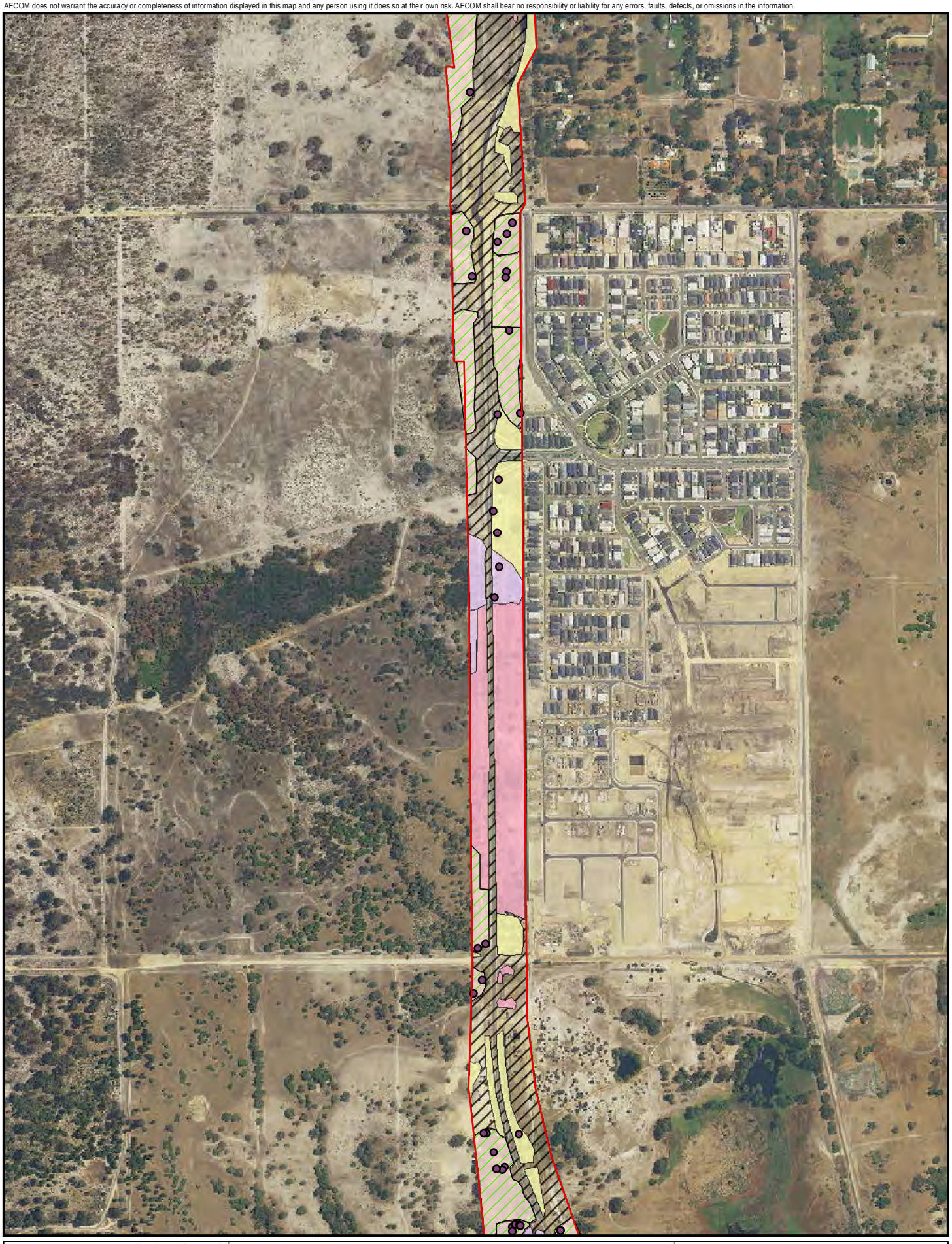

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Fauna Values of the Project Area

ELLENBROOK BUS RAPID TRANSPORT

Figure

8C

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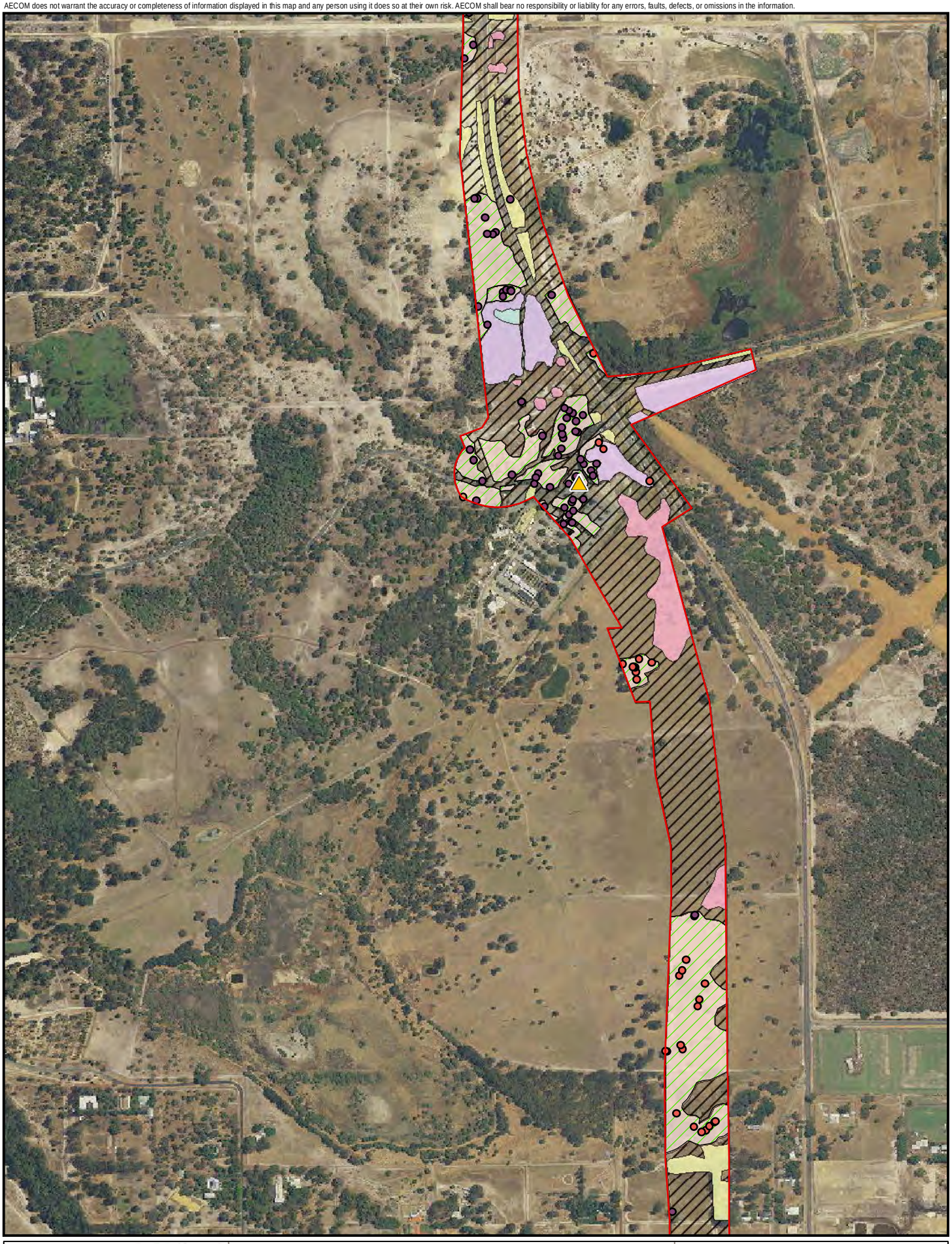

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Fauna Values of the Project Area

ELLENBROOK BUS RAPID TRANSPORT

Figure

8D

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Fauna Values of the Project Area

ELLENBROOK BUS RAPID TRANSPORT

Figure

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6.0 Discussion

The biological assessment was conducted within a defined Study Area for the Department of Transport in spring, 2015. The assessments included a Level 1 Flora and Vegetation Assessment and Level 1 Fauna Assessment and were completed by a qualified botanist and zoologist during ideal survey season. The entire Study Area was traversed on foot by Lyn van Gorp and Matthew Cann and floristic, fauna, and vegetation data collected.

6.1 Flora and Vegetation

Table 14 shows the total area of native remnant vegetation that lies within the Study Area, regardless of vegetation condition. It also shows the area of native vegetation contained within each MRS zone. Parts of the surveyed area occur within Rural, Public Purpose – State Energy Commission, Public Purpose – Water Authority of WA, Parks and Recreation, and Urban zoned areas.

Table 14 Area of Native Vegetation within each MRS Zone

MRS Zoning	Area of Native Vegetation (ha)
Primary Regional Roads	38.0
Public Purpose – Special Use (Transit)	17.2
Rural	17.2
Public Purpose – State Energy Commission	0.03
Public Purpose – Water Authority of WA	0.1
Parks and Recreation	1.4
Urban	0.01
Total	**74.08**

A total of 129 vascular plant species were recorded within the Study Area from 43 families and 103 genera. A large proportion (38%) of the species recorded consists of introduced (weed) species. This was anticipated due to the highly degraded nature of the Study Area, with the majority of the surveyed area consisting of cleared paddocks.

Three flora species of conservation significance were identified in the desktop assessment as ‘may occur’ within the Study Area. Despite this, none of these species were recorded during the field survey. Their absence is likely to be attributed to the degraded nature of the site and the geographical barrier between the remnant native vegetation within the Study Area, and populations of these species in the vicinity. No Threatened or Priority flora species were recorded or are considered likely to occur within the Study Area based primarily on lack of or degraded condition of suitable habitat.

A large proportion of the Study Area (37.4%) has been highly modified and was mapped as Completely Degraded. A further 53.5% of the Study Area was mapped as ‘Cleared’, being largely devoid of any vegetation aside from weeds in places. In comparison, only 9.1% of the Study Area comprises native vegetation where native species were present in more than one strata of the vegetation community. The 9.1% of native vegetation is represented by nine mapped vegetation communities. None of these were considered to represent a Threatened or Priority Ecological Community.

The areas of highest quality vegetation are located in Whiteman Park near the main entrance to the park and in a small area of remnant vegetation located near the intersection of Gnangara Road and The Promenade. None of the vegetation communities recorded within the Study Area are considered to be locally, regionally or nationally significant.

Six disturbed vegetation communities were recorded, including isolated trees in paddocks, pine plantation, and landscaping/rehabilitated areas. The high proportion of cleared and Completely Degraded areas within the Study Area are largely associated with past agricultural land uses in the area as well as clearing for the provision of infrastructure such as residential housing and the existing Lord Street, which have subsequently resulted in encroachment by numerous weed species.

The Study Area contains 2.24 ha of Bush Forever Site 304 and 124.62 ha of ESA. It is important to note that much of the area of Bush Forever and ESA intersected is already cleared or Completely Degraded. Direct impacts on Bush Forever and ESA are therefore likely to be considerably lesser than the total areas contained within the Study Area.

6.2 Fauna

6.2.1 Threatened, Migratory and Priority fauna species

Forest Red-tailed Black Cockatoo (Vulnerable, EPBC Act and Schedule 1, WC Act) was confirmed as occurring within the Study Area by three direct observations. At numerous locations throughout the Study Area, chewing evidence from this species was observed. This evidence was recorded in the Eucalypt and Marri woodland over grasses habitat which occurs in 58.71 ha or 30.9% of the Study Area. This habitat was considered low quality foraging habitat with the majority of this area consisting of introduced grasses.

Carnaby's Black Cockatoo (Endangered, EPBC Act and Schedule 1, WC Act) and Baudin's Black Cockatoo (Vulnerable, EPBC Act and Schedule 1, WC Act) were not recorded during the field survey. Baudin's Black Cockatoo was recorded during a field survey component of an Environmental Management Plan (Kinhill Engineers Pty Ltd., 1995). Suitable habitat does occur within the Study Area and both species can be expected to occur.

In terms of Black Cockatoo Breeding habitat, 291 potential breeding trees were identified within the Study Area. A total of 20 hollows with an opening diameter of 5 cm and above were recorded. Of these, four hollows had an opening diameter large enough (larger than 20 cm) to accommodate Black Cockatoos. Depths of these hollows were unable to be ascertained so suitability of these hollows can't be concluded upon. No hollows were in use by Black Cockatoo species. Over coming years and decades however some of these hollows may become suitable breeding hollows. Consideration should be given to minimise the clearing of the trees, particularly those with hollows.

Rainbow Bee-eater (Migratory, EPBC Act and Schedule 3, WC Act) was recorded during the survey and the Study Area is considered to provide quality habitat for this species, particularly sandy banks near the wetlands or sandy tracks which it may utilise for nest construction. Most habitats in the Study Area provide some potential breeding habitat for this species given the sandy substrate present. The Rainbow Bee-eater is a common and widespread species however it is protected under the international agreement JAMBA and thus, consideration should be given to mitigating impacts to the species.

The Quenda (Priority 5) is considered likely to occur within the Study Area. Potential indirect evidence was recorded at the southern portion of the Study Area, south of Reid Highway. It is classified as a Priority 5 species. This classification is given to fauna that is considered by the DPAW as not threatened but is under a specific conservation program. It is found in woodland, heath and shrub communities on the Swan Coastal Plain and prefers a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008). The Quenda is considered likely to utilise the *Banksia* Woodland, Marri Woodland and Melaleuca Woodland habitats of the Study Area. Key threatening processes for the Quenda include habitat loss and degradation, road trauma and predation by introduced carnivores.

The Western Quoll (Vulnerable, EPBC Act and Schedule 1, WC Act) was not recorded. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (Van Dyck & Strahan, 2008). The majority of records are found in the contiguous Jarrah forests of the south west of Western Australia (DotE, 2015). Recent records exist within the Gnangara pine forest and Walyunga National Park and these indicate the presence of the species in those areas. Given the narrowness of the Study Area, it is unlikely that an individual of this species will occur within the Study Area. Key threatening processes for this species have been identified as fox and cat predation, altered fire regimes, road trauma, loss of habitat, shooting and climate change (DotE, 2015).

The Woylie (endangered, EPBC Act and Schedule 1, WC Act) was not recorded in the survey. Woylies prefer patches of dense undergrowth, that provide continuous canopy and therefore refuges against introduced predators. Inappropriate fire regimes cause the loss of the protective understorey. In Western Australia, wide scale fox baiting and reintroduction projects implemented under the *Western Shield* program, have led to an increase in the distribution and abundance of the Woylie (DotE, 2015). In Western Australia, scattered Woylie populations may be found throughout the jarrah forest in the south-west corner of the state. They have been recorded in nearby Whiteman Park and are likely to prefer the park's habitat to that around Lord Street. Key threatening processes are predation and habitat destruction.

The Tammar Wallaby (Priority 4, WC Act) was not recorded in the field survey. The tammar wallabies have a protected habitat within the 200 hectare enclosure at Whiteman Park. Woodland Reserve wis a feral predator-proof facility that allows threatened species to thrive within its native bushland habitat. The tammar wallabies are sourced from Karakamia in Chidlow, where the wild population has steadily increased within the specially-designed 6-foot high feral predator-proof fence. These 30 animals formed the base group for the reintroduction of the species at Whiteman Park. The tammar wallaby is the third species to be translocated to Woodland Reserve, following the woylie (Bettongia penicillata ogilbyi) translocation in March 2010 and the bush stone-curlew (Burhinus grallarius) in August 2013 (Whiteman Park, 2016).

Australian Painted Snipe (Endangered EPBC Act and Schedule 1 WC Act) typically inhabits shallow terrestrial freshwater or brackish wetlands, inundated or waterlogged grassland, dams or saltmarsh (DotE, 2015). This species was not recorded during the survey and was not expected to be recorded as it is rarely recorded in Western Australia. Suitable habitat for this species is the Melaleuca and swampy areas within the Study Area.

Glossy Ibis, Cattle Egret, Eastern Great Egret, Fork-tailed swift, White Bellied Sea Eagle are all common and widespread species. The former three species rely on wetland habitat and may be present within the Study Area in those habitats. The Fork-tailed Swift is predominantly an aerialist and is rarely observed on land. It may overfly the Study Area but is not likely to utilise habitat within the Study Area. The White Bellied Sea Eagle may overfly the area though are rarely recorded far inland from the coast (DPaW, 2015).

The Black-striped Snake is a Priority 4 species and is mostly confined to the Swan Coastal Plain between Mandurah and Lancelin. It takes shelter in upper layers of loose soil beneath leaf litter in *Eucalyptus/Banksia* woodlands, typically at the base of trees and shrubs (Bush *et al,* 2010). This species may occur in suitable habitat within the Study Area. Suitable habitat for this species comprises the *Banksia* woodland of the Study Area (0.26 ha or 0.14% of the Study Area).

6.2.2 Fauna underpass consideration

The provision of fauna underpasses was considered in the 1995 Fauna Environmental Management Plan. Underpasses were not recommended for this section of the Perth – Darwin National Highway but were recommended further north to assist movement of fauna between the Lexia Wetlands and Saw Pit Gully north of the Study Area (Kinhill Engineers Pty Ltd., 1995*).* AECOM supports this conclusion. The Study Area does not bisect any areas of habitat that may currently have high value as an ecological corridor for fauna. The Study Area traverses through mostly paddock with trees (58.7% of Study Area) or isolated patches of Melaleuca woodland or swampland (8% of Study Area) and development would not result in the bisection of critical fauna habitat where high numbers of vehicle-fauna strikes may be expected.

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7.0 Conclusion

The following key findings have been made based on the results of the desktop and field assessments for the Project:

- No Threatened or Priority flora species were recorded or are considered likely to occur within the Study Area.
- No TECs or PECs were recorded or are known to occur within the Study Area.
- Four of the weed species recorded are listed as Declared Pests under the BAM Act and would require management as part of any proposed construction of the BRT system.
- The Threatened Forest Red-tailed Black Cockatoo was recorded in the Study Area during the field survey. Although neither the Carnaby's Black Cockatoo nor Baudin's Black Cockatoo were recorded, both species are considered likely to occur. The Study Area contains potential breeding and foraging habitat for all three of the listed Black Cockatoo species.
- The Migratory Rainbow Bee-eater was recorded during the survey and the Study Area is considered to provide quality habitat for this species.
- The Quenda (Priority 5) is considered likely to occur within the Study Area.

It is recommended that detailed design minimise disturbance of native vegetation and Black Cockatoo potential breeding and foraging habitat. In particular, it is recommended that disturbance of native vegetation within Bush Forever and ESA is minimised.

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