Supporting Documentation
Clearing Permit Application

Gosnells Quarry

Lot 3 Cockram Road, Martin

DOCUMENT NO:
(GOS-CPA-2017/09/15-V0)

Holcim Australia Pty Ltd
Level 3, 200 Adelaide Terrace
East Perth WA 6004

15 September 2017

REVISION HISTORY

Version	Date	Author
Version 0 Document No: GOS-CPA-2017/09/15-V0	15 September 2017	Holcim (Australia) Pty Ltd

TABLE OF CONTENTS

1. INTRODUCTION 1

1.1 OVERVIEW 1

1.2 THE APPLICANT 1

1.3 TENURE 2

1.4 ENVIRONMENTAL APPROVALS HISTORY 3

1.4.1 CURRENT ENVIRONMENTAL APPROVALS 3

1.4.2 HISTORY OF DEVELOPMENT APPROVAL, LAND SWAP AND EIL 4

1.5 HOLCIM'S CURRENT SITUATION 5

1.6 HOLCIM'S REQUEST 6

2. PROJECT DESCRIPTION 7

2.1 CLEARING PERMIT APPLICATION AREA 7

2.2 LAND SWAP AREA 7

3. EXISTING ENVIRONMENT 8

3.1 LAND SYSTEMS AND SOILS 8

3.2 SURFACE WATER 8

3.3 GROUNDWATER 8

3.4 FLORA AND VEGETATION 9

3.4.1 Studies Undertaken 9

3.4.2 Flora and Conservation Significant Flora 9

3.4.3 Vegetation Communities 12

3.4.4 Comparison Between the Clearing Permit Application Area and Land Swap Area 13

3.5 FAUNA AND HABITAT 13

3.5.1 Studies Undertaken 13

3.5.2 Fauna and Conservation Significant Fauna 14

3.5.3 Cockatoo Presence and Foraging Habitat 17

3.5.4 Roosting and Breeding Habitat 17

3.5.5 Comparison Between the Clearing Permit Application Area and Land Swap Area 18

3.6 CONSERVATION AREAS 19

4. CLEARING PRINCIPLES 20

4.1 OVERVIEW 20

4.2 CLEARING PRINCIPLE A 20

4.3 CLEARING PRINCIPLE B 21

4.4 CLEARING PRINCIPLE C 21

4.5 CLEARING PRINCIPLE D 22

4.6 CLEARING PRINCIPLE E 22

4.7 CLEARING PRINCIPLE F 22
4.8 CLEARING PRINCIPLE G 22
4.9 CLEARING PRINCIPLE H 23
4.10 CLEARING PRINCIPLE I 24
4.11 CLEARING PRINCIPLE J 24

5. CONCLUSION 26

6. REFERENCES 28

LIST OF TABLES

Table 1: Conservation Significant Flora Species Likely or May Occur in the Clearing Permit Application Area (CPAA) and Land Swap Area 10
Table 2: Conservation Significant Vertebrate Fauna Species Likely To Occur in the Clearing Permit Application Area and Land Swap Area 14
Table 3: Conservation Significant Invertebrate Fauna Species Likely To Occur in the Clearing Permit Application Area and Land Swap Area 16
Table 4: Summary of Results from Breeding Tree Transects 18

LIST OF FIGURES

Figure 1 Site Location Map
Figure 2 Site Context Map
Figure 3 Land Swap Map
Figure 4 Vegetation Communities Clearing Permit Application Area
Figure 5 Vegetation and Substrate Associations, Clearing Permit Application Area and Land Swap Area
Figure 6 Foraging Values for Carnaby's Black Cockatoo, Clearing Permit Application Area and Land Swap Area
Figure 7 Foraging Values for Red-Tailed Black-Cockatoo, Clearing Permit Application Area and Land Swap Area

LIST OF APPENDICES

Appendix A. Development Approval
Appendix B. EPBC Act Exemption
Appendix C. Extractive Industries Licence
Appendix D. Category 12 Licence L6821/1967/12
Appendix E. Clearing Permit CPS 5543/2
Appendix F. EPA Correspondence 2005
Appendix G. EPA Correspondence 2007
Appendix H. City of Gosnells Local Planning Policy 5.4
Appendix I. AECOM Gosnells Quarry Flora and Vegetation Survey
Appendix J. Bennett Environmental Consulting Targeted Search for *Thelymitra stellata* and *Thelymitra magnifica*
Appendix K. AECOM Environmental Values Identification – Land Swap Areas, Gosnells Quarry

Appendix L. Bamford Consulting Ecologists Fauna Assessment of the Gosnells Quarry

Appendix M. Bamford Consulting Ecologists Fauna Assessment of the Land Swap Area

1. INTRODUCTION

1.1 OVERVIEW

This document presents information to support an Application by Holcim (Australia) Pty Ltd (HAUS) to clear up to 200 ha of vegetation progressively over the life of the quarry on land that it owns within the City of Gosnells, Western Australia in accordance with requirements of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. HAUS owns and operates the Gosnells hard rock quarry located approximately 20 kilometres (km) south-east of the Perth central business district in the locality of Martin (Figure 1).

The Gosnells Quarry supplies aggregate for concrete which is used in residential and commercial construction, rock for road construction (base course), rail construction (ballast), armour rock, drainage aggregate along with specialist product for particular products. The quarry's operations comprise of but are limited to the following:

- material extraction from the pit;
- crushing and screening;
- stockpiling; and
- distribution of material.

It is important to note at the outset that the Gosnells Quarry has:

- Development Approval (Appendix A) issued by the Metropolitan Regional Planning Authority (MRPA) and the City of Gosnells in 1984 following submission of an Environmental Review and Management Programme (ERMP) to the Environmental Protection Authority (EPA) by Readymix in 1982 under the *Environmental Protection Act* 1971 (EP Act 1971) (Readymix, 1982; EPA Bulletin 120).
- Previously (1984) swapped 236.8 ha of land owned by HAUS (previously trading as Readymix) for 143 ha of land owned by the State of Western Australia as part of the Development Approval Agreement. At the time of the land swap, the land owned by HAUS was assessed as of higher conservation value than that owned by the State.
- An Exemption from referral to the Commonwealth of Australia under Section 43B of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) (Appendix B).
- Been defined as a Key Extraction Area in the Statement of Planning Policy No. 2.4 Basic Raw Materials (Western Australian Planning Commission, 2000).

1.2 THE APPLICANT

The Applicant for the Clearing Permit is:

Holcim (Australia) Pty Ltd

Planning and Environment Team

Level 3, 200 Adelaide Terrace

East Perth, WA 6004

HAUS is a member of LafargeHolcim, a major supplier in the building materials industry. With 115,000 staff, and a local presence in 90 countries, Holcim in Australia and New Zealand employs 3,000 staff and operates over 300 sites across both countries. The Gosnells Quarry has been in operation since the 1930's and has been integral in servicing Western Australia's infrastructure, construction and mining industries for more than 110 years under the well-known Readymix, Humes and Aggregates brands.

The contact for the Applicant is:

Jenny Moro
Planning and Environment Manager – WA/NT
(08) 9212 2146
jenny.moro@lafargeholcim.com

1.3 TENURE

The Gosnells Quarry, located on Lot 3 Cockram Road, Martin, Western Australia, is owned by HAUS. Lot 3 comprises two parts and is located on property title Lot 3 on Plan 14769 of Volume 1683 and Folio 198 (Figure 1 and 2). The first part comprises the quarry and measures 246.3 ha in area. The second part comprises the stockpiles and measures 21.7 ha in area. The total area for both parts of Lot 3 is 268 ha. HAUS also owns the following adjacent lots to the west of the Gosnells Quarry, Lots 27, 30, 31, 32, 35, 36, 37, 38, 233, 5000, 5003 and 5037, which comprise 87.5 ha in area (Figure 2).

The Gosnells Quarry is located within the City of Gosnells approximately 2 km east of the Gosnells town centre and 20 km south-east of the Perth Central Business District (CBD)(Figure 1). It is situated within the 'Rural Zone' of the Metropolitan Region Scheme and the 'Extractive Industry Zone' under the City of Gosnells Town Planning Scheme No. 6 (City of Gosnells, 2001).

The Gosnells Quarry is covered by Local Planning Policy (LPP) No. 5.4 – Gosnells Hard Rock Quarry – Lot 3 Cockram Road, Martin (City of Gosnells, 2010). LPP No. 5.4 clarifies the role and relationship between City of Gosnells planning approval and the current and future Extractive Industry Licence (EIL) granted to the Project Site.

The Gosnells Quarry is also defined as a Key Extraction Area in the Statement of Planning Policy No. 2.4 Basic Raw Materials as an "*area of recognised regional resources providing for the **long term** supply of basic raw materials. These areas should be protected in relevant town planning schemes.*" (Western Australian Planning Commission, 2000).

1.4 ENVIRONMENTAL APPROVALS HISTORY

1.4.1 CURRENT ENVIRONMENTAL APPROVALS

In addition to the Development Approval already mentioned in place for the life of the quarry, the Gosnells Quarry currently operates in accordance with the following licences and environmental management procedures:

- An EIL (Appendix C) granted to HAUS by the City of Gosnells in 2007 for a period of 21 years.
- Department of Water and Environmental Regulation (DWER) "Prescribed Premises" (Category 12) Licence L6821/1967/12 (Appendix D) issued under the Environmental Protection Act 1986 (EP Act 1986) and valid until 2027.
- Clearing Permit CPS 5543/2 (Appendix E) issued under the EP Act 1986.
- Department of Mines, Industry Regulation and Safety (DMIRS) Dangerous Goods Licence (DGS001429).
- The existing Gosnells Quarry Environmental Management Plan (EMP) prepared to support the EIL, as updated from time to time (HAUS, 2014).

The EIL granted by the City of Gosnells in 2007 refers to a Limit of Extraction for the quarry pit development that occurs within the Maximum Development Area, and was expected to be operational for a period of approximately 14 years (Figure 2). The Maximum Development Area was cited in the 1982 ERMP and refers to an area that could be operational for the life of the quarry.

HAUS was misinformed of the status of the existing environmental approvals and as a consequence, sought Clearing Permits [CPS 1752/1 (now expired) and CPS 5543/2] in 2007 and 2013, respectively, and submitted a Clearing Permit Application (CPS 5534/3) in 2013. Correspondence subsequently provided by the DWER in 2014 advised HAUS that clearing permits do apply to the Gosnells Quarry as the Development Approval for the site does not constitute an "implementation Agreement or Decision" under Schedule 6 Item 2(a) of the EP Act 1986.

HAUS withdrew the Clearing Permit Application in 2014 following the DWER's request for an offset. The DWER's request did not align with knowledge of the existing Development Approval where a land swap had already been enacted with the State Government in 1984.

As indicated earlier, in 2013, HAUS confirmed (via legal opinion and correspondence with the Commonwealth Department of Environment) that exemption from referral applies under Section 43B of the EPBC Act. Prior and future development of the Gosnells Quarry is in accordance with existing approvals, which are a lawful continuation of the land use and were in place immediately prior to the commencement of the EPBC Act (Appendix B).

In 2016, HAUS lodged a submission on Action Plan D of the Green Growth Plan for the Gosnells Quarry. HAUS supports the approach adopted for Existing Environmental Approvals as described in Section 3.1 of Action Plan D (ie., non-inclusion in Class of Action) and believes that it has all the necessary State and Commonwealth Government environmental and planning approvals required to further develop its Gosnells Quarry within its approved Maximum Development Area.

1.4.2 HISTORY OF DEVELOPMENT APPROVAL, LAND SWAP AND EIL

Prior to 1985, the Gosnells Quarry was located on Lots 45 to 49 Cockram Road, which was owned (together with other land in the vicinity) by HAUS. HAUS then proposed to extend the quarry to the south east and commenced considerable consultation and review of various options for further development of the quarry. This resulted in a report by the Darling Escarpment Aggregate Resources Committee to the Minister for Urban Development and Town Planning in 1981. The report presented the preferred option, referred to as Option 4, for development of the quarry that was determined following consultation. Option 4 involved a land-swap arrangement with the State, whereby in exchange for other land owned by HAUS, the State granted to HAUS the land the subject of Reserve 11681 (Figure 3). The reserve was to be cancelled and the subject land amalgamated with Lots 45 to 49 to form Lot 3.

In 1981, as required under Sections 55 and 56 of the *EP Act 1971*, the Minister for Urban Development and Town Planning and the MRPA, respectively, referred Option 4 to the EPA for assessment. The EPA determined that the proposal be assessed by public environmental review and requested that the ERMP be prepared by HAUS for public review and consideration. On 4 June 1982, HAUS published its ERMP for public comment. Preparation of the ERMP involved highly respected environmental experts, including Professor Brian J O'Brien and Dr Harry Butler. The public comment period closed on 30 July 1982.

The EPA submitted its Report and Recommendations to the Minister of the Environment on 11 October 1982 and recommended that the proposal for Option 4 as presented in the ERMP be implemented subject to a number of conditions (EPA Bulletin 120). One of these conditions was to obtain an EIL from the City of Gosnells which was to be supported by a Development and Environmental Program (DEP).

The land-swap was subsequently effected pursuant to an agreement dated 9 October 1984 (Agreement) at the highest levels of government between the Crown, HAUS and others. HAUS exchanged 236.8 ha of land held by HAUS for 143 ha of land held by the State. The land swap was formalised on site by a ceremony and a plaque installed in the presence of the Premier of Western Australia, Hon Brian Burke MLA on the 22nd of February 1985.

The 236.8 ha land held by HAUS and exchanged to the State was assessed in a System 6 study (The Darling System – Proposals for Parks and Reserves – The System 6 Study Report, 9 April 1981) as having greater conservation value than the State reserve (refer to EPA Bulletin 120). The land exchange area led to the creation of what is now referred to as Banyowla Regional Park. The 143 ha area previously held by the State is now the approved site for the Gosnells Quarry.

Development Approval was granted by the City of Gosnells and the MRPA on 10 and 23 January 1985, respectively. A 21 year EIL was granted to HAUS by the City of Gosnells in 1984 following submission of an application for an EIL and a DEP. The second EIL was granted in 2005 and expired in 2007. The current EIL was sought by HAUS and granted in 2007. This EIL expires on 30 June 2028.

Correspondence from the Office of the EPA in 2005 and 2007 at the time the 2007 EIL was being sought, states that environmental impact assessments undertaken by the

EPA under the *EP Act 1971* are valid assessments and if development occurs within the scope of the assessed defined proposal no further referral or assessment by the EPA is required (refer Appendices F and G).

In 2010, the City of Gosnells released Local Planning Policy 5.4 (Appendix H) to clarify the relationship between the City's original planning approval for the quarry (granted in 1984) and future EIL's relating to the quarry. It is clear from this Policy that the City of Gosnells recognised that:

1. The original Development Approval was a long term approval and that the quarry could be operational for the life of the resource.
2. The condition requiring the submission of a DEP to support the original EIL has now been discharged and is no longer applicable to the current quarrying operations.
3. The quarry perimeter delineated in Figure 14 of the 1982 ERMP represents the approved maximum extraction limit or footprint of the quarry.

1.5 HOLCIM'S CURRENT SITUATION

It is HAUS's understanding based on correspondence received from the DWER in 2014 that clearing permits do apply to the Gosnells Quarry as the Development Approval for the site does not constitute an "implementation agreement or decision" under Schedule 6 Item 2(a) of the *EP Act 1986*. Therefore, continuation of quarry development in accordance within the Maximum Development Area under the Development Approval will require a clearing permit for the clearing of native vegetation.

HAUS does not believe that it should have to undergo further assessment under the *EP Act 1986* for future EIL applications, nor should it need to seek clearing permits, or provide additional offsets as it believes it has all the necessary State and Commonwealth government environmental and planning approvals required to further develop its Gosnells Quarry in accordance with Action Plan D of the Green Growth Plan, and has already provided a substantial offset via the land swap in 1984.

HAUS also believes that a major oversight was made when amendments to the *EP Act 1986* occurred during enactment of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 where prior environmental assessments undertaken under the *EP Act 1971* were not recognised as an "implementation agreement or decision". It is believed that the Gosnells Quarry may be one of few projects in Western Australia operating under an *EP Act 1971* approval.

However, in response to the DWER's correspondence received in 2014 advising that clearing permits do apply to the Gosnells Quarry, HAUS submits this Clearing Permit Application to seek approval to clear native vegetation within its Maximum Development Area and a surrounding area allowed for overburden placement for the ongoing extraction of this resource for the life of the quarry (Figure 2). In addition, HAUS requests that the land swap enacted with the State government in 1984 is recognised by DWER as an acceptable offset for this Clearing Application.

To this end, HAUS has assessed whether the basis of the original land swap assessment in 1982 still applies, ie that the land exchanged is of similar or better conservation value. HAUS has also responded to the comments raised by DWER in 2014 during the assessment of Clearing Permit Application CPS 5543/3 by undertaking a number of detailed and targeted flora and fauna surveys over the extent of the Clearing Permit Application Area (CPAA) and the Land Swap Area to quantify the conservation values of both areas as well as address requests for further information in relation to Black Cockatoos and the rare orchids, *Thelymitra magnifica* [Department of Biodiversity, Conservation and Attraction (DBCA) Priority 1] and *Thelymitra stellata* [Endangered under the *Biodiversity Conservation Act* 2016 (BC Act) and EPBC Act].

1.6 HOLCIM'S REQUEST

HAUS seeks clearing approval for the Maximum Development Area for pit development and surrounding area for overburden in accordance with the Development Approval within Lot 3. HAUS also seeks recognition of its prior Land Swap Area as an offset for clearing within Lot 3.

2. PROJECT DESCRIPTION

2.1 CLEARING PERMIT APPLICATION AREA

HAUS seeks clearing approval for the Maximum Development Area for pit development and surrounding area for overburden in accordance with the Development Approval within Lot 3, hereafter referred to as the Clearing Permit Application Area (CPAA). This area measures approximately 200 ha in size and includes the current operational pit and cleared areas (Figure 2). The area of native vegetation within the CPAA is approximately 138 ha, with an additional 6.9 ha of open regrowth and 54.1 ha of cleared area.

2.2 LAND SWAP AREA

HAUS seeks recognition of it's prior Land Swap Area as an offset for clearing within the CPAA. The area measures 236.8 ha in size and includes approximately 222 ha of native vegetation and approximately 14.7 ha of cleared area (Figure 3). The area is now referred to as Banyowla Regional Park.

3. EXISTING ENVIRONMENT

The following section describes the existing environment of the CPAA and the Land Swap Area. It is noted that some sections are relevant for both areas as they provide regional context.

3.1 LAND SYSTEMS AND SOILS

The land systems and soils at the CPAA and Land Swap Areas have a weathering zone up to approximately 10 m deep overlying the fresh granite. Lateritic soils overly a zone of sandy clay that extends to a few metres depth. This is underlain by a white kaolin clay zone derived from weathered granite that grades rapidly into fresh bedrock (URS, 2005).

The land systems and soils at the Gosnells Quarry have been modified by quarrying activities.

3.2 SURFACE WATER

The CPAA and the Land Swap Areas are located in the lower reaches of the Canning River catchment, on the edge of the Darling Scarp. The Canning River drains to the north-west through the Canning River Regional Park to the Canning and Swan River Estuaries at Perth. Major tributaries to the Canning River nearby include the Southern River, Ellis Brook and Bickley Brook (URS, 2005).

The CPAA has no major drainage lines and is high in the landscape. Surface hydrology at the quarry due to pit and supporting infrastructure development has been modified and surface water is currently managed in accordance with the surface water management programme at the site. A combination of groundwater and surface runoff water is stored in dams at the site.

The Land Swap Area includes several drainage lines as part of the Ellis Brook and contains the 60 Foot Falls.

3.3 GROUNDWATER

The CPAA and the Land Swap Areas occur in the Darling Scarp Province of Western Australia. Groundwater in the foothills of the Darling Scarp is generally located at the base of weathering of the local bedrock area and/or in fractures and joints in the bedrock. These aquifers are usually of limited areal extent and as such supplies of groundwater are small. Therefore, if these aquifers are pumped and dewatered then the impact is localised (URS, 2005).

Groundwater flow is to the west towards the existing quarry through fractures in the granite and dolerite. Inflows have been noted on the eastern and northern walls of the main pit and below the Main Dam. Inflows were noted in the steeply dipping zones of fractured granite and at the edge of dolerite dykes. Site personnel have reported that flows increase following heavy rainfall (URS, 2005). The groundwater flowing into the main pit comprises natural groundwater from the regional aquifer and rainfall recharge that exits the aquifer at the quarry face. The water in the dams

in the pit is composed of this groundwater and any rainwater falling directly into the pit.

Little is known regarding the hydrogeology of the Land Swap Area, however it is assumed that the groundwater flow would also be to the west through any fractures in the granite and dolerite.

3.4 FLORA AND VEGETATION

3.4.1 Studies Undertaken

A number of flora and vegetation studies have been undertaken over the last 12 years. These surveys/studies comprise:

1. Vegetation and Flora Readymix Quarry Gosnells (Bennett Environmental Consulting (Bennett), 2005).
2. Vegetation and Flora Readymix Quarry Gosnells (Bennett, 2006).
3. Gosnells Quarry Desktop Flora, Vegetation and Fauna Assessment (Astron, 2012a).
4. Gosnells Quarry Field Flora, Vegetation and Fauna Survey (Astron, 2012b).
5. Search for *Thelymitra stellata* and *Thelymitra magnifica* (Bennett, 2014).
6. Gosnells Quarry Flora, Vegetation and Targeted Orchid Assessment (AECOM, 2015).
7. Gosnells Quarry Flora, Vegetation and Targeted Orchid Assessment (AECOM, 2016).
8. Gosnells Quarry Flora, Vegetation and Targeted Survey (AECOM, 2017a).
9. Environmental Values Identification – Land Swap Areas, Gosnells Quarry (AECOM, 2017b)

Surveys/studies 1, 3, 6, 7 and 8 relate to the entire Gosnells Quarry site (CPAA). Survey 2 relates to an area of 0.5 ha that has been already quarried. Surveys 4 and 5 relate to an area of approximately 15 ha adjacent to the existing pit. Study 9 refers to the Land Swap Area.

The following information for the CPAA is primarily sourced from the survey undertaken by AECOM in 2016 (AECOM, 2017a) as this is the most current comprehensive survey available for the area and incorporates the AECOM surveys undertaken in 2014 and 2015. This has been supplemented with information from the searches for *Thelymitra stellata* [Endangered under the BC Act and EPBC Act] and *Thelymitra magnifica* (Priority 1) completed by Bennett in 2014. These surveys are attached in Appendices I and J, respectively.

The following information for the Land Swap Area is sourced from the study undertaken by AECOM in 2017 (AECOM, 2017b) and is attached in Appendix K.

3.4.2 Flora and Conservation Significant Flora

A total of 319 vascular flora species from 50 plant families and 150 genera and were recorded within the CPAA. This included 305 (95%) native species and 14 (5%) introduced (weed) species. None of the weeds recorded were listed as Declared Pests under the *Biosecurity and Agriculture Management Act* 2007, as Weeds of National Significance, or listed on the Swan Weeds database (DPaW, 2015). The most

abundant families represented include Proteaceae (44 taxa; all native), Fabaceae (36 taxa; all native), Myrtaceae (32 taxa; all native) and Asparagaceae (18 species).

A desktop assessment was undertaken to determine the likelihood of occurrence of conservation significant flora species within the CPAA and the Land Swap Area. This was informed by a DBCA database search for rare and Priority flora and prior surveys/studies conducted (AECOM, 2017a and b).

The following flora species of conservation significance are considered likely to occur or may occur in the CPAA (29 species) and Land Swap Area (33 species) as listed in Table 1 below.

Table 1: Conservation Significant Flora Species Likely or May Occur in the Clearing Permit Application Area and Land Swap Area

Taxa	Conservation status		Likelihood	
	State	Cmwlth	Clearing Permit Application Area (CPAA)	Land Swap Area
Acacia aphylla	T (VU)	VU	May	Likely
Acacia horridula	P 3	-	Likely	Known
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P 1	-		May
Acacia oncinophylla subsp. *patulifolia*	P 4	-	Known	Known
Allocasuarina grevilleoides	P 3	-	Likely	Likely/May
Andersonia sp. Audax (F. Hort, B. Hort & J.Hort 3179)	P 3		May	
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	P 2	-	Likely	May
Andersonia sp. Saxatilis (F. & J. Hort 3324)	P 1		May	
Anthocercis gracilis	T (VU)	VU	May	Likely
Aponogeton hexatepalus	P 4	-		Likely
Asteridea gracilis	P 3	-	Known	Likely
Austrostipa jacobsiana	T (CR)		May	
Banksia kippistiana var. *paenepeccata*	P 3	-	Likely	Likely
Banksia mimica	T (VU)	EN	May	
Beaufortia purpurea	P 3	-	Known	Known
Boronia tenuis	P 4	-	Likely	May
Bylbis gigantea	P 3	-		Likely

Taxa	Conservation status		Likelihood	
	State	Cmwlth	Clearing Permit Application Area (CPAA)	Land Swap Area
Calothamnus accedens	P 4	-	Likely	May
Calothamnus graniticus subsp. *leptophyllus*	P 4	-	Known	May
Calytrix breviseta subsp. *breviseta*	T (CR)	EN		May
Darwinia apiculata	T (EN)	EN	Likely	May
Drosera occidentalis subsp. *occidentalis*	P 4	-		May
Goodenia arthrotricha	T (EN)	-	Likely	Known
Grevillea crowleyae	P 2		May	
Grevillea manglesii subsp. ornithopoda	P 2	-	May	Likely
Hemigenia rigida	P 1		May	
Halgania corymbosa	P 3	-	Likely	Known
Lasiopetalum glutinosum subsp. *glutinosum*	P 3	-	Likely	Known
Paracaleana gracilicordata	P 1	-	May	May
Paracaleana granitica	P 1	-		May
Pimelea rara	P 4	-	Likely	Known
Stackhousia sp. Red-blotched corolla	P 3	-	Likely	Likely
Tetratheca sp. Granite (S. Patrick SP1224)	P 3	-	Likely	Likely
Thelymitra magnifica	P 1	-	Likely	Likely
Thelymitra stellata	T (EN)	-	Likely	Likely
Thysanotus anceps	P 3	-		May
Verticordia lindleyi subsp. *lindleyi*	P 4	-		Likely
Total Number of Species			**29**	**33**

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct

BC Act listed species:, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

DBCA Priority Species: P1 – P4 = Priority 1 - 4.

Five flora species of conservation significance were recorded within the CPAA and two flora species of conservation significance were recorded within the Land Swap Area. These were all Priority flora species. No species listed under the EPBC Act or the BC Act were recorded. The conservation significant flora species recorded comprised:

- *Acacia horridula* (Priority 3) recorded in both the CPAA and Land Swap Area.
- *Acacia oncinophylla* subsp. *palustre* (Priority 4) recorded in the Land Swap Area.

- *Acacia oncinophylla* subsp. *patulifolia* (Priority 4) recorded in the CPAA.
- *Asteridea gracilis* (Priority 3) recorded in the CPAA
- *Beaufortia purpurea* (Priority 3) recorded in the CPAA.
- *Lasiopetalum glutinosum* subsp. *glutinosum* (Priority 3) recorded in the CPAA.

There are also records of *Lasiopetalum glutinosum* subsp. *glutinosum* (Priority 3), *Halgania corymbosa* (Priority 3), *Goodenia arthrotricha* (Endangered under the BC Act), *Beaufortia purpurea* (Priority 3) and *Pimelea rara* (Priority 4) from the WA herbarium within the Land Swap Area, however these were unconfirmed during the field assessment.

Targeted surveys for the conservation significant species *Thelymitra magnifica* (Priority 1), *Thelymitra stellata* (Endangered under the BC Act and EPBC Act), *Darwinia apiculata* (Endangered under the BC Act and EPBC Act) and *Goodenia arthrotricha* (Endangered under the BC Act) were conducted within the CPAA during ideal detection periods with methodology confirmed by DPaW prior to commencement of the surveys (Bennett, 2014, AECOM, 2015, 2016 and 2017a). None of these species were recorded from within the CPAA

3.4.3 Vegetation Communities

A total of nine native vegetation communities were mapped within the CPAA, this included four heath communities, one Calothamnus thicket, three forest communities and one woodland community (AECOM, 2017a). These vegetation communities are shown on Figure 4.

The above communities were amalgamated into a total of four vegetation types to enable high level comparison with the Land Swap Area.

Key Vegetation Soil Associations (VSAs) in the CPAA comprise (Figure 5):

- VSA 1 (99.7 ha) - Open Jarrah/Marri woodland to forest over open banksia and mixed shrub understorey on lateritic gravels high in the landscape.
- VSA 2 (5.1 ha) - Open Wandoo woodland over a mixed high to low shrub understorey on lateritic gravels.
- VSA 3 (33 ha) - Mixed heath and thicket on sandy-gravels around granite outcrops; scattered trees include Jarrah, Marri and Wandoo.
- VSA 4 (6.9 ha) - Open regrowth and rehabilitation (including planted non-native species in some areas) with few remnant trees over disturbed understorey.
- Cleared, disturbed and operational areas (54.1 ha) (Bamford, 2017a).

Key VSAS in the Land Swap Area comprise (Figure 5):

- VSA 1 (72.7 ha) - Open Jarrah/Marri woodland to forest over open banksia and mixed shrub understorey on lateritic gravels high in the landscape.
- VSA 2 (38.4 ha) - Open Wandoo woodland over a mixed high to low shrub understorey on lateritic gravels.
- VSA 3 (111 ha) - Mixed heath and thicket on sandy-gravels around granite outcrops; scattered trees include Jarrah, Marri and *Eucalyptus lane-poolei* in Banyowla Regional Park.

- VSA 4 - Seasonal watercourse and wetlands (including Ellis Brook Valley Reserve in Banyowla Regional Park) with associated riparian vegetation. Area is included in VSA 3 (Mixed Heath).
- Cleared areas (14.7 ha) (Bamford, 2017b).

The majority of the vegetation in the CPAA and Land Swap Area were both in 'Excellent' condition (AECOM, 2017a and b). The CPAA comprised 140.13 ha of native vegetation, 4.58 ha of completely degraded areas that were devoid of native vegetation with only weed species present and 53.84 ha of cleared areas. Degradation from weeds and rubbish was observed within the narrow riparian zone associated with Ellis Brook Valley Reserve.

No Threatened Ecological Communities (TEC) or Priority Ecological Communities (PEC) were identified within either the CPAA or the Land Swap Area (AECOM, 2017a and b).

3.4.4 Comparison Between the Clearing Permit Application Area and Land Swap Area

The environmental values of the land swap and the CPAA are very similar in both extent and significance. The heath vegetation occurring within the CPAA extends considerably into the Land Swap Area, providing suitable habitat for Priority flora species historically recorded at HAUS.

The total number of conservation significant flora species is similar (Table 1); the broad vegetation associations is similar (Figure 5); and no TECs or PECs were recorded in either of the two areas.

3.5 FAUNA AND HABITAT

3.5.1 Studies Undertaken

A number of vertebrate fauna studies have been undertaken over the last five years. These studies and surveys comprise:

1. Gosnells Quarry Desktop Flora, Vegetation and Fauna Assessment (Astron, 2012a).
2. Gosnells Quarry Field Flora, Vegetation and Fauna Survey (Astron, 2012b).
3. Gosnells Quarry Black-Cockatoo Tree Inspection (Astron, 2013).
4. Targeted Qualitative Black-Cockatoo and Quenda Habitat Assessment of the Holcim Gosnells Quarry and Adjacent Areas (Bamford Consulting Ecologists (Bamford), 2014).
5. Holcim Gosnells Quarry Targeted Black-Cockatoo Habitat Assessment (Bamford, 2015).
6. Holcim Gosnells Quarry - Fauna Assessment of the Quarry Area (Bamford, 2017a).
7. Holcim Gosnells Quarry - Fauna Assessment of the Land Swap Area (Banyowla Regional Park) (Bamford, 2017b)

Study 1 and Survey 6 extend over the entire Gosnells Quarry site (CPAA). Surveys 2, 3, 4 and 5 extend over an area of up to approximately 15 ha adjacent to the existing pit. Survey 7 relates to the Land Swap Area.

The following information for the CPAA is primarily sourced from the survey undertaken by Bamford in 2016 (2017a). This study also summarises the past surveys/studies and is appended as Appendix L.

The following information for the Land Swap Area is sourced from the study undertaken by Bamford in 2016 (Bamford, 2017b) and is attached in Appendix M.

3.5.2 Fauna and Conservation Significant Fauna

The desktop study identified 194 vertebrate fauna species as potentially occurring in the CPAA: 13 frogs, 42 reptiles, 106 birds, 23 native and 10 introduced mammals and 202 vertebrate fauna species as potentially occurring in the Land Swap Area: 6 fish, 13 frogs, 42 reptiles, 108 birds, 23 native and 10 introduced mammals. No fish species are likely to occur in the CPAA due to the lack of suitable habitat, however six fish species are expected to be visitors to Ellis Brook Valley Reserve in the Land Swap Area when this flows in winter.

The current vertebrate assemblage potentially includes 34 species of conservation significance in the CPAA and 35 species of conservation significance in the Land Swap Area, with a further five conservation significant species considered to be locally extinct in both areas (Table 2). Conservation significant species that are likely to occur in both the CPAA and Land Swap Areas and regularly use the sites are similar and include the Brush-tailed Phascogale and both the Forest Red-tailed and Carnaby's Black-Cockatoos.

Table 2: Conservation Significant Vertebrate Fauna Species Likely To Occur in the Clearing Permit Application Area and Land Swap Area

Common Name	Latin Name	Conservation Status	Clearing Permit Application Area		Land Swap Area	
			Confirmed	Expected Status	Confirmed	Expected Status
FISH						
Pouched Lamprey	*Geotria australis*	P1				Visitor
REPTILES						
Darling Range South-west Ctenotus	*Ctenotus delli*	P4		Resident		Resident
Carpet Python	*Morelia spilota imbricata*			Resident		Resident
Common Death Adder	*Acanthophis antarcticus*	P3		Resident		Resident
BIRDS						
Fork-tailed Swift	*Apus pacificus*	M S5		Migrant		Migrant
Painted Button-quail	*Turnix varius*			Resident		Resident
Peregrine Falcon	*Falco peregrinus*	S7		Resident		Resident
Masked Owl	*Tyto novaehollandiae*	P3		Irregular visitor		Irregular visitor
Barking Owl	*Ninox connivens*	P2		Irregular visitor		Irregular visitor

Common Name	Latin Name	Conservation Status	Clearing Permit Application Area		Land Swap Area	
			Confirmed	Expected Status	Confirmed	Expected Status
Rainbow Bee-eater	*Merops ornatus*	S5		Migrant		Migrant
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	V S3	X	Resident		Resident
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	V S2		Migrant		Migrant
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2		Migrant		Migrant
Rufous Treecreeper	*Climacteris rufus*			Irregular visitor		Irregular visitor
Red-winged Fairy-wren	*Malurus elegans*			Visitor		Visitor
Splendid Fairy-wren	*Malurus splendens*		X	Resident	X	Resident
Southern Emu-wren	*Stipiturus malachurus*			Resident		Resident
Inland Thornbill	*Acanthiza apicalis*			Resident		Resident
Western Thornbill	*Acanthiza inornata*			Resident		Resident
White-browed Scrubwren	*Sericornis frontalis*		X	Resident	X	Resident
Grey Shrike-thrush	*Colluricincla harmonica*		X	Resident	X	Resident
Crested Shrike-tit	*Falcunculus frontatus*			Visitor		Visitor
White-breasted Robin	*Eopsaltria georgianus*			Visitor		Visitor
Western Yellow Robin	*Eopsaltria griseogularis*			Visitor		Visitor
Hooded Robin	*Melanodryas cucullata*			Irregular visitor		Irregular visitor
Red-capped Robin	*Petroica goodenovii*			Visitor		Visitor
Scarlet Robin	*Petroica multicolor*			Resident		Resident
Red-eared Firetail	*Stagonopleura oculata*			Visitor	X	Visitor
MAMMALS						
Chuditch	*Dasyurus geoffroii*	V S3		Resident		Resident
Brush-tailed Phascogale	*Phascogale tapoatafa tapoatafa*	S3	X	Resident		Resident
Numbat	*Myrmecobius fasciatus*	V S2		Locally extinct		Locally extinct
Woylie	*Bettongia penicillata ogilbyi*	E S1		Locally extinct		Locally extinct

Common Name	Latin Name	Conservation Status	Clearing Permit Application Area		Land Swap Area	
			Confirmed	Expected Status	Confirmed	Expected Status
Boodie	*Bettongia lesueur*	Ex V S4 S6		Locally extinct		Locally extinct
Brush Wallaby	*Macropus irma*	P4	X	Resident		Resident
Tammar Wallaby	*Macropus eugenii*	P4		Locally extinct		Locally extinct
Quokka	*Setonix brachyurus*	V S3		Vagrant		Vagrant
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S1		Locally extinct		Locally extinct
Quenda	*Isoodon obesulus*	P4	X	Resident		Resident
Western False Pipistrelle	*Falsistrellus mackenziei*	P4	X	Resident		Resident
Rakali	*Hydromys chrysogaster*	P4		Visitor		Visitor
Total Number of Species			**8**	**34**	**4**	**35**

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct, M = Migratory.

BC Act listed species: S1 – S7 = Schedule 1 – 7.

DBCA Priority Species: P1 – P5 = Priority 1 - 5.

Only one invertebrate species of conservation significance is likely to occur in the CPAA and three invertebrate species of conservation significant invertebrates are likely to occur in the Land Swap Area (Table 3), however none were recorded during the survey.

Table 3: Conservation Significant Invertebrate Fauna Species Likely To Occur in the Clearing Permit Application Area and Land Swap Area

Common Name	Latin Name	Conservation Status (State)	Likelihood	
			Clearing Permit Application Area	Land Swap Area
Scorpionfly	*Austromerope poultoni*	P2	Likely	Likely
freshwater snail	*Glacidorbis occidentalis*	P2		Likely
Carter's Freshwater Mussel	*Westralunio carteri*	S3		Likely

BC Act listed species: S1 – S7 = Schedule 1 – 7.

DBCA Priority Species: P1 – P5 = Priority 1 - 5.

Species recorded of other significance in the Land Swap Area were the Short Range Endemic (SRE) woodlouse *Buddelundia '04'* and the SRE land snail *Bothriembryon*

kendricki. The SRE woodlouse is common in Jarrah forests around Perth and the SRE land snail is not uncommon on the Perth Coastal Plain and adjacent Scarp. The granite outcrops have the characteristics that should encourage the evolution of SRE invertebrate species and the Land Swap Area has large areas of granites and larger areas of mesic refugia along Ellis Brook Valley Reserve.

All of these species (including other species that were not recorded) in both the CPAA and Land Swap Area are likely to be represented in adjacent conservation estates and in similar vegetation complexes within the Darling Range (Bamford, 2017a and b).

3.5.3 Cockatoo Presence and Foraging Habitat

Carnaby's Black-Cockatoo

Carnaby's Black-Cockatoos are expected to be regular migrants in both the CPAA and the Land Swap Area. The overall foraging value of the CPAA was slightly higher at 3-4 (Low/Moderate to Moderate) compared to the Land Swap Area which was 2-3 (Low/Low to Moderate).

Foraging values for Carnaby's Black-Cockatoo within the CPAA and within the Land Swap Area are presented on Figure 6. Further discussion of VSAs is provided in a subsequent section.

Forest Red-tailed Black-Cockatoo

Forest Red-tailed Black-Cockatoos are expected to be resident in both the CPAA and Land Swap Area, with foraging habitat well-represented due to the presence of preferred native food sources (such as Marri and Jarrah). The overall foraging value of the CPAA was slightly higher at 3 (Low/Moderate) compared to the Land Swap Area which was 2 (Low).

Foraging values for the Forest Red-tailed Black-Cockatoo within the CPAA and within the Land Swap Area are presented on Figure 7.

Baudin's Black-Cockatoo

Baudin's Black-Cockatoo is expected to be at least an occasional visitor to both the CPAA and Land Swap Area as it occurs regularly nearby and the area provides suitable foraging habitat. The overall foraging value of the CPAA was higher at 4 (Moderate) compared to the Land Swap Area which was 2 (Low).

Foraging requirements of Baudin's Black-Cockatoo are similar to those of the Forest Red-tailed Black-Cockatoo and are presented on Figure 7.

3.5.4 Roosting and Breeding Habitat

The breeding tree transects found that the CPAA had a density of 11.6 potential breeding trees per hectare with an estimated total of 1,679 trees, whilst the Land Swap Area had a density of 9.6 potential breeding trees per hectare with an estimated total of 2,133 trees as presented in Table 4. These estimates assume that the areas covered by the transects are representative of the total area.

Table 4: Summary of Results from Breeding Tree Transects

Site	Bamford Score					Total	Trees/ha	Estimated Total Trees
	1	2	3	4	5			
Quarry Area	0	2	72	91	253	418	11.6	1679
Land Swap Area	0	0	31	17	216	264	9.6	2133

Note: Density calculations do not include cleared areas

Bamford scores:

1. Active nest observed.
2. Suitable hollow with chew marks.
3. Suitable hollow without chew marks.
4. Potentially suitable hollow.
5. Tree>500mm Diameter Breast Height, no hollows.

Most of the trees in both the CPAA and Land Swap Area are regrowth which are not yet big enough to serve as roosting or breeding habitat.

Only two trees (0.5% of total trees) with a score of 2 (large hollow with recent chew-marks around entrance) were found in the CPAA. These are not confirmed but are highly likely to be active or recently active black-cockatoo nests. Two adult Forest Red-tailed Black-Cockatoos with a dependent chick were observed within the area and may well have used one of these hollows. The remaining trees observed within the CPAA comprised 72 trees (17.2% of total trees) with a score of 3 (suitable hollow without chew marks), 91 trees (22.8% of total trees) with a score of 4 (potentially suitable hollow) and 253 trees (60.5% of total trees) with a score of 5 (tree >500 mm Diameter Breast Height, no hollows).

No trees with a score of 1 or 2 (active nest observed; large hollow with recent chew-marks around entrance, respectively) were found in the Land Swap Area. The only trees observed within the Land Swap Area comprised 31 trees (11.7% of total trees) with a score of 3 (suitable hollow without chew marks), 17 trees (6.4% of total trees) with a score of 4 (potentially suitable hollow) and 216 trees (81.8% of total trees) with a score of 5 (tree >500mm Diameter Breast Height, no hollows).

3.5.5 Comparison Between the Clearing Permit Application Area and Land Swap Area

In comparison with the Land Swap Area, the CPAA is of greater value to Black-Cockatoo and woodland species due to the slightly higher density of large trees. Whilst the Land Swap Area is of greater value to aquatic and wetland fauna because of the presence of Ellis Brook, and granite heath specialists, because of the larger area of exposed granite rock

These differences can be quantified with the density of potential breeding trees being slightly higher in the CPAA than in the Land Swap Area (11.6/ha compared with 9.6/ha). However, when considering the greater size of the Land Swap Area, the estimated number of potential breeding trees is about 15% more in the Land Swap Area than in the CPAA (1,679 compared with 2,133 respectively, refer Table 4).

It is likely over the life of the quarry that the size of larger trees suitable for breeding in the land swap area will increase over time.

Other conservation significant fauna species that have been recorded in the CPAA include the Brush-tailed Phascogale, Quenda and Brush Wallaby. These species (including other species that were not recorded, e.g. Chuditch, Carpet Python, Peregrine Falcon and Darling Range Ctenotus) are likely to be represented in the Land Swap Area, adjacent conservation estates and in similar vegetation complexes within the Darling Range.

3.6 CONSERVATION AREAS

There are a number of conservation areas in proximity to the CPAA:

- Ellis Brook Valley Reserve - a Category A status reserve listed on the register of National Estate (ID. 181050) for its landscape and wildlife values. It is located approximately 1.5 km north of the CPAA
- Wrights Brook Regional Open Space – located approximately 1.5 km to the south of the CPAA.
- Banyowla Regional Park – surrounding the CPAA and extends 3 km to the south, east and north.
- Korung National Park - occurs adjacent to the east of the CPAA
- Canning River - a Bush Forever site (Site 224) located more than 1 km from Lot 3.

All habitats and species of the CPAAare represented within the Land Swap Area and are likely to be represented in State Forest and National Parks within the Darling Range (Bamford, 2017a and b).

4. CLEARING PRINCIPLES

4.1 OVERVIEW

This section provides responses to the Clearing Principles (A to J) that are used by the DWER to assess the effect of the clearing of native vegetation on the local and regional environment. The principles cover a range of environmental aspects that may be impacted as a result of native vegetation clearing including:

- Biodiversity
- Significant fauna habitat
- Significant flora and vegetation communities
- TECs
- Riparian vegetation
- Land degradation
- Environmental values of conservation areas
- Surface water quality
- Flooding.

4.2 CLEARING PRINCIPLE A

Native vegetation should not be cleared if it comprises a high level of biological diversity

The richness of flora and fauna is related to the variety of habitats present and the presence of large areas of nearby habitats, such as the Ellis Brook Valley Reserve and Wrights Brook Regional Open Space, which form part of the Banyowla Regional Park, and the Korung National Park.

The CPAA lies within the Northern Jarrah Forest subregion, which is described as having moderate species richness, ranging from 400 – 600 species per km (Williams and Mitchell, 2001). Markey (1997) undertook a floristic survey of the northern Darling Scarp, of which the CPAA falls within, and recorded a species richness of 621 native taxa for the region.

Surveys which have been undertaken in the adjacent Ellis Brook Valley Reserve have recorded 550 flowering plant species (Astron, 2012a). A total of 319 vascular flora species from 50 plant families and 150 genera and were recorded within the CPAA (inclusive of the 2014, 2015 and 2016 field surveys by AECOM). This included 305 native species and 14 introduced (weed) species. Higher biological diversity was observed on the granite outcrop areas within the CPAA. These granite outcrops were also observed in the Land Swap Area. Given this record of flora species and occurrence of granite outcrops, the surrounding remaining remnant vegetation including that of the Land Swap Area is likely to be of a similar diversity as the CPAA.

The proposed clearing is unlikely to result in significant impacts to biodiversity due to the presence of large areas retained and protected in regional park, national park and State forest of surrounding similar remnant native vegetation in very good condition. These areas would be of similar biodiversity to the CPAA and are located within the Land Swap Area (Banyowla Regional Park) given to the State as part of the Development Approval for the quarry (236.8 ha).

Given the above, the CPAA is not considered to represent an area with higher biodiversity than those found in adjacent areas and is not likely to comprise an area with a high level of biological diversity and be at variance to this Clearing Principle.

4.3 CLEARING PRINCIPLE B

Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia

In terms of diversity of fauna species, a comparison of the CPAA to the Land Swap Area (Bamford 2017a and b) found that the fauna values of both areas are similar (Section 3.5.5). Both areas provide residential habitat to 18 conservation significant fauna species including the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*; Vulnerable under the EPBC Act and Schedule 3 under the BC Act) and the Chuditch (*Dasyurus geoffroii*; Vulnerable under the EPBC Act and Schedule 3 under the BC Act), and seven to eight regular visitors.

All three Black-Cockatoo species have been recorded in the region (DPaW, 2016) and suitable foraging and breeding habitat occurs in the CPAA and Land Swap Area. Carnaby's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo were also recorded in the CPAA by Astron (2012b). Other conservation significant fauna species that have been recorded in the CPAA include the Brush-tailed Phascogale, Quenda and Brush Wallaby.

All of these species (including other species that were not recorded, e.g. Chuditch, Carpet Python, Peregrine Falcon and Darling Range Ctenotus) are likely to be represented in the Land Swap Area, adjacent conservation estates and in similar vegetation complexes within the Darling Range.

The proposed clearing is unlikely to result in significant impacts to a significant fauna habitat due to the presence of large areas of surrounding similar remnant native vegetation and fauna habitat in very good condition. This includes the Land Swap Area bequeathed to the State government as part of the original Development Approval for the Gosnells Quarry following submission of the ERMP in 1982, adjacent conservation estates and in similar vegetation complexes within the Darling Range.

As such, clearing of native vegetation within the CPAA will not affect the maintenance of, a significant habitat for fauna indigenous to Western Australia and be at variance to this Clearing Principle.

4.4 CLEARING PRINCIPLE C

Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora

No rare flora were observed in the CPAA during targeted flora surveys conducted in 2014, 2015 and 2016 by Bennett and AECOM (Bennett, 2014; AECOM, 2015, 2016 and 2017a).

Therefore, it is unlikely that clearing activities within the CPAA will have a significant impact on rare flora species and be at variance to this Clearing Principle.

4.5 CLEARING PRINCIPLE D

Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community

No TECs or PECs listed by DBCA were identified within the CPAA during the flora and vegetation survey conducted by AECOM (2017a) or the fauna survey conducted by Bamford (2017a).

Therefore, the clearing of vegetation within the CPAA will not have an impact on a TEC or PEC and be at variance with this Clearing Principle.

4.6 CLEARING PRINCIPLE E

Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared

The CPAA lies within two Beard (1979) vegetation associations, including West Darling 3 medium forest; Jarrah-Marri and, West Darling 4: medium woodland Marri and Wandoo. Currently there is 79.6% and 32.4% of the pre-European vegetation extent remaining within these two vegetation associations respectively. Each of these vegetation complexes has greater than 30% of their pre-European extent remaining and the vegetation of the study area is therefore not considered to be of regional significance or below the critical threshold in accordance with EPA Position Statement 2 (AECOM, 2017a).

In addition, HAUS have provided a significant area of protected native vegetation (now known as the Banyowla Regional Park) as part of the offset requirements for the Gosnells Quarry during the assessment of the ERMP in 1982, which protects native vegetation in the region.

Therefore, the vegetation to be cleared is not considered to be a significant area of remnant native vegetation in an area that has been extensively cleared and at variance to this Clearing Principle.

4.7 CLEARING PRINCIPLE F

Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland

As described in Section 3.2, there are no watercourses or wetlands within the CPAA.

As there are no wetlands or watercourses in the CPAA, no native vegetation will be cleared that is associated with a watercourse or wetland and as such is not at variance with this Clearing Principle.

4.8 CLEARING PRINCIPLE G

Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation

Activities associated with the clearance of vegetation have the potential for increasing land degradation through increased surface water run-off and the spread of dieback and weed species.

An existing EMP is in place for the Gosnells Quarry and HAUS will continue to implement the EMP measures for the CPAA and revise and update the EMP as necessary during extension of the pit. As for the current operational pit, it is likely that surface water will collect within the pit extension. Roads will have appropriate gullying and surface water infrastructure will be installed, if required. Therefore, HAUS have sufficient management processes in place to control any run off or increase in sediment load as a result of the vegetation clearance.

There is the potential for dieback to occur within the area, in addition to a number of weeds recorded throughout the CPAA. Therefore, there is the potential for heavy vehicle and plant movement to spread introduced species and dieback. HAUS has an existing Dieback and Weed Management Plan in place as part of the Gosnells Quarry EMP (HAUS, 2014) to reduce the spread of weeds and dieback and will revise and update the EMP as necessary during extension of the pit.

There is the potential for impacts to surrounding areas from dust emissions generated through clearing activities. Dust related impacts are controlled through the Gosnells Quarry EMP (HAUS, 2014), which has the following mitigation measures:

- Regularly wet down with water cart / truck dust prone unsealed surfaces.
- Undertake progressive rehabilitation in accordance with the Progressive Rehabilitation Plan (PRP).
- Undertake dust monitoring as per the Dust Management Plan. Undertake progressive rehabilitation in accordance with the PRP.
- Implementing additional dust control measures.

This EMP will be revised and updated as necessary during extension of the pit within the CPAA.

Due to the controls in place, it is unlikely that appreciable land degradation will occur due to clearing of native vegetation and unlikely to be at variance to this Clearing Principle.

4.9 CLEARING PRINCIPLE H

Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area

The CPAA is located close to Ellis Brook Valley Reserve which forms part of the Banyowla Regional Park. To the south is the Wrights Brook Regional Open Space. Ellis Brook Valley Reserve is a Category A status reserve listed on the register of National Estate (ID. 181050) for its landscape and wildlife values. To the east is the Korung National Park.

These conservation areas represent areas of remnant native vegetation and may provide habitat for conservation significant flora and fauna species. The Land Swap Area occurs within Banyowla Regional Park which was bequeathed to the State government as part of the original Development Approval for the Gosnells Quarry following submission of the ERMP in 1982. This provided an offset opportunity for the loss of vegetation and fauna habitat from the quarry.

Potential impacts to adjacent conservation areas can occur through weed and dieback invasion which may lower the environmental value of the conservation areas. In order to manage impacts, appropriate management plans are in place to control weed and dieback propagation. In addition, the Gosnells Quarry EMP (HAUS, 2014) has specific mitigation measures surrounding control of water.

There is the potential for impacts to surrounding conservation areas from dust emissions from clearing activities. Dust related impacts are controlled through the EMP (HAUS, 2014).

This EMP will be revised and updated as necessary during extension of the pit within the CPAA.

Therefore, controls are in place to prevent the spread of impacts and no native vegetation will be cleared that is considered to have an impact on the environmental values of any adjacent or nearby conservation area. As such, this is not at variance to this Clearing Principle.

4.10 CLEARING PRINCIPLE I

Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

As detailed in the Gosnells Quarry EMP (HAUS, 2014), erosion and sedimentation of surface water from cleared areas may occur during rainfall events. Activities associated with the clearance of vegetation have the potential for increasing land degradation through increased surface water run-off.

As with the current operations, sedimentation runoff will be minimised in accordance with the existing surface water management programme within the Gosnells Quarry EMP. This EMP will be revised and updated as necessary during extension of the pit within the CPAA. Roads will have appropriate gullying and surface water infrastructure will be installed around the pit extension, if required. Therefore, HAUS has sufficient management processes in place to control any run off or increase in sediment load as a result of the vegetation clearance. Loose topsoil will be removed and stockpiled for use in site rehabilitation.

Given that the groundwater aquifers occurring at the Gosnells Quarry are of limited areal extent and groundwater inflows have been noted on the eastern and northern walls of the existing main pit and below the Main Dam in small quantities, clearing of vegetation is unlikely to cause the groundwater level to rise.

Following the appropriate management measures, the clearance of native vegetation in the CPAA is unlikely to cause the deterioration in the quality of surface or underground water and be at variance to the Clearing Principle.

4.11 CLEARING PRINCIPLE J

Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding

It is unlikely that the clearing of vegetation will cause or exacerbate the incidence of flooding as all surface water flows through the CPAA will be managed in

accordance with the Gosnells Quarry existing surface water management programme within the EMP. This EMP will be revised and updated as necessary during extension of the pit within the CPAA.

As for the current operational pit, it is likely that surface water will collect within the pit extension. Roads will have appropriate gullying and surface water infrastructure will be installed around the pit extension, if required.

Flooding is not currently an issue at the quarry and it is unlikely that the clearing of vegetation within the CPAA will change this. Therefore, the clearing of vegetation within the CPAA is unlikely to cause, or exacerbate, the incidence or intensity of flooding and be of variance to this Clearing Principle.

5. CONCLUSION

The assessment of Clearing Principles presented in Section 4.0 concludes that none of the Principles are likely to be adversely impacted by the proposed clearing.

In Section 3.0 of this Clearing Permit Application, HAUS has detailed and compared the conservation values of both the original Land Swap Area and the CPAA to assess whether the basis of the original land swap assessment in 1982 still applies, ie that the land exchanged is of similar or greater conservation value than the land given to HAUS.

The land held by HAUS and exchanged to the State in 1984 was originally assessed in a System 6 study (The Darling System – Proposals for Parks and Reserves – The System 6 Study Report, 9 April 1981) as having greater conservation value than the State reserve (refer to EPA Bulletin 120) in 1982. At the time, the Land Swap Area was assessed as having the significant features of the 60 Foot Falls, Ellis Brook Valley Reserve and a group of *Eucalyptus lane-poolei* (considered rare when the ERMP was assessed, it has since been delisted).

In the last 12 years, HAUS has undertaken a number of detailed flora and fauna surveys over the extent of the CPAA and the Land Swap Area to quantify the conservation value of both areas as well as to address DWER requests for further information in relation to the presence of Black Cockatoos and the rare orchids, *Thelymitra magnifica* (Priority 1), *Thelymitra stellata* (Endangered under the BC Act and EPBC Act) in the CPAA.

Targeted flora surveys commissioned by HAUS (Bennett, 2014 and AECOM 2015a, 2015b and 2017a) have confirmed that these rare orchids do not occur in the CPAA. Vegetation surveys have confirmed that the same vegetation communities and soil associations occur in both the CPAA and the Land Swap Area, with the exception of a riparian vegetation association occurring adjacent Ellis Brook Valley Reserve in the Land Swap Area. The presence of the Ellis Brook in the Land Swap Area provides for greater biodiversity and a source of water for resident fauna. The same vegetation surveys have confirmed that there are no TEC's or PEC's in either area.

Hence, the floristic values of the CPAA and the Land Swap Area are similar in both extent and significance (Section 3.4).

In terms of diversity of fauna species, a comparison of the CPAA to the Land Swap Area (Bamford 2017a and b) found that the fauna values of both areas are similar (Section 3.5.5). Both areas provide residential habitat to 18 conservation significant fauna species including the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*; Vulnerable under the EPBC Act and Schedule 3 under the BC Act) and the Chuditch (*Dasyurus geoffroii*; Vulnerable under the EPBC Act and Schedule 3 under the BC Act), and seven to eight regular visitors.

All three Black-Cockatoo species have been recorded in the region (DpaW, 2016) and suitable foraging and breeding habitat occurs in the CPAA and Land Swap Area. Carnaby's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo were also recorded in the CPAA by Astron (2012b). Other conservation significant fauna

species that have been recorded in the CPAA include the Brush-tailed Phascogale, Quenda and Brush Wallaby.

All of these species (including other species that were not recorded, e.g. Chuditch, Carpet Python, Peregrine Falcon and Darling Range Ctenotus) are likely to be represented in the Land Swap Area, adjacent conservation estates and in similar vegetation complexes within the Darling Range (Bamford, 2017a).

Given the above, HAUS believes it has demonstrated that the historical Land Swap Area given to the State in 1985 is of similar conservation value to the portion of Lot 3 given to HAUS by the State.

HAUS also believes that the Land Swap Area should be considered by DWER to be a suitable offset for the clearing of native vegetation within the CPAA given that:

- None of the Clearing Principles are likely to be adversely impacted by the proposed clearing.
- The land area given to the State Government was a much greater area (236.8 ha) than that given to HAUS (143 ha).
- The clearing does not need assessment under the EPBC Act (Appendix B).

As indicated earlier in Section 1.4.1, HAUS has confirmed (via legal opinion and correspondence with the Commonwealth Department of Environment) that exemption from referral applies under Section 43B of the EPBC Act. Prior and future development of the Gosnells Quarry is in accordance with existing approvals, which are a lawful continuation of the land and were in place immediately prior to the commencement of the EPBC Act.

Therefore, HAUS requests that clearing approval is given for the CPAA and that the historic Land Swap Area is recognised as an acceptable offset without the need to seek further clearing approvals or provide further offsets for the progressive development of the resource for the life of the quarry, as this was entirely the intention of the original land swap.

6. REFERENCES

AECOM Australia Pty Ltd (2017a). Gosnells Quarry: Flora, Vegetation and Targeted Survey. Consultant report prepared for Holcim (Australia) Pty Ltd.

AECOM Australia Pty Ltd (2017b). Environmental Values Identification – Landswap Areas, Gosnells Quarry. Consultant letter prepared for Holcim (Australia) Pty Ltd.

AECOM Australia Pty Ltd (2016). Holcim Gosnells Quarry: Flora, Vegetation and Targeted Orchid Assessment. Consultant report prepared for Holcim (Australia) Pty Ltd.

AECOM Australia Pty Ltd (2015). Holcim Gosnells Quarry: Flora, Vegetation and Targeted Orchid Assessment. Consultant report prepared for Holcim (Australia) Pty Ltd.

Astron Environmental Services (2012a). Gosnells Quarry Desktop Flora, Vegetation and Fauna Survey. Consultant report prepared for Holcim (Australia) Pty Ltd.

Astron Environmental Services (2012b). Gosnells Quarry Field Flora, Vegetation and Fauna Survey. Consultant report prepared for Holcim (Australia) Pty Ltd.

Astron Environmental Services (2013). Gosnells Quarry Black-Cockatoo Tree Inspection. Consultant report prepared for Holcim (Australia) Pty Ltd.

Bamford Consulting Ecologists (2017a). Holcim Gosnells Quarry – Fauna Assessment of Quarry Area. Consultant report prepared for Holcim (Australia) Pty Ltd.

Bamford Consulting Ecologists (2017b). Holcim Gosnells Quarry – Fauna Assessment of the Land Swap Area (Banyowla Regional Park). Consultant report prepared for Holcim (Australia) Pty Ltd.

Bamford Consulting Ecologists (2015). Holcim Gosnells Quarry – Targeted Black-Cockatoo Habitat Assessment. Consultant report prepared for Holcim (Australia) Pty Ltd.

Bamford Consulting Ecologists (2014). Targeted Qualitative Black-Cockatoo and Quenda Habitat Assessment. Holcim Gosnells Quarry and adjacent areas. Consultant report prepared for Holcim (Australia) Pty Ltd.

Beard, J. S. (1979) Vegetation survey of Western Australia. SH 50-14, Perth. Puiblished by Vegmap Publications, Perth.

Bennett Environmental Consulting Pty Ltd (2014). Search for *Thelymitra stellata* and *Thelymitra magnifica*. Consultant report prepared for Holcim (Australia) Pty Ltd.

Bennett Environmental Consulting Pty Ltd (2006). Vegetation and Flora: Readymix Quarry Gosnells. Consultant report prepared for Holcim (Australia) Pty Ltd.

Bennett Environmental Consulting Pty Ltd (2005). Vegetation and Flora: Readymix Quarry Gosnells. Consultants report prepared for Readymix Holdings Pty Ltd.

Brian J. O'Brien & Associates Pty Ltd (1982). Environmental Review and Management Programme for Long-Term Planning of Readymix Land-use at Gosnells. Consultant report prepared for Readymix Group (WA).

City of Gosnells, Western Australia (2010). Local Planning Policy 5.4 – Gosnells Hard Rock Quarry – Lot 3 Cockram Road, Martin.

City of Gosnells, Western Australia (2001). Town Planning Scheme No. 6 Scheme Report, December 2001.

Department of Parks and Wildlife (2015). FloraBase - The Swan Weeds Database. Available at https://florabase.dpaw.wa.gov.au/weeds/swanweeds (Accessed 17 June 2015).

Environmental Protection Authority (1982). Bulletin 120: Report and Recommendations by the Environmental Proection Authority: Proposed Readymix Quarry Development, Gosnells.

Holcim (Australia) Pty Ltd (2014). Gosnells Quarry: Environmental Management Plan.

Markey, Adrienne (1997). Floristic survey of the northern Darling Scarp. A report to the Western Australian Department of Conservation and Land Management for the Australian Heritage Commission.

URS Australia Pty Ltd (2005). Gosnells Quarry – Groundwater And Surface Water Review. Consultant report prepared for Readymix Holdings Pty Ltd.

Williams K. and Mitchell D. (2001). Jarrah Forest 1. JF1 – Northern Jarrah Forest subregion. A biodiversity Audit of Western Australia's 53 Biographic Subregions in 2002. Department of Conservation and Land Management, Perth.

Western Australian Planning Commission (2000). Statement of Planning Policy No. 2.4: Basic Raw Materials. Gazetted Copy from State Law Publisher, Special Gazetter No. 150.

Western Australia Department of Conservation and Environment (1981). The Darling System Western Australia: Proposals for Parks and Reserves – The System 6 Study Report. Published by Department of Conservation and Environment, Western Australia.

Figures

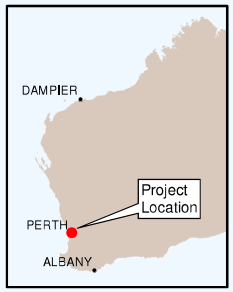
GOSNELLS QUARRY
SITE LOCATION MAP

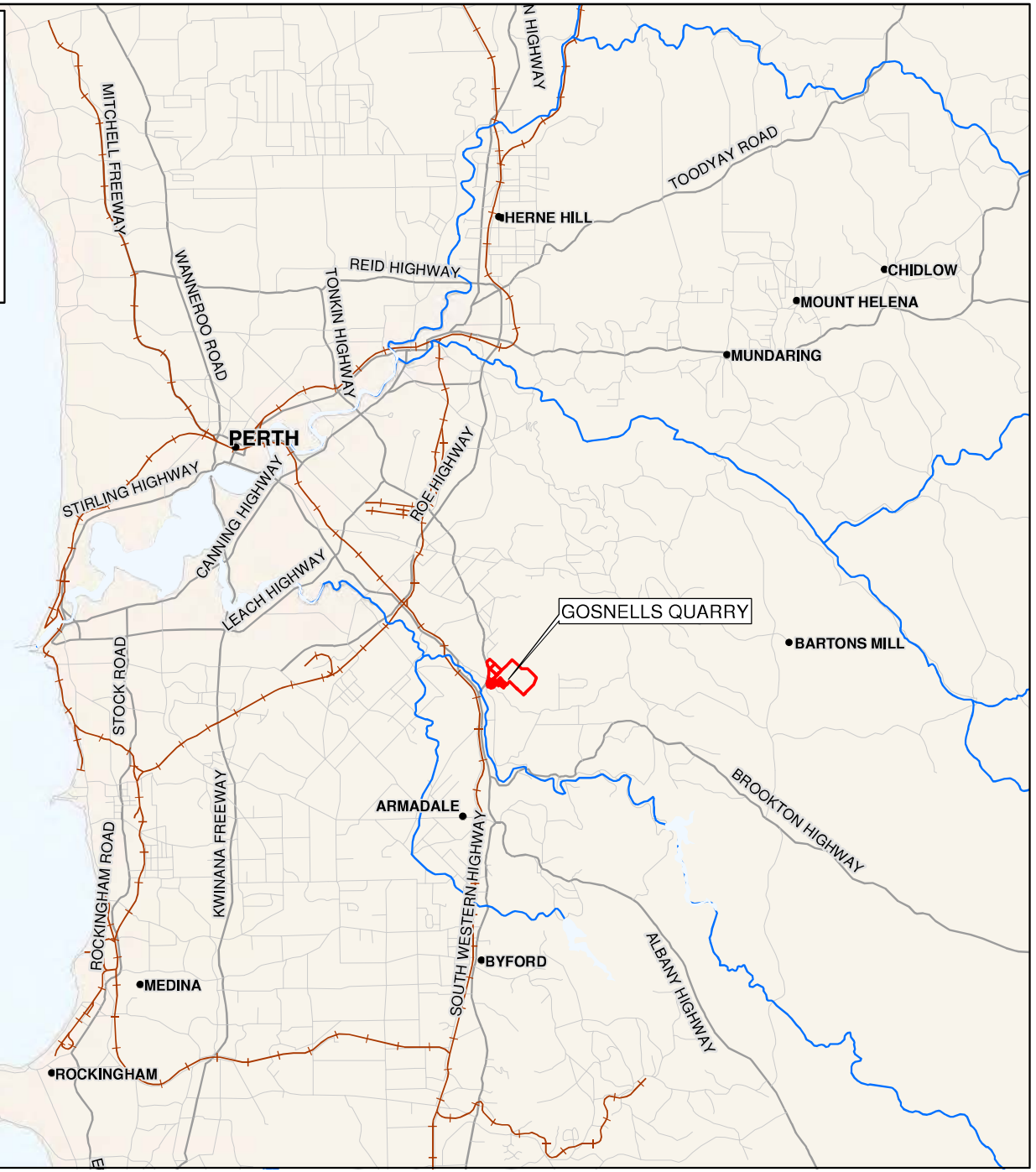
Author: RNM	Office: Perth, WA	Date: 5/09/2017
Aerial Photography: N/A	Digital Mapping: N/A	
Contour Interval: N/A	Grid: N/A Vertical Datum: N/A	Figure 1
Scale: 1:350,000 (A4) Path: Gosnells_20170727\02_MXDs\GQCPA_July2017		Version: 1 Plan: GQCPA

N

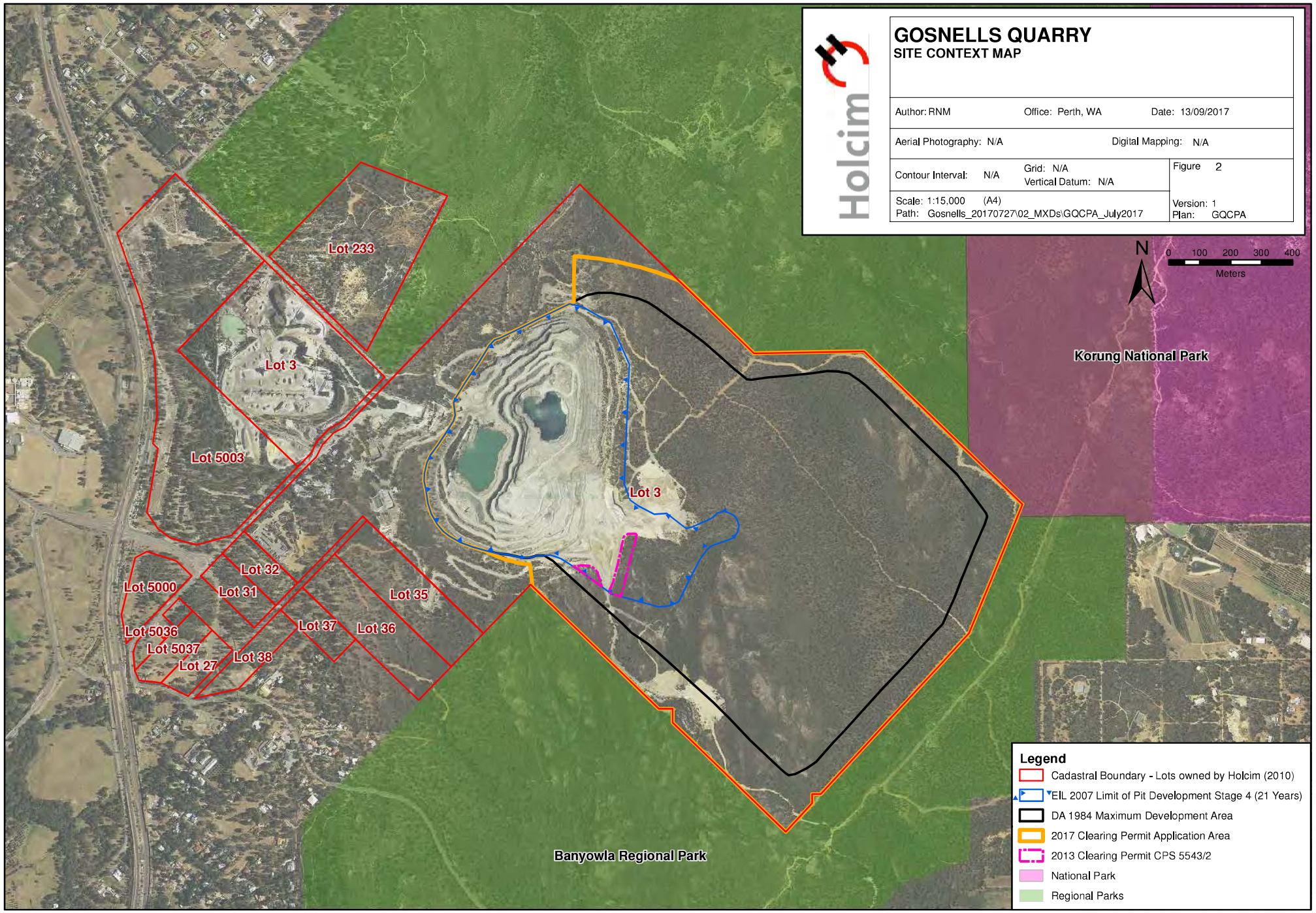
0 5 10 15 20
Kilometers

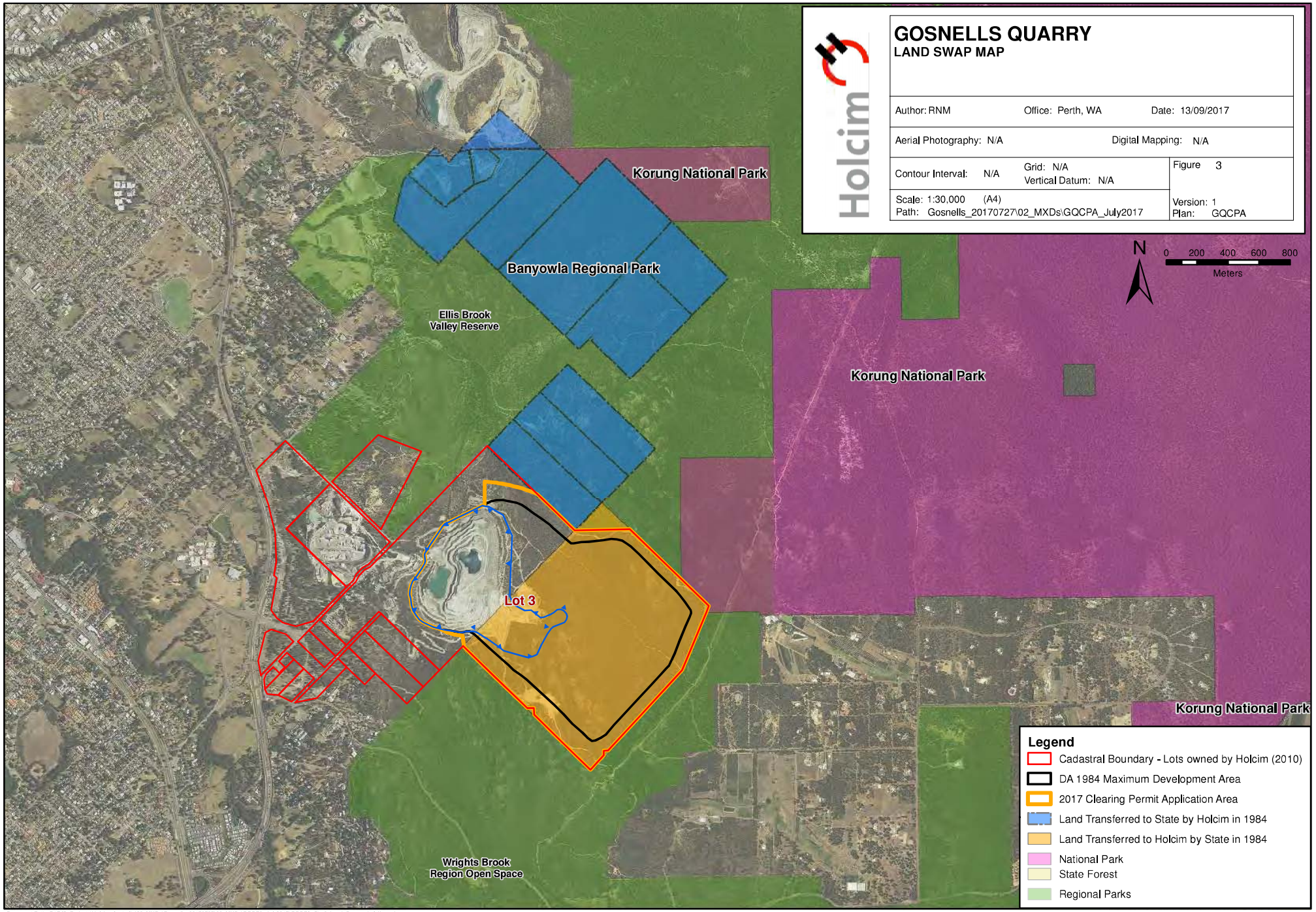
Legend
- Cadastral Boundary - Lots owned by Holcim
- Major Watercourse
- Railways
- Major Road
- Minor Road

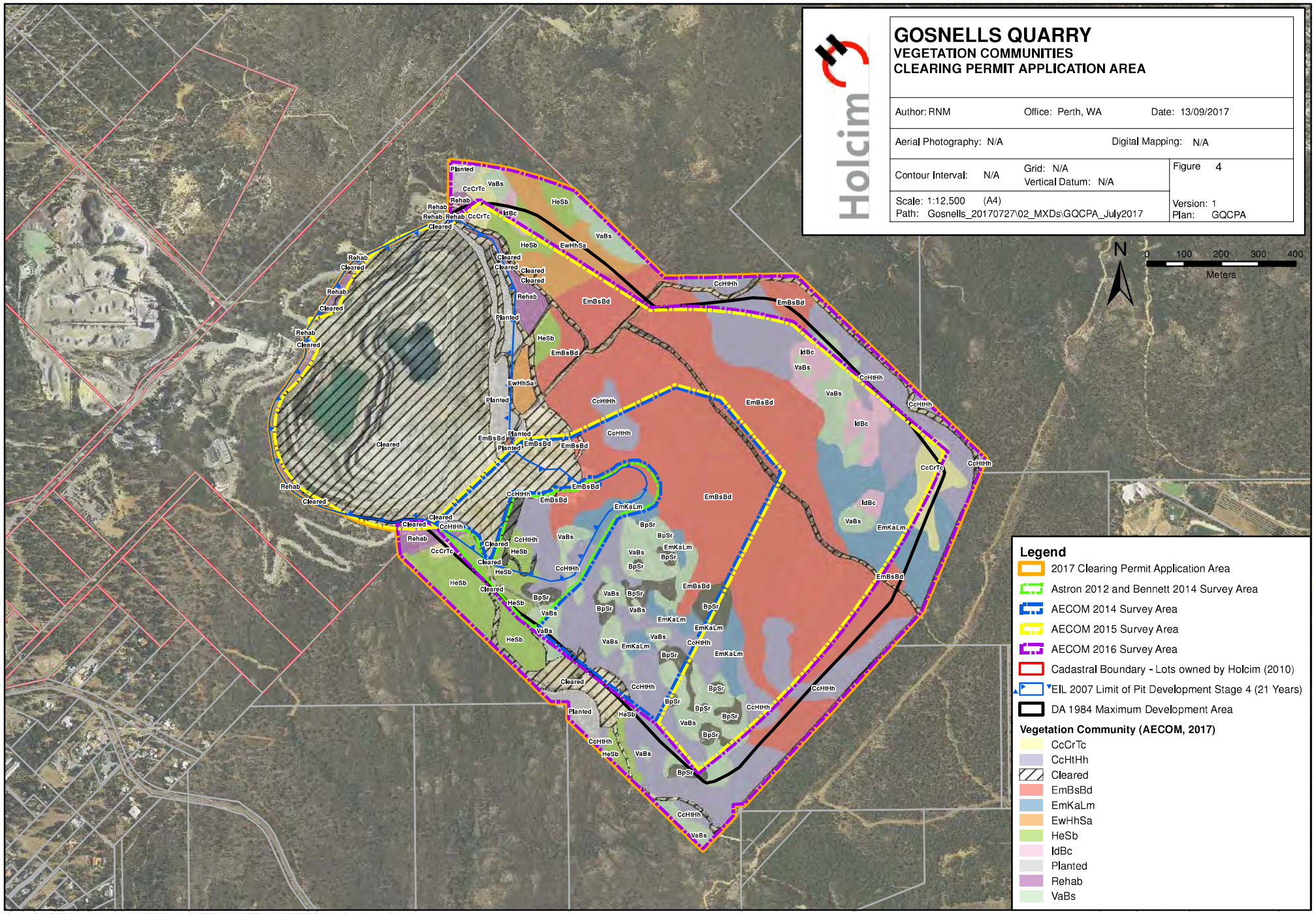


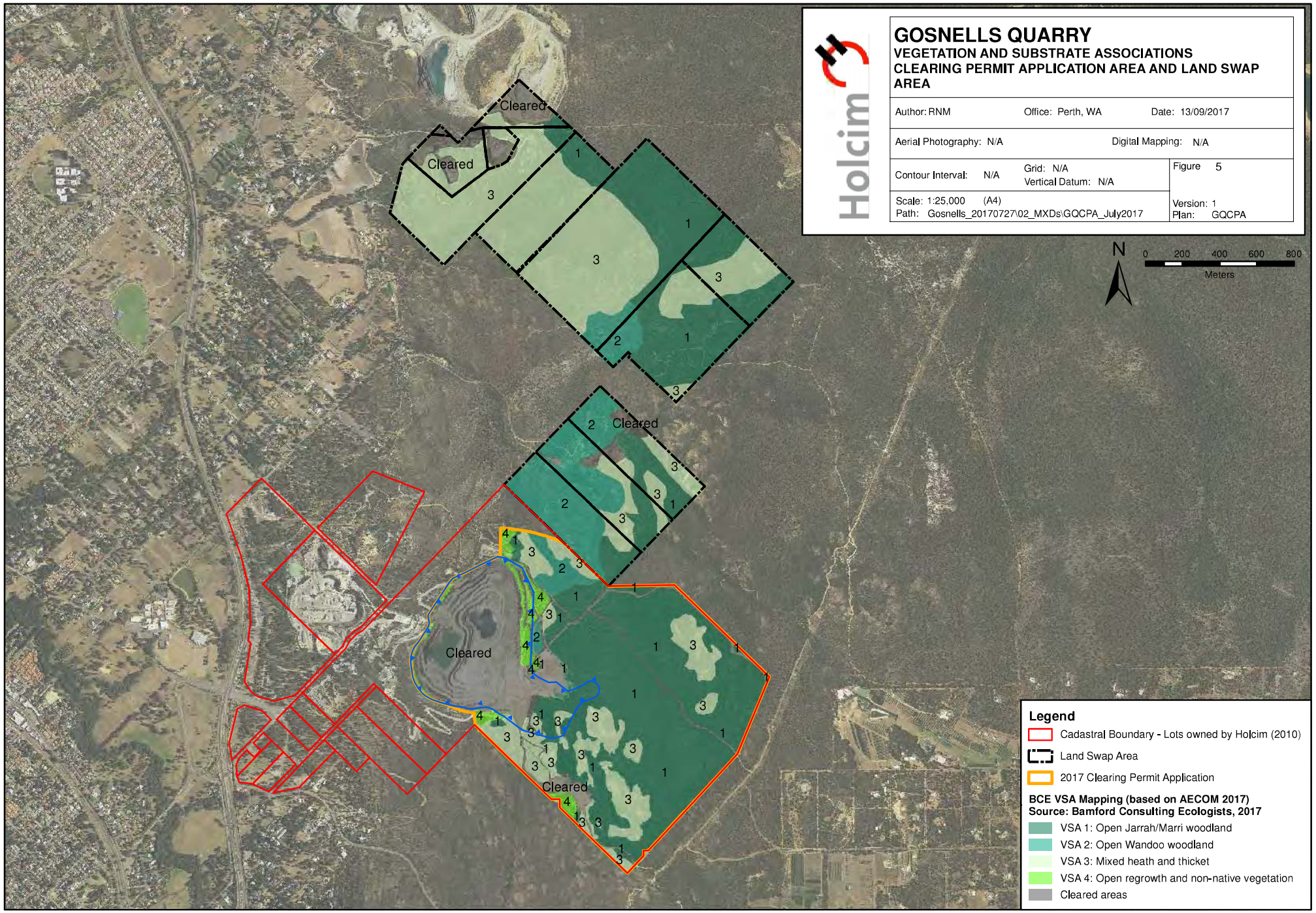


Document Path: G:\GIS_Projects\Holcim_Australia\02_MXDs\Gosnells_20170727\02_MXDs\GQCPA_July2017\GQCPA_Fig 1_Site_Location_v1_A4L.mxd


GOSNELLS QUARRY
SITE CONTEXT MAP
Author: RNM
Office: Perth, WA
Date: 13/09/2017
Aerial Photography: N/A
Digital Mapping: N/A
Contour Interval: N/A
Grid: N/A
Vertical Datum: N/A
Figure 2
Scale: 1:15,000 (A4)
Path: Gosnells_20170727\02_MXDs\GQCPA_July2017
Version: 1
Plan: GQCPA
N
0 100 200 300 400
Meters
Lot 233
Lot 3
Lot 5003
Lot 3
Lot 5000
Lot 32
Lot 31
Lot 35
Lot 5036
Lot 37
Lot 36
Lot 5037
Lot 38
Lot 27
Korung National Park
Banyowla Regional Park
Legend
Cadastral Boundary - Lots owned by Holcim (2010)
EIL 2007 Limit of Pit Development Stage 4 (21 Years)
DA 1984 Maximum Development Area
2017 Clearing Permit Application Area
2013 Clearing Permit CPS 5543/2
National Park
Regional Parks


GOSNELLS QUARRY
LAND SWAP MAP
Author: RNM
Office: Perth, WA
Date: 13/09/2017
Aerial Photography: N/A
Digital Mapping: N/A
Contour Interval: N/A
Grid: N/A
Vertical Datum: N/A
Figure 3
Scale: 1:30,000 (A4)
Path: Gosnells_20170727\02_MXDs\GQCPA_July2017
Version: 1
Plan: GQCPA
N
0 200 400 600 800
Meters
Korung National Park
Banyowla Regional Park
Ellis Brook Valley Reserve
Korung National Park
Lot 3
Korung National Park
Wrights Brook Region Open Space
Legend
Cadastral Boundary - Lots owned by Holcim (2010)
DA 1984 Maximum Development Area
2017 Clearing Permit Application Area
Land Transferred to State by Holcim in 1984
Land Transferred to Holcim by State in 1984
National Park
State Forest
Regional Parks


GOSNELLS QUARRY
VEGETATION COMMUNITIES
CLEARING PERMIT APPLICATION AREA
Author: RNM
Office: Perth, WA
Date: 13/09/2017
Aerial Photography: N/A
Digital Mapping: N/A
Contour Interval: N/A
Grid: N/A
Vertical Datum: N/A
Figure 4
Scale: 1:12,500 (A4)
Path: Gosnells_20170727\02_MXDs\GQCPA_July2017
Version: 1
Plan: GQCPA
Holcim
N
0 100 200 300 400
Meters
Legend
2017 Clearing Permit Application Area
Astron 2012 and Bennett 2014 Survey Area
AECOM 2014 Survey Area
AECOM 2015 Survey Area
AECOM 2016 Survey Area
Cadastral Boundary - Lots owned by Holcim (2010)
EIL 2007 Limit of Pit Development Stage 4 (21 Years)
DA 1984 Maximum Development Area
Vegetation Community (AECOM, 2017)
CcCrTc
CcHtHh
Cleared
EmBsBd
EmKaLm
EwHhSa
HeSb
IdBc
Planted
Rehab
VaBs

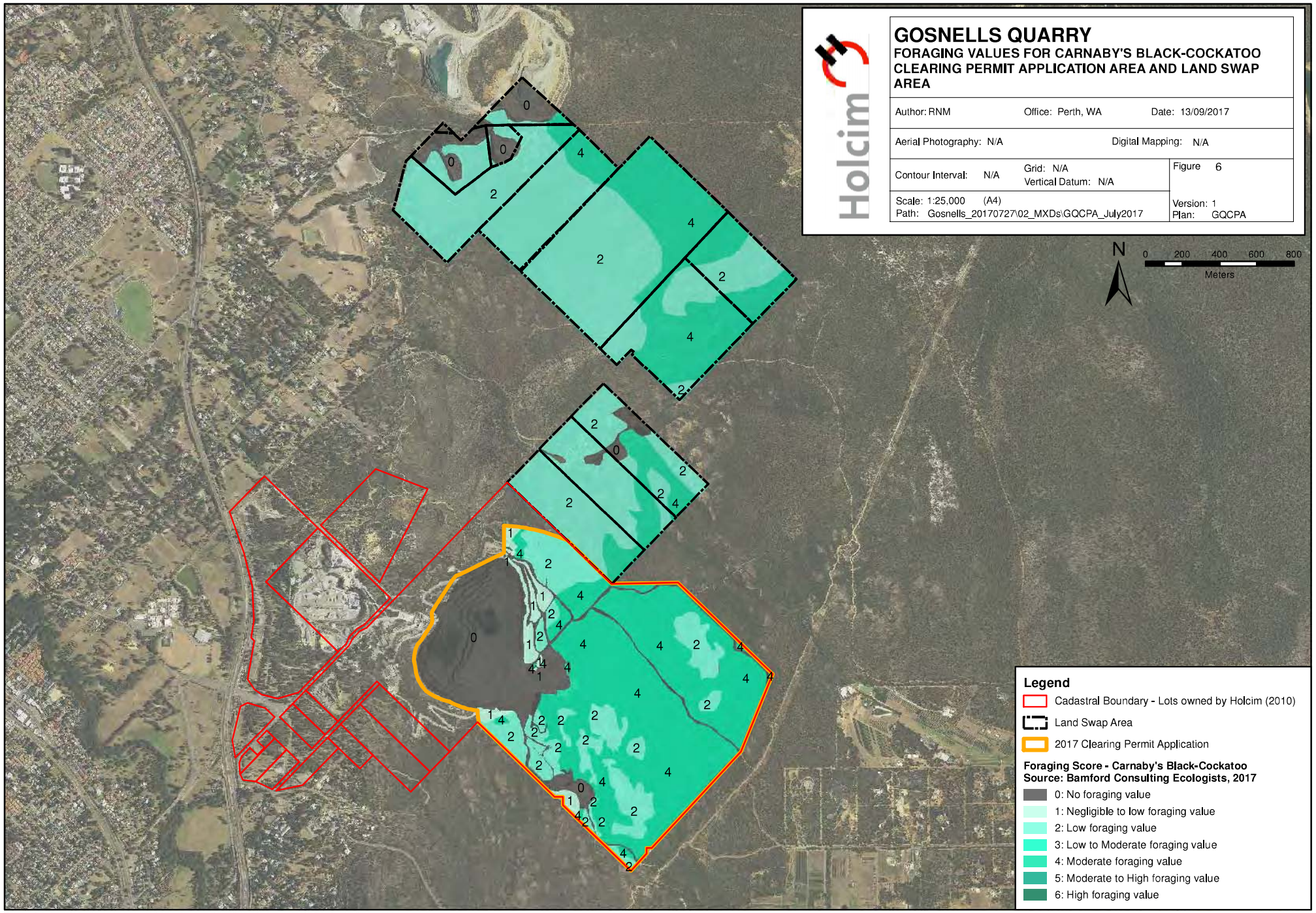


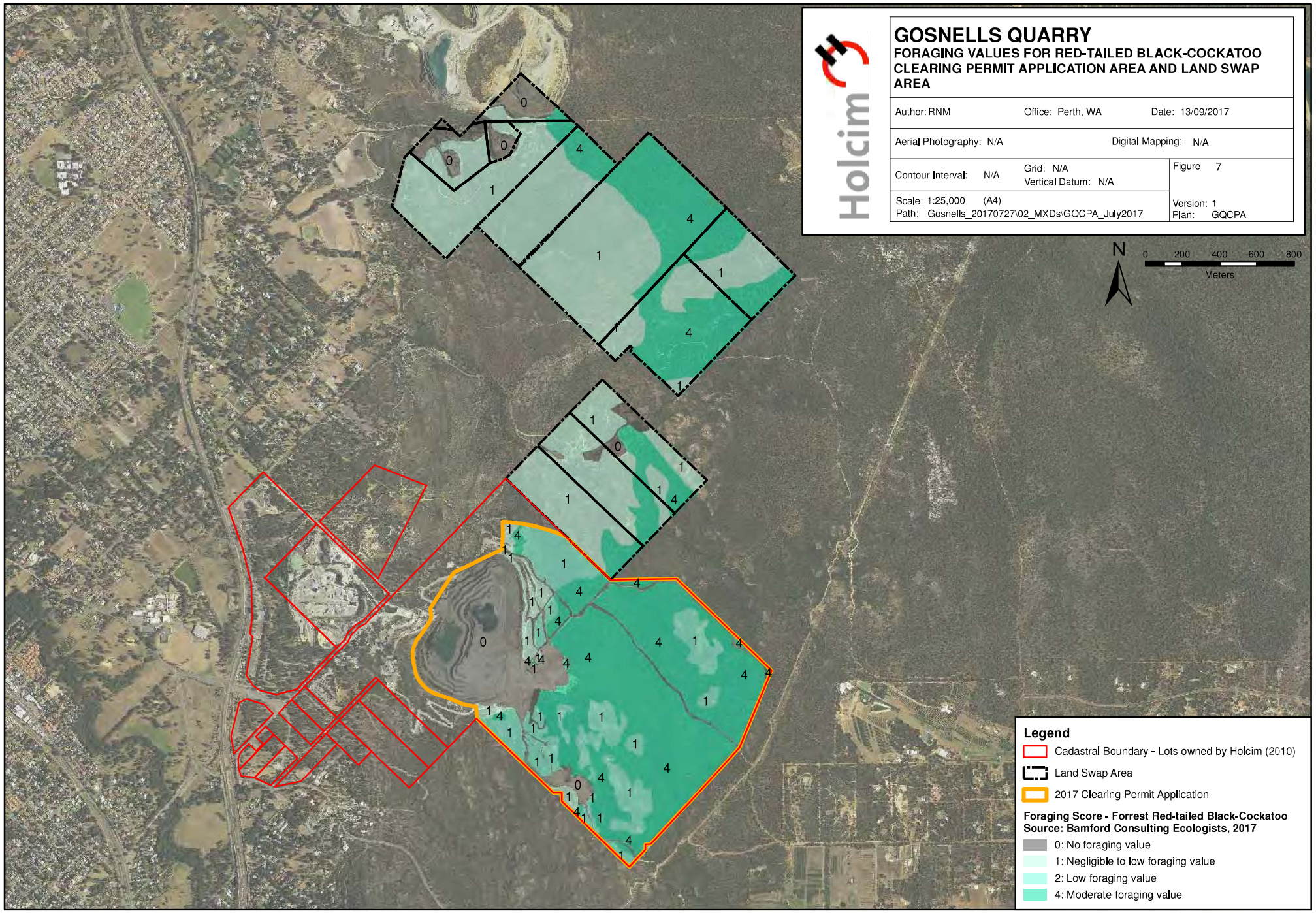
GOSNELLS QUARRY

VEGETATION AND SUBSTRATE ASSOCIATIONS CLEARING PERMIT APPLICATION AREA AND LAND SWAP AREA

Author: RNM	Office: Perth, WA	Date: 13/09/2017	
Aerial Photography: N/A		Digital Mapping: N/A	
Contour Interval: N/A	Grid: N/A Vertical Datum: N/A		Figure 5
Scale: 1:25,000 (A4) Path: Gosnells_20170727\02_MXDs\GQCPA_July2017			Version: 1 Plan: GQCPA

Document Path: G:\GIS_Projects\Holcim_Australia\02_MXDs\Gosnells_20170727\02_MXDs\GQCPA_July2017\GQCPA_Fig 5_Veg_Substrate_v1_A4.mxd


GOSNELLS QUARRY
FORAGING VALUES FOR CARNABY'S BLACK-COCKATOO
CLEARING PERMIT APPLICATION AREA AND LAND SWAP AREA
Author: RNM
Office: Perth, WA
Date: 13/09/2017
Aerial Photography: N/A
Digital Mapping: N/A
Contour Interval: N/A
Grid: N/A
Vertical Datum: N/A
Figure 6
Scale: 1:25,000 (A4)
Path: Gosnells_20170727\02_MXDs\GQCPA_July2017
Version: 1
Plan: GQCPA
N
0 200 400 600 800
Meters
Legend
Cadastral Boundary - Lots owned by Holcim (2010)
Land Swap Area
2017 Clearing Permit Application
Foraging Score - Carnaby's Black-Cockatoo
Source: Bamford Consulting Ecologists, 2017
0: No foraging value
1: Negligible to low foraging value
2: Low foraging value
3: Low to Moderate foraging value
4: Moderate foraging value
5: Moderate to High foraging value
6: High foraging value


GOSNELLS QUARRY
FORAGING VALUES FOR RED-TAILED BLACK-COCKATOO CLEARING PERMIT APPLICATION AREA AND LAND SWAP AREA
Author: RNM
Office: Perth, WA
Date: 13/09/2017
Aerial Photography: N/A
Digital Mapping: N/A
Contour Interval: N/A
Grid: N/A
Vertical Datum: N/A
Figure 7
Scale: 1:25,000 (A4)
Path: Gosnells_20170727\02_MXDs\GQCPA_July2017
Version: 1
Plan: GQCPA
Holcim
N
0 200 400 600 800
Meters
Legend
Cadastral Boundary - Lots owned by Holcim (2010)
Land Swap Area
2017 Clearing Permit Application
Foraging Score - Forrest Red-tailed Black-Cockatoo
Source: Bamford Consulting Ecologists, 2017
0: No foraging value
1: Negligible to low foraging value
2: Low foraging value
4: Moderate foraging value

Appendix A Development Approval

cc: RAS
BCP
BSC

Land Exchange

7 GEORGE'S TERRACE, PERTH, 6000 W.A. TELEPHONE 325 2966

METROPOLITAN REGION PLANNING AUTHORITY

Please note - new telephone number from Sept 3, 1984 is 4257333

M.R.P.A. Ref. : 25-3317-1

Recd 25-1-1985

23 January 1985

RECEIVED
25 JAN 1985
GOSNELLS

THE READYMIX GROUP (AUSTRALIA) LIMITED
POst Office Box 20
BENTLEY WA 6102

Dear Sir,

Application for Approval to Commence Development dated 29 November, 1984 received 17 January 1985
LOT : - LOC : Canning Location 3343 PLAN: -
VOL : 1679 FOL : 94
Owner : THE READYMIX GROUP OF (AUSTRALIA) LIMITED 1091 Albany Highway BENTLEY WA 6102

Under the provisions of the Metropolitan Region Scheme this application has been referred to this Authority for determination.

The application has now been considered by the Authority and the formal notice setting out the terms of the decision is attached.

A copy of this decision has been forwarded to the local authority for information.

You are advised of the need to consult with the local authority with regard to the gaining of all necessary approvals and the issuing of the requisite building licence.

Should you be aggrieved by this decision there is a right of appeal pursuant to the provisions of Clause 33 of the Metropolitan Region Scheme. Such an appeal must be submitted in accordance with Part V of the Town Planning and Development Act 1928 (as amended).

Yours faithfully,

R.E PETERS,
A/SECRETARY

FOOTNOTE TO APPLICANT : This approval is issued pursuant to the

METRO RAW MATERIALS

Bartholomew, M		
BELLOCH, P		
COX, E		
DIAMOND, M		
DOWELL, N		
FIGUEIRA, D		
NADASSIN, L		
RAMMOND, R		
JOHNSTON, F		
LEFEVRE, G		
PHONES		
VLAMING, H	✓	P.P
ALL STAFF		
NOTICE BOARD		✓
FILE	✓	

ST. GEORGE'S TERRACE, PERTH, 6000 W.A. TELEPHONE 325 2966

METROPOLITAN
REGION
PLANNING
AUTHORITY

provisions of the Metropolitan Region Scheme, and the applicant is advised that the proposal must also comply with the requirements of Council's Town Planning Scheme(s).

ST GEORGE'S TERRACE, PERTH, 6000 W.A. TELEPHONE 325 2966

METROPOLITAN REGION PLANNING AUTHORITY

Please note - new telephone number from Sept 3, 1984 is 4257333

23 January 1985
Serial No.25-3317-1

METROPOLITAN REGION SCHEME

Form 2

City of Gosnells

APPROVAL/~~REFUSAL OF APPROVAL~~ TO COMMENCE DEVELOPMENT

Name and Address of Owner and Land on which Development Proposed:

THE READYMIX GROUP OF (AUSTRALIA) LIMITED 1091 Albany Highway BENTLEY WA 6102
LOT : - LOC : Canning Location 3343 PLAN: -
VOL : 1679 FOL : 94
Application Date : 29 November, 1984 Application rec'd : 17 January 1985

The application for approval to commence development in accordance with the plans attached thereto is granted, subject to the following condition(s):

1. Compliance with the terms and intent of the "Environmental Review and Management Programme 1982".
2. Compliance with the "Development and Environmental Programme for Readymix Quarry at Gosnells" report.

This approval is valid for a period of two years only. If development is not completed within this period a fresh approval must be obtained before commencing or continuing with development.

R.E. PEEL,
A/SECRETARY

Appendix B EPBC Act Exemption

Aggregate Planning & Environment - WA/ NT

Holcim

Holcim (Australia) Pty Ltd
18 Brodie Hall Drive
BENTLEY WA 6102
Australia

Attn: Con Voutas
Department of Sustainability, Environment, Water, Population and Communities
GPO Box 787
CANBERRA ACT 2601

2nd September 2013
lisa.honan@holcim.com

Dear Con,

RE: GOSNELLS QUARRY EXTRACTIVE INDUSTRY LICENCE DEVELOPMENT – LOT 3 COCKRAM ROAD, MARTIN, WA (Lot 3 on Plan 14769)

Holcim Australia Pty Ltd (**Holcim**) has been in recent discussions with the Department of Sustainability Environment, Water Populations and Communities (**DSEWPaC**) concerning Holcim's Gosnells Quarry and future development in accordance with existing approvals.

We provide below an update on this matter, following our recent teleconference with you and others.

Teleconference: 3 July 2013.

As you will recall, I spoke to you and Matt Barwick (also of DSEWPaC), together with Jenny Moro and Jared Leigh (of URS), regarding Holcim's development of the Gosnells Quarry. We discussed the following matters:

- There is a current Extractive Industries Licence (**EIL**);
- Holcim proposes to expand operations to the south-east of the current pit (approximately 14.08 hectares (ha), and within the current area allocated by the EIL;
- Holcim was concerned to ensure it was meeting all necessary consultation on this proposed expansion;
- Holcim had commissioned an environmental baseline study of the proposal by URS, which identified particular fauna and flora species (listed under the *Environmental Protection and Biodiversity Act 1999* (**EPBC Act**))
- Holcim sought to consult initially with DEWSPaC to establish whether a referral would be required to DSEWPaC to determine whether the proposal would have a significant impact, as defined by the EPBC Act

Update on amendment to proposal

Since our teleconference, Holcim has amended the clearing activity proposed to be undertaken as part of the expansion, reducing the proposed cleared area from 14.08 ha to 7.35 ha.

Holcim has also sought legal clarification of the approval status of the existing and future operations of the quarry. We have undertaken a review of the documentation underlying the operational approvals.

Prior to the commencement of the EPBC Act, the Gosnells Quarry was operating lawfully, in accordance with the necessary approvals and associated documents, and has continued to do so. Additionally, the approvals and associated documents clearly anticipated the expansion as is currently proposed.

Holcim is of the opinion that the planned ground disturbance and clearing meets the criteria for an exemption under section 43B of the EPBC Act, as these actions are a lawful continuation of the use of land, which was occurring immediately prior to the commencement of the EPBC Act.

On this basis, we wish to confirm that Holcim will not be referring the proposal under the EPBC Act. Holcim will continue to comply with existing approvals and all requirements pursuant to relevant State and Federal legislation.

Should you wish to discuss further, please don't hesitate to me on 08 9212 2146 or lisa.honan@holcim.com

Yours Sincerely,



Lisa Honan
Senior Planning & Environment Coordinator – WA/NT

CC: Jenny Moro, URS Australia, jenny.moro@urs.com

Honan, Lisa

From: Voutas, Con <Con.Voutas@environment.gov.au>
Sent: Wednesday, 4 September 2013 1:02 PM
To: Honan, Lisa
Cc: 'Moro, Jenny'; Curtin, Daniel
Subject: Expansion of Gosnells Quarry Extractive Industry Licence Development [SEC=UNCLASSIFIED]

Dear Lisa,

Thank you for your letter dated 2 September 2013 in which Holcim (Australia) Pty Ltd has advised that it has all the necessary approvals and associated documents, predating the commencement of the EPBC Act, for the expansion of the Gosnells Quarry in WA. I have forwarded you letter to the relevant area in the Department who may be in contact with you to seek further information in relations to the relevant existing State approvals. The Director of the area is Daniel Curtin, who can be contacted on (02) 6275 9359 (e-mail address above).

Regards

Con Voutas
Director
South West Section
North, West and Offshore Assessment Branch
Environment Assessment and Compliance Division
Phone +61 2 6274 2363

If you have received this transmission in error please notify us immediately by return e-mail and delete all copies. If this e-mail or any attachments have been sent to you in error, that error does not constitute waiver of any confidentiality, privilege or copyright in respect of information in the e-mail or attachments. Please consider the environment before printing this email.

Appendix C Extractive Industries Licence

State Administrative Tribunal
Western Australia

Local Government Act 1995

IN THE MATTER OF:

Rinker Australia Pty Ltd Applicant
-and-
City of Gosnells Respondent

Matter Number: DR 207 2007
Application Lodged: 5 June 2007

ORDER

By consent of the parties, it is on 18 October 2007 ordered that:

1. The application for review is allowed.
2. The decision of the respondent made on 8 May 2007 to determine a period for the applicant's extractive industry licence of 5 years commencing on 1 July 2007, is set aside.
3. The term of the applicant's extractive industry licence is determined to be 21 years commencing on 1 July 2007.

Member Marie Connor

STATE ADMINISTRATIVE TRIBUNAL Western Australia

I certify the foregoing to be a true and correct copy of the original

State Administrative Tribunal
Date: 19.10.07

2120 Albany Highway Gosnells WA 6110
Mail to: PO Box 662 Gosnells WA 6990

T 08 9391 3222
F 08 9398 2922
E council@gosnells.wa.gov.au
W www.gosnells.wa.gov.au
ABN 18 374 412 891

17 May 2007

Rinker Australia Pty Limited
18 Brodie Hall Drive
BENTLEY WA 6102

Attention: Georgia Manning

Our Reference: EIL 2007 – Readymix 302967
Enquiries: Simon Wilkes/ Jeff Flatow 9391 3222

Dear Georgia

Application for Extractive Industries Licence – Gosnells Quarry

I refer to your application dated 9 February 2007 for the above. Council at its Ordinary Meeting of 8 May 2007 considered the application and conditionally grant approval for the issuance of an extractive industry licence for a period of five (5) years commencing 1 July 2007; a copy of the minutes from the Council Meeting are enclosed for your records.

In accordance with Clause 8(4) of the Extractive Industries Local Law 2000, the Chief Executive Officer of the City of Gosnells shall issue the licence to the applicant upon the payment of the annual licence fee ($2400). Can you please make arrangements for the licence fee to be paid at your earliest convenience to enable the licence to be issued. Enclosed for your reference is a tax invoice.

Staff are currently making arrangements for documentation to be executed by the Chief Executive Officer. Should you wish to discuss this matter further in the interim, please do not hesitate to contact either Jeff Flatow or the undersigned on 9391 3222.

Yours faithfully

Simon Wilkes
Coordinator Strategic Planning

Enc. Tax Invoice
Council Meeting Mintues

CITY OF GOSNELLS

2120 Albany Highway Gosnells WA 6110
Mail to: PO Box 662 Gosnells WA 6990

T 08 9391 3222
F 08 9393 2922
E council@gosnells.wa.gov.au
W www.gosnells.wa.gov.au
ABN 18 374 412 891

TAX INVOICE

Rinker Australia Pty Ltd
Po Box 1143
MILTON QLD 4064

Account No	**262610**
Invoice Number	**6297**
Invoice Date	**15-May-07**

Details	Nett Amount	GST	Amount
Extractive Industry Licence Period: Jul 1 2007 to Jun 30 2008	2,400.00	0.00	$2,400.00

Total Amount Payable	**$2,400.00**
Includes GST	**$0.00**

Please return this slip with your Payment

City of Gosnells
PO Box 662
GOSNELLS WA 6990

Account No	**262610**
Invoice Number	**6297**
Total Amount	**$2,400.00**
Due Date	**30-Jun-07**

Appendix D Category 12 Licence L6821/1967/12

Government of Western Australia
Department of Environment Regulation

Your ref: L6821/1967/12
Our ref: DEC6389-02
Enquiries: Jamie Piotrowski
Phone: (08) 9725 4300
Email: jamie.piotrowski@der.wa.gov.au

Ms Jo Russell
Planning and Environment Manager – WA/NT
Holcim (Australia) Pty Ltd
18 Brodie Hall Drive
BENTLEY WA 6102

RECEIVED 20 JAN 2016

Dear Ms Russell

***ENVIRONMENTAL PROTECTION ACT 1986* – AMENDMENT TO LICENCE**

Licence: L6821/1967/12
Premises: Holcim Gosnells Hardrock Quarry

Further to my letter dated 11 December 2015, please find enclosed your amended *Environmental Protection Act 1986* licence.

If you have any questions or objections relating to the licence, please do not hesitate to contact the enquiries officer above on (08) 9725 4300 for clarification or discussion of any grievances you have.

If you are concerned about, or object to any aspect of the amendment, you may lodge an appeal with the Minister for the Environment within 21 days from the date on which this licence is received. The Office of the Appeals Convenor can be contacted on 6467 5190 to find out the procedure and fee.

Members of the public may also appeal the amendments. The Appeals Registrar at the Office of the Appeals Convenor can be contacted after the closing date of appeals to check whether any appeals were received.

Yours sincerely

Tim Gentle
Manager Licensing – Industry Regulation (Resource Industries)
Officer delegated under Section 20
of the *Environmental Protection Act 1986*

21 January 2016

The Atrium, 168 St Georges Terrace, Perth WA 6000
Phone (08) 6467 5000 Fax (08) 6467 5562
Postal Address: Locked Bag 33, Cloisters Square, Perth WA 6850
www.der.wa.gov.au

Government of Western Australia
Department of Environment Regulation

Licence

Environmental Protection Act 1986, Part V

Licensee: Holcim (Australia) Pty Ltd

Licence: L6821/1967/12

Registered office: Level 8, Tower B
799 Pacific Hwy
Chatswood NSW 2067

ACN: 099 732 297

Premises address: Gosnells Hardrock Quarry
89 Cockram Road
MARTIN WA 6110
Being Lot 3 on Plan 14769 and Lot 5003 on Plan 28867 as depicted in Schedule 1.

Issue date: 21 January 2016

Commencement date: 25 January 2016

Expiry date: 30 September 2027

Prescribed premises category
Schedule 1 of the *Environmental Protection Regulations 1987*

Category number	Category description	Category production or design capacity	Approved Premises production or design capacity
12	Screening etc. of material: premises (other than premises within category 5 or 8) on which material extracted from the ground is screened, washed, crushed, ground, milled, sized or separated.	50 000 tonnes or more per year	5 million tonnes per annual period
13	Crushing of building material: premises on which waste building or demolition material (for example, bricks stones or concrete) is crushed or cleaned.	1 000 tonnes or more per year	250 000 tonnes per annual period
62	Solid waste depot – premises on which waste is stored or sorted pending final disposal or re-use.	500 tonnes or more per year	250 000 tonnes per annual period

Conditions
This Licence is subject to the conditions set out in the attached pages.

.....
Tim Gentle
Officer delegated under section 20
of the *Environmental Protection Act 1986*

Contents

Licence 1
Contents 2
Introduction 2
Licence conditions 4
1 General 4
2 Emissions 5
3 Monitoring 6
4 Information 7
Schedule 1: Maps 9

Introduction

This Introduction is not part of the Licence conditions.

DER's industry licensing role
The Department of Environment Regulation (DER) is a government department for the state of Western Australia in the portfolio of the Minister for Environment. DER's purpose is to advise on and implement strategies for a healthy environment for the benefit of all current and future Western Australians.

DER has responsibilities under Part V of the *Environmental Protection Act 1986* (the Act) for the licensing of prescribed premises. Through this process DER regulates to prevent, control and abate pollution and environmental harm to conserve and protect the environment. DER also monitors and audits compliance with works approvals and licence conditions, takes enforcement action as appropriate and develops and implements licensing and industry regulation policy.

Licence requirements
This Licence is issued under Part V of the Act. Conditions contained within the Licence relate to the prevention, reduction or control of emissions and discharges to the environment and to the monitoring and reporting of them.

Where other statutory instruments impose obligations on the Premises/Licensee the intention is not to replicate them in the licence conditions. You should therefore ensure that you are aware of all your statutory obligations under the Act and any other statutory instrument. Legislation can be accessed through the State Law Publisher website using the following link: http://www.slp.wa.gov.au/legislation/statutes.nsf/default.html

For your Premises relevant statutory instruments include but are not limited to obligations under the:

- *Environmental Protection (Unauthorised Discharges) Regulations 2004* – these Regulations make it an offence to discharge certain materials such as contaminated stormwater into the environment other than in the circumstances set out in the Regulations.
- *Environmental Protection (Controlled Waste) Regulations 2004* - these Regulations place obligations on you if you produce, accept, transport or dispose of controlled waste.
- *Environmental Protection (Noise) Regulations 1997* – these Regulations require noise emissions from the Premises to comply with the assigned noise levels set out in the Regulations.

You must comply with your licence. Non-compliance with your licence is an offence and strict penalties exist for those who do not comply.

Licence holders are also reminded of the requirements of section 53 of the Act which places restrictions on making certain changes to prescribed premises unless the changes are in accordance with a works approval, licence, closure notice or environmental protection notice.

Licence fees
If you have a licence that is issued for more than one year, you are required to pay an annual licence fee prior to the anniversary date of issue of your licence. Non-payment of annual licence fees will result in your licence ceasing to have effect meaning that it will no longer be valid and you will need to apply for a new licence for your Premises.

Ministerial conditions
If your Premises has been assessed under Part IV of the Act you may have had conditions imposed by the Minister for Environment. You are required to comply with any conditions imposed by the Minister.

Premises description and Licence summary
The Gosnells Hardrock Quarry is located on the edge of the Darling Scarp, approximately 20km south-east of Perth, Western Australia. The quarry produces aggregate and sand for use in pre-mix and pre-cast concrete manufacturing, along with asphalt and road-base products, at a production rate of approximately five million tonnes per annum.

For the purposes of conducting investigations into possible dust impacts as a result of quarry operations, the licensee has implemented a property boundary dust monitoring program. The license has committed to utilising acceptable dust monitoring equipment for this purpose. The licensee has also provided the Department of Environment Regulation (DER) with informal updates on the results of this work on a quarterly basis. The licensee has also submitted a document to DER, which outlines the dust monitoring program.

This licence is the result of the licensee applying for an amendment to include category 13 onto the licence to enable the crushing of concrete and asphalt waste at the premises. The amended licence also includes category 62 to provide for storage and sorting of the crushed concrete and asphalt at the premises.

The licences and works approvals issued for the Premises since 1/10/2011 are:

Instrument log

Instrument	Issued	Description
L6821/1967/12	01/10/2011	Licence Reissue
L6821/1964/12	05/02/2015	Licence amendment to REFIRE format
L6821/1964/12	14/01/2016	Licence amendment to include categories 13 and 62

Severance
It is the intent of these Licence conditions that they shall operate so that, if a condition or a part of a condition is beyond the power of this Licence to impose, or is otherwise *ultra vires* or invalid, that condition or part of a condition shall be severed and the remainder of these conditions shall nevertheless be valid to the extent that they are within the power of this Licence to impose and are not otherwise *ultra vires* or invalid.

END OF INTRODUCTION

Licence conditions

1 General

1.1 Interpretation

1.1.1 In the Licence, definitions from the *Environmental Protection Act 1986* apply unless the contrary intention appears.

1.1.2 For the purposes of this Licence, unless the contrary intention appears:

'Act' means the *Environmental Protection Act 1986;*

'Annual period' means the inclusive period from 1 August until 31 July in the following year;

'CEO' means Chief Executive Officer of the Department of Environment Regulation;

'CEO' for the purpose of correspondence means;

Chief Executive Officer
Department Administering the *Environmental Protection Act 1986*
Locked Bag 33
CLOISTERS SQUARE WA 6850
Email: info@der.wa.gov.au

'Dangerous goods' has the meaning defined in the *Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007*;

'Licence' means this Licence numbered L6821/1967/12 and issued under the Act;

'Licensee' means the person or organisation named as Licensee on page 1 of the Licence;

'Premises' means the area defined in the Premises Map in Schedule 1 and listed as the Premises address on page 1 of the Licence;

'Schedule 1' means Schedule 1 of this Licence unless otherwise stated; and

'Schedule 2' means Schedule 2 of this Licence unless otherwise stated.

1.1.3 Any reference to an Australian or other standard in the Licence means the relevant parts of the standard in force from time to time during the term of this Licence.

1.1.4 Any reference to a guideline or code of practice in the Licence means the version of that guideline or code of practice in force from time to time, and shall include any amendments or replacements to that guideline or code of practice made during the term of this Licence.

1.2 Premises operation

1.2.1 The Licensee shall ensure surface water is managed in accordance with the document specified in Table 1.2.1.

Table 1.2.1: Management plans

Management plan reference	Parts	Date of document
Gosnells Quarry – Surface Water Management Plan	Entire	March 2015

1.2.2 The Licensee shall only accept waste on to the Premises if:
(a) it is of a type listed in Table 1.2.2; and
(b) the quantity accepted is below any quantity limit listed in Table 1.2.2; and
(c) it meets any specification listed in Table 1.2.2.

Table 1.2.2: Waste acceptance criteria

Waste type	Quantity limit	Specification
Waste concrete	250,000 tonnes per annual period (combined)	None specified
Waste asphalt		

2 Emissions

2.1 Fugitive emissions

2.1.1 The Licensee shall ensure fugitive emissions are managed in accordance with the documents, or parts of documents, specified in Table 2.1.1.

Table 2.1.1: Management plans

Management plan reference	Parts	Date of document
Gosnells Quarry Environmental Management Plan	8.0 – Dust Management Plan	May 2014

3 Monitoring

3.1 General monitoring

3.1.1 The licensee shall ensure that all laboratory samples are submitted to and tested by a laboratory with current NATA accreditation for the parameters being measured.

3.1.2 The Licensee shall ensure that all monitoring equipment used on the Premises to comply with the conditions of this Licence is calibrated in accordance with the manufacturer's specifications.

3.1.3 The Licensee shall, where the requirements for calibration cannot be practicably met, or a discrepancy exists in the interpretation of the requirements, bring these issues to the attention of the CEO accompanied with a report comprising details of any modifications to the methods.

3.2 Ambient environmental quality monitoring

3.2.1 The Licensee shall undertake the monitoring in Table 3.2.1 according to the specifications in that table.

Table 3.2.1: Monitoring of ambient air quality

Monitoring point reference and location	Parameter	Units	Frequency
AQ1	PM_{10}	$\mu g/m^3$	Continuous

4 Information

4.1 Records

4.1.1 All information and records required by the Licence shall:
- (a) be legible;
- (b) if amended, be amended in such a way that the original and subsequent amendments remain legible or are capable of retrieval;
- (c) except for records listed in 4.1.1(d) be retained for at least 6 years from the date the records were made or until the expiry of the Licence or any subsequent licence; and
- (d) for those following records, be retained until the expiry of the Licence and any subsequent licence:
  - (i) off-site environmental effects; or
  - (ii) matters which affect the condition of the land or waters.

4.1.2 The Licensee shall complete an Annual Audit Compliance Report indicating the extent to which the Licensee has complied with the conditions of the Licence, and any previous licence issued under Part V of the Act for the Premises for the previous annual period.

4.1.3 The Licensee shall:
- (a) implement a complaints management system that shall record the following information (if known or provided) about complaints received at the Premises concerning any environmental impact of the activities undertaken at the Premises:
  - (i) name and address of the complainants (if consented);
  - (ii) date and time of complaint;
  - (iii) date and time of alleged incident;
  - (iv) alleged source of the incident;
  - (v) general description of the alleged incident, including any environmental or health impacts reported by the complainant;
  - (vi) wind direction, wind speed and temperature at time of alleged incident;
  - (vii) likely source of the alleged incident; and
  - (viii) actions taken by the Licensee to address the complaint, including the outcome of any investigation(s) and action(s) to verify any impacts.
- (b) Complete an annual analysis and review of complaints recorded under 4.1.3(a) to identify any common factors and root cause of complaints and proposals to address these.

4.2 Reporting

4.2.1 The Licensee shall submit to the CEO an Annual Environmental Report within 28 calendar days after the end of the annual period. The report shall contain the information listed in Table 4.2.1 in the format or form specified in that table.

Table 4.2.1: Annual Environmental Report

Condition or table (if relevant)	Parameter	Format or form
-	Summary of any failure or malfunction of any pollution control equipment and any environmental incidents that have occurred during the annual period and any action taken	None specified
4.1.2	Compliance	Annual Audit Compliance Report (AACR)
4.1.3	Complaints summary	None specified
Table 3.2.1	PM_{10}	
-	Measures taken to minimise noise	
-	Annual production throughput	

Note 1: Forms are in Schedule 2

4.3 Notification

4.3.1 The Licensee shall ensure that the parameters listed in Table 4.3.1 are notified to the CEO in accordance with the notification requirements of the table.

Table 4.3.1: Notification requirements

Condition or table (if relevant)	Parameter	Notification requirement	Format or form[2]
-	Breach of any limit specified in the Licence	Part A: As soon as practicable but no later than 5pm of the next usual working day. Part B: As soon as practicable	N1

Note 1: Notification requirements in the Licence shall not negate the requirement to comply with s72 of the Act
Note 2: Forms are in Schedule 2

Schedule 1: Maps

Premises map

The Premises is shown in the map below. The pink line depicts the Premises boundary



Schedule 2: Reporting & notification forms

These forms are provided for the proponent to report monitoring and other data required by the Licence. They can be requested in an electronic format.

ANNUAL AUDIT COMPLIANCE REPORT PROFORMA

SECTION A

LICENCE DETAILS

Licence Number:	Licence File Number:
Company Name: Trading as:	ABN:
Reporting period: _____ to _____	

STATEMENT OF COMPLIANCE WITH LICENCE CONDITIONS

1. Were all conditions of the Licence complied with within the reporting period? (please tick the appropriate box)

Yes ☐ Please proceed to Section C

No ☐ Please proceed to Section B

Each page must be initialled by the person(s) who signs Section C of this Annual Audit Compliance Report (AACR).

Initial:

SECTION B
DETAILS OF NON-COMPLIANCE WITH LICENCE CONDITION.

Please use a separate page for each Licence condition that was not complied with.

a) Licence condition not complied with:

b) Date(s) when the non compliance occurred, if applicable:

c) Was this non compliance reported to DER?:

☐ Yes ☐ Reported to DER verbally
Date _____
☐ Reported to DER in writing
Date _____

☐ No

d) Has DER taken, or finalised any action in relation to the non compliance?:

e) Summary of particulars of the non compliance, and what was the environmental impact:

f) If relevant, the precise location where the non compliance occurred (attach map or diagram):

g) Cause of non compliance:

h) Action taken, or that will be taken to mitigate any adverse effects of the non compliance:

i) Action taken or that will be taken to prevent recurrence of the non compliance:

Each page must be initialled by the person(s) who signs Section C of this AACR

Initial:

SECTION C

SIGNATURE AND CERTIFICATION

This Annual Audit Compliance Report (AACR) may only be signed by a person(s) with legal authority to sign it. The ways in which the AACR must be signed and certified, and the people who may sign the statement, are set out below.

Please tick the box next to the category that describes how this AACR is being signed. If you are uncertain about who is entitled to sign or which category to tick, please contact the licensing officer for your premises.

If the licence holder is		The Annual Audit Compliance Report must be signed and certified:
An individual	☐ ☐	by the individual licence holder, or by a person approved in writing by the Chief Executive Officer of the Department of Environment Regulation to sign on the licensee's behalf.
A firm or other unincorporated company	☐ ☐	by the principal executive officer of the licensee; or by a person with authority to sign on the licensee's behalf who is approved in writing by the Chief Executive Officer of the Department of Environment Regulation.
A corporation	☐ ☐ ☐ ☐ ☐ ☐	by affixing the common seal of the licensee in accordance with the *Corporations Act 2001*; or by two directors of the licensee; or by a director and a company secretary of the licensee, or if the licensee is a proprietary company that has a sole director who is also the sole company secretary – by that director, or by the principal executive officer of the licensee; or by a person with authority to sign on the licensee's behalf who is approved in writing by the Chief Executive Officer of the Department of Environment Regulation.
A public authority (other than a local government)	☐ ☐	by the principal executive officer of the licensee; or by a person with authority to sign on the licensee's behalf who is approved in writing by the Chief Executive Officer of the Department of Environment Regulation.
a local government	☐ ☐	by the chief executive officer of the licensee; or by affixing the seal of the local government.

It is an offence under section 112 of the *Environmental Protection Act 1986* for a person to give information on this form that to their knowledge is false or misleading in a material particular. There is a maximum penalty of $50,000 for an individual or body corporate.

I/We declare that the information in this annual audit compliance report is correct and not false or misleading in a material particular.

SIGNATURE: _____

NAME:
(printed) _____

POSITION: _____

DATE: _____/_____/_____

SIGNATURE: _____

NAME:
(printed) _____

POSITION: _____

DATE: _____/_____/_____

SEAL (if signing under seal)

Decision Document

Environmental Protection Act 1986, Part V

Proponent: Holcim (Australia) Pty Ltd

Licence: L6821/1967/12

Registered office:	Level 8, Tower B 799 Pacific Hwy Chatswood NSW 2067
ACN:	099 732 297
Premises address:	Gosnells Hardrock Quarry 89 Cockram Road MARTIN WA 6110 Being Lot 3 on Plan 14769 and Lot 5003 on Plan 28867 as depicted in Schedule 1.
Issue date:	Thursday, 8 September 2011
Commencement date:	Saturday, 1 October 2011
Expiry date:	Thursday, 30 September 2027

Decision

Based on the assessment detailed in this document the Department of Environment Regulation (DER) has decided to issue an amended licence. DER considers that in reaching this decision, it has taken into account all relevant considerations and legal requirements and that the Licence and its conditions will ensure that an appropriate level of environmental protection is provided.

Decision Document prepared by: Jamie Piotrowski
Licensing Officer

Decision Document authorised by: Tim Gentle
Manager Licensing

Contents

Decision Document 1
Contents 2
1 Purpose of this Document 2
2 Administrative summary 2
3 Executive summary of proposal and assessment 3
4 Decision table 4
5 Advertisement and consultation table 9
6. Risk Assessment 10

1 Purpose of this Document

This decision document explains how DER has assessed and determined the application and provides a record of DER's decision-making process and how relevant factors have been taken into account. Stakeholders should note that this document is limited to DER's assessment and decision making under Part V of the *Environmental Protection Act 1986*. Other approvals may be required for the proposal, and it is the proponent's responsibility to ensure they have all relevant approvals for their Premises.

2 Administrative summary

Administrative details		
Application type	Works Approval ☐ New Licence ☐ Licence amendment ☒ Works Approval amendment ☐	
Activities that cause the premises to become prescribed premises	**Category number(s)**	**Assessed design capacity**
	12: Screening etc. of material	5 million tonnes per annual period
	13: Crushing of building material	250 000 tonnes per annual period
	62: Solid waste depot	250 000 tonnes per annual period
Application verified	Date: N/A	
Application fee paid	Date: N/A	
Works Approval has been complied with	Yes☐ No☐ N/A☒	
Compliance Certificate received	Yes☐ No☐ N/A☒	
Commercial-in-confidence claim	Yes☐ No☒	
Commercial-in-confidence claim outcome		
Is the proposal a Major Resource Project?	Yes☐ No☒	
Was the proposal referred to the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986*?	Yes☐ No☒	Referral decision No: Managed under Part V ☐

		Assessed under Part IV ☐
Is the proposal subject to Ministerial Conditions?	Yes☐ No☒	Ministerial statement No: EPA Report No:
Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the *Environmental Protection Act 1986*)?	Yes☐ No☒ Department of Water consulted Yes ☐ No ☐	
Is the Premises within an Environmental Protection Policy (EPP) Area Yes☐ No☒ If Yes include details of which EPP(s) here.		
Are the Premises subject to any EPP requirements? Yes☐ No☒ If Yes, include details here, eg Site is subject to SO_2 requirements of Kwinana EPP.		

3 Executive summary of proposal and assessment

The Gosnells quarry is located on the edge of the Darling Scarp, approximately 20km south-east of Perth, Western Australia. The quarry produces aggregate and sand for use in pre-mix and pre-cast concrete manufacturing and is a strategic resource for the Perth Metropolitan and Greater Regional Area. The Gosnells quarry has been in operation since the 1930's and has been operated by Holcim since 1961.

The Gosnells quarry currently comprises the following existing key components and supporting infrastructure:

- An extraction area;
- Mobile screens;
- Stockpiling areas for aggregates, topsoil and overburden;
- Water storage dam;
- Wash down areas;
- Internal access and haul roads;
- Workshop and testing laboratory;
- Manned weighbridge;
- Diesel storage area;
- Administration block and amenities;
- Order and distribution office; and
- Laydown and salvage yard.

Approximately 1 million tonnes of hard rock is extracted annually from the pit and approximately 120 000 tonnes of aggregate is processed annually onsite. Activities are mainly limited to 0700 to 1800 Monday to Friday and 0700 to 1400 Saturday, although the operations can be undertaken 24 hours a day if needed.

This proposal is to allow Holcim to undertake crushing and screening of concrete and asphalt waste under category 13, as well as introducing a mobile air separator unit which contains a built in baghouse to capture a nominated 99.99% of dust emissions.

The proposal will also allow Holcim to store and sort waste material (crushed concrete and asphalt waste), pending final disposal or reuse, under category 62. Holcim's application makes clear that only "fresh" waste concrete from Holcim's own concrete batching plants, and asphalt from the site-based asphalt plant, will be accepted. The materials which will be crushed, screened, stored and sorted will therefore not contain any asbestos.

4 Decision table

All applications are assessed in line with the *Environmental Protection Act 1986*, the *Environmental Protection Regulations 1987* and DER's Operational Procedure on Assessing Emissions and Discharges from Prescribed Premises. Where other references have been used in making the decision they are detailed in the decision document.

DECISION TABLE			
Licence section	**Condition number L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Premises operations	L1.2.1 Table 1.2.1	Emission Description *Emissions:* Stormwater contaminated from crushing and screening and associated activities leaving the premises during extreme rainfall events. *Impact:* Contamination of surrounding land and surface water drainage systems. Potential impacts on water quality of Lumen Christi dam within 50m of the site and ecology of the Canning River catchment from the addition of sediments, oil and grease and heavy metals. *Controls:* The licensee has submitted the document *Gosnells Quarry – Surface Water Management Plan* as required under previous licence condition 4.1.1. Stormwater runoff from the Gosnells Quarry site is managed via a number of drains and bunds that capture potentially contaminated water in the Stockpile Dam at the western edge of the operational area, flowing into the Overflow Dam and then ultimately discharging off-site in high rainfall events. Water levels in the Overflow and Stockpile dams are managed by pumping the water from the Stockpile Dam to the upper quarry pit lake. This management action allows for the licensee to capture the "critical duration" (first flush) runoff volume of a 1 in 100-year ARI event. Risk Assessment *Consequence:* Moderate *Likelihood:* Possible *Risk Rating:* Moderate Regulatory Controls L1.2.1 and Table 1.2.1 - DER has previously required Holcim to develop a stormwater	General provisions of the *Environmental Protection Act 1986*. *Environmental Protection (Unauthorised Discharges) Regulations 2004*. Gosnells Quarry Environmental Management Plan – Water Management Plan

DECISION TABLE

Licence section	Condition number L= Licence	Justification (including risk description & decision methodology where relevant)	Reference documents
		management plan under licence condition 4.1.1 - Improvements. This document has been submitted to DER. Holcim will undertake stormwater management through their *Gosnells Quarry Environmental Management Plan – Water Management Plan* to ensure the risk of water contamination is minimised. Residual Risk *Consequence*: Moderate *Likelihood*: Unlikely *Risk Rating*: Moderate	
	L1.2.2 Table 1.2.2	L1.2.2 and Table 1.2.2 have been added to the licence to limit the amount of concrete and asphalt waste accepted onsite to a combined total of 250,000 tonnes per annual period.	
Emissions general	N/A	There are no emissions general from the premises that require regulation through this section	N/A
Point source emissions to air including monitoring	N/A	The proposed Air Separator is fitted with a baghouse to capture dust emissions from an enclosed unit. The baghouse is a CP-2340 model with a self-cleaning function and is designed to filter a minimum 99.99% of dust generated by the unit. The projected emissions from the baghouse are minor and adequately regulated under general provisions of the Act. There are no point source emissions to air from the premises that require regulation through this section.	General provisions of the *Environmental Protection Act 1986*. *Environmental Protection (Unauthorised Discharges) Regulations 2004*.
Point source emissions to surface water including monitoring	N/A	There are no point source emissions to surface water from the premises.	N/A

DECISION TABLE			
Licence section	**Condition number L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Point source emissions to groundwater including monitoring	N/A	There are no point source emissions to groundwater from the premises.	N/A
Emissions to land including monitoring	N/A	There are no point source emissions to land from the premises.	N/A
Fugitive emissions	L2.1.1 Table 2.1.1 L3.2.1 Table 3.2.1	**Normal & abnormal operation** Emission Description *Emission:* Fugitive dust at unknown concentration, generated during crushing and screening operations. The addition of Category 13 to the licence will possibly increase the risk of dust emissions if poorly managed. *Impact:* Dust emissions can be harmful to human health and the environment. Elevated TSP levels can impact ambient environmental quality resulting in amenity impacts and can smother vegetation. PM_{10} or $PM_{2.5}$ can be drawn deep into the lungs causing human health impacts. The chemical and physical properties of the particles, the size of the particles and the duration of exposure are all factors which may affect human health impacts. The closest receptor to the quarry is located 450 meters to the north of the premises boundary. *Controls:* Visual inspection of site and access roads for dust generation that is moving off site. Water cart application over dust prone areas to reduce dust lift-off. Crushing and stockpiling activities located in topographic low points with stockpiles arranged such that wind breaks are created to further shield sensitive receptors. Risk Assessment *Consequence:* Moderate *Likelihood:* Possible *Risk Rating:* Moderate Regulatory Controls The risk of fugitive dust emissions from crushing and screening operations causing	General provisions of the *Environmental Protection Act 1986.* *Gosnells Quarry Environmental Management Plan – Dust Management Plan*

DECISION TABLE

Licence section	Condition number L= Licence	Justification (including risk description & decision methodology where relevant)	Reference documents
		amenity impacts and smothering vegetation is deemed to be moderate having regard to the distance to receptors. Currently, Holcim's Dust Management Plan includes constant monitoring of PM_{10} at the western boundary of the site with an EBAM dust monitor. The weather station and the E-BAM send live data to the Win Collect software system, which sends alarms and SMS messages to nominated quarry personnel when a contingency trigger is reached (100µg/m^3) to prevent an exceedance of the 24-hour average PM_{10} NEPM (50µg/m^3) at the quarry boundary. Condition 2.1.1 and Table 2.1.1 have been added to the licence to require Holcim to manage dust as documented in *Gosnells Quarry Environmental Management Plan – Dust Management Plan*. This is based on the risk to receptors and will mean dust mitigation policies will be implemented to reduce the risk of dust impacts. Monitoring of fugitive dust is addressed in the Ambient Environmental Quality Monitoring section. <u>Residual Risk Assessment</u> *Consequence*: Minor *Likelihood:* Possible *Risk Rating:* Moderate	
Odour	N/A	Odour has not been reassessed as part of this amendment. As the previous licence did not impose controls on odour, no specified conditions have been included in this section.	General provisions of the *Environmental Protection Act 1986.*
Noise	N/A	Noise modelling of the proposed activities combined with current activities and background noise shows that for the worst case scenario, noise levels at the nearest receptor will be received below the limit set in the *Environmental Protection (Noise) Regulations 1997*. To ensure compliance with the *Environmental Protection (Noise) Regulations 1997*, the licensee has developed and implemented a Noise Management Plan. No additional licence conditions are deemed necessary to manage noise at the site.	*Environmental Protection (Noise) Regulations 1997* Gosnells Quarry Environmental Management Plan – Noise Management Plan

DECISION TABLE			
Licence section	**Condition number L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Monitoring general	L3.1.1 – 3.1.3	No additional general monitoring conditions are required on the licence other than the standard NATA accreditation, monitoring timeframes and calibration requirements.	N/A
Monitoring of inputs and outputs	N/A	Monitoring requirements have not been reassessed as part of this amendment. As the previous licence did not require monitoring of inputs and outputs no specified conditions have been included in this section.	N/A
Process monitoring	N/A	Monitoring requirements have not been reassessed as part of this amendment. As the previous licence did not require process monitoring no specified conditions have been included in this section.	N/A
Ambient quality monitoring	L3.2.1 Table 3.2.1	Monitoring of ambient air quality (dust levels) is required to provide assurance over the effectiveness of site dust management and demonstrate performance against the limit set at the boundary. Continuous monitoring using EBAM dust monitor will provide data to validate assessment predictions. The EBAM monitor is linked to an audible alarm that notifies the Quarry Manager when the PM_{10} levels exceed 100 $\mu g/m^3$. Once the alarm sounds, a number of contingency actions will be undertaken to control dust.	General provisions of the *Environmental Protection Act 1986.* Gosnells Quarry Environmental Management Plan – Dust Management Plan
Meteorological monitoring	N/A	Monitoring requirements have not been reassessed as part of this amendment. As the previous licence did not require meteorological monitoring no specified conditions have been included in this section.	N/A
Improvements	N/A	Improvement conditions are not required for this licence amendment. Condition 4.1.1 required the licensee to submit a Stormwater Management Plan to the CEO. This plan has been received by DER and is implemented in condition 1.3.1; therefore this condition has been removed.	N/A
Information	L4.1.1 – 4.1.3	L4.1.1 – 4.1.3 have been added to the licence requiring the licensee to submit an Annual Report and AACR to DER and compile a complaints management system to record and investigate complaints made about the operations.	N/A
Licence Duration	N/A	The Licence expiry date has been amended to align with the Extractive Industry Licence granted by the City of Gosnells. The licence will expire on 30 September 2027.	N/A

5 Advertisement and consultation table

Date	Event	Comments received/Notes	How comments were taken into consideration
11/12/2015	Proponent sent a copy of draft instrument	Reply received via email on 17 December 2015 requesting minor administrative word changes in the Decision Document.	Requested changed were made to Decision Document.

6. Risk Assessment

Note: This matrix is taken from the DER Corporate Policy Statement No. 07 - Operational Risk Management

Table 1: Emissions Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Moderate	High	High	Extreme	Extreme
Likely	Moderate	Moderate	High	High	Extreme
Possible	Low	Moderate	Moderate	High	Extreme
Unlikely	Low	Moderate	Moderate	Moderate	High
Rare	Low	Low	Moderate	Moderate	High

Appendix E Clearing Permit CPS 5543/2

Government of **Western Australia**
Department of **Environment Regulation**

Your ref:
Our ref: CPS 5543/2
Enquiries: Victoria Inman
Phone: 6467 5035
Fax: 6467 5039
Email: nvp@der.wa.gov.au

Ms Lisa Honan
Senior Planning and Approvals Coordinator
Holcim (Australia) Pty Ltd
18 Brodie Hall Drive
BENTLEY WA 6102

Dear Ms Honan

AMENDED PERMIT TO CLEAR NATIVE VEGETATION UNDER THE *ENVIRONMENTAL PROTECTION ACT 1986*

I refer to Holcim (Australia) Pty Ltd's request to amend Clearing Permit CPS 5543/1 to update the revegetation condition and extend the duration of the permit.

Thank you for your advice of 9 July 2013 that you waive the 28 day notification period.

Please find enclosed amended Clearing Permit CPS 5543/2 to clear native vegetation granted under s.51E of the *Environmental Protection Act 1986*. This permit replaces Clearing Permit 5543/1 and gives Holcim (Australia) Pty Ltd approval to clear, subject to certain terms, conditions or restrictions.

A copy of the amended permit is now available for the public to view, as required by the regulations.

As previously advised, please read the permit carefully. If you wish to discuss the permit, contact the Department of Environment Regulation immediately. There are penalties for failing to comply with the requirements of your permit.

Compliance with the terms, conditions or restrictions of this permit does not absolve the Permit Holder from responsibility for compliance with the requirements of all Commonwealth, State and Local Government legislation.

If you have any queries regarding this matter, please contact Victoria Inman at the Department's Native Vegetation Conservation Branch on 6467 5035.

Yours sincerely

RECEIVED - 1 AUG 2013

M Warnock
MANAGER
NATIVE VEGETATION CONSERVATION BRANCH

Officer delegated under Section 20
of the Environmental Protection Act 1986

25 July 2013

Attached: Clearing Permit (CPS 5543/2, Plan 5543/2) and Decision Report

GOVERNMENT OF
WESTERN AUSTRALIA

CLEARING PERMIT

Granted under section 51E of the Environmental Protection Act 1986

PERMIT DETAILS
Area Permit Number: 5543/2
File Number: DEC2096-2
Duration of Permit: From 31 May 2013 to 31 May 2033

PERMIT HOLDER
Holcim (Australia) Pty Ltd

LAND ON WHICH CLEARING IS TO BE DONE
Lot 3 on Plan 14769, Martin

AUTHORISED ACTIVITY
The Permit Holder shall not clear more than 0.987 hectares of native vegetation within the area shaded yellow on attached Plan 5543/2.

CONDITIONS

1. **Period in which clearing is authorised**
   The Permit Holder shall not clear any native vegetation after 31 May 2028.

2. **Dieback and weed control**
   When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of *weeds* and *dieback*:
   (a) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;
   (b) shall only move soils in *dry conditions*;
   (c) ensure that no *dieback* or *weed*-affected soil, *mulch*, *fill* or other material is brought into the area to be cleared; and
   (d) restrict the movement of machines and other vehicles to the limits of the areas to be cleared.

3. **Retain vegetative material and topsoil, revegetation and rehabilitation**
   The Permit Holder shall:
   (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared;
   (b) within 12 months following completion of extractive activities, revegetate and rehabilitate the area shaded yellow, with the exception of the pit void, on attached Plan 5543/2 by:
      (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and
      (ii) laying the vegetative material and topsoil retained under condition 3(a) on the cleared area.
   (c) within 24 months of laying the vegetative material and topsoil on the cleared area in accordance with condition 3(b) of this Permit:
      (i) engage an *environmental specialist* to determine the species composition, structure and density of the area *revegetated* and *rehabilitated*; and

(ii) where, in the opinion of an *environmental specialist*, the composition structure and density determined under condition 3(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, *revegetate* the area by deliberately *planting* and/or *direct seeding* native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only *local provenance* seeds and propagating material are used.

(d) Where additional *planting* or *direct seeding* of native vegetation is undertaken in accordance with condition 3(c)(ii) of this permit, the Permit Holder shall repeat condition 3(c)(i) and 3(c)(ii) within 24 months of undertaking the additional *planting* or *direct seeding* of native vegetation.

(e) Where a determination by an *environmental specialist* that the composition, structure and density within areas *revegetated* and *rehabilitated* will result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, as determined in condition 3(c)(i) and (ii) of this permit, that determination shall be submitted for the CEO's consideration. If the CEO does not agree with the determination made under condition 3(c)(ii), the CEO may require the Permit Holder to undertake additional *planting* and *direct seeding* in accordance with the requirements under condition 3(c)(ii).

4. Records to be kept

The Permit Holder must maintain the following records for activities done pursuant to this Permit:

(a) In relation to the clearing of native vegetation authorised under this Permit:
   (i) the species composition, structure and density of the cleared area;
   (ii) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings;
   (iii) the date that the area was cleared; and
   (iv) the size of the area cleared (in hectares).

(b) In relation to the *revegetation* and *rehabilitation* of areas pursuant to condition 3 of this Permit:
   (i) the location of any areas *revegetated* and *rehabilitated*, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;
   (ii) a description of the *revegetation* and *rehabilitation* activities undertaken;
   (iii) the size of the area *revegetated* and *rehabilitated* (in hectares);
   (iv) the species composition, structure and density of *revegetation* and *rehabilitation*, and
   (v) a copy of the environmental specialist's report.

5. Reporting

(a) The Permit Holder must provide to the CEO on or before 30 June of each year, a written report:
   (i) of records required under condition 4 of this Permit; and
   (ii) concerning activities done by the Permit Holder under this Permit between 1 January to 31 December of the preceding calendar year.

(b) If no clearing authorised under this Permit was undertaken between 1 January to 31 December of the preceding calendar year, a written report confirming that no clearing under this permit has been carried out, must be provided to the CEO on or before 30 June of each year.

(c) Prior to 28 February 2033, the Permit Holder must provide to the CEO a written report of records required under condition 4 of this Permit where these records have not already been provided under condition 5(a) of this Permit.

DEFINITIONS

The following meanings are given to terms used in this Permit:

dieback means the effect of *Phytophthora* species on native vegetation;

direct seeding means a method of re-establishing vegetation through the establishment of a seed bed and the introduction of seeds of the desired plant species;

dry conditions means when soils (not dust) do not freely adhere to rubber tyres, tracks, vehicle chassis or wheel arches;

environmental specialist means a person who is engaged by the Permit Holder for the purpose of providing environmental advice, who holds a tertiary qualification in environmental science or equivalent, and has experience relevant to the type of environmental advice that an environmental specialist is required to provide under this Permit;

fill means material used to increase the ground level, or fill a hollow;

local provenance means native vegetation seeds and propagating material from natural sources within 20 kilometres of the area cleared.

mulch means the use of organic matter, wood chips or rocks to slow the movement of water across the soil surface and to reduce evaporation;

planting means the re-establishment of vegetation by creating favourable soil conditions and planting seedlings of the desired species;

regenerate/ed/ion means re-establishment of vegetation from in situ seed banks and propagating material (such as lignotubers, bulbs, rhizomes) contained either within the topsoil or seed-bearing *mulch*;

rehabilitate/ed/ion means actively managing an area containing native vegetation in order to improve the ecological function of that area;

revegetate/ed/ion means the re-establishment of a cover of *local provenance* native vegetation in an area using methods such as natural *regeneration*, *direct seeding* and/or *planting*, so that the species composition, structure and density is similar to pre-clearing vegetation types in that area.

weed/s means any plant -

(a) that is a declared pest under section 22 of the *Biosecurity and Agriculture Management Act 2007*; or

(b) published in the Department of Environment and Conservation Regional Weed Assessments, regardless of ranking; or

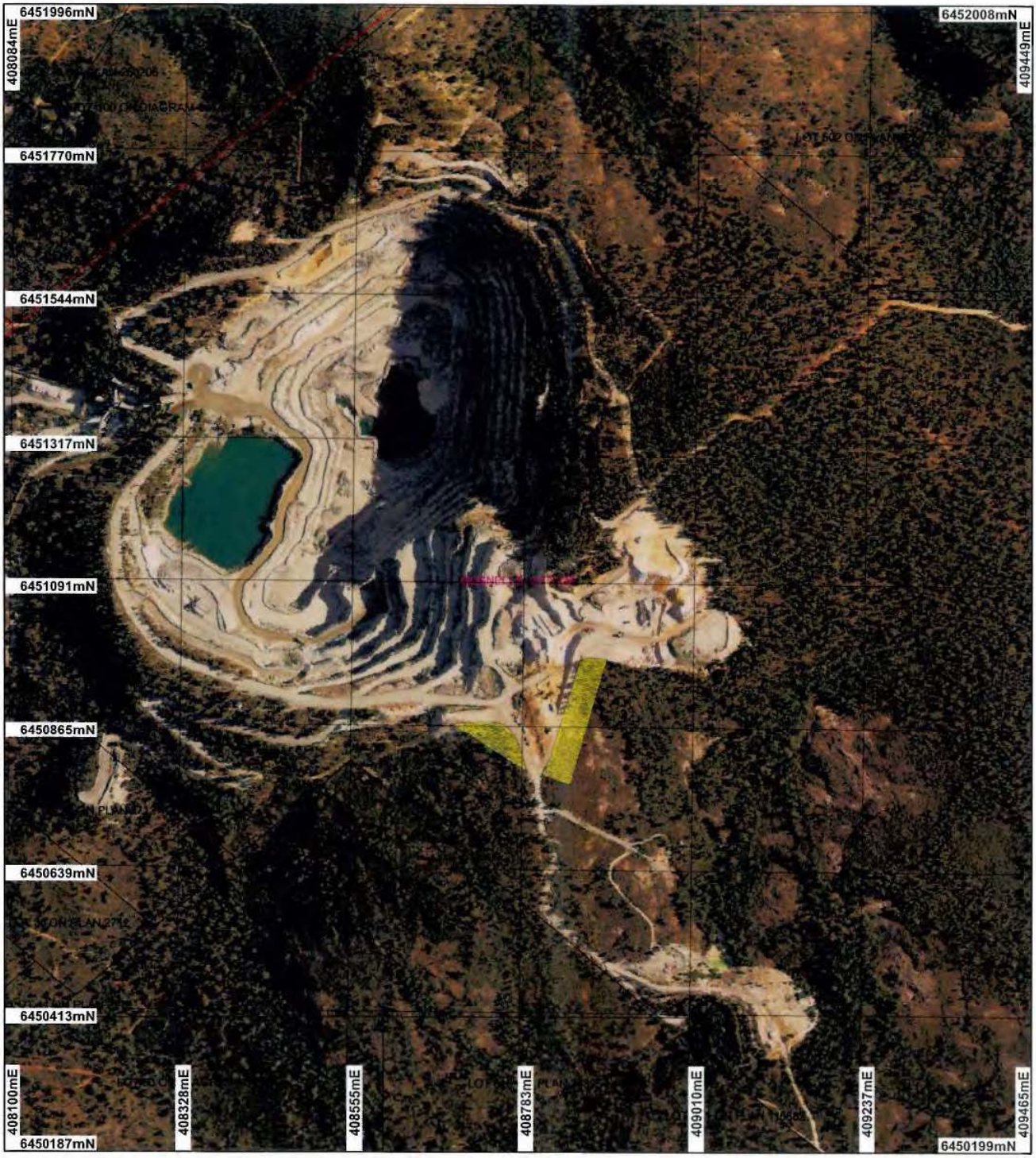
(c) not indigenous to the area concerned.

M Warnock
MANAGER
NATIVE VEGETATION CONSERVATION BRANCH

Officer delegated under Section 20
of the Environmental Protection Act 1986

25 July 2013

Plan 5543/2



LEGEND

- Cadastre
- Local Government Authorities
- Road Centrelines
- Clearing Instruments
- Areas Approved to Clear

Perth Metropolitan Area
Central 15cm Orthomosaic - Landgate 2012

N

0 ~200 m

Scale 1:8000
(Approxmate when reproduced at A4)

Geocentric Datum Australia 1994

Note: the data in this map have not been projected. This may result in geometric distortion or measurement inaccuracies.

Date 25/7/13

M. Warnock

Officer with delegated authority under Section 20 of the Environmental Protection Act 1986

Information derived from this map should be confirmed with the data custodian acknowleged by the agency acronym in the legend

Government of Western Australia
Department of Environment Regulation

WA Crown Copyright 2002

* Project Data is denoted by asterisk. This data has not been quality assured. Please contact map author for details.

GOVERNMENT OF WESTERN AUSTRALIA

Clearing Permit Decision Report

Government of Western Australia
Department of Environment Regulation

1. Application details

1.1. Permit application details

Permit application No.: 5543/2
Permit type: Area Permit

1.2. Proponent details

Proponent's name: **Holcim (Australia) Pty Ltd**

1.3. Property details

Property: LOT 3 ON PLAN 14769 (House No. 89 COCKRAM MARTIN 6110)
Local Government Area: City of Gosnells

1.4. Application

Clearing Area (ha)	No. Trees	Method of Clearing	For the purpose of:
0.987		Mechanical Removal	Extractive Industry

1.5. Decision on application

Decision on Permit Application: Grant
Decision Date: 25 July 2013

2. Site Information

2.1. Existing environment and information

2.1.1. Description of the native vegetation under application

Vegetation Description	Clearing Description	Vegetation Condition	Comment
Beard Vegetation Association: 4 - Medium woodland; marri and wandoo (Shepherd et al. 2001). Heddle Vegetation Complex: Darling Scarp Complex - Vegetation ranges from low open woodland to lichens according to depth of soils. Woodland components chiefly Eucalyptus wandoo (Wandoo) with Eucalyptus laeliae (Darling Range Ghost Gum) in the north, Corymbia haematoxylon (Mountain Marri) in the south, and Corymbia calophylla (Marri) throughout the region. Dominant vegetation types R. R. (Heddle et al. 1980). Mattiske Vegetation Complex: Darling Scarp - Mosaic of open forest of Eucalyptus marginata subsp. marginata-Corymbia calophylla, with some admixtures with Eucalyptus laeliae in the north (subhumid zone), with occasional Eucalyptus marginata subsp. elegantella (mainly in subhumid zone) and Corymbia haematoxylon in the south (humid zone) on deeper soils adjacent to outcrops, woodland of Eucalyptus wandoo (subhumid and semiarid zones), low woodland of Allocasuarina huegeliana on shallow soils over granite outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complex on or near granite outcrops in all climate zones (Mattiske and Havel 1998).	The application is to clear up to 0.987 hectares of native vegetation within Lot 3 on Plan 14769, Martin, for the purpose of extending the Gosnells Quarry. The application area is comprised of three vegetation types (Astron Environmental Service 2012): Eucalyptus marginata subsp. Thalassica and Corymbia calophylla Open Forest over Allocasuarina fraseriana Low Woodland over mixed species Open Low Heath dominated by Hibbertia hypericoides and Verticordia acerosa. Hakea erinacea and Verticordia acerosa Open Low Heath. Corymbia calophylla occasionally with Eucalyptus marginata subsp. Thalassica Woodland over Eucalyptus drummondii Low Open Woodland over Hakea trifurcata Tall Open Scrub over Hakea undulata Open heath over Hibbertia hypericoides Closed Low Heath.	Very Good: Vegetation structure altered; obvious signs of disturbance (Keighery 1994). To Excellent: Vegetation structure intact; disturbance affecting individual species, weeds non-aggressive (Keighery 1994)	Vegetation description and condition were determined through aerial imagery, site inspection (DEC 2013) and supporting documentation provided by the applicant (Astron Environmental Service 2012).

3. Assessment of application against clearing principles

Comments

The applicant has applied to extend the duration of the permit and amend the revegetation condition of CPS 5543/1. A review of current environmental information reveals no new additional information. Therefore the assessment against the clearing principles has not changed and can be found in the Clearing Permit Decision Report CPS 5543/1.

Methodology

Planning instrument, Native Title, Previous EPA decision or other matter.

Comments

The proponent has applied to extend the duration of the permit CPS 5543/1 and to amend the revegetation condition on the permit so that it is consistent with their Extractive Industry Licence (EIL) revegetation requirements.

The applicant has an EIL over Lot 3 on Plan 14769 (City of Gosnells 2007). The original EIL expired on 30 June 2012. A review of the EIL by the State Administration Tribunal required the original period be set aside and determined that the EIL be valid for 21 years, commencing on 1 July 2007 (SAT 2007).

The City of Gosnells has no objections to the application to clear native vegetation as the subject area is within the footprint for which approval for quarrying activities has been granted (City of Gosnells 2013).

No public submissions have been received in relation to this application.

Methodology

References:
City of Gosnells 2007
City of Gosnells 2013
SAT 2007

4. References

Astron Environmental Service (2012) Gosnells Quarry Field Flora, Vegetation and Fauna Survey. Astron Environmental Services, Western Australia. DEC REF: A622936.

City of Gosnells (2007) Extractive Industry Licence - Gosnells Quarry - Lot 3 on Plan 14769, Martin. City of Gosnells, Western Australia. DEC REF: A610788.

City of Gosnells (2013) Response to Direct Interest Letter for clearing permit application CPS 5543/1. Received 28/03/2012. DEC REF: A614744.

DEC (2013) Site Inspection Report for Clearing Permit Application CPS 5543/1, Lot 3 on Plan 14769, Martin. Site inspection undertaken 22/04/2013. Department of Environment and Conservation, Western Australia (DEC REF: A624904 and A624888).

Heddle, E. M., Loneragan, O. W., and Havel, J. J. (1980) Vegetation Complexes of the Darling System, Western Australia. In Department of Conservation and Environment, Atlas of Natural Resources, Darling System, Western Australia.

Keighery, B.J. (1994) Bushland Plant Survey: A Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc). Nedlands, Western Australia.

Mattiske, E.M. and Havel, J.J. (1998) Vegetation Complexes of the South-west Forest Region of Western Australia. Maps and report prepared as part of the Regional Forest Agreement, Western Australia for the Department of Conservation and Land Management and Environment Australia.

SAT (2007) Order regarding the Gosnells Quarry EIL. Matter between Rinker Australia Pty Ltd and City of Gosnells. State Administrative Tribunal, Western Australia. DEC REF: A610788.

Shepherd, D.P., Beeston, G.R., and Hopkins, A.J.M. (2001), Native Vegetation in Western Australia. Technical Report 249. Department of Agriculture Western Australia, South Perth.

5. Glossary

Term	Meaning
BCS	Biodiversity Coordination Section of DEC
CALM	Department of Conservation and Land Management (now BCS)
DAFWA	Department of Agriculture and Food
DEC	Department of Environment and Conservation
DEP	Department of Environmental Protection (now DEC)
DoE	Department of Environment
DoIR	Department of Industry and Resources
DRF	Declared Rare Flora
EPP	Environmental Protection Policy
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
TEC	Threatened Ecological Community
WRC	Water and Rivers Commission (now DEC)

Appendix F EPA Correspondence 2005

Environmental Protection Authority

Westralia Square,
141 St Georges Terrace, Perth, Western Australia 6000.
Telephone: (08) 9222 7000. Facsimile: (08) 9222 7155.

Postal Address: PO Box K822,
Perth, Western Australia 6842.
Website: www.epa.wa.gov.au

Ms Sharron Sylvester
Quarry Planning and Development Manager - West
Readymix Holdings Pty Limited
PO Box 555
VICTORIA PARK WA 6979

Your Ref
Our Ref CRN 215446
Enquiries Graham Storey 9222 7075
Email
graham.storey@environment.wa.gov.au

Dear Ms Sylvester

ENVIRONMENTAL APPROVALS FOR READYMIX GOSNELLS QUARRY

Thank you for your letter dated 30 August 2005 requesting confirmation that Readymix Holdings Pty Limited (Readymix) has environmental approval for long-term operation of its Gosnells Quarry.

Readymix was granted environmental approval to extend operations at the Gosnells Quarry prior to commencement of the current *Environmental Protection Act 1986* (The Act). Readymix therefore does not have approval for the quarry operations under Part IV of the Act. The Environmental Protection Authority (EPA) assessed Readymix's Gosnells Quarry development in 1982 and reported its findings and recommendations to the Minister for the Environment in EPA Bulletin No. 120 *Proposed Readymix Quarry Development, Gosnells*. However, since the recommendations were made prior to 1986 they are not legally enforceable under Part IV of the Act.

The EPA assesses new proposals or changes to existing proposals if it considers that implementation of a proposal is likely to have a significant impact on the environment. Readymix is not required to refer its second 21-year stage of development to the EPA for assessment unless the plan is considered to be a significant departure from the proposal that was assessed by the EPA in 1982.

The EPA notes that the Gosnells Quarry is licensed under Part V of the Act and that Readymix was granted a Development Approval through the Metropolitan Regional Planning Authority and an Extractive Industry Licence from the City of Gosnells. Under Section 38(5) of the Act a decision making authority is required to refer the second 21-year development plan to the EPA for assessment if the development plan is not consistent with the original development strategy (EPA Bulletin No. 120) and if implementation of the plan is likely to have a significant impact on the environment.

Should you have any questions regarding this matter, please contact Graham Storey on 9222 7075.

Yours sincerely

K J Taylor
DIRECTOR
ENVIRONMENTAL IMPACT ASSESSMENT DIVISION

31 October 2005

cc Department of Environment – Regional Operations.
cc City of Gosnells.
cc Western Australian Planning Commission.

Appendix G EPA Correspondence 2007

Government of **Western Australia**
Office of the **Environmental Protection Authority**

Mr Joshua Marks
Holcim (Australia) Pty Ltd
18 Brodie Hall Drive
BENTLEY WA 6102

Our Ref: *IM04-2016-0002*
Enquiries: *Sandra Dowding, 6145 0971*
Email: *Sandra.dowding@epa.wa.gov.au*

Dear Mr Marks

FREEDOM OF INFORMATION (FOI) APPLICATION – RENEWAL OF EXTRACTIVE INDUSTRY LICENCE – READYMIX QUARRY LOT 3 COCKRAM ROAD WEST MARTIN

I refer to your request for access to documents under the *Freedom of Information Act 1992* (FOI Act) which was received by the Office of the Environmental Protection Authority (OEPA) on 19 January 2016.

Your request is confirmed as:

> *"Advice of EPA to Gosnells City Council regarding further development of the Gosnells (Martin) Quarry."*

For the reasons set out in the attached Notice of Decision, I have decided to grant edited access to one document.

Please find enclosed:

a) notice of decision dated 10 February 2016 (including internal review rights); and
b) document schedule.

If you are not satisfied with this decision, you have the right to apply for an internal review. Details of the internal review process are enclosed on the attached notice of decision for information.

Please do not hesitate to contact our A/FOI Coordinator Sandra Dowding if you have any queries regarding this matter.

Yours sincerely

Anthony Sutton
Director Assessment and Compliance

10 February 2016

Att. Notice of decision

NOTICE OF DECISION

under section 30 of the *Freedom of Information Act (WA) 1992*

APPLICANT	**Mr Joshua Marks – Holcim (Australia) Pty Ltd**
SCOPE OF REQUEST	*"Advice of EPA to Gosnells City Council regarding further development of the Gosnells (Martin) Quarry."*
DECISION MADE BY	**Anthony Suttor, Director Assessment and Compliance**
DECISION	1. grant edited access to one document.
REASONS FOR DECISION	**<u>Documents where edited access has been granted:</u>** ***The following document contains personal information which is exempt under clause 3 Schedule 1 of the FOI Act:*** Document 1.
RIGHTS OF REVIEW	If you are not satisfied with the decision relating to your access application, you have the right to apply for an internal review. You are required to lodge your application for internal review of that decision with the Office of the Environmental Protection Authority within 30 days of receiving this notice. The application must be: • in writing; • give particulars of the decision to be reviewed; and • give an address in Australia. There is no charge payable for lodging an application for internal review.

An application for an internal review should be addressed to:

Office of the Environmental Protection Authority
FOI Coordinator
Locked Bag 10
EAST PERTH WA 6892

If an application for internal review is received, please note that it will not be dealt with by the person who made the initial decision, or by any person who is subordinate to the original decision maker.

The outcome of an application for internal review may result in a confirmation, variation or reversal of the original decision under review. You will be advised of the outcome within 15 days.

If the 30 days available to you for lodging an application for internal review expires and an application has not been made, the decision becomes final.

Anthony Sutton
Director Assessment and Compliance

10 February 2016

OFFICE OF ENVIRONMENTAL PROTECTION AUTHORITY, WESTERN AUSTRALIA

DOCUMENT SCHEDULE

Freedom of Information Application

APPLICANT	Holcim (Australia) Pty Ltd
TITLE OF PROJECT	Renewal of Extractive Industry Licence - Readymix Quarry Lot 3 Cockram Road West Martin
FILE REFERENCE	IM04-2016-0002
FOI COORDINATOR	Sandra Dowding
DECISION MAKER	Anthony Sutton
DATE OF DECISION	10 February 2016

Doc. No:	Date:	Description:	Decision:	Reason/s for decision:
1	8/03/2007	Letter from Environmental Protection Authority to City of Gosnells	Edited Access	Information contained within this document is exempt under clause 3(1) Schedule 1 to the FOI Act, being personal information, for this reason edited access has been granted
2				
3				
4				
5				

Doc.

10

Environmental Protection Authority

The Atrium,
Level 8, 168 St Georges Terrace,
Perth, Western Australia 6000.
Telephone: (08) 6364 6500. Facsimile: (08) 6364 6522.

Postal Address: PO Box K822,
Perth, Western Australia 6842.
Website: www.epa.wa.gov.au

Manager City Planning
City of Gosnells
PO Box 662
GOSNELLS WA 6990

Attention: Andrew Lefort

Dear Sir

Development Application – Readymix Quarry – Lot 3 Cockram Road, West Martin.

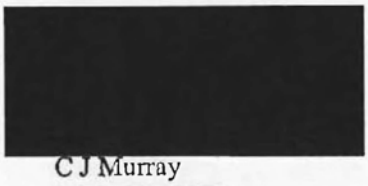
I refer to your letter of 30 January 2007 to the Environmental Protection Authority (EPA) seeking advice in relation to the status of the 1982 assessment of the long term development of the Readymix Quarry.

Environmental impact assessments undertaken by the EPA under the *Environmental Protection Act 1971* are valid assessments, albeit that the capacity to apply conditions was not put in place until the *Environmental Protection Act 1986*. Therefore, the assessment of the Readymix Quarry carried out by the EPA in 1982 still applies and the EPA would agree with the view put to the City by Rinker Australia.

The 1982 assessment was of a defined proposal, in this instance to a long term development plan for the quarry. Should the development of the quarry outlined in a new Extractive Industry Licence application clearly go outside the scope of the assessed defined proposal, there may be grounds for considering that that development has not been assessed by the EPA. Referral could only be for that part of the development beyond the assessed proposal and would still need to pass the test of 'significant effect on the environment' indicated in section 37(B)(1) of the *Environmental Protection Act 1986*.

I trust that this advice assists the City of Gosnells. Please contact Colin Murray (6467 5477) if your need any clarification.

Yours faithfully



C J Murray
A/DIRECTOR
ENVIRONMENTAL IMPACT ASSESSMENT

8 March 2007

Appendix H City of Gosnells Local Planning Policy 5.4

LPP 5.4

POLICY STATEMENT:	**GOSNELLS HARD ROCK QUARRY – LOT 3 COCKRAM ROAD, MARTIN**
REASON:	To clarify and formalise the role of and relationship between the City's planning approval (granted 10 January 1985) for extractive industry operations at Lot 3 Cockram Road, Martin and the current and any future Extractive Industry Licences relating to that land.

BACKGROUND

On 10 January 1985 the City of Gosnells granted planning approval (under the then Town Planning Scheme No. 1) for Extractive Industry at the property now known as Lot 3 Cockram Road, Martin. The planning approval was subject to five conditions, as listed below:

"1. Compliance with the provisions of City of Gosnells Town Planning Scheme No 1 and Town Planning Scheme No 6 when it is granted final approval.

2. Compliance with the terms and intent of the "Environmental Review and Management Programme 1982" as prepared by the Readymix Group and endorsed by Council.

3. Compliance with the terms and intent of the "Development and Environmental Programme for the Readymix Quarry at Gosnells 1984" as prepared by the Readymix Group and endorsed by Council.

4. Compliance with the City of Gosnells Extractive Industries By-Laws as amended and or reviewed from time to time.

5. All stock piles, access roads and general working areas to be water sprayed as required to control the dust to the satisfaction of Council."

On 23 January 1985 the (then) Metropolitan Region Planning Authority (MRPA) granted planning approval for Extractive Industry on Lot 3, subject to two conditions, which were almost identical to Conditions 2 and 3 of Council's planning approval.

Separate to these planning approvals for the quarry, the City's Extractive Industries Local Law requires quarrying activities to be the subject of an approved Extractive Industry Licence (EIL). Under the City's current Extractive Industries Local Law the maximum EIL term is 21 years. If the Local Law remains in place, then future quarrying activities on the site will need to be subject of a new EIL upon the expiration of each previous EIL.

In view of this requirement, and due to the ambiguous nature of the City's planning approval granted for the quarry in January 1985, it is necessary for Council to clearly express its position on the relationship between that planning approval and subsequent EILs granted for the quarry.

Further background to this Policy and quarrying activities on Lot 3 Cockram Road, Martin is contained in officer reports to Council on 8 May 2007 (Item 13.5.3) and 9 October 2007 (Item 13.5.4).

POLICY:

1. This Policy only applies to clarify and formalise the role of and relationship between the City's planning approval for the quarry and the current and any future Extractive Industry Licences (EILs) relating to quarrying activities at Lot 3 Cockram Road, Martin. It is not the role of this Policy, nor the City's responsibility, to provide guidance on the interpretation, application or enforcement of the MRPA's planning approval for the quarry – that is the responsibility of the (now) Department of Planning and Western Australian Planning Commission.

2. It is Council's position that the City's planning approval granted on 10 January 1985 for quarrying activities at Lot 3 Cockram Road, Martin, was intended to be non-prescriptive in nature, with specific details relating to the quarrying operations to be governed by subsequent Extractive Industry Licences issued by the City, and other applicable licences (whether issued by the City or not).

3. The position stated in Clause 2 above has been reached following detailed examination of:

   (a) the construction, purpose and intent of the document referred to in Condition 2 of the City's planning approval for the quarry (being the *"Environmental Review and Management Programme 1982"*, herein after referred to as the ERMP);

   (b) the construction, purpose and intent of the document referred to in Condition 3 of the City's planning approval for the quarry (being the *"Development and Environmental Programme for the Readymix Quarry at Gosnells 1984"*, herein after referred to as the DEP);

   (c) correspondence dated 10 January 1985 from the then City of Gosnells Town Clerk to the MRPA, relating to the City's planning approval for the quarry, stating (among other things):

   > *"The Development Approval is of course a long term approval and in respect to the quarry could well be operative for beyond two hundred years. Within that period circumstances and mining technology will no doubt change and any conditions imposed at this stage may not be relevant in the future. For this reason it is considered appropriate to keep the Metropolitan Region Planning Authority's conditions in a general nature and leave the shorter term specific conditions to run with the Extractive Industry License. The conditions on the licence can then be reviewed at a regular interval ie twenty-one (21) years."*

4. It is acknowledged that the ERMP was generally intended to provide a long-term framework to guide the steadily-evolving quarry project. The exception to this though is Figure 14 of the ERMP (titled "Final Development"), which is included as Attachment 1 to this Policy. For comparative purposes, the plan included as Attachment 2 provides an aerial photograph image of the quarry operator's landholding, the current quarry extent (approximate, as at the time of preparing this Policy) and the "Final Development" perimeter from Figure 14 of the ERMP.

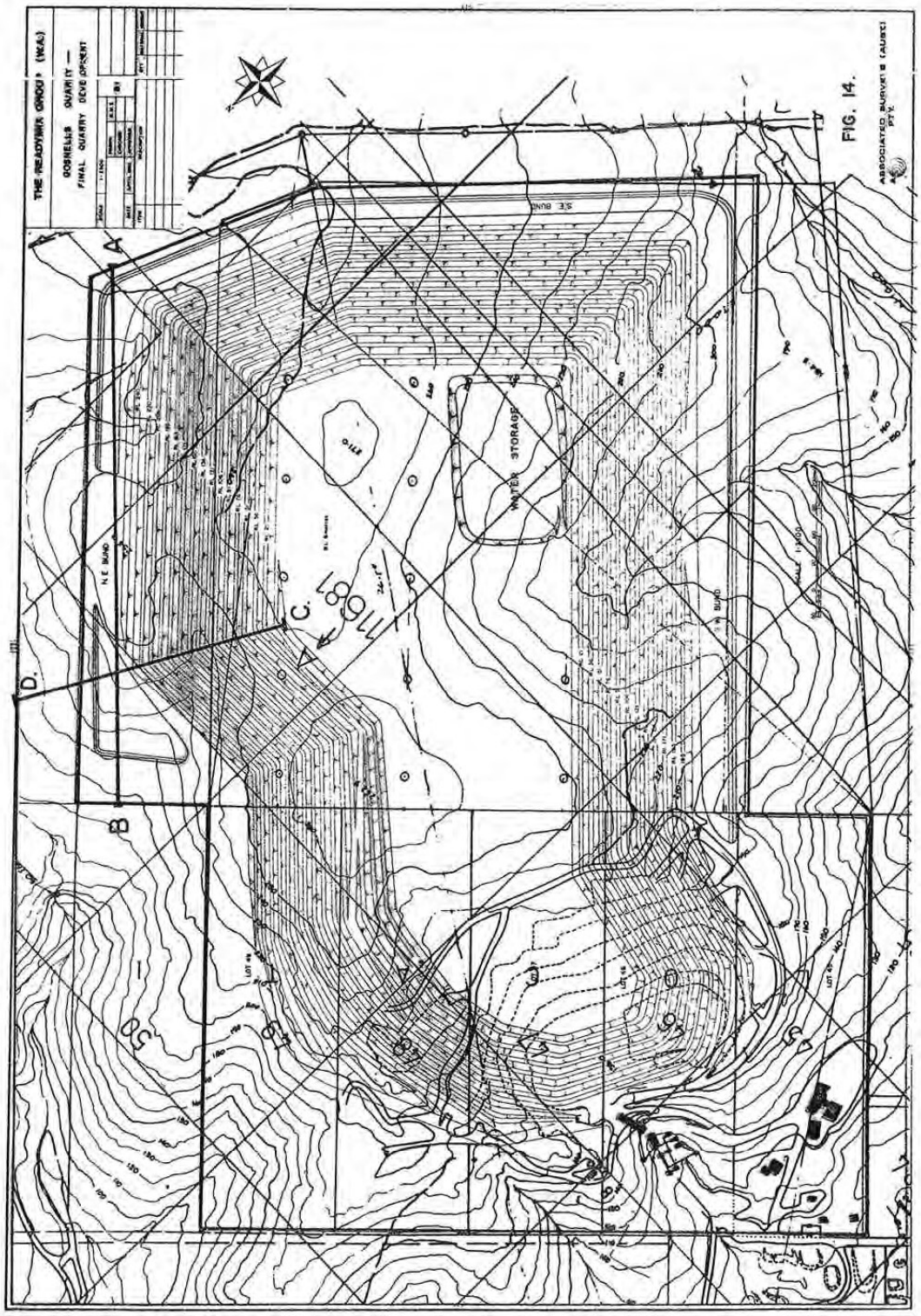
5. It is Council's position that the quarry perimeter delineated in Figure 14 of the ERMP (Attachment 1) represents the approved extraction limit ('footprint') for the quarry, while other elements of Figure 14, such as the sloping and batters are indicative only and not intended to reflect the ultimate sloping or batters of the quarry. This is partly due to the fact that sloping and batters can evolve over time with changes in quarrying technology, best practice, safety standards and extraction methods.

6. In relation to Condition 3 of the City's planning approval from 10 January 1985, it is acknowledged that the DEP was submitted as a supporting document to a 21 year EIL granted in 1984. As a result, the DEP had a life of 21 years, in accordance with the term of the EIL, which expired in 2005. It is therefore accepted that Condition 3 has been discharged and is no longer applicable to the continued quarrying operations.

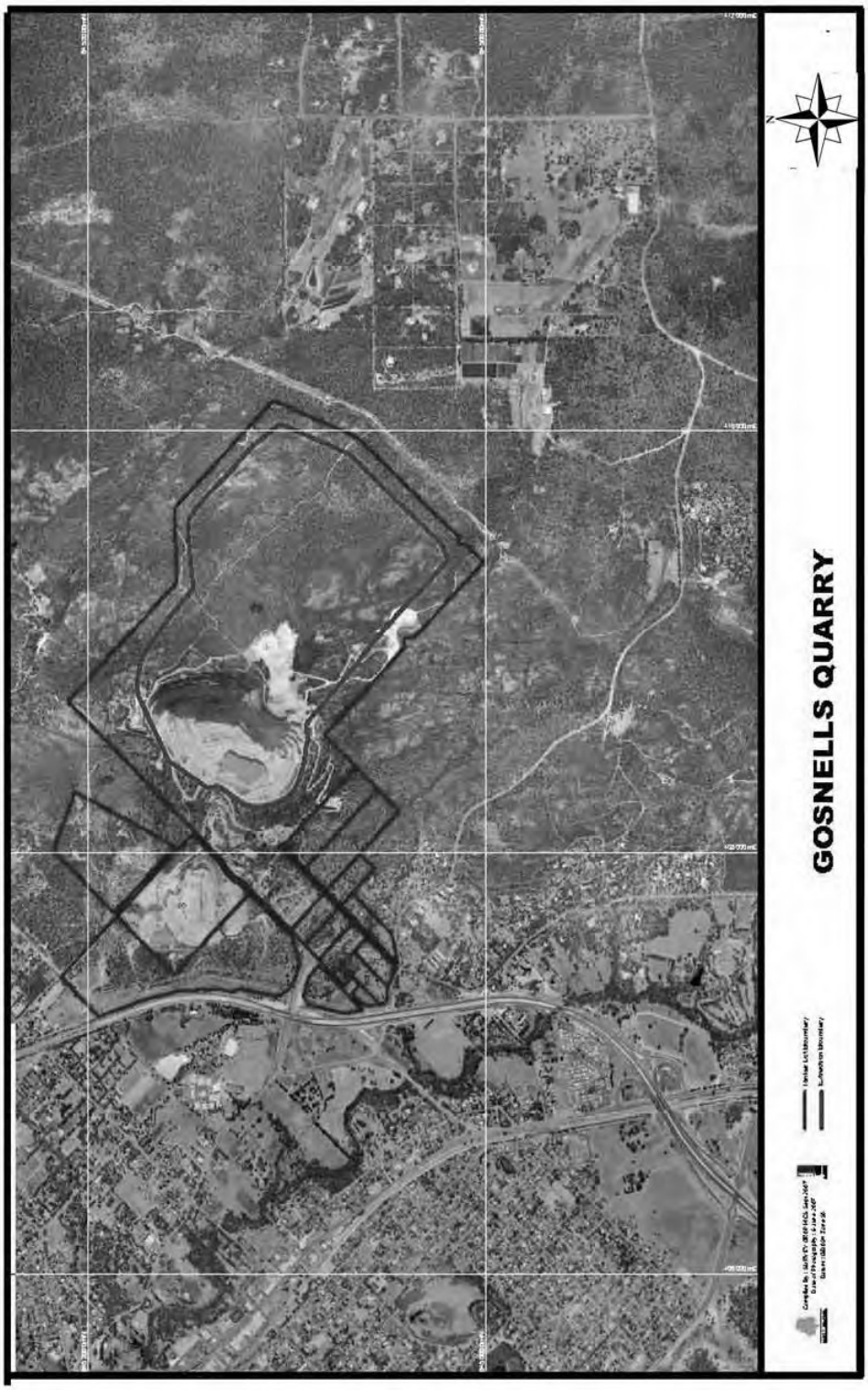
7. Conditions 4 and 5 of the City's planning approval from 10 January 1985 will continue to apply to quarrying operations at Lot 3 Cockram Road, Martin, as guided by the City's operative Extractive Industries Local Law and having regard to the existence and application of other licences or approvals relating to the quarry operations, whether administered by the City or not. In this regard, nothing in this Policy or the City's planning approval, or the current and any future EILs will affect the quarry operator's legal responsibility to comply with all other statutory requirements applicable to the quarry operations.

8. Specific details relating to quarrying operations at Lot 3 Cockram Road, Martin will, where desired by Council and required by City Local Laws, be governed by subsequent Extractive Industry Licences issued by the City.

ATTACHMENT 1



ATTACHMENT 2



GOVERNANCE REFERENCES

Statutory Compliance	Planning and Development Act 2005 City of Gosnells Town Planning Scheme No. 6 City of Gosnells planning approval dated 10 January 1985
Industry Compliance	Former Metropolitan region Planning Authority planning approval dated 23 January 1985
Organisational Compliance	City of Gosnells Extractive Industries Local Law (2000)
Process Links	Nil

LOCAL PLANNING POLICY ADMINISTRATION

Directorate	**Officer Title**	**Contact:**
Planning & Sustainability	Manager Planning Implementation	9397 3170

Risk Rating	Medium	**Review Cycle**	Triannually	Next Due:	2013

Version	**Decision To Advertise**	**Decision to Adopt**	**Synopsis**
1.	OCM 611/25/11/2008		Local public notice with a 21 day submission period
2.		OCM 380/24/08/2010	Clarifies relationship between Council's 1985 Planning approval and EILs granted for the above quarry
3.			

Appendix I AECOM Gosnells Quarry Flora and Vegetation Survey

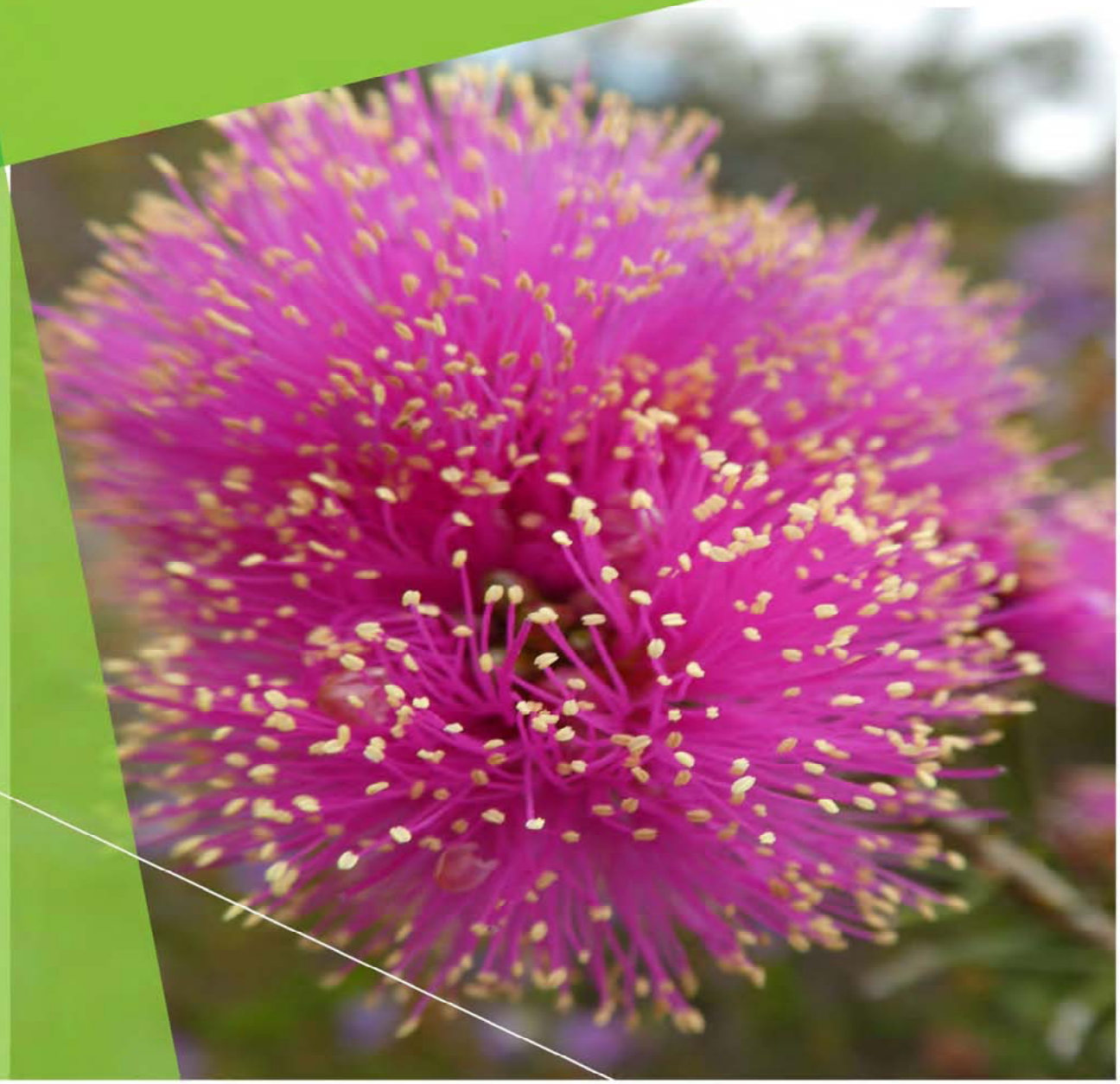
AECOM

Holcim (Australia) Pty Ltd
04-Aug-2017

Commercial-in-Confidence

Gosnells Quarry

Flora, Vegetation and Targeted Survey



Gosnells Quarry

Flora, Vegetation and Targeted Survey

Client: Holcim (Australia) Pty Ltd

ABN: 87 099 732 297

Prepared by

AECOM Australia Pty Ltd
3 Forrest Place, Perth WA 6000, GPO Box B59, Perth WA 6849, Australia
T +61 8 6208 0000 F +61 8 6208 0999 www.aecom.com
ABN 20 093 846 925

04-Aug-2017

Job No.: 60522332

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Quality Information

Document Gosnells Quarry

Ref 60522332

Date 04-Aug-2017

Prepared by Floora de Wit

Reviewed by Linda Kirchner

Revision History

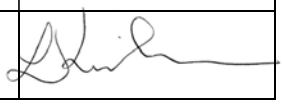
Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	07-Dec-2016	Draft for internal review	Linda Kirchner Associate Director - Environment	
B	09-Dec-2016	Draft for client review	Linda Kirchner Associate Director - Environment	
0	19-Dec-2016	Final for submission	Linda Kirchner Associate Director - Environment	
1	04-Aug-2017	Final with Amendments	Linda Kirchner Associate Director - Environment	

Table of Contents

Executive Summary i
1.0 Introduction 1
1.1 Project Background 1
1.2 Project Location 1
1.3 Objectives 1
2.0 Legal Framework 3
2.1 Overview 3
2.2 Commonwealth Legislation 3
2.2.1 Matters of National Environmental Significance 3
2.2.2 Flora 4
2.2.3 Communities 4
2.3 Western Australian Legislation 4
2.3.1 Flora 4
2.3.2 Communities 5
3.0 Methodology 6
3.1 Desktop Assessment 6
3.2 Field Survey 6
3.2.1 Bennett 2005 Survey 6
3.2.2 Astron 2012b Field Survey 7
3.2.3 2014 Level 1 Flora Survey 8
3.2.4 2015 Level 2 Flora Survey 9
3.2.5 2016 Level 2 Flora Survey 10
3.2.6 Threatened Orchids 10
3.2.7 Other Threatened and Priority flora 11
3.3 Reporting 14
3.3.1 Vegetation Community Mapping 14
3.3.2 Priority Flora 14
3.4 Limitations 15
4.0 Existing Environment 17
4.1 Climate 17
4.2 Soil and Geology 18
4.3 IBRA Regions 18
4.4 Vegetation 19
4.4.1 Pre-European Vegetation 19
4.4.2 Floristic Community Types 19
4.4.3 Vegetation Communities 20
5.0 Desktop Assessment 22
5.1 Threatened and Priority Flora 22
5.2 Vegetation 26
6.0 Results and Discussion 27
6.1 Vegetation Communities 27
6.2 Vegetation Condition 36
6.3 Flora 38
6.3.1 Conservation Significant Species 38
6.3.2 Weed species 52
7.0 References 53

Appendix A
DPaW Consultation 2016

Appendix B
Desktop Assessment A

Appendix C
Flora Species List, Holcim 2016 B

Appendix D
Species by Communities Matrix

Appendix E
Plot Data

List of Plates

Plate 1	*Acacia oncinophylla* subsp. *patulifolia* minni ritchi Bark, Leaves, and Habit	42
Plate 2	*Asteridea gracilis*	45
Plate 3	***Beaufortia purpurea* Flower and Habit**	47
Plate 4	***Lasiopetalum glutinosum* subsp. *glutinosum* Flower and Habit**	50

List of Tables

Table 1	Relevant legislation, regulations and guidance	3
Table 2	Categories of species listed under Schedule 179 of the EPBC Act	4
Table 3	Categories of TECs that are listed under the EPBC Act	4
Table 4	Conservation codes for WA flora listed under the WA Act	4
Table 5	Conservation codes for WA flora as endorsed by the Minister for Environment	5
Table 6	Conservation codes for State-listed Threatened Ecological Communities	5
Table 7	Conservation codes for Priority Ecological Communities	5
Table 8	Bushland condition ratings (Keighery 1994)	9
Table 9	Factors considered to improve detectability of both *Thelymitra* species	11
Table 10	Bushland Condition Ratings (Keighery 1994)	14
Table 11	Limitations of the Assessment	15
Table 12	Pre-European vegetation complexes within the study area	19
Table 13	Consolidation of Vegetation Communities Previously Mapped within the Project Area by Bennett (2005) and Astron (2012b)	20
Table 14	Survey and Sample Effort and Intensity	22
Table 15	Conservation Significant Flora Species Known and Likely to Occur within the Study Area	23
Table 16	Threatened Ecological Communities within close proximity to the study area	26
Table 17	Vegetation communities described within the study area	28
Table 18	Vegetation Condition within the Study Area	36
Table 19	*Acacia oncinophylla* subsp. *patulifolia* Population Details	39
Table 20	*Acacia horridula* Significance Assessment	39
Table 21	*Acacia oncinophylla* subsp. *patulifolia* Population Details	41
Table 22	*Acacia oncinophylla* subsp. *patulifolia* Significance Assessment	41
Table 23	*Asteridea gracilis* Populations Recorded by AECOM (2016)	44
Table 24	*Asteridea gracilis* Significance using DPaW and WA Herbarium Data	44
Table 25	*Beaufortia purpurea* Populations Recorded by AECOM (2016)	47
Table 26	*Beaufortia purpurea* Significance using DPaW and WA Herbarium Data	47
Table 27	*Lasiopetalum glutinosum* subsp. *glutinosum* populations recorded by AECOM (2016)	49
Table 28	*Lasiopetalum glutinosum* subsp. *glutinosum* Significance using DPaW and WA Herbarium Data	49

List of Figures

Figure 1	Holcim Quarry Development Footprint	2
Figure 2	2016 Study Area	12
Figure 3	Surveys Undertaken To-Date	13
Figure 4	Rainfall statistics for Gosnells City meteorological recording station 9106 showing mean annual rainfall, monthly minimum and maximum temperatures, and rainfall and temperature recorded in the 12 months preceding the field survey. Note, November and December show 2015 data (BoM, 2016)	17
Figure 5	Desktop Flora Results	25
Figure 6	Cluster analysis of woodland communities	33
Figure 7	Cluster analysis of heath communities	34
Figure 8	Vegetation Communities	35
Figure 9	Vegetation Condition	37
Figure 10	*Acacia horridula*	40
Figure 11	*Acacia oncinophylla* subsp. *patulifolia*	43
Figure 12	*Asteridea gracilis*	46
Figure 13	*Beaufortia purpurea*	48
Figure 14	*Lasiopetalum glutinosum* subsp. *glutinosum*	51

Executive Summary

Holcim (Australia) Pty Ltd (Holcim) is planning to further develop the Gosnells Quarry (the Project) within their approved maximum development area in accordance with the site's Development Approval. The study area is located on the Darling Scarp, approximately 19 km south-east of Perth. AECOM Australia Pty Ltd (AECOM) was commissioned to undertake a flora and vegetation assessment and targeted Threatened orchid and Priority flora surveys to support the environmental assessment process.

Historically, six flora and vegetation assessments have been undertaken at the study area. This report attempts to amalgamate data obtained for the study area, including the vegetation mapping and Priority flora population extent and size. A level 2 flora and vegetation assessment was undertaken in October 2016 for areas previously not surveyed within the study area. The entire study area was traversed on foot and Priority flora boundaries and individual counts obtained for four Priority species previously recorded in the study area.

A total of nine vegetation communities were described and mapped within the study area. This included four heath communities, considered locally significant due to their unique and highly diverse floristic composition of shrubs and forbs. These communities also support the majority of Priority flora species. No Threatened Ecological Communities or Priority Ecological Communities were identified within the study area.

Five species of conservation significance were recorded within the study area. These were all Priority flora species. No species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the *Wildlife Conservation Act 1950* (WC Act) were recorded. The conservation significant flora species recorded comprised:

- *Acacia horridula* (Priority 3) – lacking recent count data this species may be locally significant. Known from multiple adjacent local government areas therefore not considered regionally significant.
- *Acacia oncinophylla* subsp. *patulifolia* (Priority 4) – locally common and not considered regionally significant
- *Asteridea gracilis* (Priority 3) – may be locally common but under-sampled, may be regionally significant as it represents western extent of range
- *Beaufortia purpurea* (Priority 3) – locally significant and potentially regionally significant due to population size and extent within study area
- *Lasiopetalum glutinosum* subsp. *glutinosum* (Priority 3) – locally and potentially regionally significant due to size and extent of populations within the study area.

Targeted surveys for the conservation significant orchid species *Thelymitra magnifica* (Priority 1) and *Thelymitra stellata* (Endangered under the WC Act and the EPBC Act) were conducted during ideal detection periods in 2014, 2015 and 2016. Neither species was recorded in the study area. All areas of potentially suitable habitat were surveyed within the study area.

There were no significant limitations associated with the surveys, with sufficient rainfall recorded in the three months preceding the field survey, and an additional 11 limitations considered and addressed. No additional flora and vegetation surveys are recommended.

1.0 Introduction

1.1 Project Background

Holcim (Australia) Pty Ltd (Holcim) owns and operates Gosnells Quarry (the Quarry), providing a major source of hard rock products for the construction industry in the Perth region since the 1930s. The Quarry operation includes material extraction, crushing and screening, stockpiling, and distribution of material.

Holcim operates within an approved limit of extraction under their Extractive Industry Licence, granted by the City of Gosnells in 2007. Their maximum extraction limit has been defined within a Development Approval, granted by City of Gosnells in 1985.

Multiple biological investigations have been undertaken within the approved development approval area to define floristic and vegetation values. This has included flora and vegetation assessments and targeted Threatened and Priority flora surveys.

Holcim is planning to further develop its current operations at the Quarry within the approved development approval footprint. Additional flora and vegetation surveys were required to define the vegetation communities and condition, and map and quantify the presence of Threatened and Priority flora.

1.2 Project Location

The Quarry is located at Lot 3 Cockram Road in Martin, WA, situated on the Darling Scarp, approximately 19 km south-east of Perth. The Holcim tenement boundary (Figure 1) represents the development perimeter (project area), including 54.26 ha cleared areas for the existing quarry and associated infrastructure, 137.79 ha native vegetation and 7.85 ha of planted/rehabilitated vegetation.

The study area refers to the area surveyed in 2016 and includes a buffer perimeter of additional vegetation mapping undertaken to supplement 2015 mapping, and Threatened and Priority flora mapping within the larger area previously surveyed in 2014, 2015 and 2016.

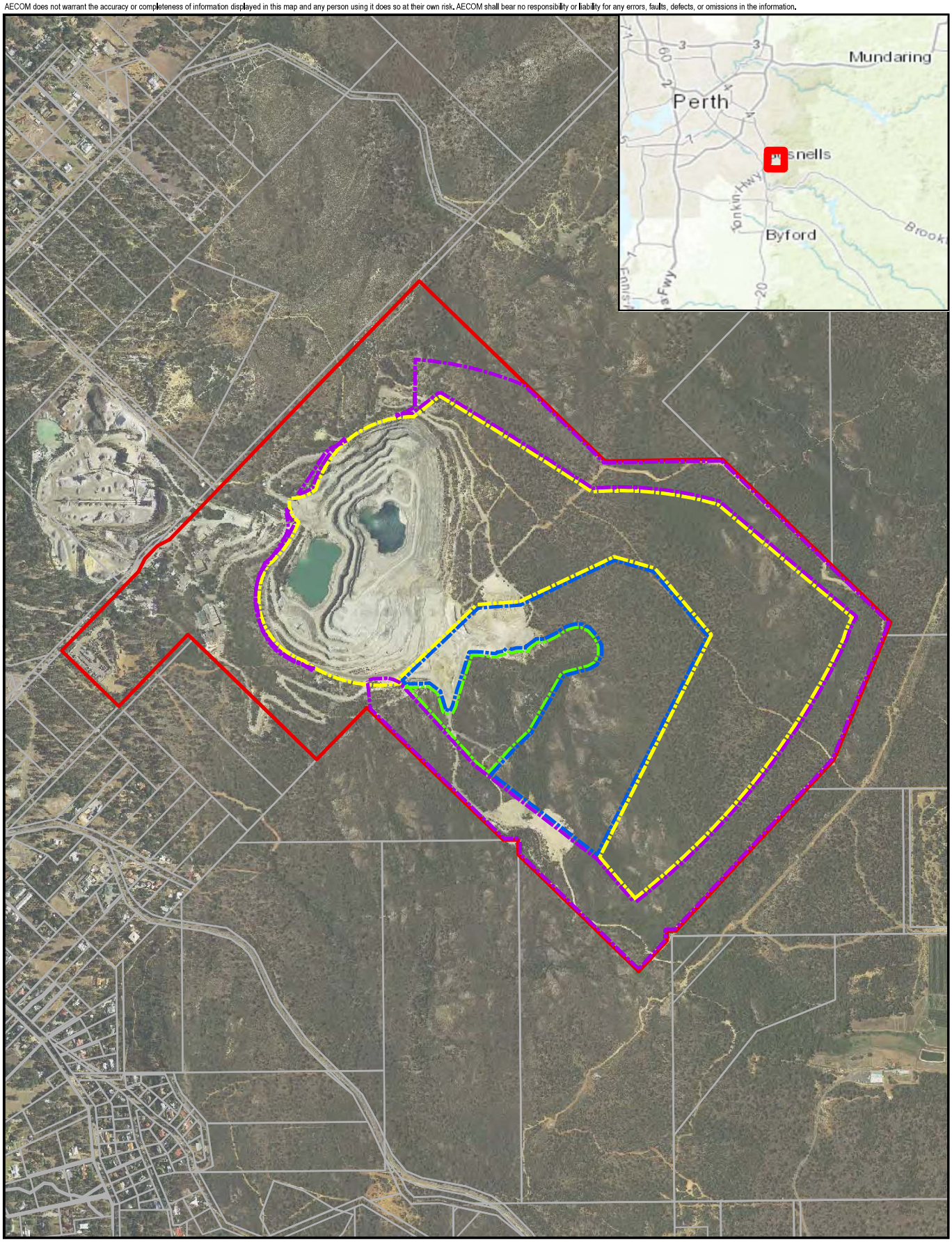
1.3 Objectives

The objective of this assessment was to collate the previous studies undertaken at the Quarry and undertake a flora and vegetation assessment for areas not previously assessed. Specifically, the scope included:

- A review and summary of existing information available including flora and vegetation assessments previously undertaken at the Quarry and Department of Parks and Wildlife (DPaW) and Protected Matters database results
- Undertake a flora and vegetation assessment compliant with current Environmental Protection Authority (EPA) and Department of Parks and Wildlife (DPaW) guidelines within areas not previously subject to these investigations, including:
    - vegetation community and condition mapping
    - Threatened and Priority targeted flora searches
- Complete targeted Threatened and Priority flora searches within the development approval area to ascertain the presence and locations of all significant flora species.

This report presents a collation of the results of all previous studies and the 2016 field survey results.

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID 60522332
CREATED BY DGF/RNM
APPROVED BY FDW
LAST MODIFIED 29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 110 220 330 440
metres

1:15,000 when printed at A4

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

Data sources: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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

Site Location

HOLCIM QUARRY

Figure
1

Map Document: P:\605X\60522332\4. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig1_DevFootprint_RNM_v03_20170829.mxd (rob.mcgregor)

A4 size

2.0 Legal Framework

2.1 Overview

Key legislation governing the protection and management of Western Australia's conservation significant flora and vegetation are summarised in Table 1 and further discussed below.

Table 1 Relevant legislation, regulations and guidance

Legislation	Purpose
Commonwealth of Australia	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity. Gosnells Quarry is exempt from the assessment and approval provisions of the EPBC Act in accordance with Section 43B of the EPBC Act.
Western Australia	
Wildlife Conservation Act 1950 (WC Act)	Provides for the conservation and protection of Western Australia's wildlife.
Environmental Protection Act 1986 (EP Act)	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
Biosecurity and Agriculture Management Act 2007 (BAM Act)	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally.

2.2 Commonwealth Legislation

The EPBC Act is the main piece of federal legislation protecting biodiversity in Australia. If an action or project is likely to have a significant impact on a matter of national environmental significance this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

2.2.1 Matters of National Environmental Significance

Matters of national environmental significance include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties
- national Heritage places
- Great Barrier Reef Marine Park
- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

2.2.2 Flora

Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 2.

Table 2 Categories of species listed under Schedule 179 of the EPBC Act

Conservation code	Category
Ex	Extinct Taxa
ExW	Extinct in the Wild
CE	Critically Endangered
E	Endangered
V	Vulnerable
CD	Conservation Dependent

2.2.3 Communities

Communities can be classified as Threatened Ecological Communities (TECs) under the EPBC Act. The EPBC Act protects Australia's ecological communities by providing for:

- identification and listing of ecological communities as threatened
- development of conservation advice and recovery plans for listed ecological communities
- recognition of key threatening processes
- reduction of impacts of these processes through threat abatement plans.

Categories of federally listed TECs are described in Table 3.

Table 3 Categories of TECs that are listed under the EPBC Act

Conservation Code	Category
CE	Critically Endangered - is facing an extremely high risk of extinction in the wild in the immediate future
E	Endangered - not critically endangered and is facing a very high risk of extinction in the wild in the near future
V	Vulnerable - not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium-term future

2.3 Western Australian Legislation

2.3.1 Flora

Plants that are considered threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the WC Act. These categories are defined in Table 4.

Table 4 Conservation codes for WA flora listed under the WA Act

Conservation Code	Category
CR	Critically endangered species
EN	Endangered species
VU	Vulnerable species
EX	Presumed extinct species

Species that have not yet been adequately surveyed to warrant being listed under the WA Act are added to the Priority flora List by the State Minister of Environment.

Table 5 Conservation codes for WA flora as endorsed by the Minister for Environment

Conservation Code	Category
Priority One	Poorly known species
Priority Two	Poorly known species
Priority Three	Poorly known species
Priority Four	Rare, Near Threatened and other species in need of monitoring
Priority Five	Conservation Dependent species

2.3.2 Communities

State listed TECs are not protected under any legislation, rather they are endorsed by the Minister for Environment. Categories of TECs are defined in Table 6. Priority Ecological Communities (PECs) are endorsed by the Minister for Environment as having insufficient information available to be considered as a TEC, or which are rare but not currently threatened. These categories are described in Table 7.

Table 6 Conservation codes for State-listed Threatened Ecological Communities

Conservation Code	Category
PD	Presumed Totally Destroyed
CR	Critically Endangered
EN	Endangered
VU	Vulnerable

Table 7 Conservation codes for Priority Ecological Communities

Conservation	Code Category
P1	Priority One - poorly-known ecological communities
P2	Priority Two - poorly-known ecological communities
P3	Priority Three - poorly known ecological communities
P4	Priority Four - ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list.
P5	Priority Five - Conservation Dependent ecological communities

3.0 Methodology

3.1 Desktop Assessment

The desktop assessment included a comprehensive literature review of all studies previously conducted at the quarry and government database searches. Documents and sources incorporated in this report include:

- Vegetation and Flora Readymix Quarry Gosnells (Bennett Environmental Consulting [Bennett], 2005)
- Vegetation survey of two sites at Readymix quarry at Gosnells (Bennett, 2006)
- Desktop flora and vegetation assessment undertaken for the Holcim development area (Astron, 2012a)
- Field survey of flora, vegetation and fauna (Astron, 2012b)
- Gosnells Quarry Clearing Permit CPS 5543/2 Amendment Application Supporting Information (URS Australia Pty Ltd [URS], 2013)
- Review of habitat and targeted searches for *Thelymitra stellata* and *Thelymitra magnifica* (Bennett, 2014)
- Flora, Vegetation and Targeted Orchid Assessment (AECOM, 2014)
- Flora, Vegetation and Targeted Orchid Assessment (AECOM, 2015)
- DPaW database searches (requested February 2016).

Studies undertaken prior to the AECOM surveys were used to inform the sample plan and targeted searches undertaken in 2014, 2015 and 2016. Significant vegetation communities and species identified in the desktop assessment were reviewed to determine the likelihood of their presence within the study area. The likelihood of occurrence was based on locations of known records/locations of significant values, and the presence of suitable habitat within the study area.

Context of the survey results, including their local and regional significance, was based on current published knowledge of species, and informed by publicly available information including:

- Geological Survey of Western Australia and Geoscience (2008)
- WA Atlas (Landgate, 2016)
- Climate statistics (BOM, 2016)
- Vegetation complexes (Heddle *et al.*, 1980)
- Pre-European vegetation complexes (Beard, 1981).

3.2 Field Survey

Six flora and vegetation assessments of various intensity and extent have been undertaken at the Quarry since 2005. The survey methodology can be reviewed in each of the detailed flora and vegetation assessment reports. Field survey methodology detailed in this section applies only to the field survey undertaken by AECOM in 2016.

3.2.1 Bennett 2005 Survey

The field assessment was undertaken on 7th and 8th October 2004. An aerial photograph of the area to be surveyed was provided prior to undertaking the field work. Transects were walked through the bush, ensuring that all variations in vegetation noted in the aerial were included. During the survey any Declared Rare or Priority Flora located were recorded with a GPS reading in WGS84, a photograph, and an estimate of the number.

Prior to undertaking the field work all listed Declared Rare and Priority Flora had been checked against specimens housed at the Western Australian Herbarium

Where plants were unknown in the field they were collected, pressed and later identified using appropriate keys and by comparison with collections housed at the Western Australian Herbarium. A pressed collection of each species of Declared Rare and Priority Flora was submitted to the Western Australian Herbarium for incorporation in their collection and all data was forwarded to the Rare Flora Section of the Department of Conservation and Land Management.

3.2.2 Astron 2012b Field Survey

The field survey was conducted by Astron personnel on 8 October 2012. The team consisted of Alice Bott (Botanist) and Dr Jessica Oates (Senior Zoologist).

The vegetation and flora field survey was undertaken in accordance with the requirements for a Level 1 assessment outlined in the EPAs *Position Statement 3: Terrestrial Biologica*l *Surveys as an Element of Biodiversity Protection* (2002) and *Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (2004a). Information acquired during the desktop study assisted in the design of the field survey. Pre- survey planning involved the examination of 1:10,000 scale aerial photography, landforms, surrounding vegetation mapping and vegetation community descriptions.

The number and location of sampling sites were determined based on the following criteria:

- the inclusion of at least one sample site in each vegetation association, distinguishable on aerial photographs
- sampling in homogenous vegetation and the avoidance of ecotone (transition) areas between associations
- the inclusion of target areas that are prospective for listed ecological communities and flora species identified during the desktop study
- the inclusion of target areas that are prospective for ecosystems identified as being at risk orof high priority for reservation (Williams and Mitchell 2001)
- the availability of safe access to the site.

A total of seven relevé quadrats (unmarked and unbounded sample areas) were surveyed in representative vegetation associations within the survey area. The following information was collected at each relevé:

- Location – coordinates measured using a handheld GPS (MGA50, GDA94). One set of coordinates taken from a central location of each relevé.
- Recorder and date–a list of the personnel involved in sampling that location and the survey date.
- Species – dominant vascular plant species present including introduced species. Species that could not be identified in the field were collected for later identification at the Astron herbarium or WA Herbarium.
- Weeds – the coordinates and density of any introduced flora.
- Vegetation description – Vegetation was described according to Keighery 1994, as adapted from Muir 1977 and Aplin 1979,and the National Vegetation Inventory System (NVIS), level 5. At this level, vegetation is described to ‘association’ where up to three dominant genera for each of the upper, mid and ground strata are categorised based on dominant growth form, cover and height.
- Vegetation condition – assessed according to the Vegetation Condition Scale modified from Trudgen 1991 by Keighery 1994.
- Habitat – a broad description of the surrounding landscape based on landform, topography and soil.
- Disturbances – records of any obvious disturbances such as fire, tracks or grazing.
- Photographs – a photograph was taken of each relevé.

A hard copy colour aerial photograph on an A3 map at a scale of 1: 10,000 was used to locate the survey area and to assist in navigation as well as delineating vegetation boundaries.

3.2.3 2014 Level 1 Flora Survey

The flora and vegetation survey was conducted in accordance with EPA Guidance Statement 51: *Terrestrial Surveys for Environmental Impact Assessment in Western Australia* (2004).

The Level 1 flora and vegetation survey was conducted by Catherine Krens (AECOM Senior Botanist) with assistance from Priscilla Fleming (Holcim personnel). The survey involved identifying and spatially mapping the vegetation communities present within the project area.

Flora and vegetation was sampled following DEC's (now DPaW) Standard Operating Procedure SOP No. 6.1 - Establishing Vegetation Quadrats, which recommends establishing 10 x 10m quadrats within the Jarrah Forest bioregion. A minimum of two quadrats were established within each vegetation community (DEC, 2009). Within each quadrat the following parameters were recorded:

- site number
- date
- GPS location
- photograph of the vegetation
- soil type
- topography
- vegetation type
- vegetation condition using the Keighery (1994) scale
- disturbance notes
- fire history
- species present
    - stratum
    - dominant species
    - estimated height
    - estimated percentage cover.

Characterisation of the vegetation communities involved describing the vegetation type using the National Vegetation Information System (NVIS) vegetation attribute standards. Vegetation communities were spatially mapped based on changes in landform and dominant species structure and composition. Where marked changes in species composition and floristic structure are observed a new vegetation community was described documenting all species observed (taking note of dominants) and structure.

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 condition of the project area was determined at a range of detailed recording sites and in between as necessary, where condition was observed to change. The categories of vegetation condition used were consistent with a combination of methods developed by Keighery (1994) Table 8.

Table 8 Bushland condition ratings (Keighery 1994)

Condition category	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance. *0% weed cover*
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. *1 – 5% weed cover*
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. *5 – 25% weed cover*
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. *25 – 50% weed cover*
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. *50 – 75% weed cover*
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. *75 – 100% weed cover*

An inventory of species including weed species was recorded within the project area. Areas of weed infestation were mapped with particular attention paid to Declared Pests (i.e. weeds listed under the BAM Act). If Declared Pests were observed their location and extent were mapped and recorded with a GPS.

Plants unable to be identified in the field were collected and processed in accordance with the Western Australian Herbarium (WAH) Standards. To aid in recognising individuals during the survey a field herbarium was maintained. To verify identification the collected specimens were compared to specimens held at the WAH with reference to taxonomic keys. Where appropriate, expertise from DPaW taxonomists were sought out to ensure accurate identification of specimens.

3.2.4 2015 Level 2 Flora Survey

A single-phase Level 2 Flora and Vegetation Assessment was conducted within the Project area (Figure 1) in accordance with EPA Guidance Statement 51: *Terrestrial Surveys for Environmental Impact Assessment in Western Australia* (2004). The survey was led by Senior Botanist Floora de Wit with Lyn Van Gorp as field assistant.

Floristic data was collected at sample point locations using a combination of 10 m x 10 m non-permanent quadrats and relevés to document the floristics, community composition, condition, and other identifying features of the Project area. Sample point locations were selected to ensure accurate representation of native vegetation within the Project area. Changes in floristic composition and structure were recorded and mapped as the Project area was traversed.

Flora and vegetation sampling followed methodology used in 2014, described in Section 3.2.1.

Quantitative flora data were used to define the vegetation communities. Vegetation communities were described and mapped based on changes in dominant species composition and landform. Vegetation community descriptions were based on the National Vegetation Information System (NVIS) framework (Commonwealth of Australia, 2003).

Vegetation condition was determined using the Keighery (1994) condition scale.

3.2.5 2016 Level 2 Flora Survey

A level 2 flora and vegetation assessment was undertaken within a corridor surrounding areas previously surveyed by AECOM in 2015 (the study area, Figure 2). This included quadrat-based sampling of floristic and vegetation community data and targeted threatened species searches following methodology outlined in EPA Guidance Statement 51 (GS51; 2004) and the EPA & DPaW technical guide (2015).

Floristic data was sampled from a combination of non-permanent quadrats and relevès following DPaW's Standard Operating Procedure (SOP) No. 6.1 - Establishing Vegetation Quadrats (DEC, 2009). Quadrats were 10x10 metres (m) defined by a measuring tape. Data collected from quadrats included the presence of plant species, their cover abundance, structural composition of vegetation, physical environment, and presence/absence of disturbance. Each sample point location was given a unique site number, and the following parameters recorded:

- date
- location using hand-held GPS (accuracy of 5 m)
- photograph
- soil details (type, colour, moisture)
- topography
- vegetation condition using the Keighery (1994) scale
- disturbance notes
- fire history
- species present
    - estimated height
    - estimated percentage cover.

Changes in floristic composition and structure were recorded and mapped as the study area was traversed. The AECOM survey effort including track logs for targeted surveys and all quadrats completed is shown in Figure 2.

Preliminary mapping of vegetation communities was undertaken prior to conducting the field survey to ensure that a minimum of three quadrats were sampled. Information gaps identified in previous surveys allowed for additional quadrats to be sampled in vegetation communities considered under-represented. The floristically diverse heath community mosaics were subject to additional sampling endeavouring to capture all vascular flora species present. This also ensures compliance with the regulator standards.

Flora species unable to be identified in the field were collected and processed in accordance with the Western Australian Herbarium (WAH) standards. A field herbarium was maintained to aid in recognising individuals during the survey. To verify identification the collected specimens were compared with reference to taxonomic keys to specimens held at the WAH. Where appropriate, expertise from DPaW taxonomists were sought out to ensure accurate identification of specimens.

3.2.6 Threatened Orchids

Previous biological assessments at the Gosnells Quarry concluded that there is the potential for the two conservation significant orchid species *Thelymitra stellata* (Endangered under the WC Act and EPBC Act) and *Thelymitra magnifica* (Priority 1) to occur at the Quarry. The project area has been comprehensively searched for both orchid species by Bennett and AECOM. A summary of survey effort and factors critical to the detectability of orchids is addressed in Table 9. These factors were derived from the Threatened orchid survey guidelines, published by Commonwealth of Australia (2013a).

Threatened orchid surveys were undertaken by AECOM in 2014, 2015 and 2016.

Prior to undertaking targeted surveys in 2016, advice from DPaW was sought in lieu of current climate conditions. DPaW advised on ideal survey timing and survey methodology which verified previous survey effort as suitable (communication provided in Appendix A).

The identification of orchids encountered was based on their key morphological features defined by Jones (2006) and Brown *et al.* (2013).

Table 9 Factors considered to improve detectability of both *Thelymitra* species

Factor	Survey Year			
	2014a	2014b	2015	2016
Use of appropriate personnel	Dr Eleanor Bennett Priscilla Fleming	Dr Andrew Batty Lyn van Gorp	Dr Andrew Batty Lyn van Gorp Floora de Wit	Floora de Wit Lyn van Gorp
Determining the optimal timing of survey	20 Oct, 3 Nov	17-19 Nov	26-28 Oct 11-13 Nov. A known population of *T. magnifica* was visited to verify flowering period.	25-27 Oct, confirmed by A. Brown and J. Donaldson from DPaW
Characterisation of the study area	Suitable habitat identified prior to undertaking surveys.	Study area was categorised into three habitat types including Prime, Marginal and Unsuitable. Prime habitat was defined by vegetation most commonly associated with the species. Marginal habitat lacked typical associated species and/or soil types were not considered ideal. Unsuitable habitat lacked all associated species and/or foliage cover was considered unsuitable.		
Establishing a sample design	Transects of 5-10 metres were walked side by side, distance dependent on detectability of flower.			
Applying sufficient survey effort	Unknown	GPS track logs were used as a quality control measure to ensure adequate coverage of the study area, see Figure 2		

3.2.7 Other Threatened and Priority flora

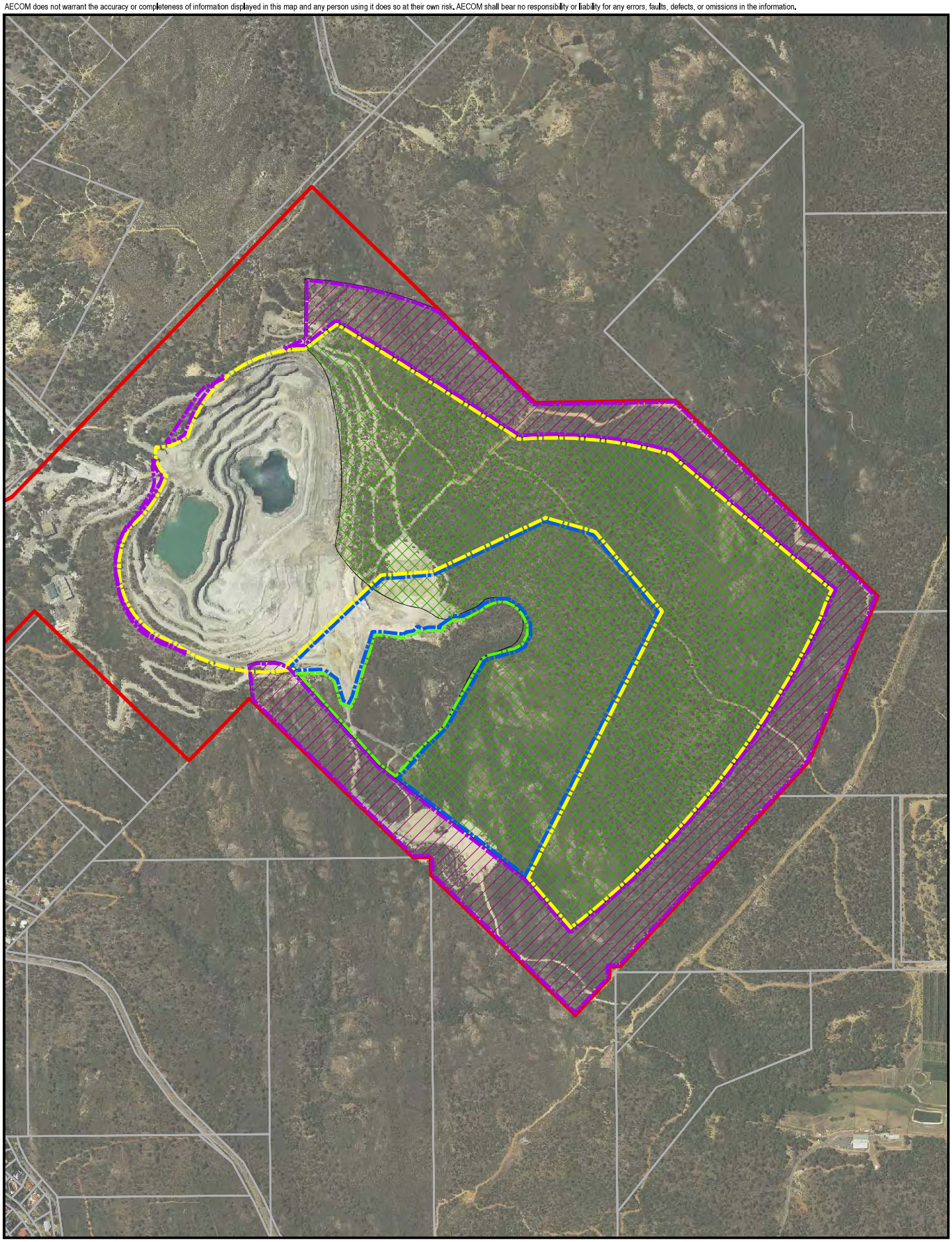
Targeted flora searches were undertaken within a larger study area (targeted study area), most of which has been previously surveyed by AECOM in 2014 and 2015 (Figure 2).

Two flora species listed as Threatened under the EPBC Act were targeted during the 2016 surveys. *Darwinia apiculata* and *Goodenia arthrotricha* are both associated with rocky outcrops and heath. The field surveys were undertaken during both these species' flowering period (October). A DPaW record of *G. arthrotricha* was visited to obtain further species information. This record was located on a steep gravel slope north of the project area. The steep slope made it unsafe to undertake detailed searches at this location. The record is from 2005 therefore location data is likely to be accurate. Absence of a species from one survey event is not adequate to dismiss the species as present at this location.

Priority flora species have been recorded within the heath vegetation at the Quarry by Bennett (2006), Astron (2012b), and AECOM (2014 and 2015). All heath vegetation within the project area, excluding areas previously surveyed by Bennett (2006) and Astron (2012b) was subject to a targeted survey.

Previously recorded locations of Priority flora were visited to quantify and map the population size and extent. The 2016 survey provided comprehensive details for all Priority flora encountered at the Quarry. All heath vegetation was traversed by walking meandering transects. Where possible, Priority flora individuals were recorded using a hand-held GPS. Where populations of species extended over large areas, the population boundary was recorded and an estimated number was recorded at regular intervals. This provided an estimate of abundance for defined populations or sub-populations.

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 125 250 375 500
metres

1:12,500 when printed at A4

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2016 Survey Area
- AECOM 2015 Survey Area
- AECOM 2014 Survey Area
- AECOM 2016 Area Subject to the Flora and Vegetation Assessment (subject to Targeted Survey Including Thelymitra sp.).
- AECOM 2016 Targeted Survey Excluding Thelymitra
- Holcim Tenement
- Cadastre Boundaries

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).

2016 Study Area

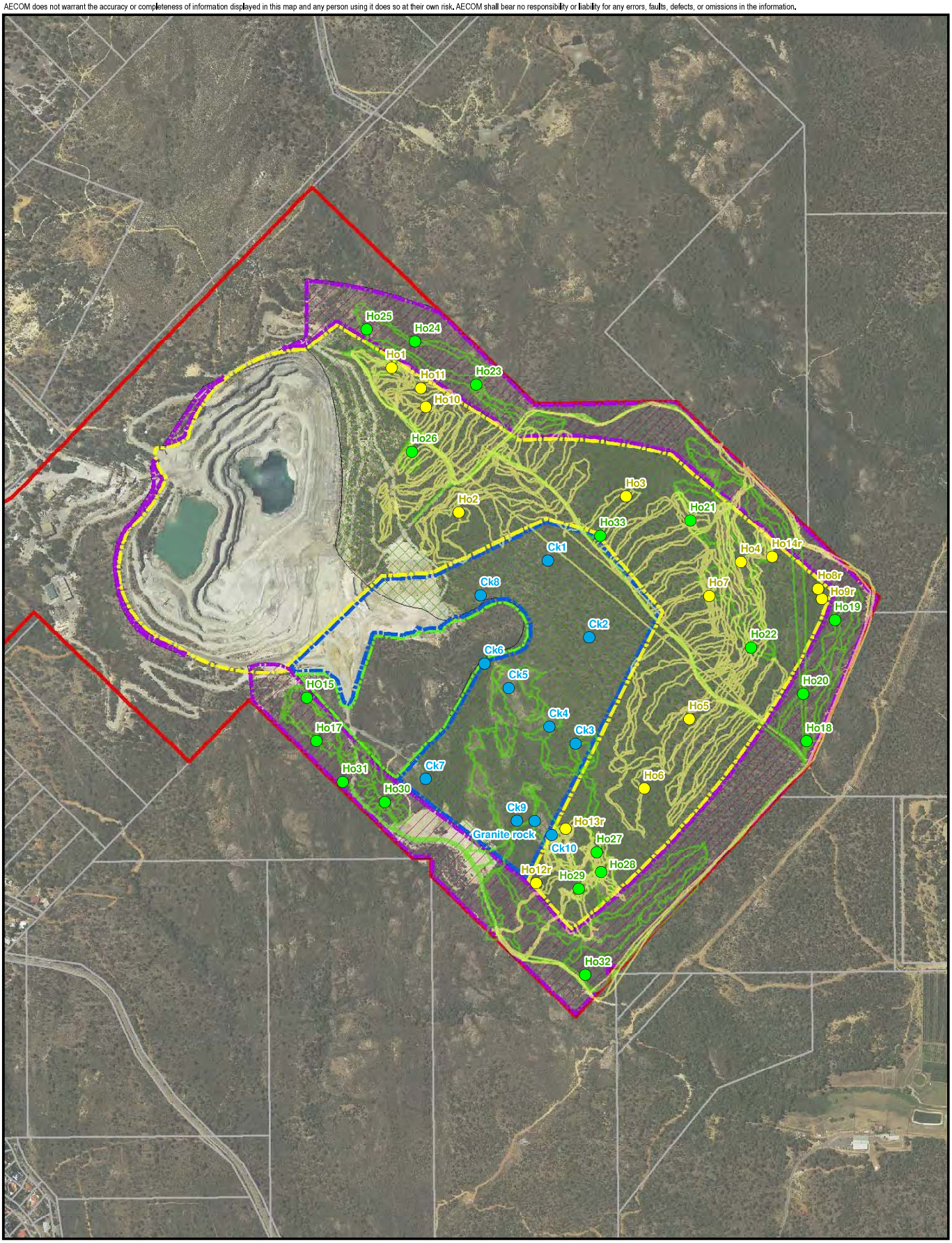
HOLCIM QUARRY

Figure 2

Map Document: P:\605X\60522332\4. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig2_2016StudyArea_RNM_v03_20170829.mxd (rob.mcgregor)

A4 size

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID 60522332
CREATED BY DGF/RNM
APPROVED BY FDW
LAST MODIFIED 29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 125 250 375 500
metres

1:12,500 when printed at A4

LEGEND

- 2014 Sites
- 2015 Sites
- 2016 Sites
- 2015 Track Logs
- 2016 Track Logs
- Holcim Tenement
- Cadastre Boundaries

Data sources:

- Astron 2012 and Bennett 2014 Survey
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- AECOM 2016 Area Subject to the Flora and Vegetation Assessment (subject to Targeted Survey Including Thelymitra sp.).
- AECOM 2016 Targeted Survey Excluding Thelymitra Sp.

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

Surveys Undertaken To-Date

HOLCIM QUARRY

Figure 3

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\605223324. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig3_SurveysToDate_RNM_RNM_v03_20170829.mxd (rob.mcgregor)

A4 size

3.3 Reporting

3.3.1 Vegetation Community Mapping

Quantitative flora data were used to define the vegetation communities. Vegetation community mapping was undertaken by amalgamating the AECOM 2014, 2015 and 2016 data. Astron (2012b) and Bennett (2005) data was not included in any further data analysis. Vegetation community descriptions were based on the National Vegetation Information System (NVIS) framework (Commonwealth of Australia, 2003) to Level VI Sub-Association as prescribed in the flora survey technical guide (DPaW & EPA, 2015).

Mapping of a small portion of the study area was undertaken by Astron (2012a). Whilst traversing the study area and collecting additional data, this mapping was amended to reflect current communities observed. This particularly affected heath communities which were traversed entirely on foot for the targeted flora survey and observations made for species composition changes.

Vegetation condition was determined using the Keighery (1994) condition scale (Table 10). The scale is based on disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure and site ecology.

Table 10 Bushland Condition Ratings (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.

3.3.2 Priority Flora

Populations were mapped in accordance with DECs Threatened and Priority Flora Report Form Field Manual (DEC, 2010). Populations are a discrete group of interbreeding individuals of a species (DEC, 2010). The following guidelines were applied:

- Plants more than 500 m from a known population are considered a new population
- Within a population, plants that have considerable, recognisable separation between them are considered separate sub-populations
- Population data including a vouchered specimens, spatial data and abundance counts/estimated were provided to DPaW and WAH.

An assessment of local and regional significance of all Priority flora populations recorded at the Quarry was undertaken. This assessment was informed by existing information available for each species including DPaW and WAH database results obtained on 22 February 2016, and Florabase (WAH, 1998).

Priority flora populations at the Quarry were considered locally significant if they represented a significant proportion of locally known populations based on number of individuals and total number of populations recorded.

Priority flora populations were considered regionally significant if there are no known records on DPaW and/or WAH databases and/or they represent the limit or extension of their current known range (as published on Florabase).

Similar habitat was observed outside the study area which may provide suitable habitat for Priority species recorded within the study area.

Database records older than 1970 were discounted due to the uncertainty/unreliability of location.

3.4 Limitations

Limitations associated with the 2016 field surveys undertaken at the Quarry are discussed in Table 11. It should be noted that limitations do not consider methodology applied during previous surveys. These can be reviewed in the original flora and vegetation assessment reports of Bennett, Astron and AECOM.

Table 11 Limitations of the Assessment

Limitation	Impact on 2016 Survey
Competency/experience of consultant conducting survey	**Not a constraint.** The field surveys, mapping and reporting was led by Floora de Wit who has more than 9 years' experience undertaking similar scopes. She was involved with the 2014 and 2015 field surveys which gives her a good understanding of the floristic and vegetation values at the Quarry.
Scope (i.e. what life forms were sampled)	**Not a constraint.** All vascular flora species were recorded, including sampling species not able to be accurately identified in the field. Quality control samples of common species were taken to verify their identification at the WAH.
Proportion of flora identified, recorded and/or collected (based on sampling, timing and intensity)	**Not a constraint.** Results from previous surveys were used to inform the 2016 sample plan and targeted search locations. A combination of quadrats (19) and relevès (two) were used to sample flora and vegetation. Furthermore, the total AECOM survey effort including 2014 and 2015 incorporates 37 quadrats and five relevès. A minimum of three quadrats were sampled within each vegetation community in accordance with the technical guide. The field survey was undertaken during the ideal detection period for all Threatened and Priority flora species based on their known flowering period. Orchid survey methods and timing was verified by DPaW.

Limitation	Impact on 2016 Survey
Sources of information	**Not a constraint**. All previous surveys undertaken at the Quarry were considered and informed the sample plan and preliminary mapping. The SPRAT (2016) database provides adequate identification information for the three Threatened flora and Priority flora? species subject to targeted surveys. Publicly available information outlined in Section 3.1 is suitable for providing adequate context for evaluating results of the field survey.
Completion (is further work needed)	**Not a constraint.** Taking into account the total survey effort of the project area to-date, no additional survey work or resampling of quadrats is considered necessary.
Timing, weather, season, cycle	**Not a constraint.** The field survey was undertaken in Spring, coinciding with the flowering period of the majority of species including the three Threatened flora and Priority flora? species.
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	**Minor.** Minor clearing for drilling, including access tracks and drill pads, was observed in the study area. Access tracks resulted in the clearing and/or dissection of Priority flora populations in the area. The clearing for the exploration programme was approved as an exemption under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 for the clearing of vehicular tracks in 2015. No other disturbances were observed in the study area.
Intensity (was the intensity adequate)	**Not a constraint.** Floristic data was collected from 19 quadrats and two relevès, further supported by observations recorded whilst traversing the study area on foot during targeted flora searches.
Completeness (was relevant area fully surveyed)	**Not a constraint.** The entire study area was traversed on foot to document the flora and vegetation values.
Resources (degree of expertise available in plant/animal identification)	**Not a constraint.** The field survey and data analysis was undertaken by Floora de Wit who has more than 9 years' experience conducting similar surveys in the Jarrah Forest bioregion. Priority flora species were previously identified by Floora de Wit and Lyn van Gorp in 2015 and were therefore easily identified in the field.
Remoteness and/or access problems	**Not a constraint.** The entire study area was traversed on foot.
Availability of contextual information on the region	**Not a constraint**. DPaW and WAH database search results and previous surveys undertaken at the Quarry were used to provide local context. Regional context was obtained from publicly available resources including Beard (1979), Heddle *et al.* (1980) and Mattiske & Havel (1998).

4.0 Existing Environment

4.1 Climate

The Perth region has a warm Mediterranean climate, characterised by hot dry summers and cool to mild wet winters. The closest meteorological recording station with comprehensive long-term data is Gosnells City (Station 009106), located less than 2 km to the west of the Quarry. Gosnells City meteorological station is maintained by the Bureau of Meteorology (BoM) and commenced recording in 1961.

Gosnells City has experienced an average annual rainfall of 825 mm since 1961, with the majority of rainfall occurring between May and August (BoM, 2015). Mean maximum temperature at Gosnells City ranges from 18.7°C in June to 33.2°C in January. Average minimum temperatures range from 8.7°C in July to 18.8°C in February. The low temperatures experienced in July, August and particularly September was not considered to have affected flowering times. This was confirmed by DPaW when advice was sought regarding orchid flowering times.

Rainfall in the twelve months preceding the 2016 field survey (Figure 4) was close to the annual average for most months. June experienced significantly below average rainfall, with only 71.4 mm recorded despite the 167.7 mm historical average. The near-average rainfall recorded at City of Gosnells indicates that rainfall is not a limiting factor of the survey, in particular the presence of ephemeral species and germination of orchids.

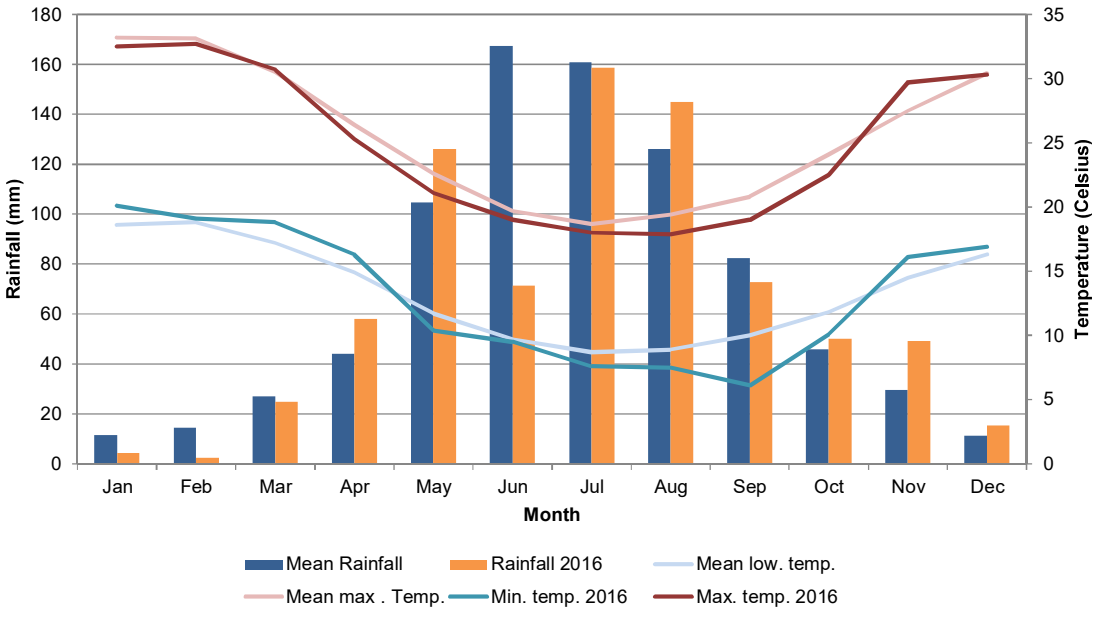


Figure 4 Rainfall statistics for Gosnells City meteorological recording station 9106 showing mean annual rainfall, monthly minimum and maximum temperatures, and rainfall and temperature recorded in the 12 months preceding the field survey. Note, November and December show 2015 data (BoM, 2016)

4.2 Soil and Geology

The Quarry is located on the eastern edge of the Darling Scarp. The surface geology of the entire study area consists of igneous felsic intrusives, which are described as undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, and pegmatite. Locally metamorphosed, foliated gneissic, local abundant mafic and ultramafic inclusions (Geological Survey of Western Australia and Geoscience, 2008).

The study area consists of two differing soil types, JZ1 and Mw31. Soil type JZ1 is described as dissected plateau having a strongly undulating relief, and with some moderately incised valleys. The unit comprises much of the western part of the Darling Range south of the Swan River. It is characterized by lateritic gravels and block laterite (Geological Survey of Western Australia and Geoscience, 2008).

Soil type Mw31 is described as deeply incised, steep scarp and valley side slopes of the Darling Scarp. The chief soils are acid red earths on colluvial slope deposits and are associated with soils on moderate to steep upper slopes with some soils containing ironstone gravel on spurs and ridge tops (Geological Survey of Western Australia and Geoscience, 2008).

4.3 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. The nationally agreed regionalisation of Australia was first published in Thackway & Cresswell (1995). This dataset is regularly updated to reflect current information on vegetation communities and ecosystem boundaries with IBRA7 reflecting the latest update (Commonwealth of Australia, 2012). The objective of mapping these boundaries was to inform the National Reserve System, providing quantitative data on the current extent of pre-European vegetation remaining within each bioregion, subregion, and local government area. Currently 7.06 % of Australia's native vegetation is protected in the National Reserve System (DPaW, 2016).

The Quarry lies within the Jarrah Forest IBRA Region. The Jarrah Forest Region, described by Thackway & Cresswell (1995), is a duricrusted plateau of Yilgarn Craton characterised by Jarrah-Marri forest on laterite gravels and, in the eastern part, by Marri-Wandoo woodlands on clayey soils. Eluvial and alluvial deposits support *Agonis* shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species rich shrublands. Currently there is approximately 54% of the original pre-European vegetation remaining in the Jarrah Forest region, with 13.7% protected for conservation (DPaW, 2016).

The Jarrah Forest IBRA region comprises two subregions, the northern and southern Jarrah Forest. The Quarry lies within the Northern Jarrah Forest subregion. This subregion, described in the CALM (2002) Biodiversity Audit, incorporates the area east of the Darling Scarp which overlies Archaean granite and metamorphic rocks capped by extensive lateritic duricrust, dissected by drainage and broken by occasional granite hills.

Williams & Mitchell (2001) further characterise the Northern Jarrah Forest subregion, with Jarrah-Marri forest in the west, Bullich-Blackbutt in the valleys which shifts to Wandoo-Marri in the east, and Powder bark on breakaways. The granite rocks support heath communities and comprise the common understorey of the woodlands in the north and east. Land use is predominantly forestry, conservation, grazing and mining. Rare features of the area include the extensive native forest cover. There is currently 58.5% of the pre-European vegetation remaining, with 9.9% of this protected for conservation (DPaW, 2016).

4.4 Vegetation

4.4.1 Pre-European Vegetation

Broad-scale vegetation mapping has been undertaken for the south-west of Western Australia, including the Beard (1979) pre-European vegetation mapping which provides the basis for the National Reserve System in Western Australia, and the Heddle *et al.* (1980) vegetation complex mapping.

The study area lies within two Beard (1979) vegetation associations, including West Darling 3 medium forest; Jarrah-Marri and, West Darling 4: medium woodland Marri and Wandoo. Currently there is 79.6% and 32.4% of the pre-European vegetation extent remaining within these two vegetation associations respectively. Each of these vegetation complexes has greater than 30% of their pre-European extent remaining and the vegetation of the study area is therefore not considered to be of regional significance or below the critical threshold in accordance with EPA Position Statement 2 (EPA, 2000).

The study area intersects with three Heddle *et al*. (1980) vegetation complexes, described in Table 12. The study area is located on the Darling Scarp vegetation complex, described as a wide range of vegetation from bare rock and lichen-fields through to shrublands to woodlands of Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*), Butter-bark (*Eucalyptus laeliae*), Rock Sheoak (*Allocasuarina huegeliana*) and mountain Marri (*Corymbia haematoxylon*).

Table 12 Pre-European vegetation complexes within the study area

Vegetation complex	Landform	Vegetation description
Darling Scarp complex	Steeply sloping western margin of the Darling Plateau. Major valley floors and scarps.	A wide range of vegetation from bare rock and lichen-fields through shrublands to woodlands of Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*), Butter-bark (*E. laeliae*), Rock Sheoak (*Allocasuarina huegeliana*) and Mountain Marri (*C. haematoxylon*)
Dwellingup complex	Lateritic uplands, in medium to high rainfall.	Predominantly consists of open forest of Jarrah-Marri (*Eucalyptus marginata-Corymbia calophylla*)
Murray complex	Major valleys combining slopes, in medium to high rainfall in humid and sub humid zones.	Consists of open forest of Jarrah-Marri-Swan River Blackbutt (*Eucalyptus marginata-Corymbia calophylla-E. patens*) on valley slopes to a fringing woodland of Flooded Gum-Swamp Paperbark (*E. rudis – Melaleuca rhaphiophylla*) on the valley floors

**Source: Western Australian Local Government Association, 2013*

4.4.2 Floristic Community Types

In 1997, Markey undertook a detailed study of the Northern Darling Scarp, which includes the study area. The results of the study were used to define the major types of Floristic Community Types (FCT), of which there were three distinct groups:

Supergroup 1 – Woodland and Shrublands on Scarp and Valley Slopes

- FCT 1a – Upper slope *Eucalyptus wandoo* woodland
- FCT1b – *Eucalyptus wandoo – Corymbia calophylla* woodland on poorly drained clay flats
- FCT1c – Northern granite shrubland and woodland
- FCT 2 – Southern granite shrubland and woodland
- FCT 3 – Woodland on steep, loamy scarp and valley slopes
- FCT 4 – Woodland on steep colluvial slopes of scarp face and upper valleys.

Supergroup 2 - Ridge Hill Shelf Woodlands and Granite Shrublands

- FCT 5 – Central granite shrubland
- FCT 6 – Talbot Road *Corymbia calophylla – Eucalyptus wandoo* woodland and heath
- FCT 7 – Woodland on poorly drained colluvial deposits
- FCT 8 – Shrubland on upper slope granite outcrops.

Supergroup 3 - Woodlands of the Lateritic Uplands

- FCT 9 – Upper *Eucalyptus marginata* forest
- FCT 10 – Upland *Corymbia calophylla* woodland
- FCT 11 – Upland *Corymbia calophylla – Eucalyptus marginata* woodland.

The Bennett (2005) vegetation mapping and analysis identified the presence of FCT1b, FCT2, FCT9 and FCT11.

4.4.3 Vegetation Communities

Vegetation community mapping was undertaken in 2004. Bennett (2005) mapped and described nine vegetation communities. Additional vegetation community mapping was completed by Astron (2012b), describing six vegetation communities. The Bennett (2005) and Astron (2012b) vegetation communities have been amalgamated to provide a comprehensive overview, shown in Table 13. It should be noted that the Bennett (2005) survey covered a much larger area than Astron (2012b), explaining why not all Bennett communities were represented in the Astron report.

Table 13 Consolidation of Vegetation Communities Previously Mapped within the Project Area by Bennett (2005) and Astron (2012b)

Vegetation community description	Vegetation code	
	Bennett (2005)	Astron (2012b)
Eucalyptus marginata subsp. *thalassica* and *Corymbia calophylla* Open Forest over *Allocasuarina fraseriana* Low Woodland over mixed species Open Low Heath dominated by *Hibbertia hypericoides* and *Verticordia acerosa*	EmBg, representing FCT11	F1
Open Forest of *Corymbia calophylla* and *Eucalyptus marginata* subsp. *thalassica* over Tall Shrubland of *Hakea undulata* and *Calothamnus rupestris*	EmCr, representing FCT1b	NA
Open Forest of *Eucalyptus marginata* subsp. *thalassica* over a Tall Shrubland to Tall Open Scrub of *Dryandra sessilis* over Low Shrubland of mixed species (EmDs), representing FCT9	EmDs, representing FCT9	NA
Woodland of *Corymbia calophylla, Eucalyptus marginata* subsp. *thalassica* and *Allocasuarina fraseriana* over Tall Shrubland of *Hakea trifurcata* over Open Heath of *Petrophile biloba*	Pb, representing FCT1b	NA
Eucalyptus marginata subsp. *thalassica* Open Woodland over *Xanthorrhoea preissii* and *Kingia australis* Tall Shrubland over *Hakea undulata* Open Heath over mixed species Open Low Heath	EmXp, representing FCT1b	W1
Eucalyptus wandoo and *Corymbia calophylla* Woodland to Low Woodland over *Hakea lissocarpha* and *Hakea undulata* Closed Heath over *Hibbertia hypericoides* Closed Low Heath	Ew representing FCT1b	W2

Vegetation community description	Vegetation code	
	Bennett (2005)	Astron (2012b)
Corymbia calophylla occasionally with *Eucalyptus marginata* subsp. *thalassica* Woodland over *Eucalyptus drummondii* Low Open Woodland over *Hakea trifurcata* Tall Open Scrub over *Hakea undulata* Open Heath over *Hibbertia hypericoides* Closed Low Heath	CC and Ed, representing FCT1b	W3
Hakea erinacea and *Verticordia acerosa* Open Low Heath	He, representing FCT2	H1
Mixed species Open Low Heath	Va, representing FCT2	G1

5.0 Desktop Assessment

A summary of survey effort to date is included in Table 14.

Table 14 Survey and Sample Effort and Intensity

Surveyor	Size	Intensity/Sample Effort	Timing
Bennett 2005 Eleanor Bennett	Approximately 130 ha	20 sites	7-8 October 2004
Astron 2012b Alice Bott	10.52	7 relevès	8 October 2012
AECOM 2014 Catherine Krens Priscilla Fleming	46.75 ha	10 quadrats	17-19 November 2014
AECOM 2015 Floora de Wit Lyn van Gorp	151.20 ha	9 quadrats 5 relevès	13 and 26 October 2015
AECOM 2016 Floora de Wit Lyn van Gorp	47.7 ha	19 quadrats	25-27 October 2016

5.1 Threatened and Priority Flora

The search of the DPaW database and review of previous reports identified 46 conservation significant flora species as having the potential to occur within the study area. This included seven species listed under both the EPBC Act and WC Act, four species listed under just the WC Act and 35 species listed as Priority species by DPaW. Of the 46 species:

- four species are known to occur within the study area (AECOM, 2015)
- 17 were considered likely to occur
- 16 species may occur
- 12 species were considered unlikely to occur

The complete desktop assessment results including the likelihood of occurrence within the study area are provided in **Appendix B**. The results of the DPaW database search are presented in Figure 5. Those species that are known or considered likely to occur within the study area as a result of the desktop assessment are presented in Table 15.

Previous flora and vegetation surveys have recorded four Priority flora species within the Holcim Gosnells Quarry boundary (Bennett, 2005 & 2006; Astron, 2012a). One species, *Calothamnus rupestris* was listed as a Priority 4 at the time of previous surveys in 2012, however has since been delisted. Details of Priority species previously recorded in the Holcim Gosnells Quarry boundary are provided in Table 15.

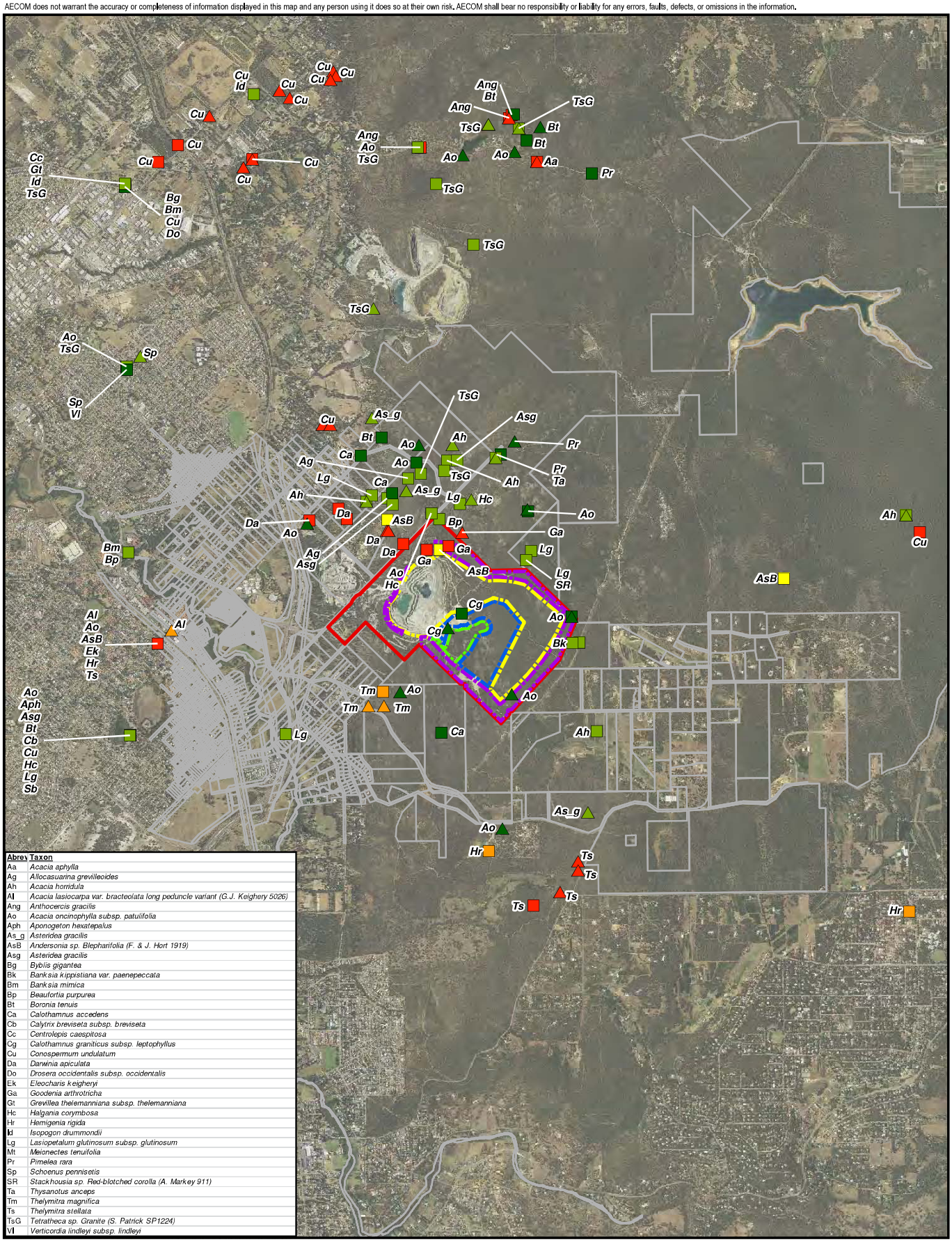
In 2014 Bennett Environmental Consulting identified two conservation significant terrestrial orchid species that have the potential to occur in the study area. These are *Thelymitra stellata* listed as Endangered under the EPBC Act and WC Act and *Thelymitra magnifica* listed a Priority 1 species by DPaW and endorsed by the Minister for Environment. Details of these species are also provided in Table 15.

Table 15 Conservation Significant Flora Species Known and Likely to Occur within the Study Area

Species	Conservation status	Description	Habitat
Known to occur			
Acacia oncinophylla subsp. *patulifolia*	Priority 4	Shrub, 0.5-3 m high. Minniritchi bark, phyllodes 40-90 mm long, 3-6 mm wide. Flowers are yellow occurring from Aug to Dec	Granitic soils, occasionally on laterite. Previously recorded within the Gosnells Quarry boundary adjacent to the study area by Bennett (2005) and Astron (2012a)
Asteridea gracilis	Priority 3	Annual, herb, 0.15-0.35 m high. Flowers are white-pink, Sep to Dec.	Sand, clay, gravelly soils.
Beaufortia purpurea	Priority 3	Erect or spreading shrub, 0.3-1.5 m high. Flowers are red-purple, Oct to Dec or Jan to Feb.	Lateritic or granitic soils. Rocky slopes.
Calothamnus graniticus subsp. *leptophyllus*	Priority 4	Erect, multi-stemmed shrub, 1-2 m high. Flowers are red occurring from June to Aug	Clay over granite, lateritic soils. Hillsides. Previously recorded within rehabilitation areas by Bennett (2005)
Likely to occur			
Acacia horridula	Priority 3	Harsh, slender, single-stemmed shrub, 0.3-0.6(-1) m high. Flowers are yellow, May to Aug.	Gravelly soils over granite, sand. Rocky hillsides.
Allocasuarina grevilleoides	Priority 3	Dioecious, lignotuberous shrub, 0.15-0.4 m high.	Sand over laterite, gravel. Previously recorded in open or dense low heathland in Ellis Brook Valley Reserve
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	Priority 2	Low erect/spreading plant with white/cream flowers.	Previously found in Jarrah, Marri woodland or heathland
Banksia kippistiana var. *paenepeccata*	Priority 3	Erect, prickly, lignotuberous shrub, 0.3-1.2 m high. Flowers are yellow-cream occurring from Oct to Nov	Lateritic gravelly soils. Previously recorded within the Gosnells Quarry boundary adjacent to the study area by Bennett (2005)
Boronia tenuis	Priority 4	Flowers pale purple.	Previously recorded on slope amongst granite boulders and outcrop. Also recorded on various loam, clay, gravel soils over granite. Recorded in Sheoak thicket or heathland or open woodland
Calothamnus accedens	Priority 4	Erect & slender shrub, to 1.8 m high. Flowers are pink-red.	Sandy soils over laterite. Road verge. Previously recorded nearby in grey sand over gravel or rocky loam or rocky clay in open woodland or dense heath

Species	Conservation status	Description	Habitat
Darwinia apiculata	EPBC Act: EN WC Act: EN	Densely branched shrub, 0.4-0.5 m high. Flowers are green & yellow/red, Oct.	Lateritic soils. Previously recorded in gravel, grey sand clay over granite or dry laterite around disturbed gravel pit site. Previously recorded in heathland or Marri woodland
Goodenia arthrotricha	WC Act: EN	Erect perennial, herb, to 0.4 m high. Flowers are blue, Oct to Nov.	Gravel. Granite rocks, slopes.
Halgania corymbosa	Priority 3	Erect shrub, 0.35-1 m high. Flowers are blue-purple, Aug to Nov.	Gravelly soils, soils over granite.
Lasiopetalum glutinosum subsp. *glutinosum*	Priority 3	Low shrub with pink flowers	Previously recorded in various soil types including lateritic gravel and clay or brown, clayey sand with laterite.
Pimelea rara	Priority 4	Shrub, 0.2-0.35 m high. Flowers are white, Dec or Jan.	Lateritic soils.
Stackhousia sp. Red-blotched corolla	Priority 3	None available on Florabase	Previously recorded in light brown yellow silty-gravel with surface granite and lateritic gravel and cobbles in heathland
Tetratheca sp. Granite (S. Patrick SP1224)	Priority 3	Erect shrub, to 0.4 m high.	Clay, moist loam, clayey sand. Granite boulders.
Thelymitra magnifica	Priority 1	Perennial, herb.	Stony ridges.
Thelymitra stellata Star Sun Orchid	EPBC Act: EN WC Act: EN	Tuberous, perennial, herb, 0.15-0.25 m high. Flowers are yellow and brown occurring from Oct to Nov	Sand, gravel, lateritic loam. Identified as potentially occurring by Bennett (2014)

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



Abrev	Taxon
Aa	*Acacia aphylla*
Ag	*Allocasuarina grevilleoides*
Ah	*Acacia horridula*
Al	*Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)*
Ang	*Anthocercis gracilis*
Ao	*Acacia oncinophylla subsp. patulifolia*
Aph	*Aponogeton hexatepalus*
As_g	*Asteridea gracilis*
AsB	*Andersonia sp. Blepharifolia (F. & J. Hort 1919)*
Asg	*Asteridea gracilis*
Bg	*Byblis gigantea*
Bk	*Banksia kippistiana var. paenepeccata*
Bm	*Banksia mimica*
Bp	*Beaufortia purpurea*
Bt	*Boronia tenuis*
Ca	*Calothamnus accedens*
Cb	*Calytrix breviseta subsp. breviseta*
Cc	*Centrolepis caespitosa*
Cg	*Calothamnus graniticus subsp. leptophyllus*
Cu	*Conospermum undulatum*
Da	*Darwinia apiculata*
Do	*Drosera occidentalis subsp. occidentalis*
Ek	*Eleocharis keigheryi*
Ga	*Goodenia arthrotricha*
Gt	*Grevillea thelemanniana subsp. thelemanniana*
Hc	*Halgania corymbosa*
Hr	*Hemigenia rigida*
Id	*Isopogon drummondii*
Lg	*Lasiopetalum glutinosum subsp. glutinosum*
Mt	*Meionectes tenuifolia*
Pr	*Pimelea rara*
Sp	*Schoenus pennisetis*
SR	*Stackhousia sp. Red-blotched corolla (A. Markey 911)*
Ta	*Thysanotus anceps*
Tm	*Thelymitra magnifica*
Ts	*Thelymitra stellata*
TsG	*Tetratheca sp. Granite (S. Patrick SP1224)*
Vl	*Verticordia lindleyi subsp. lindleyi*

PROJECT ID 60522332
CREATED BY DGF/RNM
APPROVED BY FDW
LAST MODIFIED 29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 500 1,000 1,500 2,000
metres

1:50,000 when printed at A4

LEGEND

TPFL
- Threatened
- Priority 1
- Priority 2
- Priority 3
- Priority 4

WA Herb
- Threatened
- Priority 1
- Priority 2
- Priority 3
- Priority 4

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

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).

Desktop Priority Flora Results

HOLCIM QUARRY

Figure 5

Map Document: P:\605X\60522332\4. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig5_DesktopPriorityFlora_RNM_v03_20170829.mxd (rob.mcgregor)

A4 size

5.2 Vegetation

A review of available literature conducted by Astron Environmental Services (2012a) identified two TECs that occur within 10 km of the study area. These include Claypans of the Swan Coastal Plain, and *Corymbia calophylla-Kingia australis* woodlands on heavy soils of the Swan Coastal Plain (Table 16). Both TECs are restricted to the Swan Coastal Plain bioregion and are therefore not expected to occur within the study area. Neither of these communities are listed under the EPBC Act.

No TECs or PECs have been recorded within the study area during previous surveys and none are anticipated to occur.

Table 16 Threatened Ecological Communities within close proximity to the study area

Threatened Ecological Community	Conservation status	Distance from study area
Claypans of the Swan Coastal Plain	Critically Endangered	TEC likely to occur within 10 km of the study area. This TEC is restricted to the Swan Coastal Plain bioregion.
Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	TEC known to occur within 10 km of the study area. This TEC is restricted to the Swan Coastal Plain bioregion region.

6.0 Results and Discussion

6.1 Vegetation Communities

Nine vegetation communities have been mapped and described within the study area. These include:

- four heath communities
- one *Calothamnus* thicket
- three forest communities
- one woodland community.

One woodland community, the *E. wandoo* woodland, is considered locally significant as it supports one population of Priority flora (this species is discussed further in Section 5.1). The delineation of the forest and woodland communities was supported by floristic/cluster analysis of quantitative quadrat data. The dendrogram showed clear grouping of quadrats, used as a basis for writing community descriptions (Figure 6).

Vegetation associated with granite outcrops are considered unique in high species diversity as they often represent isolated and disjunct vegetation communities (Hopper *et al.,* 1997). The granite outcrops within the study area are not considered geographically isolated as they are less than 1 km apart and are likely to continue to exchange genetic material. They are however very diverse, evident in the high species richness recorded in communities BpSr, HeSb, IdBc and VaBs (52, 122, 87 and 75 native species respectively). Combined, the species richness of these heath communities is 200 species (192 native species).

The vegetation communities on granite outcrops represent a mosaic of heaths and forbs. Floristic data analysis was undertaken in an attempt to identify clear differentiation between quadrats (Figure 7). All four heath communities are considered locally and regionally significant due to the unique floristic composition, high species diversity, and the provision of habitat for multiple Priority flora species.

The four heath communities are characterised by multiple shrub strata including a tall, medium and low layer. The code uses the dominant species from one of these strata informed by the quantitative floristic data collected from all quadrats completed within the study area since the commencement of the project by AECOM in 2014.

Table 17 presents a description of the vegetation communities, survey effort, extent, species richness and representative photographs.

Table 17 Vegetation communities described within the study area

Code	Description	Comments	Photograph
BpSr	*Beaufortia purpurea, Hakea uncinata, Verticordia acerosa* var. *acerosa, Petrophile squamata* subsp. *squamata* and *Allocasuarina humilis* mid shrubland over *Beaufortia macrostemon, Banksia armata* var. *armata, Astroloma glaucescens, Babingtonia pelloeae* and *Hibbertia hypericoides* low open shrubland over *Stylidium repens, Thysanotus manglesianus, Goodenia coerulea* and *Stylidium bulbiferum* low sparse forbland. Supports populations of *Beaufortia purpurea* (P3) and *Lasiopetalum glutinosum* subsp. *glutinosum* (P3). These are further discussed in Section 6.3.1.	Species richness: 52 native species. Survey effort: CK3, HO28, HO29. Area: 4.43 ha	
HeSb	*Eucalyptus wandoo* low isolated trees over *Hakea erinacea, Verticordia acerosa* var. *acerosa, Leucopogon sprengelioides, Melaleuca radula* and *Xanthorrhoea drummondii* mid shrubland over *Hibbertia hypericoides, Melaleuca parviceps, Babingtonia camphorosmae, Beaufortia purpurea* and *Hakea incrassata* low shrubland over *Stylidium bulbiferum, Stylidium calcaratum, Cassytha racemosa* forma *racemosa, Stylidium eriopodum* and *Drosera glanduligera* low sparse forbland. Predominantly heathland with some mallee form *Eucalyptus wandoo* and *Corymbia calophylla* as an ecotone to adjacent forest. Variable in density of *Hakea erinacea*. Supports populations of *Asteridea gracilis* (P3), *Beaufortia purpurea* (P3) and *Lasiopetalum glutinosum* subsp. *glutinosum* (P3). These are further discussed in Section 6.3.1.	Species richness: 122 native species, four weed species. Survey effort: HO1, HO17, HO26, HO30, HO31. Area: 10.11 ha	

Code	Description	Comments	Photograph
IdBc	*Acacia oncinophylla* subsp. *patulifolia* and *Xanthorrhoea drummondii* tall open shrubland over *Isopogon dubius, Verticordia acerosa* var. *acerosa, Hakea erinacea, Melaleuca holosericea* and *Allocasuarina humilis* medium shrubland over *Astroloma glaucescens, Cryptandra pungens, Hibbertia subvaginata, Melaleuca parviceps, Hakea undulata* and *Hibbertia hypericoides* low shrubland with *Borya constricta, Stylidium eriopodum, Pterochaeta paniculata, Stylidium brunonianum,* and *Thysanotus scaber* low sparse forbland. Dominated by *A. oncinophylla* subsp. *patulifolia* (P4) throughout most of the community with the exception of HO21 and HO25. This is further discussed in Section 6.3.1.	Species richness: 87 native species. Survey effort: HO4, HO14r, HO21, HO22, HO25. Area: 3.32 ha	
VaBs	*Acacia oncinophylla* subsp. *patulifolia* and *Melaleuca holosericea* tall sparse shrubs over *Verticordia acerosa* var. *acerosa, Verticordia insignis* subsp. *insignis*, *Verticordia plumosa* var. *plumosa* and *Hakea erinacea* mid shrubland over *Borya sphaerocephala, Stylidium bulbiferum*, *Drosera gigantea, Glischrocaryon aureum* and *Pterochaeta paniculata* low open forbland. Supports populations of *Acacia oncinophylla* subsp. *patulifolia* (P4), *Beaufortia purpurea* (P3) and *Lasiopetalum glutinosum* subsp. *glutinosum* (P3). These are further discussed in Section 6.3.1.	Species richness: 75 native species, eight weed species. Survey effort: CK4, CK5, CK10, HO13r, HO27. Area: 15.18 ha	

Code	Description	Comments	Photograph
Thicket			
CcCrTc	*Corymbia calophylla* mid isolated trees over *Calothamnus rupestris, Xanthorrhoea preissii* and *Hakea undulata* tall closed shrubland over *Hibbertia hypericoides, Banksia dallanneyi* var. *dallanneyi, Gompholobium tomentosum, Synaphea acutiloba* and *Hakea amplexicaulis* low sparse shrubland with *Tetraria capillaris* and *Tetraria octandra* low sparse sedgeland with *Stylidium piliferum, Stylidium bulbiferum, Trichocline spathulata, Dampiera alata* and *Patersonia occidentalis* low sparse forbland. Supports population of *Acacia horridula* (P3), discussed in Section 6.3.1.	Species richness: 46 native species. Survey effort: HO8r, HO15, HO19. Area: 3.29 ha	
Forest and Woodlands			
CcHtHh	*Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* mid open forest over *Hakea trifurcata, Xanthorrhoea preissii, Hakea undulata,* and *Hakea prostrata* mid to tall shrubland over *Hibbertia hypericoides, Hibbertia commutata, Banksia dallanneyi* var. *dallanneyi, Hibbertia huegelii* and *Bossiaea ornata* low open shrubland with *Lepidosperma leptostachyum* and *Cyathochaeta avenacea* mid open sedgeland with *Scaevola calliptera, Cassytha racemosa, Pentapeltis peltigera, Xanthosia candida, Conostylis setosa* and *Burchardia congesta* mid sparse forbland.	Species richness: 96 native species, one weed species. Survey effort: Ck6, CK7, CK9, HO3, HO12r, HO32. Area: 32.31 ha	

Code	Description	Comments	Photograph
EmBsBd	*Eucalyptus marginata* subsp. *marginata, Corymbia calophylla* and *Allocasuarina fraseriana* mid open forest over *Banksia sessilis* var. *sessilis*, *Xanthorrhoea preissii* and *Hakea undulata* tall shrubland over *Banksia dallanneyi* var. *dallanneyi, Hibbertia hypericoides, Bossiaea ornata, Hibbertia commutata* and *Hypocalymma robustum* low shrubland with *Lepidosperma leptostachyum, Tetraria capillaris* and *Lepidosperma pubisquameum* mid sparse sedgeland with *Orthrosanthus laxus* var. *laxus, Conostylis setosa*, *Lomandra caespitosa*, *Burchardia congesta, Pentapeltis peltigera,* and *Thysanotus manglesianus* low sparse forbland. Isolated occurrence of *Beaufortia purpurea* (P3) recorded in this community.	Species richness: 137 native species, two weed species. Survey effort: CK1, CK2, CK8, HO2, HO5, HO6, HO9r, HO33. Area: 53.50 ha	
EwHhSa	*Eucalyptus wandoo* subsp. *wandoo, Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* medium open forest over *Xanthorrhoea preissii* and *occasional Xanthorrhoea drummondii tall open shrubland over Macrozamia riedlei, Hibbertia hypericoides, Acacia pulchella* var. *pulchella, Boronia ovata, Hakea lissocarpha* and *Hakea stenocarpa* low shrubland over *Stylidium affine, Acanthocarpus canaliculatus, Conostylis setosa, Lagenophora huegelii* and *Trichocline spathulata* low sparse forbland. Supports populations of *Asteridea gracilis* (P3), discussed in Section 5.1.	Species richness: 92 native species, three weed species. Survey effort: HO10, HO11, HO23, HO24. Area: 5.10 ha	

Code	Description	Comments	Photograph
EmKaLm	*Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla* mid open woodland over *Kingia australis* and *Xanthorrhoea drummondii* tall open shrubland over *Lambertia multiflora* var. *darlingensis, Beaufortia macrostemon, Hibbertia hypericoides, Paragonis grandiflora and Banksia armata* var. *armata* low shrubland with *Mesomelaena tetragona* and *Lepidosperma leptostachyum* mid sparse sedgeland over *Patersonia occidentalis, Lomandra effusa, Stylidium brunonianum, Dampiera linearis* and *Drosera glanduligera* low sparse forbland. Isolated occurrence of *Beaufortia purpurea* (P3) recorded in this community.	Species richness: 83 native species. Survey effort: HO7, HO18, HO20. Area: 10.54 ha	 

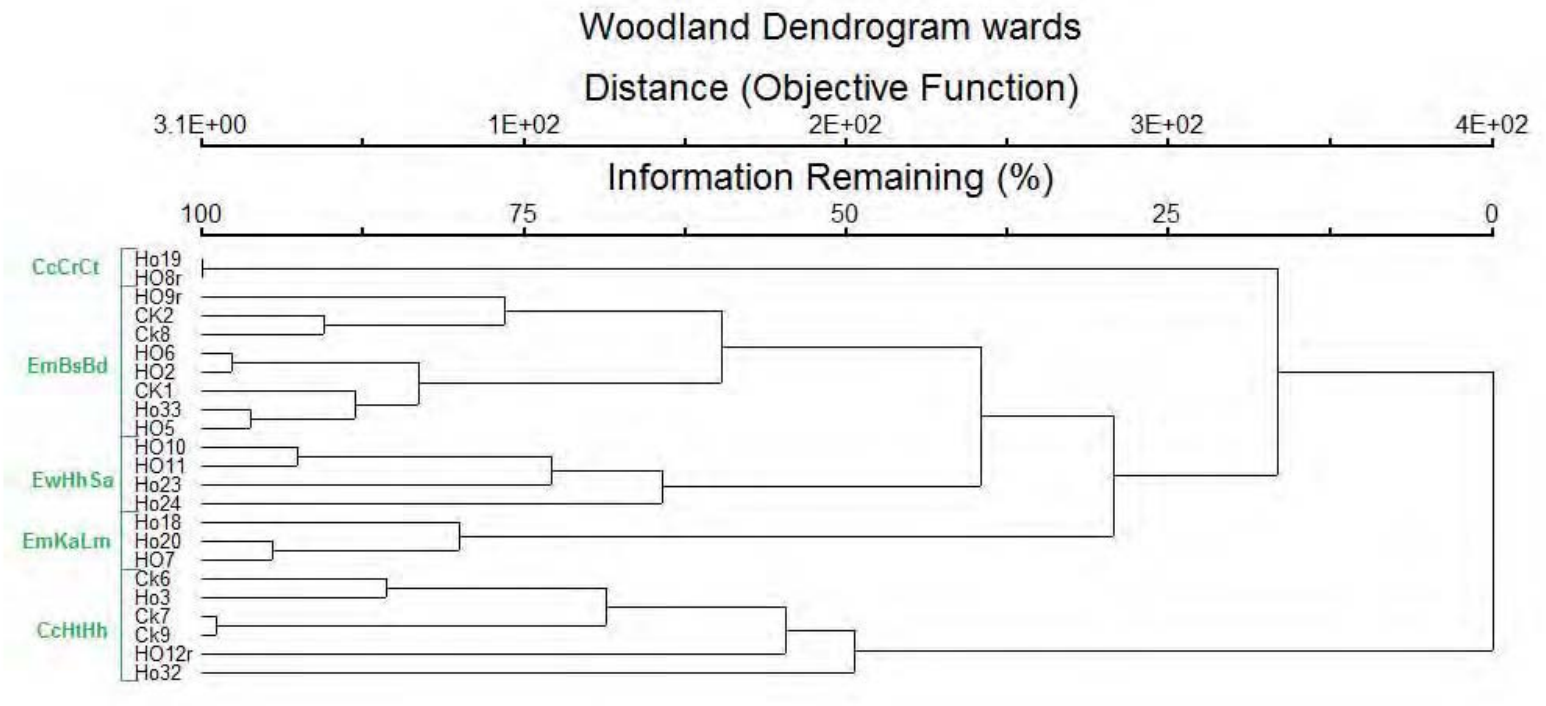


Figure 6 Cluster analysis of woodland communities

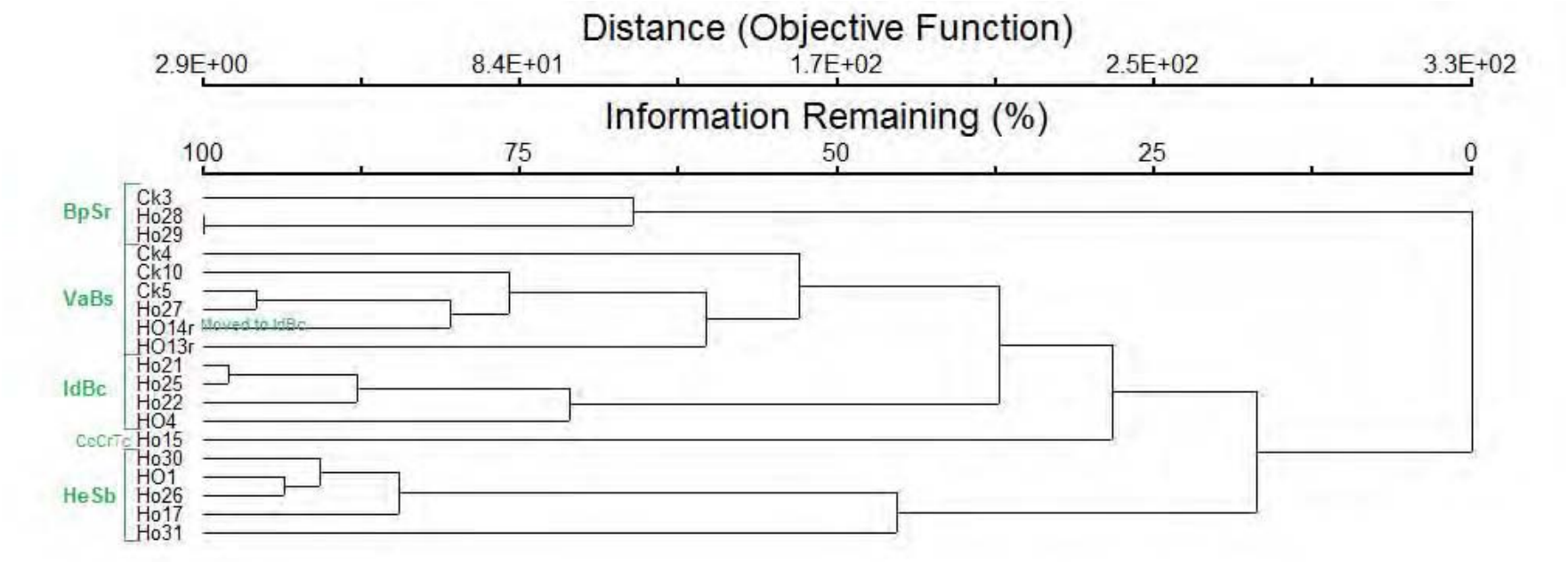
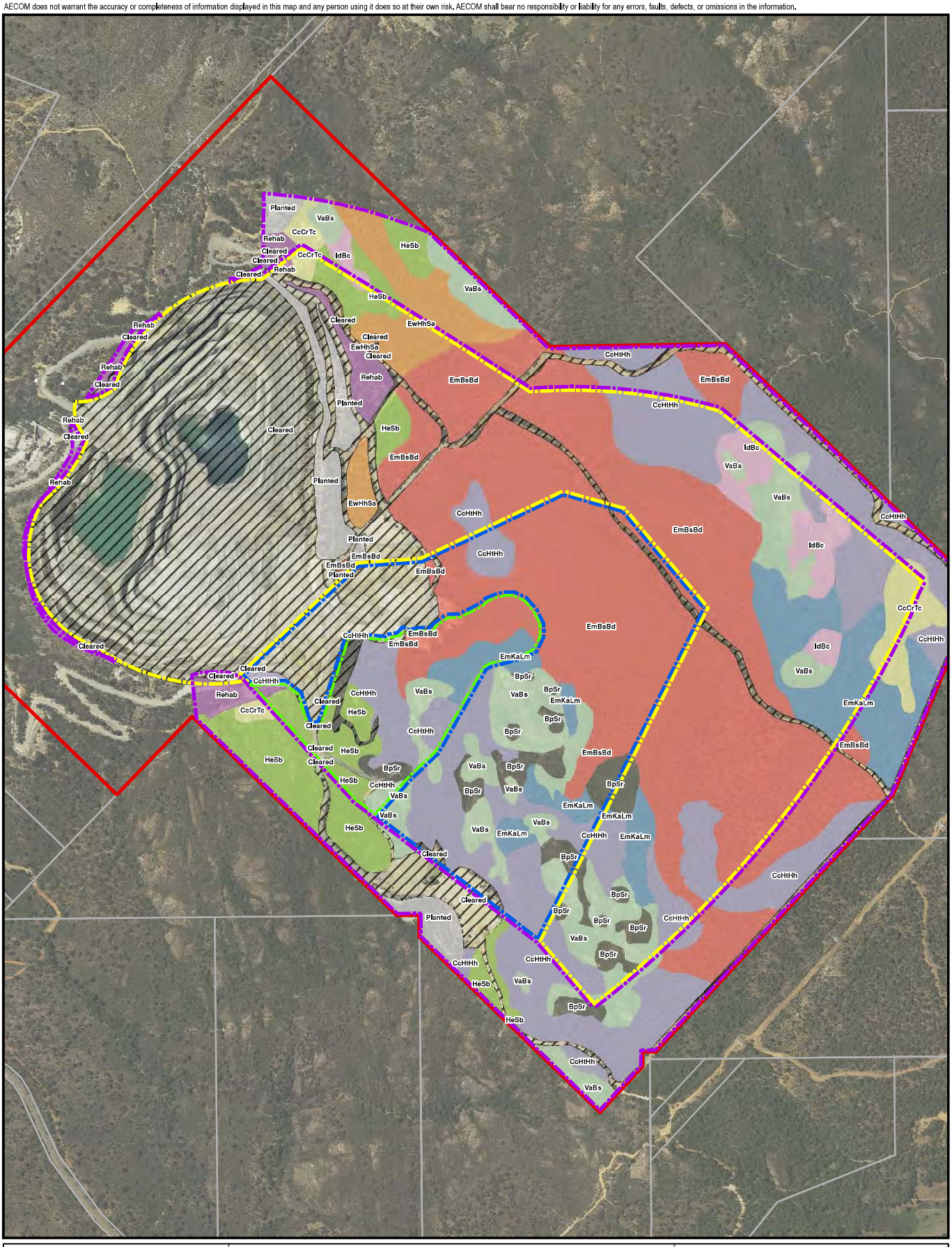


Figure 7 Cluster analysis of heath communities

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID 60522332
CREATED BY DGF/RNM
APPROVED BY FDW
LAST MODIFIED 29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 100 200 300 400
metres

1:10,000 when printed at A4

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

- BpSe
- CcCrTc
- CcHtHh
- Cleared
- EmBsBd
- EmKaLm
- EwHhSa
- HeSb
- IdBc
- Planted
- Rehab
- VaBs

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

HOLCIM QUARRY

Figure 8

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\605223324. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig8_VegetationCommunity_RNM_v04_20170829.mxd (rob.mcgregor)

A4 size

6.2 Vegetation Condition

The condition of the vegetation in the study area ranged from 'Completely Degraded' to 'Excellent', with the majority of the vegetation in the study area in 'Excellent' condition (132.79 ha, 66% of the study area). 'Cleared areas were devoid of native vegetation with only weed species present (54.26 ha, 27% of the study area).

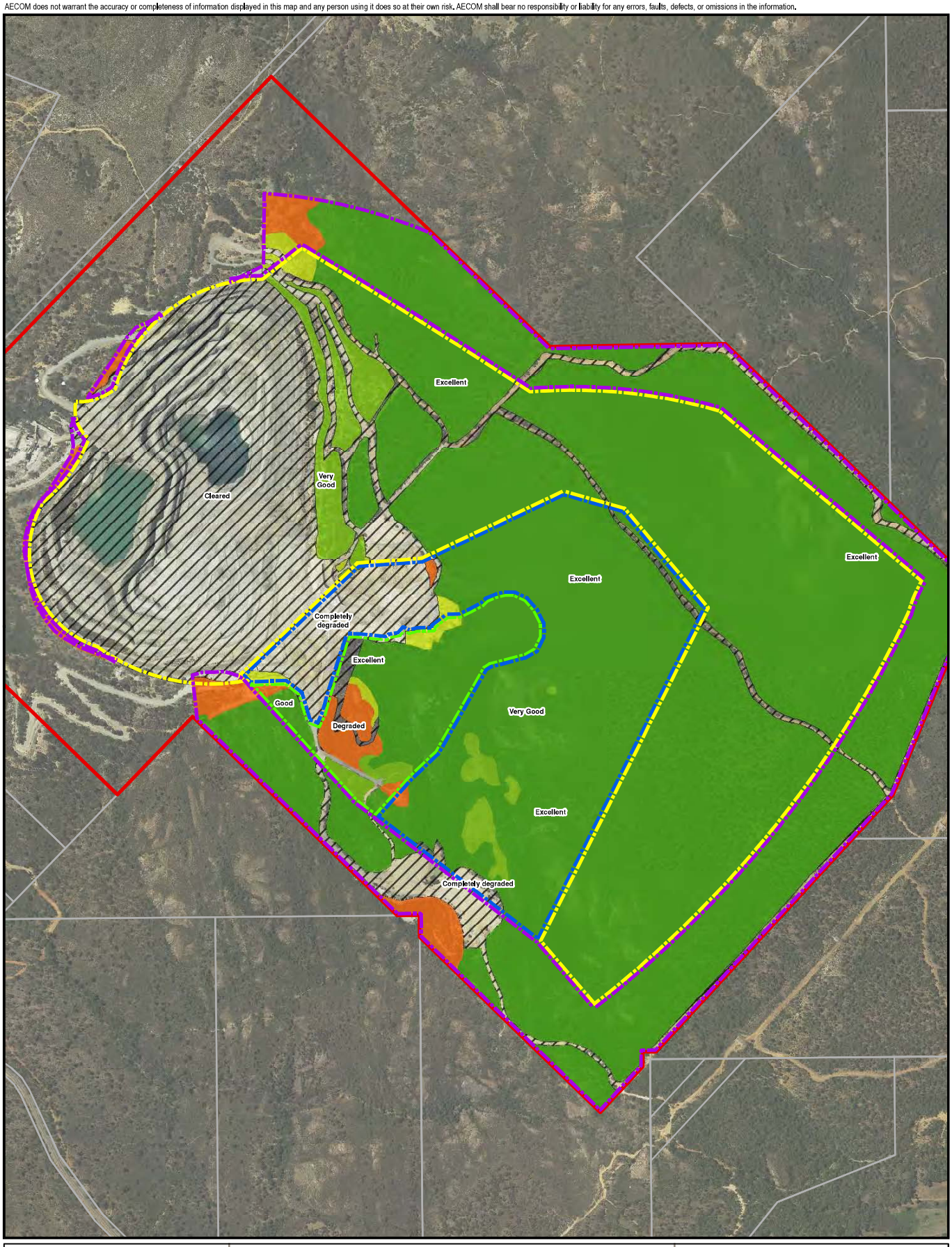
The study area is surrounded by neighbouring intact remnant vegetation, much of which is associated with Banyowla Regional Park. Low disturbance in adjacent vegetation has contributed to the low weeds recorded in the study area.

The area and percentage of vegetation condition categories within the study area is summarised in Table 18 and spatially presented in Figure 9.

Table 18 Vegetation Condition within the Study Area

Condition rating	AECOM 2014, 2015 and 2016 Condition Area	
	Area within study area (ha)	Percentage of study area (%)
Excellent	132.79	66
Very Good	7.01	4
Good	1.27	1
Degraded	4.58	2
Cleared	54.26	27
Total	**199.9**	**100**

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	04 SEP 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 100 200 300 400
metres

1:10,000 when printed at A4

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

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

HOLCIM QUARRY

Figure 9

Map Document: P:\605X\60522332\4. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig9_VegetationCondition_RNM_v04_20170829.mxd (rob.mcgregor)

A4 size

6.3 Flora

A total of 319 vascular flora species from 50 plant families and 150 genera and were recorded within the study area (inclusive of the 2014 and 2015 field surveys. This included 305 (95%) native species and 14 (5%) introduced (weed) species.

The most abundant families represented include Proteaceae (44 taxa; all native), Fabaceae (36 taxa; all native), Myrtaceae (32 taxa; all native) and Asparagaceae (18 species). The full list of flora species recorded is provided in Appendix C.

A species by communities matrix is provided in Appendix D.

6.3.1 Conservation Significant Species

No EPBC Act or WC Act listed flora species were recorded within the study area during the 2014 or 2015 surveys.

No individuals of *Thelymitra stellata* or *Thelymitra magnifica* were recorded within the study area. All areas of potentially suitable habitat were surveyed. Habitat surveyed was largely considered to provide marginal habitat for both species, excluding a small area of potential *Thelymitra stellata* prime habitat located on the northern boundary of the study area.

Five Priority flora species were recorded within the study area including:

- *Acacia horridula* (Priority 3)
- *Acacia oncinophylla* subsp. *patulifolia* (Priority 4)
- *Asteridea gracilis* (Priority 3)
- *Beaufortia purpurea* (Priority 3)
- *Lasiopetalum glutinosum* subsp. *glutinosum* (Priority 3).

Priority species confirmed to occur are discussed in Sections 6.3.1.1 to 6.3.1.5 below.

Similar habitat was observed outside the study area which may provide suitable habitat for Priority species recorded. This would need to be confirmed by survey.

6.3.1.1 *Acacia horridula* – Priority 3

A. horridula is a single-stemmed shrub that grows up to 1 m tall. It has short, pungent leaves and pale yellow flowers. A specimen suspected to be *A. horridula* was collected at one location and submitted to WAH for confirmation due to lack of identifying features available for comparison in the reference herbarium. Mike Hislop confirmed it as this species on 6 Dec 2016.

This species was recorded at one location within the study area comprising six individuals (Table 19). This population is located in community CcCrTc, extending only 0.009 ha despite extensive searching in the area. The species was recorded under a thicket of *Calothamnus rupestris.*

Table 19 *Acacia oncinophylla* subsp. *patulifolia* Population Details

AECOM Populations	Number of Individuals[1] (est.)
1	6

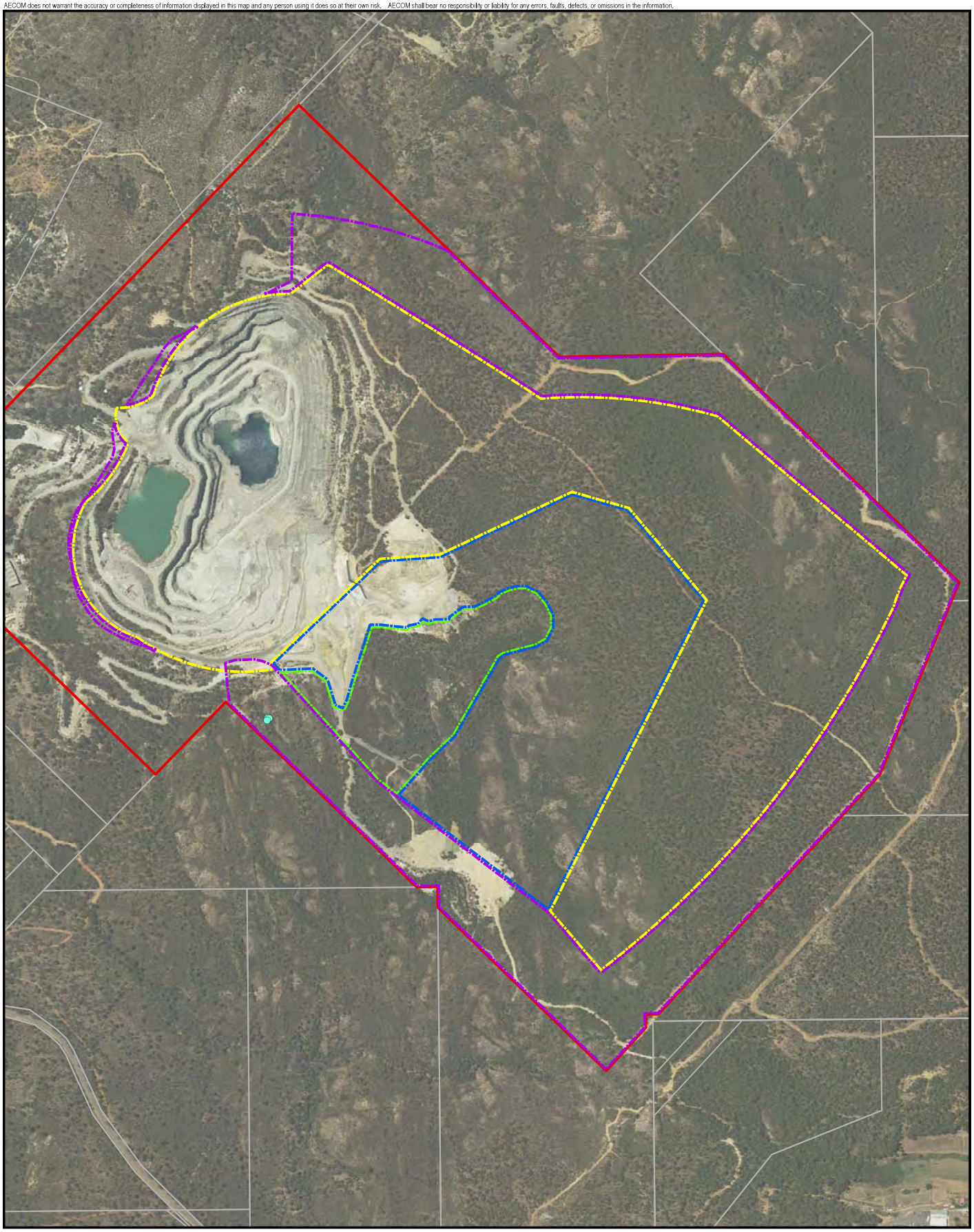
The DPaW database shows six populations in the vicinity of the study area (Table 20). These were recorded between 1900 and 1999 with one record from 2008. Due to the age of the majority of these records it is uncertain how many of these individuals are alive today. Lacking count data the significance of a population of six individuals within the study area is difficult to determine. However, it has been recorded in several local government areas in the vicinity, including Armadale, Gingin, Kalamunda, Mundaring, and Perth. It is therefore unlikely to be locally or regionally significant.

Table 20 *Acacia horridula* Significance Assessment

Measure	AECOM Counts	Database Records[1]	WA Herb Vouchers[2]
Populations	1	6	32
Individuals	6	Est. 6	

1. Sourced from Database results, not all populations have counts provided
2. Sourced from WAH (1998-)

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 75 150 225 300

metres

1:7,500 (when printed at A3)

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

Priority Flora Point Individual Count

- 0 - 25

Priority Flora Area

- *Acacia horridula*

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).

Priority Flora
Acacia horridula

Holcim Quarry

Figure
10

Map Document: P:\605X\605223324. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig10_14_PriorityFlora_RNM_v04_20170829.mxd (rob.mcgregor)

A3 size

6.3.1.2 *Acacia oncinophylla* subsp. *patulifolia* – Priority 4

A. oncinophlylla subsp. *patulifolia* is a shrub that grows up to 3 m tall. It is easily identified from other Acacia species by the 'Minni-ritchi' bark (Plate 1). Flowers are yellow and flowering occurs from August to November or November to December. Plant occurs on granitic soils, and occasionally on laterite.

This species was recorded extensively in VaBs and IdBc, both associated with granite outcrops on upper slopes. This species is considered locally common within the study area. Five populations were recorded with comprising a minimum 3,533 individuals extending approximately 4.92 ha (Table 21). Populations were extensive therefore population counts are estimates only.

Table 21 *Acacia oncinophylla* subsp. *patulifolia* Population Details

AECOM Populations	Number of Individuals[1] (est.)
1	83
2	418
3	8
4	2966
5	58
TOTAL	3533

1. Individuals are estimates only due to large size of population

The DPaW database shows 15 populations in the vicinity of the study area (Table 22). This indicates that the species is locally common. WAH shows a wide distribution including the following local government areas: Armadale, Bridgetown-Greenbushes, Gosnells, Harvey, Kalamunda, Murray, Swan, Wandering. The population within the study area is not at the extent of its known range, and is not considered regionally significant.

Lyn van Gorp collected *A. oncinophylla* subsp. *patulifolia* within the study area in 2015. This specimen has been lodged and vouchered at WAH and has since been registered on the WAH database (record number PERTH 08816611).

Table 22 *Acacia oncinophylla* subsp. *patulifolia* Significance Assessment

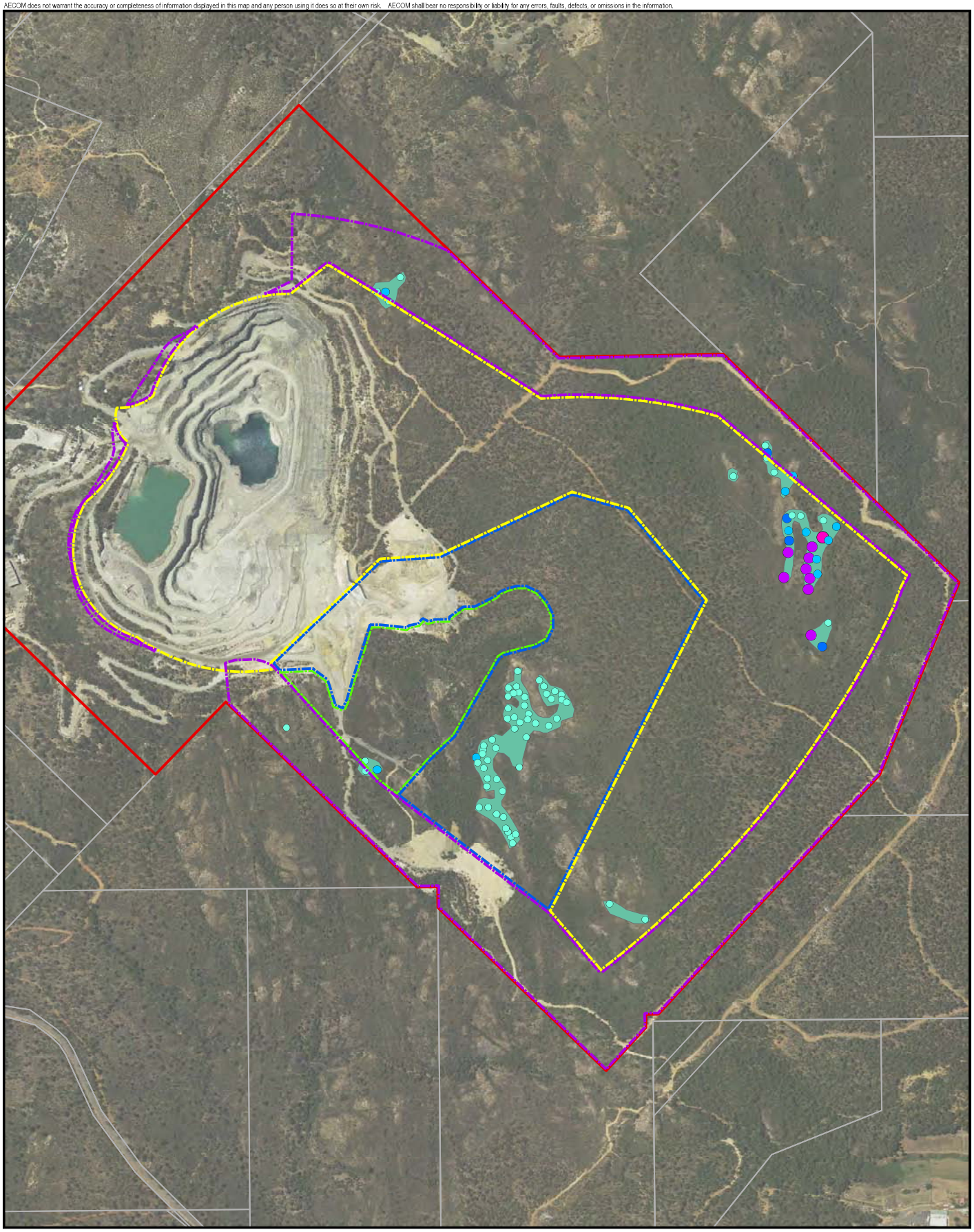
Measure	AECOM Counts	Database Records[1]	WA Herb Vouchers[2]
Populations	5	15	31
Individuals	3533	349	

1. Sourced from Database results, not all populations have counts provided
2. Sourced from WAH (1998-)



Plate 1 ***Acacia oncinophylla*** **subsp.** ***patulifolia*** **minni ritchi Bark, Leaves, and Habit**

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 75 150 225 300

metres

1:7,500 (when printed at A3)

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

Priority Flora Point Individual Count

- 0 - 25
- 26 - 50
- 51 - 100
- 101 - 300
- 301 - 1000

Priority Flora Area

- *Acacia oncinophylla subsp. patulifolia*

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).

Priority Flora
Acacia oncinophylla subsp. patulifolia

Holcim Quarry

Figure 11

Map Document: P:\605X\605223324. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig10_14_PriorityFlora_RNM_v04_20170829.mxd (rob.mcgregor)

A3 size

6.3.1.3 *Asteridea gracilis* – Priority 3

Asteridea gracilis is an annual herb with white to pink flowers. It was distinguished by its three-pronged white petals in the field (Plate 2). It is known to occur on sand, clay and gravelly soils. In the study area, two distinct populations were recorded, one south and one northwest of the existing pit (Figure 12). The northern population followed the *Eucalyptus wandoo* (EwHhSa) community, extending slightly into adjacent heath. The southern population was recorded in community HeSb, also associated with *Eucalyptus wandoo.* It appears to prefer a more open shrubland under a canopy of trees rather than the dense heath on granite. A total of 15 individuals were recorded, with population extent estimated at 0.53 ha (Table 23). Population extent is an estimate only, due to the small size of this species and arbitrary measure of 'extent' based on distance of individuals to one another.

Although extent of population has been provided it is an arbitrary measure as this species is so small, individuals could have been overlooked or hidden under foliage cover from other species.

Table 23 *Asteridea gracilis* Populations Recorded by AECOM (2016)

AECOM Populations	Number of Individuals
1	5
2	10

There are five populations of *A. gracilis* in the vicinity of the study area, with four of these lacking count data (Table 24). The 15 individuals recorded on the DPaW database therefore represents one population only. Total individual count is therefore likely to be higher. Furthermore, it is possible that due to the species' small size it may be under-sampled in the local area. With five populations present within 10 km it is not considered locally significant.

Florabase shows 11 vouchered records of *A. gracilis,* recorded within and between the Shire of Toodyay and Bremer Bay. The populations within the study area are likely to represent the western extent of its range, with all other records located on the Scarp (with the exception of one isolated record from the Esperance Plains). It therefore may be considered regionally significant.

Lyn van Gorp collected *A. gracilis* within the study area in 2015. This specimen has been lodged and vouchered at WAH and has since been registered on the WAH database (record number PERTH 08816646).

Table 24 *Asteridea gracilis* Significance using DPaW and WA Herbarium Data

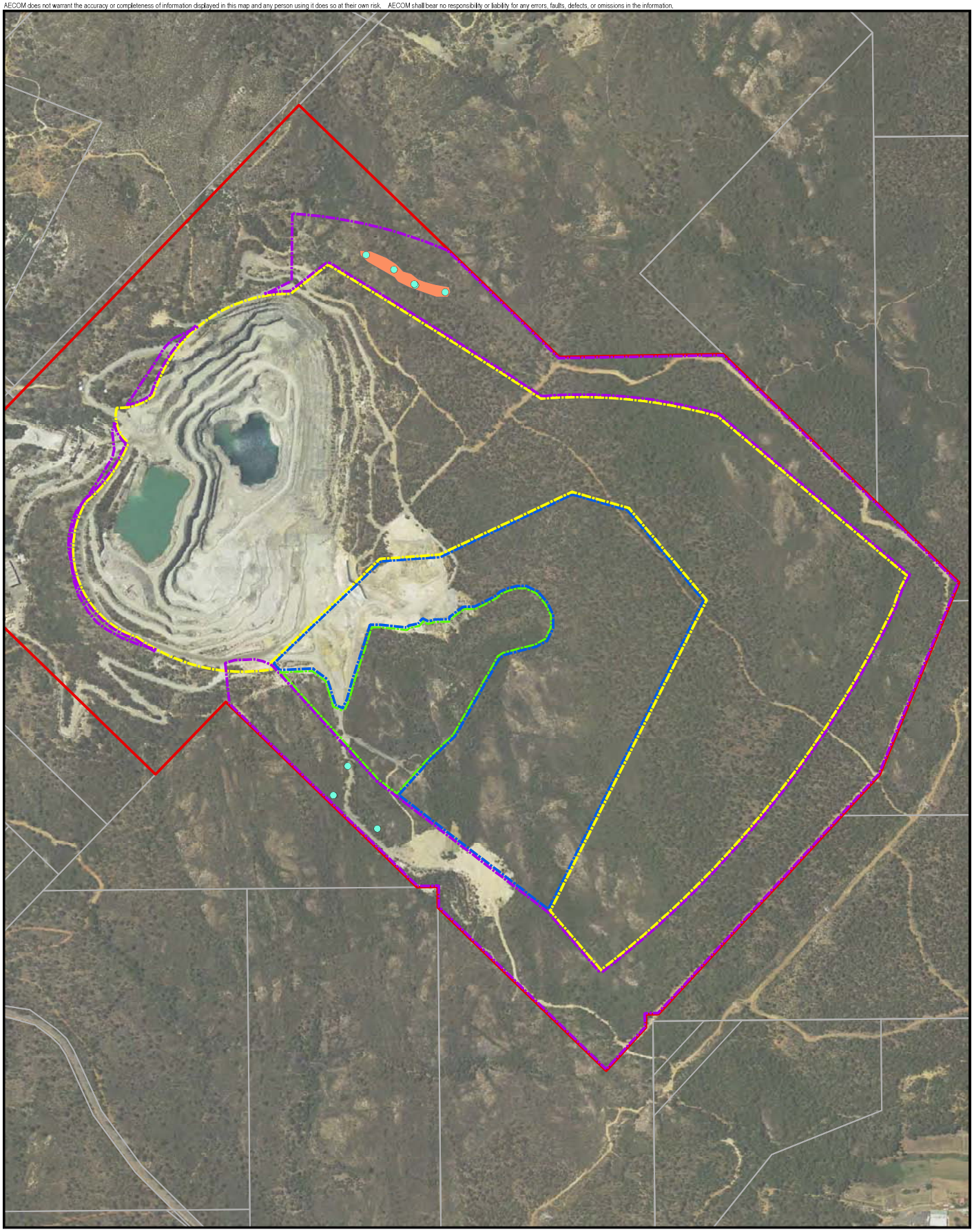
Measure	AECOM Counts	Database Records[1]	WA Herb Vouchers[3]
Populations	2	5	11
Individuals	15	15	

1. Sourced from Database results, count data missing from four populations
2. Sourced from WAH (1998-)



Plate 2 ***Asteridea gracilis***

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 75 150 225 300

metres

1:7,500 (when printed at A3)

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

Priority Flora Point Individual Count

- 0 - 25

Priority Flora Area

- *Asteridea gracilis*

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).

Priority Flora
Asteridea gracilis

Holcim Quarry

Figure
12

Map Document: P:\605X\605223324. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig10_14_PriorityFlora_RNM_v04_20170829.mxd (rob.mcgregor)

A3 size

6.3.1.4 *Beaufortia purpurea* – Priority 3

Beaufortia purpurea is an erect spreading shrub easily distinguished by its deep red to purple flowers (**Plate 3**). It grows on lateritic and granitic soils on rocky slopes.

An estimated 17,198 individuals occur within three distinct populations in the study area, extending approximately 9.28 ha (Table 23). Note that the extent of populations is not based on the community BpSe despite this community being dominated by this species.

B. purpurea was recorded in heath communities including BpSe, and some of VaBs and HeSb. There are some isolated occurrences in adjacent woodlands of EmKaLm and EmBsBd (Figure 13).

Table 25 *Beaufortia purpurea* Populations Recorded by AECOM (2016)

AECOM Populations	Number of Individuals[1]
1	17068
2	100
3	30
TOTAL	17198

1. Due to population size individual counts are estimates only

Database records show two populations of *B. purpurea* recorded in the vicinity of the study area (Table 24). Thirty-seven vouchered records exist for the species on FloraBase. Most of these have been recorded between Walyunga National Park and Gooseberry Hill. The species' distribution is restricted to five local government areas including Gosnells, Kalamunda, Mundaring, Swan and Toodyay.

Although the species was found to be common within the plant community BpSe, it is not considered locally or regionally common, shown by the lack of database records. Populations within the study area are therefore considered locally and potentially regionally significant due to the extent and size.

Lyn van Gorp collected *B. purpurea* within the study area in 2015. This specimen has been lodged and vouchered at WAH and has since been registered on the WAH database (record number PERTH 08816638).

Table 26 *Beaufortia purpurea* Significance using DPaW and WA Herbarium Data

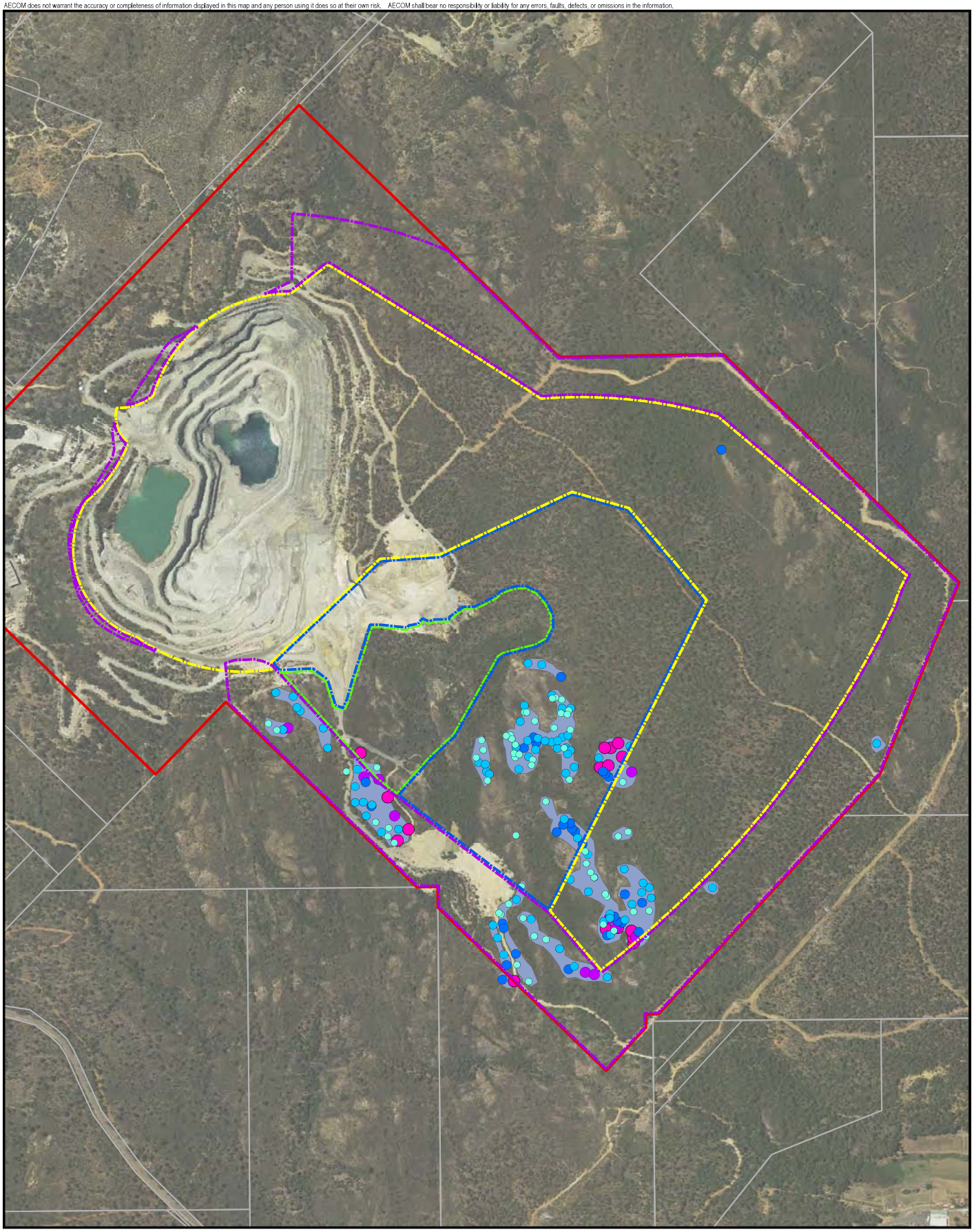
Measure	AECOM Counts	Database Records[1]	WA Herb Vouchers[3]
Populations	3	2	37
Individuals	17198	No counts provided	

1. Sourced from Database results, count data missing from four populations
2. Sourced from WAH (1998-)



Plate 3 *Beaufortia purpurea* Flower and Habit

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 75 150 225 300

metres

1:7,500 (when printed at A3)

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

Priority Flora Point Individual Count

- 0 - 25
- 26 - 50
- 51 - 100
- 101 - 300
- 301 - 1000

Priority Flora Area

- *Beaufortia purpurea*

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).

Priority Flora
Beaufortia purpurea

Holcim Quarry

Figure 13

Map Document: P:\605X\60522332\4. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig10_14_PriorityFlora_RNM_v04_20170829.mxd (rob.mcgregor)

A3 size

6.3.1.5 *Lasiopetalum glutinosum* subsp. *glutinosum* – Priority 3

Lasiopetalum glutinosum subsp. *glutinosum* is an erect to straggling shrub with pink to purple flowers. It is easily distinguishable by the sticky residue on the flowers, and almost-heart-shaped leaves (Plate 4).

Six populations comprising 313 individuals were recorded in the study area extending approximately 3.51 ha (Table 27). Population extent for this species is an arbitrary measure. Individuals were often recorded widely spaced from one another (100 m or more) making it difficult to determine which population an individual would belong too. *L. glutinosum* subsp. *glutinosum* was recorded in heath communities associated with granite outcrops including VaBs, HeSb and BpSe (Figure 14).

Table 27 *Lasiopetalum glutinosum* subsp. *glutinosum* populations recorded by AECOM (2016)

AECOM Populations	Number of Individuals
1	25
2	124
3	25
4	22
5	114
6	3
TOTAL	313

There are only four populations of *L. glutinosum* subsp. *glutinosum* recorded in the vicinity of the study according to the DPaW database, and WAH showing 47 vouchered specimens (Table 28). The majority of these records are associated with the Darling Scarp and are distributed between the local government areas of Northam and Serpentine-Jarrahdale. Lack of count data provided makes it difficult to determine the significance of the number of individuals recorded within the study area. Due to the size of the population and the size and extent of *L. glutinosum* subsp. *glutinosum* populations in the study area, it should be considered locally and potentially regionally significant.

Lyn van Gorp collected *L. glutinosum* subsp. *glutinosum* within the study area in 2015. This specimen has been lodged and vouchered at WAH and has since been registered on the WAH database (record number PERTH 08816603).

Table 28 *Lasiopetalum glutinosum* subsp. *glutinosum* Significance using DPaW and WA Herbarium Data

Measure	AECOM Counts	Database Records[1]	WA Herb Vouchers[3]
Populations	6	4	47
Individuals	313	No counts provided	

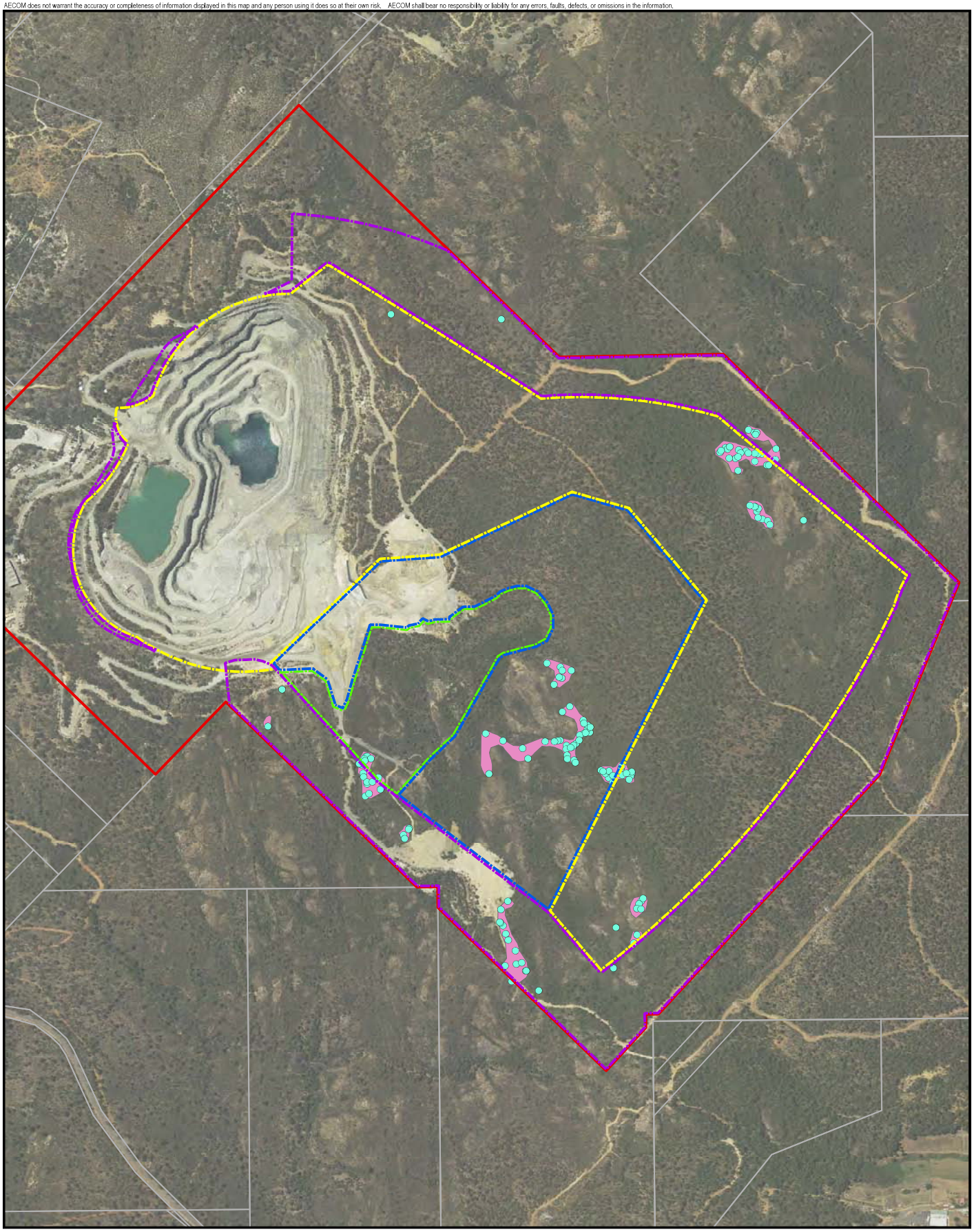
1. Sourced from Database results, count data missing from four populations

2. Sourced from WAH (1998-)



Plate 4 ***Lasiopetalum glutinosum*** **subsp.** ***glutinosum*** **Flower and Habit**

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID	60522332
CREATED BY	DGF/RNM
APPROVED BY	FDW
LAST MODIFIED	29 AUG 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 75 150 225 300

metres

1:7,500 (when printed at A3)

LEGEND

- Astron 2012 and Bennett 2014 Survey Area
- AECOM 2014 Survey Area
- AECOM 2015 Survey Area
- AECOM 2016 Survey Area
- Holcim Tenement
- Cadastre Boundaries

Priority Flora Point Individual Count

- 0 - 25

Priority Flora Area

- *Lasiopetalum glutinosum subsp. glutinosum*

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).

Priority Flora
Lasiopetalum glutinosum subsp. glutinosum

Holcim Quarry

Figure 14

Map Document: P:\605X\605223324. Tech Work Area\4.99 GIS\02_MXDs\Figures\G60522332_Fig10_14_PriorityFlora_RNM_v04_20170829.mxd (rob.mcgregor)

A3 size

6.3.2 Weed species

A total of 14 introduced (weed) species were recorded within the study area. None of the recorded weed species are categorised as Declared Pests in accordance with Section 22 of the BAM Act, as Weeds of National Significance (WONS), or listed on the Swan Weeds database (which are environmental weeds posing a serious threat to the rich natural biodiversity of the Swan Region in Western Australia).

None of the weeds recorded are considered of 'high' significance in accordance with the Weed Strategy. The low weed species count reflects the high biodiversity value and excellent condition of vegetation within the study area. The weeds recorded can be viewed in the species list in Appendix C.

7.0 References

AECOM 2015. Flora, Vegetation and Targeted Orchid Assessment. Unpublished report prepared for Holcim (Australia) Pty Ltd.

AECOM Australia Pty Ltd (AECOM) 2014. Flora, Vegetation and Targeted Orchid Assessment. Unpublished report prepared for Holcim (Australia) Pty Ltd.

Astron Environmental Services (Astron), 2012a. Gosnells Quarry Desktop Flora, Vegetation and Fauna Survey. October 2012. Unpublished report prepared for Holcim (Australia) Pty Ltd.

Astron, 2012b. Gosnells Quarry Field Flora, Vegetation and Fauna Survey. October 2012. Unpublished report prepared for Holcim (Australia) Pty Ltd.

Beard JS, 1981 Swan, 1:1,000,000 vegetation series explanatory notes to sheet 7. The vegetation of the Swan University of Western Australia, Perth WA.

Bennett Environmental Consulting (Bennett), 2005. Vegetation and Flora Readymix Quarry Gosnells. Unpublished report prepared for Holcim.

Bennett, 2006. Untitled Report. Report on vegetation results at two sites adjacent to current quarry. 2006.

Bennett, 2014. Search for *Thelymitra stellata* and *Thelymitra magnifica.* Unpublished report prepared for Holcim.

Bettink, K and Keighery, G. 2008 Environmental Weed Census and Prioritisation, Swan NRM Region. Swan Catchment Council (SCC) and Department of Environment and Conservation publication.

Brown A, Dixon K, French C, Brockman G, 2013. Field Guide to the Orchids of Western Australia. Simon Nevill Publications, Perth.

Bureau of Meteorology (BoM) 2015. *Climate Statistics for Australian Locations: Monthly Climate Statistics – Summary Statistics Gosnells City,* viewed 14 December 2015. http://www.bom.gov.au/climate/averages/tables/cw_009021.shtml

Chapman, A. 2013. *A visual guide to the Interim Biogeographic Regionalisation of Australis (IBRA) in WA,* viewed January 2015 https://florabase.dpaw.wa.gov.au/help/ibra/#map

Commonwealth of Australia 2013a. Survey Guidelines for Australia's Threatened Orchids. Guidelines for Detecting Orchids Listed as 'Threatened' Under the Environmental Protection and Biodiversity Conservation Act 1999.

Commonwealth of Australia, 2003. Australian Vegetation Attribute Manual Version 6.0. Natural Heritage Trust, Canberra.

Commonwealth of Australia, 2012. Interim Biogeographic Regionalisation for Australia, Version 7. Department of the Environment and Energy, Canberra, Australian Capital Territory.

Conservation and Land Management (CALM), 2002. Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. Department of Conservation and Land Management, Perth, Western Australia.

CSIRO Land and Water, 2014. Digital Atlas of Australian Soils. GIS data layer

DEC, 2010. Threatened and Priority Flora Report Form – Field Manual. Version 1.0. Department of Environment and Conservation, Kensington, WA.

Department of Environment and Conservation (DEC), 2009. *Standard Operating Procedure. Establishing Vegetation Quadrats. SOP No: 6.1.* Prepared by V. Clarke for Significant Native Species and Ecological Communities – Resource Condition Monitoring Project. Kensington.

Department of Parks and Wildlife (DPaW) 2015. Florabase. The western Australia Flora. Viewed November 2014. http://florabase.dpaw.wa.gov.au/

DPaW, 2016. Vegetation Statistics Statewide 2015. Available at: https://www2.landgate.wa.gov.au/web/guest/downloader.

Environmental Protection Authority (EPA), 2000. Environmental Protection of Native Vegetation in Western Australia. Position Statement 2, EPA, Perth WA.

EPA, 2004. Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 51. Environmental Protection Authority, Perth, Western Australia

Geological Survey of Western Australia and Geoscience Australia 2008. *Surface Geology of Australia 1:1,000,000 Western Australia*. GIS data layer.

Heard L, and Channon B. 1997. Guide to Native Vegetation Survey: Using the Biological Survey of South Australia.

Heddle EM, Loneragan OW and Havel JJ, 1980. Vegetation of the Darling System in *Atlas of Natural Resources Darling System, Western Australia*. Department of Conservation and Environment, Perth.

Hopper SD, Brown AP, Marchant NG. 1997. Plants of Western Australian Granite Outcrops. Journal of the Royal Society of Western Australia 80: 141-158.

Jones D, 2006. A Complete Guide To Native Orchids of Australia Including the Island Territories.

Keighery, B.J. 1994. *Bushland Plant Survey – A Guide to Plant Community Survey for the Community Wildflower Society of WA (inc)*, Nedlands, Western Australia

Markey A, 1997. A Floristic Survey of the Northern Darling Scarp, report to the Western Australian Department of Conservation and Land Management, the Department of Environmental Protection and the Western Australian Conservation Council (Inc.) for the Australia Heritage Commission, Perth.

Mattiske EM, Havel JJ, 1998. Regional Forest Agreement – Vegetation Complexes – 1:250,000 Mapsheets.

Thackway R and Cresswell ID, 1995. An Interim Biogeographic Regionalisation for Australia: A Framework for Setting Priorities in the National Reserves System Cooperative Program. Version 4. Australian Nature Conservation Agency, Canberra

URS 2013. Gosnells Quarry Clearing Permit CPS 5543/2 Amendment Application Supporting Information

Western Australian Local Government Association, 2013. 2013 Native vegetation in the Jarrah Forest and Warren IBRA regions. Publicly available information. Viewed 15 December, 2015, http://pbp.walga.asn.au/Publications.aspx

Williams K, and Mitchell D, 2001, 'Jarrah Forest 1 (JF1 – Northern Jarrah Forest subregion)' in CALM 2002. *Bioregional Summary of the 2002 Biodiversity Audit for Western Australia*. Department of Conservation and Land Management, Perth, Western Australia.

Appendix A

DPaW Consultation 2016

De Wit, Floora

From: Donaldson, Jessica <Jessica.Donaldson@dpaw.wa.gov.au>
Sent: Wednesday, 19 October 2016 1:37 PM
To: De Wit, Floora
Cc: Kirchner, Linda; Llorens, Tanya
Subject: RE: Holcim Gosnells Quarry - advice for targeted surveys
Attachments: G60444570_Map1_ProjectLocation_DF_v02_20160318.pdf; Gosnells Holcim Targeted Flora.docx

Hi Floora,

I am happy to provide advice pre-survey. Generally someone from Species and Communities will be able to assist in providing this advice and so if you are unsure of the correct contact please send the email to flora.data@dpaw.gov.au and it will be sent onto the appropriate staff member, and/or local District officer if relevant.

I would suggest using traverse line searches spaced at 10m apart, any wider and the ability to detect the orchid species *Thelymitra magnifica* and *Thelymitra stellata* would be compromised. As it is a targeted search, you need to be able to confidently state that you have systematically searched any potential habitat for the species being targeted.

I can see from our records that previous advice regarding the timing of targeted surveys for *Thelymitra magnifica* and *Thelymitra stellata* was provided by Anthea Jones (currently on maternity leave), with consultation with DPaW Orchid specialist Andrew Brown in this area in relation to a clearing permit application (CPS 5543). I have confirmed this advice with Andrew, which is that both species flowering time overlaps in late October and so surveys for these two species can be conducted then. Andrew has advised that a mid-November survey for *T. stellata* would be too late, this species flowers in the Perth area in late October to early November.

From my knowledge and discussions with other staff, there has not been any change in flowering times this year in the Swan Coastal area. I do not have any particular local knowledge of the area, the assessment of likelihood of potential conservation listed flora should be based on the habitat present in the survey area compared with the recorded habitat of the Threatened and Priority flora found in the local area. The local flora conservation officer is the best contact in regards to local knowledge of the District, the Perth Hills District flora conservation officer is Tanya Llorens (copied into this email).

For the species in your list that do not have a flowering time, it would be worthwhile checking the Departments Threatened and Priority flora list (https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants) to see whether it is recorded here. Please note that the conservation codes for Priority flora on this published list are subject to change between lists being published, and so the current conservation status should always be checked using the florabase website. Whilst a species flowering time may not be recorded on florabase website the flowering period may be sourced from the paper where the name was published or from examining the flowering specimens that have been collected.

Kind Regards

Jessica Donaldson| Botanist| Species & Communities Branch
Department of Parks and Wildlife | Kensington | Ph. 9219 8760| jessica.donaldson@dpaw.wa.gov.au
Part Time: Tuesdays, Wednesdays and Thursdays

Please think of the environment before printing this email.

From: De Wit, Floora [mailto:Floora.DeWit@aecom.com]
Sent: Friday, 14 October 2016 11:30 AM
To: Donaldson, Jessica
Cc: Kirchner, Linda
Subject: Holcim Gosnells Quarry - advice for targeted surveys

Hi Jess,

We have recently been engaged by Holcim Gosnells Quarry to undertake additional flora and vegetation surveys including targeted searches.
Previously we have liaised with you regarding the *Thelymitra* surveys undertaken on their tenement. Additional surveys are now required for a suite of other Threatened and Priority species that are considered likely to occur. These include *Goodenia arthrotricha, Darwinia apiculata* and 17 Priority species (list attached).

We propose to undertake targeted surveys in in the next two weeks since October seems to be the best month with the most overlap of flowering periods of these species. *Thelymitra magnifica* will be included in these searches. Following this, *Thelymitra stellata* searches will be undertaken in mid-November. Transects of approximately 10-20 metres will be walked across the Project Area with a field guide to identification of these species.

So my questions are:

1. Do you think this method is suitable for the objective of the survey? (identifying the environmental value and potential of cons. sig flora to occur within the Project Area)
2. Are any species of particular concern or more or less likely to occur given your knowledge of the area?
3. Has the colder climate had any impact on flowering of species in your opinion?

Thanks I appreciate your time. The client is keen to get any input from DPaW at this stage of the survey as well. Requests for liaison with DPaW regarding survey methods is becoming more and more common. Please advise if there is a more suitable general email address to use for these requests.

Cheers,

Floora de Wit
Senior Botanist
D +61 8 6208 1073
Floora.DeWit@aecom.com

AECOM
Level 6, 3 Forrest Place, Perth, WA 6000
GPO Box B59 Perth WA 6849
T +61 8 6208 0000 F +61 8 6208 0999
aecom.com

Built to deliver a better world

LinkedIn Twitter Facebook Instagram

Appendix B

Desktop Assessment

Appendix B Desktop Assessment

species	Conservation status (state)	Conservation status Cwlth	Description	Likelihood
Acacia aphylla	T (VU)	VU	Divaricately branched, spinescent, glaucous shrub, 0.9-2.5 m high. Fl. yellow, Aug to Oct. Sand, loam, clay loam. Granite outcrops, hills.	May. Suitable habitat present however no known records in vicinity of study area.
Acacia horridula	Priority 3	-	Harsh, slender, single-stemmed shrub, 0.3-0.6(-1) m high. Fl. yellow, May to Aug. Gravelly soils over granite, sand. Rocky hillsides.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	Priority 1	-	Compact or rather diffuse, spinescent shrub, 0.2-0.6(-2.5) m high. Fl. yellow, Jun to Oct. Variety of soils	Unlikely. No known records and no suitable habitat present.
Acacia oncinophylla subsp. *patulifolia*	Priority 4	-	Shrub, 0.5-2.5(-3) m high, 'minni-ritchi' bark, phyllodes 4-9 cm long, 3-6 mm wide. Fl. yellow, Aug to Nov or Nov to Dec. Granitic soils, occasionally on laterite.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Allocasuarina grevilleoides	Priority 3	-	Dioecious, lignotuberous shrub, 0.15-0.4 m high. Sand over laterite, gravel. Previously recorded in open or dense low heathland in Ellis Brook Valley Reserve	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Andersonia sp. Audax (F. Hort, B. Hort & J. Hort 3179)	Priority 3	-	No information available on habitat and no nearby records of species available	May. Unknown habitat, no known records in vicinity of study area.
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	Priority 2	-	Low erect/spreading plant with whit/cream flowers. Previously found in Jarrah, Marri woodland or heathland	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Andersonia sp. Saxatilis (F. & J. Hort 3324)	Priority 1	-	No information available on habitat and no nearby records of species available	May. Unknown habitat, no known records in vicinity of study area.
Anthocercis gracilis	T (VU)	VU	Erect, spindly shrub, to 0.6(-1) m high. Fl. yellow-green, Sep to Oct. Sandy or loamy soils. Granite outcrops.	May. Suitable habitat present, one known record 10km from study area.

species	Conservation status (state)	Conservation status Cwlth	Description	Likelihood
Aponogeton hexatepalus	Priority 4	-	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green-white, Jul to Oct. Mud. Freshwater: ponds, rivers, claypans.	Unlikely. No known records and no suitable habitat present.
Asteridea gracilis	Priority 3	-	Annual, herb, 0.15-0.35 m high. Fl. white-pink, Sep to Dec. Sand, clay, gravelly soils.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Austrostipa jacobsiana	T (CR)	-	No habitat or location data available. Assumed not occurring within 10 km due to lack of location data	May. Unknown habitat, no known records in vicinity of study area.
Banksia kippistiana var. *paenepeccata*	Priority 3	-	Erect, prickly, lignotuberous shrub, 0.3-1.2 m high. Fl. yellow-cream, Oct to Nov. Lateritic gravelly soils. Previously recorded in heath fringed by jarrah, Marri and Allocasuarina fraseriana open woodland or in open woodland of Eucalyptus marginata	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Banksia mimica	T (VU)	EN	Prostrate, lignotuberous shrub, 0.15-0.4 m high. Fl. yellow-brown, Dec or Jan to Feb. White or grey sand over laterite, sandy loam. Previously recorded in low scrub generally with Kingia	May. Suitable habitat present however no known records in vicinity of study area.
Beaufortia purpurea	Priority 3		Erect or spreading shrub, 0.3-1.5 m high. Flowers are red-purple, Oct to Dec or Jan to Feb. Lateritic or granitic soils. Rocky slopes.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Boronia tenuis	Priority 4	-	Flowers pale purple. Previously recorded on slope amoungst granite boulders and outcrop. Also recorded on various loam, clay, gravel soils over granite. Recorded in Sheoak thicket or heathland or open woodland	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Byblis gigantea	Priority 3	-	Small, branched perennial, herb (or sub-shrub), to 0.45 m high. Fl. pink-purple/white, Sep to Dec or Jan. Sandy-peat swamps. Seasonally wet areas.	Unlikely. No known records and no suitable habitat present.

species	Conservation status (state)	Conservation status Cwlth	Description	Likelihood
Calothamnus accedens	Priority 4	-	*Erect & slender shrub, to 1.8 m high. Fl. pink-red. Sandy soils over laterite. Road verge. Previously recorded nearby in grey sand over gravel or rocky loam or rocky clay in open woodland or dense heath*	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Calothamnus graniticus subsp. *leptophyllus*	Priority 4	-	*Erect, multi-stemmed shrub, 1-2 m high. Fl. red, Jun to Aug. Clay over granite, lateritic soils. Hillsides. Previously recorded in rehabilitated area in Gosnells quarry boundary*	Known.
Calytrix breviseta subsp. *breviseta*	T (CR)	EN	Shrub, 0.4-1 m high. Fl. purple-blue, Oct to Nov. Sandy clay. Swampy flats.	Unlikely. No known records and no suitable habitat present.
Centrolepis caespitosa	Priority 4		Tufted annual, herb (forming a rounded cushion up to 25 mm across). Fl. Oct to Dec. White sand, clay. Salt flats, wet areas	Unlikely. No known records and no suitable habitat present.
Conospermum undulatum	T (VU)	VU	Erect, compact shrub, 0.6-2 m high. Fl. white-other, May to Oct. Grey or yellow-orange clayey sand.	Unlikely. No suitable habitat present. Multiple records in vicinity of study area however this species is restricted to the Swan Coastal Plain.
Darwinia apiculata	T (EN)	EN	Previously recorded in gravel, grey sand clay over granite or dry laterite around disturbed gravel pit site. Previously recorded in heathland or Marri woodland	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Drosera occidentalis subsp. *occidentalis*	Priority 4		Fibrous-rooted, rosetted perennial, herb, to 0.01 m high. Fl. pink/white, Nov to Dec. Sandy & clayey soils. Swamps & wet depressions.	Unlikely. No known records and no suitable habitat present.
Eleocharis keigheryi	T (VU)	VU	Rhizomatous, clumped perennial, grass-like or herb (sedge), to 0.4 m high. Fl. green, Aug to Nov. Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Unlikely. No known records and no suitable habitat present.
Goodenia arthrotricha	T (EN)	-	Erect perennial, herb, to 0.4 m high. Fl. blue, Oct to Nov. Gravel. Granite rocks, slopes.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.

species	Conservation status (state)	Conservation status Cwlth	Description	Likelihood
Grevillea crowleyae	Priority 2	-	Dense & spreading shrub, 0.5-1.5 m high. Fl. Aug to Nov. Gravel. In gravel pit. No nearby records of species exist in close proximity to study area	May. Suitable habitat present however no known records in vicinity of study area.
Grevillea manglesii subsp. ornithopoda	Priority 2	-	Spreading, virgate shrub, 1-3(-5) m high, up to 3 m wide. Fl. Sep to Nov. Prefers habitat amongst medium trees, or low trees, or tall (sclerophyll) shrubland, or low (sclerophyll) shrubland; in gravelly soil, or sand, or clay; occupying along creek beds. No nearby records of species available.	May. Suitable habitat present howoever no known records in vicinity of study area.
Grevillea thelemanniana subsp. *thelemanniana*	T (CR)	-	Low spreading bush with pink/red flowers. Previously recorded on sand below the scarp	Unlikely. No known records and no suitable habitat present.
Halgania corymbosa	Priority 3	-	Erect shrub, 0.35-1 m high. Fl. blue-purple, Aug to Nov. Gravelly soils, soils over granite.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Hemigenia rigida	Priority 1	-	Upright or spreading shrub, 0.1-0.6(-1) m high. Fl. blue-purple/violet, Aug to Dec or Jan. Sandy soils, lateritic gravelly soils. Hillslopes, granite outcrops, flats, ironstone ridges.	May. Suitable habitat present however no recent records (1985 is the most recent) in vicinity of study area.
Isopogon drummondii	Priority 3	-	Erect, lignotuberous shrub, 0.4-1 m high. Fl. yellow/cream-yellow, Feb to Jun. White, grey or yellow sand, often over laterite.	Unlikely. No known records and no suitable habitat present.
Lasiopetalum glutinosum subsp. *glutinosum*	Priority 3	-	Previously recorded in various soil types including lateritic gravel and clay or brown, clayey sand with laterite.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Meionectes tenuifolia	Priority 3	-	No information available on habitat preferences. Previous records occur on the Swan Coastal Plain more than 4.5km to the west	Unlikely. Unknown habitat preference, records restricted to the Swan Coastal Plain.
Paracaleana gracilicordata	Priority 1	-	Perennial, herb, to 0.07 m high. Fl. green-yellow-purple, Oct to Nov. Growing on moss mats, granite. Outcrops. No nearby records of species exist in close proximity to study area	May. Suitable habitat present however no known records in vicinity of study area.

species	Conservation status (state)	Conservation status Cwlth	Description	Likelihood
Paracaleana granitica	Priority 1	-	Perennial, herb, to 0.07 m high. Fl. green-purple, Oct to Dec. Growing on moss mats, granite. Outcrops. No nearby records of species exist in close proximity to study area	May. Suitable habitat present however no known records in vicinity of study area.
Pimelea rara	Priority 4	-	Shrub, 0.2-0.35 m high. Fl. white, Dec or Jan. Lateritic soils.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Ptilotus sericostachyus subsp. *roseus*	Priority 1	-	Prostrate to ascending perennial, herb. Fl. pink-white, Sep to Dec. No nearby records of species exist in close proximity to study area	May. Unknown habitat preference and no records in vicinity of study area.
Schoenus benthamii	Priority 3	-	Rhizamatous perennial. Previously recorded in open grey sand over clay, open swamp	Unlikely. No known records and no suitable habitat present.
Schoenus pennisetis	Priority 3	-	Tufted sedge. Previously recorded in low lying sandy swamp, slightly saline	Unlikely. No known records and no suitable habitat present.
Stackhousia sp. Red-blotched corolla	Priority 3	-	Previously recorded in light brown yellow silty-gravel with surface granite and lateritic gravel and cobbels in heathland	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Tetratheca sp. Granite (S. Patrick SP1224)	Priority 3		Erect shrub, to 0.4 m high. Clay, moist loam, clayey sand. Granite boulders.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Thelymitra magnifica	Priority 1	-	Perennial, herb. Stony ridges.	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Thelymitra stellata	T (EN)	-	Tuberous, perennial, herb, 0.15-0.25 m high. Fl. yellow & brown, Oct to Nov. Sand, gravel, lateritic loam. Considered to be likely to occur by DPaW	Likely. Suitable habitat present and multiple known locations in vicinity of study area.
Thysanotus anceps	Priority 3	-	Rhizomatous, leafless perennial, herb, to 0.4 m high. Fl. purple, Oct to Dec. White or grey sand, lateritic gravel, laterite.	May. Suitable habitat present however no known records in vicinity of study area.
Verticordia lindleyi subsp. *lindleyi*	Priority 4	-	Erect shrub, 0.2-0.75 m high. Fl. pink, May or Nov to Dec or Jan. Sand, sandy clay. Winter-wet depressions.	Unlikely. No known records and no suitable habitat present.

Appendix C

Flora Species List, Holcim 2016

Appendix C: Flora Species List, Holcim 2016

Family	Cons. / Weed	Taxon
Amaranthaceae		
		Ptilotus esquamatus
		Ptilotus manglesii
Anarthiaceae		
		Lyginia barbata
Apiaceae		
		Actinotus leucocephalus
		Pentapeltis peltigera
		Platysace juncea
		Xanthosia candida
		Xanthosia ciliata
Araliaceae		
		Trachymene grandis
		Trachymene pilosa
Asparagaceae		
		Acanthocarpus canaliculatus
		Chamaescilla corymbosa
		Laxmannia grandiflora
		Laxmannia squarrosa
		Lomandra ?preissii
		Lomandra brittanii
		Lomandra caespitosa
		Lomandra effusa
		Lomandra nigricans
		Lomandra preissii
		Lomandra sericea
		Lomandra sonderi
		Lomandra sp.
		Lomandra spartea
		Thysanotus dichotomous
		Thysanotus manglesianus
		Thysanotus scaber
		Thysanotus thyrsoideus
Asteraceae		
	P3	*Asteridea gracilis*
		Craspedia variabilis
		Hyalosperma cotula
	*	*Hypochaeris glabra*
		Lagenophora huegelii
		Millotia tenuifolia var. *tenuifolia*
		Pterochaeta paniculata
		Rhodanthe citrina
		Siloxerus filifolius
		Sonchus asper
		Sonchus sp. juvenile
	*	*Taraxacum officinale*
		Trichocline spathulata
	*	*Ursinia anthemoides*
	*	*Podolepis sp.*
Boraginaceae		
		Boraginaceae sp.
Boryaceae		
		Borya constricta
		Borya sphaerocephala

Family	Cons. / Weed	Taxon
Campanulaceae		
		Lobelia gibbosa
Casuarinaceae		
		Allocasuarina fraseriana
		Allocasuarina humilis
		Allocasuarina microstachya
Celastraceae		
		Stackhousia monogyna
		Stackhousia pubescens
		Tripterococcus brunonis
Centrolepidaceae		
		Aphelia brizula
Colchicaceae		
		Burchardia congesta
Cyperaceae		
		Cyathochaeta avenacea
		Lepidosperma apricola
		Lepidosperma drummondii
		Lepidosperma leptostachyum
		Lepidosperma pubisquameum (juvenile)
		Lepidosperma squamatum
		Lepidosperma sp.
		Mesomelaena tetragona
		Schoenus armeria
		Tetraria capillaris
		Tetraria octandra
		Schoenus nanus
Dasypogonaceae		
		Kingia australis
Dillenaceae		
		Hibbertia acerosa
		Hibbertia commutata
		Hibbertia commutata (hairy form)
		Hibbertia huegelii
		Hibbertia hypericoides
		Hibbertia mylnei
		Hibbertia pachyrrhiza
		Hibbertia subvaginata
Dioscoreaceae		
		Dioscorea hastifolia
Droseraceae		
		Drosera gigantea
		Drosera glanduligera
		Drosera macrantha subsp. *macrantha*
		Drosera menziesii subsp. *menziesii*
		Drosera sp.
		Drosera stolonifera
Elaeocarpaceae		
		Tetratheca hirsuta
		Tetratheca nuda

Family	Cons. / Weed	Taxon
Ericaceae		
		Andersonia aristata
		Astroloma ciliatum
		Astroloma glaucescens
		Astroloma pallidum
		Leucopogon capitellatus
		Leucopogon pulchellus
		Leucopogon sprengelioides
		Leucopogon squarrosus
		Styphelia tenuiflora
Fabaceae		
		Acacia alata
		Acacia barbinervis subsp. *barbinervis*
		Acacia divergens
	P3	*Acacia horridula*
		Acacia huegelii
		Acacia iteaphylla
		Acacia lateriticola
		Acacia obovata
	P4	*Acacia oncinophylla subsp. patulifolia*
		Acacia pulchella var. *pulchella*
		Acacia sp.
		Acacia teretifolia
		Bossiaea ornata
		Chorizema dicksonii
		Cristonia biloba subsp. *biloba*
		Daviesia decurrens
		Daviesia horrida
		Daviesia longifolia
		Gastrolobium acutum
		Gastrolobium dilatatum
		Gastrolobium spinosum
		Gompholobium aristatum
		Gompholobium knightianum
		Gompholobium marginatum
		Gompholobium polymorphum
		Gompholobium preissii
		Gompholobium tomentosum
		Hovea chorizemifolia
		Hovea elliptica
		Hovea pungens
		Hovea trisperma
		Jacksonia alata
		Kennedia prostrata
		Labichea punctata
		Mirbelia spinosa
		Pultenaea ericifolia
Gentianaceae		
	*	*Centaurium tenuiflorum*

Family	Cons. / Weed	Taxon
Goodeniaceae		
		Dampiera alata
		Dampiera coronata
		Dampiera linearis
		Goodenia coerulea
		Goodenia fasciculata
		Lechenaultia biloba
		Scaevola calliptera
		Scaevola platyphylla
		Scaevola repens
Haemodoraceae		
		Conostylis androstemma
		Conostylis serrulata
		Conostylis setosa
		Haemodorum laxum
		Tribonanthes brachypetala
Haloragaceae		
		Glischrocaryon aureum
		Glischrocaryon flavescens
		Gonocarpus cordiger
Hemerocallidaceae		
		Agrostocrinum scabrum subsp. *scabrum*
		Caesia micrantha
		Dianella revoluta
		Tricoryne elatior
Iridaceae		
	*	*Gladiolus undulatus*
		Orthrosanthus laxus var. *laxus*
		Patersonia occidentalis
		Patersonia pygmaea
	*	*Watsonia meriana*
Lamiaceae		
		Hemiandra sp.
		Hemigenia incana
		Microcorys longifolia
Lauraceae		
		Cassytha racemosa
		Cassytha racemosa forma *racemosa*
		Cassytha sp.
Loganiaceae		
		Phyllangium paradoxum
Loranthaceae		
		Nuytsia floribunda
Malvaceae		
		Lasiopetalum floribundum
	P3	*Lasiopetalum glutinosum* subsp. *glutinosum*
		Thomasia grandiflora
		Thomasia macrocarpa
Myrtaceae		
		Astartea leptophylla
		Babingtonia camphorosmae
		Babingtonia pelloeae
		Beaufortia macrostemon
	P3	*Beaufortia purpurea*
		Calothamnus quadrifidus subsp. *quadrifidus*
		Calothamnus rupestris
		Calothamnus sanguineus

Family	Cons. / Weed	Taxon
		Calothamnus torulosus
		Calytrix acutifolia
		Calytrix glutinosa
		Calytrix variabilis
		Corymbia calophylla
		Darwinia citriodora
		Eucalyptus marginata subsp. *thalassica*
		Eucalyptus wandoo
		Eucalyptus wandoo (mallee form)
		Hypocalymma angustifolium
		Hypocalymma robustum
		Leptospermum erubescens
		Melaleuca holosericea
		Melaleuca parviceps
		Melaleuca radula
		Paragonis grandiflora
		Verticordia ? densiflora var. cespitosa
		Verticordia acerosa var. *acerosa*
		Verticordia acerosa var. *preissii*
		Verticordia huegelii var. *huegelii*
		Verticordia insignis subsp. *insignis*
		Verticordia plumosa var. *plumosa*
Orchidaceae		
		Caladenia flava
		Caladenia longicauda subsp. *?clivicola*
		Caladenia sp.
	*	*Disa bracteata*
		Elythranthera emarginata
		Pterostylis sp.
		Pterostylis sp. nana complex
		Pyrorchis nigricans
		Spiculaea ciliata
		Thelymitra ?crinita
		Thelymitra crinita
		Thelymitra sp.
Orobanchaceae		
	*	*Bartsia trixago*
		Parentucellia latifolia
Phyllanthaceae		
		Phyllanthus calycinus
Pittosporaceae		
		Cheiranthera preissiana
Poaceae		
	*	*Aira caryophyllea*
		Amphipogon amphipogonoides
		Amphipogon turbinatus
		Austrostipa campylachne
	*	*Briza maxima*
	*	*Briza minor*
	*	*Bromus* sp.
		Neurachne alopecuroidea
		Rytidosperma acerosa
		Rytidosperma pilosum
		Tetrarrhena laevis
		Poa drummondiana

Family	Cons. / Weed	Taxon
Polygalaceae		
		Comesperma ciliatum
		Comesperma virgatum
Primulaceae		
	*	*Lysimachia arvensis*
Proteaceae		
		Adenanthos obovatus
		Banksia armata var. *armata*
		Banksia bipinnatifida subsp. *bipinnatifida*
		Banksia dallanneyi var. *dallanneyi*
		Banksia dallanneyi var. *mellicula*
		Banksia nivea
		Banksia sessilis var. *sessilis*
		Banksia squarrosa subsp. *squarrosa*
		Grevillea bipinnatifida subsp. *bipinnatifida*
		Grevillea manglesii subsp. *manglesii*
		Grevillea pilulifera
		Grevillea quercifolia
		Grevillea synaphea subsp. *synaphea*
		Grevillea vestida
		Grevillea wilsonii
		Hakea amplexicaulis
		Hakea auriculata
		Hakea cyclocarpa
		Hakea erinacea
		Hakea incrasatta
		Hakea incrassata
		Hakea lissocarpha
		Hakea neospathulata
		Hakea petiolaris subsp. *petiolaris*
		Hakea prostrata
		Hakea ruscifolia
		Hakea sp.
		Hakea stenocarpa
		Hakea trifurcata
		Hakea uncinata
		Hakea undulata
		Isopogon asper
		Isopogon dubius
		Isopogon sphaerocephalus
		Isopogon dubius
		Lambertia multiflora var. *darlingensis*
		Persoonia angustifolia
		Persoonia ellipticum
		Petrophile biloba
		Petrophile seminuda
		Petrophile squamata subsp. *squamata*
		Petrophile striata
		Synaphea acutiloba
		Synaphea petiolaris subsp. *petiolaris*
Restionaceae		
		Desmocladus fasciculatus
		Desmocladus flexuosus
		Dielsia stenostachya
		Lepidobolus preissianus subsp. *preissianus*

Family	Cons. / Weed	Taxon
Rhamnaceae		
		Cryptandra pungens
		Trymalium ledifolium
		Trymalium ledifolium var. *rosmarinifolium*
Rubiaceae		
		Opercularia echinocephala
		Opercularia vaginata
Rutaceae		
		Boronia crenulata
		Boronia cymosa
		Boronia ovata
		Philotheca spicata
Sapindaceae		
		Diplopeltis huegelii subsp. *lehmannii*
Stylidiaceae		
		Levenhookia dubia
		Levenhookia pusilla
		Stylidium ?bulbiferum
		Stylidium affine
		Stylidium amoenum
		Stylidium amoenum var. *caulescens*
		Stylidium androsaceum
		Stylidium brunonianum
		Stylidium bulbiferum
		Stylidium calcaratum
		Stylidium carnosum
		Stylidium eriopodum
		Stylidium hispidum
		Stylidium piliferum
		Stylidium repens
		Stylidium sp.
		Stylidium thesioides
Thymelaeaceae		
		Pimelea ciliata subsp. *ciliata*
		Pimelea imbricata var. *piligera*
		Pimelea spectabilis
		Pimelea suaveolens
		Pimelea suaveolens subsp. *suaveolens*
Xanthorrhoeaceae		
		?Xanthorrhoea preissii
		Xanthorrhoea drummondii
		Xanthorrhoea gracilis
		Xanthorrhoea preissii
Zamiaceae		
		Macrozamia riedlei

Appendix D

Species by Communities Matrix

Appendix D Species by Community Matrix

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	?Xanthorrhoea preissii	x		x						x
	Acacia alata							x		
	Acacia barbinervis subsp. *barbinervis*				x					
	Acacia divergens			x						
	Acacia horridula		x							
	Acacia huegelii					x				
	Acacia iteaphylla				x					
	Acacia lateriticola			x	x		x	x		
	Acacia obovata			x	x					
	Acacia oncinophylla subsp. patulifolia								x	x
	Acacia pulchella var. pulchella	x	x	x	x		x	x	x	
	Acacia sp.	x								x
	Acacia teretifolia							x		
	Acanthocarpus canaliculatus						x			
	Actinotus leucocephalus									x
	Adenanthos obovatus				x	x	x			
	Agrostocrinum scabrum subsp. scabrum				x					
*	*Aira caryophyllea*				x			x		x
	Allocasuarina fraseriana			x	x	x	x			
	Allocasuarina humilis	x	x					x	x	
	Allocasuarina microstachya					x				
	Amphipogon amphipogonoides			x		x				
	Amphipogon turbinatus			x	x			x		x
	Andersonia aristata									x
	Aphelia brizula			x						
	Astartea leptophylla			x	x					
	Asteridea gracilis						x	x		
	Astroloma ciliatum				x	x	x	x		
	Astroloma glaucescens	x		x	x	x		x	x	x
	Astroloma pallidum			x	x	x				
	Austrostipa campylachne						x			
	Babingtonia camphorosmae	x		x		x		x	x	
	Babingtonia pelloeae	x			x					x
	Banksia armata var. armata	x		x		x		x		x
	Banksia bipinnatifida subsp. bipinnatifida		x		x	x	x	x	x	

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Banksia dallanneyi var. dallanneyi	x	x	x	x		x	x	x	x
	Banksia dallanneyi var. mellicula				x	x	x			
	Banksia nivea					x				
	Banksia sessilis var. sessilis	x			x				x	
	Banksia squarrosa subsp. squarrosa	x	x			x		x	x	
*	*Bartsia trixago*									
	Beaufortia macrostemon	x		x		x				
	Beaufortia purpurea	x		x	x	x		x		x
	Boraginaceae sp.									x
	Boronia crenulata		x							
	Boronia cymosa								x	
	Boronia ovata			x	x	x	x		x	
	Borya constricta							x	x	x
	Borya sphaerocephala								x	x
	Bossiaea ornata		x	x	x	x	x			
*	*Briza maxima*							x		x
*	*Briza minor*									x
*	*Bromus* sp.				x					
	Burchardia congesta	x		x	x		x	x	x	
	Caesia micrantha			x		x				
	Caladenia flava		x				x			
	Caladenia longicauda subsp. *?clivicola*						x			
	Caladenia sp.									
	Calothamnus quadrifidus subsp. *quadrifidus*			x						
	Calothamnus rupestris		x					x	x	
	Calothamnus sanguineus								x	
	Calothamnus torulosus					x			x	
	Calytrix acutifolia		x							
	Calytrix glutinosa								x	x
	Calytrix variabilis	x						x		x
	Cassytha racemosa		x	x	x		x	x	x	
	Cassytha racemosa forma *racemosa*	x	x			x	x	x	x	
	Cassytha sp.	x			x					x
*	*Centaurium tenuiflorum*									x
	Chamaescilla corymbosa			x	x					
	Cheiranthera preissiana			x						
	Chorizema dicksonii							x		

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Comesperma ciliatum								x	
	Comesperma virgatum	x								
	Conostylis androstemma									x
	Conostylis serrulata					x				
	Conostylis setosa	x	x	x	x	x	x			x
	Corymbia calophylla		x	x	x	x	x	x		
	Craspedia variabilis									x
	Cristonia biloba subsp. *biloba*								x	
	Cryptandra pungens							x	x	
	Cyathochaeta avenacea		x	x						
	Dampiera alata		x	x	x		x	x		
	Dampiera coronata			x						
	Dampiera linearis			x	x	x	x	x		
	Darwinia citriodora	x		x						x
	Daviesia decurrens				x			x		
	Daviesia horrida					x		x		
	Daviesia longifolia					x				
	Desmocladus fasciculatus				x			x		
	Desmocladus flexuosus			x		x		x		
	Dianella revoluta	x		x	x					
	Dielsia stenostachya									x
	Dioscorea hastifolia									
	Diplopeltis huegelii subsp. *lehmannii*						x		x	
*	*Disa bracteata*									
	Drosera gigantea				x				x	x
	Drosera glanduligera				x	x		x	x	x
	Drosera macrantha subsp. *macrantha*				x	x	x	x		
	Drosera menziesii subsp. *menziesii*	x			x		x	x	x	x
	Drosera sp.				x					
	Drosera stolonifera				x					
	Elythranthera emarginata								x	
	Eucalyptus marginata subsp. *thalassica*			x	x	x	x			
	Eucalyptus wandoo						x	x	x	
	Eucalyptus wandoo (mallee form)							x		
	Gastrolobium acutum							x		
	Gastrolobium dilatatum				x	x			x	
	Gastrolobium spinosum						x			

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
*	*Gladiolus undulatus*							x		x
	Glischrocaryon aureum								x	x
	Glischrocaryon flavescens									x
	Gompholobium aristatum						x			
	Gompholobium knightianum		x	x	x	x				
	Gompholobium marginatum	x		x	x		x	x	x	
	Gompholobium polymorphum			x	x					
	Gompholobium preissii			x	x					
	Gompholobium tomentosum		x							
	Gonocarpus cordiger									x
	Goodenia coerulea	x			x					x
	Goodenia fasciculata									x
	Goodeniaceae sp.			x						
	Grevillea bipinnatifida subsp. *bipinnatifida*						x	x	x	
	Grevillea manglesii subsp. *manglesii*				x					
	Grevillea pilulifera						x	x		
	Grevillea quercifolia					x				
	Grevillea synaphea subsp. *synaphea*				x					
	Grevillea vestida			x						
	Grevillea wilsonii				x					
	Haemodorum laxum			x		x	x	x	x	x
	Hakea amplexicaulis		x		x	x	x			
	Hakea auriculata								x	
	Hakea cyclocarpa					x				
	Hakea erinacea				x		x	x	x	x
	Hakea incrassata	x						x	x	x
	Hakea lissocarpha			x	x		x	x		
	Hakea neospathulata							x		
	Hakea petiolaris subsp. *petiolaris*									
	Hakea prostrata			x						
	Hakea ruscifolia					x				
	Hakea sp.				x					
	Hakea stenocarpa			x	x	x	x	x		
	Hakea trifurcata	x	x	x	x			x		x
	Hakea uncinata	x		x	x					x
	Hakea undulata		x	x	x	x	x	x	x	
	Hemiandra sp.			x						

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Hemigenia incana	x					x	x	x	
	Hibbertia acerosa			x	x	x	x			
	Hibbertia commutata			x	x	x	x	x		
	Hibbertia commutata (hairy form)				x					
	Hibbertia huegelii			x	x	x				
	Hibbertia hypericoides	x	x	x	x	x	x	x	x	x
	Hibbertia mylnei						x	x	x	
	Hibbertia pachyrrhiza				x	x				
	Hibbertia subvaginata			x				x	x	
	Hovea chorizemifolia				x	x	x			
	Hovea elliptica			x	x		x	x		
	Hovea pungens									x
	Hovea trisperma				x					
	Hyalosperma cotula							x		
	Hypocalymma angustifolium						x	x		
	Hypocalymma robustum		x	x	x	x				
*	*Hypochaeris glabra*						x	x		x
	Isopogon asper			x		x		x	x	
	Isopogon dubius	x		x		x			x	
	Isopogon sphaerocephalus				x		x			
	Isopogon dubius	x			x				x	
	Jacksonia alata				x	x		x	x	
	Kennedia prostrata			x	x					
	Kingia australis			x		x			x	
	Labichea punctata				x	x				
	Lagenophora huegelii						x	x	x	
	Lambertia multiflora var. *darlingensis*	x				x		x		
	Lasiopetalum floribundum						x			
	Lasiopetalum glutinosum subsp. *glutinosum*	x						x	x	
	Laxmannia grandiflora							x		x
	Laxmannia squarrosa							x	x	
	Lechenaultia biloba		x	x	x	x		x		
	Lepidobolus preissianus subsp. *preissianus*								x	
	Lepidosperma apricola							x	x	
	Lepidosperma drummondii						x		x	x
	Lepidosperma leptostachyum			x	x	x		x		
	Lepidosperma pubisquameum (juvenile)				x					

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Lepidosperma sp.								x	
	Lepidosperma squamatum						x	x		
	Leptospermum erubescens		x						x	
	Leucopogon capitellatus			x	x		x			
	Leucopogon pulchellus	x							x	
	Leucopogon sprengelioides	x						x		
	Leucopogon squarrosus									x
	Levenhookia dubia				x				x	x
	Levenhookia pusilla				x		x	x		x
	Lobelia gibbosa				x		x			
	Lomandra ?preissii				x					
	Lomandra brittanii				x					
	Lomandra caespitosa				x		x			
	Lomandra effusa					x				
	Lomandra nigricans				x					
	Lomandra preissii				x	x		x		
	Lomandra sericea						x			
	Lomandra sonderi					x				
	Lomandra sp.			x	x					
	Lomandra spartea				x					
	Lyginia barbata								x	
*	*Lysimachia arvensis*						x			
	Macrozamia riedlei						x	x		
	Melaleuca holosericea	x		x			x		x	x
	Melaleuca parviceps		x		x	x	x	x	x	x
	Melaleuca radula		x	x			x	x		x
	Mesomelaena tetragona			x	x	x		x		
	Microcorys longifolia							x	x	
	Millotia tenuifolia var. *tenuifolia*							x		
	Mirbelia spinosa								x	x
	Neurachne alopecuroidea						x	x	x	
	Nuytsia floribunda								x	
	Opercularia echinocephala		x	x	x			x		
	Opercularia vaginata				x	x		x		
	Orthrosanthus laxus var. *laxus*				x			x		
	Paragonis grandiflora	x		x		x		x		
	Parentucellia latifolia									x

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Patersonia occidentalis		x	x	x	x	x	x	x	x
	Patersonia pygmaea			x	x		x	x		
	Pentapeltis peltigera		x	x	x	x				
	Persoonia angustifolia				x					
	Persoonia ellipticum					x				
	Petrophile biloba				x			x		x
	Petrophile seminuda							x		
	Petrophile squamata subsp. *squamata*	x						x		
	Petrophile striata				x	x	x		x	
	Philotheca spicata				x	x		x		
	Phyllangium paradoxum							x		x
	Phyllanthus calycinus			x	x		x	x		x
	Pimelea ciliata subsp. *ciliata*				x					x
	Pimelea imbricata var. *piligera*	x					x	x	x	x
	Pimelea spectabilis					x	x	x		
	Pimelea suaveolens			x			x			
	Pimelea suaveolens subsp. *suaveolens*			x		x				
	Platysace juncea				x					
	Poa drummondiana							x		
*	*Podolepis* sp.						x			
	Pterochaeta paniculata				x		x	x	x	x
	Pterostylis sp.				x					
	Pterostylis sp. nana complex		x							
	Ptilotus esquamatus			x	x					
	Ptilotus manglesii				x		x			
	Pultenaea ericifolia							x	x	
	Pyrorchis nigricans				x					
	Rhamnaceae sp.	x								
	Rhodanthe citrina				x					
	Rytidosperma acerosa				x			x		
	Rytidosperma pilosum							x		
	Scaevola calliptera			x	x					
	Scaevola platyphylla						x			
	Scaevola repens									x
	Schoenus armeria	x							x	
	Schoenus nanus							x		x
	Siloxerus filifolius							x		x

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Sonchus asper						x			
	Sonchus sp. juvenile		x							
	Spiculaea ciliata									x
	Stackhousia monogyna							x	x	
	Stackhousia pubescens						x			
	Stylidium ?bulbiferum					x				
	Stylidium affine			x	x		x	x		
	Stylidium amoenum			x	x	x				
	Stylidium amoenum var. *caulescens*	x		x	x	x				
	Stylidium androsaceum				x					
	Stylidium brunonianum	x			x	x		x	x	
	Stylidium bulbiferum	x	x		x		x	x	x	x
	Stylidium calcaratum				x		x	x	x	
	Stylidium carnosum			x						
	Stylidium eriopodum	x		x	x		x	x	x	x
	Stylidium hispidum								x	
	Stylidium piliferum		x		x		x			
	Stylidium repens	x						x	x	x
	Stylidium sp.			x	x			x		x
	Stylidium thesioides		x					x		x
	Styphelia tenuiflora				x		x			
	Synaphea acutiloba		x		x			x	x	
	Synaphea petiolaris subsp. *petiolaris*			x						
*	*Taraxacum officinale*									x
	Tetraria capillaris	x	x	x	x	x	x	x		
	Tetraria octandra		x			x	x	x	x	
	Tetrarrhena laevis			x	x		x			
	Tetratheca hirsuta				x	x				
	Tetratheca nuda					x			x	
	Thelymitra ?crinita									
	Thelymitra crinita				x	x		x		
	Thelymitra sp.		x	x	x				x	
	Thomasia grandiflora			x		x	x			
	Thomasia macrocarpa									
	Thysanotus dichotomous				x					
	Thysanotus manglesianus	x	x		x		x	x		
	Thysanotus scaber								x	

	Taxon	Community								
		BpSr	CcCrTc	CcHtHh	EmBsBd	EmKaLm	EwHhSa	HeSb	IdBc	VaBs
	Thysanotus thyrsoideus			x	x	x	x			
	Trachymene grandis						x			
	Trachymene pilosa				x			x	x	
	Tribonanthes brachypetala									x
	Trichocline spathulata		x	x	x		x	x		
	Tricoryne elatior			x			x			
	Tripterococcus brunonis									x
	Trymalium ledifolium		x	x	x		x	x		x
	Trymalium ledifolium var. *rosmarinifolium*			x	x			x		
*	*Ursinia anthemoides*									x
	Verticordia ? densiflora var. *cespitosa*									x
	Verticordia acerosa var. *acerosa*	x	x			x		x	x	x
	Verticordia acerosa var. *preissii*									x
	Verticordia huegelii var. *huegelii*							x		x
	Verticordia insignis subsp. *insignis*	x	x					x		x
	Verticordia plumosa var. *plumosa*	x							x	x
	Verticorida insignis subsp. *insignis*									x
*	*Watsonia meriana*			x						
	Xanthorrhoea drummondii	x		x		x	x	x	x	x
	Xanthorrhoea gracilis				x					
	Xanthorrhoea preissii		x	x	x		x	x		
	Xanthosia candida			x	x		x	x		
	Xanthosia ciliata				x				x	

Appendix E

Plot Data

Plot Data

Site No: Ck1	Type: Quadrat	Latitude: -32.072184	Longitude: 116.039143

Date: 11/17/2014
Soil Types: Sandy loam gravel some clay
Observer: C Krens
Soil Colour: Brown
Topography: Mid Slope
Soil Condition: Dry
Rocky Type: Granite
Fire History: 5-10
Vegetation Condition: Excellent.

Taxon	Cons. Code	Height (cm)	% Alive
Acacia barbinervis subsp. barbinervis		30	0.1
Acacia pulchella var. pulchella		40	0.2
Banksia dallanneyi var. dallanneyi		20	0.5
Banksia sessilis var. sessilis		450	50
Boronia ovata		20	0.1
Bossiaea ornata		40	2
Cassytha sp.			0.1
Conostylis setosa		20	0.1
Corymbia calophylla		1500	30
Drosera stolonifera			0.1
Eucalyptus marginata subsp. thalassica		1200	15
Gompholobium knightianum		20	0.1
Goodenia coerulea		20	0.1
Hakea erinacea		60	2
Hakea stenocarpa		120	0.2
Hakea undulata		60	1
Hibbertia commutata		40	0.2
Hibbertia huegelii		20	0.1
Hibbertia hypericoides		40	3
Hypocalymma robustum		60	0.5
Isopogon sphaerocephalus		40	0.2
Kennedia prostrata			0.1
Lepidosperma leptostachyum		40	0.1
Lepidosperma pubisquameum (juvenile)		60	0.5
Lobelia gibbosa		5	0.1
Lomandra sp.		40	0.1
Opercularia echinocephala		10	0.1
Opercularia vaginata		20	0.2
Orthrosanthus laxus var. laxus		40	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Pentapeltis peltigera		10	0.2
Petrophile biloba			
Platysace juncea		60	0.1
Thysanotus thyrsoideus		40	0.1
Trymalium ledifolium		40	0.5
Xanthorrhoea preissii		120	2

Site No: Ck2	Type: Quadrat	Latitude: -32.07394	Longitude: 116.040228

Date: 11/17/2014 Soil Types: Loam, gravel, clay

Observer: C Krens Soil Colour: Brown

Topography: Upper Slope Soil Condition: Dry

Rocky Type: Granite Fire History: 5-10

Vegetation Condition: Excellent. Possible dieback cant see front some jarrah deaths

Taxon	Cons. Code	Height (cm)	% Alive
Acacia obovata		20	0.1
Acacia pulchella var. pulchella		60	1
Allocasuarina fraseriana		300	1
Astroloma pallidum		10	0.1
Banksia bipinnatifida subsp. bipinnatifida		30	0.2
Banksia dallanneyi var. dallanneyi		30	1
Bossiaea ornata		30	0.1
Bossiaea ornata		30	0.1
Bromus sp.	*	30	0.1
Burchardia congesta		40	0.1
Cassytha sp.			0.1
Conostylis setosa		5	0.1
Conostylis setosa		30	0.5
Corymbia calophylla		1500	25
Dampiera alata		20	0.1
Daviesia decurrens		40	0.1
Desmocladus fasciculatus		10	0.1
Eucalyptus marginata subsp. thalassica		1200	30
Gompholobium knightianum		30	0.2
Gompholobium marginatum		20	0.1
Goodenia coerulea		30	0.1
Hakea amplexicaulis		80	0.5
Hakea erinacea		180	2
Hakea undulata		100	2
Hibbertia acerosa		30	1
Hibbertia commutata		40	0.2
Hibbertia hypericoides		50	20
Hypocalymma robustum		40	0.5
Isopogon sphaerocephalus		30	0.1
Kennedia prostrata			0.1
Lepidosperma leptostachyum		80	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Levenhookia pusilla		5	0.1
Pentapeltis peltigera		10	0.1
Phyllanthus calycinus		30	0.1
Ptilotus manglesii		3	0.1
Scaevola calliptera		10	0.1
Stylidium amoenum var. caulescens		30	0.1
Stylidium eriopodum		10	0.1
Synaphea acutiloba		20	0.1
Tetratheca hirsuta		60	0.5
Thelymitra crinita		10	
Xanthorrhoea preissii		150	7

Site No: Ck3	Type: Quadrat	Latitude: -32.076356	Longitude: 116.039838

Date: 11/17/2014
Observer: C Krens
Topography: Mid Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Loam, gravel, clay
Soil Colour: Orange
Soil Condition: Dry
Fire History: 10+

Taxon	Cons. Code	Height (cm)	% Alive
?Xanthorrhoea preissii		200	5
Acacia sp.		40	0.1
Allocasuarina humilis		120	0.2
Astroloma glaucescens		40	0.2
Babingtonia pelloeae		60	5
Banksia armata var. armata		60	7
Banksia dallanneyi var. dallanneyi		30	0.5
Banksia sessilis var. sessilis		60	2
Beaufortia macrostemon		40	10
Beaufortia purpurea	P3	100	60
Burchardia congesta		40	0.1
Cassytha sp.			0.1
Comesperma virgatum		60	0.1
Dianella revoluta		80	0.1
Goodenia coerulea		30	0.1
Hakea incrassata		80	0.1
Hakea uncinata		150	15
Hibbertia hypericoides		40	2
Isopogon dubius		120	1
Lambertia multiflora var. darlingensis		40	1
Melaleuca holosericea		60	1
Paragonis grandiflora		60	2
Rhamnaceae sp.		60	0.2
Stylidium amoenum var. caulescens		30	0.1
Stylidium eriopodum		10	0.1
Tetraria capillaris		10	0.1

Site No: Ck4	Type: Quadrat	Latitude: -32.075966	Longitude: 116.039145

Date: 11/17/2014
Observer: C Krens
Topography: Lower Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Loam, gravel, clay
Soil Colour: Light brown
Soil Condition: Dry
Fire History: <5

Taxon	Cons. Code	Height (cm)	% Alive
?Xanthorrhoea preissii		180	5
Amphipogon turbinatus		50	0.1
Andersonia aristata		10	0.1
Astroloma glaucescens		40	0.5
Babingtonia pelloeae		40	10
Banksia armata var. armata		60	2
Banksia dallanneyi var. dallanneyi		30	2
Beaufortia purpurea	P3	60	1
Borya sphaerocephala		5	0.5
Cassytha sp.			0.1
Conostylis setosa		10	0.1
Goodenia coerulea		20	0.1
Goodenia coerulea		30	0.2
Haemodorum laxum		100	0.1
Hakea incrassata		80	3
Hakea uncinata		80	0.2
Hibbertia hypericoides		40	2
Levenhookia dubia		3	0.1
Melaleuca holosericea		60	20
Mirbelia spinosa		40	10
Patersonia occidentalis		60	0.1
Petrophile biloba		40	0.1
Phyllanthus calycinus		40	0.2
Pimelea imbricata var. piligera		10	0.1
Pterochaeta paniculata		3	0.1
Stylidium bulbiferum		3	0.1
Stylidium eriopodum		10	1
Stylidium sp.		10	0.1
Verticordia ? densiflora var. cespitosa		60	3
Verticordia acerosa var. preissii		70	40
Verticordia insignis subsp. insignis		50	0.1

Site No: Ck5	Type: Quadrat	Latitude: -32.075076	Longitude: 116.038067

Date: 11/18/2014
Soil Types: Loam, gravel, clay
Observer: C Krens
Soil Colour: Brown
Topography: Outcrop
Soil Condition: Dry
Rocky Type: Granite
Fire History: 10+
Vegetation Condition: Excellent.

Taxon	Cons. Code	Height (cm)	% Alive
Acacia sp.		150	1
Aira caryophyllea	*	10	0.2
Borya sphaerocephala		5	15
Briza maxima	*	10	0.1
Briza minor	*	5	0.1
Centaurium tenuiflorum	*	10	0.1
Melaleuca radula		100	0.5
Siloxerus filifolius		3	0.1
Siloxerus filifolius		5	0.1
Spiculaea ciliata		10	0.1
Ursinia anthemoides	*	10	0.1
Verticordia plumosa var. plumosa		20	0.5

Site No: Ck6	Type: Quadrat	Latitude: -32.074514	Longitude: 116.037426

Date: 11/18/2014
Observer: C Krens
Topography: Mid Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel some clay
Soil Colour: Brown
Soil Condition: Dry
Fire History: 10+

Taxon	Cons. Code	Height (cm)	% Alive
Banksia dallanneyi var. dallanneyi		30	0.5
Bossiaea ornata			2
Burchardia congesta		40	0.1
Conostylis setosa		10	0.1
Corymbia calophylla		1200	15
Darwinia citriodora		70	1
Eucalyptus marginata subsp. thalassica		1500	15
Gompholobium knightianum		20	0.1
Hakea trifurcata		350	60
Hakea uncinata		200	7
Hibbertia commutata		20	0.1
Hibbertia huegelii		50	0.1
Hibbertia hypericoides		40	2
Lepidosperma leptostachyum		60	5
Pentapeltis peltigera		10	0.1
Scaevola calliptera		30	0.1
Stylidium amoenum var. caulescens		30	0.1
Xanthorrhoea preissii		150	2

Site No: Ck7	Type: Quadrat	Latitude: -32.077129	Longitude: 116.035815

Date: 11/18/2014
Observer: C Krens
Topography: Valley
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Loamy clay
Soil Colour: Brown
Soil Condition: Dry
Fire History: 10+

Taxon	Cons. Code	Height (cm)	% Alive
?Xanthorrhoea preissii		200	3
Acacia obovata		60	0.1
Acacia pulchella var. pulchella		40	0.1
Amphipogon turbinatus		50	0.1
Aphelia brizula		40	0.1
Babingtonia camphorosmae		40	1
Banksia armata var. armata		60	0.5
Banksia dallanneyi var. dallanneyi		20	0.5
Beaufortia macrostemon		120	1
Beaufortia purpurea	P3	100	2
Cassytha racemosa			0.1
Corymbia calophylla		1000	30
Cyathochaeta avenacea		40	3
Dampiera alata		30	0.1
Dampiera coronata			0.1
Dampiera linearis		10	0.1
Goodeniaceae sp.		20	0.3
Hakea prostrata		250	5
Hakea trifurcata		400	40
Hibbertia huegelii		80	0.2
Hibbertia hypericoides		60	10
Kennedia prostrata			0.1
Lomandra sp.		40	0.1
Melaleuca holosericea		60	1
Melaleuca radula		60	0.1
Opercularia echinocephala		10	0.1
Paragonis grandiflora		120	2
Pentapeltis peltigera		10	0.1
Phyllanthus calycinus		80	0.1
Scaevola calliptera		20	0.1
Stylidium amoenum var. caulescens		30	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Stylidium eriopodum		10	0.1
Stylidium sp.		10	0.1
Trymalium ledifolium		80	0.2
Watsonia meriana	*	60	0.1
Xanthosia candida		5	0.1

Site No: Ck8	Type: Quadrat	Latitude: -32.072961	Longitude: 116.037335

Date: 11/18/2014
Observer: C Krens
Topography: Upper Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Sandy gravel, clay
Soil Colour: Brown
Soil Condition: Dry
Fire History: 5-10

Taxon	Cons. Code	Height (cm)	% Alive
Acacia barbinervis subsp. barbinervis		20	0.1
Acacia obovata		30	0.1
Acacia obovata		40	0.2
Acacia pulchella var. pulchella		40	0.2
Allocasuarina fraseriana		600	15
Amphipogon turbinatus		40	0.1
Astartea leptophylla		10	0.1
Astroloma glaucescens		40	0.5
Babingtonia pelloeae		40	5
Banksia dallanneyi var. dallanneyi		20	0.5
Banksia sessilis var. sessilis		250	2
Boronia ovata		20	0.1
Bossiaea ornata		30	0.1
Burchardia congesta		60	0.1
Cassytha sp.			0.2
Conostylis setosa		20	0.1
Corymbia calophylla		1500	5
Dianella revoluta		60	0.1
Eucalyptus marginata subsp. thalassica		1800	40
Hakea amplexicaulis		60	0.2
Hakea sp.		100	0.1
Hakea stenocarpa		60	2
Hakea uncinata		100	0.5
Hibbertia acerosa		20	0.2
Hibbertia commutata		30	3
Hibbertia huegelii		20	0.1
Hibbertia hypericoides		60	20
Hovea trisperma		20	0.2
Hypocalymma robustum		40	0.2
Isopogon sphaerocephalus		80	1
Lepidosperma leptostachyum		30	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Lepidosperma pubisquameum (juvenile)		40	0.2
Levenhookia pusilla		3	0.1
Lobelia gibbosa		5	0.1
Patersonia occidentalis		60	0.2
Pentapeltis peltigera		10	0.1
Petrophile striata		60	1
Pterochaeta paniculata		3	0.1
Ptilotus esquamatus		20	0.1
Stylidium amoenum var. caulescens		30	0.1
Stylidium eriopodum		10	0.1
Stylidium eriopodum		10	0.1
Stylidium sp.		10	0.1
Tetraria capillaris		20	0.1
Thysanotus manglesianus		30	0.1
Trymalium ledifolium		40	0.5
Trymalium ledifolium		40	0.1

Site No: Ck9	Type: Quadrat	Latitude: -32.078102	Longitude: 116.03825

Date: 11/19/2014
Observer: C Krens
Topography: Mid Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Loam, gravel, peat
Soil Colour: Dark brown
Soil Condition: Moist
Fire History: 5-10

Taxon	Cons. Code	Height (cm)	% Alive
?Xanthorrhoea preissii		400	10
Acacia pulchella var. pulchella		100	0.1
Astartea leptophylla		30	0.1
Banksia dallanneyi var. dallanneyi		40	1
Banksia dallanneyi var. dallanneyi		40	0.1
Beaufortia purpurea	P3	50	10
Bossiaea ornata		0	0.1
Cassytha racemosa			0.1
Cheiranthera preissiana			0.1
Corymbia calophylla		1200	40
Cyathochaeta avenacea		40	3
Goodeniaceae sp.		10	0.1
Hakea prostrata		120	0.5
Hakea trifurcata		350	15
Hakea undulata		200	0.5
Hemiandra sp.		20	0.1
Hibbertia huegelii		20	0.1
Hibbertia hypericoides		40	10
Pimelea suaveolens		80	0.5
Tetrarrhena laevis		40	0.1
Watsonia meriana	*	80	0.1
Xanthosia candida		5	0.1

Site No: Ck10	Type: Quadrat	Latitude: -32.078433	Longitude: 116.03918

Date: 11/19/2014
Observer: C Krens
Topography: Outcrop
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Gravel
Soil Colour: Brown skeletal
Soil Condition: Dry
Fire History: 10+

Taxon	Cons. Code	Height (cm)	% Alive
Actinotus leucocephalus		30	0.1
Aira caryophyllea	*	5	0.1
Amphipogon turbinatus		40	0.2
Beaufortia purpurea	P3	60	3
Boraginaceae sp.		30	0.1
Borya sphaerocephala		5	25
Conostylis androstemma		20	0.2
Craspedia variabilis		5	0.1
Darwinia citriodora		40	2
Gladiolus undulatus	*	60	0.2
Glischrocaryon flavescens		50	15
Gonocarpus cordiger		40	0.1
Hakea erinacea		60	1
Hakea trifurcata		120	1
Hovea pungens		1	40
Laxmannia grandiflora		60	0.1
Lepidosperma drummondii		100	0.2
Pterochaeta paniculata		3	0.1
Scaevola repens		30	0.2
Stylidium bulbiferum		3	0.1
Stylidium eriopodum		3	0.1
Taraxacum officinale	*	5	0.1
Trymalium ledifolium		40	0.1
Ursinia anthemoides	*	10	0.1
Verticordia acerosa var. preissii		60	0.5
Verticordia plumosa var. plumosa		50	5

Site No: HO01	Type: Quadrat	Latitude: -32.067765	Longitude: 116.034999

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour:
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia alata		10	0.01
Acacia lateriticola		40	5
Acacia pulchella var. pulchella		80	0.3
Acacia teretifolia		60	0.1
Allocasuarina humilis		40	0.1
Amphipogon turbinatus		10	0.1
Asteridea gracilis	P3	10	0.01
Babingtonia camphorosmae		40	3
Banksia armata var. armata		70	3
Banksia bipinnatifida subsp. bipinnatifida		10	0.1
Beaufortia purpurea	P3	30	10
Calothamnus rupestris		150	4
Cassytha racemosa			0.1
Chorizema dicksonii		60	0.1
Cryptandra pungens		50	0.4
Drosera glanduligera		5	0.1
Eucalyptus wandoo (Mallee form)		200	2
Gastrolobium acutum		40	0.1
Grevillea pilulifera		20	0.1
Haemodorum laxum		100	0.1
Hakea erinacea		80	3
Hakea incrassata		50	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Hakea neospathulata		50	0.2
Hakea stenocarpa		30	0.2
Hakea undulata		50	0.1
Hibbertia hypericoides		30	10
Hibbertia subvaginata		20	0.2
Jacksonia alata		20	0.2
Lasiopetalum glutinosum subsp. glutinosum	P3		
Laxmannia squarrosa		20	0.1
Lepidosperma leptostachyum		50	0.3
Lepidosperma squamatum		50	0.3
Leucopogon sprengelioides		80	6
Melaleuca parviceps		50	6
Melaleuca parviceps			
Melaleuca radula		100	0.4
Mesomelaena tetragona		60	0.3
Microcorys longifolia		50	0.5
Patersonia pygmaea		15	0.1
Petrophile biloba		100	0.1
Pimelea imbricata var. piligera		15	0.1
Pterochaeta paniculata		6	0.1
Pultenaea ericifolia		30	0.1
Rytidosperma acerosa		20	0.1
Stackhousia monogyna		20	0.1
Stylidium brunonianum		15	0.1
Stylidium bulbiferum		6	0.01
Stylidium calcaratum		5	0.01
Stylidium eriopodum		5	0.02
Stylidium sp.		15	0.1
Synaphea acutiloba		20	0.03
Tetraria capillaris		20	0.2
Trymalium ledifolium var. rosmarinifolium		15	0.1
Verticordia acerosa var. acerosa		80	1
Xanthorrhoea drummondii		120	1
Xanthosia candida		10	0.1

Site No: HO02	Type: Quadrat	Latitude: -32.071069	Longitude: 116.036767

Date: 10/13/2015
Soil Types: Sandy loam, clay
Observer: F de Wit, L van Gorp
Soil Colour:
Topography: Upper Slope
Soil Condition:
Rocky Type:
Fire History: 10+
Vegetation Condition: Excellent. Dieback




Taxon	Cons. Code	Height (cm)	% Alive
Acacia lateriticola		70	0.5
Acacia obovata		40	0.5
Astroloma glaucescens		10	0.1
Banksia dallanneyi var. dallanneyi		10	5
Banksia dallanneyi var. mellicula		20	3
Banksia sessilis var. sessilis		250	30
Boronia ovata		40	0.5
Bossiaea ornata		10	2
Conostylis setosa		20	0.2
Eucalyptus marginata subsp. thalassica		800	6
Gompholobium preissii		20	0.1
Hakea amplexicaulis		30	0.1
Hakea lissocarpha		30	0.5
Hibbertia acerosa		20	0.2
Hibbertia commutata		30	0.1
Hibbertia hypericoides		30	50
Hovea chorizemifolia		1	0.1
Hovea elliptica		40	0.1
Hypocalymma robustum		60	0.3
Isopogon sphaerocephalus		40	0.1
Lepidosperma leptostachyum		50	0.5

Taxon	Cons. Code	Height (cm)	% Alive
Lomandra brittanii		10	0.1
Opercularia echinocephala		10	0.1
Pentapeltis peltigera		4	0.1
Scaevola calliptera		20	0.1
Stylidium amoenum		1	0.1
Stylidium piliferum		10	0.1
Styphelia tenuiflora		40	0.2
Tetratheca hirsuta		15	0.1
Thysanotus dichotomous		40	0.1
Trichocline spathulata		5	0.1
Xanthorrhoea gracilis		40	0.2

Site No: HO03	Type: Quadrat	Latitude: -32.07074	Longitude: 116.041248

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour:
Soil Condition:
Fire History: 10+



Taxon	Cons. Code	Height (cm)	% Alive
Acacia divergens		20	0.01
Acacia lateriticola		100	0.1
Allocasuarina fraseriana		900	2
Astroloma glaucescens		60	10
Astroloma pallidum		7	0.1
Babingtonia camphorosmae		30	0.2
Banksia dallanneyi var. dallanneyi		15	0.5
Boronia ovata		15	0.1
Burchardia congesta		80	0.1
Calothamnus quadrifidus subsp. quadrifidus		80	0.1
Cassytha racemosa			0.1
Chamaescilla corymbosa		10	0.1
Conostylis setosa		20	0.1
Corymbia calophylla		2000	10
Dampiera linearis		10	0.1
Dianella revoluta		80	0.1
Eucalyptus marginata subsp. thalassica		900	3
Gompholobium marginatum		10	0.1
Gompholobium preissii		30	0.1
Gompholobium preissii		40	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Haemodorum laxum		60	0.1
Hakea stenocarpa		60	0.5
Hakea trifurcata		250	50
Hakea undulata		160	2
Hibbertia acerosa		10	0.1
Hibbertia commutata		10	0.1
Hibbertia hypericoides		50	4
Hibbertia subvaginata		40	0.2
Hovea elliptica		40	0.1
Hypocalymma robustum		70	0.2
Isopogon asper		50	0.1
Isopogon dubius		150	2
Lechenaultia biloba			
Mesomelaena tetragona		50	0.1
Paragonis grandiflora		80	0.1
Patersonia occidentalis		70	2
Patersonia pygmaea		15	0.1
Pimelea suaveolens subsp. suaveolens		50	0.1
Ptilotus esquamatus		20	0.01
Scaevola calliptera		10	0.1
Stylidium affine		40	0.1
Stylidium amoenum		20	0.1
Stylidium carnosum		5	0.1
Stylidium sp.		10	0.1
Tetraria capillaris		40	0.3
Tetrarrhena laevis		10	0.1
Thomasia grandiflora		40	0.2
Thysanotus thyrsoideus		30	0.1
Trichocline spathulata		7	0.1
Tricoryne elatior		80	0.1
Trymalium ledifolium var. rosmarinifolium		100	0.2
Xanthorrhoea drummondii		120	5

Site No: HO04	Type: Quadrat	Latitude: -32.072254	Longitude: 116.044306

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Outcrop, US, MS
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Sandy loam
Soil Colour:
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia oncinophylla subsp. patulifolia	P4	240	10
Allocasuarina humilis		50	0.5
Astroloma glaucescens		40	10
Babingtonia camphorosmae		30	4
Banksia bipinnatifida subsp. bipinnatifida			
Boronia cymosa		20	0.5
Borya sphaerocephala		5	1
Calothamnus rupestris		200	
Calytrix glutinosa		50	0.1
Cassytha racemosa			0.1
Comesperma ciliatum		15	0.01
Comesperma ciliatum			
Cryptandra pungens		100	15
Drosera glanduligera		4	0.1
Glischrocaryon aureum		90	0.3
Gompholobium marginatum		5	0.1
Haemodorum laxum		60	0.1
Hakea erinacea		120	5
Hakea undulata		50	0.2
Hemigenia incana			
Hibbertia hypericoides		50	1

Taxon	Cons. Code	Height (cm)	% Alive
Hibbertia subvaginata		30	0.1
Isopogon dubius		130	15
Lasiopetalum glutinosum subsp. glutinosum	P3	150	0.2
Lepidobolus preissianus subsp. preissianus		20	0.2
Lepidosperma drummondii		40	0.2
Leptospermum erubescens		80	1
Melaleuca parviceps		40	2
Pimelea imbricata var. piligera			
Pultenaea ericifolia			
Schoenus armeria		30	0.2
Stackhousia monogyna		40	0.1
Stylidium brunonianum		15	0.1
Stylidium eriopodum		10	0.1
Stylidium repens		7	0.1
Tetratheca nuda		15	0.1
Thysanotus scaber		15	0.1
Verticordia acerosa var. acerosa		120	4
Verticordia plumosa var. plumosa			
Xanthorrhoea drummondii		180	1

Site No: HO05	Type: Quadrat	Latitude: -32.075822	Longitude: 116.04289

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Very good. Dieback

Soil Types: Sandy loam gravel
Soil Colour: Red brown
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia lateriticola		50	0.2
Acacia pulchella var. pulchella		80	0.2
Banksia dallanneyi var. dallanneyi		15	0.5
Banksia sessilis var. sessilis		400	20
Beaufortia purpurea	P3		
Burchardia congesta		50	0.01
Chamaescilla corymbosa		10	0.1
Conostylis setosa		15	0.1
Corymbia calophylla		800	8
Dampiera linearis		10	0.3
Drosera glanduligera			
Drosera menziesii subsp. menziesii		15	0.1
Eucalyptus marginata subsp. thalassica		800	8
Gompholobium marginatum		5	0.01
Gompholobium preissii		50	0.1
Grevillea wilsonii		100	3
Hibbertia commutata		15	0.1
Hibbertia hypericoides		30	2
Lepidosperma leptostachyum		60	0.5
Levenhookia pusilla		10	0.01
Lomandra caespitosa		30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Lomandra preissii		50	0.1
Lomandra spartea		20	0.1
Orthrosanthus laxus var. laxus		50	12
Patersonia pygmaea		15	0.1
Philotheca spicata		20	0.1
Rhodanthe citrina			
Rhodanthe citrina			
Rytidosperma acerosa		10	0.01
Stylidium androsaceum		7	0.01
Stylidium bulbiferum		10	0.01
Stylidium piliferum		10	0.1
Tetraria capillaris		40	0.5
Thelymitra sp.			
Thysanotus manglesianus			0.1
Thysanotus thyrsoideus		15	0.01
Trachymene pilosa		5	0.01
Trichocline spathulata		10	0.1
Trymalium ledifolium var. rosmarinifolium		40	1.5
Xanthorrhoea preissii		120	
Xanthosia ciliata		5	0.2

Site No: HO06	Type: Quadrat	Latitude: -32.077394	Longitude: 116.041665

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour: Brown
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia lateriticola		60	0.2
Acacia pulchella var. pulchella		20	0.1
Adenanthos obovatus		20	0.1
Allocasuarina fraseriana		600	2
Astroloma ciliatum		10	
Banksia dallanneyi var. dallanneyi		10	2
Banksia dallanneyi var. mellicula		30	0.2
Banksia sessilis var. sessilis		400	50
Boronia ovata		20	0.1
Bossiaea ornata		30	0.5
Burchardia congesta		40	0.1
Conostylis setosa		20	0.1
Corymbia calophylla		1500	5
Dampiera linearis		10	0.1
Daviesia decurrens			
Desmocladus fasciculatus		10	0.1
Drosera macrantha subsp. macrantha			0.1
Drosera menziesii subsp. menziesii			
Drosera sp.		15	0.1
Eucalyptus marginata subsp. thalassica		800	30
Grevillea manglesii subsp. manglesii		10	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Grevillea wilsonii		40	
Hakea amplexicaulis		40	0.5
Hakea lissocarpha		30	0.2
Hakea trifurcata			
Hakea undulata		240	0.2
Hibbertia acerosa		20	0.1
Hibbertia commutata (hairy form)		15	0.1
Hibbertia hypericoides		40	6
Hovea chorizemifolia		50	0.1
Hypocalymma robustum		80	0.5
Isopogon sphaerocephalus		60	0.3
Jacksonia alata		10	0.01
Labichea punctata		10	0.1
Lepidosperma leptostachyum		30	0.2
Leucopogon capitellatus		20	0.2
Lomandra ?preissii		40	0.01
Lomandra caespitosa		60	0.01
Lomandra nigricans		40	0.1
Pentapeltis peltigera		4	0.01
Persoonia angustifolia		10	0.1
Petrophile striata		80	0.5
Philotheca spicata		80	0.1
Pimelea ciliata subsp. ciliata		10	0.1
Pterostylis sp.			
Pyrorchis nigricans			
Stylidium affine		20	0.1
Stylidium amoenum		20	0.1
Stylidium piliferum		10	0.1
Styphelia tenuiflora		30	0.2
Tetraria capillaris			
Tetrarrhena laevis		20	0.1
Tetratheca hirsuta		20	0.01
Thysanotus manglesianus			0.1
Thysanotus thyrsoideus			
Trichocline spathulata		10	0.1
Trymalium ledifolium var. rosmarinifolium		80	0.2
Xanthorrhoea gracilis		80	7
Xanthorrhoea preissii		100	0.5

Site No: HO07	Type: Quadrat	Latitude: -32.073021	Longitude: 116.04345

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type:
Vegetation Condition:

Soil Types:
Soil Colour:
Soil Condition:
Fire History:





Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos obovatus			
Allocasuarina fraseriana		230	0.5
Allocasuarina microstachya		30	0.2
Astroloma glaucescens		20	0.2
Astroloma pallidum		20	2
Babingtonia camphorosmae		40	0.5
Banksia armata var. armata		100	6
Banksia bipinnatifida subsp. bipinnatifida		10	0.1
Banksia dallanneyi var. mellicula		20	0.2
Beaufortia macrostemon		30	4
Beaufortia purpurea	P3	50	1
Boronia ovata		20	0.2
Boronia ovata			
Bossiaea ornata		15	0.1
Calothamnus torulosus		40	0.3
Conostylis setosa		30	0.1
Corymbia calophylla		500	2
Daviesia horrida		130	0.3
Daviesia longifolia		30	0.1
Drosera glanduligera		5	0.1
Drosera macrantha subsp. macrantha			0.01

Taxon	Cons. Code	Height (cm)	% Alive
Eucalyptus marginata subsp. thalassica		800	4
Gastrolobium dilatatum		70	0.2
Haemodorum laxum		70	0.1
Hakea amplexicaulis		60	0.2
Hakea cyclocarpa		220	0.2
Hakea stenocarpa			
Hakea undulata		100	0.3
Hibbertia hypericoides		40	3
Hibbertia pachyrrhiza		10	0.1
Hypocalymma robustum		50	0.1
Isopogon dubius		40	0.5
Jacksonia alata		10	0.1
Kingia australis		500	2
Labichea punctata		15	0.2
Labichea punctata		40	0.1
Lambertia multiflora var. darlingensis		70	3
Lepidosperma leptostachyum		50	0.1
Lomandra effusa		60	0.1
Lomandra sonderi		30	0.2
Melaleuca parviceps		60	1
Mesomelaena tetragona		60	0.2
Opercularia vaginata		15	0.1
Paragonis grandiflora		80	3
Patersonia occidentalis		50	2
Pimelea suaveolens subsp. suaveolens		50	0.1
Stylidium amoenum		10	0.1
Stylidium brunonianum		15	0.1
Tetratheca nuda		40	0.1
Xanthorrhoea drummondii		150	8

Site No: HO08r	Type: Releve	Latitude: -32.072882	Longitude: 116.046364

Date: 10/13/2015
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour:
Soil Condition:
Fire History: 10+





Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		180	0.5
Calothamnus rupestris		350	80
Cassytha racemosa			0.1
Corymbia calophylla		600	5
Hakea undulata		200	0.5
Hypocalymma robustum		100	0.2
Stylidium thesioides		15	0.1
Tetraria capillaris		40	1
Tetraria octandra		40	0.2
Trichocline spathulata		10	0.1
Xanthorrhoea preissii		150	3

Site No: HO09r	Type: Releve	Latitude: -32.073112	Longitude: 116.046468

Date: 10/26/2015
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Sandy loam
Soil Colour:
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia iteaphylla		50	0.2
Acacia lateriticola		15	0.1
Acacia pulchella var. pulchella		100	0.5
Agrostocrinum scabrum subsp. scabrum		80	0.2
Astroloma glaucescens		40	0.2
Banksia bipinnatifida subsp. bipinnatifida		15	2
Banksia dallanneyi var. dallanneyi		15	2
Bossiaea ornata		25	0.3
Burchardia congesta		80	0.1
Cassytha racemosa			
Conostylis setosa			
Corymbia calophylla		800	20
Desmocladus fasciculatus		10	0.1
Gastrolobium dilatatum		50	0.2
Gompholobium marginatum		20	0.2
Gompholobium polymorphum		30	0.1
Gompholobium preissii		20	0.2
Grevillea wilsonii		40	0.2
Hakea amplexicaulis		50	0.5
Hakea lissocarpha		50	2
Hakea undulata		220	25

Taxon	Cons. Code	Height (cm)	% Alive
Hibbertia acerosa			
Hibbertia hypericoides		40	30
Hibbertia pachyrrhiza		15	0.1
Hovea elliptica		15	0.5
Hypocalymma robustum		40	0.2
Lechenaultia biloba		10	0.1
Lepidosperma leptostachyum		30	0.1
Melaleuca parviceps		40	0.3
Mesomelaena tetragona		60	2
Myrt pink clumps		50	0.5
Patersonia occidentalis		50	0.5
Pentapeltis peltigera			
Petrophile striata		100	1
Philotheca spicata		30	0.2
Phyllanthus calycinus		40	0.2
Stylidium brunonianum		10	0.1
Tetraria capillaris		30	2
Trichocline spathulata			
Xanthorrhoea preissii		200	5

Site No: HO10	Type: Quadrat	Latitude: -32.068663	Longitude: 116.035913

Date: 10/26/2015
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour: Brown
Soil Condition: Dry
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia lateriticola		60	0.2
Acanthocarpus canaliculatus		10	2
Adenanthos obovatus		30	0.3
Allocasuarina fraseriana		800	6
Astroloma ciliatum		10	0.1
Banksia dallanneyi var. dallanneyi		10	7
Boronia ovata		30	0.4
Cassytha racemosa			0.1
Corymbia calophylla		800	4
Drosera menziesii subsp. menziesii			
Eucalyptus marginata subsp. thalassica		1100	10
Eucalyptus wandoo		1500	30
Haemodorum laxum		100	0.1
Hakea lissocarpha		70	0.2
Hakea stenocarpa		40	0.2
Hibbertia acerosa		20	0.2
Hibbertia commutata		30	0.3
Hibbertia hypericoides		70	8
Hovea chorizemifolia		20	0.1
Isopogon sphaerocephalus		40	0.1
Lepidosperma squamatum		50	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Leucopogon capitellatus		20	0.1
Lomandra caespitosa		40	0.2
Macrozamia riedlei		200	10
Melaleuca radula		200	0.2
Patersonia occidentalis		20	0.5
Pimelea spectabilis		80	
Ptilotus manglesii		5	0.2
Scaevola platyphylla		40	0.2
Stylidium affine		15	0.5
Stylidium eriopodum		10	0.1
Styphelia tenuiflora		60	1
Tetraria capillaris		20	0.2
Thysanotus manglesianus			0.1
Trichocline spathulata		10	0.1
Xanthorrhoea preissii		220	10

Site No: HO11	Type: Quadrat	Latitude: -32.068234	Longitude: 116.035783

Date: 10/26/2015
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour:
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia lateriticola		50	0.3
Acacia pulchella var. pulchella		80	0.1
Acanthocarpus canaliculatus		10	1
Austrostipa campylachne		120	0.1
Banksia bipinnatifida subsp. bipinnatifida		30	0.2
Banksia dallanneyi var. mellicula		40	1
Boronia ovata		40	0.5
Cassytha racemosa			0.1
Conostylis setosa		30	0.1
Eucalyptus wandoo		1800	40
Gastrolobium spinosum		30	0.1
Gompholobium marginatum		5	0.1
Hakea lissocarpha		70	0.1
Hakea stenocarpa		50	0.1
Hakea undulata		50	0.2
Hibbertia commutata		40	0.4
Hibbertia hypericoides		40	40
Hovea elliptica		20	2
Lagenophora huegelii		2	0.1
Leucopogon capitellatus		20	0.2
Lomandra caespitosa		30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Lomandra sericea		40	0.1
Macrozamia riedlei		130	5
Petrophile striata		80	0.2
Podolepis sp.	*	40	0.1
Pterochaeta paniculata		5	0.1
Stylidium affine		30	5
Tetrarrhena laevis		40	0.1
Trichocline spathulata		10	0.1
Xanthorrhoea preissii		200	10

Site No: HO12r	Type: Releve	Latitude: -32.079523	Longitude: 116.038753
Date: 10/26/2015		Soil Types:	
Observer: F de Wit, L van Gorp		Soil Colour:	
Topography:		Soil Condition:	
Rocky Type:		Fire History:	
Vegetation Condition:			

Taxon	Cons. Code	Height (cm)	% Alive
Corymbia calophylla			15
Grevillea vestita			30
Hakea trifurcata			50
Hibbertia commutata			50
Kingia australis			5

Site No: HO13r	Type: Releve	Latitude: -32.078294	Longitude: 116.039557

Date: 10/26/2015
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Sandy loam gravel
Soil Colour:
Soil Condition:
Fire History: 10+



Taxon	Cons. Code	Height (cm)	% Alive
Beaufortia purpurea	P3		10
Calytrix glutinosa		80	30
Hakea erinacea		60	2
Leucopogon squarrosus		60	2
Melaleuca parviceps			
Stylidium eriopodum			
Tripterococcus brunonis			
Verticordia insignis subsp. insignis		50	10
Xanthorrhoea drummondii		100	2

Site No: HO14r	Type: Releve	Latitude: -32.072145	Longitude: 116.045145

Date: 10/26/2015
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Loam
Soil Colour:
Soil Condition:
Fire History: 10+





Taxon	Cons. Code	Height (cm)	% Alive
Acacia oncinophylla subsp. patulifolia	P4	350	10
Borya sphaerocephala		10	30
Drosera gigantea			
Glischrocaryon aureum		80	4
Lepidosperma drummondii			5
Pimelea ciliata subsp. ciliata			
Verticordia acerosa var. acerosa		100	40
Verticordia huegelii var. huegelii			
Verticordia insignis subsp. insignis		30	1

Site No: HO15	Type: Releve	Latitude: -32.0752544	Longitude: 116.032655

Date: 10/25/2016
Soil Types: Loam Gravel
Observer: F de Wit, L van Gorp
Soil Colour:
Topography: Mid Slope
Soil Condition: Dry
Rocky Type:
Fire History: 10+
Vegetation Condition: Excellent.

Taxon	Cons. Code	Height (cm)	% Alive
Acacia horridula	P3		
Acacia pulchella var. pulchella		30	0.1
Allocasuarina humilis		200	5
Banksia dallanneyi var. dallanneyi		30	0.2
Banksia squarrosa subsp. squarrosa			
Boronia crenulata			
Calothamnus rupestris		300	90
Calytrix acutifolia		100	0.3
Corymbia calophylla		400	5
Cyathochaeta avenacea		30	1
Dampiera alata		10	0.1
Hakea trifurcata		80	0.3
Hakea undulata		30	0.1
Hibbertia hypericoides		30	1
Melaleuca parviceps		40	0.1
Melaleuca radula		200	0.2
Pterostylis sp. nana complex			
Sonchus sp. juvenile		5	0.1
Stylidium bulbiferum		10	0.3
Thysanotus manglesianus			0.1
Trymalium ledifolium		60	0.2
Verticordia acerosa var. acerosa			
Verticordia insignis subsp. insignis			

Site No: Ho17	Type: Quadrat	Latitude: -32.07624307	Longitude: 116.0329072
Date: 10/25/2016		Soil Types: Clay Sand	
Observer: F de Wit, L van Gorp		Soil Colour: Medium Brown	
Topography: Mid Slope		Soil Condition:	
Rocky Type: Granite		Fire History:	
Vegetation Condition:			





Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		150	1
Aira caryophyllea	*	10	0.3
Babingtonia camphorosmae		30	2
Banksia dallanneyi var. dallanneyi		10	0.5
Banksia squarrosa subsp. squarrosa		100	0.5
Beaufortia purpurea	P3	80	2
Cassytha racemosa forma racemosa			0.1
Corymbia calophylla		500	3
Dampiera alata		20	0.5
Desmocladus fasciculatus		15	0.01
Drosera glanduligera		5	0.1
Drosera menziesii subsp. menziesii			0.1
Eucalyptus wandoo		700	5
Gladiolus undulatus	*		
Gompholobium marginatum		10	0.1
Hakea erinacea		100	10
Hakea incrassata		50	0.2
Hakea trifurcata		300	2
Hakea undulata		30	0.3
Hemigenia incana		20	0.1
Hibbertia hypericoides		50	7

Taxon	Cons. Code	Height (cm)	% Alive
Hovea elliptica		40	0.1
Hyalosperma cotula		5	0.1
Hypocalymma angustifolium		40	3
Hypochaeris glabra	*		0.1
Lepidosperma apricola		40	0.1
Lepidosperma leptostachyum		40	0.2
Levenhookia pusilla		3	0.1
Lomandra preissii		15	0.1
Melaleuca parviceps		50	8
Melaleuca radula		180	3
Millotia tenuifolia var. tenuifolia		5	0.1
Neurachne alopecuroidea		10	0.1
Opercularia echinocephala		20	0.1
Petrophile seminuda		60	1
Philotheca spicata		20	0.1
Poa drummondiana		40	0.2
Rytidosperma pilosum			
Schoenus nanus		10	0.2
Siloxerus filifolius		3	0.1
Stylidium bulbiferum		5	2
Stylidium calcaratum		5	0.2
Tetraria octandra		20	0.1
Thysanotus manglesianus			0.1
Trachymene pilosa			
Trichocline spathulata			
Trymalium ledifolium		30	3
Xanthorrhoea drummondii		100	3

Site No: Ho18	Type: Quadrat	Latitude: -32.07634692	Longitude: 116.04601753

Date: 10/25/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Clay Loam
Soil Colour: Medium Brown
Soil Condition: Dry
Fire History:





Taxon	Cons. Code	Height (cm)	% Alive
Amphipogon amphipogonoides		40	0.1
Astroloma ciliatum		10	0.1
Banksia bipinnatifida subsp. bipinnatifida		15	0.1
Banksia nivea		10	2
Banksia squarrosa subsp. squarrosa		40	0.3
Beaufortia macrostemon		40	4
Beaufortia macrostemon		30	10
Bossiaea ornata		30	0.5
Caesia micrantha		80	0.1
Cassytha racemosa forma racemosa			0.1
Conostylis setosa		30	0.01
Corymbia calophylla		600	5
Dampiera linearis		10	0.1
Desmocladus flexuosus		10	0.1
Drosera glanduligera		5	0.1
Drosera macrantha subsp. macrantha			0.01
Eucalyptus marginata subsp. thalassica		700	16
Gastrolobium dilatatum		30	0.2
Gompholobium knightianum			0.1
Grevillea quercifolia		30	1
Hakea amplexicaulis		40	0.5

Taxon	Cons. Code	Height (cm)	% Alive
Hakea cyclocarpa		80	0.2
Hakea ruscifolia		80	0.1
Hakea stenocarpa		40	0.1
Hakea undulata		50	0.4
Hibbertia hypericoides		40	15
Hypocalymma robustum		20	0.5
Jacksonia alata		20	0.1
Kingia australis		500	
Labichea punctata		40	0.1
Lambertia multiflora var. darlingensis		30	1
Lechenaultia biloba		20	0.2
Lepidosperma leptostachyum		70	3
Lomandra effusa		30	1
Lomandra preissii		80	0.1
Mesomelaena tetragona		30	8
Paragonis grandiflora		50	3
Patersonia occidentalis		30	1
Pentapeltis peltigera		10	0.1
Persoonia ellipticum			
Petrophile striata		20	0.1
Philotheca spicata		30	0.1
Pimelea spectabilis		30	0.1
Stylidium amoenum var. caulescens		20	0.1
Stylidium brunonianum		20	0.1
Tetraria capillaris		30	3
Thelymitra crinita		20	0.1
Thysanotus thyrsoideus		20	0.01
Verticordia acerosa var. acerosa		40	0.2
Xanthorrhoea drummondii		220	7

Site No: Ho19	Type: Releve	Latitude: -32.0735957	Longitude: 116.04681314

Date: 10/25/2016
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Medium Brown
Soil Condition: Moist
Fire History: 10+



Taxon	Cons. Code	Height (cm)	% Alive
Banksia bipinnatifida subsp. bipinnatifida		20	0.2
Banksia dallanneyi var. dallanneyi		30	0.5
Bossiaea ornata		20	0.5
Caladenia flava		15	0.1
Calothamnus rupestris		300	75
Cassytha racemosa forma racemosa			0.1
Conostylis setosa		20	0.2
Dampiera alata		20	0.1
Gompholobium knightianum		20	0.1
Gompholobium tomentosum		20	0.5
Hakea amplexicaulis		80	0.3
Hakea undulata		30	0.1
Hibbertia hypericoides		30	20

Taxon	Cons. Code	Height (cm)	% Alive
Lechenaultia biloba		10	0.1
Leptospermum erubescens			
Opercularia echinocephala		20	0.1
Patersonia occidentalis		30	0.2
Pentapeltis peltigera		5	0.1
Stylidium piliferum		20	0.3
Synaphea acutiloba		20	0.3
Tetraria capillaris		30	2
Tetraria octandra		20	0.2
Thelymitra sp.		30	0.1
Trichocline spathulata		10	0.1
Xanthorrhoea preissii		80	5

Site No: Ho20	Type: Quadrat	Latitude: -32.0752714	Longitude: 116.045937
Date: 10/25/2016		Soil Types: Clay Loam	
Observer: F de Wit, L van Gorp		Soil Colour: Medium Brown	
Topography: Upper Slope		Soil Condition: Dry	
Rocky Type:		Fire History: 10+	
Vegetation Condition:			



Taxon	Cons. Code	Height (cm)	% Alive
Acacia huegelii		20	0.2
Astroloma ciliatum		10	0.2
Banksia nivea		20	0.2
Beaufortia macrostemon		20	5
Boronia ovata		40	1
Caesia micrantha		5	0.1
Conostylis serrulata		10	0.1
Dampiera linearis		10	0.1
Desmocladus flexuosus		5	0.1
Eucalyptus marginata subsp. thalassica		1000	8
Gompholobium knightianum		15	0.2
Hakea amplexicaulis		70	0.4
Hibbertia acerosa			

Taxon	Cons. Code	Height (cm)	% Alive
Hibbertia commutata		20	0.2
Hibbertia huegelii		20	0.1
Hibbertia hypericoides		30	16
Hovea chorizemifolia		15	0.1
Hypocalymma robustum		40	0.5
Isopogon asper		40	0.3
Kingia australis		350	7
Labichea punctata		10	0.2
Lambertia multiflora var. darlingensis		110	8
Mesomelaena tetragona		30	0.3
Paragonis grandiflora		60	2
Patersonia occidentalis		30	0.4
Philotheca spicata		60	0.2
Stylidium ?bulbiferum		10	0.2
Stylidium brunonianum		15	0.1
Tetraria octandra		20	0.5
Tetratheca hirsuta		20	0.1
Thomasia grandiflora		40	0.2
Xanthorrhoea drummondii		150	12

Site No: Ho21	Type: Quadrat	Latitude: -32.0712986	Longitude: 116.0429663
Date: 10/25/2016		Soil Types: Gravel Clay	
Observer: F de Wit, L van Gorp		Soil Colour: Grey	
Topography: Lower Slope		Soil Condition: Dry	
Rocky Type: Laterite		Fire History: 10+	
Vegetation Condition:			



Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina humilis		60	0.5
Astroloma glaucescens		30	1
Babingtonia camphorosmae		30	1
Borya constricta		5	5
Calothamnus sanguineus		50	
Calothamnus torulosus			
Cristonia biloba subsp. biloba		10	0.01
Gompholobium marginatum		10	0.1
Haemodorum laxum			
Hakea undulata		40	0.2
Hibbertia hypericoides			
Isopogon asper			
Ispogon dubius		80	8

Taxon	Cons. Code	Height (cm)	% Alive
Jacksonia alata		15	0.1
Kingia australis			
Levenhookia dubia		5	0.1
Lyginia barbata		20	0.5
Melaleuca parviceps		50	0.3
Mirbelia spinosa		20	0.1
Neurachne alopecuroidea		40	0.1
Patersonia occidentalis		30	0.1
Petrophile striata		60	1
Pimelea imbricata var. piligera		15	0.1
Pterochaeta paniculata		5	0.1
Schoenus armeria		20	0.2
Stackhousia monogyna		50	0.2
Stylidium brunonianum		20	0.01
Stylidium eriopodum		10	0.5
Stylidium repens		10	1
Tetratheca nuda		20	0.1
Verticordia acerosa var. acerosa		90	15
Xanthorrhoea drummondii		180	3

Site No: Ho22	Type: Quadrat	Latitude: -32.074204	Longitude: 116.044557

Date: 10/25/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Grey
Soil Condition: Dry
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia oncinophylla subsp. patulifolia	P4	450	20
Allocasuarina humilis		100	4
Astroloma glaucescens		30	2
Babingtonia camphorosmae		30	3
Banksia dallanneyi var. dallanneyi		30	0.1
Banksia squarrosa subsp. squarrosa		100	0.5
Boronia ovata		30	0.1
Borya constricta		5	4
Burchardia congesta		70	0.1
Cassytha racemosa forma racemosa			0.1
Cryptandra pungens		80	0.5
Drosera gigantea			
Drosera menziesii subsp. menziesii			0.1
Elythranthera emarginata		15	0.1
Gastrolobium dilatatum		110	0.5
Glischrocaryon aureum		100	4
Grevillea bipinnatifida subsp. bipinnatifida		80	1
Hakea auriculata		30	0.3
Hakea erinacea		100	5
Hakea incrassata		30	0.3
Hakea undulata		40	2

Taxon	Cons. Code	Height (cm)	% Alive
Hibbertia hypericoides		30	0.4
Hibbertia subvaginata		80	1
Isopogon dubius		80	10
Kingia australis		400	1.5
Lepidosperma sp.		60	0.5
Lyginia barbata		20	1
Melaleuca holosericea		80	0.2
Melaleuca parviceps		50	3
Pterochaeta paniculata		5	0.1
Stylidium calcaratum		10	0.1
Stylidium eriopodum		10	
Tetraria octandra		20	0.4
Thelymitra sp.		40	0.1
Thysanotus scaber		20	0.1
Verticordia acerosa var. acerosa		140	1
Xanthorrhoea drummondii		200	6
Xanthosia ciliata		15	0.1

Site No: Ho23	Type: Quadrat	Latitude: -32.06816258	Longitude: 116.0372687

Date: 10/25/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Loam Gravel
Soil Colour: Medium Brown
Soil Condition: Dry
Fire History: 10+





Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		90	2
Astroloma ciliatum		10	0.1
Banksia bipinnatifida subsp. bipinnatifida		20	0.2
Banksia dallanneyi var. dallanneyi		20	5
Boronia ovata		50	1
Bossiaea ornata		60	0.2
Burchardia congesta		100	0.01
Cassytha racemosa forma racemosa			0.1
Conostylis setosa		20	0.1
Dampiera alata		30	0.3
Dampiera linearis		10	0.1
Eucalyptus marginata subsp. thalassica		800	6
Eucalyptus wandoo		1500	10
Gompholobium aristatum		15	0.2
Gompholobium marginatum		15	0.1
Grevillea pilulifera		50	0.3
Hakea amplexicaulis		100	0.2
Hakea lissocarpha		40	0.2
Hakea stenocarpa		60	0.2
Hibbertia hypericoides		70	30
Hibbertia mylnei		20	0.5

Taxon	Cons. Code	Height (cm)	% Alive
Lepidosperma drummondii		70	1
Melaleuca holosericea		30	0.2
Melaleuca parviceps		40	1
Melaleuca parviceps		100	0.5
Melaleuca radula		130	0.3
Neurachne alopecuroidea		30	0.3
Patersonia pygmaea		10	0.1
Petrophile striata		60	0.5
Pimelea suaveolens		70	0.3
Stylidium calcaratum		5	0.01
Stylidium piliferum		25	0.1
Tetraria capillaris		30	2
Tetraria octandra		30	1
Thomasia grandiflora		50	0.1
Thysanotus thyrsoideus		40	0.1
Tricoryne elatior		30	0.1
Xanthorrhoea drummondii		250	10
Xanthosia candida		20	0.1

Site No: Ho24	Type: Quadrat	Latitude: -32.06716966	Longitude: 116.035638

Date: 10/25/2016
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour:
Soil Condition: Moist
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		100	0.5
Asteridea gracilis	P3	10	0.01
Astroloma ciliatum		20	0.1
Caladenia flava			
Caladenia longicauda subsp. ?clivicola			
Cassytha racemosa forma racemosa			
Corymbia calophylla		2100	20
Diplopeltis huegelii subsp. lehmannii		30	0.3
Drosera macrantha subsp. macrantha			0.1
Eucalyptus wandoo		2200	20
Grevillea bipinnatifida subsp. bipinnatifida		100	0.5
Hakea erinacea		120	0.5
Hakea lissocarpha		50	0.2
Hakea undulata		100	0.2
Hemigenia incana		20	0.1
Hibbertia hypericoides		30	2
Hypocalymma angustifolium		60	8
Hypochaeris glabra	*	2	0.2
Lagenophora huegelii			0.2
Lasiopetalum floribundum		30	0.2
Levenhookia pusilla		5	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Lobelia gibbosa			
Lysimachia arvensis	*		
Macrozamia riedlei			
Melaleuca radula		160	0.5
Neurachne alopecuroidea		40	0.2
Patersonia occidentalis		40	0.1
Phyllanthus calycinus		30	6
Pimelea imbricata var. piligera		20	1
Ptilotus manglesii		5	0.2
Sonchus asper		8	0.01
Stackhousia pubescens		30	0.3
Stylidium affine		30	1
Stylidium bulbiferum		10	0.1
Stylidium calcaratum		5	0.4
Trachymene grandis		10	0.1
Trymalium ledifolium		120	4
Xanthorrhoea preissii		200	4
Xanthosia candida		10	0.1

Site No: Ho25	Type: Quadrat	Latitude: -32.0668884	Longitude: 116.0343433

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Clay Loam
Soil Colour: Medium Brown
Soil Condition: Dry
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		100	0.5
Allocasuarina humilis		100	0.5
Astroloma glaucescens		30	0.2
Babingtonia camphorosmae		30	4
Banksia sessilis var. sessilis			
Borya constricta		10	1
Calothamnus rupestris		150	1
Cassytha racemosa forma racemosa			0.1
Diplopeltis huegelii subsp. lehmannii		20	0.3
Drosera glanduligera		6	0.1
Eucalyptus wandoo		900	0.5
Grevillea bipinnatifida subsp. bipinnatifida		60	
Hakea erinacea		100	0.3
Hakea undulata		60	0.2
Hemigenia incana		30	0.1
Hibbertia hypericoides		30	0.5
Hibbertia mylnei		20	0.1
Hibbertia subvaginata		60	8
Isopogon dubius		60	3
Jacksonia alata		20	0.1
Lagenophora huegelii			0.1

Taxon	Cons. Code	Height (cm)	% Alive
Laxmannia squarrosa		15	0.1
Lepidosperma apricola		30	0.1
Leucopogon pulchellus		60	1
Melaleuca holosericea		90	4
Melaleuca parviceps		80	
Microcorys longifolia		100	0.2
Neurachne alopecuroidea		30	0.1
Nuytsia floribunda			
Pimelea imbricata var. piligera		30	0.1
Pterochaeta paniculata		5	0.1
Schoenus armeria		20	0.2
Stylidium brunonianum		30	0.1
Stylidium bulbiferum		10	0.1
Stylidium eriopodum		10	0.1
Stylidium hispidum		10	0.1
Synaphea acutiloba		15	0.2
Trachymene pilosa		5	0.1
Verticordia acerosa var. acerosa		60	1
Verticordia plumosa var. plumosa		80	4
Xanthorrhoea drummondii		189	1

Site No: Ho26	Type: Quadrat	Latitude: -32.0696762251034	Longitude: 116.03552623662701

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Medium Brown
Soil Condition: Dry
Fire History: 10+





Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		70	Oppo
Acacia teretifolia		60	Oppo
Aira caryophyllea	*	10	0.1
Allocasuarina humilis		110	0.3
Astroloma ciliatum		20	0.1
Astroloma glaucescens		30	4
Babingtonia camphorosmae		30	4
Banksia dallanneyi var. dallanneyi		50	0.2
Banksia squarrosa subsp. squarrosa		80	0.3
Borya constricta		15	0.1
Cassytha racemosa forma racemosa		0	0.1
Chorizema dicksonii		60	0.1
Dampiera alata		15	Oppo
Daviesia decurrens		40	0.1
Drosera macrantha subsp. macrantha		0	Oppo
Gompholobium marginatum		20	0.2
Hakea erinacea		100	1
Hakea incrassata		80	0.3
Hakea stenocarpa		40	0.1
Hakea undulata		100	3

Taxon	Cons. Code	Height (cm)	% Alive
Hibbertia hypericoides		40	3
Hibbertia mylnei		30	0.5
Isopogon asper		40	0.3
Lagenophora huegelii		10	0.1
Lambertia multiflora var. darlingensis		100	Oppo
Laxmannia grandiflora		15	0.1
Lechenaultia biloba		25	Oppo
Leucopogon sprengelioides		80	3
Levenhookia pusilla		5	0.01
Melaleuca parviceps		70	2
Melaleuca parviceps		50	2
Neurachne alopecuroidea		25	0.1
Opercularia vaginata		20	Oppo
Philotheca spicata		30	0.3
Phyllanthus calycinus		40	0.1
Pimelea spectabilis		70	Oppo
Pterochaeta paniculata		5	0.1
Schoenus nanus		4	0.1
Stylidium brunonianum		12	0.2
Stylidium bulbiferum		10	0.1
Stylidium calcaratum		5	0.1
Stylidium eriopodum		10	0.5
Tetraria capillaris		25	0.2
Thelymitra crinita		40	0.01
Trichocline spathulata		30	0.1
Verticordia acerosa var. acerosa		60	20
Xanthorrhoea drummondii		230	10

Site No: Ho27	Type: Quadrat	Latitude: -32.0788323	Longitude: 116.0403803

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Clay Gravel
Soil Colour: Grey
Soil Condition: Dry
Fire History: 10+



Taxon	Cons. Code	Height (cm)	% Alive
Aira caryophyllea	*	10	0.1
Borya constricta		4	0.3
Calytrix variabilis		80	5
Darwinia citriodora		80	4
Dielsia stenostachya		20	0.02
Drosera gigantea		30	5
Drosera glanduligera		4	0.1
Drosera menziesii subsp. menziesii		20	0.01
Goodenia fasciculata		30	0.1
Hakea erinacea		100	2
Hypochaeris glabra	*		0.1
Levenhookia pusilla		2	0.01
Melaleuca holosericea		100	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Parentucellia latifolia		3	0.1
Phyllangium paradoxum		5	0.01
Pterochaeta paniculata		5	0.1
Schoenus nanus		3	0.01
Stylidium bulbiferum		10	2
Stylidium repens		5	0.01
Stylidium thesioides		15	2
Tribonanthes brachypetala		20	0.01
Trymalium ledifolium		20	0.2
Verticordia acerosa var. acerosa		80	2
Verticordia huegelii var. huegelii		60	1
Verticordia plumosa var. plumosa		60	2

Site No: Ho28	Type: Quadrat	Latitude: -32.07928253	Longitude: 116.04049123

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Medium Brown
Soil Condition: Dry
Fire History: 10+






Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		130	1
Astroloma glaucescens		30	0.2
Babingtonia camphorosmae		20	0.5
Banksia squarrosa subsp. squarrosa		120	0.5
Beaufortia purpurea	P3	120	80
Calytrix variabilis		40	0.5
Cassytha racemosa forma racemosa		0	0.1
Conostylis setosa		20	0.01
Darwinia citriodora		80	0.2
Drosera menziesii subsp. menziesii		0	0.01
Gompholobium marginatum		20	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Hemigenia incana		130	0.2
Hibbertia hypericoides		30	2
Lasiopetalum glutinosum subsp. glutinosum	P3	140	0.01
Leucopogon pulchellus		130	0.1
Petrophile squamata subsp. squamata		200	4
Schoenus armeria		30	0.1
Stylidium brunonianum		15	0.1
Stylidium bulbiferum		10	0.1
Stylidium repens		5	0.1
Thysanotus manglesianus		0	0.1
Verticordia acerosa var. acerosa		110	3
Xanthorrhoea drummondii		220	0.5

Site No: Ho29	Type: Releve	Latitude: -32.07966268	Longitude: 116.039890

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour:
Soil Condition: Dry
Fire History:



Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina humilis		80	0.5
Astroloma glaucescens		40	0.2
Babingtonia camphorosmae		50	0.5
Beaufortia purpurea	P3	100	80
Calytrix variabilis		90	1
Drosera menziesii subsp. menziesii		0	0.01
Hakea trifurcata		270	3
Hemigenia incana		80	0.3
Isopogon dubius		150	1
Leucopogon sprengelioides		60	0.1
Petrophile squamata subsp. squamata		200	3
Pimelea imbricata var. piligera		15	0.01
Stylidium repens		5	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Thysanotus manglesianus		0	0.01
Verticordia acerosa var. acerosa		140	4
Verticordia insignis subsp. insignis		110	0.6
Verticordia plumosa var. plumosa		80	0.4
Xanthorrhoea drummondii		300	1

Site No: Ho30	Type: Quadrat	Latitude: -32.0776484	Longitude: 116.034717

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Medium Brown
Soil Condition:
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		160	0.5
Babingtonia camphorosmae		50	1
Banksia dallanneyi var. dallanneyi			
Beaufortia purpurea	P3	70	14
Borya constricta		5	1
Calytrix variabilis		70	0.5
Cassytha racemosa forma racemosa			0.5
Dampiera alata			
Desmocladus flexuosus		10	0.1
Drosera glanduligera		4	0.1
Drosera menziesii subsp. menziesii			0.1
Grevillea bipinnatifida subsp. bipinnatifida		110	0.5
Hakea erinacea		100	5
Hakea trifurcata		200	8
Hakea undulata		60	2
Hibbertia hypericoides		30	1
Hypocalymma angustifolium		50	0.5
Lepidosperma leptostachyum		30	0.2
Leucopogon sprengelioides		80	1
Melaleuca parviceps		80	2
Neurachne alopecuroidea		10	0.5

Taxon	Cons. Code	Height (cm)	% Alive
Paragonis grandiflora		60	2
Patersonia occidentalis		30	0.5
Petrophile squamata subsp. squamata		200	2
Phyllangium paradoxum		5	0.1
Pimelea imbricata var. piligera			
Pultenaea ericifolia		40	0.05
Schoenus nanus		5	0.1
Siloxerus filifolius			
Stylidium bulbiferum		15	4
Stylidium calcaratum		4	0.1
Stylidium repens			0.2
Stylidium thesioides		15	2
Tetraria octandra		30	0.3
Thysanotus manglesianus			0.1
Verticordia acerosa var. acerosa		100	20
Verticordia huegelii var. huegelii		20	0.2
Verticordia insignis subsp. insignis		40	0.2
Xanthorrhoea drummondii		230	5

Site No: Ho31	Type: Releve	Latitude: -32.07718088	Longitude: 116.0335957

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Granite
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Medium Brown
Soil Condition: Dry
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		30	0.1
Asteridea gracilis	P3	10	0.02
Astroloma ciliatum		15	0.1
Banksia armata var. armata		100	1
Banksia dallanneyi var. dallanneyi		50	0.3
Briza maxima	*	30	0.1
Burchardia congesta		40	0.1
Cassytha racemosa forma racemosa			0.2
Corymbia calophylla		800	4
Dampiera linearis		15	0.01
Daviesia horrida			
Eucalyptus wandoo		700	10
Hakea erinacea		160	70
Hakea lissocarpha		100	0.5
Hakea undulata		70	1
Hemigenia incana		40	0.2
Hibbertia commutata		30	2
Hibbertia hypericoides		50	1
Hypocalymma angustifolium		80	0.2
Macrozamia riedlei			
Melaleuca radula		200	15

Taxon	Cons. Code	Height (cm)	% Alive
Neurachne alopecuroidea		40	0.5
Orthrosanthus laxus var. laxus		40	2
Petrophile squamata subsp. squamata		200	1
Phyllanthus calycinus		40	1
Pimelea imbricata var. piligera		30	0.1
Stylidium affine		20	3
Stylidium brunonianum		20	0.1
Stylidium bulbiferum		10	3
Stylidium calcaratum		5	0.1
Trymalium ledifolium		40	1
Xanthorrhoea preissii		100	2

Site No: Ho32	Type: Quadrat	Latitude: -32.081620	Longitude: 116.040042

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Mid Slope
Rocky Type:
Vegetation Condition: Excellent.

Soil Types: Loam Clay
Soil Colour: Dark Brown
Soil Condition: Moist
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		120	0.2
Amphipogon amphipogonoides		60	0.1
Astroloma pallidum			
Bossiaea ornata		50	3
Burchardia congesta		40	0.1
Caesia micrantha		50	1
Corymbia calophylla		1700	70
Desmocladus flexuosus		10	0.1
Eucalyptus marginata subsp. thalassica		1900	10
Gompholobium polymorphum		20	0.5
Hakea lissocarpha		40	0.2
Hakea trifurcata		200	1
Hakea undulata		300	5
Hibbertia hypericoides			
Lechenaultia biloba		5	0.01
Lepidosperma leptostachyum		60	30
Leucopogon capitellatus		30	1
Mesomelaena tetragona			
Pentapeltis peltigera		10	2
Scaevola calliptera		20	0.3
Synaphea petiolaris subsp. petiolaris		20	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria capillaris			
Tetrarrhena laevis		15	1
Thelymitra sp.			0.1
Xanthorrhoea preissii		100	0.1

Site No: Ho33	Type: Quadrat	Latitude: -32.0716289	Longitude: 116.0405528

Date: 10/27/2016
Observer: F de Wit, L van Gorp
Topography: Upper Slope
Rocky Type: Laterite
Vegetation Condition: Excellent.

Soil Types: Loam Sand
Soil Colour: Red
Soil Condition: Dry
Fire History: 10+




Taxon	Cons. Code	Height (cm)	% Alive
Acacia barbinervis subsp. barbinervis		30	0.2
Acacia lateriticola		40	0.2
Aira caryophyllea	*	10	0.1
Allocasuarina fraseriana		1400	4
Astroloma pallidum		15	0.1
Banksia dallanneyi var. dallanneyi		15	2
Banksia sessilis var. sessilis		400	20
Boronia ovata		30	0.2
Bossiaea ornata		30	0.2
Burchardia congesta		70	0.1
Conostylis setosa		20	0.01
Drosera gigantea		10	0.1
Eucalyptus marginata subsp. thalassica		2000	10
Grevillea synaphea subsp. synaphea		20	0.1
Grevillea wilsonii		110	2
Hakea lissocarpha		60	0.3
Hakea trifurcata		350	2
Hibbertia commutata		30	1
Hibbertia hypericoides		50	10
Hovea chorizemifolia		25	
Isopogon dubius		50	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Lepidosperma leptostachyum		40	0.2
Levenhookia dubia		2	0.1
Lomandra caespitosa		40	0.5
Orthrosanthus laxus var. laxus		25	4
Pterochaeta paniculata		5	0.1
Stylidium affine		20	1
Stylidium calcaratum		4	0.2
Stylidium eriopodum		10	0.1
Stylidium piliferum		8	0.01
Tetraria capillaris		30	0.1
Tetrarrhena laevis		20	0.1
Thysanotus manglesianus			0.1
Trachymene pilosa		4	0.1
Trichocline spathulata		6	0.1
Trymalium ledifolium		40	1.5
Xanthosia candida		5	0.1

Appendix J Bennett Environmental Consulting Targeted Search for *Thelymitra stellata* and *Thelymitra magnifica*

Search for *Thelymitra stellata* and *Thelymitra magnifica*





Prepared for:
Holcim (Australia) Pty Ltd
GOSNELLS

Prepared by:
Bennett Environmental Consulting Pty Ltd

Billardiera heterophylla

PO Box 341
KALAMUNDA 6926

November 2014

STATEMENT OF LIMITATIONS

Scope of Services

This report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Eleanor Bennett ("the Author"). In some circumstances a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services.

Reliance on Data

In preparing the report, the Author has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, the Author has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. The Author will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to the Author.

Environmental Conclusions

In accordance with the scope of services, the Author has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. The Author assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of the Author or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

The Author will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report. The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

INDEX

SUMMARY i
1 INTRODUCTION 1
1.1 Background 1
1.2 Scope of Works 2
2 BACKGROUND INFORMATION 2
3. METHODS 3
4. RESULTS 3
5. DISCUSSION 3
6. REFERENCES 3
APPENDIX A 4

SUMMARY

No plants of the Threatened Flora, *Thelymitra stellata* or the Priority 1 Flora *Thelymitra magnifica* were located at the nominated area at the Holcim quarry site. Transects were walked through the bushland by Dr Bennett and Ms Fleming on 20th October and 3rd November 2014 and additional searches were undertaken by Ms Fleming on 13th, 15th and 17th October 2014.

1 INTRODUCTION

1.1 Background

Bennett Environmental Consulting Pty Ltd was contracted to undertake a search of a selected area at the Holcim quarry in Gosnells. The vegetation unit and vegetation condition had previously been mapped by Astron (2012) as illustrated in Diagram 1.

Thelymitra stellata is listed as a Threatened Flora by the Department of Parks and Wildlife (2014) and as an Endangered flora under the Environment Protection and Biodiversity Conservation Act 1999 (Department of Sustainability, Environment, Water, Populations and Communities (2014).

Threatened Flora are defined as Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee (Department of Parks and Wildlife, (2014).

Endangered Flora are native species not critically endangered; and not facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

Thelymitra magnifica is listed as a Priority 1 Flora by the Department of Parks and Wildlife (2014).

Priority 1 Flora are defined as Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, rail reserves and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

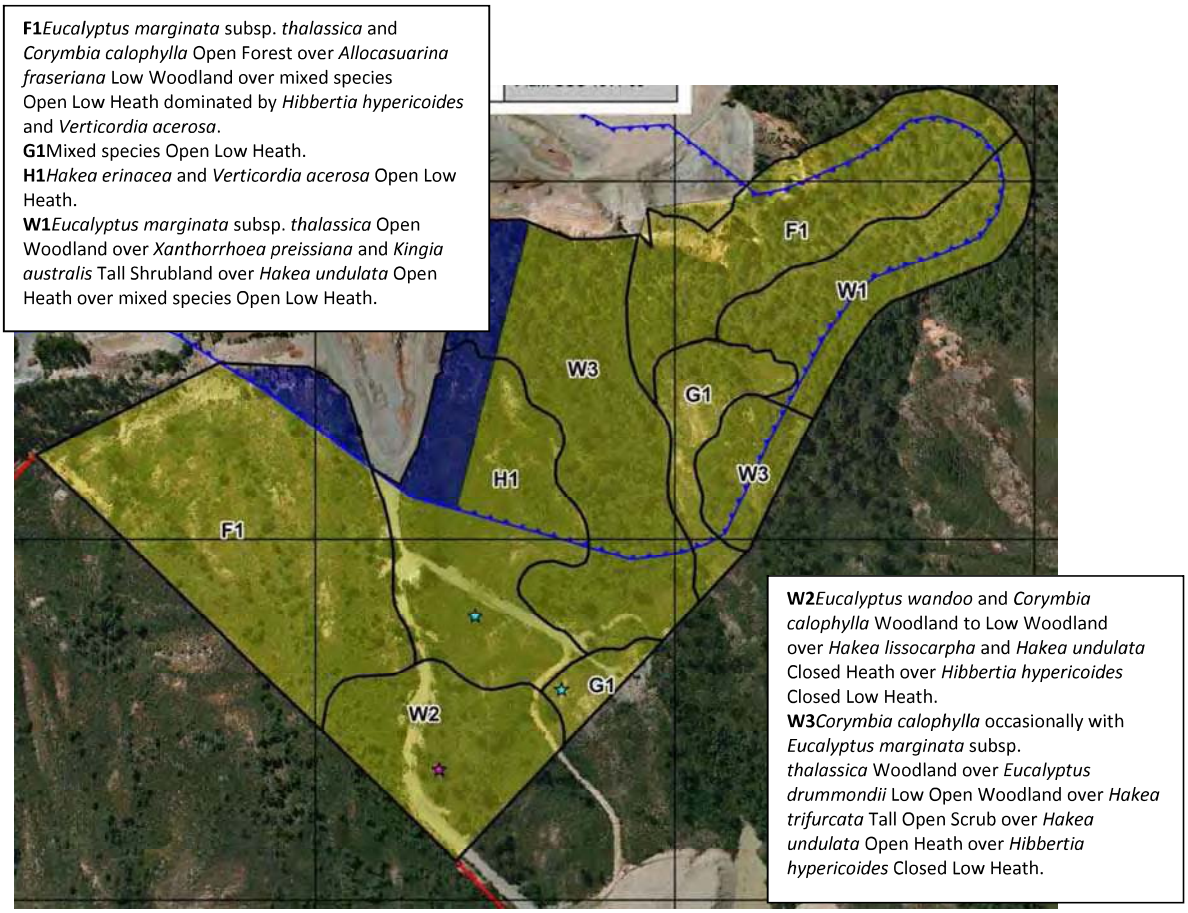


Diagram 1. Vegetation map of the search area prepared by Astron (2012)

1.2 Scope of Works

The requirements for this project were to:

i. Search for *Thelymitra stellata* (Threatened Flora) and *Thelymitra magnifica* (Priority 1 Flora) within the nominated proposed development area; and
ii. Undertake a detailed record of all plants of these two species located.

2 BACKGROUND INFORMATION

A search was undertaken of the two species on Florabase (Western Australian Herbarium 2014) for information about recorded locations, soil preferences and flowering times. In addition, Andrew Brown (pers.com) at the Department of Parks and Wildlife was contacted about the suggested search times for these species. It was recommended that the *Thelymitra magnifica* search be undertaken in mid-October and the *Thelymitra stellata* search in early November.

Jeanes (2006) explained how to distinguish the species in the *Thelymitra fuscolutea* group, ie the yellow flowering *Thelymitra* species, which included the 2 search species. The major distinguishing differences between these 2 species in this article were:

1. FLOWER COLOUR
   T. magnifica flowers are dark, golden brown with large yellow blotches and striations; *T. stellata* flowers are brown to reddish brown with large yellow blotches and striations
2. SCENT
   T. magnifica has a cinnamon-like scent; *T. stellata* has a sweet scent

3. FLOWERING TIMES
   T. magnifica flowers in September and October; *T. stellata* flowers in October and November.
4. SOIL
   T. magnifica prefers seasonally moist, granitic soils; *T. stellata* prefers dry lateritic soil.

3. METHODS

It was suggested by Holcim that their environmental technician, Priscilla Fleming also assist with undertaking the searches. Ms Fleming works 1 full day and 2 half days at the quarry and it was agreed that information be forwarded to her so that she could start the searches a week prior to Dr Bennett being available. Dr Bennett prepared background information (See Appendix A) together with a collection data sheet which was forwarded to Ms Fleming ahead of her being able to conduct the first search on 13th October. In addition it was suggested that the first search was to be for *Thelymitra magnifica* and that the searches commence in vegetation units F1, H1 and G1 (See Diagram 1). Dr Bennett undertook searches with Ms Fleming on 20th October and 3rd November 2014.

Transects were walked through the bushland when searching for the two species.

4. RESULTS

Ms Fleming and Dr Bennett undertook searches for *Thelymitra magnifica* and *Thelymitra stellata* on 20th October and 3rd November 2014 and Ms Fleming also undertook additional searches on 13th, 15th and 17th October. No yellow/brown flowered *Thelymit*ra species were located by Ms Fleming when she undertook the searches or by Dr Bennett. Some late flowering and many fruiting *Thelymitra crinita* were observed during all surveys. In addition the following orchids were recorded:

- *Caladenia flava*;
- *Eriochilus dilatatus*;
- *Thelymitra macrophylla*;
- *Pyrorchis nigricans*,
- *Spiculaea ciliata* (on granite rocks);
- *Lyperanthus serratus*; and
- *Microtis media.*

5. DISCUSSION

No plants of *Thelymitra stellata* or *Thelymitra magnifica* were located during the searches.

.

6. REFERENCES

Astron (2012). *Gosnells Quarry Field Flora, Vegetation and Fauna Survey.* Unpublished report for Holcim (Australia) Pty Ltd

Department of Parks and Wildlife (2014). *Declared Rare and Priority List for Western Australia.* Published list by the Department of Parks and Wildlife, Western Australia

Department of Sustainability, Environment, Water, Populations and Communities (2014). *EPBC Act List of Threatened Flora.* http://www.deh.gov.au/

Jeanes J.A. (2006). *Resolution of the Thelymitra fuscolutea R. Br. (Orchidaceae) complex of southern Australia***.** Muelleria 24: 3–24

Western Australian Herbarium (2014). *Florabase*. Department of Parks and Wildlife. http://www.calm.wa.gov.au/science/florabase.html

APPENDIX A

How to Distinguish *Thelymitra stellata* and *Thelymitra magnifica*

Thelymitras are commonly called Sun Orchids as they open during the day and close at night. On an overcast day they may not open at all. A search is to be undertaken for two of the brown coloured flower species, *Thelymitra magnifica* and *Thelymitra stellata*.

Below is a diagram of a typical Sun Orchid. The petals and sepals are alike so that they appear to have six petals. Also all petals and sepals are of a similar colour. There are a few technical terms that will need to be understood:
Column – a structure formed by the fusion of the stamens and style;
Column wings – out growths from the column possibly to attract insects; and
Bract is the leaf-like structure under each individual flower stalk.

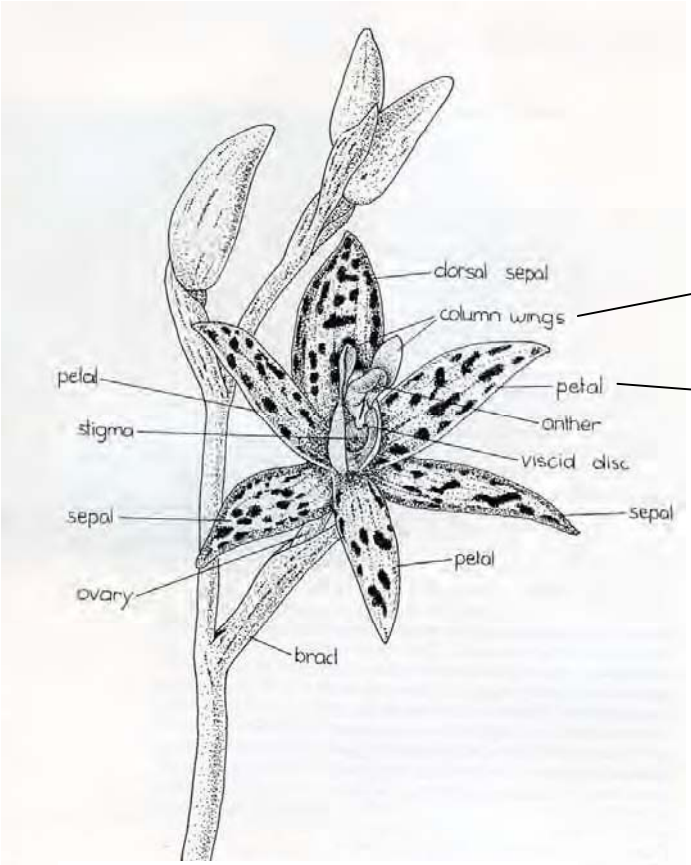


Diagram 1. *Thelymitra* flower



Flower of *Thelymitra magnifica*.

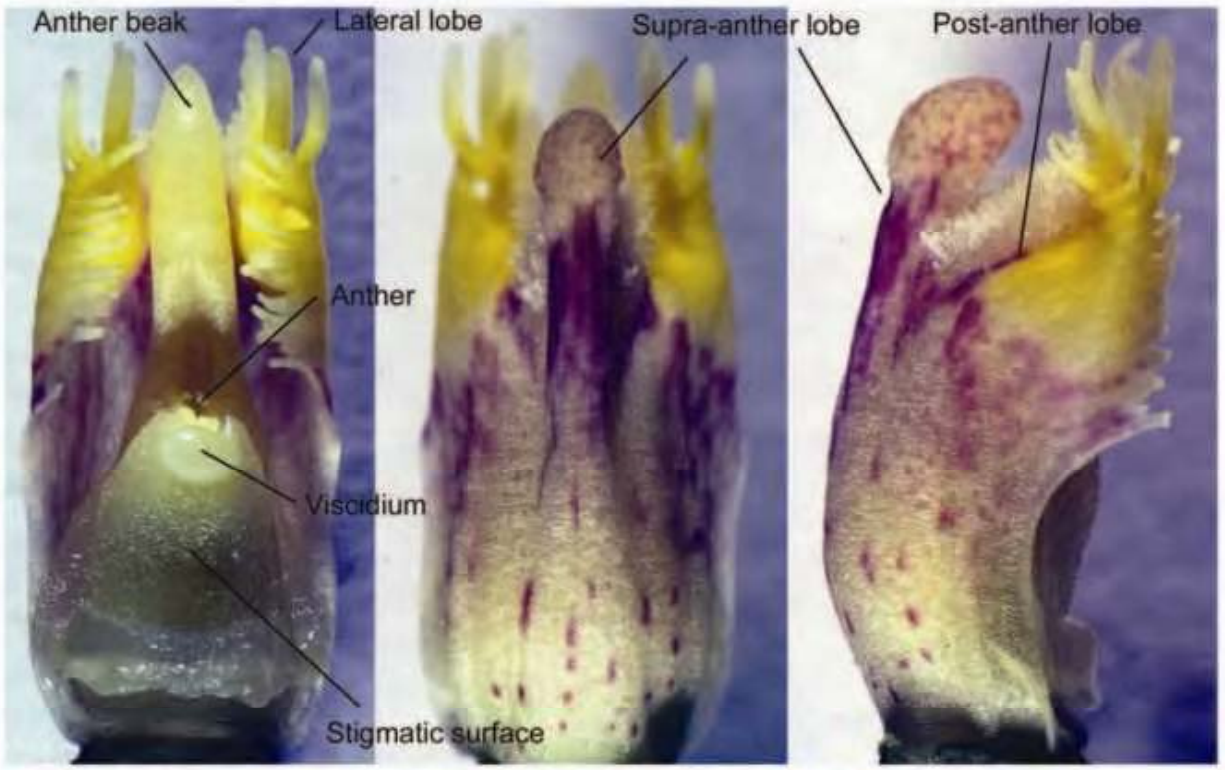


Diagram 2. Column features, explaining terms used below

Thelymitra magnifica is the first of the two orchids to flower:

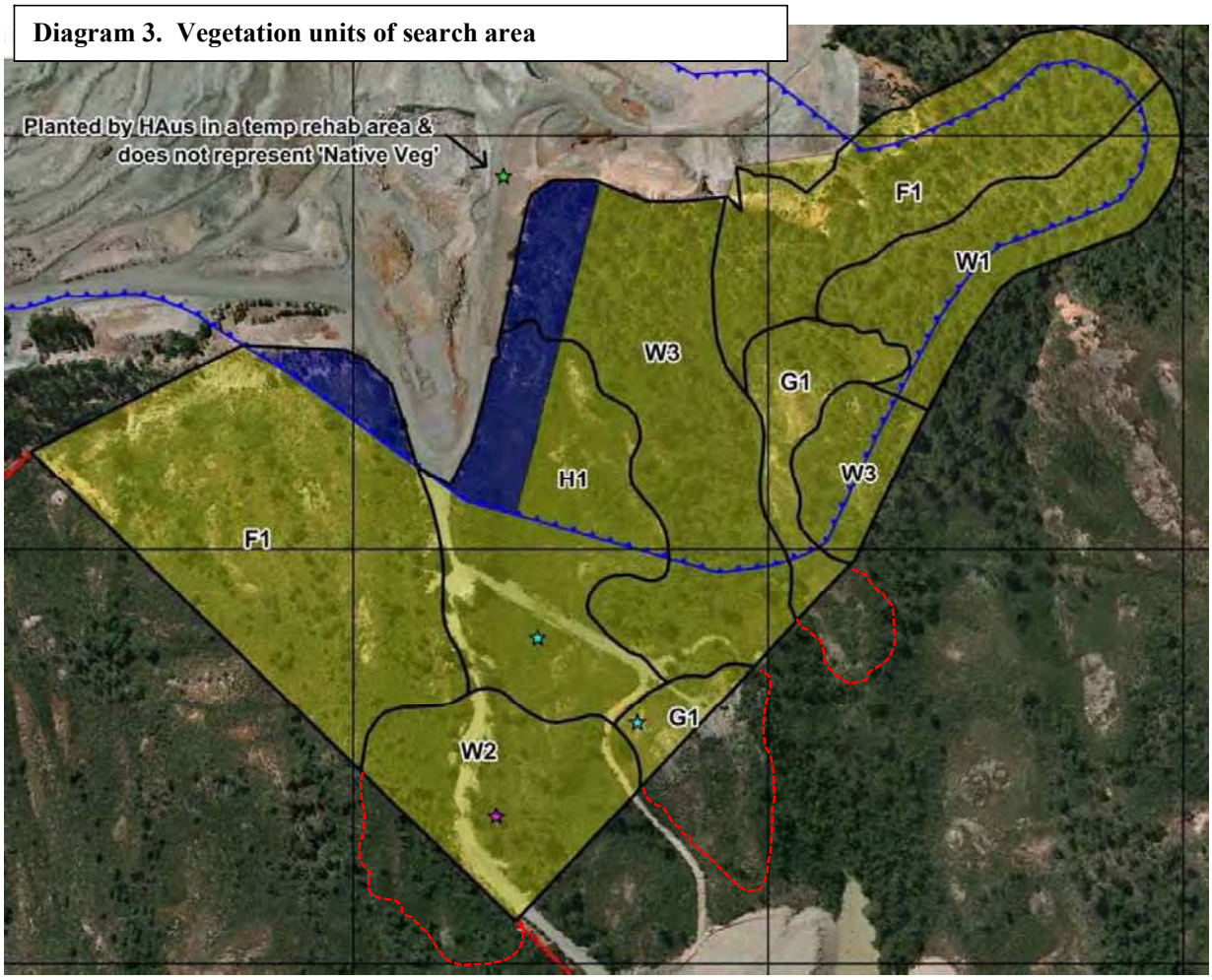
- The leaves of are 6-15cm long and 1-2.5cm wide, with a sheathing base;
- The flowers are dark, golden brown with large yellow blotches and striations;
- It has a cinnamon-like scent;
- The column (see diagram 1) is 7-9mm long, 5-6mm wide, golden brown at base and yellow towards apex, broadly winged, the wings have teeth along the margins;
- Post anther lobe (see Diagram 2) is covered in dense mass of orange hairs;
- Supra-anther lobe (see Diagram 2) is rod-like with a swollen club shaped apex, orange; and
- Occurs on slopes in seasonally moist sandy clay and granitic soils in the vicinity of *Eucalyptus wandoo* trees.

Thelymitra stellata flowers later than *T. magnifica.*

- The leaves are 5-20cm long and 1-3.5cm wide, with a sheathing base;
- The flowers are brown to reddish brown with large yellow blotches and stripes on inner surface;
- It is sweetly scented;
- The column is 5.5-8mm long and 3-5mm wide, orange brown at the base, orange towards apex, broadly winged, the wings have teeth along the margins;
- Post anther lobe is covered with dense mass of orange hairs;
- Supra-anther lobe is rod like with a swollen club-shaped, notched apex, orange; and
- Occurs in low shrubs of the Jarrah Forest or in low heath on rocky lateritic slopes. Soil lateritic loam.

Search Method

Diagram 3. Vegetation units of search area



Search for *Thelymitra magnifica* in areas: W2 (Wandoo Woodland), G1 (Granite Rocks) and H1 (Heath).

Search for *Thelymitra stellata* in areas F1, W1, W3 (*Eucalyptus marginata* subsp. *thalassica* Forest & Woodland) and H1 (Heath).
If plants of these species are found it would be beneficial to extend the search into the adjoining same vegetation – I have drawn approximate areas outlined in red).
Field work:

- Transects are to be walked through the bushland about 5m apart or at a distance where it would be possible to see these plants when in flower;
- When plant(s) is found record position using a GPS, record the number of plants; their condition ie if flowering or past flowering; and take a photograph for confirmation; and
- Leave a small piece of flagging next to the plant(s) to ensure they are not counted a second time.

DO NOT PICK THESE PLANTS – A SPECIAL PERMIT IS REQUIRED
THELYMTRA MAGNIFICA AND THELYMITRA STELLATA

Major differences

1. FLOWER COLOUR
   T. magnifica flowers are dark, golden brown with large yellow blotches and striations
   T. stellata flowers are brown to reddish brown with large yellow blotches and stripes
2. SCENT
   T. magnifica has a cinnamon-like scent
   T. stellata has a sweet scent
3. FLOWERING TIMES
   T. magnifica flowers in September and October
   T. stellata flowers in October and November
4. SOIL
   T. magnifica prefers seasonally moist, granitic soils
   T. stellata prefers dry lateritic soil

PHOTOGRAPHS

Look up FLORABASE on the internet. This is a DPAW site. When the site opens click on NAMES. Enter *Thelymitra* under genus and then each species individually under species, then click on SEARCH at the bottom of the page. Next to the name there is a line of letters and pictures, click on the leaf. This will give you the information that is available on the site, which is not much, but it does have a good photograph of the inflorescence and closer one of the flowers. You can see on Florabase the differences in the flower colour.



Thelymitra magnifica



Thelymitra stellata

Appendix K AECOM Environmental Values Identification – Land Swap Areas, Gosnells Quarry

AECOM Australia Pty Ltd
3 Forrest Place
Perth WA 6000
GPO Box B59
Perth WA 6849
Australia
www.aecom.com

+61 8 6208 0000 tel
+61 8 6208 0999 fax
ABN 20 093 846 925

4 Sep 2017

Commercial-in-Confidence

Jenny Moro
Planning & Environment Manager, WA
Holcim (Australia) Pty Ltd
Level 3, 200 Adelaide Terrace

East Perth WA 6004

Dear Jenny Moro

Environmental Values Identification - Landswap Areas, Gosnells Quarry

This letter presents the findings of our recent flora and vegetation walk over survey at the historic land swap areas adjacent to Holcim (Australia) Pty Ltd's (Holcim) Gosnells Quarry, located at Lot 3 Cockram Road, Martin. The land swap areas, situated within the Banyowla Regional Park, were originally within the Gosnells Quarry lease boundary. However, during assessment of an Environmental Review and Management Programme in 1982, under the *Environmental Protection Act 1971,* these were subject to a land exchange with the State Government in 1984. The land swap areas were excised from the lease area and returned to the conservation estate to be managed by the City of Gosnells, while Lot 3 was given to Holcim in exchange for the land swap areas. This was done as a way of offsetting the environmental values from the 60 Foot Falls and the *Eucalyptus lane-poolei* habitat (considered rare at the time) and minimising visual impact due to the future operation of the quarry.

The survey conducted was not intended to be a comprehensive detailed botanical assessment, but one which would provide a high level understanding of the type and quality of floristic and vegetative values within the areas. The purpose of the survey was to record those values and compare them to the comprehensive data set that currently exists for Lot 3 of the Gosnells Quarry lease area. This letter provides the following:

- a concise presentation of results and discussion of values observed in the land swap areas
- summary of Lot 3 environmental values as documented by detailed flora, vegetation and fauna assessments
- mapping and quantifying broad vegetation types within land swap areas
- assessment of similarity between the land swap areas and Lot 3.

Methodology

As shown in Figure 1, the land swap area comprises two parts, Landswap Area 1 and Area 2, situated within Banyowla Regional Park. As part of the study, a desktop assessment was undertaken to determine the likelihood of occurrence of conservation significant flora and fauna species. This was informed by the Fauna Assessment (Bamford Consulting Ecologists, 2017a) and Flora and Vegetation Report (AECOM, 2016). Categories of likelihood of occurrence were based on the proximity of records to the Land Swap Areas, and presence of suitable habitat.

The field team visited the two land swap areas on 15 June 2017, and the survey was executed by Lyn van Gorp (Environmental Scientist) and Floora de Wit (Senior Botanist) of AECOM.

Land Swap Area 1 is located directly adjacent to Orange Grove Boral Quarry. Due to its size, it was accessed via vehicle. There were few suitable tracks and the area is dissected by a deep gully. Access difficulties in some locations prevented further investigations to be undertaken. Aerial imagery and driving the available tracks showed that the heath and granite outcrop communities appeared homogenous throughout the area, including outside the Land Swap Area for up to 2 km. Where access was too limiting, representative vegetation was used to determine the community type and potential environmental values that it may support. This was particularly necessary for the heath with scattered trees located on steep slopes.

Land Swap Area 2 was traversed on foot. Using existing tracks the field team walked up to 60-Foot Falls, then looped north and back to assess the Woodland, Forest, and Heath vegetation types. Granite outcrops and heath were, where accessible, further investigated in an attempt to determine the likelihood that priority species are present.

Following the field survey, the broad vegetation types were mapped using Arc GIS 10.3 and Landgate aerial imagery. Effort was made to ensure that vegetation mapping conducted in Land Swap Area 2 matched vegetation mapping undertaken for the Holcim's Lot 3 directly adjacent. Photographs and short descriptions of each vegetation type are presented in this letter. Results have been tabulated, and further informed by the Fauna Assessment (Bamford Consulting Ecologists, 2017a) and the Environmental Review and Management Programme (O'Brien & Associates, 1982). The information obtained from the Bamford (2017a) report does not separate Land Swap Areas 1 and 2, therefore results are presented for both combined in the table.

The Fauna Assessment used broad vegetation types to characterise the Black Cockatoo foraging habitat. In the absence of the report's spatial data files or Black Cockatoo foraging habitat maps, the same broad vegetation types mapped as part of this exercise were used to define total extent of Black Cockatoo foraging habitat.

The Holcim Lot 3 summary of environmental values was informed by the Flora and Vegetation Report (AECOM, 2016) and Fauna Assessment [Bamford Consulting Ecologists (Bamford), 2017b]. Significant environmental values were tabulated to allow for comparison with the Land Swap Areas.

1.0 Land Swap Area 1

Land Swap Area 1 is the northern-most block of land, comprising nine tenements that extend across a deep valley, and includes steep slopes and adjacent hill crests. It is situated on the western edge of the Darling Scarp and located entirely within Banyowla Regional Park (managed by City of Gosnells). The northeast border of Area 1 is directly adjacent to Korung National Park. The area includes approximately 165 ha of native vegetation in 'Excellent' condition using Keighery *et al.* (1994) condition rating scale. An additional approximate area of 11.24 ha has been cleared for the Police Tactical Response Group and Boral's Orange Grove Quarry.

Historically, a cluster of *Eucalyptus lane-poolei* has been recorded in Area 1, upslope from the 60-Foot Falls around the Ellis Brook stream bed (O.Brien & Associates 1982; Bamford 2017a). Approximately 50 trees have been mapped there previously. Because the site walk-over was time and access restricted the location was not inspected / observed on 15 June 2017.

Three broad vegetation types were mapped, including Wandoo Woodland, Jarrah Forest and Heath (Table 1, Figure 1). Two Priority flora species were opportunistically recorded, including *Acacia horridula* (Priority 3) and *Acacia oncinophylla* subsp. *palustre* (P4). *Pimelea rara* (P4) is also known to occur from a WA Herbarium record (see Figure 1). An additional 12 species are considered likely to occur including:

- Four species listed under the *Wildlife Conservation Act 1950* (WC Act), two are listed under the *Environment Protection and Biodiversity Act 1999* (EPBC Act)
- Ten species listed as Priority flora by the Minister of Environment and Department of Biodiversity, Conservation and Attractions (DBCA).

An additional nine species may occur, and 22 species are considered unlikely to occur. The detailed results of the desktop assessment are provided in Appendix A.

The Fauna Assessment undertaken by Bamford Consulting Ecologists (Bamford; 2017a) states that both Carnaby's Black Cockatoo (listed as Endangered under the EPBC Act and the WC Act) and Forest Red-tailed Black Cockatoo (listed as Vulnerable under the EPBC Act and WC Act) are expected to occur regularly in Area 1. The presence of Jarrah and Wandoo provide adequate food resources and potential breeding hollows. Transect surveys undertaken by Bamford in both Area 1 and 2 indicate a density of 9.6 potential breeding trees per hectare. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. The Woodland and Forests are considered to have moderate foraging value (rated 4 out of 6), extending for 66.52 ha. The Heath was mapped as having low foraging quality (rated 2 out of 6), extending for 98.86 ha.

An additional 17 conservation significant fauna species are anticipated to reside in the Land Swap Areas (Bamford 2017a). This includes one species listed under the EPBC Act (Chuditch), two listed under the WC Act, and five Priority fauna species. An additional two Priority species are anticipated to visit the area. The detailed fauna desktop results are provided in Appendix B.

Table 1 Broad vegetation types of Land Swap Area 1

Vegetation Description	Area (ha)	Photograph
Jarrah Woodland to Forest *Eucalyptus marginata* forest over diverse understorey. *Acacia horridula* (P3) recorded at one location.	59.37	
Wandoo Woodland *Eucalyptus wandoo* woodland over sparse understorey.	7.15	
Heath Diverse mosaic of heath. Some exposed granite. Patches of *Eucalyptus wandoo* and *E. marginata.* Incorporates steep slopes, valley floor and hill tops. *Acacia oncinophylla* subsp. *patulifolia* (P4) recorded at one location.	98.86	

2.0 Land Swap Area 2

Land Swap Area 2 is located directly north of Holcim's Lot 3 on the western edge of the Darling Scarp. It is also situated entirely within Banyowla Regional Park. Area 2 includes 55.05 ha of native vegetation, mostly in 'Excellent' condition using Keighery *et al.* (1994) condition rating scale. Degradation from weeds and rubbish was observed within the narrow riparian zone associated with Ellis Brook. An additional 3.31 ha has been historically cleared. Area 2 has several significant features, including 60-Foot Falls (Plate 1), Ellis Brook (Plate 2), a historical quarry with associated cleared infrastructure, and tourism infrastructure associated with the Falls.



Plate 1 60 Foot Falls



Plate 2 Ellis Brook

Area 2 includes the deep channel formed by Ellis Brook, steep slopes, and part of one hill top. It is dominated by Wandoo woodland to open woodland on the steep slopes with variable understorey. Heath mosaic communities were observed to penetrate into the Wandoo woodland along the slopes. Their exact boundaries were difficult to map due to the sporadic intermittent patches of Wandoo. The three broad vegetation types identified within Area 2 are described in Table 2 and shown in Figure 1.

One Priority species, *Acacia oncinophylla* subsp. *Patulifolia,* was recorded opportunistically in the Land Swap Area. There are also records of priority flora species *Lasiopetalum glutinosum* subsp. *glutinosum* (P3), *Halgania corymbosa* (P3), *Goodenia arthrotricha* (Endangered under the WC Act), and *Beaufortia purpurea* (P3) from WA herbarium within the Land Swap Area. However, these were unconfirmed during the field assessment. Historical searches for *Goodenia arthrotricha* was undertaken in 2016 however this species was not recorded. The steep slopes presented unsafe conditions for a detailed targeted survey at that time.

The Fauna Assessment (Bamford 2017a) discusses Area 2 simultaneously with Area 1, results are therefore considered similar between the two areas. The tree transects show a density of approximately 9.6 potential breeding trees per hectare. Black Cockatoo foraging habitat consists mostly of the Woodlands and Forests (rated 4 out of 6), which extends for 43.89 ha. Heath was considered to have low foraging value (rated 2 out of 6), extending for 11.16 ha.

The conservation significant fauna species likely to use Land Swap Area 2 are the same as those that reside and/or visit Land Swap Area 1. The most significant of these include the Forest Red-tailed Black Cockatoo and the Chuditch, both listed as Vulnerable under the EPBC Act.

Table 2 Broad vegetation types of Land Swap Area 2

Vegetation Description	Area (ha)	Photograph
Heath Mosaic heath mostly on hill tops and slopes. Includes some exposed rock and 60-Foot Falls. Some patches/emergent *Eucalyptus wandoo* and *E. marginata*. One population of *Acacia oncinophylla* subsp. *palustre* (P4) recorded.	11.16	
Marri and Wandoo Woodland *Corymbia calophylla* Forest with *Eucalyptus wandoo* scattered trees. Varies between forest and woodland. Occupies upper slopes.	12.88	No photograph taken.

Vegetation Description	Area (ha)	Photograph
Wandoo Woodland. *Eucalyptus wandoo* tall woodland over mid to tall shrubs, predominantly *Calothamnus rupestris*. Community predominantly on steep slopes.	31.01	

3.0 Lot 3

Detailed biological surveys have been completed for Lot 3 in recent years. These studies include:

- Vegetation and Flora Readymix Quarry Gosnells (Bennett Environmental Consulting [Bennett], 2005)
- Vegetation survey of two sites at Readymix quarry at Gosnells (Bennett, 2006)
- Desktop flora and vegetation assessment undertaken for the Holcim development area (Astron, 2012a)
- Field survey of flora, vegetation and fauna (Astron, 2012b)
- Gosnells Quarry Clearing Permit CPS 5543/2 Amendment Application Supporting Information (URS Australia Pty Ltd [URS], 2013)
- Review of habitat and targeted searches for *Thelymitra stellata* and *Thelymitra magnifica* (Bennett, 2014)
- Flora, Vegetation and Targeted Orchid Assessment (AECOM, 2014)
- Flora, Vegetation and Targeted Orchid Assessment (AECOM, 2015)
- DPaW database searches (requested February 2016)
- Gosnells Quarry Flora, Vegetation and Targeted Survey (AECOM, 2016)
- Holcim Gosnells Quarry Fauna Assessment (Bamford Consulting Ecologists, 2017b).

From these studies five Priority flora species have been recorded, which are:

- *Acacia horridula* (Priority 3) –may be locally significant. Known from multiple adjacent local government areas therefore not considered regionally significant
- *Acacia oncinophylla* subsp. *patulifolia* (Priority 4) – locally common and not considered regionally significant
- *Asteridea gracilis* (Priority 3) – may be locally common but under-sampled, may be regionally significant as it represents western extent of range
- *Beaufortia purpurea* (Priority 3) – locally significant and potentially regionally significant due to population size and extent within study area
- *Lasiopetalum glutinosum* subsp. *glutinosum* (Priority 3) – locally and potentially regionally significant due to size and extent of populations within the study area.

Also from these studies nine vegetation communities have been recorded, these included four Heath mosaic communities, three Jarrah/Marri Forests, one Wandoo Woodland and one *Calothamnus* thicket. Vegetation communities have been amalgamated into broad vegetation types based on the highest superficial similarity, including geographical and landscape context, dominant species, and vegetation type (Table 3). Grouping of communities has been undertaken to allow comparison with the land swap areas and Lot 3.

Suitable foraging habitat for the Carnaby and Forest Red-tailed Black Cockatoos was mapped by Bamford (2017b). Approximately 95 ha was considered Moderate value (rated 4 out of 6), and 30 ha of Low quality (rated 2 out of 4).

Table 3 Broad Vegetation Types of Holcim Lot 3

Vegetation Type	Area (ha)
Marri/Jarrah Forest	99.65
Heath	33.04
Wandoo Woodland	5.09
Rehabilitated	7.85

4.0 Overview of environmental values: Land Swap, Lot 3 and surrounds

Lot 3 and the Land Swap Areas are situated on the western slopes of the Darling Scarp. The west of the Darling Scarp has slowly eroded over time, creating breakaways, steep slopes deep valleys, and hills, now covered in woodland and forest.

The broad vegetation communities and topography of the Holcim-held tenements are readily comparable. Ellis Brook, which is located exclusively in Land Swap Area 1 provides an important refuge for riparian and winter-wet dependent fauna species. Vegetation within and surrounding Lot 3 and the Land Swap Areas comprise slopes covered in dense heath vegetation. Wandoo, Marri and/or Jarrah woodlands and forests are more readily found on the upper gentle slopes. Vegetation was observed in excellent condition, except where minor gravel tracks and historical infrastructure has been constructed.

Exposed granite outcrops are prevalent within Lot 3. This was not observed in the Land Swap Areas but appears prolific in the surrounding area according to aerial imagery.

The desktop assessment identified 46 Threatened and Priority flora species, likely to be present within Lot 3, the land swap areas and the forest surrounding them. A summary of conservation significant species, their associated habitat, and likely presence is provided as follows:

- Fourteen species are restricted to the Swan Coastal Plain and are associated with sand, clay and/or winter-wet areas and/or wetlands
- Ten species are associated with granite outcrops. This habitat is evident on aerial imagery as occurring both within and outside lands held by Holcim. This is supported by known records in close proximity of the Holcim tenements
- 14 species are associated with gravel soils. Within Lot 3 and Land Swap Areas the gravel seams recorded were associated with Wandoo/Jarrah and Marri woodlands
- Two species are associated with heath and woodland associated with the western edge of the Darling Scarp
- Six species have no habitat information available and no nearby records.

The local area within and around Holcim tenements is known for the high level of plant species richness. Markey (1997) completed a survey of the northern Darling Scarp, recording 621 native flora species. City of Gosnells (2016) recorded 550 native species within the Ellis Brook Reserve area. Similarly, 319 native flora species have been recorded within Lot 3 (AECOM, 2017).

The local and regional area supports a rich assemblage of fauna species (51 reptiles and amphibians, 116 birds, and 23 mammals have been recorded in the Ellis Brook Valley region (City of Gosnells, 2016). This is due to the relatively undisturbed nature of vegetation, and the preservation of vegetation within Banyowla Regional Park. The fauna diversity within Lot 3 is comparatively lower due to the lack of wetland environments (Bamford, 1997a). The fauna assemblages identified were typical of the Jarrah Forest and Northern Jarrah Forest subregions.

Bamford (1997a) identified 18 residents, seven visitors, one vagrant and four migrant conservation significant fauna species to occur within Lot 3. The reports by Bamford Consulting Ecologists (2017a; 2017b) show similar conservation significant faunal assemblages are present in Area 1 and 2 compared to Holcim's Lot 3. An additional unique feature of Land Swap Area 2 is the Ellis Brook riparian zone. This would make the area more important for aquatic and wetland fauna. Furthermore, the Heath vegetation present in all areas is considered seasonally important for nectar feeding birds and mammals.

The results of the high level environmental value assessment, further informed by the Fauna Assessments and Flora and Vegetation Assessments, is summarised in Table 4.

Table 4 Vegetation type comparisons with Lot 3

Environmental values	Land Swap 1	Land Swap 2	Lot 3
Heath Low Black Cockatoo foraging quality	98.86 ha	11.16 ha	30 ha
Forest and woodlands of Wandoo, Marri and Jarrah Moderate Black Cockatoo foraging quality	66.52 ha Excellent	43.89 ha Excellent	95 ha Excellent
Granite outcrops	Yes – less rock outcrop noted than in Lot 3	Yes – less rock outcrop noted than in Lot 3	Yes – extensive areas of exposed granite outcrops
Black Cockatoo potential breeding and roosting	9.6 trees/ha, 2,133 trees total		Yes, 11.6 trees/ha, 1,679 trees total
Conservation significant flora including Priority and Threatened species	3 - 12 additional species considered likely	5 – 15 additional species considered likely	5
Conservation Significant Fauna	18 resident species and eight regular visitors expected to occur		18 residents and seven regular visitors expected to occur

5.0 Conclusion

This high level walk over survey found that the environmental values of the Land Swap areas and Lot 3 are very similar in both extent and significance. The heath vegetation occurring with Lot 3 extends considerably into Area 1 and 2 (110 ha), providing suitable habitat for Priority flora species historically recorded at Holcim except that exposed granite rocks do not appear to be as prevalent in the Land Swap Area as in Lot 3.

Land Swap Area 1 supports an extensive mosaic of high-diversity heath vegetation on granite outcrops. There are three records of Priority flora within this area, two of which were recorded in 2017 and include *Acacia horridula* (P3) and *Acacia oncinophylla* subsp. *palustre* (P4), and one WA Herbarium record *Pimelea rara* (P4). The area provides habitat to nine conservation significant fauna species including the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*; Vulnerable) and the Chuditch (*Dasyurus geoffroii*; Vulnerable).

Land Swap Area 2 supports significant environmental features including 60-Foot Falls, Ellis Brook, a group of *Eucalyptus lane-poolei* (considered rare when the ERMP was assessed, it has since been delisted), and extensive Heath. Four Priority species have been historically recorded in the area including one that was verified in 2017. Species include *Acacia oncinophylla* subsp. *patulifolia* (P4),

Lasiopetalum glutinosum subsp. *glutinosum* (P3), *Halgania corymbosa* (P3), *Goodenia arthrotricha* (Endangered under the WC Act), and *Beaufortia purpurea* (P3). Ellis Brook provides an important role for wetland and aquatic fauna in this area, and potential habitat for the Pouched Lamprey (*Geotria australis*; P1).

The richness of the flora and fauna is related to the variety of habitats present and the contiguous high quality native vegetation connecting to Ellis Brook Valley Reserve and Banyowla Regional Park. A number of studies undertaken in the local area indicate high species diversity across the region, with similar geography, topography, soils and position on the Darling Scarp.

Yours sincerely



Floora de Wit
Senior Botanist
floora.dewit@aecom.com

Direct Dial: +61 8 6 208 1073
Direct Fax: +61 8 6 208 0999

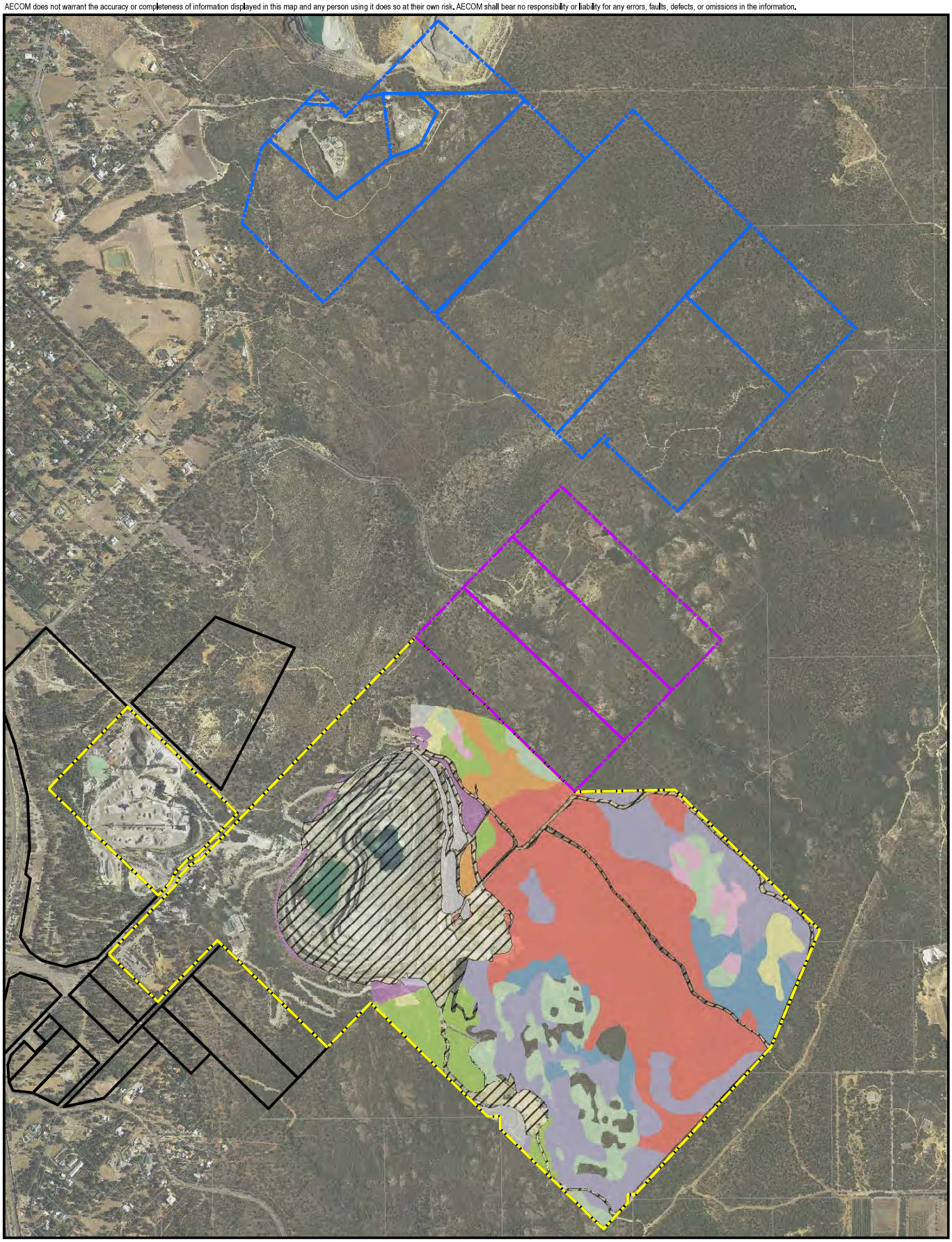
encl: Figures
Reference list
Appendix A Flora Desktop Results
Appendix B Fauna Desktop Results

Figure 1 Vegetation Types of Lot 3

Code	Description
Heath	
BpSr	*Beaufortia purpurea, Hakea uncinata, Verticordia acerosa* var. *acerosa, Petrophile squamata* subsp. *squamata* and *Allocasuarina humilis* mid shrubland over *Beaufortia macrostemon, Banksia armata* var. *armata, Astroloma glaucescens, Babingtonia pelloeae* and *Hibbertia hypericoides* low open shrubland over *Stylidium repens, Thysanotus manglesianus, Goodenia coerulea* and *Stylidium bulbiferum* low sparse forbland. Supports populations of *Beaufortia purpurea* (P3) and *Lasiopetalum glutinosum* subsp. *glutinosum* (P3).
HeSb	*Eucalyptus wandoo* low isolated trees over *Hakea erinacea, Verticordia acerosa* var. *acerosa, Leucopogon sprengelioides, Melaleuca radula* and *Xanthorrhoea drummondii* mid shrubland over *Hibbertia hypericoides, Melaleuca parviceps, Babingtonia camphorosmae, Beaufortia purpurea* and *Hakea incrassata* low shrubland over *Stylidium bulbiferum, Stylidium calcaratum, Cassytha racemosa* forma *racemosa, Stylidium eriopodum* and *Drosera glanduligera* low sparse forbland. Predominantly heathland with some mallee form *Eucalyptus wandoo* and *Corymbia calophylla* as an ecotone to adjacent forest. Variable in density of *Hakea erinacea*. Supports populations of *Asteridea gracilis* (P3), *Beaufortia purpurea* (P3) and *Lasiopetalum glutinosum* subsp. *glutinosum* (P3).
IdBc	*Acacia oncinophylla* subsp. *patulifolia* and *Xanthorrhoea drummondii* tall open shrubland over *Isopogon dubius, Verticordia acerosa* var. *acerosa, Hakea erinacea, Melaleuca holosericea* and *Allocasuarina humilis* medium shrubland over *Astroloma glaucescens, Cryptandra pungens, Hibbertia subvaginata, Melaleuca parviceps, Hakea undulata* and *Hibbertia hypericoides* low shrubland with *Borya constricta, Stylidium eriopodum, Pterochaeta paniculata, Stylidium brunonianum,* and *Thysanotus scaber* low sparse forbland. Dominated by *A. oncinophylla* subsp. *patulifolia* (P4) throughout most of the community with the exception of HO21 and HO25.
VaBs	*Acacia oncinophylla* subsp. *patulifolia* and *Melaleuca holosericea* tall sparse shrubs over *Verticordia acerosa* var. *acerosa, Verticordia insignis* subsp. *insignis*, *Verticordia plumosa* var. *plumosa* and *Hakea erinacea* mid shrubland over *Borya sphaerocephala, Stylidium bulbiferum*, *Drosera gigantea, Glischrocaryon aureum* and *Pterochaeta paniculata* low open forbland. Supports populations of *Acacia oncinophylla* subsp. *patulifolia* (P4), *Beaufortia purpurea* (P3) and *Lasiopetalum glutinosum* subsp. *glutinosum* (P3).
Woodland	
CcCrTc	*Corymbia calophylla* mid isolated trees over *Calothamnus rupestris, Xanthorrhoea preissii* and *Hakea undulata* tall closed shrubland over *Hibbertia hypericoides, Banksia dallanneyi* var. *dallanneyi, Gompholobium tomentosum, Synaphea acutiloba* and *Hakea amplexicaulis* low sparse shrubland with *Tetraria capillaris* and *Tetraria octandra* low sparse sedgeland with *Stylidium piliferum, Stylidium bulbiferum, Trichocline spathulata, Dampiera alata* and *Patersonia occidentalis* low sparse forbland. Supports population of *Acacia horridula* (P3).

Code	Description
CcHtHh	*Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* mid open forest over *Hakea trifurcata, Xanthorrhoea preissii, Hakea undulata,* and *Hakea prostrata* mid to tall shrubland over *Hibbertia hypericoides, Hibbertia commutata, Banksia dallanneyi* var. *dallanneyi, Hibbertia huegelii* and *Bossiaea ornata* low open shrubland with *Lepidosperma leptostachyum* and *Cyathochaeta avenacea* mid open sedgeland with *Scaevola calliptera, Cassytha racemosa, Pentapeltis peltigera, Xanthosia candida, Conostylis setosa* and *Burchardia congesta* mid sparse forbland.
EmBsBd	*Eucalyptus marginata* subsp. *marginata, Corymbia calophylla* and *Allocasuarina fraseriana* mid open forest over *Banksia sessilis* var. *sessilis*, *Xanthorrhoea preissii* and *Hakea undulata* tall shrubland over *Banksia dallanneyi* var. *dallanneyi, Hibbertia hypericoides, Bossiaea ornata, Hibbertia commutata* and *Hypocalymma robustum* low shrubland with *Lepidosperma leptostachyum, Tetraria capillaris* and *Lepidosperma pubisquameum* mid sparse sedgeland with *Orthrosanthus laxus* var. *laxus, Conostylis setosa*, *Lomandra caespitosa*, *Burchardia congesta, Pentapeltis peltigera,* and *Thysanotus manglesianus* low sparse forbland. Isolated occurrence of *Beaufortia purpurea* (P3) recorded in this community.
EwHhSa	*Eucalyptus wandoo* subsp. *wandoo, Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* medium open forest over *Xanthorrhoea preissii* and *occasional Xanthorrhoea drummondii tall open shrubland over Macrozamia riedlei, Hibbertia hypericoides, Acacia pulchella* var. *pulchella, Boronia ovata, Hakea lissocarpha* and *Hakea stenocarpa* low shrubland over *Stylidium affine, Acanthocarpus canaliculatus, Conostylis setosa, Lagenophora huegelii* and *Trichocline spathulata* low sparse forbland. Supports populations of *Asteridea gracilis* (P3).
EmKaLm	*Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla* mid open woodland over *Kingia australis* and *Xanthorrhoea drummondii* tall open shrubland over *Lambertia multiflora* var. *darlingensis, Beaufortia macrostemon, Hibbertia hypericoides, Paragonis grandiflora and Banksia armata* var. *armata* low shrubland with *Mesomelaena tetragona* and *Lepidosperma leptostachyum* mid sparse sedgeland over *Patersonia occidentalis, Lomandra effusa, Stylidium brunonianum, Dampiera linearis* and *Drosera glanduligera* low sparse forbland. Isolated occurrence of *Beaufortia purpurea* (P3) recorded in this community.

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID 60545986
CREATED BY DGF/RNM
APPROVED BY FdeWit
LAST MODIFIED 04 SEP 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 125 250 375 500
metres

1:17,500 when printed at A4

LEGEND

- Land Swap Area 1
- Land Swap Area 2
- Lot 3
- Holcim Owned Lots
- Cadastral Boundary

Holcim Vegetation Mapping for Lot 3

BpSe	EmBsBd	IdBc
CcCrTc	EmKaLm	Planted
CcHtHh	EwHhSa	Rehab
Cleared	HeSb	VaBs

Data sources Holcim Australia, Landgate, Geoscience Australia, Department of Water, Department of Mines and Petroleum

Detailed Vegetation Types of Lot 3

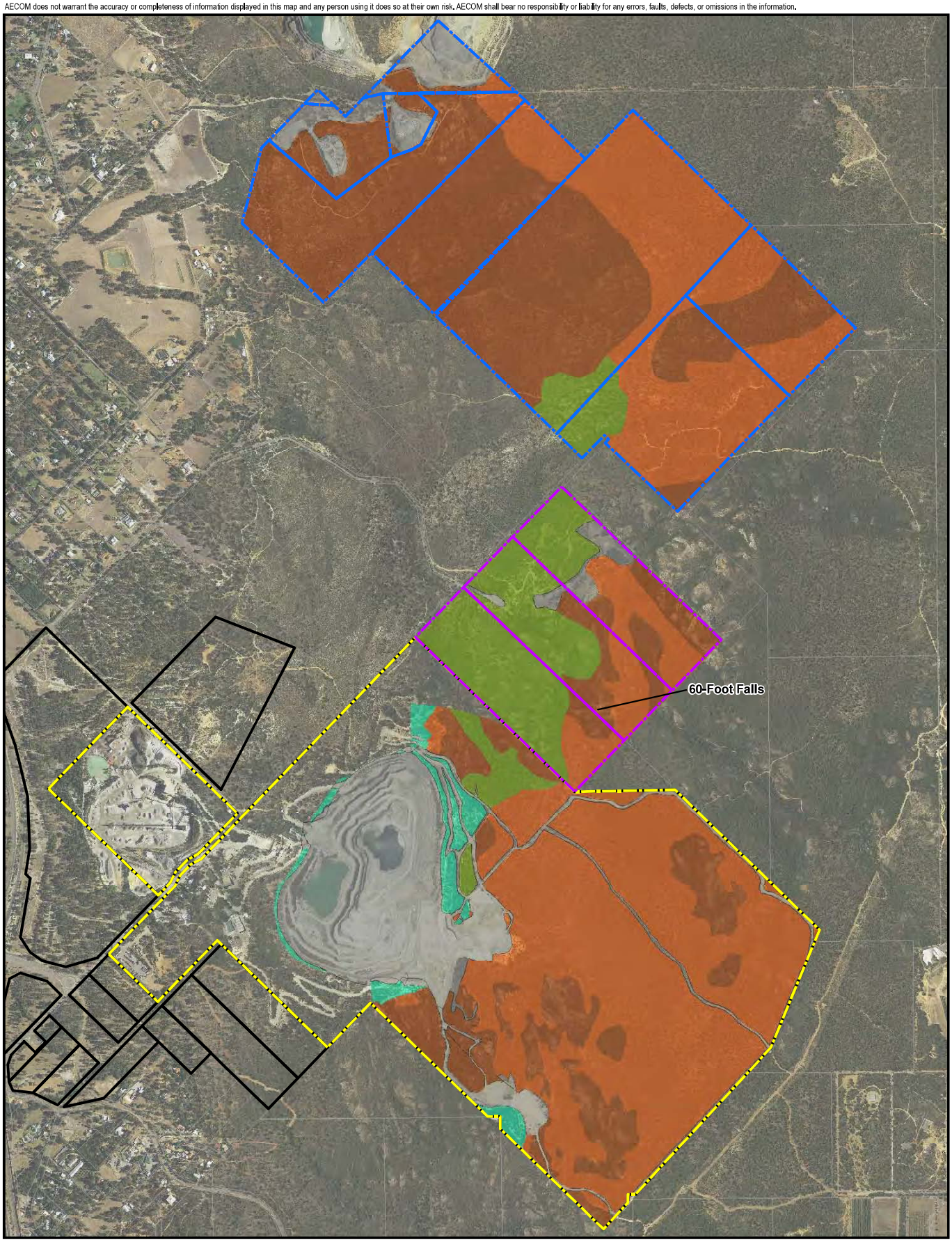
HOLCIM (AUSTRALIA) PTY LTD

BROAD VEGETATION MAPPING OF HOLCIM LAND SWAP AREAS

HOLCIM GOSNELLS QUARRY

Figure 1

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID 60545986
CREATED BY DGF/RNM
APPROVED BY FdeWit
LAST MODIFIED 04 SEP 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 125 250 375 500
metres

1:17,500 when printed at A4

LEGEND

- Land Swap Area 1
- Land Swap Area 2
- Lot 3
- Holcim Owned Lots
- Cadastral Boundary

BCE VSA Mapping (based on AECOM 2017)

- VSA 1: Open Jarrah/Marri woodland
- VSA 2: Open Wandoo woodland
- VSA 3: Mixed heath and thicket
- VSA 4: Open regrowth and non-native vegetation
- Cleared areas

Data sources:Holcim Australia, Landgate, Geoscience Australia, Department of Water, Department of Mines and Petroleum, AECOM , Bamfords
Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

Broad Vegetation Types

HOLCIM (AUSTRALIA) PTY LTD

BROAD VEGETATION MAPPING OF HOLCIM LAND SWAP AREAS

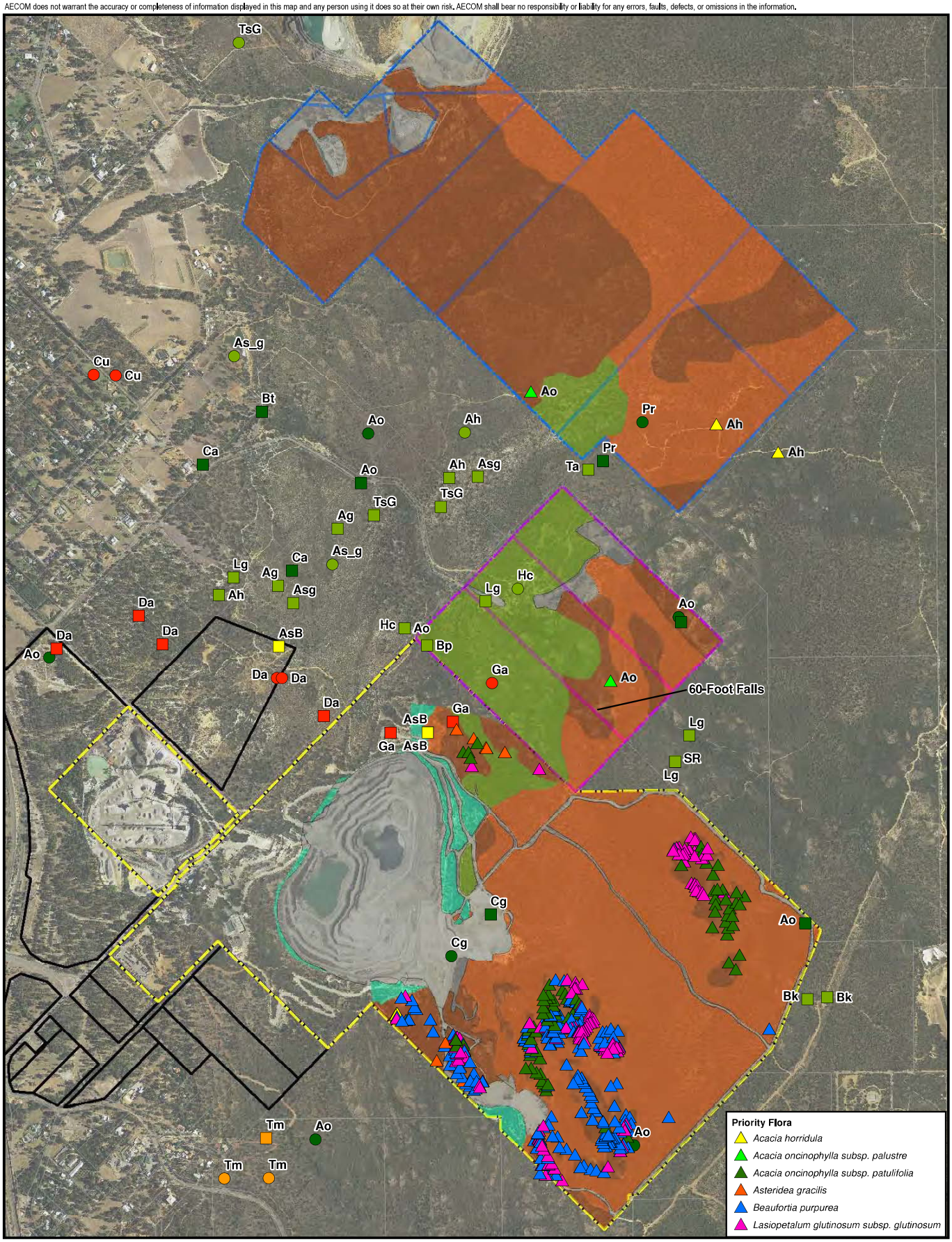
HOLCIM GOSNELLS QUARRY

Figure 2

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60545986\4. Tech Work Area\4.99 GIS\02_MXDs\BVMHLSA_Jun20174\G60545986_Fig 2_BroadVegTypes_v02.mxd (rob.mcgregor)

A4 size

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.



PROJECT ID 60545986
CREATED BY DGF/RNM
APPROVED BY FdeWit
LAST MODIFIED 04 SEP 2017

AECOM
www.aecom.com

N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 125 250 375 500
metres

1:17,500 when printed at A4

LEGEND

- Land Swap Area 1
- Land Swap Area 2
- Lot 3
- Holcim Owned Lots
- Cadastral Boundary

BCE VSA Mapping (based on AECOM 2017)

- VSA 1: Open Jarrah/Marri woodland
- VSA 2: Open Wandoo woodland
- VSA 3: Mixed heath and thicket
- VSA 4: Open regrowth and non-native vegetation
- Cleared areas

Desktop Results

WA Herb	TPFL
T	T
1	1
2	2
3	3
4	4

Data sources:Holcim Australia, Landgate, Geoscience Australia, Department of Water, Department of Mines and Petroleum

Priority Flora

HOLCIM (AUSTRALIA) PTY LTD

BROAD VEGETATION MAPPING OF HOLCIM LAND SWAP AREAS

HOLCIM GOSNELLS QUARRY

Figure 3

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60545986\4. Tech Work Area\4.99 GIS\02_MXDs\BVMHLSA_Jun20174\G60545986_Fig 3_PriorityFlora_v02.mxd (rob.mcgregor)

A4 size

Taxon Abbreviations for Figure 3

Abbrev	Taxon
Aa	*Acacia aphylla*
Ag	*Allocasuarina grevilleoides*
Ah	*Acacia horridula*
Al	*Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)*
Ang	*Anthocercis gracilis*
Ao	*Acacia oncinophylla subsp. patulifolia*
Aph	*Aponogeton hexatepalus*
As_g	*Asteridea gracilis*
AsB	*Andersonia sp. Blepharifolia (F. & J. Hort 1919)*
Asg	*Asteridea gracilis*
Bg	*Byblis gigantea*
Bk	*Bank sia k ippistiana var. paenepeccata*
Bm	*Bank sia mimica*
Bp	*Beaufortia purpurea*
Bt	*Boronia tenuis*
Ca	*Calothamnus accedens*
Cb	*Calytrix breviseta subsp. b reviseta*
Cc	*Centrolepis caespitosa*
Cg	*Calothamnus graniticus subsp. leptophyllus*
Cu	*Conospermum undulatum*
Da	*Darwinia apiculata*
Do	*Drosera occidentalis subsp. occidentalis*
Ek	*Eleocharis k eigheryi*
Ga	*Goodenia arthrotricha*
Gt	*Grevillea thelemanniana subsp. thelemanniana*
Hc	*Halgania corymbosa*
Hr	*Hemigenia rigida*
Id	*Isopogon drummondii*
Lg	*Lasiopetalum glutinosum subsp. glutinosum*
Mt	*Meionectes tenuifolia*
Pr	*Pimelea rara*
Sp	*Schoenus pennisetis*
SR	*Stack housia sp. Red-blotched corolla (A. Mark ey 911)*
Ta	*Thysanotus anceps*
Tm	*Thelymitra magnifica*
Ts	*Thelymitra stellata*
TsG	*Tetratheca sp. Granite (S. Patrick SP1224)*
Vl	*Verticordia lindleyi subsp. lindleyi*

6.0 References

AECOM (Australia) Pty Ltd, 2016. Gosnells Quarry Flora, Vegetation and Targeted Survey. Unpublished report prepared for Holcim (Australia) Pty Ltd.

Astron Environmental Services, 2012. Gosnells Quarry Desktop Flora, Vegetation and Fauna Survey, October 2012. Unpublished report prepared for Holcim (Australia) Pty Ltd.

Bamford Consulting Ecologists, 2017a. Holcim Gosnells Quarry – Fauna Assessment of the Land Swap Area (Banyowla Regional Park). Unpublished report prepared for Holcim (Australia) Pty Ltd.

Bamford Consulting Ecologists, 2017b. Holcim Gosnells Quarry – Fauna Assessment of the Quarry Area. Unpublished report prepared for Holcim (Australia) Pty Ltd.

City of Gosnells, 2016. Ellis Brook Valley Reserve Strategic Management Plan 2016-2026. Available at: http://www.gosnells.wa.gov.au/files/sharedassets/public/pdfs/environment/ellis_brook_valley_management_plan.pdf. Viewed August 2017.

Keighery BJ, 1994. Bushland Plant Survey – A Guide to Plant Community Survey for the Community Wildflower Society of WA (inc), Nedlands, Western Australia

M.J. & A.R. Bamford Consulting Ecologists, 2017a. Holcim Gosnells Quarry – Fauna Assessment of the Land Swap Area (Banyowla Regional Park). Unpublished report (draft) prepared for Holcim (Australia) Pty Ltd.

M.J. & A.R. Bamford Consulting Ecologists, 2017b. Holcim Gosnells Quarry – Fauna Assessment of the Quarry Area. Unpublished report (draft) prepared for Holcim (Australia) Pty Ltd.

O'Brien & Associates Pty Ltd, 1982. Environmental Review and Management Programme – Long-term Planning for Readymix Land-use at Gosnells. Unpublished report prepared for The Readymix Group (WA).

Appendix A Flora Desktop Assessment

Taxon	Conservation status		Description	Likelihood		
	WC Act	EPBC Act		LS 1	LS 2	Lot 3
Acacia aphylla	VU	V	Sand, loam, clay loam. Granite outcrops, hills.	Likely	Likely	May
Acacia horridula	P 3	-	Gravelly soils over granite, sand. Rocky hillsides.	Known	Likely	Known
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P 1	-	Variety of soils	May	May	Unlikely
Acacia oncinophylla subsp. *patulifolia*	P 4	-	Granitic soils, occasionally on laterite.	Known	Known	Known
Allocasuarina grevilleoides	P 3	-	Previously recorded in open or dense low heathland in Ellis Brook Valley Reserve	May	Likely	Likely
Andersonia sp. Audax (F. Hort, B. Hort & J. Hort 3179)	P 3	-	No information available, no close records.	Unlikely	Unlikely	May
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	P 2	-	Previously found in Jarrah, Marri woodland or heathland	May	May	Likely
Andersonia sp. Saxatilis (F. & J. Hort 3324)	P 1	-	No information available on habitat and no nearby records of species available	Unlikely	Unlikely	May
Anthocercis gracilis	VU	V	Sandy or loamy soils. Granite outcrops.	Likely	Likely	May
Aponogeton hexatepalus	P 4	-	Mud. Freshwater: ponds, rivers, claypans.	Unlikely	Likely	Unlikely
Asteridea gracilis	P 3	-	Sand, clay, gravelly soils.	Likely	Likely	Likely
Austrostipa jacobsiana	CR	-	No habitat or location data available. Assumed not occurring within 10 km due to lack of location data	Unlikely	Unlikely	May
Banksia kippistiana var. *paenepeccata*	P 3	-	Lateritic gravelly soils. Previously recorded in heath fringed by Jarrah, Marri and Sheoak open woodland or in open woodland of Eucalyptus marginata	Likely	Likely	Likely
Banksia mimica	VU	E	White or grey sand over laterite, sandy loam. Previously recorded in low scrub generally with *Kingia australis* on the Plain	Unlikely	Unlikely	May

Taxon	Conservation status		Description	Likelihood		
	WC Act	EPBC Act		LS 1	LS 2	Lot 3
Beaufortia purpurea	P 3		Lateritic or granitic soils. Rocky slopes.	Likely	Known	Known
Boronia tenuis	P 4	-	Previously recorded on slope amongst granite boulders and outcrop. Also recorded on various loam, clay, gravel soils over granite. Recorded in Sheoak thicket or heathland or open woodland at base of scarp.	May	May	Likely
Byblis gigantea	P 3	-	Sandy-peat swamps. Seasonally wet areas.	Unlikely	Likely	Unlikely
Calothamnus accedens	P 4	-	Sandy soils over laterite. Road verge. Previously recorded nearby in grey sand over gravel or rocky loam or rocky clay in open woodland or dense heath	May	May	Likely
Calothamnus graniticus subsp. *leptophyllus*	P 4	-	Clay over granite, lateritic soils. Hillsides. Previously recorded in rehabilitated area in Gosnells quarry boundary	May	May	Known
Calytrix breviseta subsp. *breviseta*	CR	E	Sandy clay. Swampy flats.	Unlikely	May	Unlikely
Centrolepis caespitosa	P 4		White sand, clay. Salt flats, wet areas	Unlikely	Unlikely	Unlikely
Conospermum undulatum	VU	V	Grey or yellow-orange clayey sand.	Unlikely	Unlikely	Unlikely
Darwinia apiculata	EN	E	Previously recorded in gravel, grey sand clay over granite or dry laterite around disturbed gravel pit site. Previously recorded in heathland or Marri woodland	May	May	Likely
Drosera occidentalis subsp. *occidentalis*	P 4		Sandy & clayey soils. Swamps & wet depressions.	Unlikely	May	Unlikely
Eleocharis keigheryi	VU	V	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Unlikely	Unlikely	Unlikely
Goodenia arthrotricha	EN	-	Gravel. Granite rocks, slopes.	Likely	Known	Likely

Taxon	Conservation status		Description	Likelihood		
	WC Act	EPBC Act		LS 1	LS 2	Lot 3
Grevillea crowleyae	P 2	-	Gravel. In gravel pit.	Unlikely	Unlikely	May
Grevillea manglesii subsp. ornithopoda	P 2	-	Prefers habitat amongst medium trees, or low trees, or tall (sclerophyll) shrubland, or low (sclerophyll) shrubland; in gravelly soil, or sand, or clay; occupying along creek beds.	Unlikely	Likely	May
Grevillea thelemanniana subsp. *thelemanniana*	CR	-	Previously recorded on sand below the scarp.	Unlikely	Unlikely	Unlikely
Halgania corymbosa	P 3	-	Gravelly soils, soils over granite.	Likely	Known	Likely
Hemigenia rigida	P 1	-	Sandy soils, lateritic gravelly soils. Hillslopes, granite outcrops, flats, ironstone ridges. Recorded on Swan Coastal Plain only.	Unlikely	Unlikely	May
Isopogon drummondii	P 3	-	White, grey or yellow sand, often over laterite.	Unlikely	Unlikely	Unlikely
Lasiopetalum glutinosum subsp. *glutinosum*	P 3	-	Previously recorded in various soil types including lateritic gravel and clay or brown, clayey sand with laterite.	Likely	Known	Likely
Meionectes tenuifolia	P 3	-	No information available on habitat preferences.	Unlikely	Unlikely	Unlikely
Paracaleana gracilicordata	P 1	-	Growing on moss mats, granite. Outcrops.	May	May	May
Paracaleana granitica	P 1	-	Growing on moss mats, granite. Outcrops.	May	May	May
Pimelea rara	P 4	-	Lateritic soils.	Known	Likely	Likely
Ptilotus sericostachyus subsp. *roseus*	P 1	-	No information, not recorded within 10 km.	Unlikely	Unlikely	May
Schoenus benthamii	P 3	-	Previously recorded in open grey sand over clay, open swamp on Swan Coastal Plain.	Unlikely	Unlikely	Unlikely
Schoenus pennisetis	P 3	-	Previously recorded in low lying sandy swamp, slightly saline, on Swan Coastal Plain.	Unlikely	Unlikely	Unlikely
Stackhousia sp. Red-blotched corolla	P 3	-	Previously recorded in light brown yellow silty-gravel with surface granite and lateritic gravel and cobbels in heathland	Likely	Likely	Likely
Tetratheca sp. Granite (S. Patrick SP1224)	P 3		Clay, moist loam, clayey sand. Granite boulders.	Likely	Likely	Likely
Thelymitra magnifica	P 1	-	Found over small area along edge of Darling Scarp growing	Likely	Likely	Likely

Taxon	Conservation status		Description	Likelihood		
	WC Act	EPBC Act		LS 1	LS 2	Lot 3
			amongst dense heath in rocky soils surrounding exposed granite outcrops.			
Thelymitra stellata	EN	-	Sand, gravel, lateritic loam. Jarrah and Wandoo woodland on gravelly loam among low heath and scrub.	Likely	Likely	Likely
Thysanotus anceps	P 3	-	White or grey sand, lateritic gravel, laterite.	Unlikely	May	May
Verticordia lindleyi subsp. *lindleyi*	P 4	-	Sand, sandy clay. Winter-wet depressions.	Unlikely	Likely	Unlikely

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct

WC Act listed species:, VU = Vulnerable, EN = Endangered, CR = Critically Endangered. DPaW Priority Species: P1 – P4 = Priority 1 - 4.

Appendix B Fauna Desktop Results

CS Species	Scientific Name	Status	CS Level	Land Swap Areas	Lot 3
Fish					
Pouched Lamprey	*Geotria australis*	P1	CS2	Visitor	Absent
Reptiles					
Darling Range South-west Ctenotus	*Ctenotus delli*	P4	CS2	Resident	Resident
Carpet Python	*Morelia spilota imbricata*		CS3	Resident	Resident
Common Death Adder	*Acanthophis antarcticus*	P3	CS2	Resident	Resident
Birds					
Fork-tailed Swift	*Apus pacificus*	M S5	CS1	Migrant	Migrant
Painted Button-quail	*Turnix varius*		CS3	Resident	Resident
Peregrine Falcon	*Falco peregrinus*	S7	CS1	Resident	Resident
Masked Owl	*Tyto novaehollandiae*	P3	CS2	Irregular visitor	Irregular visitor
Barking Owl	*Ninox connivens*	P2	CS2	Irregular visitor	Irregular visitor
Rainbow Bee-eater	*Merops ornatus*	S5	CS1	Migrant	Migrant
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	V S3	CS1	Resident	Resident
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	V S2	CS1	Migrant	Migrant
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2	CS1	Migrant	Migrant
Rufous Treecreeper	*Climacteris rufus*		CS3	Irregular visitor	Irregular visitor
Red-winged Fairy-wren	*Malurus elegans*		CS3	Visitor	Visitor
Splendid Fairy-wren	*Malurus splendens*		CS3	Resident	Resident
Southern Emu-wren	*Stipiturus malachurus*		CS3	Resident	Resident
Inland Thornbill	*Acanthiza apicalis*		CS3	Resident	Resident
Western Thornbill	*Acanthiza inornata*		CS3	Resident	Resident
White-browed Scrubwren	*Sericornis frontalis*		CS3	Resident	Resident

CS Species	Scientific Name	Status	CS Level	Land Swap Areas	Lot 3
Grey Shrike-thrush	*Colluricincla harmonica*		CS3	Resident	Resident
Crested Shrike-tit	*Falcunculus frontatus*		CS3	Visitor	Visitor
White-breasted Robin	*Eopsaltria georgianus*		CS3	Visitor	Visitor
Western Yellow Robin	*Eopsaltria griseogularis*		CS3	Visitor	Visitor
Hooded Robin	*Melanodryas cucullata*		CS3	Irregular visitor	Irregular visitor
Red-capped Robin	*Petroica goodenovii*		CS3	Visitor	Visitor
Scarlet Robin	*Petroica multicolor*		CS3	Resident	Resident
Red-eared Firetail	*Stagonopleura oculata*		CS3	Visitor	Visitor
Mammals					
Chuditch	*Dasyurus geoffroii*	V S3	CS1	Resident	Resident
Brush-tailed Phascogale	*Phascogale tapoatafa tapoatafa*	S3	CS1	Resident	Resident
Numbat	*Myrmecobius fasciatus*	V S2	CS1	Locally extinct	Locally extinct
Woylie	*Bettongia penicillata ogilbyi*	E S1	CS1	Locally extinct	Locally extinct
Boodie	*Bettongia lesueur*	Ex V S4 S6	CS1	Locally extinct	Locally extinct
Western Brush Wallaby	*Macropus irma*	P4	CS2	Resident	Resident
Tammar Wallaby	*Macropus eugenii*	P4	CS2	Locally extinct	Locally extinct
Quokka	*Setonix brachyurus*	V S3	CS1	Vagrant	Vagrant
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S1	CS1	Locally extinct	Locally extinct
Quenda	*Isoodon obesulus*	P4	CS2	Resident	Resident
Western False Pipistrelle	*Falsistrellus mackenziei*	P4	CS2	Resident	Resident
Rakali	*Hydromys chrysogaster*	P4	CS2	Visitor	Visitor

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct, M = Migratory.
WC Act listed species: S1 – S7 = Schedule 1 - 7, DPaW Priority Species: P1 – P5 = Priority 1 - 5.

Appendix L Bamford Consulting Ecologists Fauna Assessment of the Gosnells Quarry

Holcim Gosnells Quarry -
Fauna Assessment of the Quarry Area



Potential active Black-Cockatoo breeding hollow. Photo by Wesley Bancroft.

Prepared for: Holcim (Australia) Pty Ltd
Level 3, 200 Adelaide Terrace
EAST PERTH WA 6004

Prepared by: Mike Bamford, Andrew Moore and Katherine Chuk
M.J. & A.R. Bamford Consulting Ecologists
23 Plover Way
KINGSLEY WA 6026

19th July 2017

Contents

Contents i
List of Tables ii
List of Figures ii
List of Appendices iii
1 Introduction 1
1.1 Overview 1
1.2 Description of the quarry area 1
2 Background 3
2.1 Regional description 3
3 Methods 4
3.1 Desktop Assessment 4
3.1.1 Sources of information 4
3.1.2 Previous Fauna Surveys 4
3.1.3 Nomenclature and taxonomy 5
3.1.4 Interpretation of species lists 5
3.2 Field survey 6
3.2.1 Overview 6
3.2.2 Dates and Personnel 6
3.2.3 Vegetation and Substrate Associations 6
3.2.4 Assessment of nesting habitat for black-cockatoos 6
3.2.5 Other conservation significant species 10
3.2.6 Opportunistic observations 10
3.3 Survey limitations 11
4 Results 12
4.1 Vertebrate Fauna 12
4.1.1 Overview of fauna assemblage 12
4.1.2 Species of conservation significance 14
4.1.3 Cockatoo presence and foraging habitat 19
4.1.3.1 Carnaby's Black-Cockatoo 19
4.1.3.2 Forest Red-tailed Black-Cockatoo 20
4.1.3.3 Baudin's Black-Cockatoo 20

4.1.4 Roosting and breeding habitat 23
4.1.5 Invertebrate Species 25
4.1.6 Introduced / Feral Species 25
4.2 Vegetation and Substrate Associations (VSAs) 27
4.3 Patterns of biodiversity 31
4.4 Ecological processes 31
4.5 Summary of fauna values 31
4.6 Regional context 32
5 Conclusion 35
6 References 36
7 Appendices 41

List of Tables

Table 1. Sources of information used for the desktop assessment. 4
Table 2. Scoring system for the assessment of foraging value of vegetation for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos. 8
Table 3. Survey limitations as outlined by EPA (2004). 11
Table 4. Composition of vertebrate fauna assemblage of the quarry area. 13
Table 5. Number and class of conservation significant fauna species. 14
Table 6. Conservation status of significant fauna species expected to occur in the quarry area. 14
Table 7. Summary of results from breeding tree transects. 23
Table 8. Conservation significant invertebrate species returned from database searches 25
Table 9. Introduced fauna species expected to occur in the quarry area. 26
Table 10. Regional vegetation context analysis. 33
Table 11. Frog species expected to occur in the quarry area. 54
Table 12. Reptile species expected to occur in the quarry area. 55
Table 13. Bird species expected to occur in the quarry area. 58
Table 14. Mammal species expected to occur in the quarry area. 66
Table 15. Mammal species which are locally extinct in the quarry area. 69
Table 16. Species returned in database searches which are unlikely to occur in the quarry area. 70
Table 17. Results of cockatoo breeding tree transects in the quarry area (including results from BCE 2015). BCE Scores are defined in Section 3.2.4. 77

List of Figures

Figure 1. Location of the study area. 2
Figure 2. IBRA Subregions in Western Australia. 3
Figure 3. Brush-tailed Phascogale recorded in the quarry area. 17
Figure 4. Brush Wallaby in the quarry area. 18
Figure 5. Quenda in the quarry area. 18

Figure 6. Foraging values for Carnaby's Black-Cockatoo. 21
Figure 7. Foraging values for the Red-tailed Black-Cockatoo. 22
Figure 8. Potential breeding trees found in the survey transects. 24
Figure 9. Cat recorded in the quarry area. 26
Figure 10. Red Fox recorded in the quarry area. 27
Figure 11. Vegetation and Substrate Associations (VSAs) in the quarry area. 28
Figure 12. VSA 1 - Open Jarrah/Marri woodland. 29
Figure 13. VSA 2 - Wandoo woodland. 30
Figure 14. VSA 3 - Mixed heath and thicket on sandy-gravels around granite outcrops. 30
Figure 15. Regional vegetation within a five km radius of the quarry area. 34
Figure 16. Location of the cockatoo breeding tree transects. Motion camera sites are indicated. 77

List of Appendices

Appendix 1. Explanation of fauna values. 41
Appendix 2. Background information - Black-cockatoos. 44
Appendix 3. Categories used in the assessment of conservation status. 50
Appendix 4. Ecological and threatening processes identified under legislation and in the literature. 51
Appendix 5. Fauna expected to occur in the quarry area (Table 11 to Table 15). 53
Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the quarry area. 70
Appendix 7. Details of cockatoo breeding tree transects. 77

1 Introduction

1.1 Overview

Bamford Consulting Ecologists was commissioned by Holcim to conduct a fauna assessment (desktop review, site inspection and targeted fauna surveys) of the remaining Maximum Development Area (hereafter referred to as quarry area) at Holcim's Gosnells Quarry. The Maximum Development Area was cited in the approved 1982 Environmental Review and Management Programme and refers to an area that could be operational for a period of at least 100 years. The targeted fauna surveys focussed on species of conservation significance, particularly three species of black-cockatoo: Carnaby's Black-Cockatoo, *Calyptorhynchus latirostris*, the Forest Red-tailed Black-Cockatoo, *C. banksii naso* and Baudin's Black-Cockatoo *C. baudinii*.

The aim of this assessment was to identify the key fauna values within the quarry area. Key fauna values (described in detail in Appendix 1) are:

- Assemblage characteristics (uniqueness, completeness and richness);
- Species of conservation significance;
- Recognition of ecotypes or vegetation/substrate associations (VSAs);
- Patterns of biodiversity across the landscape; and
- Ecological processes upon which the fauna depend.

This report presents an overview of the fauna assemblage, species of conservation significance and black-cockatoo assessment (including breeding, foraging and roosting habitat) within the quarry area.

1.2 Description of the quarry area

The quarry area is located on the Darling Scarp east of Tonkin Highway, approximately 19 kilometres south-east of the Perth CBD. The quarry study site covers an area of 198.8 ha, which includes the current operational pit and cleared areas (Figure 1). The area of native vegetation within the quarry study site is approximately 138 ha, with an additional 6.9 ha of open regrowth and 54.1 ha of cleared area. The vegetation is broadly eucalypt woodland (mostly Jarrah *Eucalyptus marginata* and Marri *Corymbia calophylla*) and mixed heath on granite outcrops.

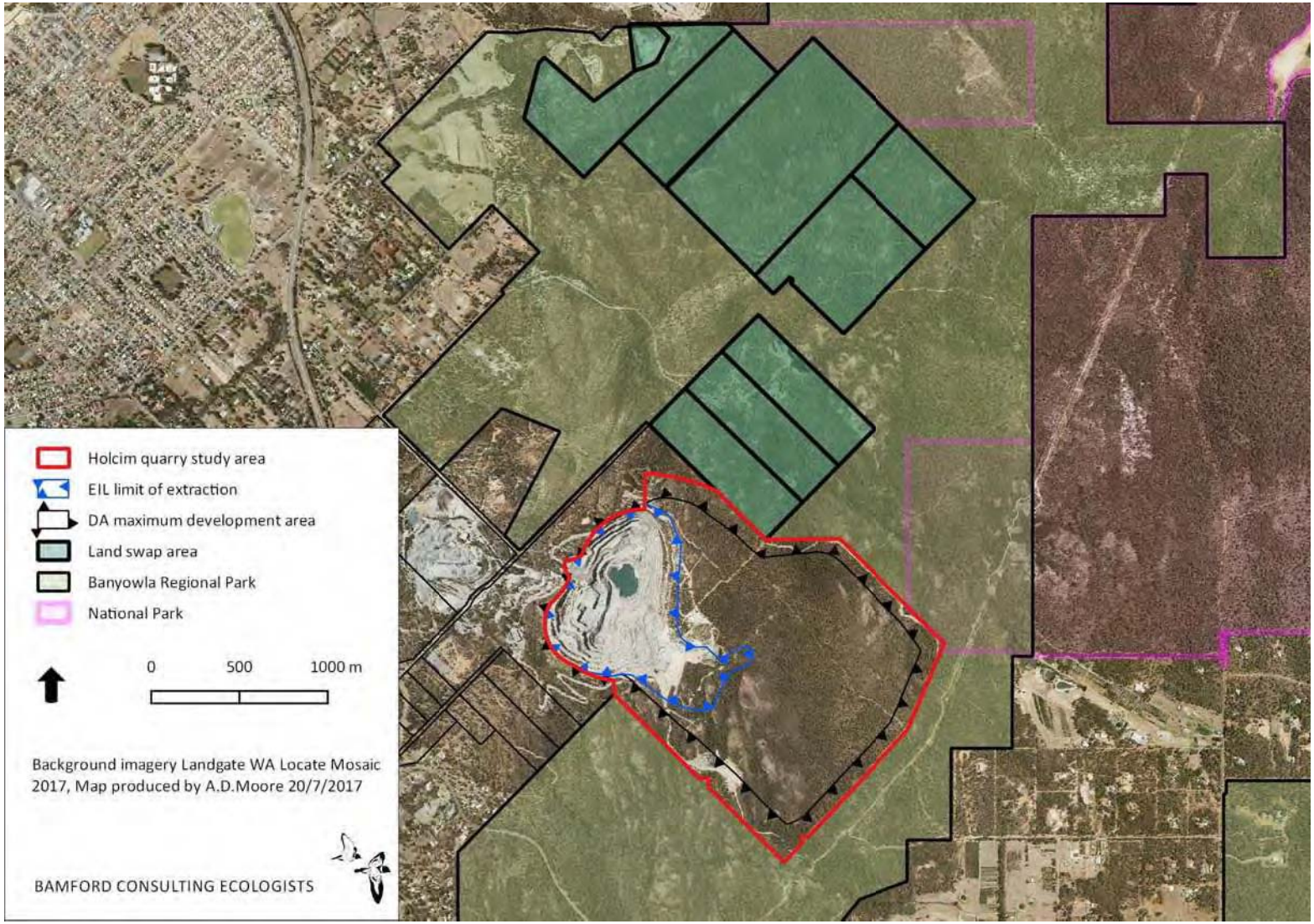


Figure 1. Location of the study area.

2 Background

2.1 Regional description

The Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia 2000) has identified 26 bioregions in Western Australia (Figure 2). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA 2004).

The quarry area lies in the Jarrah Forest IBRA Bioregion, in the Northern Jarrah Forest 1 (JAF01) subregion. The Northern Jarrah Forest overlies Archaean granite and metamorphic rocks capped by an extensive lateritic duricrust. It is also interrupted by occasional granite outcrops in the form of isolated hills. Vegetation consists of Jarrah-Marri forest in the west (with Bullich and Blackbutt in the valleys), and grades into Wandoo woodlands in the east. There are extensive but localised sand sheets with Banksia low woodlands. Heath is found on granite rocks and as a common understorey of forests and woodlands (Mckenzie *et al.* 2003). Ecosystems affected by Jarrah dieback (*Phytophthora cinnamomi*) are considered to be ecosystems at risk (Williams and Mitchell 2001). Dieback impacts several plant families including Proteaceae and Myrtaceae.



Figure 2. IBRA Subregions in Western Australia.

Note the survey area lies in the JAF01 IBRA subregion.

3 Methods

3.1 Desktop Assessment

3.1.1 Sources of information

Information on the fauna assemblage of the area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the DPaW Naturemap (incorporating the Western Australian Museum's FaunaBase and the DPaW Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler *et al.* (2000);
- Reptiles: Storr *et al.* (1983;1990; 1999 and 2002) and Wilson and Swan (2008);
- Birds: Blakers *et al*. (1984); Johnstone and Storr (1998, 2004) and Barrett *et al.* (2003); and
- Mammals: Menkhorst & Knight (2001); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia (ALA 2016)	Records provided by collecting institutions, individual collectors and community groups	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer.
NatureMap (DPaW 2016)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer.
BirdLife Australia Atlas Database (Birdlife 2016)	Records of bird observations in Australia, 1998-2016.	Species list for area containing: 32° 4' 26"S, 116° 2' 26"E – plus 20km buffer
EPBC Protected Matters (DotE 2016)	Records on matters of national environmental significance protected under the EPBC Act.	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer

3.1.2 Previous Fauna Surveys

Fauna surveys were conducted in the Holcim area by ERM (2005), Astron (2012a; 2012b; 2013) and more recently by Bamford and Moore (2014), Bamford and Everard (2015) and Bamford *et al.* (2016). These included general fauna and habitat assessments, black-cockatoo nest tree assessment, foraging habitat assessment, roosting survey and searching for signs of the Quenda *Isoodon obesulus*, a priority species.

3.1.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Fauna of Western Australia 2016*. The authorities used for each vertebrate group were: amphibians (Doughty *et al*. 2016), reptiles (Doughty *et al*. 2016), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.1.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey areas, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance. Species returned from databases but excluded from species lists are presented in Appendix 6.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- Locally extinct: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which a site is not important in a conservation sense, and species which use a site in other ways but for which the site is important at least occasionally. This is

particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals.

3.2 Field survey

3.2.1 Overview

The field survey included several components:

- identification of major Vegetation and Substrate Associations (VSAs);
- black-cockatoo habitat assessment;
- targeted searching for other conservation significant fauna; and
- opportunistic fauna observations.

3.2.2 Dates and Personnel

The quarry area was visited on the 16th and 19th of August 2016 and 28th June 2017. Survey personnel include Dr Mike Bamford (B.Sc. Hons. Ph.D.), Mr Andrew Moore (B.Sc. B.AppSc. MSc.), Dr Wes Bancroft (B.Sc. Hons. Ph.D), Mr Cameron Everard (B.Sc. MSc) and Ms Katherine Chuk (B.Sc. Hons). This fauna assessment document was prepared by Mike Bamford, Andrew Moore and Katherine Chuk.

3.2.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) were assessed during the desktop review and as part of the field investigations. Within the quarry area, all major VSAs were visited to develop an understanding of the range of environments providing habitats for fauna and to assess the likelihood of conservation significant species being present in the area.

3.2.4 Assessment of nesting habitat for black-cockatoos

The suitability of the area for nesting by black-cockatoos was assessed by conducting a survey for potential hollow-bearing (nest) trees consistent with the recommendations of DSEWPaC (2012a, b, c, d). Transects located within the quarry area were examined for the presence of suitable nest trees; tree species known to be used for nesting in the area (e.g. Wandoo *Eucalyptus wandoo*, Jarrah *E. marginata* and Marri *Corymbia calophylla*) and with a diameter-at-breast-height (DBH) greater than 400 mm (Wandoo) or 500 mm (other species; see Appendix 2). The total area of transect surveys conducted in the quarry area was 36 ha.

For any tree that met this criterion:

- DBH was measured;
- trees were assessed (from the ground) for presence of hollows suitable for black-cockatoos (entrance diameter greater than 100 mm, see Appendix 2);
- trees were given a score based on their likely value as a breeding site (see below); and

- tree location was recorded (UTM, zone 50, datum WGS84).

The score given to trees meeting the DBH criterion reflects their likely value for breeding and has been developed by Bamford Consulting Ecologists. These scores are:

1. Active nest observed; adult (or immature) bird seen entering or emerging from hollow.
2. Hollow of suitable size and angle (i.e. near-vertical) visible with chew marks around entrance. While it cannot with certainty be assumed that such chew marks were made by a black-cockatoo, they indicate activity of a parrot at a hollow potentially suitable for use by black-cockatoos.
3. Potentially suitable hollow visible but no chew marks present; or potentially suitable hollow present (as suggested by structure of tree, such as large, vertical trunk broken off at a height of >10m).
4. Tree with large hollows or broken branches that might contain large hollows but hollows or potential hollows are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by black-cockatoos.
5. Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

The suitability of the area for foraging by black-cockatoos was assessed by inspecting the site on foot and determining the presence of preferred forage plants (as set out in Appendix 2). Each survey area was assigned a foraging value score (out of six) based upon vegetation characteristics. Descriptions of foraging value scores for each black-cockatoo species are provided in Table 2. While a different score can be assigned to the same vegetation type for each species, all species are relying largely on Marri and Jarrah and thus a single foraging value score could be assigned to cover all species.

Table 2. Scoring system for the assessment of foraging value of vegetation for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos.

Site score	Description of vegetation		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples would be salt lakes and bare ground.	No foraging value. No eucalypts or other potential sources of food.	No foraging value. No eucalypts (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri) or other potential sources of food.
1	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <2%. Could include urban areas with scattered foraging trees. Blue Gum plantations are considered to have a score of 1 as foraging by Black-Cockatoos has been reported but appears to be unusual.	Negligible to low foraging value. Scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with <10% projected foliage cover. • Open eucalypt woodland/mallee of small-fruited species. • Paddocks with melons or other weeds (a short-term, seasonal food source).	Low foraging value. Example: • Woodland or forest with scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these 1-<5%. Could include urban areas with scattered foraging trees.	Low foraging value. Examples: • Open eucalypt woodland (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri). Projected foliage cover of these 1-<5% • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *Eucalyptus erythrocorys*.
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with 10-20% projected foliage cover. • Woodland with tree banksias 2-10% projected foliage cover. • Eucalypt woodland/mallee of small-fruited species; Marri, if present, <10% project foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 5-<10%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 10-<20% can be considered low-to-moderate because of poor long-term viability without management.	Low to Moderate foraging value. Examples: • Eucalypt woodland (i.e. Marri, Jarrah, Wandoo, and Blackbutt), if present, <10% project foliage cover.

Site score	Description of vegetation		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland with tree banksias 20-40% projected foliage cover. • Eucalypt woodland/forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 10-<20%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 20-<40% can be considered moderate because of poor long-term viability without management. • Areas of orchards and especially those with apples can be considered of moderate value.	Moderate foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with 20-40% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia woodlands with tree banksias >40%. Vegetation condition moderate due to weed invasion and some tree deaths.	Moderate to High foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 20-<40%. Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of >40% can be considered moderate because of poor long-term viability without management.	Moderate to High foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >40% projected foliage cover. Vegetation condition moderate due to weed invasion and some tree deaths.
6	High foraging value. Example: • Banksia woodlands of key species (e.g. *B. attenuata, B. menziesii*) with projected foliage cover >60%. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest with a high proportion of Marri (>40% projected foliage cover). Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >60% projected foliage cover. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.

Proteaceous plants include species such as *Banksia*, *Hakea* and *Grevillea.*

3.2.5 Other conservation significant species

The Quenda or Southern Brown Bandicoot and other conservation significant species such as the Chuditch and Brush-tailed Phascogale may be present in the quarry area. Opportunistic sightings of tracks, scats, diggings and other signs were recorded and three motion sensitive cameras were set for 21 nights; a total of 63 camera-nights. Camera locations were; 6451254mE 409404mS, 6450218mE 409167mS and 6450664mE 409882mS (Zone 50, datum WGS84) (Appendix 7, Figure 16).

3.2.6 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while walking through the survey area.

3.3 Survey limitations

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These limitations are discussed in the context of the fauna survey in Table 3.

Table 3. Survey limitations as outlined by EPA (2004).

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study with reconnaissance survey). Survey intensity was deemed adequate due to the small area and availability of previous studies in the area.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews, fauna surveys and Black-Cockatoo assessments in the Perth Region.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The site investigation targeted descriptions of the environment and fauna values for significant species.
Proportion of fauna identified, recorded and/or collected.	Key significant species were identified and the desktop provided information on other species
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous fauna surveys in the area: ERM (2005), Astron (2012a; 2012b; 2013), Bamford and Moore (2014), Bamford and Everard (2015) and Bamford *et al*. (2016; 2017). Databases checked include: ALA, BA, DPaW, EPBC and BCE.
The proportion of the task achieved and further work which might be needed.	This report provides fauna values for significant species
Timing/weather/season/cycle.	There were no constraints from the weather and mild conditions allowed personnel to move around readily.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	All major Vegetation and Substrate Associations (VSAs) were visited and intensive targeted surveys for significant species carried out.
Completeness (e.g. was relevant area fully surveyed).	Survey intensity was moderate, but supported by previous studies in nearby and similar habitats. Desktop study covered survey area and adjacent habitats. All suitable habitat within the survey area were visited and assessed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna in the region
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

4 Results

4.1 Vertebrate Fauna

4.1.1 Overview of fauna assemblage

The desktop study identified 194 vertebrate fauna species as potentially occurring in the quarry area (see **Error! Reference source not found.**Appendix 5; Table 4 presents a summary): 13 frogs, 42 reptiles, 106 birds, 23 native and 10 introduced mammals. This does not include species considered to be locally extinct (listed in Table 16 of Appendix 5). Species returned from databases but which are not considered to be part of the fauna assemblage are presented in Appendix 6. No fish species are likely to occur in the quarry area due to the lack of suitable habitat.

The 13 frog species are all locally common, considered resident or regular visitors and are regionally widespread. Some of the smaller species (*Crinia pseudinsignifera*, *Pseudophryne guentheri*) may be able to breed in temporary pools formed at the base of granites within the survey area. All the frog species are capable of dispersing through upland environment and most are residents of upland environments outside the mostly winter breeding season. The most terrestrial of the frogs are the *Heleioporus* species that would occur throughout the survey area.

The 42 reptile species are all considered resident except for the Long-necked Tortoise, which may occasionally visit nearby Ellis Brook. The terrestrial species are widespread but the assemblage is distinctive with the presence of several species associated with granite outcrops (e.g. Ornate Dragon and Tree Dtella), one at the western edge of its range (the gecko *Diplodactylus granariensis*) and several with restricted distributions along the Darling Escarpment (Darling Range Ctenotus and Granite Worm-Lizard). The quarry area provides different areas of a range of environments that provide habitat for reptiles, with areas of granites and associated shallow soils that may favour the species with more restricted distributions.

Of 106 bird species the vast majority are woodland species which are considered resident in the quarry area. Several migrants may use the area seasonally such as the Rainbow Bee-eater and Carnaby's Black-Cockatoo; it is also possible that these species may breed in the quarry area. A suite of woodland species that are declining in the Perth region due to habitat loss may also be resident in the quarry area. Eight introduced bird species may be present. Large numbers of bird species returned from the database search were excluded (Appendix 6, Table 16) due to the small area of wetland environment within the quarry area.

Of 33 mammal species expected at the site almost one third are introduced. Of those the Red Fox and Cat in particular are likely to be having a negative impact on the local fauna and, along with habitat loss, have played a significant role in several local extinctions. A small group (three or four) of semi-wild cattle was observed in the survey area during the site work. Most of the native species are considered resident and are likely to be most abundant in the woodland areas with an intact understorey. The motion-sensitive cameras confirmed the presence of several species, notably the Brush-tailed Phascogale. There may be five locally extinct species that are not included in the assemblage total, but those locally extinct species of conservation significance are included in the relevant section below.

The overall fauna assemblage is not as rich as nearby locations due to the virtual lack of wetland environments. Key features of the fauna assemblage are:

- Uniqueness: The assemblage is likely to be typical of Jarrah woodlands in the Northern Jarrah Forest subregion.
- Completeness: The assemblage of species from the survey area is missing a significant number of native mammal species. Some bird species may make limited use of the site because of nearby cleared areas (quarry, residential and rural).
- Richness: The assemblage is likely to vary annually and seasonally according to climatic conditions. The nearby cleared areas mean some species may be absent or uncommon visitors, but the location of the study area connected to large areas of better quality bushland may offset this effect.

As a fauna value, the site's assemblage is likely to be typical for the region but slightly depauperate due to nearby cleared areas.

Table 4. Composition of vertebrate fauna assemblage of the quarry area.

Taxon	Number of species	Number of species in each status category (number in parenthesis is number confirmed present)				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Fish	0	-	-	-	-	-
Frogs	13	13 (2)	-	-	-	-
Reptiles	42	41 (5)	1	-	-	-
Birds	106 (8 introduced)	49 (27)	35 (2)	20	2	?
Native Mammals	23	21 (9)	1	-	1	5
Introduced Mammals	10	5 (4)	3 (1)	1	1	-
Total	**194**	**129**	**40**	**21**	**4**	

NB. Locally extinct species not included in total.

4.1.2 Species of conservation significance

The current vertebrate assemblage potentially includes 34 species of conservation significance, with a further five conservation significant species considered to be locally extinct (**Error! Reference source not found.** and 6). Significant species returned from databases but for which the survey area provide no habitat, such as waterbirds and fish, have been excluded (but are presented in Appendix 6). Numbers and classes of significant species broken down by major taxonomic group and still expected to be present are summarised in Table 5.

Table 5. Number and class of conservation significant fauna species.

Taxon	Conservation Significance (CS) Level			
	CS1	CS2	CS3	Total
FISH	0	0	0	0
FROGS	0	0	0	0
REPTILES	0	2	1	3
BIRDS	6	2	16	24
MAMMALS*	3	4	0	7
Total	**9**	**8**	**17**	**34**

*Excludes five locally extinct CS1 species

As outlined in Appendix 3, species classed as CS1 are those listed under legislation, while those classed as CS2 are listed as Priority by the Department of Parks and Wildlife. The CS3 class is more subjective, but includes species that have declined extensively in nearby urban areas. The CS3 class also includes potential short range endemic (SRE) invertebrates and the potential for these is discussed with other CS3 species below. All significant species are discussed below.

Table 6. Conservation status of significant fauna species expected to occur in the quarry area.

Their expected status is indicated (as per section 3.1.4), as are those recorded during field investigations.

CS Species		Status	CS Level	Confirmed	Expected Status
REPTILES					
Darling Range South-west Ctenotus	*Ctenotus delli*	P4	CS2		Resident
Carpet Python	*Morelia spilota imbricata*		CS3		Resident
Common Death Adder	*Acanthophis antarcticus*	P3	CS2		Resident
BIRDS					
Fork-tailed Swift	*Apus pacificus*	M S5	CS1		Migrant
Painted Button-quail	*Turnix varius*		CS3		Resident
Peregrine Falcon	*Falco peregrinus*	S7	CS1		Resident
Masked Owl	*Tyto novaehollandiae*	P3	CS2		Irregular visitor
Barking Owl	*Ninox connivens*	P2	CS2		Irregular visitor
Rainbow Bee-eater	*Merops ornatus*	S5	CS1		Migrant
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	V S3	CS1	X	Resident

CS Species		Status	CS Level	Confirmed	Expected Status
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	V S2	CS1		Migrant
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2	CS1		Migrant
Rufous Treecreeper	*Climacteris rufus*		CS3		Irregular visitor
Red-winged Fairy-wren	*Malurus elegans*		CS3		Visitor
Splendid Fairy-wren	*Malurus splendens*		CS3	X	Resident
Southern Emu-wren	*Stipiturus malachurus*		CS3		Resident
Inland Thornbill	*Acanthiza apicalis*		CS3		Resident
Western Thornbill	*Acanthiza inornata*		CS3		Resident
White-browed Scrubwren	*Sericornis frontalis*		CS3	X	Resident
Grey Shrike-thrush	*Colluricincla harmonica*		CS3	X	Resident
Crested Shrike-tit	*Falcunculus frontatus*		CS3		Visitor
White-breasted Robin	*Eopsaltria georgianus*		CS3		Visitor
Western Yellow Robin	*Eopsaltria griseogularis*		CS3		Visitor
Hooded Robin	*Melanodryas cucullata*		CS3		Irregular visitor
Red-capped Robin	*Petroica goodenovii*		CS3		Visitor
Scarlet Robin	*Petroica multicolor*		CS3		Resident
Red-eared Firetail	*Stagonopleura oculata*		CS3		Visitor
MAMMALS					
Chuditch	*Dasyurus geoffroii*	V S3	CS1		Resident
Brush-tailed Phascogale	*Phascogale tapoatafa tapoatafa*	S3	CS1	X	Resident
Numbat	*Myrmecobius fasciatus*	V S2	CS1		Locally extinct
Woylie	*Bettongia penicillata ogilbyi*	E S1	CS1		Locally extinct
Boodie	*Bettongia lesueur*	Ex V S4 S6	CS1		Locally extinct
Brush Wallaby	*Macropus irma*	P4	CS2	X	Resident
Tammar Wallaby	*Macropus eugenii*	P4	CS2		Locally extinct
Quokka	*Setonix brachyurus*	V S3	CS1		Vagrant
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S1	CS1		Locally extinct
Quenda	*Isoodon obesulus*	P4	CS2	X	Resident
Western False Pipistrelle	*Falsistrellus mackenziei*	P4	CS2	X	Resident
Rakali	*Hydromys chrysogaster*	P4	CS2		Visitor
Total Number of Species:	**39**			**8**	

See Appendix 3 for descriptions of conservation significance levels.

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct, M = Migratory.

WC Act listed species: S1 – S7 = Schedule 1 - 7, DPaW Priority Species: P1 – P5 = Priority 1 - 5.

Conservation Significance Level 1

Migratory Bird Species

Fork-tailed Swift (*Apus pacificus*)

Rainbow Bee-eater (*Merops ornatus*)

These bird species are listed under one or more of the agreements/conventions relating to the protection of migratory species that Australia is signatory to i.e. JAMBA, CAMBA, ROKAMBA and the Bonn Convention. As such, the swift is listed as migratory under both the *WA Wildlife Conservation Act* and the Federal *EPBC Act*, but the bee-eater was recently removed from the EPBC migratory list and is therefore not a Matter of National Environmental Significance. It remains listed as migratory under the State Act. The Rainbow Bee-eater is a regular summer breeding migrant that may construct nesting burrows in sandy substrates; including in cleared land and along road verges. The species was recorded in the quarry area by ERM (2005), although may not breed in the area due to the lack of sandy substrate. The Fork-tailed Swift may pass over the area but is a largely aerial species mostly independent of terrestrial ecosystems.

Peregrine Falcon (*Falco peregrinus*)

This species is found in a wide variety of habitats, with its distribution often linked to the abundance of prey. Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. Suitable habitat exists for this species in the region and quarry area. It nests on cliffs or in very large trees and has the potential to nest in the quarry area. The quarry area may also be part of the foraging range of a pair.

Black-Cockatoos (*Calyptorhynchus banksii naso, C. baudinii* and *C. latirostris*)

The Forest Red-tailed Black-Cockatoos was recorded. All three Black-Cockatoo species have been recorded in the region (DPaW 2016) and suitable foraging and breeding habitat occurs in the quarry area. The value of the quarry area as foraging and breeding habitat for three Black-Cockatoo species is assessed in detail in Section 4.1.3.

Chuditch (*Dasyurus geoffroii*)

This species inhabits a variety of habitats in the region, especially riparian and Jarrah forests, and is known from the region (DPaW 2016). Suitable habitat (i.e. Marri and Jarrah Woodland) occurs in the quarry area and therefore may be resident.

Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)

The Brush-tailed Phascogale inhabits Jarrah forests in the region and is confirmed to be resident in the quarry area. Suitable habitat for this species occurs in the quarry area. This species was recorded in the quarry area with a motion-sensitive camera (Figure 3).



Figure 3. Brush-tailed Phascogale recorded in the quarry area.

Conservation Significance Level 2

CS2 Reptiles (*Ctenotus delli* and *Acanthophis antarcticus*)

The Darling Range South-west Ctenotus and Common Death Adder are both at the western and northern extent of their range in the quarry area. The Ctenotus is found only in the Darling Range in Jarrah and Marri Woodland, while the Common Death Adder is found in open woodland, heathland and shrubland throughout the Darling Range. Both species are considered resident in the quarry area due to the presence of suitable habitat.

Barking Owl and Masked Owl (*Ninox connivens connivens* and *Tyto novaehollandiae*)

These species are patchily distributed in the Darling Range and may be resident in the quarry area where they may breed in hollows in the larger trees (i.e. Jarrah, Marri and Wandoo Woodland).

Brush Wallaby (*Notamacropus irma*)

The Brush Wallaby is likely to be resident in eucalypt woodland in the region and was recorded on the motion-sensitive cameras in the quarry area (Figure 4).



Figure 4. Brush Wallaby in the quarry area.

Quenda (*Isoodon obesulus*)

The Quenda is known to occur in dense shrubland, eucalypt woodland near drainage lines and low lying areas. The Quenda is likely to be resident in the region and was recorded on the motion-sensitive cameras in the quarry area (Figure 5). Suitable habitat occurs throughout the quarry area for this species.



Figure 5. Quenda in the quarry area.

Western False Pipistrelle (*Falsistrellus mackenziei*)

The Western False Pipistrelle occurs in Jarrah and Marri Woodland and roosts in tree hollows. This species is a known resident in the region and may utilise parts of the quarry area for foraging or roosting. The species was confirmed in the quarry area during the 2015 surveys.

Rakali (*Hydromys chrysogaster*)

The Rakali is a known from watercourses of the region, but is unlikely to visit ephemeral drainage lines in the quarry area.

Conservation Significance Level 3

Carpet Python (*Morelia spilota imbricata*)

The Carpet Python occurs throughout the Darling Range with no clear environmental preferences, although for shelter it relies on tree hollows, especially those on the ground, and rocky areas. As suitable habitat is present and it has been previously recorded in the area, the Carpet Python is likely to be a resident in the quarry area.

Conservation Significance level 3 birds

This suite of birds is considered to be of local conservation significance (CS3) because they have been identified in the Bush Forever Report (Dell and Banyard 2000) as declining in the Perth region and being reliant on native vegetation. For many of the species this has been reinforced by Davis *et al.* (2012). These are species reliant to varying degrees on large and interconnected areas of native vegetation within the urban landscape. Many of these species are known to occur in habitats found in the Darling Range (e.g. Marri and Jarrah woodland, associated shrublands and drainage lines). They make up a large proportion of the significant birds that may use the quarry area. Just two of these species have been recorded, the White-browed Scrubwren and the Splendid Fairy-wren in 2015 and 2016, but a further six species are expected to be resident.

4.1.3 Cockatoo presence and foraging habitat

4.1.3.1 Carnaby's Black-Cockatoo

Carnaby's Black-Cockatoos are expected to be regular migrants in the quarry area. Main food species present were: Marri, Jarrah, Wandoo, *Banksia (Dryandra) sessilis* and Hakea. Other species were present which may be used for foraging such as some low banksias in the heathland. The majority of vegetation within the quarry area is in excellent condition (AECOM 2016). The foraging value of the quarry area varied from 2-4 (Low to Moderate; see Table 2 for descriptions of foraging value) and consists of approximately 99.7 ha of Jarrah/Marri woodland (VSA 1) (foraging value 4), 5.1 ha of Wandoo woodland (VSA 2) (foraging value 2) and 33 ha of mixed heath, thicket and granite outcrops (VSA 3) (foraging value 2). As much of the area consisted of Jarrah/Marri woodland (foraging value 4), the overall value for the site was 3-4 (Low/Moderate to Moderate). Approximately 6.9 ha is planted non-native species and 54.1 ha is cleared within the quarry area and has effectively no foraging value. Foraging values for Carnaby's Black-Cockatoo are presented in Figure 6. Further discussion of VSAs is provided in Section 4.2.

4.1.3.2 Forest Red-tailed Black-Cockatoo

Forest Red-tailed Black-Cockatoos are expected to be resident in the quarry area, with foraging habitat well-represented due to the presence of preferred native food sources (such as Marri and Jarrah). The foraging value of the quarry area varied from 1-4 (Negligible to Moderate) with approximately 99.7 ha of Jarrah/Marri woodland (foraging value 4), 5.1 ha of Wandoo woodland (VSA 2) (foraging value 1) and 33 ha of heath (forging value 1); the overall value for the site was 3 (Low/Moderate). Foraging values for the Forest Red-tailed Black-Cockatoo are presented in Figure 7.

4.1.3.3 Baudin's Black-Cockatoo

Baudin's Black-Cockatoo is expected to be at least an occasional visitor to the quarry area as it occurs regularly nearby and the area provides suitable foraging habitat. Foraging requirements of Baudin's Black-cockatoo are similar to those of the Forest Red-tailed Black-Cockatoo (refer to Figure 7). The foraging value of the quarry area varied from 1-5 (Negligible to Moderate/High), comprising of approximately 99.7 ha of Jarrah/Marri woodland (foraging value 5), 5.1 ha of Wandoo woodland (foraging value 1) and 33 ha of heath and granite outcrops (foraging value 1). The overall value for the site was 4 (Moderate).

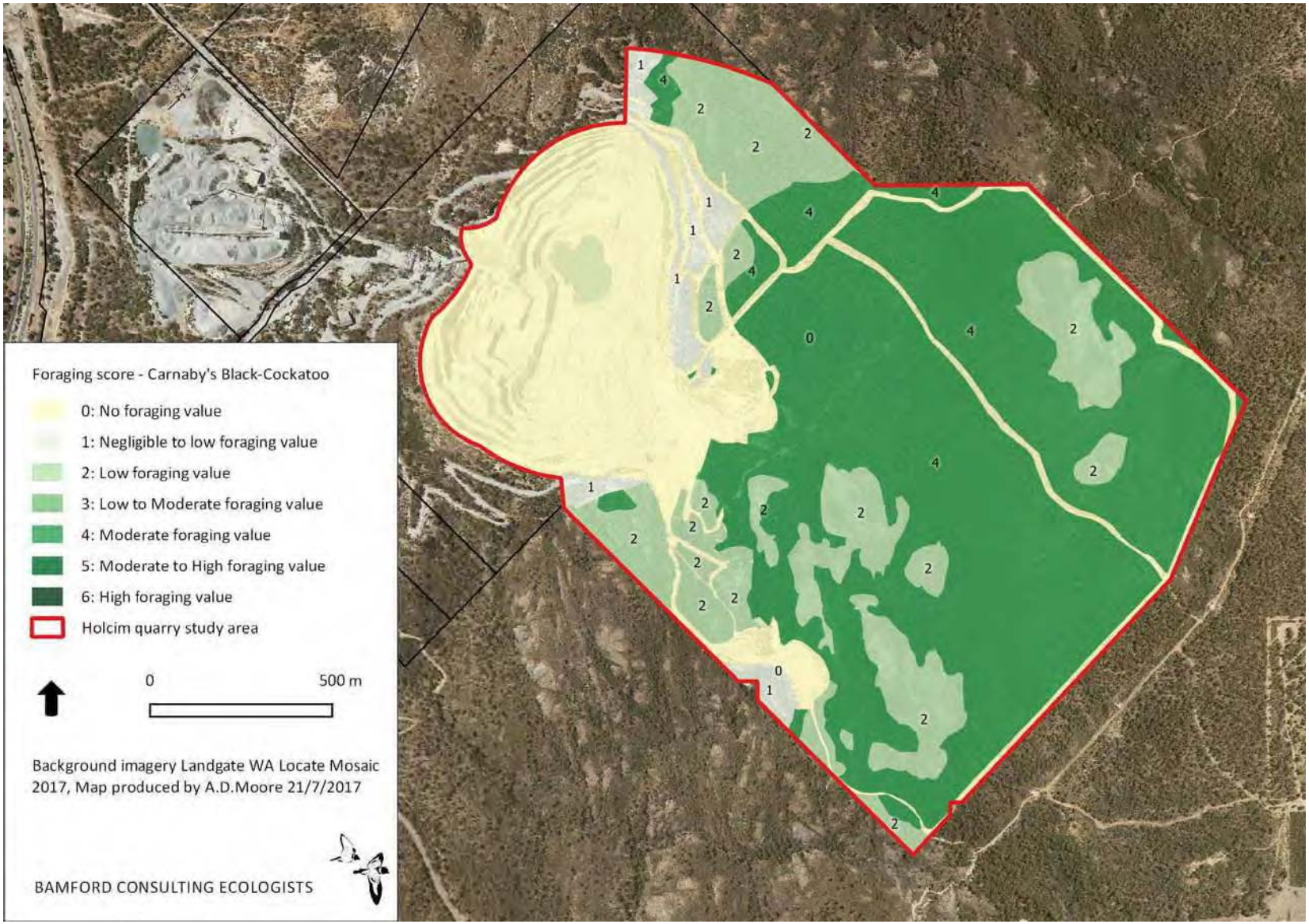


Figure 6. Foraging values for Carnaby's Black-Cockatoo.

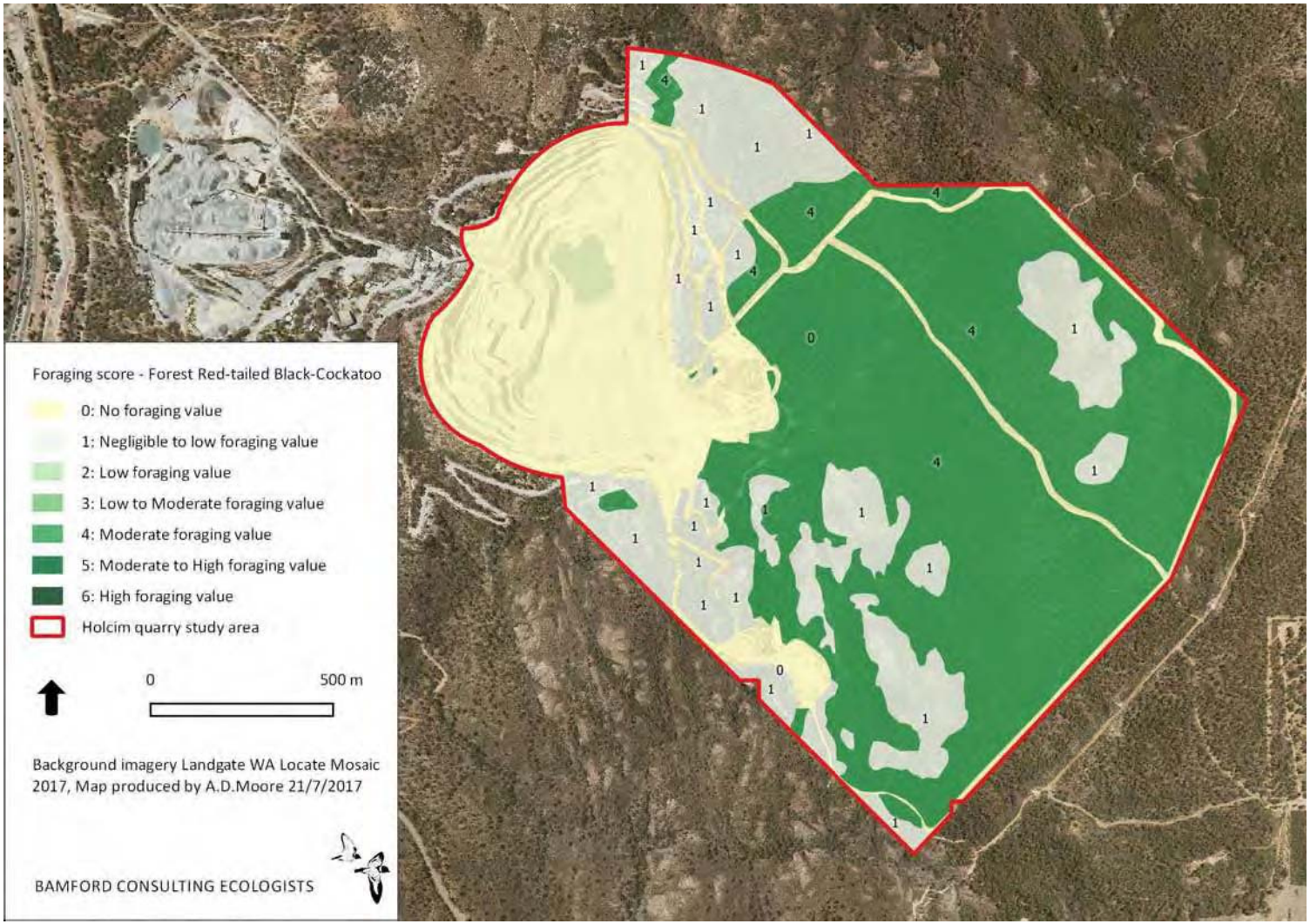


Figure 7. Foraging values for the Red-tailed Black-Cockatoo.

4.1.4 Roosting and breeding habitat

Most of the trees in the quarry area are regrowth which are not yet big enough to serve as roosting or breeding habitat, however remnant large trees are present throughout the quarry area, particularly in VSA1 (see Section 4.2).

The breeding tree transects found that the quarry area had a density of 11.6 potential breeding trees per hectare (Table 7). These estimates assume that the areas covered by the transects are representative of the total area. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. It is thus possible that black-cockatoos roost and breed in the quarry area. Two trees with a score of 2 (large hollow with recent chew-marks around entrance) were found in the quarry area (see cover photo). These are not confirmed but are highly likely to be active or recently active black-cockatoo nests. Two adult Forest Red-tailed Black-Cockatoos with a dependent chick were observed within the quarry area and may well have used one of these hollows.

Table 7. Summary of results from breeding tree transects.

Site	BCE score					Total	Trees/ha	Estimated total trees
	1	2	3	4	5			
Quarry Area	0	2	72	91	253	418	11.6	1679

Breeding tree score categories are discussed in Section 3.2.4. Density calculations do not include cleared areas.

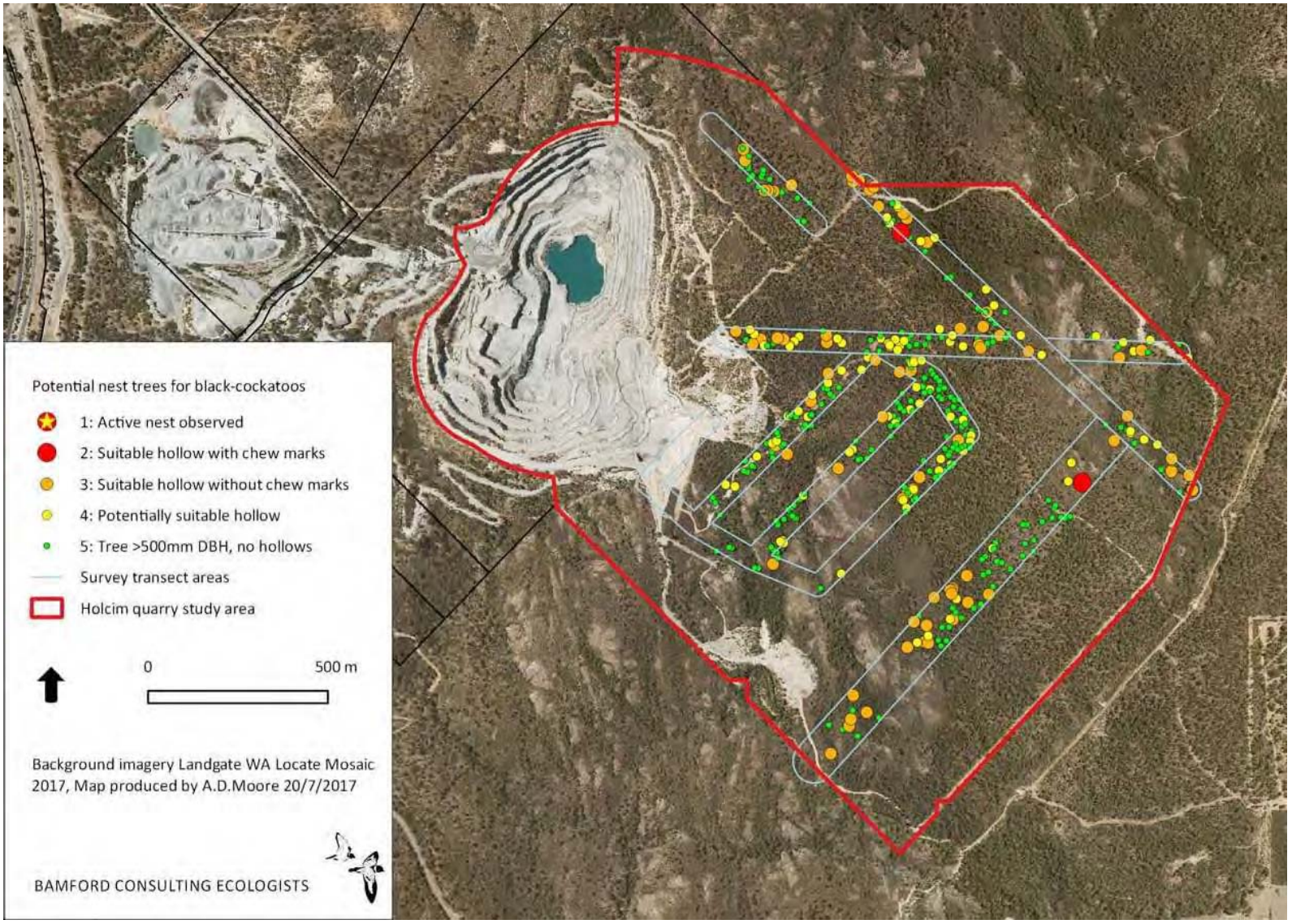


Figure 8. Potential breeding trees found in the survey transects.

BCE scores are as follows: green – 5, yellow – 4, orange – 3 and red – 2. No trees were given a score of 1 (i.e. no trees confirmed with active nests).

4.1.5 Invertebrate Species

Six conservation significant invertebrates are known to occur in the region (Table 8). No conservation significant species were recorded during the site visit. Species recorded were the widespread Marri Millipede *Antichiropus variabilis*, the SRE woodlouse *Buddelundia '04'* and the SRE land snail *Bothriembryon kendricki*. The SRE woodlouse is common in Jarrah forests around Perth and the SRE land snail is not uncommon on the Perth Coastal Plain and adjacent Scarp. The Millipede *Dinocambala ingens* was also recorded and is mostly restricted to granite outcrops of the northern Darling Escarpment, but is locally common and moderately widespread. The granite outcrops have the characteristics that should encourage the evolution of SRE invertebrate species, and V. Framinau (pers comm.) has suggested that *Synsphyronus* spp. pseudoscorpions and *Karaops* spp. spiders may be of interest in this regard.

Of the six conservation significant invertebrate species returned from database searches (Table 8), the scorpionfly *Austromerope poultoni* is most likely to occur. The species is associated with Jarrah woodland which is widespread in the quarry area, and it has been recorded 18km to the north and 20km to the east.

The biting midge *Austroconops mcmillani* has been recorded at only a handful of sites, the closest being a record from Armadale in 1934; the next closest records are from Yanchep, over 60km to the north-west. This species is unlikely to occur in the quarry area as it is associated with the coastal plain. The cricket *Kawaniphila pachomai* is known from only two records, one of which is from only 5km to the east from 1981, with the only other record from near Augusta. The bees *Leioproctus bilobatus*, *Leioproctus douglasiellus* and *Neopasiphae simplicior* have all been recorded within 10km of the quarry area however they appear to be associated with the coastal plain and are unlikely to be present on the scarp.

Table 8. Conservation significant invertebrate species returned from database searches .

Common Name	Latin Name	Conservation Status	Likelihood in the quarry area
Scorpionfly	*Austromerope poultoni*	P2 (CS2)	Likely
Biting midge	*Austroconops mcmillani*	P2 (CS2)	Unlikely
Cricket	*Kawaniphila pachomai*	P1 (CS2)	Unlikely
Bee	*Leioproctus bilobatus*	P2 (CS2)	Unlikely
Bee	*Leioproctus douglasiellus*	Cr S2 (CS1)	Unlikely
Bee	*Neopasiphae simplicior*	Cr S2 (CS1)	Unlikely

4.1.6 Introduced / Feral Species

The desktop study identified 18 introduced fauna species as potentially occurring in the quarry area (Table 9). Several of these were confirmed and two important feral predators, the Fox and Cat, are almost certainly resident.

Table 9. Introduced fauna species expected to occur in the quarry area.

Common Name	Latin Name	Expected Status
BIRDS		
Rock Dove	*Columba livia*	Resident
Spotted Dove	*Streptopelia chinensis*	Resident
Laughing Dove	*Streptopelia senegalensis*	Resident
Laughing Kookaburra	*Dacelo novaeguineae*	Resident
Sulphur-crested Cockatoo	*Cacatua galerita*	Occasional visitor
Long-billed Corella	*Cacatua tenuirostris*	Occasional visitor
Rainbow Lorikeet	*Trichoglossus moluccanus*	Visitor
Red-browed Finch	*Neochmia temporalis*	Visitor
MAMMALS		
Cattle	*Bos taurus*	Visitor
Dog	*Canis lupus familiaris*	Visitor
Goat	*Capra hircus*	Irregular visitor
Cat	*Felis catus*	Resident
House Mouse	*Mus musculus*	Resident
Rabbit	*Oryctolagus cuniculus*	Resident
Brown Rat	*Rattus norvegicus*	Vagrant
Black Rat	*Rattus rattus*	Resident
Pig	*Sus scrofa*	Visitor
Fox	*Vulpes vulpes*	Resident



Figure 9. Cat recorded in the quarry area.



Figure 10. Red Fox recorded in the quarry area.

4.2 Vegetation and Substrate Associations (VSAs)

Key VSAs in the quarry study area are:

- VSA 1. Open Jarrah/Marri woodland to forest over open banksia and mixed shrub understorey on lateritic gravels high in the landscape. VSA 1 consists of 99.7 ha.
- VSA 2. Open Wandoo woodland over a mixed high to low shrub understorey on lateritic gravels. VSA 2 covers an area of 5.1 ha.
- VSA 3. Mixed heath and thicket on sandy-gravels around granite outcrops; scattered trees include Jarrah, Marri and Wandoo. VSA 3 consists of 33 ha.
- VSA 4. Open regrowth and rehabilitation (including planted non-native species in some areas) with few remnant trees over disturbed understorey. VSA 4 covers an area of 6.9 ha.
- Cleared, disturbed and operational areas (54.1 ha).

VSAs 1 and 2 (eucalypt woodland) and 3 (heathland) are present within the quarry area and the surrounding areas to the east, although consists mostly of VSA 1 (Figure 11), with a small area of VSA 2 located in the north and VSA 3 in the east and south. VSA 4 is only found in a few small areas adjacent to the pit, situated in the western area of the site. Photographs of the key VSAs are provided in Figures 12 to 14. A detailed assessment of the vegetation and flora in the quarry area is provided in AECOM (2016).

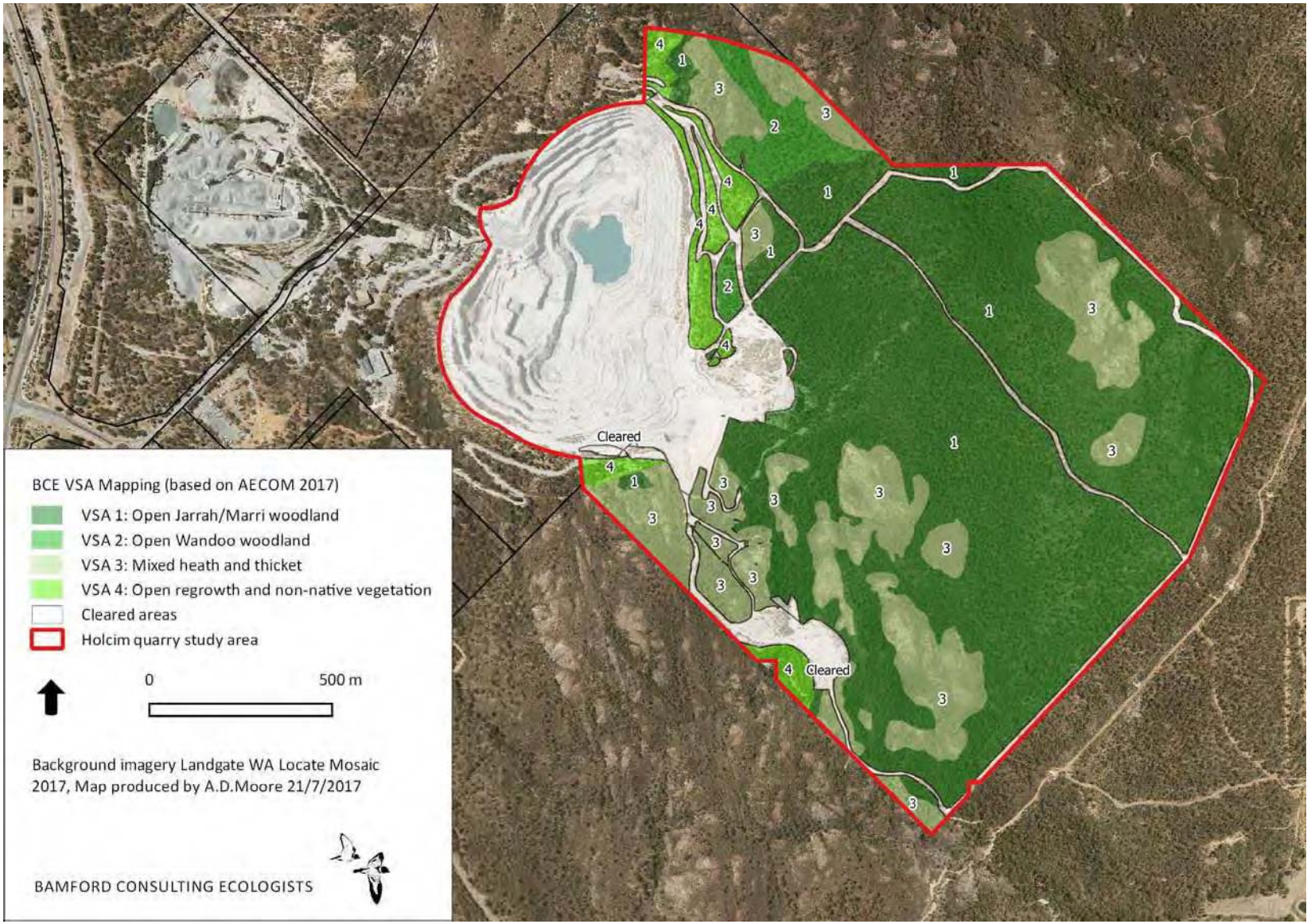


Figure 11. Vegetation and Substrate Associations (VSAs) in the quarry area.



Figure 12. VSA 1 - Open Jarrah/Marri woodland.



Figure 13. VSA 2 - Wandoo woodland.



Figure 14. VSA 3 - Mixed heath and thicket on sandy-gravels around granite outcrops.

4.3 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations. However, the quarry area contains more woodland than heath and therefore more species dependant on woodland habitat i.e. Black-Cockatoos, possums and some owls. The heath would be seasonally important for nectar feeding birds and mammals, while the heaths and thickets around outcrops may have SRE invertebrate species. As there were no major drainage lines in the expansion area it is of lesser value to aquatic and wetland fauna.

4.4 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 4 for descriptions and other ecological processes). These include:

Local hydrology. The quarry area has no major drainage lines and is high in the landscape. However, some elements of the vegetation in the quarry area, such as the banksias, may be reliant upon groundwater. In addition, the granites close to the surface mean that local sub-surface hydrology is likely to be complex.

Fire. Jarrah woodlands of the Northern Jarrah Forest are fire-adapted but the flora and fauna assemblages can be altered by too-frequent fires; and even by fire exclusion. Fire season may also be important. The quarry area has been burnt in the past and as a result the fauna assemblage has almost certainly been altered by fire. The heaths (VSA 3) are probably more sensitive to fire as much of the biomass is close to the ground.

Feral species and interactions with over-abundant native species. The fauna assemblage of the quarry area has already been impacted by feral species (loss of a major component of the mammal fauna), and both feral and domestic herbivores are likely leading to some degradation of native vegetation. The presence of cattle in the quarry area is a concern and trampling by them was evident.

Habitat degradation due to weed invasion. Most of the quarry area has very low levels of weed invasion, in particular, the granite outcrop was more or less pristine (no trampling or disturbance of rocks as occurs where such outcrops can be accessed by the public).

Connectivity and landscape permeability. The quarry area lies on the western end of a larger area of native vegetation running from north to south, and is likely to provide a connectivity function for fauna.

4.5 Summary of fauna values

The desktop study identified 194 vertebrate fauna species as potentially occurring in the quarry area: 13 frogs, 42 reptiles, 106 birds, 23 native and 10 introduced mammals. The vertebrate assemblage includes 34 species of conservation significance, of particular importance and the most likely to heavily use the site being the Forest Red-tailed and Carnaby's Black-Cockatoos.

Fauna values within the quarry area can be summarised as follows:

Fauna assemblage. Not especially rich due to scarcity of wetland environments, and also lacking some mammal species, but distinctive because of location on edge of escarpment and presence of granite outcrops.

Species of conservation significance. Significant species of note that are likely to occur in the quarry area regularly include the Brush-tailed Phascogale and both the Forest Red-tailed and Carnaby's Black-Cockatoos. There may be SRE invertebrates associated with the granite outcrops. The quarry expansion area had a density of 11.6 potential breeding trees per hectare.

Vegetation and Substrate Associations (VSAs). The quarry area contains open woodland with Jarrah and Marri (VSA 1), Wandoo woodland (VSA 2), heath on shallow soils over granite (VSA 3) and open regrowth/rehabilitation (VSA 4). VSA 1 (Marri/Jarrah woodland) is best-represented in the quarry area, with small areas of VSA 2 located in the north and VSA 3 in the east and south.

Patterns of biodiversity. Detailed patterns of biodiversity could not be examined, but it can be predicted that biodiversity will differ across the landscape because of the different proportions of VSAs present. The quarry area contains more woodland than heath and therefore more species dependant on woodland habitat i.e. Black-Cockatoos, possums and some owls. The heath would be seasonally important for nectar feeding birds and mammals.

Key ecological processes. Main processes currently affecting the fauna assemblage in the quarry area include local hydrology, fire, feral species and connectivity.

4.6 Regional context

At a regional level, the proposed quarry area is situated on the western edge of the Darling Scarp. A largely contiguous landscape dominated by Marri, Jarrah and Wandoo woodland/forest occurs to the north-east, east and south-east. Urban development dominates the landscape to the west of the quarry area.

Several conservation estates (i.e. Regional Parks and National Parks) occur in the region and provide critical foraging, breeding and roosting habitat for black-cockatoos. These include:

- Banyowla Regional Park, to the north and south of the quarry area;
- Korung National Park, four km east of the quarry area;
- Darling Range Regional Park, three km south of the quarry area; and
- Wungong Regional Park, 10 km south-east of the quarry area.

As conservation estates, these are likely to remain intact in the long-term, providing foraging, breeding and roosting habitat for all three Black-Cockatoo species, and supporting other conservation significant fauna species such as Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python. To provide some context, vegetation was assessed at a regional level (i.e. within a radius of five km). Based on the work of Heddle *et al.* (1980), the following three vegetation complexes were identified by AECOM (2016) as present in the expansion area:

1. **Darling Scarp** – Consists of *Eucalyptus wandoo* with *E. laeliae* in the north, *E. haematoxylon* in the south, with *Corymbia calophylla* occurring throughout the region;

2. **Dwellingup** – Mostly open forest of Jarrah (*E. marginata*) and Marri (*C. calophylla*); and
3. **Murray** - Consists of open forest of Jarrah (*E. marginata*), Marri (*C. calophylla*) and Swan River Blackbutt (*E. patens*) on valley slopes to a fringing woodland of Flooded Gum (*E. rudis*) and Swamp Paperbark (*Melaleuca rhaphiophylla*) on the valley floors.

The amount of land within a five km radius of the quarry area that is managed for conservation by the DPaW (based on the three vegetation complexes Darling Scarp, Dwellingup and Murray) is 1,483 ha (of 4,373.2 ha) or 33.9% (Table 10 and Figure 15). The development of the quarry will result in clearing 138 ha of native vegetation and represents approximately 3.2% of similar vegetation in the five km area.

With respect to Black-Cockatoos, which are key significant species in the region, several other vegetation complexes occur within the five km radius that are suitable for foraging but are not represented in the quarry area (Table 10 and Figure 15). The vegetation complexes Cook (81.9 ha), Yarragil (620.2 ha), and Helena (469.7 ha) contain Marri, Jarrah and other plant species useful for foraging by black-cockatoos. If these additional areas are included, then clearing 138 ha would represent 2.5% of foraging vegetation in the five km area. Several other conservation significant fauna (e.g. the Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python) are likely to be associated with these vegetation complexes. Of the 5,545 ha within the five km radius, approximately 1,785.3 ha (or 32.2%) is currently managed by DPaW.

The Darling Scarp, Dwellingup and Murray complexes have greater than 30% of their pre-European extent remaining and the vegetation within the quarry area is therefore not considered to be of regional significance or below the critical threshold in accordance with EPA Position Statement 2 (EPA 2000) (AECOM 2016).

Table 10. Regional vegetation context analysis.

Heddle vegetation types within 5 km radius	ha	% of radius	DPaW Managed Land within 5 km radius				Total managed by DPaW	Total % of vegetation type within radius managed by DPaW
			Crown Freehold	National Park	SRT - River Reserve	State Forest		
Darling Scarp Complex*	**1651**	**21.0%**	**357.4**	**0.1**	**0**	**0**	**357.5**	**21.7%**
Dwellingup Complex*	**2077.6**	**26.5%**	**93**	**580.6**	**0**	**0**	**673.6**	**32.4%**
Murray Complex*	**644.6**	**8.2%**	**28.6**	**375.4**	**0**	**47.9**	**451.9**	**70.1%**
Total	**4,373.2**	**55.7%**	**479**	**956.1**	**0**	**47.9**	**1,483**	**33.9%**
Cook Complex+	81.9	1.0%	0	63.1	0	0	63.1	77.0%
Yarragil Complex+	620.2	7.9%	0	174.2	0	0.2	174.4	28.1%
Helena Complex+	469.7	6.0%	46.6	18.2	0	0	64.8	13.8%
Forrestfield Complex	1187.7	15.1%	18.5	0	1.9	0	20.4	1.7%
Swan Complex	467.5	6.0%	1.2	0	12.3	0	13.5	2.9%
Guildford Complex	392.3	5.0%	0	0	0	0	0	0.0%
Southern River Complex	261	3.3%	0	0	0	0	0	0.0%
Total	7853.5	100.0%	545.3	1211.6	14.2	48.1	1819.2	23.2%
% of 5 km radius	100.0%	-	6.9%	15.4%	0.2%	0.6%	23.2%	23.2%

*Vegetation types recorded within the quarry area.

+ Vegetation types not present within quarry area but provide potential foraging habitat for black-cockatoos.

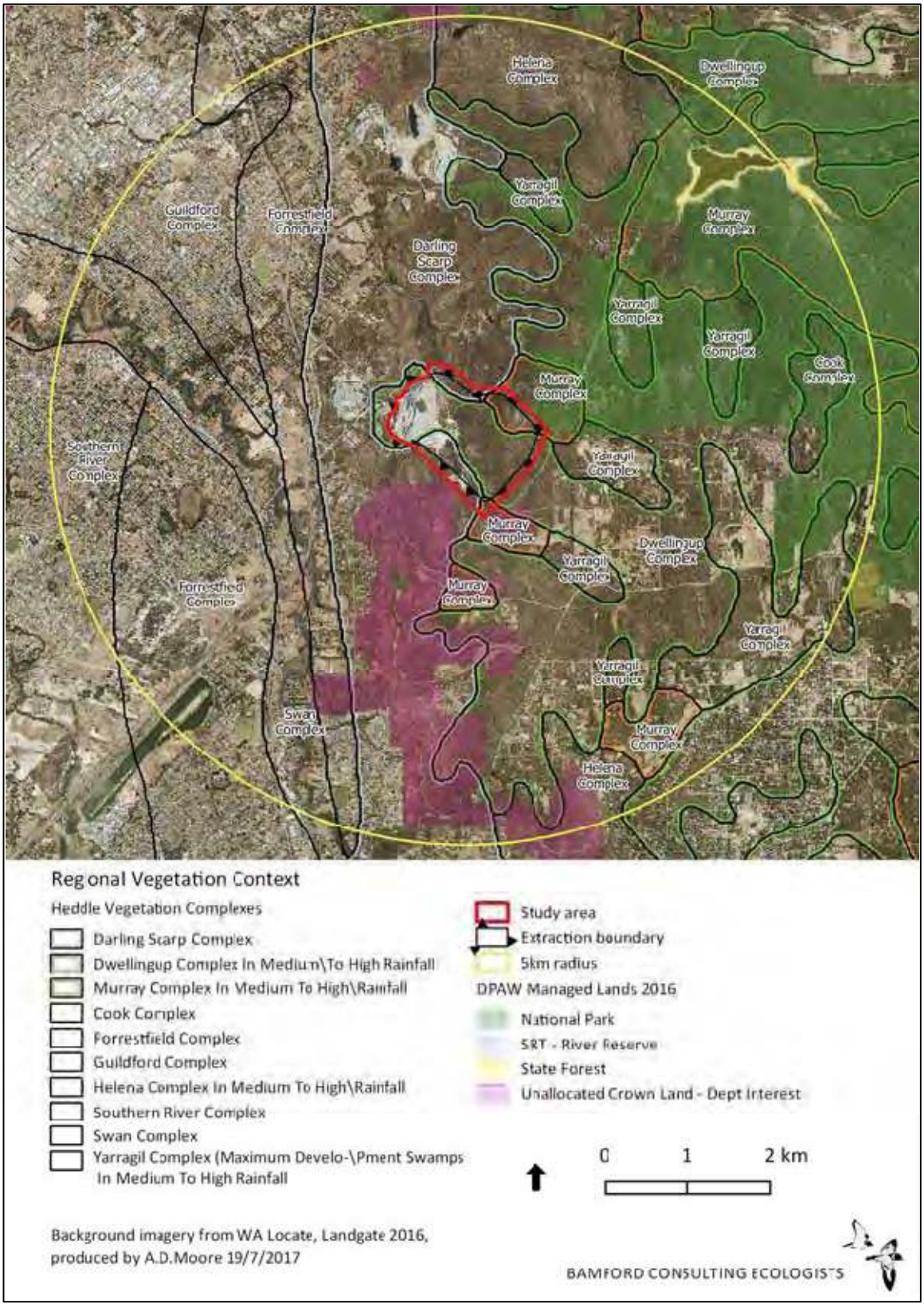


Figure 15. Regional vegetation within a five km radius of the quarry area.

5 Conclusion

The quarry area encompasses eucalypt woodland and forest, heaths and granite outcrops, and is typical of landscapes in the immediate region. It is situated on the western edge of the Darling Scarp and a largely contiguous landscape dominated by Marri, Jarrah and Wandoo woodland/forest occurs to the north-east, east and south-east.

At a regional level, the quarry will result in clearing of up to 138 ha of native vegetation, representing approximately 3.2% of similar native vegetation within a five km radius. Approximately 33.9% of this regional native vegetation (1,483 ha of 4,373.2 ha) is managed for conservation by the DPaW.

Key significant species in the quarry area are Carnaby's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo, with both expected to be present regularly in the area, with foraging and nesting habitat (such as Marri and Jarrah) well-represented in the quarry area. Baudin's Black-Cockatoo is also expected to be at least an occasional visitor to the area as it occurs regularly nearby and suitable foraging habitat is present in the quarry area.

The foraging value of the quarry area for Black-Cockatoos varied from 1-5 (Negligible to Moderate/High). However, there was approximately 99.7 ha of Jarrah/Marri woodland (foraging value 4-5), 5.1 ha of Wandoo woodland (foraging value 1-2) and 33 ha of mixed heathland (foraging value 1-2), therefore the overall value for the site was averaged at 4 (Moderate value).

Transect surveys found that the quarry area had a density of 11.6 potential breeding trees for Black-Cockatoos per hectare (not including cleared areas). This also assumes that the areas covered by the transects are representative of the total area. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. Two trees with a score of 2 (large hollow with recent chew-marks around entrance) were found in the quarry area. These are not confirmed but are highly likely to be active or recently active Black-Cockatoo nests. Two adult Forest Red-tailed Black-Cockatoos with a dependent chick were observed within the quarry area and may well have used one of these hollows.

Large areas of similar breeding and foraging habitat are available outside the quarry area in conservation estates such as the Banyowla Regional Park, Korung National Park, Darling Range Regional Park and Wungong Regional Park.

Similarly, other conservation significant fauna species such as the Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python are likely to be represented in the adjacent conservation estates and in similar vegetation complexes in the Darling Range.

6 References

AECOM (2016). Gosnells Quarry - Flora, Vegetation and Targeted Orchid Assessments. Unpubl. report to Holcim by AECOM Australia Pty Ltd, Perth.

Astron (2012a). Gosnells Quarry Desktop Flora, Vegetation and Fauna Survey. Prepared for Holcim (Australia) Pty Ltd, October 2012.

Astron (2012b). Gosnells Quarry Field Flora, Vegetation and Fauna Survey. Prepared for Holcim (Australia) Pty Ltd, October 2012.

Astron (2013) Gosnells Quarry Black-Cockatoo Tree Inspection. Prepared for Holcim (Australia) Pty Ltd, October 2013.

Atlas of Living Australia (2016) Atlas of Living Australia Mapping Tool. http://spatial.ala.org.au/ (Accessed September 2016)

Bamford, M.J. and Moore, A.D. (2014). Targeted Qualitative Black-Cockatoo and Quenda Habitat Assessment - Holcim Gosnells Quarry and adjacent areas. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley.

Bamford, M.J. and Everard, C. (2015). Holcim Gosnells Quarry - Targeted Black-Cockatoo Habitat Assessment. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley.

Bamford, M.J., Moore, A.D. and Chuk, K. (2016). Holcim Gosnells Quarry - Fauna Habitat Assessment of the Stockpile Area. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). *The new atlas of Australian birds*. Melbourne: Birds Australia.

Birdlife Australia (2016). Birdata Database. www.birdata.com.au (accessed September 2016).

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). *The Atlas of Australian Birds*. Royal Australasian Ornithologists Union. Melbourne University Press.

Cale, B. (2003). Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) Recovery Plan. Western Australian Threatened Species and Communities Unit, Department of Conservation and Land Management, Wanneroo, Western Australia.

Calver, M., Lymbery, A., McComb, J. and Bamford, M. (2009). *Environmental Biology*. Cambridge University Press, Melbourne.

Churchill, S. (2008). *Australian Bats*. Reed New Holland Press, Sydney.

Davies, S. J. J. F. (1966). The movements of the White-tailed Black-Cockatoos (*Calyptorhynchus baudinii*) in south-western Australia. The Western Australian Naturalist 10: 33-42.

Davis, R. D., Gole, C. and Roberts, J. D. (2012). Impacts of urbanisation on the native avifauna of Perth, Western Australia. Urban Ecosystems 15 (4).

Dell, J. and Banyard, J. (eds). (2000). Bush Forever. Vol. 2. Dept of Environmental Protection, Perth.

DotE. (2014). Key Threatening Processes. http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl (accessed May 2014). Department of the Environment

DotE. (2016). EPBC Protected Matters Search Tool. (Accessed September 2016). Department of the Environment.

DPaW. (2013). Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan October 2013. Prepared by the Department of Parks and Wildlife, Perth, Western Australia.

DPaW. (2016). NatureMap Database. http://naturemap.dec.wa.gov.au/default.aspx (accessed September). Department of Parks and Wildlife

DEP. (2000). Bush Forever Volume 2.Government of Western Australia, Perth. Department of Environmental Protection

DEWHA. (2009a). Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DEWHA. (2009b). Approved Conservation Advice for *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo). Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DEWHA. (2010). Survey guidelines for Australia's threatened birds. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

Doughty, P., Ellis, R.J. & Bray, R. (2016). Checklist of the Amphibians of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

Doughty, P., Ellis, R.J. & Bray, R. (2016). Checklist of the Reptiles of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

DSEWPaC. (2012a). *Calyptorhynchus banksii naso* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/sprat

DSEWPaC. (2012b). *Calyptorhynchus baudinii* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/sprat

DSEWPaC. (2012c). *Calyptorhynchus latirostris* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/sprat

DSEWPaC. (2012d). EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii,* Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso*. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/resource/epbc-act-referral-guidelines-three-threatened-black-cockatoo-species-carnabys-cockatoo

EPA. (2000). Environmental Protection of Native Vegetation in Western Australia. Position Statement 2. Environmental Protection Authority, Perth, Western Australia.

EPA. (2002). Terrestrial Biological surveys as an Element of Biodiversity Protection. Position Statement No. 3. Environmental Protection Authority, Perth, Western Australia.

EPA. (2004). Guidance for the assessment of environmental factors: Terrestrial fauna surveys for environmental impact assessment in Western Australia. No. 56. Environmental Protection Authority, Perth, Western Australia.

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1 - Summary Report. Environment Australia, Department of Environment and Heritage, Canberra, Australian Capital Territory.

ERM (2005). Gosnells Quarry Fauna Survey. Report prepared by Environmental Resources Management Australia, April 2005.

Garnett, S., Szabo, J. and Dutson, G. (2011). *The Action Plan for Australian Birds* 2010.CSIRO Publishing.

Gibbons, P. and Lindenmayer, D. (2002). Tree Hollows and Wildlife Conservation in Australia. CSIRO Publishing, Collingwood, Victoria, Australia.

Groom, C. (2011). Plants Used by Carnaby's Black Cockatoo. Department of Environment and Conservation, Perth, Western Australia.

Harvey, M. (2002). Short-range Endemism amongst the Australian fauna: examples from non-marine environments. *Invertebrate Systematics*, 16: 555-570.

Heddle, E. M., Loneragan, O. W. and Havel, J.J. (1980). Vegetation Complexes of the Darling System, Western Australia. In Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment.

Higgins, P. J. (Ed.) (1999). Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird. Oxford University Press, Melbourne, Australia.

Johnstone, R. E. (2006). Going, going, gone! Veteran and stag trees: a valuable resource. Western Wildlife 10: 6.

Johnstone, R. E and Darnell, J.C. (2016). Checklist of the Birds of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

Johnstone, R.E., Johnstone, C. and Kirkby, T. (2011). Black-cockatoos on the Swan Coastal Plain. Report prepared for the Department of Planning, Western Australia, by the Western Australian Museum, Welshpool, Western Australia.

Johnstone, R.E. and Kirkby, T. (1999). Food of the Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso in south-west Western Australia. The Western Australian Naturalist 22: 167-177.

Johnstone, R.E. and Kirkby, T. (2008). Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (Calyptorhynchus baudinii) in South-west Western Australia. Records of the Western Australian Museum 25: 107-118.

Johnstone, R.E. and Storr, G.M. (1998).*Handbook of Western Australian Birds* Vol 1 – Non-passerines (Emu to Dollarbird).Western Australian Museum, Perth.

Johnstone, R.E. and Storr, G.M. (2004).*Handbook of Western Australian Birds*. Vol 2: Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.

Kabat, A. P., Scott, R., Kabat, T. J. and Barrett, G. (2012). 2011 Great Cocky Count: Population estimates and identification of roost sites for the Carnaby's Cockatoo (Calyptorhynchus latirostris). Report prepared for the Western Australian Department of Environment and Conservation by BirdLife Australia Floreat, Western Australia.

Mace, G. and Stuart, S. (1994). Draft IUCN Red List Categories, Version 2.2.Species; Newsletter of the Species Survival Commission.IUCN - The World Conservation Union. No. 21-22: 13-24.

McKenzie, N. L., May, J. E. and McKenna, S. (2003). Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. The National Land and Water Resources Audit and the Western Australian Department of Conservation and Land Management, Perth, Western Australia.

Menkhorst, P. and Knight, F. (2001). *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.

Saunders, D. A. (1974). Breeding biology of the Short-billed form of the White-tailed Black Cockatoo Calyptorhynchus baudinii latirostris (Carnaby). Emu 74: 292-293.

Saunders, D. A. (1979a). The availability of tree hollows for use as nest sites by White-tailed Black Cockatoos. Australian Wildlife Research 6: 205-216.

Saunders, D. A. (1979b). Distribution and taxonomy of the White-tailed and Yellow-tailed Black-Cockatoos Calyptorhynchus spp. Emu 79.

Saunders, D. A. (1980). Food and movements of the short-billed form of the White-tailed Black Cockatoo. Australian Wildlife Research 7: 257-269.

Saunders, D. A. (1986). Breeding season, nestling success and nestling growth in Carnaby's Black-Cockatoo, Calyptorhynchus funereus latirostris, over 16 years at Coomallo Creek, and a method for assessing the viability of populations in other areas. Australian Wildlife Research 13: 261-273.

Saunders, D. A., Smith, G. T. and Rowley, I. (1982). The availability and dimensions of tree hollows that provide nest sites for cockatoos (Psittaciformes) in Western Australia. Australian Wildlife Research 9: 541-556.

Soule, M. E., Mackey, B. G., Recher, H. F., Williams, J. E., Woinarski, J. C. Z., Driscoll, D., Dennison, W. C. and Jones, M. E. (2004). The role of connectivity in Australian conservation. *Pacific Conservation Biology*10: 266-279.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1983).*Lizards of Western Australia*. II. Dragons and Monitors. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990).*Lizards of Western Australia*. III. Geckoes and Pygopodids. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1999).*Lizards of Western Australia*. I. Skinks. Revised Edition. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002).*Snakes of Western Australia*. W.A. Museum, Perth.

Thackway, R. and Cresswell, I.D. (1995). *An Interim Biogeographic Regionalisation for Australia: A framework for establishing the national system of reserves, Version 4*.0. Australian Nature Conservation Agency, Canberra.

Travouillon, K. (2016). Checklist of the Mammals of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

Tyler, M.J., Smith, L.A. and Johnstone, R.E. (2000). *Frogs of Western Australia*. W.A. Museum, Perth.

Van Dyck, S. and Strahan, R. (Eds.) (2008).*Mammals of Australia*. 3rd Edition. Australian Museum, Sydney.

Western Australian Museum (2016) Checklists of the Fauna of Western Australia. Unpublished checklist. Western Australian Museum, Perth.

Whitford, K. R. (2001). Dimensions of tree hollows used by birds and mammals in the jarrah forest: improving the dimensional description of potentially usable hollows. Calmscience 3: 499-511.

Whitford, K. R. (2002). Hollows in jarrah (Eucalyptus marginata) and marri (Corymbia calophylla) trees I. Hollow sizes, tree attributes and ages. Forest Ecology and Management 160: 201-214.

Whitford, K. R. and Williams, M. R. (2002). Hollows in jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees II. Selecting trees to retain for hollow dependent fauna. Forest Ecology and Management 160: 215-232.

Williams, K. and Mitchell, D. (2001). Jarrah Forest 1 (JF1 – Northern Jarrah Forest subregion. In: A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions.

Wilson S, Swan G (2008) *A Complete Guide to Reptiles of Australia*. Second edition. New Holland Publishers (Australia), Sydney

7 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.

The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Federal and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Parks and Wildlife (DPaW) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 3.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DPaW but not listed under State or Commonwealth Acts.

In Western Australia, the DPaW has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DPaW feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common)

species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DPaW, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Background information - Black-cockatoos.

Species, ecology, habitat requirements and threats

The three south-western Western Australian taxa of black-cockatoo are listed in Table i. All species are listed under both the Federal Environment Protection and Biodiversity Conservation Act (1999) and the Western Australian Wildlife Conservation Act (1950), as indicated in Table i. These three species are likely to occur in the survey area.

Table i. Black-cockatoos likely to occur in the survey area.

The status of each species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Western Australian Wildlife Conservation Act 1950 (WC Act) is shown.

Species		EPBC Act	WC Act
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable	Schedule 1 (Vulnerable)
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Schedule 1 (Endangered)
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Schedule 1 (Endangered)

There is considerable published information on the ecology of, and threats to, these black-cockatoo species. Key references include:

- Action plans (Garnett *et al.* 2011);
- Recovery plans (DPaW 2013);
- EPBC guidelines (DEWHA 2010; DSEWPaC 2012d);
- Federal listing and conservation advice (DEWHA 2009a, b);
- The federal Department of Sustainability, Environment, Water, Population and Communities' (SEWPaC; formerly DEWHA) Species Profile and Threats (SPRAT) Database (DSEWPaC 2012a, b, c);
- Scientific literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders *et al.* 1982; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008); and
- Major reports (Johnstone *et al.* 2011; Kabat et al. 2012).

Much of this information has been compiled by DSEWPaC (2012a, b, c, d). Summarising this work further, there are several salient points for assessing the potential value of the survey area for black-cockatoos:

Key ecology

- All species are long-lived with low annual reproduction rates and cannot, therefore, rapidly increase their population size.
- Carnaby's and Baudin's Black-Cockatoos undergo regular, seasonal migration between breeding and non-breeding areas.
- Forest Red-tailed Black-Cockatoos are currently considered not to undergo regular migration. In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area.

- In recent years there have been considerable shifts in the breeding ecology, distribution and movement patterns of Forest Red-tailed and Carnaby's Black-Cockatoos. These may be a response to habitat degradation/clearing and/or climatic factors.

Key habitat requirements

- All species are reliant on large tree-hollows in eucalypts, in which they breed. Each species has its own preference for nesting tree species and its own geographical breeding range (although these overlap between species). There is a solid understanding of these preferences (see Table ii for summary).
- All species primarily feed on plant seeds and flowers, but also consume wood-boring insect larvae when available. Each species has its own preference for food plant species (with considerable overlap). There is a solid understanding of these preferences (see Table ii for summary).

Key threats

- Key threatening processes include illegal shooting, habitat loss, habitat degradation, nest hollow shortage, competition for available nest hollows from other parrots and feral Honeybees (*Apis mellifera*), and illegal trade.

Table ii. Plants known to be used for foraging, roosting and nesting by black-cockatoos in south-western Western Australia.

Data compiled from the literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012a, b, c, d, R. Johnstone pers. comm.).

FRTBC = Forest Red-tailed Black-Cockatoo, CBC = Carnaby's Black-Cockatoo, BBC = Baudin's Black-Cockatoo (see **Error! Reference source not found.** for scientific names).

Plant status: blank = Western Australian native, AN = Australian native (but not naturally occurring in Western Australia), E = exotic (i.e. not native to Australia).

F = foraging, R = roosting, N or n = nesting (main and less commonly used species, respectively).

Plant Species	Plant Status	FRTBC	CBC	BBC
Acacia baileyana (Cootamundra Wattle)	AN		F	
Acacia pentadenia (Karri Wattle)			F	
Acacia saligna (Orange Wattle)			F	
Agonis flexuosa (Peppermint Tree)			F	
Allocasuarina fraseriana (Sheoak)		F		F
Anigozanthos flavidus (Tall Kangaroo Paw)				F
Araucaria heterophylla (Norfolk Island Pine)	E		F	
Banksia ashbyi (Ashby's Banksia)			F	
Banksia attenuata (Slender Banksia)			F	
Banksia baxteri (Baxter's Banksia)			F	
Banksia carlinoides (Pink Dryandra)			F	
Banksia coccinea (Scarlet Banksia)			F	
Banksia dallanneyi (Couch Honeypot Dryandra)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Banksia ericifolia (Heath-leaved Banksia)	AN		F	
Banksia fraseri (Dryandra)			F	
Banksia gardneri (Prostrate Banksia)			F	
Banksia grandis (Bull Banksia)			F	F
Banksia hookeriana (Hooker's Banksia)			F	
Banksia ilicifolia (Holly Banksia)			F	F
Banksia kippistiana (Dryandra)			F	
Banksia leptophylla			F	
Banksia lindleyana (Porcupine Banksia)				F
Banksia littoralis (Swamp Banksia)			F	F
Banksia menziesii (Firewood or Menzie's Banksia)			F	
Banksia mucronulata (Swordfish Dryandra)			F	
Banksia nivea (Honeypot Dryandra)			F	
Banksia nobilis (Golden Dryandra)			F	
Banksia praemorsa (Cut-leaf Banksia)			F	F
Banksia prionotes (Acorn Banksia)			F	
Banksia quercifolia (Oak-leaved Banksia)			F	F
Banksia sessilis (Parrot Bush)			F	F
Banksia speciosa (Showy Banksia)			F	
Banksia squarrosa (Pingle)			F	F
Banksia tricuspis (Lesueur Banskia or Pine Banksia)			F	
Banksia undata (Urchin or Cut-leaf Dryandra)			F	
Banksia verticillata (Granite Banksia)			F	
Brassica campestris (Canola, Rape)	E		F	
Callistemon spp.				F
Callistemon viminalis (Captain Cook Bottlebrush)	AN		F	
Callitris sp.			F	
Carya illnoinensis (Pecan)	E		F	F
Casuarina cunninghamiana (River Sheoak)	AN		F	
Citrullus lanatus (Pie or Afghan Melon)	E		F	
Corymbia calophylla (Marri)		F,N	F,n,R	F,n
Corymbia ficifolia (Red Flowering Gum)			F	
Corymbia haematoxylon (Mountain Marri)			F	
Corymbia maculata (Spotted Gum)			R	
Darwinia citriodora (Lemon-scented Darwinia)	AN		F	F
Diospryros sp. (Sweet Persimmon)	E		F	F
Eremophila glabra (Tarbush)			F	
Erodium aureum (Corkscrew Grass or Storksbill)	E		F	
Erodium botrys (Corkscrew Grass or Storksbill)	E		F	F
Eucalyptus caesia (Silver Princess)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Eucalyptus camaldulensis (River Red Gum)	AN		R	
Eucalyptus citriodora (Lemon Scented Gum)	AN	F	F,R	F
Eucalyptus diversicolor (Karri)		n	n	N
Eucalyptus globulus (Tasmaniam Blue Gum)	AN		R	
Eucalyptus gomphocephala (Tuart)		n	F,n,R	
Eucalyptus grandis (Flooded Gum, Rose Gum)	AN		R	
Eucalyptus longicornis (Red Morrell)			n	
Eucalyptus loxophleba (York Gum)			F,n	
Eucalyptus marginata (Jarrah)		F,N	F,n,R	F
Eucalyptus megacapa (Bullich)		n		n
Eucalyptus occidentalis (Swamp Yate)			n	
Eucalyptus patens (Blackbutt)		F	F,R	
Eucalyptus pleurocarpa (Tallerack)			F	
Eucalyptus preissiana (Bell-fruited Mallee)			F	
Eucalyptus robusta (Swamp Mahogany)			F,R	
Eucalyptus rudis (Flooded Gum)			R	
Eucalyptus salmonophloia (Salmon Gum)			F,N	
Eucalyptus salubris (Gimlet)			n	
Eucalyptus todtiana (Coastal Blackbutt or Prickley Bark)			F	
Eucalyptus wandoo (Wandoo)			F,N,R	F,n
Ficus sp. (Fig)			F	
Grevillea armigera (Prickly Toothbrushes)			F	
Grevillea bipinnatifida (Fuschia Grevillea)			F	
Grevillea hookeriana (Red Toothbrushes)			F	
Grevillea hookeriana subsp. *apiciloba* (Black Toothbrushes)			F	
Grevillea paniculata (Kerosene Bush)			F	
Grevillea paradoxa (Bottlebrush Grevillea)			F	
Grevillea petrophiloides (Pink Poker)			F	
Grevillea robusta (Silky Oak)			F	
Grevillea wilsonii (Native Fuchsia)				F
Hakea auriculata			F	
Hakea candolleana			F	
Hakea circumalata (Coastal Hakea)			F	
Hakea commutata			F	
Hakea conchifolia			F	
Hakea costata (Ribbed Hakea)			F	
Hakea cristata (Snail Hakea)			F	F
Hakea cucullata (Snail Hakea)			F	
Hakea cyclocarpa (Ramshorn)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Hakea eneabba			F	
Hakea erinacea (Hedgehog Hakea)			F	F
Hakea falcata (Sickle Hakea)			F	
Hakea flabellifolia (Fan-leaved Hakea)			F	
Hakea gilbertii			F	
Hakea incrassata (Golfball or Marble Hakea)			F	
Hakea lasiantha (Woolly Flowered Hakea)			F	
Hakea lasianthoides			F	F
Hakea laurina (Pin-cushion hakea)			F	
Hakea lissocarpha (Honeybush)			F	F
Hakea marginata				F
Hakea megalosperma (Lesueur Hakea)			F	
Hakea multilineata (Grass Leaf Hakea)			F	
Hakea obliqua (Needles and Corks)			F	
Hakea oleifolia (Dungyn or Olive-leaved Hakea)			F	
Hakea pandanicarpa subsp. *crassifolia* (Thick-leaved Hakea)			F	
Hakea petiolaris (Sea Urchin Hakea)			F	
Hakea polyanthema			F	
Hakea preissii (Needle Tree)			F	
Hakea prostrata (Harsh Hakea)			F	F
Hakea psilorrhyncha			F	
Hakea ruscifolia (Candle Hakea)			F	F
Hakea scoparia (Kangaroo Bush)			F	
Hakea smilacifolia			F	
Hakea spathulata			F	
Hakea stenocarpa (Narrow-fruited Hakea)			F	F
Hakea sulcata (Furrowed Hakea)			F	
Hakea trifurcata (Two-leaved Hakea)			F	F
Hakea undulata (Wavy-leaved Hakea)			F	
Hakea varia (Variable-leaved Hakea)			F	F
Helianthus annuus (Sunflower)	E		F	
Hibiscus sp. (Hibiscus)	E		F	
Isopogon scabriusculus			F	
Jacaranda mimosifolia (Jacaranda)	E		F	F
Jacksonia furcellata (Grey Stinkwood)			F	
Kingia australis (Kingia)				F
Lambertia inermis (Chittick)			F	
Lambertia multiflora (Many-flowered Honeysuckle)			F	
Liquidamber styraciflua (Liquid Amber)	E		F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Lupinus sp. (Lupin)	E		F	
Macadamia integrifolia (Macadamia)	E		F	F
Malus domestica (Apple)	E		F	F
Melaleuca leuropoma			F	
Melia azedarach (Cape Lilac or White Cedar)	E	F	F	
Mesomeleana sp.			F	
Persoonia longifolia (Snottygobble)		F		
Pinus canariensis (Canary Island Pine)	E		F	
Pinus caribea (Caribbean Pine)	E		F	
Pinus pinaster (Pinaster or Maritime Pine)	E		F,R	
Pinus radiata (Radiata Pine)	E		F,R	F
Protea 'Pink Ice'	E		F	
Protea repens	E		F	
Prunus amygdalus (Almond Tree)	E		F	
Pyrus communis (European Pear)	E			F
Quercus spp. (Oak spp.)	E			F
Raphanus raphanistrum (Wild Radish)	E		F	
Reedia spathacea				F
Tipuana tipu (Tipu or Rosewood Tree)	E		F	
Xanthorrhoea preissii (Grass Tree)			F	F

Nesting tree size and hollow dimensions

Black-cockatoos require tree hollows that have an entrance diameter of more than 100 mm (Whitford 2001). Internal dimensions may be more important than entrance diameter, although these are much more difficult to assess (Whitford 2001; Gibbons and Lindenmayer 2002; Whitford and Williams 2002). For Forest Red-tailed Black-Cockatoos, the minimum height of a nesting hollow was 4.4 m above the ground (Whitford 2001). The minimum diameter at breast height (DBH) of a nesting tree was 608 mm and the minimum age of an actual nesting tree was 214 years (Whitford 2002). In the study by Whitford and Williams (2002) the youngest tree to bear a hollow that was potentially suited to Forest Red-tailed Black-Cockatoos was 131 years (although this was not used). In general, hollows of sufficient size to support black-cockatoos do not form until trees at least 230 years old, and the majority of nests are found in 300-500 year old trees (Johnstone 2006).

DSEWPaC (2012a, b, c, d) recommend that surveys for potential hollow-bearing trees should identify trees greater than 500 mm DBH (to include trees that are likely to become hollow-bearing in the next 50 years).

Appendix 3. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Wildlife Conservation Act 1950*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Wildlife Conservation Act 1950*

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Parks and Wildlife Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4.	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5.	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 20 key threatening processes listed by the federal Department of the Environment (DotE 2014):

- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha).
- Predation by feral cats.

- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, DSEWPaC has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

Appendix 5. Fauna expected to occur in the quarry area (Table 11 to Table 15).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. Results do not include returned marine species. Data sources are:

- Naturemap = Naturemap Database, searched September 2016;
- BA = Birdlife Australia's Birdata database, searched September 2016;
- EPBC = EPBC Protected Matters Search, searched September 2016;
- BCE 2015 = Previous investigations at Holcim Quarry (Bamford and Everard 2015) and other BCE records from sites in the region;
- BCE 2016 = Current field investigation, September 2016.

Status codes:

- Cons. Status: CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 3 for full explanation. Details on species of conservation significance are given in Table 6.
- Int: introduced.

Table 11. Frog species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
HYLIDAE									
Slender Tree Frog	*Litoria adelaidensis*			Resident/regular visitor	X	X			
Motorbike Frog	*Litoria moorei*			Resident/regular visitor	X	X			
MYOBATRACHIDAE									
Quacking Frog	*Crinia georgiana*			Resident/regular visitor	X	X			X
Glauert's Froglet	*Crinia glauerti*			Resident/regular visitor	X	X			X
Squelching Froglet	*Crinia insignifera*			Resident/regular visitor	X	X			
Bleating Froglet	*Crinia pseudinsignifera*			Resident/regular visitor	X	X			
Lea's Frog	*Geocrinia leai*			Resident/regular visitor	X	X			
Western Marsh Frog	*Heleioporus barycragus*			Resident/regular visitor	X	X			
Moaning Frog	*Heleioporus eyrei*			Resident/regular visitor	X	X			
Chocolate Frog	*Heleioporus inornatus*			Resident/regular visitor	X	X			
Sand Frog	*Heleioporus psammophilus*			Resident/regular visitor	X	X			
Banjo Frog	*Limnodynastes dorsalis*			Resident/regular visitor	X	X			
Gunther's Toadlet	*Pseudophryne guentheri*			Resident/regular visitor	X	X			
Total Number of Species Expected:	**13**	**0**	**0**		**13**	**13**	**0**	**0**	**2**

Table 12. Reptile species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
CHELIDAE									
South-West Long-necked Tortoise	*Chelodina colliei*			Visitor	X	X			
AGAMIDAE									
Ornate Dragon	*Ctenophorus ornatus*			Resident	X	X			X
Dwarf Bearded Dragon	*Pogona minor*			Resident	X	X			
DIPLODACTYLIDAE									
Clawless Gecko	*Crenadactylus ocellatus*			Resident		X			X
	Diplodactylus granariensis			Resident		X			
Speckled Stone Gecko	*Diplodactylus lateroides*			Resident	X				
Soft Spiny-tailed Gecko	*Strophurus spinigerus*			Resident	X	X			
CARPHODACTYLIDAE									
Barking Gecko	*Underwoodisaurus milii*			Resident	X	X			
GEKKONIDAE									
Marbled Gecko	*Christinus marmoratus*			Resident	X	X			
Tree Dtella	*Gehyra variegata*			Resident	X	X			X
PYGOPODIDAE									
Granite Worm-lizard	*Aprasia pulchella*			Resident	X	X			
Fraser's Delma	*Delma fraseri*			Resident	X	X			
Burton's Snake-lizard	*Lialis burtonis*			Resident	X	X			
Common Scaly-foot	*Pygopus lepidopodus*			Resident	X	X			
SCINCIDAE									
Western Three-lined Skink	*Acritoscincus trilineatus*			Resident	X	X			
Buchanan's Snake-eyed Skink	*Cryptoblepharus buchananii*			Resident	X	X			

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
Darling Range South-west Ctenotus	*Ctenotus delli*	CS2		Resident	X	X			
Odd-striped Ctenotus	*Ctenotus impar*			Resident	X	X			
Common South-west Ctenotus	*Ctenotus labillardieri*			Resident	X	X			
King's Skink	*Egernia kingii*			Resident	X	X			
South-western Crevice-skink	*Egernia napoleonis*			Resident	X	X			
	Hemiergis initialis			Resident		X			
South-western Orange-tailed Slider	*Lerista distinguenda*			Resident	X	X			
Common Dwarf Skink	*Menetia greyii*			Resident	X	X			
Shrubland Morethia Skink	*Morethia obscura*			Resident	X	X			
Bobtail	*Tiliqua rugosa*			Resident	X	X			X
VARANIDAE									
Gould's Goanna	*Varanus gouldii*			Resident	X	X			
Heath Monitor	*Varanus rosenbergi*			Resident	X	X			
Black-headed Monitor	*Varanus tristis*				X	X			
TYPHLOPIDAE									
Southern Blind Snake	*Anilios australis*			Resident	X				
Fat Blind Snake	*Anilios pinguis*			Resident	X				
BOIDAE									
Stimson's Python	*Antaresia stimsoni*			Resident		X			
Carpet Python	*Morelia spilota imbricata*	CS3		Resident		X			
ELAPIDAE									
Common Death Adder	*Acanthophis antarcticus*	CS2		Resident	X	X			
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*			Resident	X	X			
Yellow-faced Whip Snake	*Demansia psammophis*			Resident	X	X			

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
Bardick	*Echiopsis curta*			Resident	X	X			
Western Crowned Snake	*Elapognathus coronatus*			Resident	X	X			
Tiger Snake	*Notechis scutatus*			Resident	X	X			
Gould's Hooded Snake	*Parasuta gouldii*			Resident	X	X			X
Mitchell's Short-tailed Snake	*Parasuta nigriceps*			Resident	X	X			
Dugite	*Pseudonaja affinis*			Resident		X			
Total Number of Species Expected:	**42**	**3**			**37**	**40**	**0**	**0**	**5**

Table 13. Bird species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
CASUARIIDAE										
Emu	*Dromaius novaehollandiae*			Irregular visitor	X	X		X		
COLUMBIDAE										
Rock Dove	*Columba livia*		X	Irregular visitor	X	X	X			
Crested Pigeon	*Ocyphaps lophotes*			Irregular visitor	X	X		X		
Common Bronzewing	*Phaps chalcoptera*			Resident	X	X		X	X	X
Brush Bronzewing	*Phaps elegans*			Visitor	X	X		X		
Spotted Dove	*Streptopelia chinensis*		X	Irregular visitor	X	X	X	X		
Laughing Dove	*Streptopelia senegalensis*		X	Irregular visitor	X	X	X	X		
CUCULIDAE										
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			Migrant	X	X		X		
Pallid Cuckoo	*Cacomantis pallidus*			Migrant	X	X		X		
Horsfield's Bronze-Cuckoo	*Chalcites basalis*			Migrant	X			X		
Shining Bronze-Cuckoo	*Chalcites lucidus*			Migrant	X	X		X		X
PODARGIDAE										
Tawny Frogmouth	*Podargus strigoides*			Resident	X	X		X		
CAPRIMULGIDAE										
Spotted Nightjar	*Eurostopodus argus*			Migrant	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
AEGOTHELIDAE										
Australian Owlet-nightjar	*Aegotheles cristatus*			Resident	X	X		X		
APODIDAE										
Fork-tailed Swift	*Apus pacificus*	CS1		Migrant	X		X	X		
TURNICIDAE										
Painted Button-quail	*Turnix varius*	CS3		Resident	X	X		X		
Little Button-quail	*Turnix velox*			Irregular visitor				X		
ACCIPITRIDAE										
Collared Sparrowhawk	*Accipiter cirrocephalus*			Resident	X	X		X		X
Brown Goshawk	*Accipiter fasciatus*			Resident	X	X		X		
Wedge-tailed Eagle	*Aquila audax*			Resident	X	X		X	X	X
Black-shouldered Kite	*Elanus axillaris*			Irregular visitor	X	X		X		
Whistling Kite	*Haliastur sphenurus*			Visitor	X	X		X		
Little Eagle	*Hieraaetus morphnoides*			Visitor	X	X		X		
Square-tailed Kite	*Lophoictinia isura*			Migrant	X	X		X		X
FALCONIDAE										
Brown Falcon	*Falco berigora*			Visitor	X	X		X		
Nankeen Kestrel	*Falco cenchroides*			Visitor	X	X		X		
Australian Hobby	*Falco longipennis*			Resident		X		X		
Peregrine Falcon	*Falco peregrinus*	CS1		Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
TYTONIDAE										
Barn Owl	*Tyto alba*			Visitor	X	X		X		
Masked Owl	*Tyto novaehollandiae*	CS2		Irregular visitor	X			X		
STRIGIDAE										
Southern Boobook	*Ninox boobook*			Resident	X	X		X		
Barking Owl	*Ninox connivens*	CS2		Irregular visitor	X	X		X		
MEROPIDAE										
Rainbow Bee-eater	*Merops ornatus*	CS1		Migrant	X	X	X	X		
HALCYONIDAE										
Laughing Kookaburra	*Dacelo novaeguineae*		X	Resident	X	X		X		X
Sacred Kingfisher	*Todiramphus sanctus*			Migrant	X	X		X		
CACATUIDAE										
Sulphur-crested Cockatoo	*Cacatua galerita*		X	Irregular visitor	X	X		X		
Western Corella	*Cacatua pastinator*			Vagrant	X	X		X		
Little Corella	*Cacatua sanguinea*		X	Irregular visitor		X		X		
Long-billed Corella	*Cacatua tenuirostris*		X	Irregular visitor	X	X		X		
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	CS1		Resident	X	X	X	X		X
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	CS1		Migrant	X	X	X	X		
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1		Migrant	X	X	X	X		
Galah	*Eolophus roseicapilla*			Resident	X	X		X	X	X

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
PSITTACIDAE										
Australian Ringneck	*Barnardius zonarius*			Resident	X	X		X		X
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*			Irregular visitor	X	X		X		
Elegant Parrot	*Neophema elegans*			Visitor	X	X		X		X
Western Rosella	*Platycercus icterotis*			Visitor	X	X		X		
Regent Parrot	*Polytelis anthopeplus*			Irregular visitor	X			X		
Red-capped Parrot	*Purpureicephalus spurius*			Resident	X	X		X	X	X
Rainbow Lorikeet	*Trichoglossus moluccanus*		X	Visitor	X	X		X		
CLIMACTERIDAE										
Rufous Treecreeper	*Climacteris rufus*	CS3		Irregular visitor	X	X		X		
MALURIDAE										
Red-winged Fairy-wren	*Malurus elegans*	CS3		Visitor	X	X		X		
Splendid Fairy-wren	*Malurus splendens*	CS3		Resident	X	X		X	X	X
Southern Emu-wren	*Stipiturus malachurus*	CS3		Resident	X	X		X		
ACANTHIZIDAE										
Inland Thornbill	*Acanthiza apicalis*	CS3		Resident		X		X		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			Resident	X	X		X		
Western Thornbill	*Acanthiza inornata*	CS3		Resident	X	X		X		
Western Gerygone	*Gerygone fusca*			Resident	X	X		X		X
White-browed Scrubwren	*Sericornis frontalis*	CS3		Resident	X	X		X	X	X

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
Weebill	*Smicrornis brevirostris*			Resident	X	X		X	X	X
PARDALOTIDAE										
Spotted Pardalote	*Pardalotus punctatus*			Resident	X	X		X		
Striated Pardalote	*Pardalotus striatus*			Resident	X	X		X	X	X
MELIPHAGIDAE										
Western Spinebill	*Acanthorhynchus superciliosus*			Resident	X	X		X	X	X
Red Wattlebird	*Anthochaera carunculata*			Resident	X	X		X	X	X
Western Wattlebird	*Anthochaera lunulata*			Resident	X	X		X		
Singing Honeyeater	*Gavicalis virescens*			Irregular visitor	X			X		
Tawny-crowned Honeyeater	*Glyciphila melanops*			Visitor	X	X		X		X
Brown Honeyeater	*Lichmera indistincta*			Resident	X	X		X	X	X
Yellow-throated Miner	*Manorina flavigula*			Visitor	X	X		X		
Brown-headed Honeyeater	*Melithreptus brevirostris*			Resident						
Gilbert's (White-naped) Honeyeater	*Melithreptus chloropsis*			Resident						
Yellow-plumed Honeyeater	*Ptilotula ornata*			Visitor						
White-cheeked Honeyeater	*Phylidonyris niger*			Resident	X	X		X	X	X
New Holland Honeyeater	*Phylidonyris novaehollandiae*			Resident	X	X		X		X
NEOSITTIDAE										
Varied Sittella	*Daphoenositta chrysoptera*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
CAMPEPHAGIDAE										
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			Visitor	X	X		X		
White-winged Triller	*Lalage tricolor*			Migrant	X			X		
PACHYCEPHALIDAE										
Grey Shrike-thrush	*Colluricincla harmonica*	CS3		Resident	X	X		X		X
Crested Shrike-tit	*Falcunculus frontatus*	CS3		Visitor	X					
Western Whistler	*Pachycephala occidentalis*			Resident	X	X		X		X
Rufous Whistler	*Pachycephala rufiventris*			Resident	X	X		X	X	X
ARTAMIDAE										
Black-faced Woodswallow	*Artamus cinereus*			Resident		X		X		
Dusky Woodswallow	*Artamus cyanopterus*			Resident	X	X		X	X	X
Australian Magpie	*Cracticus tibicen*			Resident	X	X		X	X	X
Grey Butcherbird	*Cracticus torquatus*			Resident	X	X		X		
Grey Currawong	*Strepera versicolor*			Resident	X	X		X		
RHIPIDURIDAE										
Grey Fantail	*Rhipidura fuliginosa*			Resident	X	X		X	X	X
Willie Wagtail	*Rhipidura leucophrys*			Resident	X	X		X		
CORVIDAE										
Australian Raven	*Corvus coronoides*			Resident		X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
MONARCHIDAE										
Magpie-lark	*Grallina cyanoleuca*			Resident	X	X		X		
Restless Flycatcher	*Myiagra inquieta*			Visitor	X	X		X		
PETROICIDAE										
White-breasted Robin	*Eopsaltria georgianus*	CS3		Visitor	X	X		X		
Western Yellow Robin	*Eopsaltria griseogularis*	CS3		Visitor	X	X		X		
Hooded Robin	*Melanodryas cucullata*	CS3		Irregular visitor	X			X		
Red-capped Robin	*Petroica goodenovii*	CS3		Visitor	X	X		X		
Scarlet Robin	*Petroica multicolor*	CS3		Resident	X	X		X		
LOCUSTELLIDAE										
Rufous Songlark	*Cincloramphus mathewsi*			Migrant	X	X		X		
HIRUNDINIDAE										
White-backed Swallow	*Cheramoeca leucosterna*			Irregular visitor				X		
Fairy Martin	*Hirundo ariel*			Vagrant	X			X		
Welcome Swallow	*Hirundo neoxena*			Migrant	X	X		X		
Tree Martin	*Hirundo nigricans*			Migrant	X	X		X		
NECTARINIIDAE										
Mistletoebird	*Dicaeum hirundinaceum*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in expansion area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
ESTRILDIDAE										
Red-browed Finch	*Neochmia temporalis*		X	Irregular visitor	X	X		X		
Red-eared Firetail	*Stagonopleura oculata*	CS3		Visitor	X	X		X		
MOTACILLIDAE										
Australasian Pipit	*Anthus novaeseelandiae*			Irregular visitor	X			X		
ZOSTEROPIDAE										
Silvereye	*Zosterops lateralis*			Resident	X	X		X	X	X
Total Number of Species Expected:	**106**	**24**	**8**		**99**	**93**	**8**	**103**	**17**	**29**

Table 14. Mammal species expected to occur in the quarry area.

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
TACHYGLOSSIDAE									
Short-beaked Echidna	*Tachyglossus aculeatus*			Resident	X	X		X	X
DASYURIDAE									
Mardo	*Antechinus flavipes*			Resident		X			X
Chuditch	*Dasyurus geoffroii*	V S3		Resident		X	X		
Brush-tailed Phascogale	*Phascogale tapoatafa*	S3		Resident		X			X
Gilbert's Dunnart	*Sminthopsis gilberti*			Resident	X	X			
BURRAMYIDAE									
Western Pygmy-possum	*Cercartetus concinnus*			Resident	X	X			
TARSIPEDIDAE									
Honey Possum	*Tarsipes rostratus*			Resident	X	X			
MACROPODIDAE									
Western Grey Kangaroo	*Macropus fuliginosus*			Resident	X	X		X	X
Brush Wallaby	*Notamacropus irma*	P4		Resident	X	X			X
Quokka	*Setonix brachyurus*	V S3		Vagrant		X	X		
PHALANGERIDAE									
Common Brushtail Possum	*Trichosurus vulpecula*			Resident	X	X			
PERAMELIDAE									
Quenda	*Isoodon obesulus*	P4		Resident	X	X		X	X
MOLLOSIDAE									

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
White-striped Bat	*Austronomus australis*			Resident	X				
	Mormopterus kitcheneri			Resident	X	X			
VESPERTILIONIDAE									
Gould's Wattled Bat	*Chalinolobus gouldii*			Resident	X	X			
Chocolate Wattled Bat	*Chalinolobus morio*			Resident				X	
Western False Pipistrelle	*Falsistrellus mackenziei*	P4		Resident				X	
Greater Long-eared Bat	*Nyctophilus major*			Resident				X	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			Resident		X			
Gould's Long-eared Bat	*Nyctophilus gouldi*			Resident	X	X			
Southern Forest Bat	*Vespadelus regulus*			Resident	X	X			
MURIDAE									
Rakali	*Hydromys chrysogaster*	P4		Visitor	X	X			
Moodit or Bush Rat	*Rattus fuscipes*			Resident					
INTRODUCED MAMMALS									
BOVIDAE									
Cattle	*Bos taurus*		X	Visitor			X		X
Goat	*Capra hircus*		X	Irregular visitor			X		
CANIDAE									
Dog	*Canis lupus familiaris*		X	Visitor			X		
Fox	*Vulpes vulpes*		X	Resident	X	X	X		X
FELIDAE									
Cat	*Felis catus*		X	Resident	X	X	X		X

English name	Latin name	Cons Status	Int.	Expected status in expansion area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
LEPORIDAE									
Rabbit	*Oryctolagus cuniculus*		X	Resident			X	X	X
MURIDAE									
House Mouse	*Mus musculus*		X	Resident	X	X	X		X
Brown Rat	*Rattus norvegicus*		X	Vagrant			X		
Black Rat	*Rattus rattus*		X	Resident	X	X	X		
SUIDAE									
Pig	*Sus scrofa*		X	Visitor			X		
Total Number of Species Expected:	**33**	**7**	**10**		**16**	**21**	**12**	**7**	**5**

Table 15. Mammal species which are locally extinct in the quarry area.

Species		CS	ALA	N	EPBC	BA
MYRMECOBIIDAE						
Numbat	*Myrmecobius fasciatus*	V S2		X		
PSEUDOCHEIRIDAE						
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S2		X	X	
POTOROIDAE						
Woylie	*Bettongia penicillata subsp. ogilbyi*	E S1		X	X	
Boodie	*Bettongia lesueur*	Ex V S4 S6				
MACROPODIDAE						
Tammar Wallaby	*Macropus eugenii*	P4				
Total Number of Species:	**5**	**5**	**0**	**3**	**2**	**0**

Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the quarry area.

Database searches can include species found nearby but that are unlikely to be present in the survey area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors, out-of-date Latin names, zoo specimens and subtleties of distribution that are not recognised in databases. All of the species listed below are considered unlikely to be found in the survey area (note some birds could occur as vagrants).

Table 16. Species returned in database searches which are unlikely to occur in the quarry area.

Species	
FISH	
Common Silver-biddy	*Gerres oyena*
	Hemiramphus robustus
Porbeagle	*Lamna nasus*
Reef Manta Ray	*Manta alfredi*
Giant Manta Ray	*Manta birostris*
	Urocampus carinirostris
Pouched Lamprey	*Geotria australis*
Nightfish	*Bostockia porosa*
Western Pygmy Perch	*Edelia vittata*
Western Minnow	*Galaxias occidentalis*
Freshwater Cobbler	*Tandanus bostocki*
Mosquitofish	*Gambusia holbrooki*
AMPHIBIANS	
Turtle Frog	*Myobatrachus gouldii*
REPTILES	
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Leatherback Turtle	*Dermochelys coriacea*
Flatback Turtle	*Natator depressus*
Western Heath Dragon	*Ctenophorus adelaidensis*
South Coast Gecko	*Diplodactylus calcicolus*
Spotted Sandplain Gecko	*Diplodactylus polyophthalmus*
Fine-faced Gecko	*Diplodactylus pulcher*
House Gecko	*Hemidactylus frenatus*
Sand-plain Worm-lizard	*Aprasia repens*
Side-barred Delma	*Delma grayii*
Keeled Legless Lizard	*Pletholax gracilis*
Inland Snake-eyed Skink	*Cryptoblepharus australis*
Metallic Snake-eyed Skink	*Cryptoblepharus metallicus*

Species	
Peron's Snake-eyed Skink	*Cryptoblepharus plagiocephalus*
Tawny Snake-eyed Skink	*Cryptoblepharus ruber*
	Ctenotus fallens
Bar-shouldered Ctenotus	*Ctenotus inornatus*
	Ctenotus ora
Two-toed Earless Skink	*Hemiergis quadrilineata*
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Elegant Slider	*Lerista elegans*
Perth Slider	*Lerista lineata*
West Coast Morethia Skink	*Morethia lineoocellata*
Western Blue-tongue	*Tiliqua occipitalis*
Flowerpot Blind Snake	*Anilios braminus*
Beaked Blind Snake	*Anilios waitii*
Black-naped Snake	*Neelaps bimaculatus*
Black-striped Snake	*Neelaps calonotos*
Mulga Snake	*Pseudechis australis*
Jan's Banded Snake	*Simoselaps bertholdi*
BIRDS	
Malleefowl	*Leipoa ocellata*
Canada Goose	*Branta canadensis*
Plumed Whistling-Duck	*Dendrocygna eytoni*
Greylag Goose	*Anser anser*
Muscovy Duck	*Cairina moschata*
Chestnut Teal	*Anas castanea*
Grey Teal	*Anas gracilis*
Northern Mallard	*Anas platyrhynchos*
Pacific Black Duck	*Anas superciliosa*
Hardhead	*Aythya australis*
Musk Duck	*Biziura lobata*
Australian Wood Duck	*Chenonetta jubata*
Black Swan	*Cygnus atratus*
Pink-eared Duck	*Malacorhynchus membranaceus*
Blue-billed Duck	*Oxyura australis*
Australasian Shoveler	*Spatula rhynchotis*
Freckled Duck	*Stictonetta naevosa*
Australian Shelduck	*Tadorna tadornoides*

Species	
Indian Peafowl	*Pavo cristatus*
Red Junglefowl	*Gallus gallus*
Stubble Quail	*Coturnix pectoralis*
Brown Quail	*Coturnix ypsilophora*
Great Crested Grebe	*Podiceps cristatus*
Hoary-headed Grebe	*Poliocephalus poliocephalus*
Australasian Grebe	*Tachybaptus novaehollandiae*
Diamond Dove	*Geopelia cuneata*
Black-eared Cuckoo	*Chrysococcyx osculans*
White-throated Needletail	*Hirundapus caudacutus*
Australian Pied Oystercatcher	*Haematopus longirostris*
Eurasian Coot	*Fulica atra*
Dusky Moorhen	*Gallinula tenebrosa*
Buff-banded Rail	*Gallirallus philippensis*
Purple Swamphen	*Porphyrio porphyrio*
Australian Spotted Crake	*Porzana fluminea*
Baillon's Crake	*Porzana pusilla*
Spotless Crake	*Porzana tabuensis*
Black-tailed Native-hen	*Tribonyx ventralis*
Banded Stilt	*Cladorhynchus leucocephalus*
Black-winged Stilt	*Himantopus leucocephalus*
Red-necked Avocet	*Recurvirostra novaehollandiae*
Little Ringed Plover	*Charadrius dubius*
Greater Sand Plover	*Charadrius leschenaultii*
Hooded Plover	*Charadrius rubricollis*
Red-capped Plover	*Charadrius ruficapillus*
Black-fronted Dotterel	*Elseyornis melanops*
Red-kneed Dotterel	*Erythrogonys cinctus*
Pacific Golden Plover	*Pluvialis fulva*
Grey Plover	*Pluvialis squatarola*
Masked Lapwing	*Vanellus miles*
Banded Lapwing	*Vanellus tricolor*
Common Sandpiper	*Actitis hypoleucos*
Ruddy Turnstone	*Arenaria interpres*
Sharp-tailed Sandpiper	*Calidris acuminata*
Red Knot	*Calidris canutus*
Curlew Sandpiper	*Calidris ferruginea*

Species	
Pectoral Sandpiper	*Calidris melanotos*
Little Stint	*Calidris minuta*
Ruff	*Calidris pugnax*
Red-necked Stint	*Calidris ruficollis*
Long-toed Stint	*Calidris subminuta*
Swinhoe's Snipe	*Gallinago megala*
Pin-tailed Snipe	*Gallinago stenura*
Bar-tailed Godwit	*Limosa lapponica*
Black-tailed Godwit	*Limosa limosa*
Eastern Curlew	*Numenius madagascariensis*
Little Curlew	*Numenius minutus*
Wood Sandpiper	*Tringa glareola*
Common Greenshank	*Tringa nebularia*
Marsh Sandpiper	*Tringa stagnatilis*
Australian Painted Snipe	*Rostratula australis*
Australian Pelican	*Pelecanus conspicillatus*
Great Egret	*Ardea alba*
Intermediate Egret	*Ardea intermedia*
White-necked Heron	*Ardea pacifica*
Australasian Bittern	*Botaurus poiciloptilus*
Cattle Egret	*Bubulcus ibis*
Little Egret	*Egretta garzetta*
White-faced Heron	*Egretta novaehollandiae*
Eastern Reef Egret	*Egretta sacra*
Australian Little Bittern	*Ixobrychus dubius*
Black Bittern	*Ixobrychus flavicollis*
Nankeen Night-Heron	*Nycticorax caledonicus*
Yellow-billed Spoonbill	*Platalea flavipes*
Royal Spoonbill	*Platalea regia*
Glossy Ibis	*Plegadis falcinellus*
Australian White Ibis	*Threskiornis moluccus*
Straw-necked Ibis	*Threskiornis spinicollis*
Little Pied Cormorant	*Microcarbo melanoleucos*
Great Cormorant	*Phalacrocorax carbo*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Pied Cormorant	*Phalacrocorax varius*
Australasian Darter	*Anhinga novaehollandiae*

Species	
Whiskered Tern	*Chlidonias hybrida*
White-winged Black Tern	*Chlidonias leucopterus*
Silver Gull	*Chroicocephalus novaehollandiae*
Australian Gull-billed Tern	*Gelochelidon macrotarsa*
Caspian Tern	*Hydroprogne caspia*
Crested Tern	*Thalasseus bergii*
Amsterdam Albatross	*Diomedea amsterdamensis*
Grey-headed Albatross	*Diomedea chrysostoma*
Southern Royal Albatross	*Diomedea epomophora*
Wandering Albatross	*Diomedea exulans*
Northern Royal Albatross	*Diomedea sanfordi*
Shy Albatross	*Thalassarche cauta*
Campbell Albatross	*Thalassarche impavida*
Black-browed Albatross	*Thalassarche melanophris*
White-capped Albatross	*Thalassarche steadi*
Southern Giant Petrel	*Macronectes giganteus*
Northern Giant Petrel	*Macronectes halli*
Kerguelen Petrel	*Pterodroma brevirostris*
White-headed Petrel	*Pterodroma lessonii*
Great-winged Petrel	*Pterodroma macroptera*
Fairy Prion	*Pachyptila turtur*
Australian Lesser Noddy	*Anous tenuirostris*
Black-faced Cormorant	*Phalacrocorax fuscescens*
Swamp Harrier	*Circus approximans*
Spotted Harrier	*Circus assimilis*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Letter-winged Kite	*Elanus scriptus*
Black-breasted Buzzard	*Hamirostra melanosternon*
Black Kite	*Milvus migrans*
Osprey	*Pandion haliaetus*
Australian Bustard	*Ardeotis australis*
Bush Stone-curlew	*Burhinus grallarius*
Major Mitchell's Cockatoo	*Cacatua leadbeateri*
Cockatiel	*Nymphicus hollandicus*
Budgerigar	*Melopsittacus undulatus*
Rock Parrot	*Neophema petrophila*
Scarlet-chested Parrot	*Neophema splendida*

Species	
Superb Parrot	*Polytelis swainsonii*
Ring-necked Parakeet	*Psittacula krameri*
Variegated Fairy-wren	*Malurus lamberti*
White-winged Fairy-wren	*Malurus leucopterus*
Blue-breasted Fairy-wren	*Malurus pulcherrimus*
Western Bristlebird	*Dasyornis longirostris*
Brown Thornbill	*Acanthiza pusilla*
Chestnut-rumped Thornbill	*Acanthiza uropygialis*
Redthroat	*Pyrrholaemus brunneus*
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*
White-fronted Chat	*Epthianura albifrons*
Lewin's Honeyeater	*Meliphaga lewinii*
White-naped Honeyeater	*Melithreptus lunatus*
White-eared Honeyeater	*Nesoptilotis leucotis*
White-fronted Honeyeater	*Purnella albifrons*
Black Honeyeater	*Sugomel niger*
White-browed Babbler	*Pomatostomus superciliosus*
Chestnut Quail-thrush	*Cinclosoma castanotum*
Ground Cuckoo-shrike	*Coracina maxima*
Masked Woodswallow	*Artamus personatus*
Pied Butcherbird	*Cracticus nigrogularis*
Little Crow	*Corvus bennetti*
Jacky Winter	*Microeca fascinans*
Brown Songlark	*Cincloramphus cruralis*
Little Grassbird	*Megalurus gramineus*
Australian Reed-Warbler	*Acrocephalus australis*
Chestnut-breasted Mannikin	*Lonchura castaneothorax*
Zebra Finch	*Taeniopygia guttata*
House Sparrow	*Passer domesticus*
Eurasian Tree Sparrow	*Passer montanus*
European Goldfinch	*Carduelis carduelis*
Grey Wagtail	*Motacilla cinerea*
Indian Myna	*Acridotheres tristis*
Common Starling	*Sturnus vulgaris*
Common Blackbird	*Turdus merula*
MAMMALS	

Species	
Grey-bellied Dunnart	*Sminthopsis griseoventer*
Common Dunnart	*Sminthopsis murina*
Black Flying-fox	*Pteropus alecto*
Little Red Flying-fox	*Pteropus scapulatus*
Northern Palm Squirrel	*Funambulus pennantii*

Appendix 7. Details of cockatoo breeding tree transects.

All coordinates Zone 50, datum WGS84.

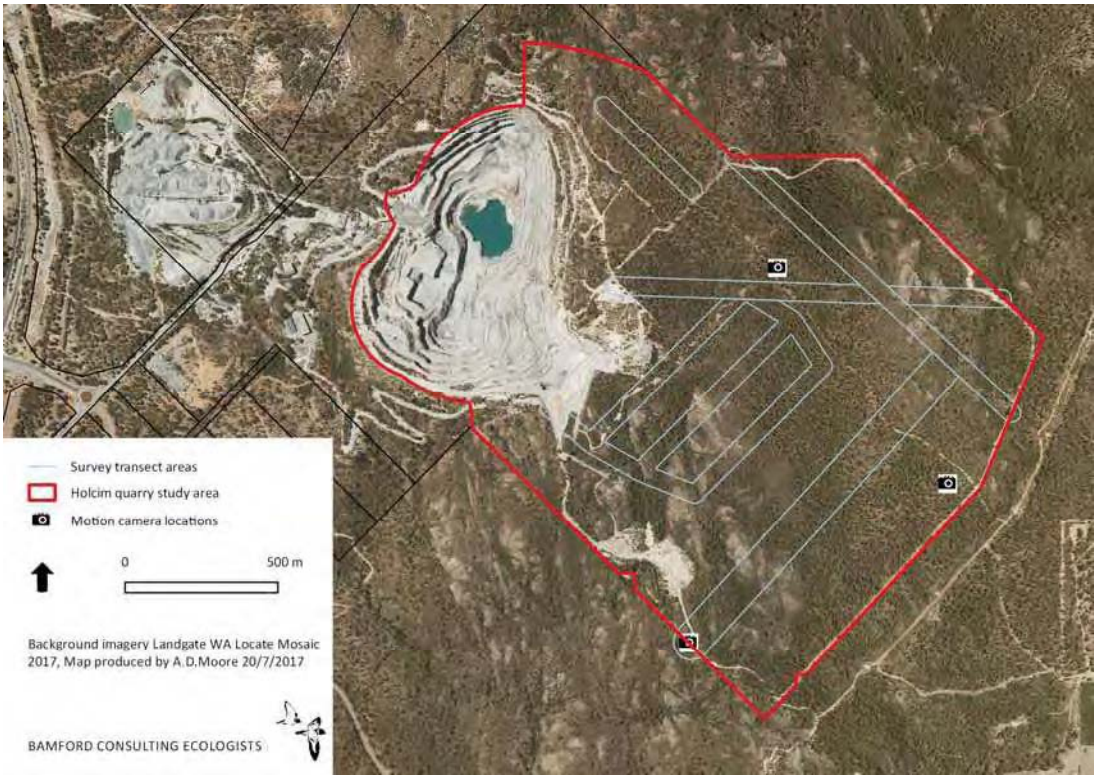


Figure 16. Location of the cockatoo breeding tree transects. Motion camera sites are indicated.

Table 17. Results of cockatoo breeding tree transects in the quarry area (including results from BCE 2015).
BCE Scores are defined in Section 3.2.4.

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
BCE 2015							
27/05/2015	409186	6450623	Wandoo	Alive	400	5	
27/05/2015	409030	6450669	Marri	Alive	600	5	
27/05/2015	409073	6450678	Marri	Alive	600	3	
27/05/2015	409083	6450693	Wandoo	Alive	300	5	
27/05/2015	409079	6450694	Wandoo	Alive	400	5	
27/05/2015	409082	6450705	Marri	Alive	550	5	
27/05/2015	409075	6450706	Marri	Alive	720	5	
27/05/2015	408940	6450707	Marri	Alive	500	5	
27/05/2015	409075	6450710	Wandoo	Alive	490	5	
27/05/2015	408975	6450714	Marri	Alive	500	5	
27/05/2015	408970	6450716	Marri	Alive	500	5	
27/05/2015	409068	6450717	Marri	Alive	730	5	
27/05/2015	409098	6450727	Marri	Alive	650	4	
27/05/2015	409090	6450730	Wandoo	Alive	600	4	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409095	6450733	Wandoo	Alive	600	4	
27/05/2015	409084	6450769	Marri	Alive	860	5	
27/05/2015	409080	6450779	Wandoo	Alive	480	5	
27/05/2015	409098	6450782	Wandoo	Alive	780	5	
27/05/2015	409127	6450784	Wandoo	Alive	420	5	Has two trunks (other 330mm).
27/05/2015	409123	6450785	Wandoo	Alive	300	5	
27/05/2015	409118	6450790	Wandoo	Alive	420	5	
27/05/2015	408947	6450791	Wandoo	Alive	400	5	
27/05/2015	409386	6450801	Marri	Alive	600	5	
27/05/2015	409108	6450802	Wandoo	Alive	560	5	
27/05/2015	409107	6450805	Wandoo	Alive	530	5	
27/05/2015	409115	6450809	Marri	Alive	530	5	
27/05/2015	409388	6450811	Marri	Alive	650	4	
27/05/2015	409121	6450815	Wandoo	Alive	370	5	
27/05/2015	408936	6450819	Marri	Alive	500	5	
27/05/2015	409134	6450827	Wandoo	Alive	430	5	
27/05/2015	409136	6450829	Wandoo	Alive	420	5	
27/05/2015	409380	6450829	Marri	Alive	860	4	
27/05/2015	409404	6450830	Marri	Alive	770	5	
27/05/2015	408930	6450831	Marri	Alive	600	5	
27/05/2015	409379	6450832	Marri	Alive	800	3	
27/05/2015	409410	6450834	Jarrah	Alive	550	5	
27/05/2015	409143	6450838	Wandoo	Alive	790	4	
27/05/2015	409146	6450842	Marri	Alive	570	5	
27/05/2015	409391	6450846	Marri	Alive	780	5	
27/05/2015	409390	6450847	Marri	Alive	700	3	
27/05/2015	409403	6450854	Marri	Alive	700	3	
27/05/2015	409404	6450854	Marri	Alive	750	4	
27/05/2015	409383	6450859	Jarrah	Alive	800	5	
27/05/2015	408960	6450861	Marri	Alive	500	4	
27/05/2015	409456	6450881	Jarrah	Alive	680	5	
27/05/2015	409418	6450882	Marri	Alive	900	3	
27/05/2015	409465	6450885	Jarrah	Alive	660	5	
27/05/2015	409002	6450892	Marri	Alive	650	5	
27/05/2015	409442	6450896	Jarrah	Alive	570	5	
27/05/2015	409477	6450897	Jarrah	Alive	650	5	
27/05/2015	409225	6450900	Marri	Alive	600	3	
27/05/2015	409021	6450904	Jarrah	Alive	650	5	
27/05/2015	409488	6450905	Jarrah	Alive	750	5	
27/05/2015	409492	6450911	Jarrah	Alive	500	4	
27/05/2015	409499	6450914	Jarrah	Alive	640	5	
27/05/2015	409272	6450920	Jarrah	Alive	760	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409277	6450922	Marri	Alive	540	5	
27/05/2015	409070	6450923	Jarrah	Alive	500	5	
27/05/2015	409273	6450924	Marri	Alive	620	5	
27/05/2015	409468	6450924	Jarrah	Alive	600	4	
27/05/2015	409033	6450926	Marri	Alive	550	4	
27/05/2015	409104	6450932	Marri	Alive	1100	3	
27/05/2015	409486	6450933	Jarrah	Alive	670	5	
27/05/2015	409068	6450937	Jarrah	Alive	600	5	
27/05/2015	409251	6450938	Marri	Alive	600	4	
27/05/2015	409489	6450939	Jarrah	Alive	640	5	
27/05/2015	409521	6450943	Jarrah	Alive	840	4	
27/05/2015	409258	6450944	Jarrah	Alive	600	4	
27/05/2015	409508	6450946	Jarrah	Alive	590	5	
27/05/2015	409497	6450950	Jarrah	Alive	700	5	
27/05/2015	409537	6450950	Jarrah	Alive	500	5	
27/05/2015	409092	6450951	Jarrah	Alive	600	5	
27/05/2015	409516	6450951	Jarrah	Alive	780	5	
27/05/2015	409077	6450952	Marri	Alive	800	3	
27/05/2015	409531	6450953	Jarrah	Alive	600	5	
27/05/2015	409096	6450955	Jarrah	Alive	600	5	
27/05/2015	409523	6450955	Jarrah	Alive	720	5	
27/05/2015	409536	6450955	Jarrah	Alive	500	5	
27/05/2015	409056	6450956	Jarrah	Alive	570	5	
27/05/2015	409069	6450957	Jarrah	Alive	500	4	
27/05/2015	409503	6450959	Jarrah	Alive	500	5	
27/05/2015	409079	6450962	Marri	Alive	650	4	
27/05/2015	409266	6450964	Jarrah	Alive	500	5	
27/05/2015	409537	6450965	Jarrah	Alive	1250	4	
27/05/2015	409509	6450968	Jarrah	Alive	600	3	
27/05/2015	409083	6450975	Jarrah	Alive	550	5	Potential Possum tree (scratch marks)
27/05/2015	409482	6450975	Jarrah	Alive	900	5	
27/05/2015	409539	6450979	Jarrah	Alive	820	4	
27/05/2015	409526	6450980	Jarrah	Alive	800	5	
27/05/2015	409080	6450982	Marri	Alive	620	5	
27/05/2015	409541	6450990	Marri	Alive	710	5	
27/05/2015	409143	6450993	Marri	Alive	600	5	
27/05/2015	409161	6450999	Jarrah	Alive	700	5	
27/05/2015	409349	6450999	Jarrah	Alive	1020	5	
27/05/2015	409517	6450999	Jarrah	Alive	600	5	
27/05/2015	409147	6451000	Jarrah	Alive	500	5	
27/05/2015	409365	6451001	Marri	Alive	510	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409360	6451006	Marri	Alive	830	4	
27/05/2015	409525	6451006	Marri	Alive	780	5	
27/05/2015	409504	6451012	Jarrah	Alive	700	5	
27/05/2015	409367	6451014	Jarrah	Alive	580	5	
27/05/2015	409520	6451015	Jarrah	Alive	1180	4	
27/05/2015	409125	6451019	Jarrah	Alive	690	5	
27/05/2015	409152	6451019	Jarrah	Alive	800	4	
27/05/2015	409105	6451020	Jarrah	Alive	900	4	
27/05/2015	409107	6451021	Jarrah	Alive	620	5	
27/05/2015	409329	6451021	Marri	Alive	700	3	
27/05/2015	409159	6451022	Marri	Alive	500	5	
27/05/2015	409343	6451022	Marri	Alive	500	4	
27/05/2015	409113	6451023	Jarrah	Alive	800	5	
27/05/2015	409355	6451023	Marri	Alive	600	5	
27/05/2015	409161	6451024	Jarrah	Alive	700	5	
27/05/2015	409524	6451030	Jarrah	Alive	790	5	
27/05/2015	409130	6451032	Jarrah	Alive	870	4	
27/05/2015	409380	6451034	Jarrah	Alive	840	5	
27/05/2015	409401	6451034	Marri	Alive	520	5	
27/05/2015	409484	6451035	Jarrah	Alive	700	5	
27/05/2015	409395	6451038	Jarrah	Alive	1000	4	
27/05/2015	409512	6451039	Jarrah	Alive	600	5	
27/05/2015	409515	6451040	Jarrah	Alive	600	5	
27/05/2015	409371	6451041	Jarrah	Alive	650	5	
27/05/2015	409497	6451045	Jarrah	Alive	790	5	
27/05/2015	409370	6451046	Jarrah	Alive	500	5	
27/05/2015	409184	6451049	Marri	Alive	500	5	
27/05/2015	409417	6451052	Jarrah	Alive	620	4	
27/05/2015	409364	6451054	Jarrah	Alive	600	5	
27/05/2015	409159	6451055	Marri	Alive	1050	3	
27/05/2015	409396	6451058	Jarrah	Alive	770	5	
27/05/2015	409499	6451061	Marri	Alive	560	5	
27/05/2015	409510	6451062	Jarrah	Alive	590	5	
27/05/2015	409469	6451063	Jarrah	Alive	500	5	
27/05/2015	409211	6451067	Marri	Alive	600	5	
27/05/2015	409463	6451068	Jarrah	Alive	700	5	
27/05/2015	409490	6451068	Jarrah	Alive	800	5	
27/05/2015	409162	6451070	Jarrah	Alive	640	4	
27/05/2015	409204	6451072	Jarrah	Alive	600	5	
27/05/2015	409376	6451075	Marri	Alive	600	5	
27/05/2015	409428	6451077	Jarrah	Alive	500	5	
27/05/2015	409441	6451080	Jarrah	Alive	600	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409198	6451084	Jarrah	Alive	600	5	
27/05/2015	409190	6451085	Jarrah	Alive	650	5	
27/05/2015	409441	6451085	Jarrah	Alive	700	4	
27/05/2015	409225	6451088	Jarrah	Alive	1100	5	
27/05/2015	409475	6451089	Jarrah	Alive	680	5	
27/05/2015	409409	6451090	Jarrah	Alive	500	4	
27/05/2015	409424	6451091	Jarrah	Alive	700	5	
27/05/2015	409465	6451091	Marri	Alive	780	5	
27/05/2015	409421	6451094	Jarrah	Alive	700	5	
27/05/2015	409463	6451105	Marri	Alive	540	5	
27/05/2015	409428	6451112	Marri	Alive	600	5	
27/05/2015	409456	6451112	Jarrah	Alive	560	5	
27/05/2015	409456	6451114	Jarrah	Alive	500	5	
27/05/2015	409200	6451120	Jarrah	Alive	1400	3	
27/05/2015	409448	6451120	Jarrah	Alive	610	5	
27/05/2015	409369	6451125	Marri	Alive	600	3	
27/05/2015	409231	6451127	Jarrah	Alive	950	4	
27/05/2015	409278	6451129	Jarrah	Alive	900	4	
27/05/2015	409396	6451129	Marri	Alive	600	3	
27/05/2015	409443	6451129	Marri	Alive	580	5	
27/05/2015	409396	6451136	Jarrah	Alive	500	5	
27/05/2015	409397	6451147	Jarrah	Alive	690	4	
27/05/2015	409403	6451148	Jarrah	Alive	560	4	
27/05/2015	409389	6451151	Marri	Alive	600	5	
27/05/2015	409311	6451152	Jarrah	Alive	600	5	
27/05/2015	409403	6451152	Jarrah	Alive	720	4	
27/05/2015	409421	6451152	Jarrah	Alive	720	4	
27/05/2015	409293	6451158	Jarrah	Alive	800	4	
27/05/2015	409290	6451170	Jarrah	Alive	610	5	
27/05/2015	409320	6451173	Jarrah	Alive	500	5	
27/05/2015	409364	6451176	Jarrah	Alive	700	4	
27/05/2015	409345	6451187	Jarrah	Alive	500	4	
27/05/2015	409341	6451196	Marri	Alive	560	5	
27/05/2015	409299	6451198	Jarrah	Alive	500	5	
27/05/2015	409234	6450657	Jarrah	Dead	750	4	
27/05/2015	409039	6450668	Marri	Dead	600	5	
27/05/2015	409085	6450692	Marri	Dead	590	5	
27/05/2015	408982	6450857	Jarrah	Dead	600	4	
27/05/2015	409422	6450882	Jarrah	Dead	600	5	
27/05/2015	409011	6450889	Jarrah	Dead	800	5	
27/05/2015	409464	6450897	Jarrah	Dead	790	4	
27/05/2015	409025	6450902	Marri	Dead	600	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
27/05/2015	409006	6450915	Jarrah	Dead	580	5	
27/05/2015	409427	6450920	Jarrah	Dead	900	5	
27/05/2015	409293	6450924	Jarrah	Dead	700	5	
27/05/2015	409303	6450944	Marri	Dead	700	5	
27/05/2015	409477	6450948	Jarrah	Dead	600	5	
27/05/2015	409350	6450976	Jarrah	Dead	700	5	
27/05/2015	409510	6451015	Marri	Dead	700	5	
27/05/2015	409490	6451022	Marri	Dead	700	4	
27/05/2015	409462	6451085	Jarrah	Dead	600	5	
27/05/2015	409199	6451098	Jarrah	Dead	1200	4	
27/05/2015	409311	6451152	Jarrah	Dead	600	3	
27/05/2015	409342	6451191	Jarrah	Dead	650	4	
27/05/2015	409323	6451209	Jarrah	Dead	560	5	
Current Survey							
16/08/2016	409241	6450296	Wandoo	Alive	330	5	
16/08/2016	409256	6450304	Marri	Alive	1000	3	
16/08/2016	409208	6450306	Marri	Alive	550	5	
16/08/2016	409260	6450320	Marri	Alive	750	3	
16/08/2016	409264	6450340	Marri	Alive	510	5	
16/08/2016	409265	6450375	Marri	Alive	600	3	
16/08/2016	409416	6450499	Marri	Alive	750	4	
16/08/2016	409442	6450515	Marri	Alive	700	4	
16/08/2016	409438	6450539	Jarrah	Alive	900	3	
16/08/2016	409408	6450547	Jarrah	Alive	1200	3	
16/08/2016	409493	6450554	Jarrah	Alive	600	4	
16/08/2016	409420	6450561	Jarrah	Alive	560	5	
16/08/2016	409499	6450580	Marri	Alive	510	5	
16/08/2016	409508	6450601	Jarrah	Alive	630	4	
16/08/2016	409455	6450604	Marri	Alive	800	3	
16/08/2016	409567	6450693	Jarrah	Alive	550	5	
16/08/2016	409575	6450700	Marri	Alive	550	5	
16/08/2016	409595	6450718	Jarrah	Alive	680	5	
16/08/2016	409592	6450719	Jarrah	Alive	650	4	
16/08/2016	409599	6450732	Jarrah	Alive	650	5	
16/08/2016	409663	6450775	Jarrah	Alive	550	5	
16/08/2016	409769	6450876	Marri	Alive	700	4	
16/08/2016	409379	6451197	Jarrah	Alive	700	4	
16/08/2016	409358	6451200	Jarrah	Alive	850	4	
16/08/2016	409388	6451201	Jarrah	Alive	520	5	
16/08/2016	409194	6451209	Jarrah	Alive	600	3	
16/08/2016	409024	6451210	Jarrah	Alive	580	4	
16/08/2016	409396	6451211	Jarrah	Alive	520	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
16/08/2016	409374	6451217	Marri	Alive	550	5	
16/08/2016	409186	6451219	Jarrah	Alive	560	5	
16/08/2016	409014	6451220	Jarrah	Alive	800	4	
16/08/2016	409276	6450281	Marri	Dead	600	5	
16/08/2016	409326	6450324	Marri	Dead	500	5	
16/08/2016	409393	6450488	Marri	Dead	800	3	
16/08/2016	409442	6450498	Marri	Dead	500	3	
16/08/2016	409435	6450500	Marri	Dead	900	3	
16/08/2016	409500	6450554	Marri	Dead	600	3	
16/08/2016	409507	6450570	Jarrah	Dead	550	5	
16/08/2016	409496	6450613	Marri	Dead	700	3	
16/08/2016	409493	6450621	Jarrah	Dead	1000	3	
16/08/2016	409498	6450622	Marri	Dead	750	3	
16/08/2016	409499	6450626	Jarrah	Dead	700	3	
16/08/2016	409532	6450655	Jarrah	Dead	600	3	
16/08/2016	409570	6450658	Marri	Dead	850	5	
16/08/2016	409776	6450918	Marri	Dead	1000	4	
16/08/2016	409346	6451183	Jarrah	Dead	600	4	
16/08/2016	409409	6451189	Jarrah	Dead	600	5	
16/08/2016	409079	6451201	Jarrah	Dead	900	3	
16/08/2016	409324	6451202	Jarrah	Dead	500	4	
16/08/2016	409213	6450239	Marri	Alive	950	3	
16/08/2016	409297	6450336	Marri	Alive	800	3	
16/08/2016	409473	6450491	Marri	Alive	700	5	
16/08/2016	409485	6450504	Marri	Alive	500	5	
16/08/2016	409466	6450505	Jarrah	Alive	550	5	
16/08/2016	409475	6450535	Marri	Alive	550	5	
16/08/2016	409491	6450536	Jarrah	Alive	700	5	
16/08/2016	409520	6450557	Jarrah	Alive	500	5	
16/08/2016	409549	6450580	Jarrah	Alive	500	5	
16/08/2016	409566	6450589	Jarrah	Alive	600	5	
16/08/2016	409535	6450593	Marri	Alive	600	3	
16/08/2016	409584	6450612	Jarrah	Alive	750	3	
16/08/2016	409593	6450631	Jarrah	Alive	500	5	
16/08/2016	409583	6450664	Marri	Alive	800	5	
16/08/2016	409634	6450672	Jarrah	Alive	800	5	Twin trunks.
16/08/2016	409614	6450686	Jarrah	Alive	650	5	
16/08/2016	409602	6450689	Jarrah	Alive	550	5	
16/08/2016	409663	6450703	Jarrah	Alive	700	5	
16/08/2016	409688	6450713	Jarrah	Alive	600	5	
16/08/2016	409669	6450730	Jarrah	Alive	600	5	
16/08/2016	409689	6450739	Jarrah	Alive	500	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
16/08/2016	409672	6450775	Jarrah	Alive	500	5	
16/08/2016	409709	6450782	Jarrah	Alive	650	5	
16/08/2016	409762	6450790	Marri	Alive	600	5	
16/08/2016	409732	6450791	Marri	Alive	650	5	
16/08/2016	409752	6450792	Jarrah	Alive	500	5	
16/08/2016	409774	6450795	Marri	Alive	550	5	
16/08/2016	409737	6450814	Marri	Alive	800	5	
16/08/2016	409739	6450820	Marri	Alive	600	5	
16/08/2016	409723	6450832	Jarrah	Alive	600	5	
16/08/2016	409802	6450873	Marri	Alive	850	2	Chew marks on vertical entrance.
16/08/2016	409877	6450970	Marri	Alive	650	3	
16/08/2016	409108	6451183	Jarrah	Alive	500	4	
16/08/2016	409055	6451183	Marri	Alive	500	5	
16/08/2016	409048	6451184	Jarrah	Alive	500	4	
16/08/2016	409392	6451185	Jarrah	Alive	500	5	
16/08/2016	409109	6451185	Jarrah	Alive	600	4	
16/08/2016	409369	6451185	Jarrah	Alive	550	4	
16/08/2016	409020	6451186	Jarrah	Alive	650	3	
16/08/2016	409071	6451189	Jarrah	Alive	500	5	
16/08/2016	409429	6451189	Marri	Alive	550	5	
16/08/2016	409231	6451191	Jarrah	Alive	800	4	
16/08/2016	409195	6451192	Jarrah	Alive	600	3	
16/08/2016	409119	6451194	Jarrah	Alive	600	4	
16/08/2016	409339	6451194	Marri	Alive	600	5	
16/08/2016	409005	6451197	Jarrah	Alive	500	5	
16/08/2016	409040	6451197	Marri	Alive	700	3	
16/08/2016	409094	6451199	Marri	Alive	650	3	
16/08/2016	409221	6451201	Jarrah	Alive	650	4	
16/08/2016	409131	6451204	Jarrah	Alive	700	4	
16/08/2016	409025	6451206	Jarrah	Alive	700	5	
16/08/2016	408981	6451216	Jarrah	Alive	600	3	
16/08/2016	408985	6451217	Jarrah	Alive	550	4	
19/08/2016	410031	6450854	Jarrah	Alive	500	5	
19/08/2016	410062	6450859	Marri	Alive	90	3	
19/08/2016	410054	6450892	Marri	Alive	120	3	
19/08/2016	410012	6450901	Marri	Alive	600	3	
19/08/2016	410015	6450919	Marri	Alive	50	5	
19/08/2016	410012	6450929	Marri	Alive	90	3	
19/08/2016	409978	6450962	Marri	Alive	60	4	
19/08/2016	409947	6450974	Marri	Alive	50	4	
19/08/2016	409914	6450988	Jarrah	Alive	600	4	
19/08/2016	409915	6450993	Marri	Alive	60	4	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
19/08/2016	409906	6450995	Jarrah	Alive	500	5	
19/08/2016	409892	6451001	Marri	Alive	500	5	
19/08/2016	409857	6451007	Marri	Alive	600	5	
19/08/2016	409908	6451028	Jarrah	Alive	80	3	
19/08/2016	410049	6451164	Marri	Alive	70	4	
19/08/2016	409709	6451166	Marri	Alive	500	5	
19/08/2016	409704	6451168	Marri	Alive	50	4	
19/08/2016	409954	6451176	Jarrah	Alive	55	5	
19/08/2016	409921	6451178	Jarrah	Alive	50	4	
19/08/2016	409939	6451180	Marri	Alive	70	3	
19/08/2016	409518	6451186	Jarrah	Alive	75	4	
19/08/2016	409884	6451188	Marri	Alive	600	5	
19/08/2016	409556	6451189	Marri	Alive	600	3	Bees
19/08/2016	409576	6451193	Jarrah	Alive	500	5	
19/08/2016	410027	6451194	Marri	Alive	500	5	
19/08/2016	409488	6451196	Jarrah	Alive	500	4	
19/08/2016	409589	6451196	Marri	Alive	600	5	
19/08/2016	409483	6451197	Jarrah	Alive	500	5	
19/08/2016	409896	6451199	Marri	Alive	600	4	
19/08/2016	409551	6451203	Jarrah	Alive	600	5	
19/08/2016	409437	6451205	Jarrah	Alive	500	5	
19/08/2016	409468	6451206	Jarrah	Alive	500	5	
19/08/2016	409619	6451207	Jarrah	Alive	500	5	
19/08/2016	409821	6451208	Marri	Alive	600	5	
19/08/2016	409588	6451210	Jarrah	Alive	700	5	
19/08/2016	409493	6451211	Marri	Alive	600	4	
19/08/2016	409605	6451211	Jarrah	Alive	600	3	
19/08/2016	409831	6451212	Marri	Alive	600	4	
19/08/2016	409654	6451212	Jarrah	Alive	500	4	
19/08/2016	409626	6451217	Jarrah	Alive	600	5	
19/08/2016	409458	6451223	Jarrah	Alive	500	5	
19/08/2016	409457	6451223	Jarrah	Alive	600	5	
19/08/2016	409463	6451225	Marri	Alive	900	4	
19/08/2016	409512	6451227	Jarrah	Alive	700	3	
19/08/2016	409594	6451239	Jarrah	Alive	600	5	
19/08/2016	409583	6451250	Jarrah	Alive	600	5	
19/08/2016	409579	6451260	Jarrah	Alive	600	5	
19/08/2016	409574	6451265	Jarrah	Alive	600	3	
19/08/2016	409570	6451265	Jarrah	Alive	500	5	
19/08/2016	409617	6451266	Jarrah	Alive	55	5	
19/08/2016	409572	6451266	Jarrah	Alive	500	5	
19/08/2016	409555	6451271	Jarrah	Alive	600	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
19/08/2016	409552	6451274	Jarrah	Alive	700	5	
19/08/2016	409590	6451281	Marri	Alive	75	4	
19/08/2016	409533	6451305	Jarrah	Alive	500	5	
19/08/2016	409571	6451318	Marri	Alive	70	4	
19/08/2016	409478	6451344	Jarrah	Alive	600	5	
19/08/2016	409488	6451346	Marri	Alive	600	5	
19/08/2016	409427	6451405	Jarrah	Alive	500	5	
19/08/2016	409432	6451422	Jarrah	Alive	500	5	
19/08/2016	409431	6451426	Marri	Alive	900	3	
19/08/2016	409416	6451429	Jarrah	Alive	600	4	
19/08/2016	409449	6451437	Marri	Alive	70	4	
19/08/2016	409390	6451437	Jarrah	Alive	600	5	
19/08/2016	409370	6451448	Marri	Alive	500	2	
19/08/2016	409343	6451469	Jarrah	Alive	600	4	
19/08/2016	409336	6451474	Jarrah	Alive	500	5	
19/08/2016	409350	6451476	Jarrah	Alive	500	5	
19/08/2016	409383	6451482	Jarrah	Alive	110	3	
19/08/2016	409336	6451483	Jarrah	Alive	600	4	
19/08/2016	409381	6451492	Jarrah	Alive	50	4	
19/08/2016	409375	6451493	Marri	Alive	90	3	
19/08/2016	409362	6451507	Marri	Alive	80	4	
19/08/2016	409316	6451508	Jarrah	Alive	600	3	
19/08/2016	409360	6451512	Jarrah	Alive	50	4	
19/08/2016	409349	6451515	Jarrah	Alive	50	5	
19/08/2016	409294	6451547	Jarrah	Alive	800	3	
19/08/2016	409303	6451554	Jarrah	Alive	600	3	
19/08/2016	409254	6451565	Jarrah	Alive	600	3	
19/08/2016	409256	6451567	Jarrah	Alive	500	5	
19/08/2016	409277	6451567	Jarrah	Alive	700	5	
19/08/2016	409268	6451568	Jarrah	Alive	800	3	
19/08/2016	409251	6451577	Jarrah	Alive	900	3	
19/08/2016	409988	6450904	Marri	Dead	500	5	
19/08/2016	409924	6450965	Jarrah	Dead	500	5	
19/08/2016	409887	6451163	Marri	Dead	80	3	
19/08/2016	409672	6451176	Jarrah	Dead	110	3	
19/08/2016	409673	6451176	Jarrah	Dead	1000	3	
19/08/2016	409560	6451183	Jarrah	Dead	500	3	
19/08/2016	409960	6451204	Marri	Dead	600	4	
19/08/2016	409493	6451205	Jarrah	Dead	500	5	
19/08/2016	409565	6451232	Jarrah	Dead	1100	3	
28/06/2017	409139	6451472	Marri	Alive	500	5	
28/06/2017	409124	6451473	Jarrah	Alive	500	5	

Date	Easting	Northing	Species	Live or dead	DBH	BCE score	Notes
28/06/2017	409152	6451515	Jarrah	Alive	700	5	
28/06/2017	409123	6451526	Jarrah	Alive	600	5	
28/06/2017	409109	6451556	Jarrah	Dead	700	3	
28/06/2017	409086	6451539	Jarrah	Alive	500	5	
28/06/2017	409067	6451541	Jarrah	Alive	600	3	
28/06/2017	409062	6451541	Jarrah	Dead	600	4	
28/06/2017	409062	6451535	Jarrah	Dead	500	5	
28/06/2017	409054	6451543	Jarrah	Dead	500	3	
28/06/2017	409045	6451543	Jarrah	Dead	500	3	
28/06/2017	409045	6451541	Jarrah	Dead	600	5	
28/06/2017	409031	6451552	Jarrah	Alive	800	5	
28/06/2017	409057	6451569	Wandoo	Alive	600	5	
28/06/2017	409038	6451574	Wandoo	Alive	500	5	
28/06/2017	409041	6451582	Wandoo	Alive	500	5	
28/06/2017	409042	6451590	Wandoo	Alive	400	5	
28/06/2017	409017	6451579	Wandoo	Alive	600	5	
28/06/2017	409017	6451577	Wandoo	Alive	500	5	
28/06/2017	409008	6451568	Wandoo	Alive	500	5	
28/06/2017	409007	6451594	Wandoo	Alive	400	5	Echidna diggings around many of the tree bases
28/06/2017	409007	6451600	Wandoo	Alive	500	5	
28/06/2017	409001	6451602	Wandoo	Alive	300	5	
28/06/2017	409000	6451601	Wandoo	Alive	500	5	
28/06/2017	408990	6451597	Wandoo	Alive	400	5	
28/06/2017	408993	6451605	Wandoo	Alive	500	5	1 FRTBC flying S to N
28/06/2017	408999	6451612	Wandoo	Dead	800	3	
28/06/2017	409008	6451622	Wandoo	Alive	500	5	
28/06/2017	408995	6451638	Wandoo	Alive	700	3	
28/06/2017	408993	6451640	Wandoo	Alive	600	5	

Appendix M Bamford Consulting Ecologists Fauna Assessment of the Land Swap Area

Holcim Gosnells Quarry -
Fauna Assessment of the Land Swap Area
(Banyowla Regional Park)



Mixed heath and thicket around granite outcrops. Photo Andrew Moore.

Prepared for: Holcim (Australia) Pty Ltd
Level 3, 200 Adelaide Terrace
EAST PERTH WA 6004

Prepared by: Mike Bamford, Andrew Moore and Katherine Chuk
M.J. & A.R. Bamford Consulting Ecologists
23 Plover Way
KINGSLEY WA 6026

20th July 2017

Contents

Contents i
List of Tables ii
List of Figures ii
List of Appendices iii
1 Introduction 1
1.1 Overview 1
1.2 Description of the land swap area 1
2 Background 3
2.1 Regional description 3
3 Methods 4
3.1 Desktop Assessment 4
3.1.1 Sources of information 4
3.1.2 Previous Fauna Surveys 4
3.1.3 Nomenclature and taxonomy 4
3.1.4 Interpretation of species lists 5
3.2 Field survey 6
3.2.1 Overview 6
3.2.2 Dates and Personnel 6
3.2.3 Vegetation and Substrate Associations 6
3.2.4 Assessment of nesting habitat for black-cockatoos 6
3.2.5 Other conservation significant species 10
3.2.6 Opportunistic observations 10
3.3 Survey limitations 11
4 Results 12
4.1 Vertebrate Fauna 12
4.1.1 Overview of fauna assemblage 12
4.1.2 Species of conservation significance 14
4.1.3 Cockatoo presence and foraging habitat 18
4.1.3.1 Carnaby's Black-Cockatoo 18
4.1.3.2 Forest Red-tailed Black-Cockatoo 18
4.1.3.3 Baudin's Black-Cockatoo 18
4.1.4 Roosting and breeding habitat 21

4.1.5 Invertebrate Species 23
4.1.6 Introduced / Feral Species 23
4.2 Vegetation and Substrate Associations (VSAs) 24
4.3 Patterns of biodiversity 28
4.4 Ecological processes 28
4.5 Summary of fauna values 28
5 Conclusion 29
6 References 31
7 Appendices 36

List of Tables

Table 1. Sources of information used for the desktop assessment. 4
Table 2. Scoring system for the assessment of foraging value of vegetation for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos. 8
Table 3. Survey limitations as outlined by EPA (2004) 11
Table 4. Composition of vertebrate fauna assemblage of the land swap area. 13
Table 5. Number and class of conservation significant fauna species. 14
Table 6. Conservation status of significant fauna species expected to occur in the land swap area. 14
Table 7. Summary of results from breeding tree transects. 21
Table 8. Conservation significant invertebrate species returned from database searches. 23
Table 9. Introduced fauna species expected to occur in the land swap area 24
Table 10. Fish species expected to occur in the land swap area. 49
Table 11. Frog species expected to occur in the land swap area. 50
Table 12. Reptile species expected to occur in the land swap area. 51
Table 13. Bird species expected to occur in the land swap area. 54
Table 14. Mammal species expected to occur in the land swap area. 62
Table 15. Mammal species which are locally extinct in the land swap area. 65
Table 16. Species returned in database searches which are unlikely to occur in the land swap area. 66
Table 17. Results of cockatoo breeding tree transects in the land swap area. 72

List of Figures

Figure 1. Location of the land swap areas (shaded dark green). 2
Figure 2. IBRA Subregions in Western Australia. 3
Figure 3. Foraging values for Carnaby's Black-Cockatoo. 19
Figure 4. Foraging values for the Forest Red-tailed Black-Cockatoo. 20
Figure 5. Potential breeding trees found in the survey transects. 22
Figure 6. Vegetation and Substrate Associations (VSAs) in the land swap area 25
Figure 7. VSA 1 - Jarrah/Marri woodland 26
Figure 8. VSA 2 – Open Wandoo Woodland. 26
Figure 9. VSA 3 – Mixed heath. 27

Figure 10. VSA 3 and 4. Ellis Brook flowing over a granite ridge. There is a narrow belt of riparian vegetation along the brook. VSA 3 (heath) lies to the right and heath with emergent eucalypts (also VSA 3) to the left. 27
Figure 11. Location of the cockatoo breeding tree transects. 72

List of Appendices

Appendix 1. Explanation of fauna values. 36
Appendix 2. Background information on Black-cockatoos. 39
Appendix 3. Categories used in the assessment of conservation status. 45
Appendix 4. Ecological and threatening processes identified under legislation and in the literature. 46
Appendix 5. Fauna expected to occur in the land swap area (Table 10 to Table 15). 48
Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the land swap area. 66
Appendix 7. Details of cockatoo breeding tree transects. 72

1 Introduction

1.1 Overview

Holcim (Australia) Pty Ltd (Holcim) operates the hard rock and aggregates Gosnells quarry for the Perth Metropolitan area. As part of the original development approval for the site in 1984, a land exchange was enacted and resulted in Holcim giving the State government land to create Banyowla Regional Park in exchange for a development footprint for the Gosnells Quarry.

Bamford Consulting Ecologists was commissioned by Holcim to conduct a fauna assessment (desktop review, site inspection and targeted fauna surveys) of the land exchange area located within the Banyowla Regional Park (referred to hereafter as land swap area).
The aim of this assessment was to identify the key fauna values within the land swap area. Key fauna values (described in detail in Appendix 1) are:

- Assemblage characteristics (uniqueness, completeness and richness);
- Species of conservation significance;
- Recognition of ecotypes or vegetation/substrate associations (VSAs);
- Patterns of biodiversity across the landscape; and
- Ecological processes upon which the fauna depend.

This report presents an overview of the fauna assemblage, species of conservation significance and black-cockatoo assessment (including breeding, foraging and roosting habitat) within the land swap area. The targeted fauna surveys focussed on species of conservation significance, particularly three species of black-cockatoo: Carnaby's Black-Cockatoo, *Calyptorhynchus latirostris*, the Forest Red-tailed Black-Cockatoo, *C. banksii naso* and Baudin's Black-Cockatoo *C. baudinii*.

1.2 Description of the land swap area

The land swap area is located on the Darling Scarp east of Tonkin Highway, approximately 19 kilometres south-east of the Perth CBD. The land swap area consists of two separate areas located to the north of the existing quarry operations (Figure 1). The area of native vegetation within the two land swap sites is approximately 222.2 ha, with an additional 14.7 ha of cleared area (Total area, 236.8 ha). The vegetation is broadly mixed heath and thicket on sandy-gravels around granite outcrops and eucalypt woodland (Jarrah *Eucalyptus marginata* and Marri *Corymbia calophylla*). Banyowla Regional Park surrounds the land swap area and includes a seasonal stream (Ellis Brook).

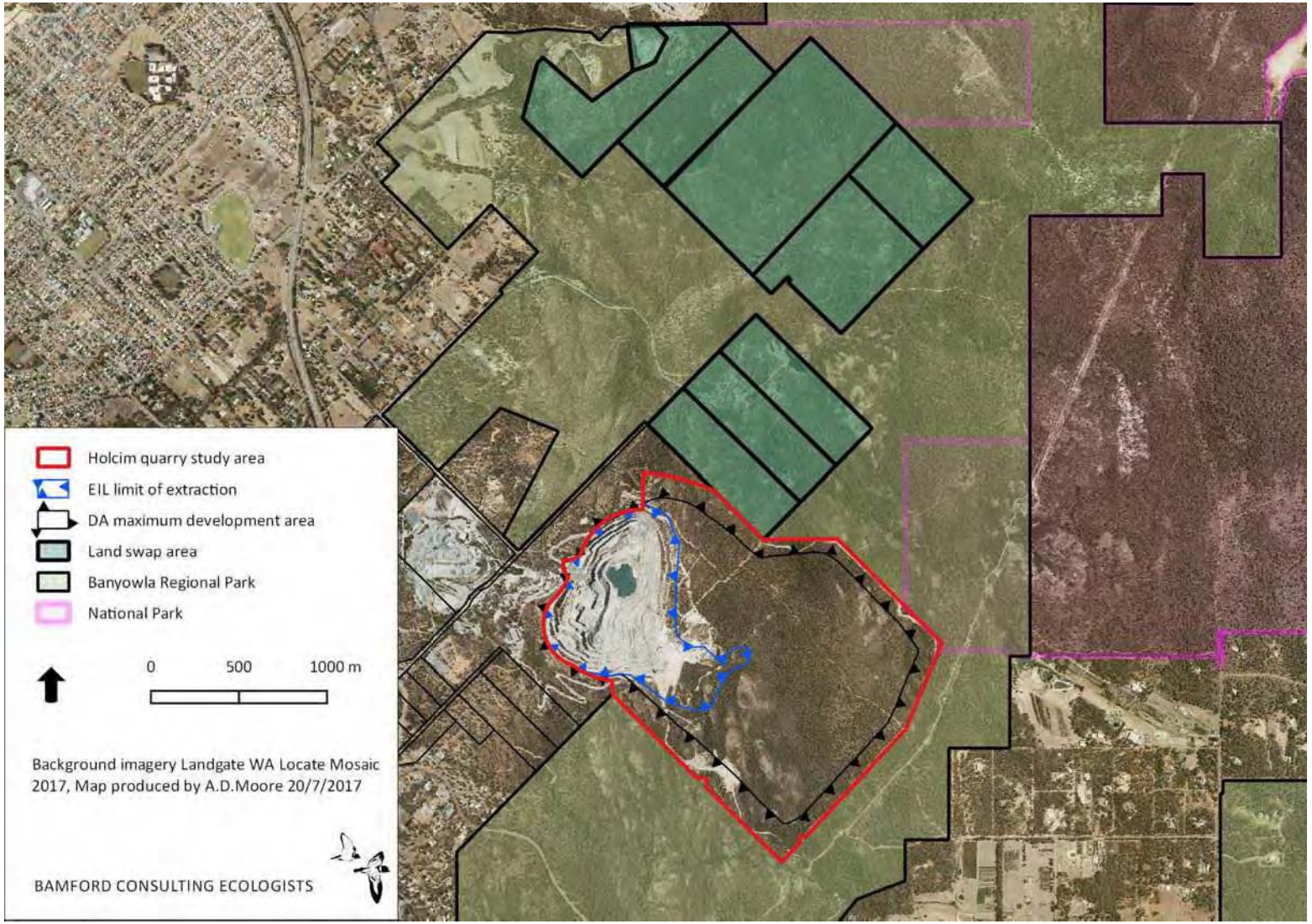


Figure 1. Location of the land swap areas (shaded dark green).

2 Background

2.1 Regional description

The Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia 2000) has identified 26 bioregions in Western Australia (Figure 2). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA 2004).

The land swap area lies in the Jarrah Forest IBRA Bioregion, in the Northern Jarrah Forest 1 (JAF01) subregion. The Northern Jarrah Forest overlies Archaean granite and metamorphic rocks capped by an extensive lateritic duricrust. It is also interrupted by occasional granite outcrops in the form of isolated hills. Vegetation comprises Jarrah-Marri forest in the west (with Bullich and Blackbutt in the valleys), and grades into Wandoo woodlands in the east. There are extensive but localised sand sheets with Banksia low woodlands. Heath is found on granite rocks and as a common understorey of forests and woodlands (Mckenzie *et al.* 2003). Ecosystems affected by Jarrah dieback (*Phytophthora cinnamomi*) are considered to be ecosystems at risk (Williams and Mitchell 2001). Dieback impacts several plant families including Proteaceae and Myrtaceae.

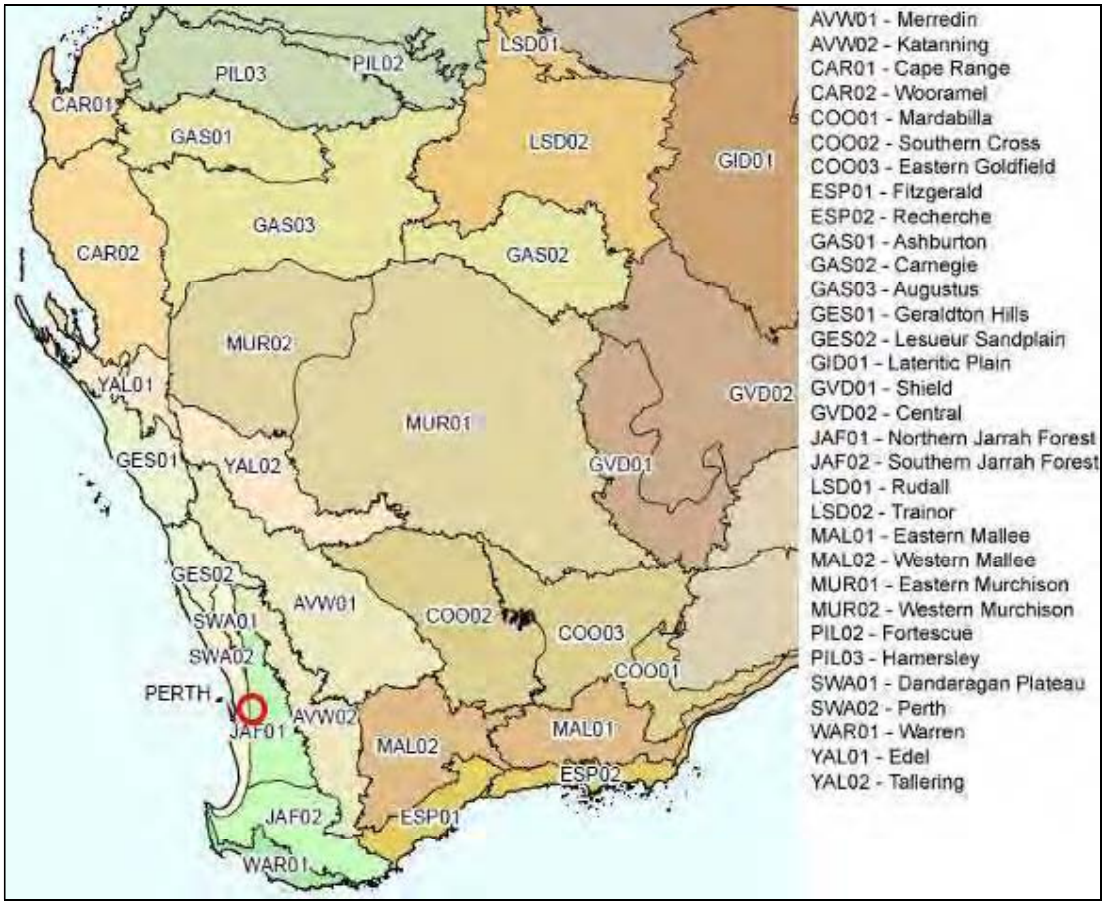


Figure 2. IBRA Subregions in Western Australia.

Note the survey area lies in the JAF01 IBRA subregion.

3 Methods

3.1 Desktop Assessment

3.1.1 Sources of information

Information on the fauna assemblage of the area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the DPaW Naturemap (incorporating the Western Australian Museum's FaunaBase and the DPaW Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Frogs: Tyler *et al.* (2000);
- Reptiles: Storr *et al.* (1983;1990; 1999 and 2002) and Wilson and Swan (2008);
- Birds: Blakers *et al*. (1984); Johnstone and Storr (1998, 2004) and Barrett *et al.* (2003); and
- Mammals: Menkhorst & Knight (2001); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia (ALA 2016)	Records provided by collecting institutions, individual collectors and community groups	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer.
NatureMap (DPaW 2016)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer.
BirdLife Australia Atlas Database (Birdlife 2016)	Records of bird observations in Australia, 1998-2016.	Species list for area containing: 32° 4' 26"S, 116° 2' 26"E – plus 20km buffer
EPBC Protected Matters (DotE 2016)	Records on matters of national environmental significance protected under the EPBC Act.	32° 4' 26"S, 116° 2' 26"E – plus 20 km buffer

3.1.2 Previous Fauna Surveys

Fauna surveys were conducted in the Holcim area by ERM (2005), Astron (2012a; 2012b; 2013) and more recently by Bamford and Moore (2014), Bamford and Everard (2015) and Bamford *et al.* (2016). These included general fauna and habitat assessments, black-cockatoo nest tree assessment, foraging habitat assessment, roosting survey and searching for signs of the Quenda *Isoodon obesulus*, a priority species.

3.1.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Fauna of Western Australia 2016*. The authorities used for each vertebrate group were: amphibians

(Doughty *et al*. 2016), reptiles (Doughty *et al*. 2016), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.1.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey areas, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance. Species returned from databases but excluded from species lists are presented in Appendix 6.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- Locally extinct: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which a site is not important in a conservation sense, and species which use a site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a

resident unless there is very good evidence the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals.

3.2 Field survey

3.2.1 Overview

The field survey included several components:

- identification of major Vegetation and Substrate Associations (VSAs);
- black-cockatoo habitat assessment;
- targeted searching for other conservation significant fauna; and
- opportunistic fauna observations.

3.2.2 Dates and Personnel

The land swap area was visited on the 23rd and 25th August and 2nd September 2016 by Dr Mike Bamford (B.Sc. Hons. Ph.D.), Mr Andrew Moore (B.Sc. B.AppSc. MSc.), Dr Wes Bancroft (B.Sc. Hons. Ph.D), Mr Cameron Everard (B.Sc. MSc) and Ms Katherine Chuk (B.Sc. Hons). This fauna assessment document was prepared by Mike Bamford, Andrew Moore and Katherine Chuk.

3.2.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) were assessed during the desktop review and as part of the field investigations. Within the land swap area, all major VSAs were visited to develop an understanding of the range of environments providing habitats for fauna and to assess the likelihood of conservation significant species being present in the area.

3.2.4 Assessment of nesting habitat for black-cockatoos

The suitability of the land swap area for nesting by black-cockatoos was assessed by conducting a survey for potential hollow-bearing (nest) trees consistent with the recommendations of DSEWPaC (2012a, b, c, d). Transects located within the land swap area were examined for the presence of suitable nest trees; tree species known to be used for nesting in the area (e.g. Wandoo *Eucalyptus wandoo*, Jarrah *E. marginata* and Marri *Corymbia calophylla*) and with a diameter-at-breast-height (DBH) greater than 400 mm (Wandoo) or 500 mm (other species; see Appendix 2). The total area of transect surveys was 27.5 ha in the land swap area (5.5 km of a 50 m wide transect).

For any tree that met this criterion:

- DBH was measured;
- trees were assessed (from the ground) for presence of hollows suitable for black-cockatoos (entrance diameter greater than 100 mm, see Appendix 2);
- trees were given a score based on their likely value as a breeding site (see below); and
- tree location was recorded (UTM, zone 50, datum WGS84).

The score given to trees meeting the DBH criterion reflects their likely value for breeding and has been developed by Bamford Consulting Ecologists. These scores are:

1. Active nest observed; adult (or immature) bird seen entering or emerging from hollow.
2. Hollow of suitable size and angle (i.e. near-vertical) visible with chew marks around entrance. While it cannot with certainty be assumed that such chew marks were made by a black-cockatoo, they indicate activity of a parrot at a hollow potentially suitable for use by black-cockatoos.
3. Potentially suitable hollow visible but no chew marks present; or potentially suitable hollow present (as suggested by structure of tree, such as large, vertical trunk broken off at a height of >10m).
4. Tree with large hollows or broken branches that might contain large hollows but hollows or potential hollows are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by black-cockatoos.
5. Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

The suitability of the area for foraging by black-cockatoos was assessed by inspecting the site on foot and determining the presence of preferred forage plants (as set out in Appendix 2). Each area was assigned a foraging value score (out of six) based upon vegetation characteristics. Descriptions of foraging value scores for each black-cockatoo species are provided in Table 2. While a different score can be assigned to the same vegetation type for each species, all species are relying largely on Marri and Jarrah and thus a single foraging value score could be assigned to cover all species.

Table 2. Scoring system for the assessment of foraging value of vegetation for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos.

Site score	Description of vegetation		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples would be salt lakes and bare ground.	No foraging value. No eucalypts or other potential sources of food.	No foraging value. No eucalypts (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri) or other potential sources of food.
1	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <2%. Could include urban areas with scattered foraging trees. Blue Gum plantations are considered to have a score of 1 as foraging by Black-Cockatoos has been reported but appears to be unusual.	Negligible to low foraging value. Scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with <10% projected foliage cover. • Open eucalypt woodland/mallee of small-fruited species. • Paddocks with melons or other weeds (a short-term, seasonal food source).	Low foraging value. Example: • Woodland or forest with scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these 1-<5%. Could include urban areas with scattered foraging trees.	Low foraging value. Examples: • Open eucalypt woodland (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri). Projected foliage cover of these 1-<5% • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *Eucalyptus erythrocorys*.
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with 10-20% projected foliage cover. • Woodland with tree banksias 2-10% projected foliage cover. • Eucalypt woodland/mallee of small-fruited species; Marri, if present, <10% project foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 5-<10%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 10-<20% can be considered low-to-moderate because of poor long-term viability without management.	Low to Moderate foraging value. Examples: • Eucalypt woodland (i.e. Marri, Jarrah, Wandoo, and Blackbutt), if present, <10% project foliage cover.

Site score	Description of vegetation		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland with tree banksias 20-40% projected foliage cover. • Eucalypt woodland/forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 10-<20%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 20-<40% can be considered moderate because of poor long-term viability without management. • Areas of orchards and especially those with apples can be considered of moderate value.	Moderate foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with 20-40% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia woodlands with tree banksias >40%. Vegetation condition moderate due to weed invasion and some tree deaths.	Moderate to High foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 20-<40%. Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of >40% can be considered moderate because of poor long-term viability without management.	Moderate to High foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >40% projected foliage cover. Vegetation condition moderate due to weed invasion and some tree deaths.
6	High foraging value. Example: • Banksia woodlands of key species (e.g. *B. attenuata, B. menziesii*) with projected foliage cover >60%. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest with a high proportion of Marri (>40% projected foliage cover). Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >60% projected foliage cover. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.

Proteaceous plants include species such as *Banksia*, *Hakea* and *Grevillea.*

3.2.5 Other conservation significant species

The Quenda or Southern Brown Bandicoot and other conservation significant species such as the Chuditch and Brush-tailed Phascogale may be present in the land swap area. Opportunistic sightings of tracks, scats, diggings and other signs were recorded during the survey.

3.2.6 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while walking through the survey area.

3.3 Survey limitations

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These limitations are discussed in the context of the fauna survey in Table 3.

Table 3. Survey limitations as outlined by EPA (2004).

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study with a reconnaissance survey). Survey intensity was deemed adequate due to the small area and availability of previous studies in the area.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews, fauna surveys and Black-Cockatoo assessments in the Perth Region.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The site investigation targeted descriptions of the environment and fauna values for significant species.
Proportion of fauna identified, recorded and/or collected.	Key significant species were identified and the desktop provided information on other species
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous fauna surveys in the area: ERM (2005), Astron (2012a; 2012b; 2013), Bamford and Moore (2014), Bamford and Everard (2015) and Bamford *et al.* (2016). Databases checked include: ALA, BA, DPaW, EPBC and BCE.
The proportion of the task achieved and further work which might be needed.	This report provides fauna values for significant species
Timing/weather/season/cycle.	There were no constraints from the weather and mild conditions allowed personnel to move around readily.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	All major VSAs were visited and intensive targeted surveys for significant species carried out.
Completeness (e.g. was relevant area fully surveyed).	Survey intensity was moderate, but supported by previous studies in nearby and similar habitats. Desktop study covered survey area and adjacent habitats. All suitable habitat within the survey area were visited and assessed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna in the region
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

4 Results

4.1 Vertebrate Fauna

4.1.1 Overview of fauna assemblage

The desktop study identified 202 vertebrate fauna species as potentially occurring in the land swap area (see **Error! Reference source not found.**Appendix 5; Table 4 presents a summary): 6 fish, 13 frogs, 42 reptiles, 108 birds, 23 native and 10 introduced mammals. This does not include species considered to be locally extinct (listed in Table 15 of Appendix 5). Species returned from databases but which are not considered to be part of the fauna assemblage are presented in Appendix 6.

The six fish species are expected to be visitors to Ellis Brook in Banyowla Park when this flows in winter, although their likely abundance is uncertain and the possibility exists of other fish species moving upstream at times. One of the fish species is introduced.

The 13 frog species are all locally common, considered resident or regular visitors and are regionally widespread. The frogs are likely to breed in pools associated with Ellis Brook in Banyowla Regional Park, although some of the smaller species (*Crinia pseudinsignifera*, *Pseudophryne guentheri*) may be able to breed in temporary pools formed at the base of granites. All the frog species are capable of dispersing through upland environment and most are residents of upland environments outside the mostly winter breeding season. The most terrestrial of the frogs are the *Heleioporus* species that would occur throughout Banyowla Park.

The 42 reptile species are all considered resident except for the Long-necked Tortoise, which may occasionally visit Ellis Brook. The terrestrial species are widespread but the assemblage is distinctive with the presence of several species associated with granite outcrops (e.g. Ornate Dragon and Tree Dtella), one at the western edge of its range (*Diplodactylus granariensis*) and several with restricted distributions along the Darling Escarpment (Darling Range Ctenotus and Granite Worm-Lizard). The land swap area provides different niches and a range of environments that provide habitat for reptiles. Large areas of granites and associated shallow soils at the site may favour species with more restricted distributions.

Of 108 bird species the vast majority are woodland species which are considered resident in the area. Several migrants may use the area seasonally such as the Rainbow Bee-eater and Carnaby's Black-Cockatoo; it is also possible that these species may breed in the land swap area. A suite of woodland species that are declining in the Perth region due to habitat loss may also be resident in the land swap area. Eight introduced bird species may be present. Large numbers of bird species returned from the database search were excluded (Appendix 6, Table 16) due to the small area of wetland environment within the land swap area.

Of 33 mammal species expected at the site almost one third are introduced. Of those the Red Fox and Cat in particular are likely to be having a negative impact on the local fauna and, along with habitat loss, have played a significant role in several local extinctions. Most of the native species are considered resident and are likely to be most abundant in the woodland areas with an intact understorey. There may be five locally extinct species that are not included in the assemblage total, but those locally extinct species of conservation significance are included in the relevant section below.

Key features of the fauna assemblage are:

- Uniqueness: The assemblage is likely to be typical of Jarrah woodlands in the Northern Jarrah Forest subregion.
- Completeness: The assemblage of species from the survey area is missing a significant number of native mammal species. Some bird species may make limited use of the site because of nearby cleared areas (quarry, residential and rural).
- Richness: The assemblage is likely to vary annually and seasonally according to climatic conditions. The nearby cleared areas means some species may be absent or uncommon visitors, but the location of the study area connected to large areas of better quality bushland may offset this effect.

As a fauna value, the site's assemblage is likely to be typical for the region but slightly depauperate due to nearby cleared areas.

Table 4. Composition of vertebrate fauna assemblage of the land swap area.

Taxon	Number of species	Number of species in each status category (number in parenthesis is number confirmed present)				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Fish	6	-	6	-	-	-
Frogs	13	13	-	-	-	-
Reptiles	42	41 (1)	1	-	-	-
Birds	108 (8 introduced)	51 (22)	35 (8)	20	2	?
Native Mammals	23	21 (9)	1	-	1	5
Introduced Mammals	10	5 (4)	3 (1)	1	1	-
Total	**202**	**131**	**46**	**21**	**4**	

NB. Locally extinct species not included in total.

4.1.2 Species of conservation significance

The current vertebrate assemblage potentially includes 35 species of conservation significance, with a further five conservation significant species considered to be locally extinct (**Error! Reference source not found.** and 6). Significant species returned from databases but for which the survey area provide no habitat, such as waterbirds, have been excluded (but are presented in Appendix 6). Numbers and classes of significant species broken down by major taxonomic group and still expected to be present are provided in Table 5.

Table 5. Number and class of conservation significant fauna species.

Taxon	Conservation Significance (CS) Level			
	CS1	CS2	CS3	Total
FISH	0	1	0	1
FROGS	0	0	0	0
REPTILES	0	2	1	3
BIRDS	6	2	16	24
MAMMALS*	3	4	0	7
Total	**9**	**9**	**17**	**35**

*Excludes five locally extinct CS1 species

As outlined in Appendix 3, species classed as CS1 are those listed under legislation, while those classed as CS2 are listed as Priority by the Department of Parks and Wildlife. The CS3 class is more subjective, but includes species that have declined extensively in nearby urban areas. The CS3 class also includes potential short range endemic (SRE) invertebrates and the potential for these is discussed with other CS3 species below. All significant species are discussed below.

Table 6. Conservation status of significant fauna species expected to occur in the land swap area.

Their expected status is indicated (as per section 3.1.4), as are those recorded during field investigations.

CS Species		Status	CS Level	Confirmed	Expected Status
FISH					
Pouched Lamprey	*Geotria australis*	P1	CS2		Visitor
REPTILES					
Darling Range South-west Ctenotus	*Ctenotus delli*	P4	CS2		Resident
Carpet Python	*Morelia spilota imbricata*		CS3		Resident
Common Death Adder	*Acanthophis antarcticus*	P3	CS2		Resident
BIRDS					
Fork-tailed Swift	*Apus pacificus*	M S5	CS1		Migrant
Painted Button-quail	*Turnix varius*		CS3		Resident
Peregrine Falcon	*Falco peregrinus*	S7	CS1		Resident
Masked Owl	*Tyto novaehollandiae*	P3	CS2		Irregular visitor
Barking Owl	*Ninox connivens*	P2	CS2		Irregular visitor
Rainbow Bee-eater	*Merops ornatus*	S5	CS1		Migrant

CS Species		Status	CS Level	Confirmed	Expected Status
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	V S3	CS1		Resident
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	V S2	CS1		Migrant
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2	CS1		Migrant
Rufous Treecreeper	*Climacteris rufus*		CS3		Irregular visitor
Red-winged Fairy-wren	*Malurus elegans*		CS3		Visitor
Splendid Fairy-wren	*Malurus splendens*		CS3	X	Resident
Southern Emu-wren	*Stipiturus malachurus*		CS3		Resident
Inland Thornbill	*Acanthiza apicalis*		CS3		Resident
Western Thornbill	*Acanthiza inornata*		CS3		Resident
White-browed Scrubwren	*Sericornis frontalis*		CS3	X	Resident
Grey Shrike-thrush	*Colluricincla harmonica*		CS3	X	Resident
Crested Shrike-tit	*Falcunculus frontatus*		CS3		Visitor
White-breasted Robin	*Eopsaltria georgianus*		CS3		Visitor
Western Yellow Robin	*Eopsaltria griseogularis*		CS3		Visitor
Hooded Robin	*Melanodryas cucullata*		CS3		Irregular visitor
Red-capped Robin	*Petroica goodenovii*		CS3		Visitor
Scarlet Robin	*Petroica multicolor*		CS3		Resident
Red-eared Firetail	*Stagonopleura oculata*		CS3	X	Visitor
MAMMALS					
Chuditch	*Dasyurus geoffroii*	V S3	CS1		Resident
Brush-tailed Phascogale	*Phascogale tapoatafa tapoatafa*	S3	CS1		Resident
Numbat	*Myrmecobius fasciatus*	V S2	CS1		Locally extinct
Woylie	*Bettongia penicillata ogilbyi*	E S1	CS1		Locally extinct
Boodie	*Bettongia lesueur*	Ex V S4 S6	CS1		Locally extinct
Western Brush Wallaby	*Macropus irma*	P4	CS2		Resident
Tammar Wallaby	*Macropus eugenii*	P4	CS2		Locally extinct
Quokka	*Setonix brachyurus*	V S3	CS1		Vagrant
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S1	CS1		Locally extinct
Quenda	*Isoodon obesulus*	P4	CS2		Resident
Western False Pipistrelle	*Falsistrellus mackenziei*	P4	CS2		Resident
Rakali	*Hydromys chrysogaster*	P4	CS2		Visitor
Total Number of Species:	**40**			**4**	

See Appendix 3 for descriptions of conservation significance levels.

EPBC Act listed species: V = Vulnerable, E = Endangered, Ex = Extinct, M = Migratory.

WC Act listed species: S1 – S7 = Schedule 1 - 7, DPaW Priority Species: P1 – P5 = Priority 1 - 5.

Conservation Significance Level 1

Migratory Bird Species

Fork-tailed Swift (*Apus pacificus*)

Rainbow Bee-eater (*Merops ornatus*)

These bird species are listed under one or more of the agreements/conventions relating to the protection of migratory species that Australia is signatory to i.e. JAMBA, CAMBA, ROKAMBA and the Bonn Convention. As such, the swift is listed as migratory under both the WA Wildlife Conservation Act and the Federal EPBC Act, but the bee-eater was recently removed from the EPBC migratory list and is therefore not a Matter of National Environmental Significance. It remains listed as migratory under the State Act. The Rainbow Bee-eater is a regular summer breeding migrant that may construct nesting burrows in sandy substrates; including in cleared land and along road verges. The species was recorded in the nearby quarry area by ERM (2005), although may not breed in the area due to the lack of sandy substrate. The Fork-tailed Swift may pass over the area but is a largely aerial species mostly independent of terrestrial ecosystems.

Peregrine Falcon (*Falco peregrinus*)

This species is found in a wide variety of habitats, with its distribution often linked to the abundance of prey. Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. Suitable habitat exists for this species in the region and land swap area. It nests on cliffs or in very large trees and has the potential to nest in the land swap area. The land swap area may also be part of the foraging range of a pair.

Black-Cockatoos (*Calyptorhynchus banksii naso, C. baudinii* and *C. latirostris*)

The Forest Red-tailed Black-Cockatoo was recorded. All three Black-Cockatoo species have been recorded in the region (DPaW 2016) and suitable foraging and breeding habitat occurs in the land swap area. The value of the land swap area as foraging and breeding habitat for three Black-Cockatoo species is assessed in detail in Section 4.1.3.

Chuditch (*Dasyurus geoffroii*)

This species inhabits a variety of habitats in the region, especially riparian and Jarrah forests, and is known from the region (DPaW 2016). Suitable habitat (i.e. Marri and Jarrah Woodland) occurs in the land swap area and therefore may be resident.

Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)

The Brush-tailed Phascogale inhabits Jarrah forests in the region. The species was not recorded in the land swap area, but is likely to occur, as it was recorded in the nearby Holcim quarry area with a motion-sensitive camera (Bamford *et al*. 2017) and suitable Jarrah woodland habitat is present throughout the land swap area.

Conservation Significance Level 2

Pouched Lamprey (*Geotria australis*)

This species may be present in Ellis Brook in Banyowla Park as a visitor, although its status in drainage lines in the region is uncertain.

CS2 Reptiles (*Ctenotus delli* and *Acanthophis antarcticus*)

The Darling Range South-west Ctenotus and Common Death Adder are both at the western and northern extent of their range in the land swap area. The Ctenotus is found only in the Darling Range in Jarrah and Marri Woodland, while the Common Death Adder is found in open woodland, heathland and shrubland. Both species are considered resident in the land swap area on the basis of suitable habitat.

Barking Owl and Masked Owl (*Ninox connivens connivens* and *Tyto novaehollandiae*)

These species are patchily distributed in the Darling Range and may be resident in the land swap area where they may breed in hollows in the larger trees (i.e. Jarrah, Marri and Wandoo Woodland).

Brush Wallaby (*Notamacropus irma*)

The Brush Wallaby is likely to be resident in eucalypt woodland in the region. The species was not recorded in the land swap area, but is likely to occur as it was recorded in the nearby Holcim quarry area with a motion-sensitive camera (Bamford *et al*. 2017).

Quenda (*Isoodon obesulus*)

The Quenda is known to occur in dense shrubland, eucalypt woodland near drainage lines and low lying areas. The species is likely to be resident in the region and land swap area and it was recorded on motion-sensitive cameras in the nearby Holcim quarry area (Bamford *et al*. 2017). Suitable habitat occurs throughout the land swap area for this species.

Western False Pipistrelle (*Falsistrellus mackenziei*)

The Western False Pipistrelle occurs in Jarrah and Marri Woodland and roosts in tree hollows. This species is a known resident in the region and may utilise parts of the land swap area for foraging or roosting. The species was confirmed in the nearby Holcim quarry area during the 2015 surveys.

Rakali (*Hydromys chrysogaster*)

The Rakali is a known from watercourses of the region and may be a visitor in the land swap area (i.e. Ellis Brook).

Conservation Significance Level 3

Carpet Python (*Morelia spilota imbricata*)

The Carpet Python occurs throughout the Darling Range with no clear environmental preferences, although for shelter it relies on tree hollows, especially those on the ground, and rocky areas. As suitable habitat is present and it has been previously recorded in the area, the Carpet Python is likely to be a resident in the land swap area.

Conservation Significance level 3 birds

This suite of birds is considered to be of local conservation significance (CS3) because they have been identified in the Bush Forever Report (Dell and Banyard 2000) as declining in the Perth region and being

reliant on native vegetation. For many of the species this has been reinforced by Davis *et al.* (2012). These are species reliant to varying degrees on large and interconnected areas of native vegetation within the urban landscape. Many of these species are known to occur in habitats found in the Darling Range (e.g. Marri and Jarrah woodland, associated shrublands and drainage lines). They make up a large proportion of the significant birds that may use the land swap area. Just four of these species have been recorded, the Splendid Fairy-wren, White-browed Scrubwren, Grey Shrike-thrush and the Red-eared Firetail, but a further five species are expected to be resident.

4.1.3 Cockatoo presence and foraging habitat

4.1.3.1 Carnaby's Black-Cockatoo

Carnaby's Black-Cockatoos are expected to be regular migrants in the land swap area. Main food species present were: Marri, Jarrah, Wandoo, *Banksia (Dryandra) sessilis* and Hakea. Other species were present which may be used for foraging such as some low banksias in the heathland. The foraging value of the land swap area varied from 2-4 (Low to Moderate; see Table 2 for descriptions of foraging value) and consists of approximately 72.7 ha of Jarrah/Marri woodland (VSA 1) (foraging value 4), 38.4 ha of Wandoo woodland (VSA 2) (foraging value 2) and 111 ha of mixed heath, thicket and granite outcrops (VSA 3) (foraging value 2).

As much of the area consisted of heath (foraging value 2) the overall foraging value for the site was 2-3 (Low to Low/Moderate). Foraging values for Carnaby's Black-Cockatoo are presented in Figure 3. Further discussion of VSAs is provided in Section 4.2.

4.1.3.2 Forest Red-tailed Black-Cockatoo

Forest Red-tailed Black-Cockatoos are expected to be resident in the land swap area, with foraging habitat well-represented due to the presence of preferred native food sources (such as Marri and Jarrah). The foraging value of the land swap area varied from 1-4 (Negligible to Moderate) and consists of approximately 72.7 ha of Jarrah/Marri woodland (foraging value 4), 38.4 ha of Wandoo woodland (foraging value 1) and 111 ha of heath (forging value 1), however the greater proportion of heath (foraging value 1) resulted in an overall foraging value of 2 (Low). Foraging values for the Forest Red-tailed Black-Cockatoo are presented in Figure 4.

4.1.3.3 Baudin's Black-Cockatoo

Baudin's Black-Cockatoo is expected to be at least an occasional visitor to the land swap area as it occurs regularly nearby and the area provides suitable foraging habitat. Foraging requirements of Baudin's Black-cockatoo are similar to those of the Forest Red-tailed Black-Cockatoo. The foraging value of the land swap area varied from 1-5 (Negligible to Moderate/High), comprising of approximately 72.7 ha of Jarrah/Marri woodland (foraging value 5), 38.4 ha of Wandoo woodland (foraging value 1) and 111 ha of heath and granite outcrops (foraging value 1). As much of the area consisted of heath (foraging value 1) the overall foraging value for the site was 2 (Low).

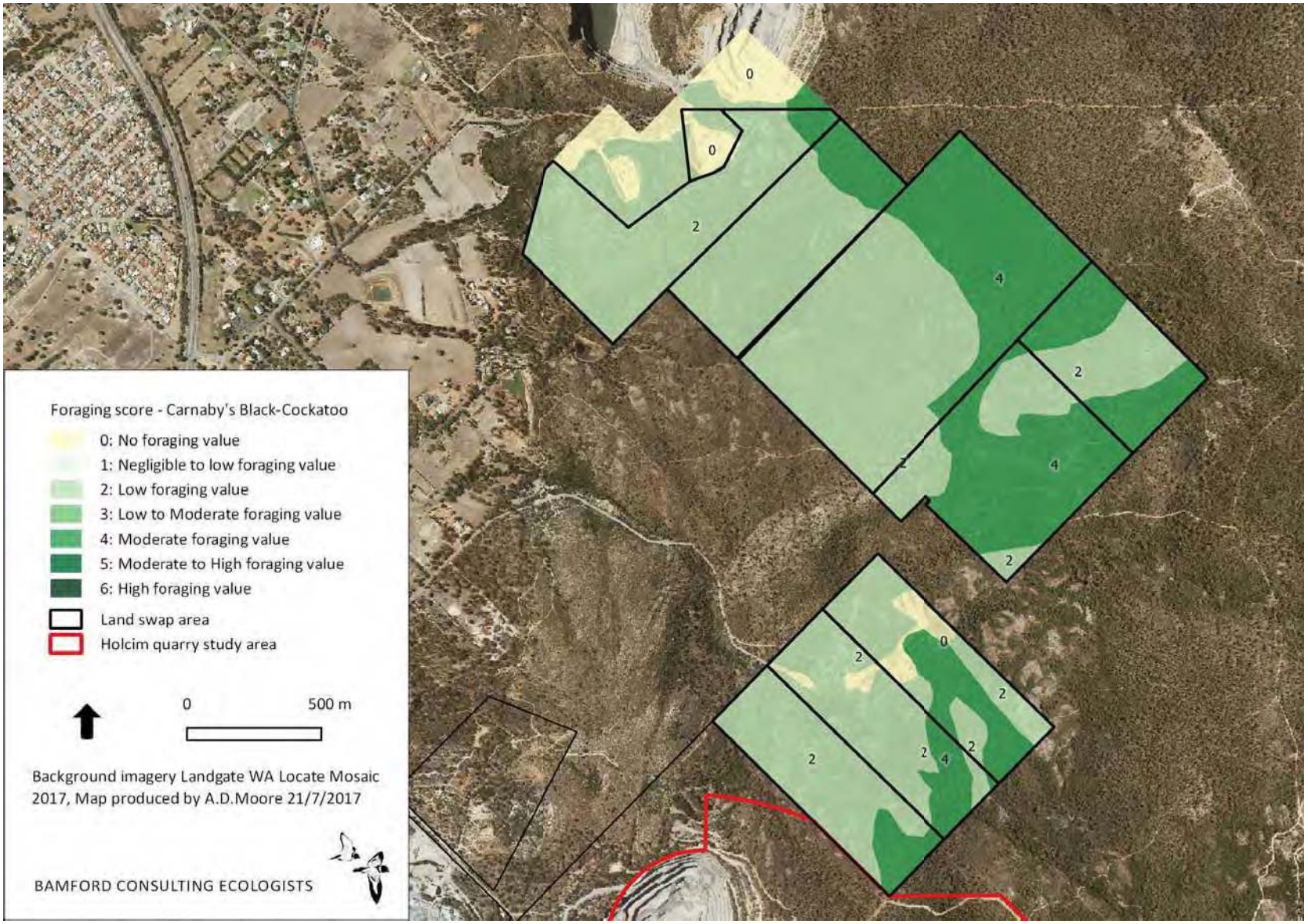


Figure 3. Foraging values for Carnaby's Black-Cockatoo.

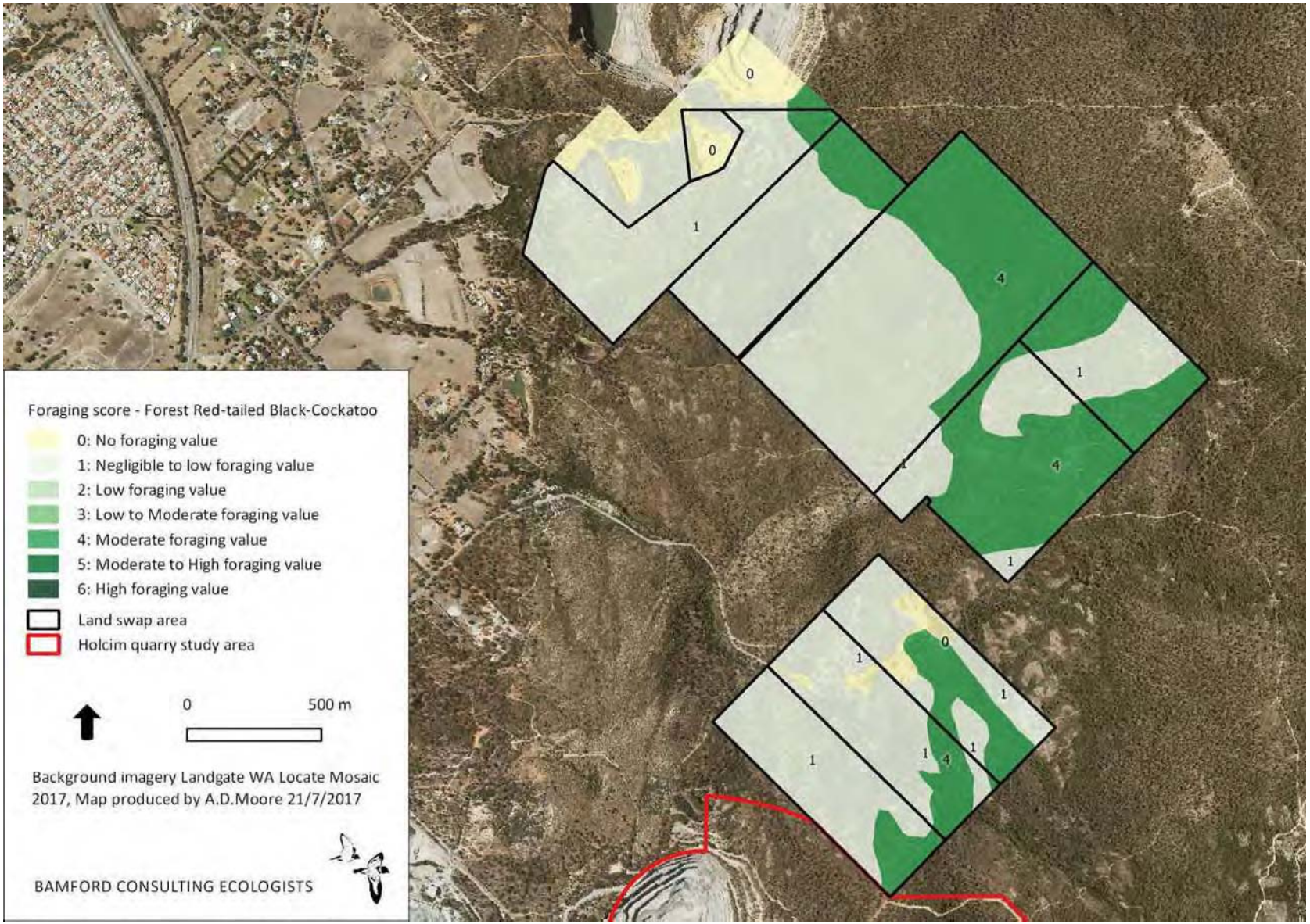


Figure 4. Foraging values for the Forest Red-tailed Black-Cockatoo.

4.1.4 Roosting and breeding habitat

Most of the trees in the land swap area are regrowth which are not yet big enough to serve as roosting or breeding habitat, however remnant large trees are present throughout the land swap area, particularly in VSA1 (see Section 4.2). The breeding tree transects found that the land swap area had a density of 9.6 potential breeding trees per hectare (Table 7). These estimates assume that the areas covered by the transects are representative of the total area. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. It is thus possible that black-cockatoos roost and breed in the land swap area.

Table 7. Summary of results from breeding tree transects.

Site	BCE score					Total	Trees/ha	Estimated total trees
	1	2	3	4	5			
Land swap Area	0	0	31	17	216	264	9.6	2133

Breeding tree score categories are discussed in Section 3.2.4. Density calculations do not include cleared areas.

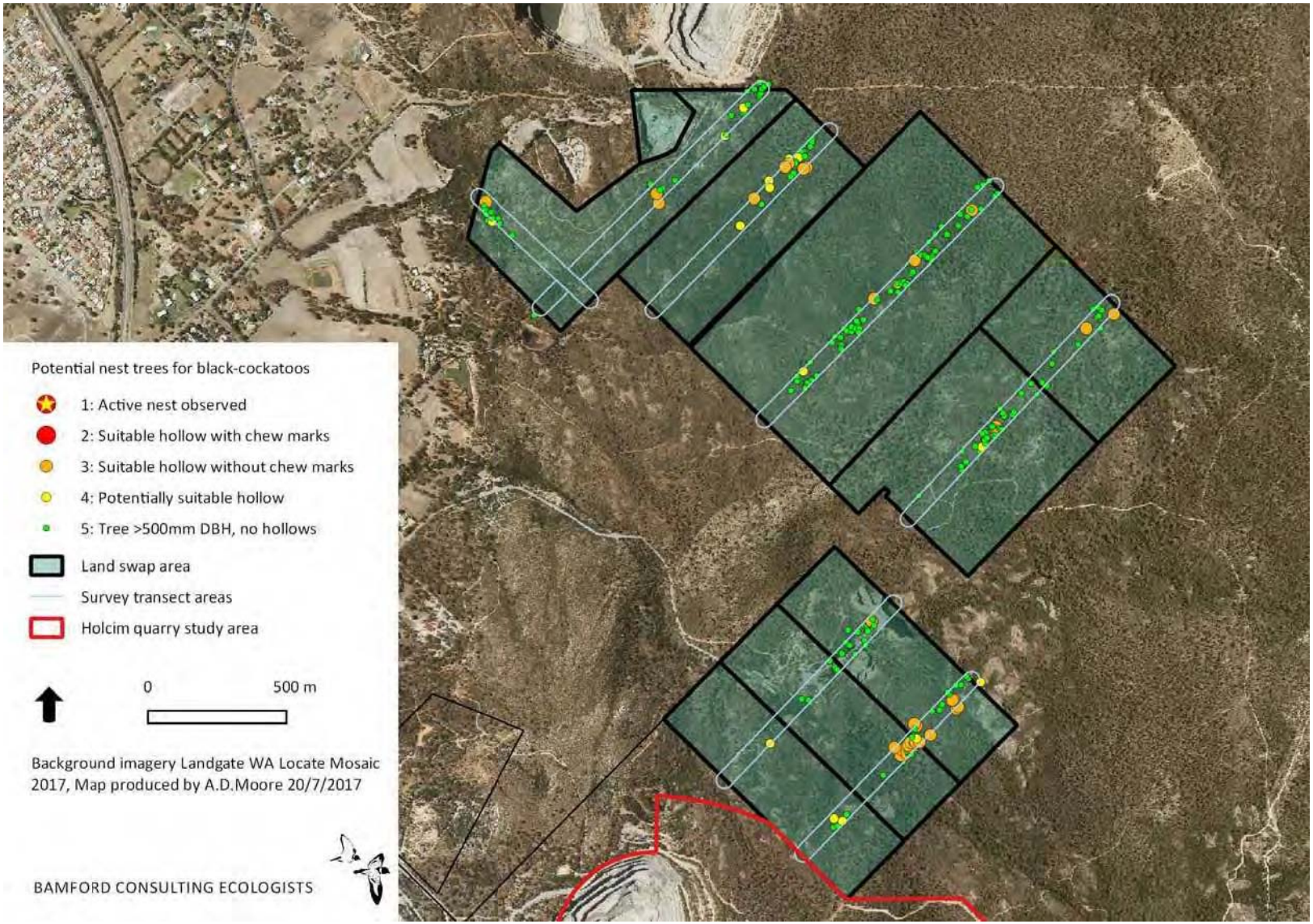


Figure 5. Potential breeding trees found in the survey transects.

BCE scores are as follows: green – 5, yellow – 4, orange – 3 and red – 2. No trees were given a score of 1 (i.e. no trees confirmed with active nests).

4.1.5 *Invertebrate Species*

Eight conservation significant invertebrates are known to occur in the region (Table 8). No conservation significant species were recorded during the site visit. Species recorded were the widespread Marri Millipede *Antichiropus variabilis*, the SRE woodlouse *Buddelundia '04'* and the SRE land snail *Bothriembryon kendricki*. The SRE woodlouse is common in Jarrah forests around Perth and the SRE land snail is not uncommon on the Perth Coastal Plain and adjacent Scarp. The Millipede *Dinocambala ingens* was also recorded and is mostly restricted to granite outcrops, but is locally common and moderately widespread. The granite outcrops have the characteristics that should encourage the evolution of SRE invertebrate species, and V. Framinau (pers comm.) has suggested that *Synsphyronus* spp. pseudoscorpions and *Karaops* spp. spiders may be of interest in this regard. The land swap area has large areas of granites and larger areas of mesic refugia along Ellis Brook.

The biting midge *Austroconops mcmillani* has been recorded at only a handful of sites, the closest being a record from Armadale in 1934, the next closest records are from Yanchep, over 60km to the north-west. This species is unlikely to occur in the land swap area as it is associated with coastal plain habitats. The scorpionfly *Austromerope poultoni* is most likely to occur. It is associated with Jarrah woodland which is present in the land swap quarry area, and it has been recorded 18km to the north and 20km to the east.

The cricket *Kawaniphila pachomai* is known from only two records, one of which is from only 5km to the east from 1981, with the only other record from near Augusta. The bees *Leioproctus bilobatus*, *Leioproctus douglasiellus* and *Neopasiphae simplicior* have all been recorded within 10km of the land swap area however they appear to be associated with the coastal plain and are unlikely to be present on the scarp. The freshwater snail and Carter's Freshwater Mussel may be present in the waterways of the Banyowla Park.

Table 8. Conservation significant invertebrate species returned from database searches.

Common Name	Latin Name	Conservation Status	Likelihood in the land swap area
Biting midge	*Austroconops mcmillani*	P2 (CS2)	Unlikely
Scorpionfly	*Austromerope poultoni*	P2 (CS2)	Likely
Cricket	*Kawaniphila pachomai*	P1 (CS2)	Unlikely
Bee	*Leioproctus bilobatus*	P2 (CS2)	Unlikely
Bee	*Leioproctus douglasiellus*	Cr S2 (CS1)	Unlikely
Bee	*Neopasiphae simplicior*	Cr S2 (CS1)	Unlikely
freshwater snail	*Glacidorbis occidentalis*	P2 (CS2)	Likely
Carter's Freshwater Mussel	*Westralunio carteri*	S3 (CS1)	Likely

4.1.6 *Introduced / Feral Species*

The desktop study identified 19 introduced fauna species as potentially occurring in the land swap area (Table 9). Several of these were confirmed and two important feral predators, the Fox and Cat, are almost certainly resident.

Table 9. Introduced fauna species expected to occur in the land swap area.

Common Name	Latin Name	Expected Status
FISH		
Mosquitofish	*Gambusia holbrooki*	Visitor
BIRDS		
Rock Dove	*Columba livia*	Resident
Spotted Dove	*Streptopelia chinensis*	Resident
Laughing Dove	*Streptopelia senegalensis*	Resident
Laughing Kookaburra	*Dacelo novaeguineae*	Resident
Sulphur-crested Cockatoo	*Cacatua galerita*	Occasional visitor
Long-billed Corella	*Cacatua tenuirostris*	Occasional visitor
Rainbow Lorikeet	*Trichoglossus moluccanus*	Visitor
Red-browed Finch	*Neochmia temporalis*	Visitor
MAMMALS		
Cattle	*Bos taurus*	Visitor
Dog	*Canis lupu. familiaris*	Visitor
Goat	*Capra hircus*	Irregular visitor
Cat	*Felis catus*	Resident
House Mouse	*Mus musculus*	Resident
Rabbit	*Oryctolagus cuniculus*	Resident
Brown Rat	*Rattus norvegicus*	Vagrant
Black Rat	*Rattus rattus*	Resident
Pig	*Sus scrofa*	Visitor
Fox	*Vulpes vulpes*	Resident

4.2 Vegetation and Substrate Associations (VSAs)

Key VSAS in the land swap area are:

- VSA 1. Open Jarrah/Marri woodland to forest over open banksia and mixed shrub understorey on lateritic gravels high in the landscape. VSA 1 consists of 72.7 ha.
- VSA 2. Open Wandoo woodland over a mixed high to low shrub understorey on lateritic gravels. VSA 2 covers an area of 38.4 ha.
- VSA 3. Mixed heath and thicket on sandy-gravels around granite outcrops; scattered trees include Jarrah, Marri and *Eucalyptus lane-poolei* in Banyowla Park. VSA 3 consists of 111 ha.
- VSA 4. Seasonal watercourse and wetlands (including Ellis Brook in Banyowla Park) with associated riparian vegetation. Area is included in VSA 3 (Mixed Heath).
- Cleared areas (14.7 ha).

VSAs 1 to 3 are present within the land swap area and the surrounding areas to the east, although the site consists mainly of VSA 3 (mixed heath) (Figure 6). Riparian vegetation associated with the watercourse (VSA 4) is found along Ellis Brook. Several small cleared areas are present at the north of the land swap area. Photographs of the key VSAs are provided in Figures 7 to 10.

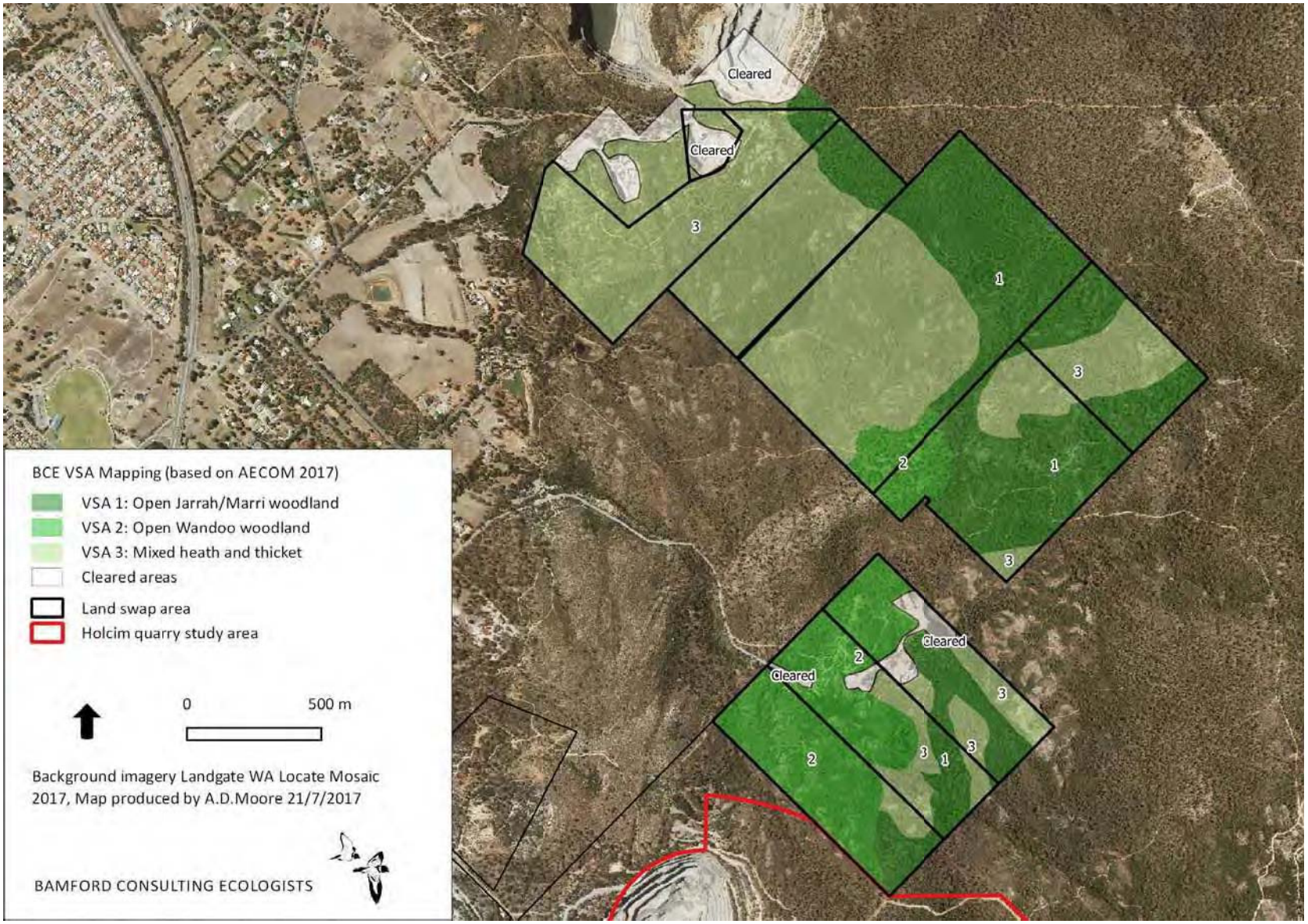


Figure 6**. Vegetation and Substrate Associations (VSAs) in the land swap area.**



Figure 7. VSA 1 - Jarrah/Marri woodland



Figure 8. VSA 2 – Open Wandoo Woodland.



Figure 9. VSA 3 – Mixed heath.



Figure 10. VSA 3 and 4. Ellis Brook flowing over a granite ridge. There is a narrow belt of riparian vegetation along the brook. VSA 3 (heath) lies to the right and heath with emergent eucalypts (also VSA 3) to the left**.**

4.3 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations. However, the land swap area contains more heath and thicket than Jarrah/Marri and Wandoo woodland and therefore some fauna reliant upon woodland would be less common. This would include species dependant on hollows such as Black-Cockatoos, possums and some owls. As there were some major drainage lines in the land swap area (e.g. Ellis Brook) it is considered of value to aquatic and wetland fauna. The area would also be more important for granite specialist (some reptiles and invertebrates), and the heaths would be seasonally important for nectar feeding birds and mammals.

4.4 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 4 for descriptions and other ecological processes). These include:

Local hydrology. The land swap area contains several drainage lines as part of Ellis Brook. Some elements of the vegetation, such as the banksias, may be reliant upon groundwater. In addition, the granites close to the surface mean that local sub-surface hydrology is likely to be complex.

Fire. Jarrah woodlands of the Northern Jarrah Forest are fire-adapted but the flora and fauna assemblages can be altered by too-frequent fires; and even by fire exclusion. Fire season may also be important. The land swap area has been burnt in the past and as a result the fauna assemblage has almost certainly been altered by fire. The heaths (VSA 3) that occupy much of the land swap area are probably more sensitive to fire as much of the biomass is close to the ground.

Feral species and interactions with over-abundant native species. The fauna assemblage of the land swap area has already been impacted by feral species (loss of a major component of the mammal fauna), and both feral and domestic herbivores are likely leading to some degradation of native vegetation.

Habitat degradation due to weed invasion. Most of the land swap area has very low levels of weed invasion, in particular, the granite outcrop was more or less pristine (no trampling or disturbance of rocks as occurs where such outcrops can be accessed by the public).

Connectivity and landscape permeability. The land swap area lies on the western end of a larger area of native vegetation running from north to south, and is likely to provide a connectivity function for fauna.

4.5 Summary of fauna values

The desktop study identified 202 vertebrate fauna species as potentially occurring in the land swap area: 6 fish, 13 frogs, 42 reptiles, 108 birds, 23 native and 10 introduced mammals. The vertebrate assemblage includes 35 species of conservation significance, of particular importance and the most likely to heavily use the site being the Forest Red-tailed and Carnaby's Black-Cockatoos.

Fauna values within the land swap area can be summarised as follows:

Fauna assemblage. The assemblage is typical of heathland and woodland located throughout the escarpment, but distinctive because of location on edge of escarpment and presence of granite outcrops. A depauperate fauna assemblage is likely to occur in the more degraded and cleared habitats in the north of the land swap area.

Species of conservation significance. Significant species of note that are likely to occur in the land swap area regularly include the Brush-tailed Phascogale and both the Forest Red-tailed and Carnaby's Black-Cockatoos. The land swap area had a density of 9.6 potential black-cockatoo breeding trees per hectare.

Vegetation and Substrate Associations (VSAs). The land swap area contains open woodland with Jarrah and Marri (VSA 1), open Wandoo woodland (VSA 2), mixed heath on shallow soils over granite (VSA 3) and Ellis Brook with its associated riparian vegetation (VSA 4). Mixed heath (VSA 3) is best-represented in the land swap area.

Patterns of biodiversity. Detailed patterns of biodiversity could not be examined, but it can be predicted that biodiversity will differ across the landscape because of the different proportions of VSAs present. The land swap area is dominated by heath and thickets around granite outcrops with small areas of Jarrah/Marri and Wandoo woodland compared with surrounding areas, and therefore some fauna reliant upon woodland would be uncommon. This would include species dependent on hollows such as Black-Cockatoos, possums and some owls. Ellis Brook is considered of value to aquatic and wetland fauna and the heaths would be seasonally important for nectar feeding birds and mammals. Granite outcrops and heaths may also have associated SRE invertebrate fauna.

Key ecological processes. Main processes currently affecting the fauna assemblage in the land swap area include local hydrology, fire, feral species and connectivity.

5 Conclusion

The land swap area (Banyowla Park) encompasses granite outcrops, heaths, a seasonal stream and some areas of eucalypt woodland and forest; it is typical of landscapes in the immediate region but the presence of the stream and large areas of granite is distinctive. These features are uncommon even along the western edge of the escarpment.

Carnaby's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo are both expected to occur regularly migrants in the area, with some foraging habitat (such as Marri and Jarrah) present. Baudin's Black-Cockatoo is also expected to be at least an occasional visitor to the area as it occurs regularly nearby and suitable foraging habitat is present in the land swap area.

The foraging value of the land swap area for Black-Cockatoos varied from 1-5 (Negligible to Moderate/High). However the large proportion of mixed heath (foraging value 1-2) resulted in an overall foraging value of 2-3 (Low to Low/Moderate). Transect surveys (5.5 km x 50 m wide) found that the land swap area had a density of 9.6 potential breeding trees per hectare; assuming that the area covered by the transects is representative of the total area. The presence of large trees makes the site appear suitable for roosting or breeding by black-cockatoos. It is thus possible that black-cockatoos roost and breed in the land swap area.

Similarly, other conservation significant fauna species such as the Brush-tailed Phascogale, Quenda, Chuditch, Brush Wallaby and Carpet Python are likely to be represented in the adjacent areas and in similar vegetation complexes in the Darling Range.

6 References

Astron (2012a). Gosnells Quarry Desktop Flora, Vegetation and Fauna Survey. Prepared for Holcim (Australia) Pty Ltd, October 2012.

Astron (2012b). Gosnells Quarry Field Flora, Vegetation and Fauna Survey. Prepared for Holcim (Australia) Pty Ltd, October 2012.

Astron (2013) Gosnells Quarry Black-Cockatoo Tree Inspection. Prepared for Holcim (Australia) Pty Ltd, October 2013.

Atlas of Living Australia (2016) Atlas of Living Australia Mapping Tool. http://spatial.ala.org.au/ (Accessed September 2016)

Bamford, M.J. and Moore, A.D. (2014). Targeted Qualitative Black-Cockatoo and Quenda Habitat Assessment - Holcim Gosnells Quarry and adjacent areas. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley.

Bamford, M.J. and Everard, C. (2015). Holcim Gosnells Quarry - Targeted Black-Cockatoo Habitat Assessment. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley.

Bamford, M.J., Moore, A.D. and Chuk, K. (2016). Holcim Gosnells Quarry - Fauna Habitat Assessment of the Stockpile Area. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley

Bamford, M.J., Moore, A.D. and Chuk, K. (2017). Holcim Gosnells Quarry - Fauna Assessment of the proposed quarry expansion area. Unpubl. report to Holcim by Bamford Consulting Ecologists, Kingsley. In progress.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). *The new atlas of Australian birds*. Melbourne: Birds Australia.

Birdlife Australia (2016). Birdata Database. www.birdata.com.au (accessed September 2016).

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). *The Atlas of Australian Birds*. Royal Australasian Ornithologists Union. Melbourne University Press.

Cale, B. (2003). Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) Recovery Plan. Western Australian Threatened Species and Communities Unit, Department of Conservation and Land Management, Wanneroo, Western Australia.

Calver, M., Lymbery, A., McComb, J. and Bamford, M. (2009). *Environmental Biology*. Cambridge University Press, Melbourne.

Churchill, S. (2008). *Australian Bats*. Reed New Holland Press, Sydney.

Davies, S. J. J. F. (1966). The movements of the White-tailed Black-Cockatoos (*Calyptorhynchus baudinii*) in south-western Australia. The Western Australian Naturalist 10: 33-42.

Davis, R. D., Gole, C. and Roberts, J. D. (2012). Impacts of urbanisation on the native avifauna of Perth, Western Australia. Urban Ecosystems 15 (4).

Dell, J. and Banyard, J. (eds). (2000). Bush Forever. Vol. 2. Dept of Environmental Protection, Perth.

DotE. (2014). Key Threatening Processes. http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl (accessed May 2014). Department of the Environment

DotE. (2016). EPBC Protected Matters Search Tool. (Accessed September 2016). Department of the Environment.

DPaW. (2013). Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan October 2013. Prepared by the Department of Parks and Wildlife, Perth, Western Australia.

DPaW. (2016). NatureMap Database. http://naturemap.dec.wa.gov.au/default.aspx (accessed September). Department of Parks and Wildlife

DEP. (2000). Bush Forever Volume 2.Government of Western Australia, Perth. Department of Environmental Protection

DEWHA. (2009a). Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DEWHA. (2009b). Approved Conservation Advice for *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo). Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DEWHA. (2010). Survey guidelines for Australia's threatened birds. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

Doughty, P., Ellis, R.J. & Bray, R. (2016). Checklist of the Amphibians of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

Doughty, P., Ellis, R.J. & Bray, R. (2016). Checklist of the Reptiles of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

DSEWPaC. (2012a). *Calyptorhynchus banksii naso* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/sprat

DSEWPaC. (2012b). *Calyptorhynchus baudinii* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/sprat

DSEWPaC. (2012c). *Calyptorhynchus latirostris* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/sprat

DSEWPaC. (2012d). EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii,* Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso*. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/resource/epbc-act-referral-guidelines-three-threatened-black-cockatoo-species-carnabys-cockatoo

EPA. (2002). Terrestrial Biological surveys as an Element of Biodiversity Protection. Position Statement No. 3. Environmental Protection Authority, Perth, Western Australia.

EPA. (2004). Guidance for the assessment of environmental factors: Terrestrial fauna surveys for environmental impact assessment in Western Australia. No. 56. Environmental Protection Authority, Perth, Western Australia.

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1 - Summary Report. Environment Australia, Department of Environment and Heritage, Canberra, Australian Capital Territory.

ERM (2005). Gosnells Quarry Fauna Survey. Report prepared by Environmental Resources Management Australia, April 2005.

Garnett, S., Szabo, J. and Dutson, G. (2011). *The Action Plan for Australian Birds* 2010.CSIRO Publishing.

Gibbons, P. and Lindenmayer, D. (2002). Tree Hollows and Wildlife Conservation in Australia. CSIRO Publishing, Collingwood, Victoria, Australia.

Groom, C. (2011). Plants Used by Carnaby's Black Cockatoo. Department of Environment and Conservation, Perth, Western Australia.

Harvey, M. (2002). Short-range Endemism amongst the Australian fauna: examples from non-marine environments. *Invertebrate Systematics*, 16: 555-570.

Higgins, P. J. (Ed.) (1999). Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird. Oxford University Press, Melbourne, Australia.

Johnstone, R. E. (2006). Going, going, gone! Veteran and stag trees: a valuable resource. Western Wildlife 10: 6.

Johnstone, R. E and Darnell, J.C. (2016). Checklist of the Birds of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

Johnstone, R.E., Johnstone, C. and Kirkby, T. (2011). Black-cockatoos on the Swan Coastal Plain. Report prepared for the Department of Planning, Western Australia, by the Western Australian Museum, Welshpool, Western Australia.

Johnstone, R.E. and Kirkby, T. (1999). Food of the Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso in south-west Western Australia. The Western Australian Naturalist 22: 167-177.

Johnstone, R.E. and Kirkby, T. (2008). Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (Calyptorhynchus baudinii) in South-west Western Australia. Records of the Western Australian Museum 25: 107-118.

Johnstone, R.E. and Storr, G.M. (1998).*Handbook of Western Australian Birds* Vol 1 – Non-passerines (Emu to Dollarbird).Western Australian Museum, Perth.

Johnstone, R.E. and Storr, G.M. (2004).*Handbook of Western Australian Birds*. Vol 2: Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.

Kabat, A. P., Scott, R., Kabat, T. J. and Barrett, G. (2012). 2011 Great Cocky Count: Population estimates and identification of roost sites for the Carnaby's Cockatoo (Calyptorhynchus latirostris). Report prepared for the Western Australian Department of Environment and Conservation by BirdLife Australia Floreat, Western Australia.

Mace, G. and Stuart, S. (1994). Draft IUCN Red List Categories, Version 2.2.Species; Newsletter of the Species Survival Commission.IUCN - The World Conservation Union. No. 21-22: 13-24.

McKenzie, N. L., May, J. E. and McKenna, S. (2003). Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. The National Land and Water Resources Audit and the Western Australian Department of Conservation and Land Management, Perth, Western Australia.

Menkhorst, P. and Knight, F. (2001). *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.

Saunders, D. A. (1974). Breeding biology of the Short-billed form of the White-tailed Black Cockatoo Calyptorhynchus baudinii latirostris (Carnaby). Emu 74: 292-293.

Saunders, D. A. (1979a). The availability of tree hollows for use as nest sites by White-tailed Black Cockatoos. Australian Wildlife Research 6: 205-216.

Saunders, D. A. (1979b). Distribution and taxonomy of the White-tailed and Yellow-tailed Black-Cockatoos Calyptorhynchus spp. Emu 79.

Saunders, D. A. (1980). Food and movements of the short-billed form of the White-tailed Black Cockatoo. Australian Wildlife Research 7: 257-269.

Saunders, D. A. (1986). Breeding season, nestling success and nestling growth in Carnaby's Black-Cockatoo, Calyptorhynchus funereus latirostris, over 16 years at Coomallo Creek, and a method for assessing the viability of populations in other areas. Australian Wildlife Research 13: 261-273.

Saunders, D. A., Smith, G. T. and Rowley, I. (1982). The availability and dimensions of tree hollows that provide nest sites for cockatoos (Psittaciformes) in Western Australia. Australian Wildlife Research 9: 541-556.

Soule, M. E., Mackey, B. G., Recher, H. F., Williams, J. E., Woinarski, J. C. Z., Driscoll, D., Dennison, W. C. and Jones, M. E. (2004). The role of connectivity in Australian conservation. *Pacific Conservation Biology*10: 266-279.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1983).*Lizards of Western Australia*. II. Dragons and Monitors. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990).*Lizards of Western Australia*. III. Geckoes and Pygopodids. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1999).*Lizards of Western Australia*. I. Skinks. Revised Edition. W.A. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002).*Snakes of Western Australia*. W.A. Museum, Perth.

Thackway, R. and Cresswell, I.D. (1995). *An Interim Biogeographic Regionalisation for Australia: A framework for establishing the national system of reserves, Version 4*.0. Australian Nature Conservation Agency, Canberra.

Travouillon, K. (2016). Checklist of the Mammals of Western Australia. Department of Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia.

Tyler, M.J., Smith, L.A. and Johnstone, R.E. (2000). *Frogs of Western Australia*. W.A. Museum, Perth.

Van Dyck, S. and Strahan, R. (Eds.) (2008).*Mammals of Australia*. 3rd Edition. Australian Museum, Sydney.

Western Australian Museum (2016) Checklists of the Fauna of Western Australia. Unpublished checklist. Western Australian Museum, Perth.

Whitford, K. R. (2001). Dimensions of tree hollows used by birds and mammals in the jarrah forest: improving the dimensional description of potentially usable hollows. Calmscience 3: 499-511.

Whitford, K. R. (2002). Hollows in jarrah (Eucalyptus marginata) and marri (Corymbia calophylla) trees I. Hollow sizes, tree attributes and ages. Forest Ecology and Management 160: 201-214.

Whitford, K. R. and Williams, M. R. (2002). Hollows in jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees II. Selecting trees to retain for hollow dependent fauna. Forest Ecology and Management 160: 215-232.

Williams, K. and Mitchell, D. (2001). Jarrah Forest 1 (JF1 – Northern Jarrah Forest subregion. In: A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions.

Wilson S, Swan G (2008) *A Complete Guide to Reptiles of Australia*. Second edition. New Holland Publishers (Australia), Sydney

7 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.

The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Federal and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Parks and Wildlife (DPaW) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 3.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DPaW but not listed under State or Commonwealth Acts.

In Western Australia, the DPaW has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DPaW feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common)

species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DPaW, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Background information on Black-cockatoos.

Species, ecology, habitat requirements and threats

The three south-western Western Australian taxa of black-cockatoo are listed in Table i. All species are listed under both the Federal Environment Protection and Biodiversity Conservation Act (1999) and the Western Australian Wildlife Conservation Act (1950), as indicated in Table i. These three species are likely to occur in the survey area.

Table i. Black-cockatoos likely to occur in the survey area.

The status of each species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Western Australian Wildlife Conservation Act 1950 (WC Act) is shown.

Species		EPBC Act	WC Act
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable	Schedule 1 (Vulnerable)
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Schedule 1 (Endangered)
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Schedule 1 (Endangered)

There is considerable published information on the ecology of, and threats to, these black-cockatoo species. Key references include:

- Action plans (Garnett *et al*. 2011);
- Recovery plans (DPaW 2013);
- EPBC guidelines (DEWHA 2010; DSEWPaC 2012d);
- Federal listing and conservation advice (DEWHA 2009a, b);
- The federal Department of Sustainability, Environment, Water, Population and Communities' (SEWPaC; formerly DEWHA) Species Profile and Threats (SPRAT) Database (DSEWPaC 2012a, b, c);
- Scientific literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders *et al.* 1982; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008); and
- Major reports (Johnstone *et al.* 2011; Kabat et al. 2012).

Much of this information has been compiled by DSEWPaC (2012a, b, c, d). Summarising this work further, there are several salient points for assessing the potential value of the survey area for black-cockatoos:

Key ecology

- All species are long-lived with low annual reproduction rates and cannot, therefore, rapidly increase their population size.
- Carnaby's and Baudin's Black-Cockatoos undergo regular, seasonal migration between breeding and non-breeding areas.
- Forest Red-tailed Black-Cockatoos are currently considered not to undergo regular migration. In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area.

- In recent years there have been considerable shifts in the breeding ecology, distribution and movement patterns of Forest Red-tailed and Carnaby's Black-Cockatoos. These may be a response to habitat degradation/clearing and/or climatic factors.

Key habitat requirements

- All species are reliant on large tree-hollows in eucalypts, in which they breed. Each species has its own preference for nesting tree species and its own geographical breeding range (although these overlap between species). There is a solid understanding of these preferences (see Table ii for summary).
- All species primarily feed on plant seeds and flowers, but also consume wood-boring insect larvae when available. Each species has its own preference for food plant species (with considerable overlap). There is a solid understanding of these preferences (see Table ii for summary).

Key threats

- Key threatening processes include illegal shooting, habitat loss, habitat degradation, nest hollow shortage, competition for available nest hollows from other parrots and feral Honeybees (*Apis mellifera*), and illegal trade.

Table ii. Plants known to be used for foraging, roosting and nesting by black-cockatoos in south-western Western Australia.

Data compiled from the literature (Davies 1966; Saunders 1974, 1979a, b, 1980; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012a, b, c, d, R. Johnstone pers. comm.).

FRTBC = Forest Red-tailed Black-Cockatoo, CBC = Carnaby's Black-Cockatoo, BBC = Baudin's Black-Cockatoo (see **Error! Reference source not found.** for scientific names).

Plant status: blank = Western Australian native, AN = Australian native (but not naturally occurring in Western Australia), E = exotic (i.e. not native to Australia).

F = foraging, R = roosting, N or n = nesting (main and less commonly used species, respectively).

Plant Species	Plant Status	FRTBC	CBC	BBC
Acacia baileyana (Cootamundra Wattle)	AN		F	
Acacia pentadenia (Karri Wattle)			F	
Acacia saligna (Orange Wattle)			F	
Agonis flexuosa (Peppermint Tree)			F	
Allocasuarina fraseriana (Sheoak)		F		F
Anigozanthos flavidus (Tall Kangaroo Paw)				F
Araucaria heterophylla (Norfolk Island Pine)	E		F	
Banksia ashbyi (Ashby's Banksia)			F	
Banksia attenuata (Slender Banksia)			F	
Banksia baxteri (Baxter's Banksia)			F	
Banksia carlinoides (Pink Dryandra)			F	
Banksia coccinea (Scarlet Banksia)			F	
Banksia dallanneyi (Couch Honeypot Dryandra)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Banksia ericifolia (Heath-leaved Banksia)	AN		F	
Banksia fraseri (Dryandra)			F	
Banksia gardneri (Prostrate Banksia)			F	
Banksia grandis (Bull Banksia)			F	F
Banksia hookeriana (Hooker's Banksia)			F	
Banksia ilicifolia (Holly Banksia)			F	F
Banksia kippistiana (Dryandra)			F	
Banksia leptophylla			F	
Banksia lindleyana (Porcupine Banksia)				F
Banksia littoralis (Swamp Banksia)			F	F
Banksia menziesii (Firewood or Menzie's Banksia)			F	
Banksia mucronulata (Swordfish Dryandra)			F	
Banksia nivea (Honeypot Dryandra)			F	
Banksia nobilis (Golden Dryandra)			F	
Banksia praemorsa (Cut-leaf Banksia)			F	F
Banksia prionotes (Acorn Banksia)			F	
Banksia quercifolia (Oak-leaved Banksia)			F	F
Banksia sessilis (Parrot Bush)			F	F
Banksia speciosa (Showy Banksia)			F	
Banksia squarrosa (Pingle)			F	F
Banksia tricuspis (Lesueur Banskia or Pine Banksia)			F	
Banksia undata (Urchin or Cut-leaf Dryandra)			F	
Banksia verticillata (Granite Banksia)			F	
Brassica campestris (Canola, Rape)	E		F	
Callistemon spp.				F
Callistemon viminalis (Captain Cook Bottlebrush)	AN		F	
Callitris sp.			F	
Carya illnoinensis (Pecan)	E		F	F
Casuarina cunninghamiana (River Sheoak)	AN		F	
Citrullus lanatus (Pie or Afghan Melon)	E		F	
Corymbia calophylla (Marri)		F,N	F,n,R	F,n
Corymbia ficifolia (Red Flowering Gum)			F	
Corymbia haematoxylon (Mountain Marri)			F	
Corymbia maculata (Spotted Gum)			R	
Darwinia citriodora (Lemon-scented Darwinia)	AN		F	F
Diospryros sp. (Sweet Persimmon)	E		F	F
Eremophila glabra (Tarbush)			F	
Erodium aureum (Corkscrew Grass or Storksbill)	E		F	
Erodium botrys (Corkscrew Grass or Storksbill)	E		F	F
Eucalyptus caesia (Silver Princess)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Eucalyptus camaldulensis (River Red Gum)	AN		R	
Eucalyptus citriodora (Lemon Scented Gum)	AN	F	F,R	F
Eucalyptus diversicolor (Karri)		n	n	N
Eucalyptus globulus (Tasmaniam Blue Gum)	AN		R	
Eucalyptus gomphocephala (Tuart)		n	F,n,R	
Eucalyptus grandis (Flooded Gum, Rose Gum)	AN		R	
Eucalyptus longicornis (Red Morrell)			n	
Eucalyptus loxophleba (York Gum)			F,n	
Eucalyptus marginata (Jarrah)		F,N	F,n,R	F
Eucalyptus megacapa (Bullich)		n		n
Eucalyptus occidentalis (Swamp Yate)			n	
Eucalyptus patens (Blackbutt)		F	F,R	
Eucalyptus pleurocarpa (Tallerack)			F	
Eucalyptus preissiana (Bell-fruited Mallee)			F	
Eucalyptus robusta (Swamp Mahogany)			F,R	
Eucalyptus rudis (Flooded Gum)			R	
Eucalyptus salmonophloia (Salmon Gum)			F,N	
Eucalyptus salubris (Gimlet)			n	
Eucalyptus todtiana (Coastal Blackbutt or Prickley Bark)			F	
Eucalyptus wandoo (Wandoo)			F,N,R	F,n
Ficus sp. (Fig)			F	
Grevillea armigera (Prickly Toothbrushes)			F	
Grevillea bipinnatifida (Fuschia Grevillea)			F	
Grevillea hookeriana (Red Toothbrushes)			F	
Grevillea hookeriana subsp. *apiciloba* (Black Toothbrushes)			F	
Grevillea paniculata (Kerosene Bush)			F	
Grevillea paradoxa (Bottlebrush Grevillea)			F	
Grevillea petrophiloides (Pink Poker)			F	
Grevillea robusta (Silky Oak)			F	
Grevillea wilsonii (Native Fuchsia)				F
Hakea auriculata			F	
Hakea candolleana			F	
Hakea circumalata (Coastal Hakea)			F	
Hakea commutata			F	
Hakea conchifolia			F	
Hakea costata (Ribbed Hakea)			F	
Hakea cristata (Snail Hakea)			F	F
Hakea cucullata (Snail Hakea)			F	
Hakea cyclocarpa (Ramshorn)			F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Hakea eneabba			F	
Hakea erinacea (Hedgehog Hakea)			F	F
Hakea falcata (Sickle Hakea)			F	
Hakea flabellifolia (Fan-leaved Hakea)			F	
Hakea gilbertii			F	
Hakea incrassata (Golfball or Marble Hakea)			F	
Hakea lasiantha (Woolly Flowered Hakea)			F	
Hakea lasianthoides			F	F
Hakea laurina (Pin-cushion hakea)			F	
Hakea lissocarpha (Honeybush)			F	F
Hakea marginata				F
Hakea megalosperma (Lesueur Hakea)			F	
Hakea multilineata (Grass Leaf Hakea)			F	
Hakea obliqua (Needles and Corks)			F	
Hakea oleifolia (Dungyn or Olive-leaved Hakea)			F	
Hakea pandanicarpa subsp. *crassifolia* (Thick-leaved Hakea)			F	
Hakea petiolaris (Sea Urchin Hakea)			F	
Hakea polyanthema			F	
Hakea preissii (Needle Tree)			F	
Hakea prostrata (Harsh Hakea)			F	F
Hakea psilorrhyncha			F	
Hakea ruscifolia (Candle Hakea)			F	F
Hakea scoparia (Kangaroo Bush)			F	
Hakea smilacifolia			F	
Hakea spathulata			F	
Hakea stenocarpa (Narrow-fruited Hakea)			F	F
Hakea sulcata (Furrowed Hakea)			F	
Hakea trifurcata (Two-leaved Hakea)			F	F
Hakea undulata (Wavy-leaved Hakea)			F	
Hakea varia (Variable-leaved Hakea)			F	F
Helianthus annuus (Sunflower)	E		F	
Hibiscus sp. (Hibiscus)	E		F	
Isopogon scabriusculus			F	
Jacaranda mimosifolia (Jacaranda)	E		F	F
Jacksonia furcellata (Grey Stinkwood)			F	
Kingia australis (Kingia)				F
Lambertia inermis (Chittick)			F	
Lambertia multiflora (Many-flowered Honeysuckle)			F	
Liquidamber styraciflua (Liquid Amber)	E		F	

Plant Species	Plant Status	FRTBC	CBC	BBC
Lupinus sp. (Lupin)	E		F	
Macadamia integrifolia (Macadamia)	E		F	F
Malus domestica (Apple)	E		F	F
Melaleuca leuropoma			F	
Melia azedarach (Cape Lilac or White Cedar)	E	F	F	
Mesomeleana sp.			F	
Persoonia longifolia (Snottygobble)		F		
Pinus canariensis (Canary Island Pine)	E		F	
Pinus caribea (Caribbean Pine)	E		F	
Pinus pinaster (Pinaster or Maritime Pine)	E		F,R	
Pinus radiata (Radiata Pine)	E		F,R	F
Protea 'Pink Ice'	E		F	
Protea repens	E		F	
Prunus amygdalus (Almond Tree)	E		F	
Pyrus communis (European Pear)	E			F
Quercus spp. (Oak spp.)	E			F
Raphanus raphanistrum (Wild Radish)	E		F	
Reedia spathacea				F
Tipuana tipu (Tipu or Rosewood Tree)	E		F	
Xanthorrhoea preissii (Grass Tree)			F	F

Nesting tree size and hollow dimensions

Black-cockatoos require tree hollows that have an entrance diameter of more than 100 mm (Whitford 2001). Internal dimensions may be more important than entrance diameter, although these are much more difficult to assess (Whitford 2001; Gibbons and Lindenmayer 2002; Whitford and Williams 2002). For Forest Red-tailed Black-Cockatoos, the minimum height of a nesting hollow was 4.4 m above the ground (Whitford 2001). The minimum diameter at breast height (DBH) of a nesting tree was 608 mm and the minimum age of an actual nesting tree was 214 years (Whitford 2002). In the study by Whitford and Williams (2002) the youngest tree to bear a hollow that was potentially suited to Forest Red-tailed Black-Cockatoos was 131 years (although this was not used). In general, hollows of sufficient size to support black-cockatoos do not form until trees at least 230 years old, and the majority of nests are found in 300-500 year old trees (Johnstone 2006).

DSEWPaC (2012a, b, c, d) recommend that surveys for potential hollow-bearing trees should identify trees greater than 500 mm DBH (to include trees that are likely to become hollow-bearing in the next 50 years).

Appendix 3. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Wildlife Conservation Act 1950*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Wildlife Conservation Act 1950*

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Parks and Wildlife Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4.	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5.	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 20 key threatening processes listed by the federal Department of the Environment (DotE 2014):

- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha).
- Predation by feral cats.

- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, DSEWPaC has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

Appendix 5. Fauna expected to occur in the land swap area (Table 10 to Table 15).

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. Results do not include returned marine species. Data sources are:

- Naturemap = Naturemap Database, searched September 2016;
- BA = Birdlife Australia's Birdata database, searched September 2016;
- EPBC = EPBC Protected Matters Search, searched September 2016;
- BCE 2015 = Previous investigations at Holcim Quarry (Bamford and Everard 2015) and other BCE records from sites in the region;
- BCE 2016 = Current field investigation, September 2016.

Status codes:

- Cons. Status: CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 3 for full explanation. Details on species of conservation significance are given in Table 6.
- Int: introduced.

Table 10. Fish species expected to occur in the land swap area.

English name	Latin name	Cons. status	Int	Expected status in land swap area	Database and survey records				
					ALA	Nat Map	EPBC	BCE 2015	BCE 2016
GEOTRIIDAE									
Pouched Lamprey	*Geotria australis*	CS2		Visitor				X	
NANNOPERCIDAE									
Nightfish	*Bostockia porosa*			Visitor	X	X			
Western Pygmy-perch	*Edelia vittata*			Visitor	X	X			
GALAXIIDAE									
Western Minnow	*Galaxias occidentalis*			Visitor	X	X			
PLOTOCIDAE									
Freshwater Cobbler	*Tandanus bostocki*			Visitor	X	X			
POECILIIDAE									
Mosquitofish	*Gambusia holbrooki*		X	Visitor		X			
Total Number of Species Expected:	**6**	**1**	**1**		**4**	**5**	**0**	**1**	**0**

NB. Pouched Lamprey record from a tributary of the Canning River in Roleystone in 1970. Species may now be extinct in the Swan/Canning system.

Table 11. Frog species expected to occur in the land swap area.

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
HYLIDAE									
Slender Tree Frog	*Litoria adelaidensis*			Resident/visitor	X	X			
Motorbike Frog	*Litoria moorei*			Resident/visitor	X	X			
MYOBATRACHIDAE									
Quacking Frog	*Crinia georgiana*			Resident/regular visitor	X	X			
Glauert's Froglet	*Crinia glauerti*			Resident/regular visitor	X	X			
Squelching Froglet	*Crinia insignifera*			Resident/regular visitor	X	X			
Bleating Froglet	*Crinia pseudinsignifera*			Resident/regular visitor	X	X			
Lea's Frog	*Geocrinia leai*			Resident/regular visitor	X	X			
Western Marsh Frog	*Heleioporus barycragus*			Resident/regular visitor	X	X			
Moaning Frog	*Heleioporus eyrei*			Resident/regular visitor	X	X			
Chocolate Frog	*Heleioporus inornatus*			Resident/regular visitor	X	X			
Sand Frog	*Heleioporus psammophilus*			Resident/regular visitor	X	X			
Banjo Frog	*Limnodynastes dorsalis*			Resident/regular visitor	X	X			
Gunther's Toadlet	*Pseudophryne guentheri*			Resident/regular visitor	X	X			
Total Number of Species Expected:	**13**	**0**	**0**		**13**	**13**	**0**	**0**	**0**

Table 12. Reptile species expected to occur in the land swap area.

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
CHELIDAE									
South-West Long-necked Tortoise	*Chelodina colliei*			Visitor	X	X			
AGAMIDAE									
Ornate Dragon	*Ctenophorus ornatus*			Resident	X	X			
Dwarf Bearded Dragon	*Pogona minor*			Resident	X	X			
DIPLODACTYLIDAE									
Clawless Gecko	*Crenadactylus ocellatus*			Resident		X			
	Diplodactylus granariensis			Resident		X			
Speckled Stone Gecko	*Diplodactylus lateroides*			Resident	X				
Soft Spiny-tailed Gecko	*Strophurus spinigerus*			Resident	X	X			
CARPHODACTYLIDAE									
Barking Gecko	*Underwoodisaurus milii*			Resident	X	X			
GEKKONIDAE									
Marbled Gecko	*Christinus marmoratus*			Resident	X	X			
Tree Dtella	*Gehyra variegata*			Resident	X	X			
PYGOPODIDAE									
Granite Worm-lizard	*Aprasia pulchella*			Resident	X	X			
Fraser's Delma	*Delma fraseri*			Resident	X	X			
Burton's Snake-lizard	*Lialis burtonis*			Resident	X	X			
Common Scaly-foot	*Pygopus lepidopodus*			Resident	X	X			
SCINCIDAE									
Western Three-lined Skink	*Acritoscincus trilineatus*			Resident	X	X			
Buchanan's Snake-eyed Skink	*Cryptoblepharus buchananii*			Resident	X	X			

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
Darling Range South-west Ctenotus	*Ctenotus delli*	CS2		Resident	X	X			
Odd-striped Ctenotus	*Ctenotus impar*			Resident	X	X			
Common South-west Ctenotus	*Ctenotus labillardieri*			Resident	X	X			
King's Skink	*Egernia kingii*			Resident	X	X			
South-western Crevice-skink	*Egernia napoleonis*			Resident	X	X			
	Hemiergis initialis			Resident		X			
South-western Orange-tailed Slider	*Lerista distinguenda*			Resident	X	X			
Common Dwarf Skink	*Menetia greyii*			Resident	X	X			
Shrubland Morethia Skink	*Morethia obscura*			Resident	X	X			
Bobtail	*Tiliqua rugosa*			Resident	X	X			X
VARANIDAE									
Gould's Goanna	*Varanus gouldii*			Resident	X	X			
Heath Monitor	*Varanus rosenbergi*			Resident	X	X			
Black-headed Monitor	*Varanus tristis*				X	X			
TYPHLOPIDAE									
Southern Blind Snake	*Anilios australis*			Resident	X				
Fat Blind Snake	*Anilios pinguis*			Resident	X				
BOIDAE									
Stimson's Python	*Antaresia stimsoni*			Resident		X			
Carpet Python	*Morelia spilota imbricata*	CS3		Resident		X			
ELAPIDAE									
Common Death Adder	*Acanthophis antarcticus*	CS2		Resident	X	X			
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*			Resident	X	X			
Yellow-faced Whip Snake	*Demansia psammophis*			Resident	X	X			

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Database and survey records				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
Bardick	*Echiopsis curta*			Resident	X	X			
Western Crowned Snake	*Elapognathus coronatus*			Resident	X	X			
Tiger Snake	*Notechis scutatus*			Resident	X	X			
Gould's Hooded Snake	*Parasuta gouldii*			Resident	X	X			
Mitchell's Short-tailed Snake	*Parasuta nigriceps*			Resident	X	X			
Dugite	*Pseudonaja affinis*			Resident		X			
Total Number of Species Expected:	**42**	**3**			**37**	**40**	**0**	**0**	**1**

Table 13. Bird species expected to occur in the land swap area.

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
CASUARIIDAE										
Emu	*Dromaius novaehollandiae*			Irregular visitor	X	X		X		
ANATIDAE										
Pacific Black Duck	*Anas superciliosa*			Resident		X		X		X
RALLIDAE										
Eurasian Coot	*Fulica atra*			Resident	X	X		X		X
COLUMBIDAE										
Rock Dove	*Columba livia*		X	Irregular visitor	X	X	X			X
Crested Pigeon	*Ocyphaps lophotes*			Irregular visitor	X	X		X		
Common Bronzewing	*Phaps chalcoptera*			Resident	X	X		X	X	X
Brush Bronzewing	*Phaps elegans*			Visitor	X	X		X		
Spotted Dove	*Streptopelia chinensis*		X	Irregular visitor	X	X	X	X		
Laughing Dove	*Streptopelia senegalensis*		X	Irregular visitor	X	X	X	X		
CUCULIDAE										
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			Migrant	X	X		X		
Pallid Cuckoo	*Cacomantis pallidus*			Migrant	X	X		X		
Horsfield's Bronze-Cuckoo	*Chalcites basalis*			Migrant	X			X		
Shining Bronze-Cuckoo	*Chalcites lucidus*			Migrant	X	X		X		X
PODARGIDAE										

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
Tawny Frogmouth	*Podargus strigoides*			Resident	X	X		X		
CAPRIMULGIDAE										
Spotted Nightjar	*Eurostopodus argus*			Migrant	X	X		X		
AEGOTHELIDAE										
Australian Owlet-nightjar	*Aegotheles cristatus*			Resident	X	X		X		
APODIDAE										
Fork-tailed Swift	*Apus pacificus*	CS1		Migrant	X		X	X		
TURNICIDAE										
Painted Button-quail	*Turnix varius*	CS3		Resident	X	X		X		
Little Button-quail	*Turnix velox*			Irregular visitor				X		
ACCIPITRIDAE										
Collared Sparrowhawk	*Accipiter cirrocephalus*			Resident	X	X		X		
Brown Goshawk	*Accipiter fasciatus*			Resident	X	X		X		
Wedge-tailed Eagle	*Aquila audax*			Resident	X	X		X	X	
Black-shouldered Kite	*Elanus axillaris*			Irregular visitor	X	X		X		
Whistling Kite	*Haliastur sphenurus*			Visitor	X	X		X		
Little Eagle	*Hieraaetus morphnoides*			Visitor	X	X		X		
Square-tailed Kite	*Lophoictinia isura*			Migrant	X	X		X		X
FALCONIDAE										
Brown Falcon	*Falco berigora*			Visitor	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
Nankeen Kestrel	*Falco cenchroides*			Visitor	X	X		X		
Australian Hobby	*Falco longipennis*			Resident		X		X		
Peregrine Falcon	*Falco peregrinus*	CS1		Resident	X	X		X		
TYTONIDAE										
Barn Owl	*Tyto alba*			Visitor	X	X		X		
Masked Owl	*Tyto novaehollandiae*	CS2		Irregular visitor	X			X		
STRIGIDAE										
Southern Boobook	*Ninox boobook*			Resident	X	X		X		
Barking Owl	*Ninox connivens*	CS2		Irregular visitor	X	X		X		
MEROPIDAE										
Rainbow Bee-eater	*Merops ornatus*	CS1		Migrant	X	X	X	X		
HALCYONIDAE										
Laughing Kookaburra	*Dacelo novaeguineae*		X	Resident	X	X		X		X
Sacred Kingfisher	*Todiramphus sanctus*			Migrant	X	X		X		
CACATUIDAE										
Sulphur-crested Cockatoo	*Cacatua galerita*		X	Irregular visitor	X	X		X		
Western Corella	*Cacatua pastinator*			Vagrant	X	X		X		
Little Corella	*Cacatua sanguinea*		X	Irregular visitor		X		X		
Long-billed Corella	*Cacatua tenuirostris*		X	Irregular visitor	X	X		X		
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*	CS1		Resident	X	X	X	X		

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	CS1		Migrant	X	X	X	X		
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1		Migrant	X	X	X	X		
Galah	*Eolophus roseicapilla*			Resident	X	X		X	X	X
PSITTACIDAE										
Australian Ringneck	*Barnardius zonarius*			Resident	X	X		X		X
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*			Irregular visitor	X	X		X		
Elegant Parrot	*Neophema elegans*			Visitor	X	X		X		
Western Rosella	*Platycercus icterotis*			Visitor	X	X		X		X
Regent Parrot	*Polytelis anthopeplus*			Irregular visitor	X			X		
Red-capped Parrot	*Purpureicephalus spurius*			Resident	X	X		X	X	X
Rainbow Lorikeet	*Trichoglossus moluccanus*		X	Visitor	X	X		X		
CLIMACTERIDAE										
Rufous Treecreeper	*Climacteris rufus*	CS3		Irregular visitor	X	X		X		
MALURIDAE										
Red-winged Fairy-wren	*Malurus elegans*	CS3		Visitor	X	X		X		
Splendid Fairy-wren	*Malurus splendens*	CS3		Resident	X	X		X	X	X
Southern Emu-wren	*Stipiturus malachurus*	CS3		Resident	X	X		X		
ACANTHIZIDAE										
Inland Thornbill	*Acanthiza apicalis*	CS3		Resident		X		X		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
Western Thornbill	*Acanthiza inornata*	CS3		Resident	X	X		X		
Western Gerygone	*Gerygone fusca*			Resident	X	X		X		
White-browed Scrubwren	*Sericornis frontalis*	CS3		Resident	X	X		X	X	X
Weebill	*Smicrornis brevirostris*			Resident	X	X		X	X	X
PARDALOTIDAE										
Spotted Pardalote	*Pardalotus punctatus*			Resident	X	X		X		X
Striated Pardalote	*Pardalotus striatus*			Resident	X	X		X	X	X
MELIPHAGIDAE										
Western Spinebill	*Acanthorhynchus superciliosus*			Resident	X	X		X	X	
Red Wattlebird	*Anthochaera carunculata*			Resident	X	X		X	X	
Western Wattlebird	*Anthochaera lunulata*			Resident	X	X		X		X
Singing Honeyeater	*Gavicalis virescens*			Irregular visitor	X			X		
Tawny-crowned Honeyeater	*Glyciphila melanops*			Visitor	X	X		X		X
Brown Honeyeater	*Lichmera indistincta*			Resident	X	X		X	X	X
Yellow-throated Miner	*Manorina flavigula*			Visitor	X	X		X		
Brown-headed Honeyeater	*Melithreptus brevirostris*			Resident						
Gilbert's (White-naped) Honeyeater	*Melithreptus chloropsis*			Resident						
Yellow-plumed Honeyeater	*Ptilotula ornata*			Visitor						
White-cheeked Honeyeater	*Phylidonyris niger*			Resident	X	X		X	X	X
New Holland Honeyeater	*Phylidonyris novaehollandiae*			Resident	X	X		X		X

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
NEOSITTIDAE										
Varied Sittella	*Daphoenositta chrysoptera*			Resident	X	X		X		
CAMPEPHAGIDAE										
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			Visitor	X	X		X		X
White-winged Triller	*Lalage tricolor*			Migrant	X			X		
PACHYCEPHALIDAE										
Grey Shrike-thrush	*Colluricincla harmonica*	CS3		Resident	X	X		X		X
Crested Shrike-tit	*Falcunculus frontatus*	CS3		Visitor	X					
Western Whistler	*Pachycephala occidentalis*			Resident	X	X		X		X
Rufous Whistler	*Pachycephala rufiventris*			Resident	X	X		X	X	
ARTAMIDAE										
Black-faced Woodswallow	*Artamus cinereus*			Resident		X		X		
Dusky Woodswallow	*Artamus cyanopterus*			Resident	X	X		X	X	X
Australian Magpie	*Cracticus tibicen*			Resident	X	X		X	X	
Grey Butcherbird	*Cracticus torquatus*			Resident	X	X		X		
Grey Currawong	*Strepera versicolor*			Resident	X	X		X		
RHIPIDURIDAE										
Grey Fantail	*Rhipidura fuliginosa*			Resident	X	X		X	X	X
Willie Wagtail	*Rhipidura leucophrys*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
CORVIDAE										
Australian Raven	*Corvus coronoides*			Resident		X		X		X
MONARCHIDAE										
Magpie-lark	*Grallina cyanoleuca*			Resident	X	X		X		
Restless Flycatcher	*Myiagra inquieta*			Visitor	X	X		X		
PETROICIDAE										
White-breasted Robin	*Eopsaltria georgianus*	CS3		Visitor	X	X		X		
Western Yellow Robin	*Eopsaltria griseogularis*	CS3		Visitor	X	X		X		
Hooded Robin	*Melanodryas cucullata*	CS3		Irregular visitor	X			X		
Red-capped Robin	*Petroica goodenovii*	CS3		Visitor	X	X		X		
Scarlet Robin	*Petroica multicolor*	CS3		Resident	X	X		X		
LOCUSTELLIDAE										
Rufous Songlark	*Cincloramphus mathewsi*			Migrant	X	X		X		
HIRUNDINIDAE										
White-backed Swallow	*Cheramoeca leucosterna*			Irregular visitor				X		
Fairy Martin	*Hirundo ariel*			Vagrant	X			X		
Welcome Swallow	*Hirundo neoxena*			Migrant	X	X		X		
Tree Martin	*Hirundo nigricans*			Migrant	X	X		X		X
NECTARINIIDAE										
Mistletoebird	*Dicaeum hirundinaceum*			Resident	X	X		X		

English name	Latin name	Cons Status	Int	Expected status in land swap area	Database and survey records					
					ALA	Nat map	EPBC	BA	BCE 2015	BCE 2016
ESTRILDIDAE										
Red-browed Finch	*Neochmia temporalis*		X	Irregular visitor	X	X		X		
Red-eared Firetail	*Stagonopleura oculata*	CS3		Visitor	X	X		X		X
MOTACILLIDAE										
Australasian Pipit	*Anthus novaeseelandiae*			Irregular visitor	X			X		
ZOSTEROPIDAE										
Silvereye	*Zosterops lateralis*			Resident	X	X		X	X	X
Total Number of Species Expected:	**108**	**24**	**8**		**100**	**95**	**8**	**105**	**17**	**30**

Table 14. Mammal species expected to occur in the land swap area.

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
TACHYGLOSSIDAE									
Short-beaked Echidna	*Tachyglossus aculeatus*			Resident	X	X		X	X
DASYURIDAE									
Mardo	*Antechinus flavipes*			Resident		X			
Chuditch	*Dasyurus geoffroii*	V S3		Resident		X	X		
Brush-tailed Phascogale	*Phascogale tapoatafa*	S3		Resident		X			
Gilbert's Dunnart	*Sminthopsis gilberti*			Resident	X	X			
BURRAMYIDAE									
Western Pygmy-possum	*Cercartetus concinnus*			Resident	X	X			
TARSIPEDIDAE									
Honey Possum	*Tarsipes rostratus*			Resident	X	X			
MACROPODIDAE									
Western Grey Kangaroo	*Macropus fuliginosus*			Resident	X	X		X	X
Brush Wallaby	*Notamacropus irma*	P4		Resident	X	X			
Quokka	*Setonix brachyurus*	V S3		Vagrant		X	X		
PHALANGERIDAE									
Common Brushtail Possum	*Trichosurus vulpecula*			Resident	X	X			
PERAMELIDAE									
Quenda	*Isoodon obesulus*	P4		Resident	X	X		X	

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
MOLLOSIDAE									
White-striped Bat	*Austronomus australis*			Resident	X				
	Mormopterus kitcheneri			Resident	X	X			
VESPERTILIONIDAE									
Gould's Wattled Bat	*Chalinolobus gouldii*			Resident	X	X			
Chocolate Wattled Bat	*Chalinolobus morio*			Resident				X	
Western False Pipistrelle	*Falsistrellus mackenziei*	P4		Resident				X	
Greater Long-eared Bat	*Nyctophilus major*			Resident				X	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			Resident		X			
Gould's Long-eared Bat	*Nyctophilus gouldi*			Resident	X	X			
Southern Forest Bat	*Vespadelus regulus*			Resident	X	X			
MURIDAE									
Rakali	*Hydromys chrysogaster*	P4		Visitor	X	X			
Bush Rat	*Rattus fuscipes*			Resident					
INTRODUCED MAMMALS									
BOVIDAE									
Cattle	*Bos taurus*		X	Visitor			X		
Goat	*Capra hircus*		X	Irregular visitor			X		
CANIDAE									
Dog	*Canis lupus familiaris*		X	Visitor			X		
Fox	*Vulpes vulpes*		X	Resident	X	X	X		

English name	Latin name	Cons Status	Int.	Expected status in land swap area	Records from databases and surveys				
					ALA	Nat map	EPBC	BCE 2015	BCE 2016
FELIDAE									
Cat	*Felis catus*		X	Resident	X	X	X		
LEPORIDAE									
Rabbit	*Oryctolagus cuniculus*		X	Resident			X	X	X
MURIDAE									
House Mouse	*Mus musculus*		X	Resident	X	X	X		
Brown Rat	*Rattus norvegicus*		X	Vagrant			X		
Black Rat	*Rattus rattus*		X	Resident	X	X	X		
SUIDAE									
Pig	*Sus scrofa*		X	Visitor			X		
Total Number of Species Expected:	**33**	**7**	**10**		**16**	**21**	**12**	**7**	**3**

Table 15. Mammal species which are locally extinct in the land swap area.

Species		CS	ALA	N	EPBC	BA
MYRMECOBIIDAE						
Numbat	*Myrmecobius fasciatus*	V S2		X		
PSEUDOCHEIRIDAE						
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S2		X	X	
POTOROIDAE						
Woylie	*Bettongia penicillata subsp. ogilbyi*	E S1		X	X	
Boodie	*Bettongia lesueur*	Ex V S4 S6				
MACROPODIDAE						
Tammar Wallaby	*Macropus eugenii*	P4				
Total Number of Species:	**5**	**5**	**0**	**3**	**2**	**0**

Appendix 6. Vertebrate species returned in database searches but unlikely to be found in the land swap area.

Database searches can include species found nearby but that are unlikely to be present in the survey area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors, out-of-date Latin names, zoo specimens and subtleties of distribution that are not recognised in databases. All of the species listed below are considered unlikely to be found in the survey area (note some birds could occur as vagrants).

Table 16. Species returned in database searches which are unlikely to occur in the land swap area.

Species	
FISH	
Common Silver-biddy	*Gerres oyena*
	Hemiramphus robustus
Porbeagle	*Lamna nasus*
Reef Manta Ray	*Manta alfredi*
Giant Manta Ray	*Manta birostris*
	Urocampus carinirostris
AMPHIBIANS	
Turtle Frog	*Myobatrachus gouldii*
REPTILES	
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Leatherback Turtle	*Dermochelys coriacea*
Flatback Turtle	*Natator depressus*
Western Heath Dragon	*Ctenophorus adelaidensis*
South Coast Gecko	*Diplodactylus calcicolus*
Spotted Sandplain Gecko	*Diplodactylus polyophthalmus*
Fine-faced Gecko	*Diplodactylus pulcher*
House Gecko	*Hemidactylus frenatus*
Sand-plain Worm-lizard	*Aprasia repens*
Side-barred Delma	*Delma grayii*
Keeled Legless Lizard	*Pletholax gracilis*
Inland Snake-eyed Skink	*Cryptoblepharus australis*
Metallic Snake-eyed Skink	*Cryptoblepharus metallicus*
Peron's Snake-eyed Skink	*Cryptoblepharus plagiocephalus*
Tawny Snake-eyed Skink	*Cryptoblepharus ruber*
	Ctenotus fallens
Bar-shouldered Ctenotus	*Ctenotus inornatus*
	Ctenotus ora

Species	
Two-toed Earless Skink	*Hemiergis quadrilineata*
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Elegant Slider	*Lerista elegans*
Perth Slider	*Lerista lineata*
West Coast Morethia Skink	*Morethia lineoocellata*
Western Blue-tongue	*Tiliqua occipitalis*
Flowerpot Blind Snake	*Anilios braminus*
Beaked Blind Snake	*Anilios waitii*
Black-naped Snake	*Neelaps bimaculatus*
Black-striped Snake	*Neelaps calonotos*
Mulga Snake	*Pseudechis australis*
Jan's Banded Snake	*Simoselaps bertholdi*
BIRDS	
Malleefowl	*Leipoa ocellata*
Canada Goose	*Branta canadensis*
Plumed Whistling-Duck	*Dendrocygna eytoni*
Greylag Goose	*Anser anser*
Muscovy Duck	*Cairina moschata*
Chestnut Teal	*Anas castanea*
Grey Teal	*Anas gracilis*
Northern Mallard	*Anas platyrhynchos*
Pacific Black Duck	*Anas superciliosa*
Hardhead	*Aythya australis*
Musk Duck	*Biziura lobata*
Australian Wood Duck	*Chenonetta jubata*
Black Swan	*Cygnus atratus*
Pink-eared Duck	*Malacorhynchus membranaceus*
Blue-billed Duck	*Oxyura australis*
Australasian Shoveler	*Spatula rhynchotis*
Freckled Duck	*Stictonetta naevosa*
Australian Shelduck	*Tadorna tadornoides*
Indian Peafowl	*Pavo cristatus*
Red Junglefowl	*Gallus gallus*
Stubble Quail	*Coturnix pectoralis*
Brown Quail	*Coturnix ypsilophora*
Great Crested Grebe	*Podiceps cristatus*

Species	
Hoary-headed Grebe	*Poliocephalus poliocephalus*
Australasian Grebe	*Tachybaptus novaehollandiae*
Diamond Dove	*Geopelia cuneata*
Black-eared Cuckoo	*Chrysococcyx osculans*
White-throated Needletail	*Hirundapus caudacutus*
Australian Pied Oystercatcher	*Haematopus longirostris*
Eurasian Coot	*Fulica atra*
Dusky Moorhen	*Gallinula tenebrosa*
Buff-banded Rail	*Gallirallus philippensis*
Purple Swamphen	*Porphyrio porphyrio*
Australian Spotted Crake	*Porzana fluminea*
Baillon's Crake	*Porzana pusilla*
Spotless Crake	*Porzana tabuensis*
Black-tailed Native-hen	*Tribonyx ventralis*
Banded Stilt	*Cladorhynchus leucocephalus*
Black-winged Stilt	*Himantopus leucocephalus*
Red-necked Avocet	*Recurvirostra novaehollandiae*
Little Ringed Plover	*Charadrius dubius*
Greater Sand Plover	*Charadrius leschenaultii*
Hooded Plover	*Charadrius rubricollis*
Red-capped Plover	*Charadrius ruficapillus*
Black-fronted Dotterel	*Elseyornis melanops*
Red-kneed Dotterel	*Erythrogonys cinctus*
Pacific Golden Plover	*Pluvialis fulva*
Grey Plover	*Pluvialis squatarola*
Masked Lapwing	*Vanellus miles*
Banded Lapwing	*Vanellus tricolor*
Common Sandpiper	*Actitis hypoleucos*
Ruddy Turnstone	*Arenaria interpres*
Sharp-tailed Sandpiper	*Calidris acuminata*
Red Knot	*Calidris canutus*
Curlew Sandpiper	*Calidris ferruginea*
Pectoral Sandpiper	*Calidris melanotos*
Little Stint	*Calidris minuta*
Ruff	*Calidris pugnax*
Red-necked Stint	*Calidris ruficollis*
Long-toed Stint	*Calidris subminuta*

Species	
Swinhoe's Snipe	*Gallinago megala*
Pin-tailed Snipe	*Gallinago stenura*
Bar-tailed Godwit	*Limosa lapponica*
Black-tailed Godwit	*Limosa limosa*
Eastern Curlew	*Numenius madagascariensis*
Little Curlew	*Numenius minutus*
Wood Sandpiper	*Tringa glareola*
Common Greenshank	*Tringa nebularia*
Marsh Sandpiper	*Tringa stagnatilis*
Australian Painted Snipe	*Rostratula australis*
Australian Pelican	*Pelecanus conspicillatus*
Great Egret	*Ardea alba*
Intermediate Egret	*Ardea intermedia*
White-necked Heron	*Ardea pacifica*
Australasian Bittern	*Botaurus poiciloptilus*
Cattle Egret	*Bubulcus ibis*
Little Egret	*Egretta garzetta*
White-faced Heron	*Egretta novaehollandiae*
Eastern Reef Egret	*Egretta sacra*
Australian Little Bittern	*Ixobrychus dubius*
Black Bittern	*Ixobrychus flavicollis*
Nankeen Night-Heron	*Nycticorax caledonicus*
Yellow-billed Spoonbill	*Platalea flavipes*
Royal Spoonbill	*Platalea regia*
Glossy Ibis	*Plegadis falcinellus*
Australian White Ibis	*Threskiornis moluccus*
Straw-necked Ibis	*Threskiornis spinicollis*
Little Pied Cormorant	*Microcarbo melanoleucos*
Great Cormorant	*Phalacrocorax carbo*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Pied Cormorant	*Phalacrocorax varius*
Australasian Darter	*Anhinga novaehollandiae*
Whiskered Tern	*Chlidonias hybrida*
White-winged Black Tern	*Chlidonias leucopterus*
Silver Gull	*Chroicocephalus novaehollandiae*
Australian Gull-billed Tern	*Gelochelidon macrotarsa*
Caspian Tern	*Hydroprogne caspia*

Species	
Crested Tern	*Thalasseus bergii*
Amsterdam Albatross	*Diomedea amsterdamensis*
Grey-headed Albatross	*Diomedea chrysostoma*
Southern Royal Albatross	*Diomedea epomophora*
Wandering Albatross	*Diomedea exulans*
Northern Royal Albatross	*Diomedea sanfordi*
Shy Albatross	*Thalassarche cauta*
Campbell Albatross	*Thalassarche impavida*
Black-browed Albatross	*Thalassarche melanophris*
White-capped Albatross	*Thalassarche steadi*
Southern Giant Petrel	*Macronectes giganteus*
Northern Giant Petrel	*Macronectes halli*
Kerguelen Petrel	*Pterodroma brevirostris*
White-headed Petrel	*Pterodroma lessonii*
Great-winged Petrel	*Pterodroma macroptera*
Fairy Prion	*Pachyptila turtur*
Australian Lesser Noddy	*Anous tenuirostris*
Black-faced Cormorant	*Phalacrocorax fuscescens*
Swamp Harrier	*Circus approximans*
Spotted Harrier	*Circus assimilis*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Letter-winged Kite	*Elanus scriptus*
Black-breasted Buzzard	*Hamirostra melanosternon*
Black Kite	*Milvus migrans*
Osprey	*Pandion haliaetus*
Australian Bustard	*Ardeotis australis*
Bush Stone-curlew	*Burhinus grallarius*
Major Mitchell's Cockatoo	*Cacatua leadbeateri*
Cockatiel	*Nymphicus hollandicus*
Budgerigar	*Melopsittacus undulatus*
Rock Parrot	*Neophema petrophila*
Scarlet-chested Parrot	*Neophema splendida*
Superb Parrot	*Polytelis swainsonii*
Ring-necked Parakeet	*Psittacula krameri*
Variegated Fairy-wren	*Malurus lamberti*
White-winged Fairy-wren	*Malurus leucopterus*
Blue-breasted Fairy-wren	*Malurus pulcherrimus*

Species	
Western Bristlebird	*Dasyornis longirostris*
Brown Thornbill	*Acanthiza pusilla*
Chestnut-rumped Thornbill	*Acanthiza uropygialis*
Redthroat	*Pyrrholaemus brunneus*
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*
White-fronted Chat	*Epthianura albifrons*
Lewin's Honeyeater	*Meliphaga lewinii*
White-naped Honeyeater	*Melithreptus lunatus*
White-eared Honeyeater	*Nesoptilotis leucotis*
White-fronted Honeyeater	*Purnella albifrons*
Black Honeyeater	*Sugomel niger*
White-browed Babbler	*Pomatostomus superciliosus*
Chestnut Quail-thrush	*Cinclosoma castanotum*
Ground Cuckoo-shrike	*Coracina maxima*
Masked Woodswallow	*Artamus personatus*
Pied Butcherbird	*Cracticus nigrogularis*
Little Crow	*Corvus bennetti*
Jacky Winter	*Microeca fascinans*
Brown Songlark	*Cincloramphus cruralis*
Little Grassbird	*Megalurus gramineus*
Australian Reed-Warbler	*Acrocephalus australis*
Chestnut-breasted Mannikin	*Lonchura castaneothorax*
Zebra Finch	*Taeniopygia guttata*
House Sparrow	*Passer domesticus*
Eurasian Tree Sparrow	*Passer montanus*
European Goldfinch	*Carduelis carduelis*
Grey Wagtail	*Motacilla cinerea*
Indian Myna	*Acridotheres tristis*
Common Starling	*Sturnus vulgaris*
Common Blackbird	*Turdus merula*
MAMMALS	
Grey-bellied Dunnart	*Sminthopsis griseoventer*
Common Dunnart	*Sminthopsis murina*
Black Flying-fox	*Pteropus alecto*
Little Red Flying-fox	*Pteropus scapulatus*
Northern Palm Squirrel	*Funambulus pennantii*

Appendix 7. Details of cockatoo breeding tree transects.

All coordinates Zone 50, datum WGS84.



Figure 11. Location of the cockatoo breeding tree transects.

Table 17. Results of cockatoo breeding tree transects in the land swap area.

BCE Scores are defined in Section 3.2.4.

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
23/08/2016	409248	6451781	Wandoo	Alive	700	5	
23/08/2016	409236	6451777	Wandoo	Dead	550	5	
23/08/2016	409264	6451797	Wandoo	Dead	650	4	
23/08/2016	409238	6451803	Wandoo	Dead	500	4	
23/08/2016	409276	6451816	Wandoo	Dead	650	5	
23/08/2016	409442	6451987	Wandoo	Dead	500	5	
23/08/2016	409444	6451992	Wandoo	Dead	350	4	
23/08/2016	409446	6451995	Wandoo	Dead	300	5	
23/08/2016	409041	6452031	Wandoo	Dead	470	4	
23/08/2016	409471	6452038	Wandoo	Dead	600	3	
23/08/2016	409490	6452050	Marri	Dead	600	4	
23/08/2016	409532	6452062	Wandoo	Dead	600	3	
23/08/2016	409484	6452080	Wandoo	Dead	400	5	
23/08/2016	409489	6452089	Marri	Dead	600	3	

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
23/08/2016	409482	6452095	Marri	Dead	700	3	
23/08/2016	409536	6452134	Wandoo	Dead	300	5	
23/08/2016	409559	6452137	Marri	Dead	500	5	
23/08/2016	409611	6452142	Marri	Dead	600	3	
23/08/2016	409616	6452148	Wandoo	Dead	600	3	
23/08/2016	409567	6452155	Wandoo	Dead	300	5	
23/08/2016	409610	6452158	Wandoo	Dead	400	5	
23/08/2016	409136	6452168	Marri	Dead	500	5	
23/08/2016	409598	6452169	Wandoo	Dead	600	3	
23/08/2016	409602	6452171	Wandoo	Dead	600	3	
23/08/2016	409624	6452215	Wandoo	Dead	800	5	
23/08/2016	409679	6452222	Marri	Dead	550	5	
23/08/2016	409684	6452224	Marri	Dead	600	4	
23/08/2016	409646	6452235	Marri	Dead	600	5	
23/08/2016	409305	6452374	Wandoo	Dead	400	5	
23/08/2016	409387	6451937	Wandoo	Alive	400	5	
23/08/2016	409448	6451979	Wandoo	Alive	400	5	
23/08/2016	409440	6451999	Wandoo	Alive	1200	3	
23/08/2016	409474	6452002	Wandoo	Alive	350	5	
23/08/2016	409459	6452005	Wandoo	Alive	550	3	
23/08/2016	409462	6452008	Wandoo	Alive	800	5	
23/08/2016	409462	6452008	Wandoo	Alive	350	5	
23/08/2016	409460	6452011	Wandoo	Alive	350	5	
23/08/2016	409445	6452015	Wandoo	Alive	500	3	
23/08/2016	409421	6452022	Wandoo	Alive	700	3	
23/08/2016	409468	6452024	Wandoo	Alive	750	3	
23/08/2016	409463	6452029	Wandoo	Alive	650	3	
23/08/2016	409476	6452036	Wandoo	Alive	300	5	
23/08/2016	409481	6452038	Wandoo	Alive	550	5	
23/08/2016	409487	6452039	Wandoo	Alive	600	3	
23/08/2016	409499	6452039	Wandoo	Alive	500	3	
23/08/2016	409479	6452042	Wandoo	Alive	500	5	
23/08/2016	409480	6452042	Wandoo	Alive	400	5	
23/08/2016	409476	6452055	Marri	Alive	500	5	
23/08/2016	409493	6452097	Wandoo	Alive	300	5	
23/08/2016	409607	6452134	Wandoo	Alive	300	5	
23/08/2016	409157	6452165	Wandoo	Alive	300	5	
23/08/2016	409588	6452186	Wandoo	Alive	600	5	
23/08/2016	409583	6452192	Wandoo	Alive	550	5	
23/08/2016	409590	6452195	Wandoo	Alive	300	5	
23/08/2016	409608	6452213	Wandoo	Alive	350	5	
23/08/2016	409641	6452241	Marri	Alive	650	5	

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
23/08/2016	409243	6452259	Wandoo	Alive	400	5	
23/08/2016	409237	6452265	Wandoo	Alive	450	5	
23/08/2016	409220	6452284	Wandoo	Alive	450	5	
23/08/2016	409220	6452285	Wandoo	Alive	400	5	
23/08/2016	409298	6452306	Wandoo	Alive	350	5	
23/08/2016	409258	6452307	Wandoo	Alive	450	5	
23/08/2016	409248	6452308	Wandoo	Alive	300	5	
23/08/2016	409250	6452308	Wandoo	Alive	350	5	
23/08/2016	409254	6452311	Wandoo	Alive	300	5	
23/08/2016	409256	6452311	Wandoo	Alive	350	5	
23/08/2016	409248	6452312	Wandoo	Alive	350	5	
23/08/2016	409277	6452333	Wandoo	Alive	300	5	
23/08/2016	409281	6452333	Wandoo	Alive	300	5	
23/08/2016	409329	6452333	Wandoo	Alive	300	5	
23/08/2016	409268	6452343	Wandoo	Alive	300	5	
23/08/2016	409326	6452349	Wandoo	Alive	300	5	
23/08/2016	409336	6452377	Wandoo	Alive	350	5	
23/08/2016	409276	6452380	Wandoo	Alive	400	5	Bee hive.
23/08/2016	409333	6452389	Wandoo	Alive	300	5	
23/08/2016	409324	6452394	Wandoo	Alive	300	5	
23/08/2016	409334	6452394	Wandoo	Alive	300	5	
23/08/2016	409355	6452394	Wandoo	Alive	300	5	
23/08/2016	409339	6452399	Wandoo	Alive	350	5	
23/08/2016	409347	6452408	Wandoo	Alive	600	3	
23/08/2016	409351	6452413	Wandoo	Alive	300	5	
23/08/2016	409350	6452413	Wandoo	Alive	400	5	
25/08/2016	409620	6452873	Jarrah	Alive	550	5	
25/08/2016	409619	6452883	Jarrah	Alive	500	5	
25/08/2016	409634	6452897	Marri	Alive	550	5	
25/08/2016	409676	6452929	Wandoo	Alive	400	5	
25/08/2016	409622	6452929	Marri	Alive	550	5	
25/08/2016	409683	6452943	Wandoo	Alive	550	4	
25/08/2016	409661	6452945	Wandoo	Alive	450	5	
25/08/2016	409692	6452953	Wandoo	Alive	550	5	
25/08/2016	409690	6452964	Wandoo	Alive	500	5	
25/08/2016	409697	6452970	Wandoo	Alive	450	5	
25/08/2016	409722	6452973	Wandoo	Alive	450	5	
25/08/2016	409717	6452977	Wandoo	Alive	700	5	
25/08/2016	409725	6452984	Wandoo	Alive	500	5	
25/08/2016	409682	6452984	Wandoo	Alive	350	5	
25/08/2016	409694	6452988	Wandoo	Alive	450	5	
25/08/2016	409690	6452988	Wandoo	Alive	350	5	

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
25/08/2016	409743	6452997	Wandoo	Alive	400	5	
25/08/2016	409739	6452998	Marri	Alive	500	5	
25/08/2016	409725	6453005	Wandoo	Alive	600	3	
25/08/2016	409713	6453005	Wandoo	Alive	400	5	
25/08/2016	409715	6453007	Wandoo	Alive	350	5	
25/08/2016	409749	6453038	Wandoo	Alive	500	5	
25/08/2016	409774	6453042	Marri	Alive	600	5	
25/08/2016	409745	6453047	Wandoo	Alive	700	5	
25/08/2016	409779	6453050	Marri	Alive	700	5	
25/08/2016	409736	6453060	Wandoo	Alive	500	5	
25/08/2016	409849	6453106	Wandoo	Alive	450	5	
25/08/2016	409801	6453108	Marri	Alive	750	5	
25/08/2016	409095	6453110	Wandoo	Alive	300	5	
25/08/2016	409139	6453121	Wandoo	Alive	350	5	
25/08/2016	409138	6453122	Wandoo	Alive	350	5	
25/08/2016	409879	6453131	Wandoo	Alive	400	5	
25/08/2016	409144	6453133	Wandoo	Alive	300	5	
25/08/2016	409145	6453134	Wandoo	Alive	300	5	
25/08/2016	409831	6453137	Marri	Alive	650	5	
25/08/2016	409113	6453138	Wandoo	Alive	300	5	
25/08/2016	409117	6453139	Wandoo	Alive	300	5	
25/08/2016	409865	6453140	Marri	Alive	500	5	
25/08/2016	409158	6453141	Wandoo	Alive	300	5	
25/08/2016	409112	6453154	Wandoo	Alive	300	5	
25/08/2016	409173	6453156	Marri	Alive	600	5	
25/08/2016	409132	6453169	Wandoo	Alive	450	4	
25/08/2016	409894	6453197	Marri	Alive	500	5	
25/08/2016	409153	6453197	Wandoo	Alive	350	5	
25/08/2016	409894	6453199	Marri	Alive	550	5	
25/08/2016	409899	6453234	Wandoo	Alive	400	5	
25/08/2016	409247	6453237	Wandoo	Alive	400	5	
25/08/2016	409247	6453241	Wandoo	Alive	400	5	
25/08/2016	409248	6453250	Wandoo	Alive	500	5	
25/08/2016	409219	6453257	Wandoo	Alive	500	5	
25/08/2016	409974	6453259	Wandoo	Alive	400	5	
25/08/2016	409245	6453274	Wandoo	Alive	500	5	
25/08/2016	409300	6453290	Wandoo	Alive	400	5	
25/08/2016	409278	6453293	Wandoo	Alive	500	5	
25/08/2016	409264	6453294	Marri	Alive	600	5	
25/08/2016	410004	6453295	Marri	Alive	600	5	
25/08/2016	409254	6453301	Wandoo	Alive	650	5	
25/08/2016	409291	6453302	Marri	Alive	700	5	

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
25/08/2016	409302	6453302	Wandoo	Alive	300	5	
25/08/2016	409278	6453305	Wandoo	Alive	300	5	
25/08/2016	409278	6453306	Wandoo	Alive	400	5	
25/08/2016	410042	6453309	Marri	Alive	700	5	
25/08/2016	409296	6453318	Wandoo	Alive	300	5	
25/08/2016	409293	6453324	Wandoo	Alive	300	5	
25/08/2016	410031	6453342	Marri	Alive	800	5	
25/08/2016	410082	6453352	Marri	Alive	700	3	
25/08/2016	409300	6453360	Wandoo	Alive	300	5	
25/08/2016	410045	6453364	Marri	Alive	600	5	
25/08/2016	410018	6453367	Marri	Alive	500	5	
25/08/2016	410032	6453373	Marri	Alive	500	5	
25/08/2016	409396	6453416	Wandoo	Alive	350	5	
25/08/2016	409420	6453432	Wandoo	Alive	400	5	
25/08/2016	409442	6453434	Wandoo	Alive	500	5	
25/08/2016	409441	6453436	Wandoo	Alive	350	5	
25/08/2016	409431	6453438	Wandoo	Alive	400	5	
25/08/2016	409417	6453440	Wandoo	Alive	350	5	
25/08/2016	409448	6453440	Wandoo	Alive	400	5	
25/08/2016	409437	6453446	Wandoo	Alive	450	5	
25/08/2016	409462	6453471	Wandoo	Alive	350	5	
25/08/2016	409466	6453476	Wandoo	Alive	450	5	
25/08/2016	409471	6453512	Wandoo	Alive	500	3	
25/08/2016	409522	6453512	Wandoo	Alive	500	5	
25/08/2016	409525	6453519	Wandoo	Alive	400	5	
25/08/2016	409523	6453519	Wandoo	Alive	300	5	
25/08/2016	409525	6453525	Wandoo	Alive	300	5	
25/08/2016	409502	6453528	Marri	Alive	500	5	
25/08/2016	409486	6453531	Marri	Alive	600	5	
25/08/2016	409485	6453532	Marri	Alive	600	5	
25/08/2016	409477	6453536	Marri	Alive	700	5	
25/08/2016	409534	6453540	Wandoo	Alive	300	5	
25/08/2016	409513	6453569	Wandoo	Alive	450	5	
25/08/2016	408239	6453576	Jarrah	Alive	500	5	
25/08/2016	409572	6453590	Wandoo	Alive	400	5	
25/08/2016	408200	6453612	Marri	Alive	700	5	
25/08/2016	409552	6453615	Jarrah	Alive	500	5	
25/08/2016	409604	6453618	Jarrah	Alive	500	5	
25/08/2016	408172	6453619	Marri	Alive	600	5	
25/08/2016	408162	6453620	Marri	Alive	550	5	
25/08/2016	408195	6453627	Marri	Alive	700	5	
25/08/2016	408176	6453628	Jarrah	Alive	550	5	

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
25/08/2016	408157	6453640	Marri	Alive	500	5	
25/08/2016	408172	6453647	Wandoo	Alive	400	5	
25/08/2016	408153	6453653	Wandoo	Alive	550	5	
25/08/2016	409608	6453653	Jarrah	Alive	500	5	
25/08/2016	409609	6453653	Jarrah	Alive	550	5	
25/08/2016	408151	6453665	Wandoo	Alive	550	5	
25/08/2016	409645	6453666	Marri	Alive	900	3	
25/08/2016	409643	6453668	Jarrah	Alive	550	5	
25/08/2016	409673	6453670	Jarrah	Alive	550	5	
25/08/2016	409633	6453672	Jarrah	Alive	500	5	
25/08/2016	409715	6453709	Jarrah	Alive	500	5	
25/08/2016	409723	6453717	Marri	Alive	500	5	
25/08/2016	409661	6453736	Jarrah	Alive	600	5	
25/08/2016	409678	6453744	Marri	Alive	600	5	
25/08/2016	409490	6452792	Marri	Dead	550	5	
25/08/2016	409735	6453001	Marri	Dead	500	5	
25/08/2016	409138	6453117	Wandoo	Dead	350	5	
25/08/2016	409228	6453278	Marri	Dead	600	5	
25/08/2016	409998	6453308	Marri	Dead	800	3	
25/08/2016	409314	6453328	Wandoo	Dead	400	5	
25/08/2016	410036	6453346	Marri	Dead	500	5	
25/08/2016	409339	6453387	Marri	Dead	500	5	
25/08/2016	409356	6453390	Marri	Dead	500	5	
25/08/2016	409346	6453393	Marri	Dead	500	3	
25/08/2016	409419	6453413	Marri	Dead	500	5	
25/08/2016	409418	6453438	Wandoo	Dead	400	4	
25/08/2016	409510	6453520	Marri	Dead	500	5	
25/08/2016	409505	6453524	Marri	Dead	500	5	
25/08/2016	409490	6453527	Marri	Dead	500	5	
25/08/2016	409570	6453590	Wandoo	Dead	600	5	
25/08/2016	409569	6453591	Wandoo	Dead	500	5	
25/08/2016	409533	6453592	Marri	Dead	500	5	
25/08/2016	408176	6453618	Marri	Dead	800	4	
25/08/2016	409631	6453646	Marri	Dead	800	5	
25/08/2016	408155	6453678	Marri	Dead	1000	3	
25/08/2016	409697	6453757	Marri	Dead	700	5	
2/09/2016	408308	6453333	Marri	Alive	500	5	
2/09/2016	408686	6453679	Marri	Alive	650	3	
2/09/2016	408977	6453696	Marri	Alive	600	3	Small feathers and down, probably duck nest in low hollow.
2/09/2016	408697	6453724	Marri	Alive	500	5	
2/09/2016	409024	6453729	Marri	Alive	500	4	

Date	Easting	Northing	Species	Alive or dead	DBH	BCE score	Notes
2/09/2016	409022	6453751	Marri	Alive	550	4	
2/09/2016	409071	6453793	Marri	Alive	600	3	
2/09/2016	409081	6453803	Marri	Alive	550	3	
2/09/2016	409102	6453804	Wandoo	Alive	300	5	
2/09/2016	409102	6453809	Wandoo	Alive	400	5	
2/09/2016	409083	6453818	Wandoo	Alive	500	4	
2/09/2016	409111	6453822	Wandoo	Alive	650	4	
2/09/2016	409130	6453828	Wandoo	Alive	500	5	
2/09/2016	409121	6453839	Wandoo	Alive	350	5	
2/09/2016	409126	6453841	Wandoo	Alive	450	5	
2/09/2016	409147	6453856	Jarrah	Alive	550	5	
2/09/2016	409152	6453870	Jarrah	Alive	500	5	
2/09/2016	409153	6453879	Marri	Alive	600	5	
2/09/2016	408886	6453886	Marri	Alive	500	4	Spotted 5 CaBC in the distance
2/09/2016	408890	6453890	Wandoo	Alive	600	5	
2/09/2016	408941	6453957	Wandoo	Alive	400	5	
2/09/2016	408945	6453961	Wandoo	Alive	650	5	
2/09/2016	408991	6454006	Wandoo	Alive	450	5	
2/09/2016	408991	6454011	Wandoo	Alive	350	5	
2/09/2016	408994	6454017	Wandoo	Alive	400	5	
2/09/2016	408997	6454031	Wandoo	Alive	400	5	
2/09/2016	409005	6454038	Wandoo	Alive	350	5	
2/09/2016	409019	6454045	Marri	Alive	900	5	
2/09/2016	409017	6454046	Wandoo	Alive	500	5	
2/09/2016	408935	6453612	Marri	Alive	850	4	
2/09/2016	409000	6453678	Marri	Alive	700	5	Bee hive.
2/09/2016	408679	6453708	Wandoo	Alive	600	3	
2/09/2016	408689	6453719	Wandoo	Alive	500	5	
2/09/2016	408660	6453737	Wandoo	Alive	350	5	
2/09/2016	408735	6453750	Wandoo	Alive	400	5	
2/09/2016	409088	6453764	Wandoo	Alive	600	5	
2/09/2016	409097	6453774	Wandoo	Alive	350	5	
2/09/2016	409127	6453788	Wandoo	Alive	750	3	
2/09/2016	409136	6453792	Wandoo	Alive	700	3	
2/09/2016	409131	6453826	Wandoo	Alive	500	5	
2/09/2016	408905	6453950	Wandoo	Alive	400	5	
2/09/2016	408942	6453973	Wandoo	Alive	600	4	
2/09/2016	408956	6453982	Wandoo	Alive	550	5	
2/09/2016	408953	6454023	Wandoo	Alive	350	5	
2/09/2016	408975	6454030	Marri	Alive	550	5	
2/09/2016	408990	6454051	Wandoo	Alive	450	5	