FINAL

East Metropolitan Regional Council (EMRC)
Offset Proposal for CPS 5743/1
Red Hill Waste Management Facility
June 2015

EMRC

Protecting Perth's Eastern Region

Prepared		C. Bridgland			
Checked		J. Gratton			
Approved		R. Lovegrove			
Record of Distribution					
Report Status:	No. of copies	Format	Distributed to	Date	Authorised by
Draft	1	Pdf	Department of the Environment	30/09/14	J. Gratton
Draft	1	Pdf	Department of Environmental Regulation	30/09/14	J. Gratton
Final	1	Pdf	Department of the Environment	30/06/15	J. Gratton
Final	1	Pdf	Department of Environmental Regulation	30/06/15	J. Gratton

Contents

Figures

Tables

Appendices

1 Introduction

1.1 Project

The Eastern Metropolitan Regional Council (EMRC) is proposing to carry out geotechnical investigations with regard to the construction of an additional cell, Farm Stage 3, 4 and 5 Landfill, for waste disposal at the established Red Hill Waste Facility located at Lot 12 on Deposited Plan 26468. The proposed geotechnical investigations will determine if the site is suitable for the desired purpose. The area of clearing proposed for this activity is 3.4Ha as part of Farm Stage 3 Landfill and then 10.5Ha as part of Farm Stage 4 and 5 Landfill within the boundaries of the greater site area of approximately 34Ha. (Stage 3, 4 and 5, refer to Appendix A)

EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility beyond the life of the rubbish tip.

1.2 Clearing Required

The area required for clearing to facilitate the geotechnical investigations with regard to the construction of an additional cell, Farm Stage 3 Landfill, is 3.4ha.

Based on the results of the geotechnical investigations for Stage 3 and further investigations for Stage 4 and 5, if the site is deemed suitable for the proposed waste disposal cell, then a further 10.5ha will be cleared for Farm Stage 4 and 5 Landfill.

In total, approximately 13.9ha of clearing is required within the boundaries of the greater site area of approximately 34ha.

For this purpose, EMRC is currently undergoing an assessment to obtain a permit to clear native vegetation (CPS 5743/1) by Department of Environment Regulation (DER) under section 51E of the *Environmental Protection Act 1986* (WA) (EP Act) for Stage 3, being 3.4ha.

In addition, EMRC has referred the proposed Stage 3, 4 and 5 Landfill activities under the *Environmental Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act) for assessment. An initial referral was made for Stage 3 however this has since been withdrawn. A new referral encompassing Stage 3, 4 and 5 was referred to the Department of the Environment (DOTE) on 30 September 2014 (EPBC 2014/7354).

1.3 Requirement for Offset

As a condition of the pending clearing permit, EMRC must develop an offset for native vegetation that is to be cleared. DER requires an offset proposal prior to finalising the clearing permit. Clearing to be authorised by this permit is also forbidden to commence prior to approval of the offset plan.

As the clearing permit is being issued by the DER, this offset plan will be submitted to the DER for approval prior to any clearing being commenced under permit CPS 5743/1.

In addition, in accordance with the 'Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy', an offset plan is required to be submitted to DOTE for approval.

1.4 Parallel requirements for offset

The project was referred to the DOTE under the EPBC Act. As part of the referral preparation process EMRC identified the likelihood of the proposed clearing triggering a requirement for an offset. It is expected that DOTE will determine that part or all of the proposed activities are a controlled action due to the potential impacts to a three listed threatened species. As part of the referral under the EPBC Act, EMRC has submitted this offset proposal for consideration during the assessment period.

Following the implementation of avoidance, mitigation and management measures, the project is anticipated to have a significant effect on three listed threatened species of Black-Cockatoo (Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*, Baudin's Black-Cockatoo *C. baudinii,* and Carnaby's Black-Cockatoo *C. latirostris*), associated with the clearing of its foraging habitat. As this impact cannot be completely avoided or mitigated, an offset under the EPBC Act is required. It is intended that this document serves as the offset plan required as part of the EP Act approval in addition to the offset proposal required under the EPBC Act, if required.

1.5 Document outline

This offset proposal has been prepared in accordance with 'Guide to developing a Clearing Permit Offset Proposal' (DEC, 2007) and 'Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy; (DOTE, 2012).

It contains the following details:

- An introduction (Section 1);
- Details of the clearing permit to which this offset relates (Section 2);
- Details of the offset being proposed by EMRC (Section 3);
- Assessment against the EP Act offset principles (Section 4);
- Assessment against the EPBC Act offset principles (Section 5);
- Offset calculation summary (Section 6);
- Management commitments and details of consultation in relation to the offset (Section 7); and
- Supporting Information (Appendices).

1.6 Contact details

Contact details of the permit holder for the Native Vegetation Clearing Permit, EPBC Referral Proponent and the Environmental Specialist is provided in Table 1.

Table 1: Contact Details

Detail	Permit holder / Proponent	Environmental Specialist
Name	Peter Schneider Chief Executive Officer	Jodi Gratton Managing Director KD.1 Pty Ltd
Company **Address**	Eastern Metropolitan Regional Council 226 Great Eastern Hwy Belmont WA 6104	KD.1 Pty Ltd PO Box 4336 Mosman Park South, WA 6012
Telephone	(08) 9424 2222	(08) 9227 7067

Detail	Permit holder / Proponent	Environmental Specialist
Email		Jodi@kd1.com.au

2 Proposed Clearing

EMRC is currently undergoing an assessment to obtain a permit to clear native vegetation (CPS 5743/1) under section 51E of the EP Act and an assessment to obtain approval under the EPBC Act (EPBC 2014/7354) under section 75 and section.

This section provides details of the pending approvals and associated information.

2.1 Native Vegetation Clearing Permit

Details of the native vegetation clearing permit to which this offset plan relates are shown in Table 2.

Table 2: Native Vegetation Clearing Permit Details

Item	Detail
Clearing permit number	CPS 5743/1
Permit holder	Eastern Metropolitan Regional Council (EMRC)
Duration of permit	Not yet approved
Purpose of clearing	Clearing for the purpose of constructing a waste disposal cell and geotechnical investigations
Land on which clearing is to be done	Lot 12 on Deposited Plan 26468
Total area of clearing	Stage 3 – 3.4ha

The clearing principle that the Clearing Permit CPS 5743/1 is at variance with principle (b) "Native vegetation should not be cleared if it comprises the whole or part of, or necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia". The project is anticipated to have a significant effect on three listed threatened species of Black-Cockatoo (Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*, Baudin's Black-Cockatoo *C. baudinii,* and Carnaby's Black-Cockatoo *C. latirostris*), associated with the clearing of its foraging habitat.

The clearing principle that the Clearing Permit CPS 5743/1 is at variance with 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". John Forest National Park is located approximately 800m south west of the Farm Stage 3, 4 and 5 Landfill area.

2.2 'Controlled Action' under EPBC Act

The assessment of the referral of the construction of waste storage cells, Farm Stage 3, 4 and 5 at the Red Hill Waste Facility under the EPBC Act (EPBC 2014/7354) has determined that the proposed action is a 'controlled action'.

The proposed action is to clear native vegetation to undertake geotechnical investigations and construct waste disposal storage cells at the Red Hill Waste Facility and the project will require assessment and approval under the EPBC Act before it can proceed.

The relevant controlling provisions are listed threatened species and communities (sections 18 and 18A of the EPBC Act). For example, based on the referral information, the proposed action is likely to have a significant impact on matters of national environmental significance because the proposed development includes the clearing of up to 13.9ha of foraging and potential breeding habitat for Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo and Baudin's Black Cockatoo.

The assessment approach under the EPBC Act will be based on preliminary documentation.

2.3 Impact of Clearing on the Environment

The impacts associated with the clearing of native vegetation are discussed in the following sections.

2.3.1 Native Vegetation

The Farm Stage 3, 4 and 5 Landfill site contains remnant vegetation which is isolated due to clearing for agriculture, quarry and landfill. Within the first area there is remnant vegetation of *Banksia sessilis var. sessilis* which was recorded as a dominant component of the vegetation structure. The second area has isolated or scattered groups of trees, predominantly *Corymbia calophylla* (Marri), or completely cleared land with a dense covering of pasture weeds.

The offset area is located within majority of remnant vegetation. The offset area is connected to John Forest National Park to the west and smaller patches of unprotected bush to the south within a residential area.

2.3.2 Flora

A flora and vegetation survey was conducted by Helena Hodlings (refer Appendix B) in 2010 and a summary of the findings is provided below.

The native vegetation of the landfill area is open Marri / Jarrah forest with scattered Sheoak. The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, Parrot Bush and Sheoak, with scattered Bull Banksia (*Banksia grandis*) and Snottygobble (*Persoonia longifolia*).

The native vegetation in the offset area is Marri / Jarrah woodland with a mostly open low understorey of proteaceous shrubs. The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, pockets of *Hakea undulata* and occasional Parrot Bush, Sheoak, Grasstree (*Xanthorrhea preissii*), Bull Banksia and Snottygobble.

Farm Stage 3, 4 and 5 Landfill site is comprised of two distinctly different areas. One area contains remnant native vegetation in the highest elevation and the second area is of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri) trees.

A search by the DPAW of their *Threatened (Declared Rare) Flora* database and *Declared Rare* and *Priority Flora* list and also the *Western Australian Herbarium specimen* database, identified 21 plant taxa of conservation significance as occurring within a 5 km radius of the survey site. Three taxa are Declared Rare plants while the remainder have varying levels of Priority status. One of the Priority 3

plants, *Nemcia acuta,* (now known as *Gastrolobium acutum*) reported in ATA (2003) as known to occur within the surrounding area, has since been taken off the list of conservation status flora.

A total of 72 taxa were recorded from the project area; 39 native taxa from a diverse range of 18 Families. Two occurrences of a Priority 4 plant *Templetonia drummondii*, were recorded from within the remnant native vegetation area.

A previous survey of the entirety of Lot 12, encompassing was undertaken in November 2003 by ATA Environmental. Four species of Priority status flora were reported to be known from the vicinity; *Halgania corymbosa* and *Nemcia acuta* Priority 3, *Darwinia pimelioides*, and *Templetonia drummondii* Priority 4. However, no conservation significant flora or vegetation was found during the survey at that time.

The clearing of foraging habitat will have some impact on the Black Cockatoo populations that may use the area for feeding, although during the period of the study no birds were observed but there were signs of past activity. The area is within the known boundaries of Cockatoo activity and as such will be deemed to have some possible impact on all three species of Black-Cockatoo.

The offset area for the Native Vegetation Clearing Permit provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as there were more large trees within the offset site compared with the landfill area that provide potential for both current and future Black-Cockatoo nest trees.

The facility is also susceptible to the introduction of floral weeds due to its acceptance of green waste and general waste (both potential sources of weed seed) and the presence of cleared areas (such as completed landfill cells). Weed species are an issue as they usually grow at pace and outcompete native species for resources. Weed monitoring and subsequent control measures are required at Red Hill to ensure that weeds do not become established within the site or spread to the adjacent John Forrest National Park.

Two species of weeds recorded for the project area are listed under the Agriculture and Related Resources Protection Act 1976, as plants that are, or may become, a problem to agriculture or the environment. *Echium plantagineum* (Paterson's curse) is a Declared Plant, and *Citrullus lanatus* (Pie Melon) is a Pest Plant. Declared Plants are placed in categories according to the control strategies required and administered by the Department of Agriculture and Food. Local Government Authorities are responsible for enforcing control of plants that are declared as Pest Plants.

2.3.4 Fauna

The clearing of foraging habitat will have some impact on the Black Cockatoo populations that may use the area for feeding, although during the period of the study no birds were observed but there were signs of past activity.

A fauna assessment was conducted by Bamford Consulting Ecologists (BCE) (refer Appendix C) to undertake investigations into the use and habitat quality of the proposed new landfill site by Black-Cockatoos and the potential for a neighbouring section of bush to be used as an offset and identified the following.

The three south-western Western Australian taxa of Black-Cockatoo that are likely to occur in the vicinity of the project area are listed below. With the status of each species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA 1999) and the Western Australian *Wildlife Conservation Act 1950* (WCA 1950) shown.

Table 3: Black-Cockatoos likely to occur in the vicinity of the project area

Species		EPBCA 1999	WCA 1950
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable	Schedule 1 (Vulnerable)
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Schedule 1 (Endangered)
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Schedule 1 (Endangered)

No Black-Cockatoos were seen or heard in the landfill area during the survey, although this was a very short time period: 3 hours. The only sign of foraging was recorded in the southeast of the larger vegetation block, where very old signs of Forest Red-tailed Black-Cockatoos feeding on Marri were found.

No Black-Cockatoos were seen in the offset area during the survey but a small flock of Carnaby's was heard to the south. BCE studies south of the site have recorded extensive foraging by all three species of Black-Cockatoos and potential breeding sites. Feeding debris between two and six months old was recorded under two Marri trees. One Marri nut with Carnaby's chew marks was also found but it was not near a Marri tree (likely dropped by a bird flying over) and so its origin could not be identified.

3 Offset Proposal

3.1 Overview

EMRC has proposed to offset the clearing of native vegetation by protecting an area of vegetation within the proposed offset area, currently a buffer zone for the waste management facility, beyond the life of the rubbish tip.

The proposed offset area (Lots 82 and 501) has existing residential areas within bushland to the south and east and John Forrest National Park to the west. The total available offset area is 52.5ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads (Appendix D). It is proposed that a portion of this area (12.1ha) be set aside as an environmental offset to meet DER requirements for Stage 3 and the whole of this area (52.5ha) be set aside to meet offset requirements under the EPBC Act.

It is proposed that when amendment or application for a native vegetation clearing permit under the EP Act be submitted for Stage 4 and 5, that the total 52.5ha area be accepted as a suitable offset to meet all requirements under EP Act and EPBC Act for Stages 3, 4 and 5 with no additional offset being required for assessment of Stage 4 and 5 under the EP Act.

3.2 Vegetation within the site to be cleared

The vegetation within Farm Stage 3, 4 and 5 Landfill site is described as one area containing remnant native vegetation in the highest elevation and the second area is of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri) trees.

The flora and vegetation survey conducted by Helena Hodlings (see Appendix B) states that the site contains remnant vegetation which is isolated due to clearing for agriculture, quarry and landfill. Within

the first area there is remnant vegetation of *Banksia sessilis var. sessilis* which was recorded as a dominant component of the vegetation structure. The second area has isolated or scattered groups of trees, predominantly *Corymbia calophylla* (Marri), or completely cleared land with a dense covering of pasture weeds.

As described by Bamford Consulting Ecologists (BCE) (refer Appendix C) an assessment shows the western two thirds of the large block of vegetation (about half the total native vegetation within the landfill area) contained a dense understorey of Parrot Bush with scattered Bull Banksia (Figure 1), refer to Table 4 below. The remainder of the area and had an open understorey with scattered Parrot Bush, Bull Banksia and the occasional Snottygobble (Figure 2). Throughout the area, Jarrah was the dominant tree species but there were few large trees. The entire site, particularly the areas with dense Parrot Bush, is thus considered quality foraging habitat for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos.

Table 4: Number of individual Black-Cockatoo foraging plants in each quadrat in the landfill area

Site	Marri	Jarrah	Parrot Bush	Sheoak	Bull Banksia	Snottygobble	Hakea	Grasstree
Landfill 01	2	6	300	2	0	0	0	0
Landfill 02	4	2	150	0	0	0	0	0
Landfill 03	0	9	100	1	0	0	0	0
Landfill 04	2	2	150	0	0	0	0	0
Landfill 05	3	3	50	0	1	0	0	0
Landfill 06	4	5	0	5	0	0	0	0
Landfill 07	5	8	5	1	1	1	0	0
Landfill 08	2	5	25	0	0	0	0	0
Landfill 09	1	7	0	2	0	0	0	0
Landfill 10	3	7	0	0	0	0	0	0
Landfill 11	1	8	6	5	0	0	0	0
Landfill 12	7	6	0	6	0	0	0	0
Total	34	68	786	22	2	1	0	0
Plants / quadrat	3	6	66	2	0.005	0.0025	0	0
Plants / ha	75	150	1650	50	0.1250	0.0625	0	0
Plants in landfill	1350	2700	29700	900	2.25	1.125	0	0

Figure 1: Example of the Marri/Jarrah forest with dense Parrot Bush in the Landfill area

Figure 2: Example of the Marri/Jarrah forest with open understorey in the Landfill area

3.2.1 Habitat Trees in Landfill Area

A total of 207 trees with the minimum diameter at breast height (DBH) of greater than 500 mm were recorded in the landfill area. As in the March 2014 survey, no active nests were found, however twelve potential nesting trees (BCE Tree Score 3) were recorded with no signs of use by Black-Cockatoos. Two other trees were recorded with possible large hollows but no vertical spout (BCE Tree Score 4). The other 193 trees recorded within the landfill area did not appear to have suitable structure or hollows (BCE Tree Score 5), although it should be noted that any large tree could have a concealed suitable hollow, or may develop such a hollow and become an important nest tree in the coming decades or centuries. Two hollow-bearing trees (BCE Tree Score 5) were hosts to other species of cockatoo: one had a nesting pair of Galahs (*Cacatua roseicapilla*) and the other had a nesting pair of Little Corellas (*Cacatua sanguinea*). One Marri tree had a hollow with apparent signs of use (recent bark wear around the opening) from something other than a cockatoo species, possibly a mammal

The majority of trees measured had a DBH of between 500 – 850 mm. Fifty trees (24.2 % of all trees measured) had a DBH greater than 850 mm; of these, 29 trees (14 % of all trees measured) had a DBH greater than 1000 mm. Of the twelve potential nesting trees recorded, four (all Marri) had a DBH of between 500 – 850 mm, three (two Marri and one Jarrah) had a DBH of between 850 – 1000 mm and five (four Jarrah and one Marri) had a DBH of greater than 1000 mm. The two trees recorded with a BCE Tree Score of 4 both had a DBH greater than 1000 mm.

Table 5: Potential breeding trees in the landfill area

BC score*	Number of trees				DBH			
	Marri	Jarrah	Total			Marri	Jarrah	Total
1	0	0	0		500 mm	17	5	22
2	0	0	0		501 mm – 850 mm	103	32	135
3	7	5	12		851 mm – mm 1000	14	7	21
4	2	0	2		1001 mm +	11	18	29
5	136	57	193					
Total	145	62	207		Total	145	62	207

*BC Score:
1 – Tree with active nest.
2 – Tree with large, suitable hollow bearing recent chew-marks.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout).
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout.
5 – Tree meets DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollows.

Table 6: Estimated number of trees with BCE Tree Scores 1-5 within the landfill area

Tree Score	1	2	3	4	5	Total
Total Trees > 500	0	0	12	2	193	207
Recorded trees/ha	0	0	0.7	0.1	10.7	11.5
Estimated trees/ha March 2014 survey	0	0	2.5	0	15	17.5

The survey undertaken by BCE in March 2014 (Bamford and Basnett 2014) was based on measurements within 20 metre by 20 metre (400 m^2) quadrats and the results of that survey were used to calculate an estimate of the total number of trees per hectare. The results of the survey reported herein gave a direct measure of the number of trees per hectare and it was significantly less than the March estimate (see Table 5). The estimated number of potential nesting trees per hectare was 3.75 times greater than the number of trees recorded in this survey (or the recorded number of trees is 27 % of the March estimate). Such a large discrepancy is not unexpected for a small number of observations, in this case one tree out of eight recorded in the initial March 2014 survey. The estimated

total number of trees with a DBH greater than 500 mm was 1.5 times greater than the number of trees recorded in this survey (or the number of trees recorded is 71 % of the March estimate).

3.3 Proposed Offset Site

As described by BCE, the proposed area to be used as an offset is similar to or better than the landfill area as potential breeding habitat and in the provision of canopy foraging habitat (Appendix C).

The total area is approximately 34ha in size, however only 13.9ha of native vegetation is required for clearing which contains remnant vegetation that is isolated due to clearing for agriculture, quarry and landfill. The offset area is 52.5ha and the majority of the site is remnant vegetation. The offset area is connected to John Forest National Park to the west and smaller patches of unprotected bush to the south within a residential area. John Forest National Park is a Class 'A' Reserve as declared in 1990 and was the second area to be declared a National Park in Australia in 1947. It is vested in the Conservation Commission of WA.

3.3.1 Black Cockatoo Foraging Habitat Values

The native vegetation in the offset area was Marri / Jarrah woodland with a mostly open low understorey of proteaceous shrubs (Figures 3, 4, 5). The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, pockets of *Hakea undulata* and occasional Parrot Bush, Sheoak, Grasstree (*Xanthorrhea preissii*), Bull Banksia and Snottygobble.

Assessment of the quadrats (Table 7) show the offset area quadrats contained a greater number of trees than the same number of quadrats in the landfill site (153 compared with 102), but far fewer understorey plants suitable for foraging by Black-Cockatoos. Two species of foraging plants, *H. undulata* and *X. preisii*, were recorded in the offset area which were not in the landfill site. In most quadrats, Marri was the dominant tree species and there were a greater number of larger trees identified. Although only small pockets of suitable feeding understorey plants were recorded, the entire site is considered quality foraging habitat for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos due to the cover of Marri and Jarrah trees.

No signs of active foraging were observed in the landfill area during the 19th December 2014 survey. Many of the trees recorded were Marri trees with considerable litter of seed capsules (honky nuts) beneath the canopy but none showed signs of Black-Cockatoo chewing.

Feeding debris between two and six months old was recorded under two Marri trees. One Marri nut with Carnaby's chew marks was also found but it was not near a Marri tree (likely dropped by a bird flying over) and so its origin could not be identified.

Signs of foraging, some recent but mostly intermediate age, were observed in the offset area around eleven of the surveyed trees (all Marri). These were attributed to both Carnaby's and Forest Red-tailed Black-Cockatoos, and calls of Forest Red-tailed Black-Cockatoos were heard nearby during the survey.

Table 7: Number of individual Black-Cockatoos foraging plants in each quadrat within offset area

Site	Marri	Jarrah	Parrot Bush	Sheoak	Bull Banksia	Snotty gobble	Hakea	Grasstree	Comments
Offset 01	7	5	4	0	0	0	0	0	
Offset 02	5	3	1	2	0	0	0	0	
Offset 03	2	7	2	0	0	0	3	0	
Offset 04	14	0	0	0	0	0	6	0	
Offset 05	11	4	0	0	0	0	0	0	
Offset 06	7	10	1	0	0	0	0	3	
Offset 07	7	13	0	0	0	0	0	4	
Offset 08	8	4	0	0	0	0	0	0	
Offset 09	5	0	0	0	0	0	0	0	2 trees just under DBH 500
Offset 10	11	3	0	0	0	0	0	0	Small trees DBH 50-100
Offset 11	6	3	0	0	0	0	2	0	
Offset 12	8	10	0	0	0	0	1	0	
Total	91	62	8	2	0	0	12	7	
Plants/quadrat	8	5	0.67	0.17	0	0	1	0.58	
Plants / ha	200	125	16.75	4.25	0	0	25	14.5	
Plants / offset	11200	7000	938	238	0	0	1400	812	

Figure 3: Example of Marri/Jarrah forest with open low proteaceous understorey in the offset area

Figure 4: Example of the Marri/Jarrah forest with dense small trees in the offset area

Figure 5: Example of Marri/Jarrah forest with sparse proteaceous understorey in the offset area

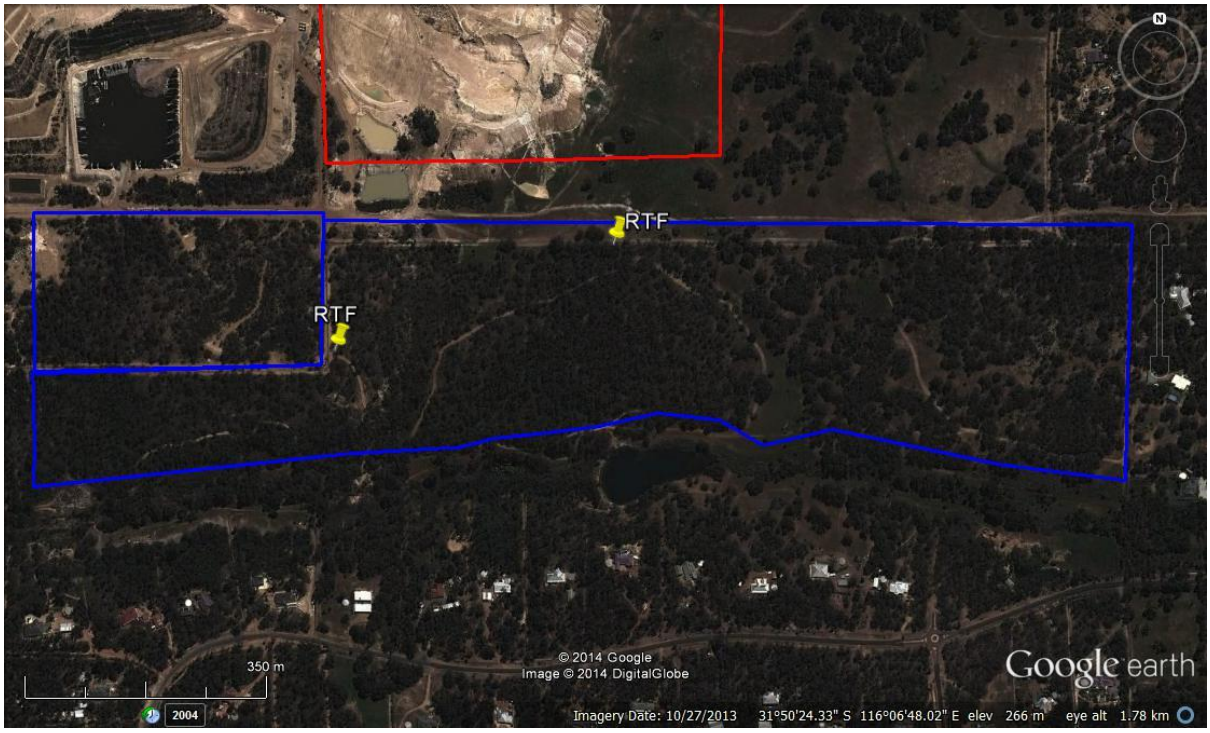


Figure 6: Locations of Forest Red-tailed Black-Cockatoo foraging debris recorded in offset area, March 2014

The offset area provides quality foraging habitat for Black-Cockatoos as they contain Marri/Jarrah forest. According to calculations from quadrat information (Table 7 and Figure 6), the offset area contains a higher density of Marri than the landfill area (200 trees/ha cf. 75 trees/ha), but a lower density of Jarrah (125 cf. 150). However, the size of the remnant vegetation in the offset area is larger, so it has a greater total number of both Marri and Jarrah trees (Table 7, Figure 7).

The landfill site had a much more dense understorey than the offset area consisting primarily of Parrot Bush (1650 plants/ha cf. 16.75 plants/ha) and Sheoak (50 cf. 4.25); both Black-Cockatoo foraging plants. The number of plants/ha was so much higher that despite the smaller size, the landfill site had a greater total number of both plant species (Table 8, Figure 7). Although at lower densities, the offset area had a greater diversity of understorey plants some of which were suitable as food species for Black-Cockatoos, *H. undulata*, Grasstrees, Parrot Bush, Sheoak and Banksia (Figure 8). There were scattered Bull Banksia and Snottygobble in the landfill area but the densities of these were very small (0.125/ha and 0.0625/ha respectively) and are unlikely to contribute to the foraging habitat of the site.

Table 8: Estimated densities of plant species suitable for foraging by Black-Cockatoos within the landfill (LF) and offset (OS) areas

Plant species with very low densities were not included in this table.

Site	Marri		Jarrah		Parrot Bush		Sheoak		Hakea		Grasstree	
	LF	OS	LF	OS	LF	OS	LF	OS	LF	OS	LF	OS
Total	34	91	68	62	786	8	22	2	0	12	0	7
Plants/quadrat	3	8	6	5	66	0.67	2	0.17	0	1	0	0.58
Plants / ha	75	200	150	125	1650	16.75	50	4.25	0	25	0	14.5
Plants in Site	1350	11200	2700	7000	29700	938	900	238	0	1400	0	812

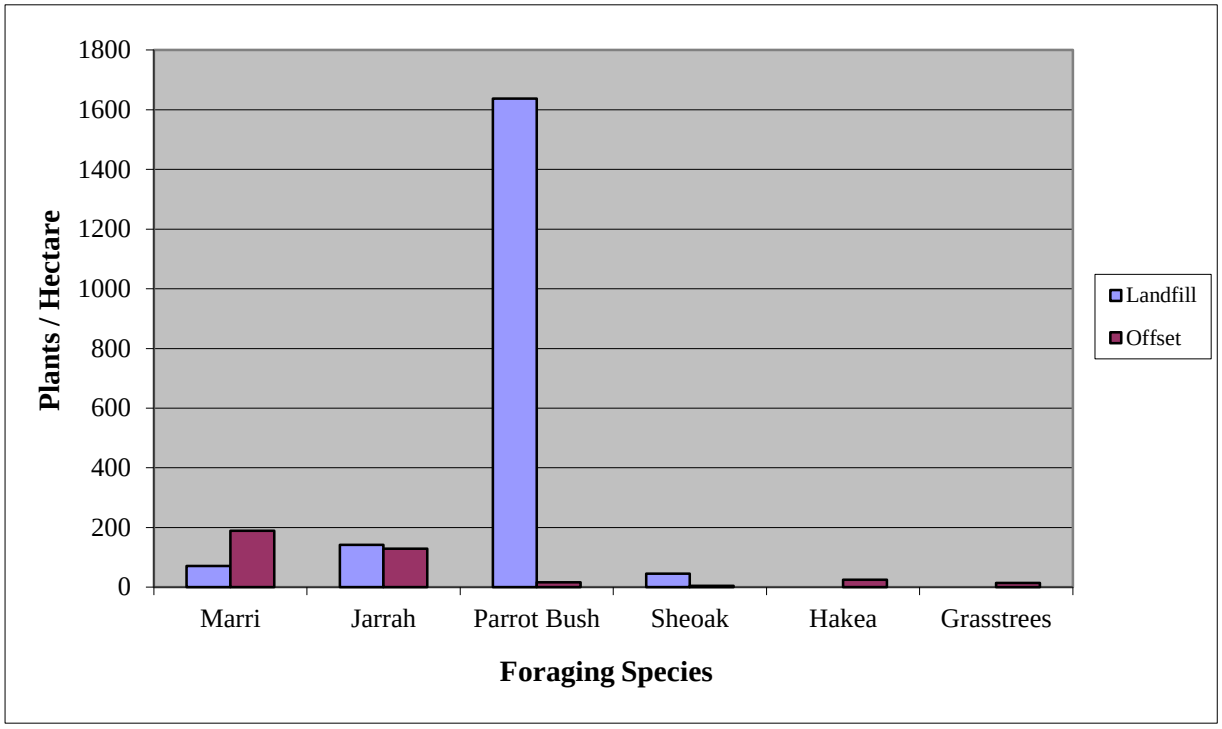


Figure 7: Estimated densities of suitable foraging plant species per ha within the landfill and offset areas

Species with very low densities were not included in this graph.

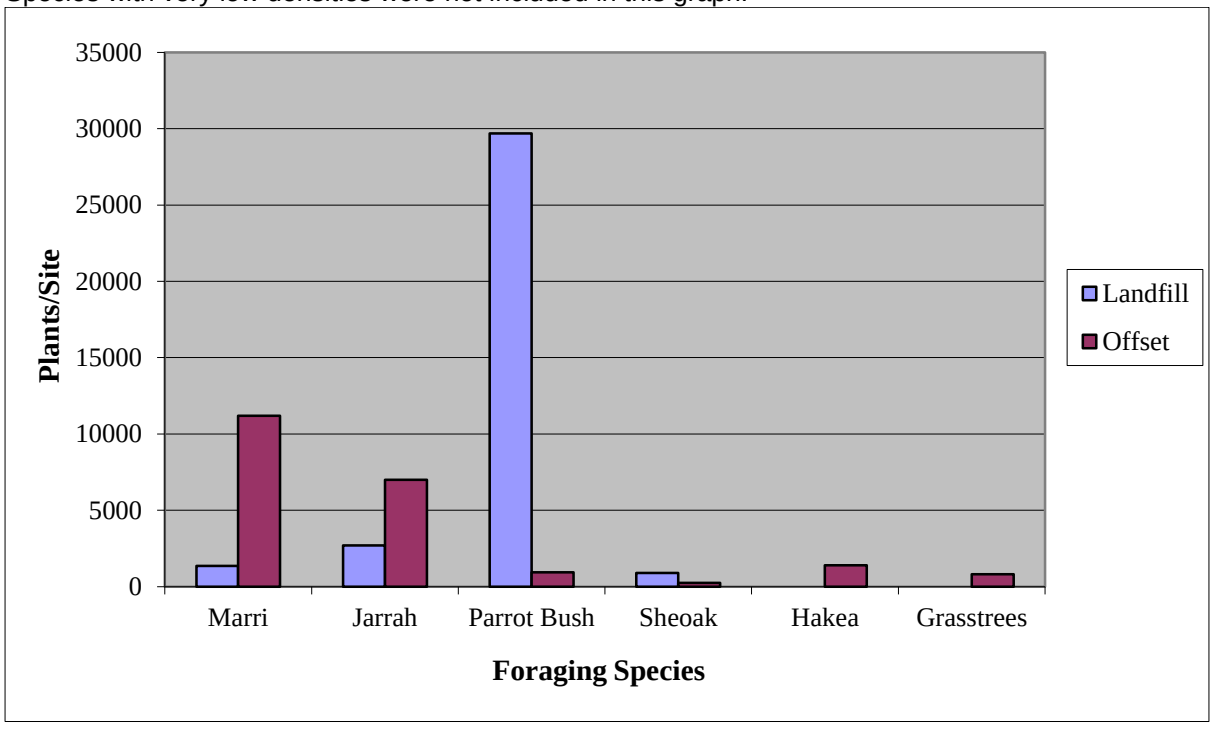


Figure 8: Estimated numbers of suitable foraging plant species per site within the landfill and offset areas

Species with very low densities were not included in this graph.

3.3.3 Habitat Trees in Offset Area

A total of 230 trees with DBH of greater than 500 mm were recorded within the sampling transects in the offset area. No active nests were found but two trees with chew marks (BCE Tree Score 2) indicating recent use by Black-Cockatoos plus 25 potential nesting trees with vertical spouts (BCE Tree Score of 3), including four dead trees, were observed, as well as 33 other trees with hollows but no vertical spout (BCE Tree Score 4). The estimated number of used nesting trees (BCE Tree Score 2) per hectare was 0.17 giving an estimated total of nine trees within the offset area. The estimated number of potential nesting trees (BCE Tree Score 3) per hectare was 2.09 giving an estimated total of 117 trees within the offset area.

As in the landfill area, the majority of trees measured had a DBH of between 500 – 850 mm. Thirty four trees (14.8 % of all trees measured) had a DBH greater than 850 mm; of these, 15 trees (6.5 % of all trees measured) had a DBH greater than 1000 mm. Both of the two used nesting trees were Marri, one with a DBH between 850 – 1000 mm and the other with a DBH greater than 1000 mm. Of the 25 potential nesting trees recorded, twelve (eleven Marri and one Jarrah) had a DBH of between 500 – 850 mm, four (three Marri and one Jarrah) had a DBH of between 850 – 1000 mm and nine (seven Marri and two Jarrah) had a DBH of greater than 1000 mm. Of the 33 trees recorded with a BCE Tree Score of 4, 22 (fifteen Marri and seven Jarrah) had a DBH of between 500 – 850 mm, seven (five Marri and two Jarrah) had a DBH of between 850 – 1000 mm and three (two Marri and one Jarrah) had a DBH of greater than 1000 mm.

Table 9: Potential breeding trees recorded in the offset area

BC score*	**Number of trees**				**DBH**			
	Marri	Jarrah	Total			Marri	Jarrah	Total
1	0	0	0		500 mm	17	5	22
2	0	0	0		501 mm – 850 mm	103	32	135
3	7	5	12		851 mm – mm 1000	14	7	21
4	2	0	2		1001 mm +	11	18	29
5	136	57	193					
Total	145	62	207		Total	145	62	207

Table 10: Estimated number of trees with BCE Tree Scores 1-5 and DBH within the offset area

DBH		BCE Tree Score 1	2	3	4	5	Total
500	Recorded	0	0	0	1	71	72
	Trees/ha	0	0	0	0.1	5.9	6.0
	Offset total	0	0	0	5	331	336
501-850	Recorded	0	0	12	22	90	124
	Trees/ha	0	0	1.0	1.8	7.5	10.3
	Offset total	0	0	56	103	420	579
851-1000	Recorded	0	1	4	7	7	19
	Trees/ha	0	0.1	0.3	0.6	0.6	1.6
	Offset total	0	5	19	32	32	88
>1000	Recorded	0	1	9	3	2	15
	Trees/ha	0	0.1	0.8	0.3	0.2	1.2
	Offset total	0	5	42	14	9	70
Total >500	Recorded	0	2	25	33	170	230
	Trees/ha	0	0.2	2.1	2.7	14.2	19.2
	Offset total	0	9	117	154	794	1074
	March 2014	0	0	336	560	840	1736

A transect design was used in this survey covering a larger area than the quadrat design used in March 2014. The estimated total number of trees with a DBH greater than 500 mm within the offset area was 1074, about 62% of the March 2014 estimate of 1736. The new estimate of the total number of potential nesting trees (BCE Tree Score 3) is 117, about 35% of the March 2014 estimate of 336 trees. These differences are similar to those observed in the landfill area where all trees were surveyed, suggesting that the estimates obtained via the transect survey design are more accurate than the March 2014 estimate.

3.3.2 Black Cockatoo Breeding Habitat Values

While both sites had potential nesting trees suitable for Black-Cockatoos only the offset had trees that showed signs of use by Black-Cockatoos.

Calculations from transect data showed the offset area contained more large trees (DBH greater than 500 mm) and potential hollows per ha and per site than the landfill area (Table 10, Figure 12 and 13). The offset area contains an estimated 9 trees with a Tree Score of 2, 117 trees with a Tree Score 3, 154 with a Tree Score 4 and 794 with a Tree Score 5 (Table 10). The landfill area contains 12 trees with a Tree Score 3, 2 trees with a Tree Score 4 and 193 with a Tree Score 5 (Table 10).

A total of 21 trees with Diameter at breast height (DBH) of greater than 500 mm were recorded in the offset area, 15 within quadrats and six large opportunistic trees (see Figures 9, 10 and 11 below). Within the quadrats, no active nests were found, however eight potential nesting trees (BCE Tree Score 3 or 4) were recorded. The other seven trees recorded did not appear to have suitable structure or hollows (BCE Tree Score 5), although it should be noted that any large tree could have a concealed suitable hollows, or may develop such a hollow and become an important nest tree in the coming decades or centuries.

Figure 9: Example of large Marri trees recorded within offset area. These trees had a score of 5, indicating they had a very low likelihood of concealed hollows.

Figure 10: Trees recorded with DBH greater than 500 mm within the offset area Lot 82. Trees recorded in quadrats (green) and outside quadrats (purple).

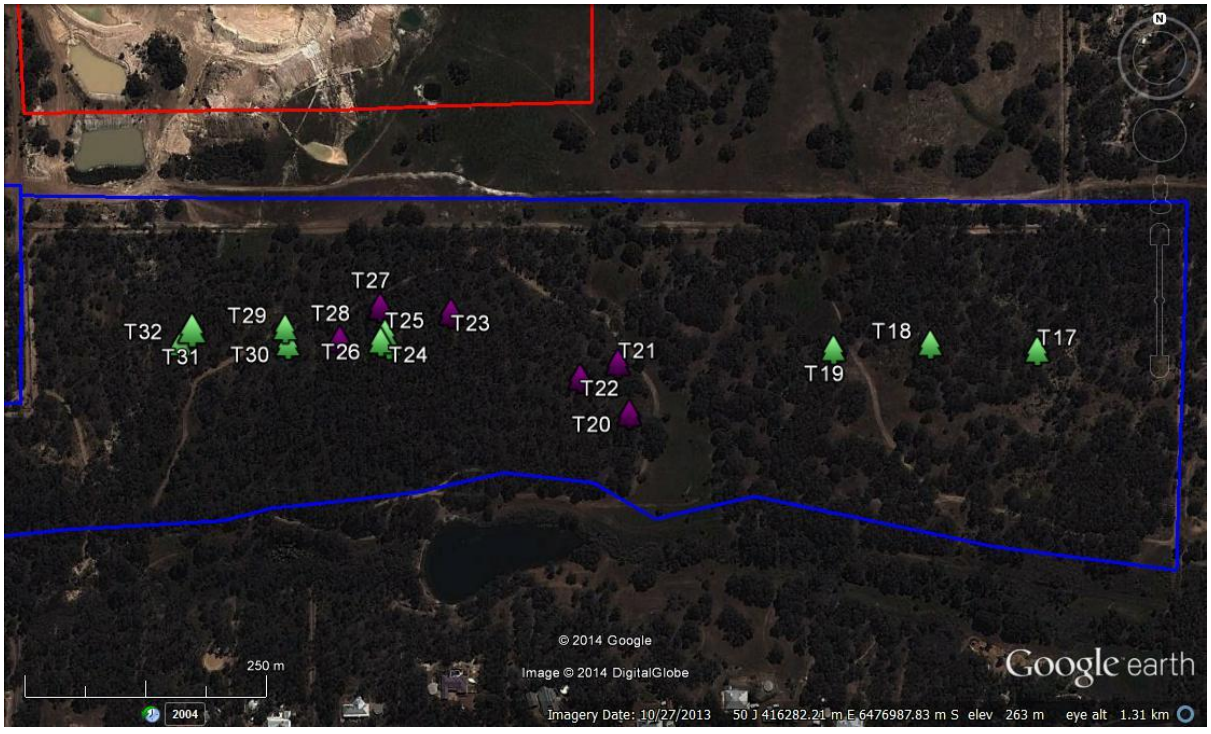


Figure 11: Trees recorded with DBH greater than 500 mm within the offset area Lot 501. Trees recorded in quadrats (green) and outside quadrats (purple).

Both survey sites had trees with DBH measurements greater than 500 mm, some of which had a BCE Tree Score of 3 or 4, meaning they are potentially suitable of Black-Cockatoo nest sites but did not

show signs of use. Out of the five categories, most of the trees scored a BCE Tree Score of 5. No current nests or suitable hollows with signs of use such as chew marks were recorded in either site.

Calculations from quadrat data showed the offset area contained more large trees (DBH greater than 500 mm) and potential hollows per ha and per site than the landfill area (Table 10, Figure 12 and 13). The offset area contains an estimated 336 trees with a Tree Score 3, 560 with a Tree Score 4 and 840 with a Tree Score 5 (Table 10). The landfill area contains an estimated 45 trees with a Tree Score 3, no trees with a Tree Score 4 and 270 with a Tree Score 5 (Table 10).

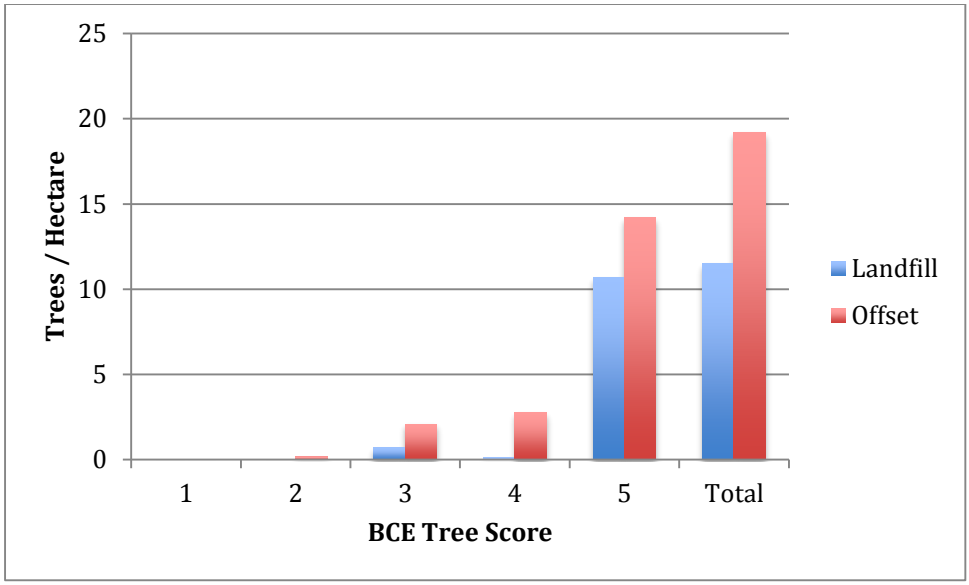


Figure 12: Estimated trees per hectare with BCE Tree Scores of 1-5 within landfill and offset areas

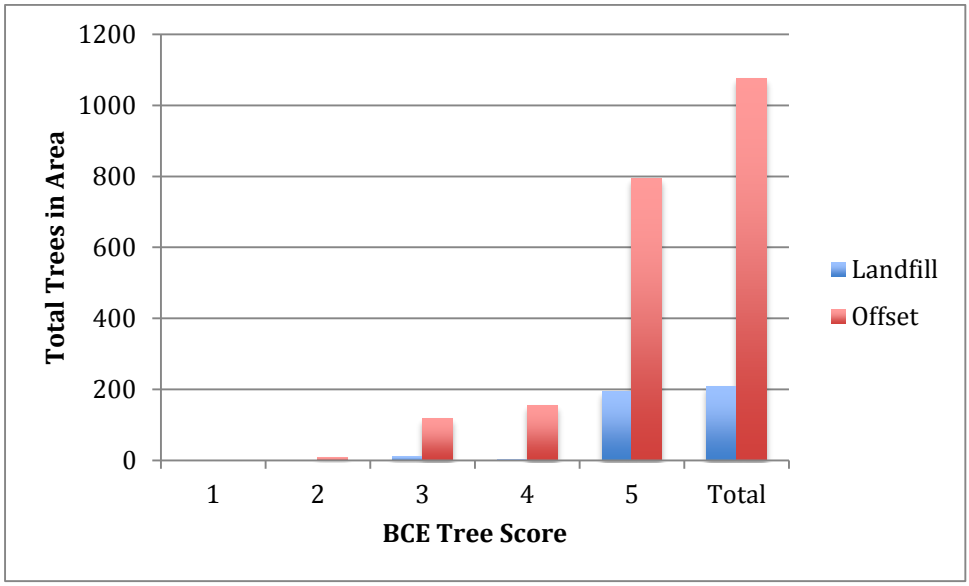


Figure 13: Total number of trees per site with BCE Tree Scores of 1-5 within the landfill (recorded) and offset areas (estimated)

In summary, the proposed offset area provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as the results of the surveys confirm that there is currently no Black-Cockatoo breeding activity and no known nest trees within the proposed landfill area however there is current and future potential breeding habitat. The actual number of potential nesting trees and future nesting trees within the proposed landfill area is smaller than estimated from the March 2014 survey: about 27 % of the original estimate for potential nesting trees (BCE Tree Score 3) and 71 % of the original estimate for future nesting trees (BCE Tree Score 4 and 5). No signs of foraging were observed though there is potential foraging habitat within the area.

Two used nest trees (BCE Tree Score 2) were observed in the offset area during the January 2015 survey, Forest Red-tailed Black-Cockatoos were heard in the area and signs of foraging attributed to both Carnaby's and Forest Red-tailed Black-Cockatoos were observed indicating that this area is currently used by Black-Cockatoos and is a suitable offset to the proposed landfill area. The area contains more large trees (>500 mm DBH) and more potential hollows per hectare than the landfill site, even after the revised data analyses from the December 2014 and January 2015 surveys results. The total number of trees within the offset area with a DBH of 500 mm or more was estimated at 1074, about 62% of the original March 2014 estimate of 1736 trees. The total number of potential nesting trees with spouts (BCE Tree Score 2 and 3) was estimated at 126, about 38% of the original March 2014 estimate of 336 trees.

While nesting habitat is confined to tall eucalypt forests, foraging habitat is more extensive than this. Along with Marri and Jarrah, it includes several of the understorey species recorded on both sites (Sheoak, Grevilleas, Hakeas and Banksias). As such, the entire survey area contains potential foraging habitat for all three species of Black-Cockatoo. Calculations of understorey species showed that the landfill site contained a higher density of suitable foraging plants but the offset area contained a higher diversity. Although mostly covered in Parrot Bush, a coloniser plant with a relatively short lifespan, the landfill area provided greater foraging potential in the understorey than the offset site. In the overstorey, however, the offset area provided more trees (Marri in particular) at a higher density than the landfill area. Marri is a food-plant for all three black-cockatoo species, whereas Parrotbush is used primarily by Carnaby's Black-Cockatoo.

This proposed offset area is similar to or better than the landfill area as potential breeding habitat and in the provision of canopy foraging habitat.

3.4 Offset Management Strategy

The objective of this offset proposal is to ensure the protection and management of the offset in such a way as to retain and improve the quality of the offset in perpetuity.

To achieve this objective, the following management strategies are proposed:

- Placement of a conservation covenant over the offset in perpetuity.
- Repair, maintenance and / or installation of fencing surrounding the offset area, however allowing an open side adjacent to the John Forest National Park.
- Weed management and control within the offset.

A description of these management strategies is provided in Table 11, listing the management strategies including, timeframes, responsible parties, performance criteria and contingency actions.

Table 11: Summary of Offset Management

	Conservation covenant	Fencing	Weed management
Management strategy	Placement of a conservation covenant over the offset in perpetuity.	Repair, maintenance and / or installation of fencing.	Weed management and control within the offset.
Objective	To protect the values of the offset in perpetuity by effectively preventing any further impacts to the site from development or clearing and managing the area to maximise its conservation values.	To prevent the intrusion of agricultural activities and practices and limit third party access	To prevent the spread of existing weeds and/or the introduction of new weeds within the offset.
Timeframe	Commence the process within one month. Placement of the conservation covenant on the title within 12.	December 2015	December 2015 – November 2015
Responsibility	EMRC	EMRC	EMRC
Performance criteria	Conservation covenant in place / memorial on title.	Fencing is intact around the north, east and south sides of offset. Fencing maintenance is planned if any section of fencing requires repair.	Weed inspection has occurred in last 12 months. Weed monitoring has not determined increase in weed species or abundance.
Contingency actions	Consultation with relevant government agencies to determine appropriate alternative actions. Provide additional information to government agencies if requested and where required.	Identify cause for damage to fence. Conduct maintenance on fence as required.	Identify cause for introduction of new weed species or spread of existing weeds. Implement weed control actions where required.
Associated Reporting	EMRC to keep record of activity. EMRC to report in any required environmental reports to DMP and DOTE. EMRC to provide written evidence to DER and DOTE within 12 months.	EMRC to keep record of activity. EMRC to report in any required environmental reports to DMP and DOTE.	EMRC to keep record of activity. EMRC to report in any required environmental reports to DMP and DOTE.

Placement of a conservation covenant over the offset in perpetuity

Following negotiations with the landowner, EMRC will enter into a conservation covenant (voluntary written agreement) with the Commissioner of Soil and Land Conservation under section 39 of the *Soil and Land Conservation Act 1945*. The purpose of the conservation covenant is to protect and manage the native vegetation within the offset in such a way as to retain and promote its growth (DAFWA, 2014). The term of the conservation covenant will be in perpetuity and will bind the landowner and all successive landowners through registration as a memorial on the property's certificate of title (DAFWA, 2014).

While it is intended that the process of placing a conservation covenant on the title will begin within one month of project activities commencing, it may take some time for the covenant to be formalised and come into effect. As this process is managed by Landgate and DAFWA and is out of EMRC's control, no date can be confirmed at this stage, although it is intended that the conservation covenant will be in place within 12 month of project activities commencing.

The objective of placing a conservation covenant on the offset is to protect in perpetuity the values of the offset by effectively preventing any further impacts to the site from development or clearing and managing the area to maximise its conservation values.

Repair and maintenance of fencing

EMRC will check and repair fencing surrounding the offset on at least three (3) sides within three months of project activities commencing. The portion of the offset area adjacent to the John Forest National Park will be left open with no fencing to assist with fauna movements between the protected areas.

EMRC will inspect and maintain fences on an annual basis following this initial check to ensure fence integrity is maintained.

The objective of this activity is to exclude feral animals and limit third party access.

Weed management and control within the offset

EMRC will be responsible for weed management and control within the offset. Weed management and control program will commence within six months of project activities commencing and will be ongoing.

The objective of the weed management and control program will be to prevent the spread of existing weeds and/or the introduction of new weeds within the offset.

EMRC will undertake weed monitoring (weed species and abundance) to ensure weed control is of a standard that achieves the objective of the weed management and control program.

4 Assessment Against EP Act (WA) Offset Principles

This section provides details of the assessment against the Offset Principles.

EP Act Offset Principles	Assessment
1. Direct offsets should directly counterbalance the loss of native vegetation.	EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility, beyond the life of the rubbish tip. The proposed offset area (Lots 82 and 501) will be determined in conjunction with the EP Act and EPBC Act approvals and will be a portion or the whole of the 52.5ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads. This proposed offset area owned by EMRC will be preserved for conservation and is considered to directly offset the total 13.9ha of native vegetation that will be cleared. The offset is of similar vegetation/habitat composition, structure and quality. Based on the use of the EPBC offset calculator, it has been determined that an area of approximately 25ha would meet the offset requirements, however final confirmation of the minimum offset area will be made in conjunction with DOTE and DER, with a maximum being 52.5ha.
2. 4.1 Contributing offsets should complement and enhance the direct offset.	The offset proposal will ensure the protection and management of the offset in such a way as to retain and improve the quality of the offset in perpetuity. The following management strategies are proposed: • Placement of a conservation covenant over the offset in perpetuity. • Repair and maintenance of fencing surrounding the offset on three (3) sides allowing synergy with the John Forest national Park on at least one side. • Weed management and control within the offset. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 & 5 Landfill.

3. Offsets are implemented only once all avenues to avoid, minimise, rectify or reduce environmental impacts have been exhausted.	The EMRC is proposing to carry out geotechnical investigations with regard to the construction of an additional cell, Farm Stage 3, 4 & 5 Landfill, for waste disposal at the established Red Hill WMF. The area needs to be cleared of native vegetation to allow for the geotechnical investigations and then for the construction of a new waste cell named Farm Stage 3 for the continuing of the Class III landfill operations at Red Hill WMF. The study will involve a 25m drilling grid and includes including ripping, dozers and rock breaking and it will not be possible to avoid clearing of this area. Most of the landfill site has been previously cleared for quarry and pastoral purposes with few to no trees and patches of remnant bushland cover. The location was chosen due to the minimal amount of remnant bush required to be cleared within the site boundary. EMRC has proposed to offset this clearing by protecting the bush within the offset area, currently a buffer zone for the waste management facility, beyond the life of the rubbish tip. Based on the results of the geotechnical investigations if the site is deemed suitable for the proposed waste disposal cell then Stage 4 and 5 (Refer to Appendix A) will then be proposed and further approvals will be required where necessary.
4. The environmental values, habitat, species, ecological community, physical area, ecosystem, landscape, and hydrology of the offset should be the same as, or better than, that of the area of native vegetation being offset.	As discussed in Section 3, the vegetation within Farm Stage 3, 4 and 5 Landfill site is described as one area containing remnant native vegetation in the highest elevation and the second area is of grazing pasture with isolated or scattered groups of predominantly Corymbia calophylla (Marri) trees. As described by Bamford Consulting Ecologists (BCE) (see Appendix C) an assessment shows the western two thirds of the large block of vegetation (about half the total native vegetation within the landfill area) contained a dense understorey of Parrot Bush with scattered Bull Banksia. The remainder of the area and had an open understorey with scattered Parrot Bush, Bull Banksia and the occasional Snottygobble. Throughout the area, Jarrah was the dominant tree species but there were few large trees. The entire site, particularly the areas with dense Parrot Bush, is thus considered quality foraging habitat for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos. The proposed offset area (Lots 82 and 501) has existing residential areas within bushland to the south and east and John Forrest National Park to the west. The offset area is 52.5Ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads. The proposed offset area provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as there were more large trees within the offset site compared with the landfill area that provide potential for both current and future Black-Cockatoo nest trees. No current nest trees were recorded within the landfill site. While nesting habitat is confined to tall eucalypt forests, foraging habitat is more extensive than this. Along with Marri

	and Jarrah, it includes several of the understorey species recorded on both sites (Sheoak, Grevilleas, Hakeas and Banksias). As such, the entire survey area contains potential foraging habitat for all three species of Black-Cockatoo. Calculations of understorey species showed that the landfill site contained a higher density of suitable foraging plants but the offset area contained a higher diversity. Although mostly covered in Parrot Bush, a coloniser plant with a relatively short lifespan, the landfill area provided greater foraging potential in the understorey than the offset site. In the overstorey, however, the offset area provided more trees (Marri in particular) at a higher density than the landfill area. Marri is a food-plant for all three black-cockatoo species, whereas Parrotbush is used primarily by Carnaby's Black-Cockatoo. This proposed offset area is similar to or better than the landfill area as potential breeding habitat and in the provision of canopy foraging habitat.
5. A ration greater that 1:1 should be applied to the size of the area of native vegetation that is offset to compensate for the risk that the offset may fail.	The proposed offset area (Lots 82 and 501) is 52.5Ha and is nearly four times the size of the 13.9Ha of native vegetation that will be cleared and this represents an offset ratio greater than 1:1.
6. Offsets must entail a robust and consistent assessment process.	A Level 1, flora and vegetation assessment survey was conducted in 2010 by Helena Holdings (see Appendix B) and Bamford Consulting Ecologists (see Appendix C) conducted a Level 1, fauna assessment in 2014. These were provided to EMRC as supporting information for the Native Vegetation Clearing Permit (CPS 5743/1). Bamford Consulting Ecologists and KD.1 Pty Ltd had subsequently identified and determined the proposed offset area that was suitable due to the nature and composition of the surrounding bushland.
7. In determining an appropriate offset, consideration should be given to ecosystem function, rarity and type of ecological community, vegetation condition, habitat quality and area of native vegetation cleared.	As discussed under the above offset principles, this offset has been selected in consideration of the area and the vegetation/habitat composition, structure and quality, to be cleared. Furthermore the offset was considered to have a greater structural diversity and complexity of habitats and so is likely to have greater biodiversity and ecological functional value than currently exists in the project area.

8. The offset should either result in no net loss of native vegetation, or lead to a net gain in native vegetation and improve the condition of the natural environment.	This offset will result in a net gain of native vegetation in terms of both spatial area and the density and diversity when compared with the Stage 3, 4 and 5 Landfill Site. EMRC will ensure the management of the offset as provided in Section 3.4 in such a way as to retain and improve the quality of the offset in perpetuity. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 and 5 Landfill.
9. Offsets must satisfy all statutory requirements	EMRC is currently undergoing an assessment to obtain a permit to clear native vegetation (CPS 5743/1) under section 51E of the Environmental Protection Act 1986 (WA) (EP Act). As a condition of the clearing permit, EMRC must develop an offset for native vegetation that is to be cleared. This document constitutes an offset proposal as required under the clearing permit. This offset plan will be submitted to the DER, for approval prior to any clearing being commenced under permit CPS 5743/1. The project was referred to the Department of the Environment (DOTE) under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) and is currently being assessed by DOTE.
10. Offsets must be clearly defined and audited	EMRC will audit performance against the approved offset proposal on an annual basis for the life of the project and report on the outcomes of this audit, if required. A record substantiating all activities associated with this offset proposal will be maintained.
11. Offset must be a long term (10-30 year) benefit.	EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility beyond the life of the rubbish tip. The Red Hill WMF was licensed for use as a landfill site and the whole area is within the current ownership of the EMRC and forms part of the Waste facilities lands. The Department of Parks and Wildlife (DPAW) provides EMRC with an annual license to operate the site. EMRC will ensure the management of the offset as provided in Section 3.4 in such a way as to retain and improve the quality of the offset in perpetuity. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 and 5 Landfill.

12. An environmental specialist must be involved in the design, assessment and monitoring of offsets.	EMTC has engaged the following environmental specialists in various stages of the assessment, development and monitoring of the offset, including: • KD.1 Pty Ltd • Bamford Consulting Ecologists • Helena Holdings

5 Assessment Against EPBC Act (Cth) Offset Policy

This section provides details of the assessment against the EPBC Offset Policy Principles.

EPBC Act Policy Principles	Assessment
1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action.	EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility, beyond the life of the rubbish tip. The proposed offset area (Lots 82 and 501) will be determined in conjunction with the EP Act and EPBC Act approvals and will be a portion or the whole of the 52.5ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads. This proposed offset area owned by EMRC will be preserved for conservation. The offset is of similar vegetation/habitat composition, structure and quality. The offset is located within the Shire of Mundaring and according to the map provided in Appendix H, Lot 501 and 82 are zoned "public purposes", with a portion to the Eastern side of Lot 501 located opposite the road being zoned "rural residential". The area below the offset area it is zoned as "conservation". In Shire of Mundaring, Local Planning Strategy Document it mentions that areas zoned under public purpose sets out a strategy to "*Encourage government agencies with management control over land Reserved for Public Purposes to retain and protect Local Natural Areas wherever possible*", and "*Negotiate with government agencies with management control over land Reserved for Public Purposes regarding the possible inclusion of larger parcels of Local Natural Areas in a conservation covenant, where those Local Natural Areas are not required for development*". The zoning of proposed offset Lots 201 and 82 provide a satisfactory commitment that does not pose a current risk of threat to the vegetation contained in the offset area as the Shire of Mundaring encourage the land to retain and protect the local natural areas.

2. Be built around direct offsets but may include other compensatory measures	The Shire of Mundaring zones for the proposed offset Lots of 501 and 82 as described above, provide adequate protection for the proposed offset area does not impact on the current state of the vegetation.
3. Be in proportion to the level of statutory protection that applies to the protected matter.	EMRC is currently undergoing an assessment to obtain a permit to clear native vegetation (CPS 5743/1) under section 51E of the Environmental Protection Act 1986 (WA) (EP Act). As a condition of the clearing permit, EMRC must develop an offset for native vegetation that is to be cleared. This document constitutes an offset proposal as required under the clearing permit. This offset plan will be submitted to the DER, for approval prior to any clearing being commenced under permit CPS 5743/1. The project was referred to the Department of the Environment (DOTE) under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) and is currently being assessed by DOTE.
4. Be of a size and scale proportionate to the residual impacts on the protected matter.	EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility beyond the life of the rubbish tip. The Red Hill WMF was licensed for use as a landfill site and the whole area is within the current ownership of the EMRC and forms part of the Waste facilities lands. The Department of Parks and Wildlife (DPAW) provides EMRC with an annual license to operate the site. This proposed offset area owned by EMRC will be preserved for conservation and is considered to directly offset the total 13.9ha of native vegetation that will be cleared. The offset is of similar vegetation/habitat composition, structure and quality. Based on the use of the EPBC offset calculator, it has been determined that an area of approximately 25ha would meet the offset requirements, however final confirmation of the minimum offset area will be made in conjunction with DOTE and DER, with a maximum being 52.5ha. The risk of loss percentage with the offset in place as outlined within the offset proposal, is considered to be 5%. This is due to the additional level of protection that will be placed of the area. It is acknowledged however that there is a potential for some loss outside of EMRC control, such as natural occurring events and therefore 5% is considered reasonable. The future quality without offset is considered to be a 6 in a scale of 1-10 as that may account for some degradation over a 10 year period if left unmanaged.

5. Effectively account for and manage the risks of the offset not succeeding.	This offset will result in a net gain of native vegetation in terms of both spatial area and the density and diversity when compared with the Stage 3, 4 and 5 Landfill Site. EMRC will ensure the management of the offset as provided in Section 3.4 in such a way as to retain and improve the quality of the offset in perpetuity. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 and 5 Landfill. The current level of protection in place for the proposed offset area does not impact on the current state of the vegetation. However, should a conservation order be placed on the title then this would ensure maximum protection of the offset area to ensure maximum protection. The risk of loss percentage without offset is therefore considered to be 35%.
6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6).	EMRC is currently undergoing an assessment to obtain a permit to clear native vegetation (CPS 5743/1) under section 51E of the Environmental Protection Act 1986 (WA) (EP Act). As a condition of the clearing permit, EMRC must develop an offset for native vegetation that is to be cleared. This document constitutes an offset proposal as required under the clearing permit. This offset plan will be submitted to the DER, for approval prior to any clearing being commenced under permit CPS 5743/1. The project was referred to the Department of the Environment (DOTE) under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) and is currently being assessed by DOTE. EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility beyond the life of the rubbish tip. The Red Hill WMF was licensed for use as a landfill site and the whole area is within the current ownership of the EMRC and forms part of the Waste facilities lands. The Department of Parks and Wildlife (DPAW) provides EMRC with an annual license to operate the site. EMRC will ensure the management of the offset as provided in Section 3.4 in such a way as to retain and improve the quality of the offset in perpetuity. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 and 5 Landfill.

7. Be efficient, effective, timely, transparent, scientifically robust and reasonable.	As discussed in Section 3, the vegetation within Farm Stage 3, 4 and 5 Landfill site is described as one area containing remnant native vegetation in the highest elevation and the second area is of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri) trees. As described by Bamford Consulting Ecologists (BCE) (see Appendix C) an assessment shows the western two thirds of the large block of vegetation (about half the total native vegetation within the landfill area) contained a dense understorey of Parrot Bush with scattered Bull Banksia. The remainder of the area and had an open understorey with scattered Parrot Bush, Bull Banksia and the occasional Snottygobble. Throughout the area, Jarrah was the dominant tree species but there were few large trees. The entire site, particularly the areas with dense Parrot Bush, is thus considered quality foraging habitat for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos. The proposed offset area (Lots 82 and 501) has existing residential areas within bushland to the south and east and John Forrest National Park to the west. The offset area is 52.5Ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads. The proposed offset area provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as there were more large trees within the offset site compared with the landfill area that provide potential for both current and future Black-Cockatoo nest trees. No current nest trees were recorded within the landfill site. While nesting habitat is confined to tall eucalypt forests, foraging habitat is more extensive than this. Along with Marri and Jarrah, it includes several of the understorey species recorded on both sites (Sheoak, Grevilleas, Hakeas and Banksias). As such, the entire survey area contains potential foraging habitat for all three species of Black-Cockatoo. Calculations of understorey species showed that the landfill site contained a higher density of suitable foraging plants but the offset area contained a higher diversity. Although mostly covered in Parrot Bush, a coloniser plant with a relatively short lifespan, the landfill area provided greater foraging potential in the understorey than the offset site. In the overstorey, however, the offset area provided more trees (Marri in particular) at a higher density than the landfill area. Marri is a food-plant for all three black-cockatoo species, whereas Parrotbush is used primarily by Carnaby's Black-Cockatoo. Bamford Consulting Ecologists and KD.1 Pty Ltd had subsequently identified and determined the proposed offset area that was suitable due to the nature and composition of the surrounding bushland. It is also identified as potential breeding habitat and in the provision of canopy foraging habitat. Furthermore the offset was considered to have a greater structural diversity and complexity of habitats and so is likely to have greater biodiversity and ecological functional value than currently exists in the project area.

8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	The offset proposal is contained within freehold land owned by EMRC, which is fenced and to gain access into this area, you are required to pass through the EMRC induction process. EMRC will audit performance against the approved offset proposal on an annual basis for the life of the project and report on the outcomes of this audit, if required. A record substantiating all activities associated with this offset proposal will be maintained. Weed monitoring and subsequent control measures are required at Red Hill to ensure that weeds do not become established within the site or spread to the adjacent John Forrest National Park. EMTC has engaged the following environmental specialists in various stages of the assessment, development and monitoring of the offset, including: • KD.1 Pty Ltd • Bamford Consulting Ecologists • Helena Holdings

6 Offset Calculation Summary

The below table provides a summary of the Offset Calculation usage.

Table 12: Offset Calculation Summary

THREATENED SPECIES HABITAT AREA TO BE DISTURBED – QUALITY OF HABITAT – RATED AS 7 OUT OF 10	The native vegetation of the landfill area is open Marri / Jarrah forest with scattered Sheoak. The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, Parrot Bush and Sheoak, with scattered Bull Banksia (*Banksia grandis*) and Snottygobble (*Persoonia longifolia*). Farm Stage 3, 4 and 5 Landfill site is comprised of two distinctly different areas. One area contains remnant native vegetation in the highest elevation and the second area is of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri) trees.

TIME UNTIL ECOLOGICAL BENEFIT – 10 YEARS	The offset area for the Native Vegetation Clearing Permit provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as there were more large trees within the offset site compared with the landfill area that provide potential for both current and future Black-Cockatoo nest trees. EMRC has proposed to offset the clearing of native vegetation by protecting the bush within the offset area, currently a buffer zone for the waste management facility beyond the life of the rubbish tip. The Red Hill WMF was licensed for use as a landfill site and the whole area is within the current ownership of the EMRC and forms part of the Waste facilities lands. The Department of Parks and Wildlife (DPAW) provides EMRC with an annual license to operate the site. EMRC will ensure the management of the offset as provided in Section 3.4 in such a way as to retain and improve the quality of the offset in perpetuity. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 and 5 Landfill.
START QUALITY RATED AS 7 OUT OF 10	The native vegetation in the offset area is Marri / Jarrah woodland with a mostly open low understorey of proteaceous shrubs. The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, pockets of *Hakea undulata* and occasional Parrot Bush, Sheoak, Grasstree (*Xanthorrhea preissii*), Bull Banksia and Snottygobble The offset area for the Native Vegetation Clearing Permit provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as there were more large trees within the offset site compared with the landfill area that provide potential for both current and future Black-Cockatoo nest trees.
RISK OF LOSS WITHOUT OFFSET – 35%	The offset proposal is contained within freehold land owned by EMRC, which is fenced and to gain access into this area, you are required to pass through the EMRC induction process. The current level of protection in place for the proposed offset area does not impact on the current state of the vegetation. The risk of loss percentage without offset is therefore considered to be 35%.
FUTURE QUALITY WITHOUT OFFSET 6 OUT OF 10	The future quality without offset is considered to be a 6 in a scale of 1-10 as that may account for some degradation over a 10 year period if left unmanaged.
RISK OF LOSS WITH OFFSET 5%	The risk of loss percentage with the offset in place as outlined within the offset proposal, is considered to be 5%. This is due to the additional level of protection that will be placed of the area. It is acknowledged however that there is a potential for some loss outside of EMRC control, such as natural occurring events and therefore 5% is considered reasonable.

FUTURE QUALITY WITH OFFSET RATED AT 7 OUT OF 10	This offset will result in a net gain of native vegetation in terms of both spatial area and the density and diversity when compared with the Stage 3, 4 and 5 Landfill Site. EMRC will ensure the management of the offset as provided in Section 3.4 in such a way as to retain and improve the quality of the offset in perpetuity. EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 and 5 Landfill.
CONFIDENCE IN THE RESULT % WITH OFFSET - 90%	The offset proposal of Lots 501 and 82 which encompasses 52.5ha is located within the Shire of Mundaring. According to the map provided in Attachment H Lot 501 and 82 are zoned “public purposes”, with a portion to the Eastern side of Lot 501 located opposite the road being zoned “rural residential”. The area below the offset area it is zoned as “conservation”. In Shire of Mundaring, Local Planning Strategy Document it mentions that areas zoned under public purpose sets out a strategy to “*Encourage government agencies with management control over land Reserved for Public Purposes to retain and protect Local Natural Areas wherever possible*”, and “*Negotiate with government agencies with management control over land Reserved for Public Purposes regarding the possible inclusion of larger parcels of Local Natural Areas in a conservation covenant, where those Local Natural Areas are not required for development*”. The zoning of Lots 201 and 82 provide a satisfactory commitment that does not pose a current risk of threat to the vegetation contained in the offset area as the Shire of Mundaring encourage the land to retain and protect the local natural areas. Additionally, there are no proposed developments to the current zoning for Lots 501 and 82 and which have the potential to affect the vegetation contained within the offset area.
CONFIDENCE IN THE RESULT % FUTURE QAULITY WITH OFFSET - 80%	The current level of protection in place for the proposed offset area does not impact on the current state of the vegetation. However, should a conservation order be placed on the title then this would ensure maximum protection of the offset area to ensure maximum protection.

7 Commitments and Consultation

7.1 Monitoring and Management Commitments

The management strategy that will be undertaken to protect and manage the proposed offset in perpetuity, including the:

- Placement of a conservation covenant over the offset in perpetuity.
- Repair and maintenance of fencing surrounding the offset.
- Weed management and control within the offset.

EMRC also has a Red Hill Landfill Rehabilitation Program which has been adopted since 1996 and forms an integral part of the site Environmental Management System. This rehabilitation plan will be applied to the proposed offset area for the Farm Stage 3, 4 & 5 Landfill. The objectives of the Landfill Rehabilitation Program are:

- Establish self-sustaining native vegetation cover over completed landfill areas;
- Integrate rehabilitated areas with neighbouring bushland to re-instate biological and wildlife links by establishing similar species composition to that of surrounding bushland;
- Rehabilitate completed landfill areas in a manner consistent with the likely future land-use options for the site (e.g. bushland, passive recreation)

The program which is undertaken annually, involves designing and constructing final cell landforms, blending and application of topsoils, construction of drainage contours and erosion control mechanisms, direct seeding, tubestock planting, and weed control.

A master species list for rehabilitation has been developed under the program and is based on flora assessments of neighbouring bushland reserves such as the John Forrest National Park. A seed collection program on remnant bushland found within the Red Hill property and buffer areas has also been implemented during 2013 to enhance the level of endemic seed used in the program.

Species selection is also based on supporting landfill rehabilitation requirements which includes shallow rooted species to avoid compromising the landfill cap and creating fugitive methane emissions. However, deep rooted species such as *Corymbia calophylla*, *Eucalyptus marginata*, and *Eucalyptus wandoo* have previously been planted on cell batters and bunds as these areas do not generate methane. The most recent planting of these species occurred over 3.25 hectares on the batters of Farm Stage 1 in 2011 and 2012.

On average, approximately 6 hectares is rehabilitated each year depending on the available completed area of landfill. The program has resulted in the rehabilitation of approximately 70 hectares of former landfill cells at the Red Hill facility. Annual rehabilitation monitoring has shown plant numbers, densities, species richness and ongoing natural recruitment to have reached healthy levels, indicating that these areas have progressed towards a self- sustaining system.

The ERMC is intent of retaining as much of the natural bush lands at the site as possible to ensure minimal impact on the foraging habitat used by Black Cockatoos and to this end will continue to quarantine areas of habitat from future development.

7.2 Consultation

An important aspect within the Farm Stage 3, 4 & 5 Landfill site pertains to consultation carried out with stakeholders and various parties which may be involved. Regular contact will be maintained stakeholders to ensure that there will be minimal inconvenience and impact on their activities.

Consultation has been undertaken with EMRC regarding the project. EMRC operates the Red Hill Waste Management Facility on behalf of six member councils. Communication with external parties about site issues and significant environmental aspects is through community liaison meetings, which are hosted on a quarterly basis.

Community liaison meetings are minuted, reviewed internally and copies distributed to relevant EMRC staff and meeting attendees. Public access to the minutes is provided through the EMRC website at http://www.emrc.org.au/environmental-management.html (under heading Community Engagement).

The dates meetings that are held this year are published on http://www.emrc.org.au/community-engagement.html and notice of meetings are advertised in three local newspapers, the Gidgegram, Hills Gazette and Midland Kalamunda Reporter.

In addition, letter drops are conducted to inform residents living near the facility of relevant environmental activities taking place on site, such as pest management and fire risk mitigation programs.

Outside these avenues of consultation, direct complaints and enquiries can be made. Complaints are handled according to our Environmental Management System. An environmental register of complaints is maintained, and investigations of complaints are conducted by relevant officers. Responses are provided to the complainant by the Site Manager, Environmental Operations Manager, or Director of Waste Services.

Appendix A: Farm Stage 3 Clearing Plan

Appendix B: Farm Stage 3, 4 & 5 Clearing Plan

Appendix C: Flora and Vegetation Assessment Site 2, Lot 12 within the Red Hill Waste Management Facility (Helena Holdings WA Pty Ltd 2010)

Appendix D: EMRC Red Hill Waste Management Facility - Black-Cockatoo Assessment (Bamford Consulting Ecologists 2014)

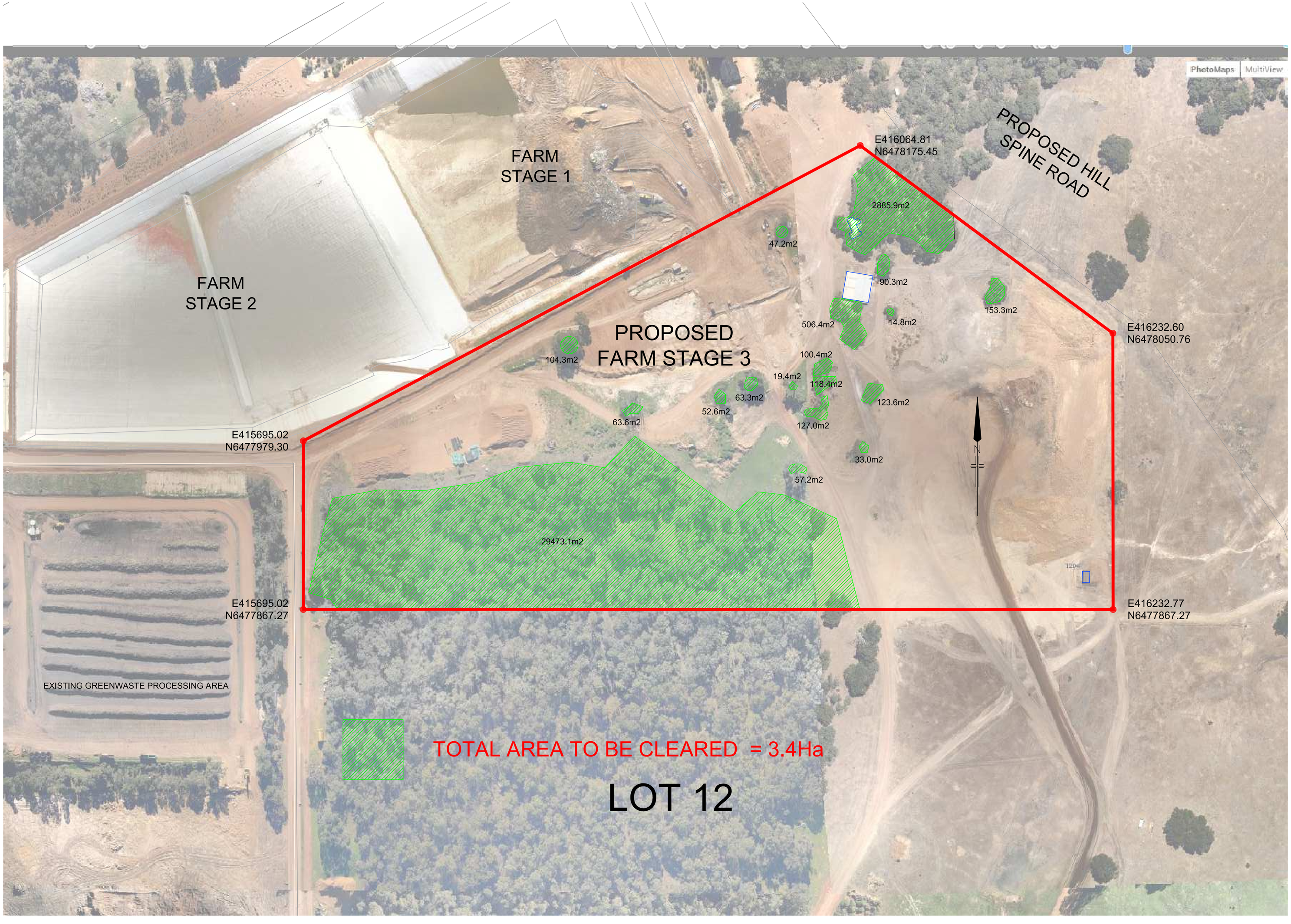
Appendix E: EMRC Red Hill Waste Management Facility - Black-Cockatoo Habitat Tree Assessment (Bamford Consulting Ecologists 2015)

Appendix F: Proposed Offset Area – NVCP Stage 3 only

Appendix G: Proposed Offset Area – Stages 3, 4 & 5 (EPBC Act and EP Act)

Appendix H: Shire of Mundaring Zones and Reserves

ID	Area (ha)	Area (m^2)
1	0.01043	104.3
2	0.00636	63.6
3	0.00526	52.6
4	0.00633	63.3
5	0.00194	19.4
6	0.01003	100.3
7	0.01184	118.4
8	0.0127	127
9	0.00572	57.2
10	0.0033	33
11	0.01236	123.6
12	0.05064	506.4
13	0.00472	47.2
14	2.94731	29473.1
15	0.00903	90.3
16	0.00148	14.8
17	0.01533	153.3
18	0.28859	2885.9
TOTAL	**3.40337**	**34033.7**



NOT FOR CONSTRUCTION

NO.	INT.	DATE	REVISION
D	GA	01/07/2014	CLEARANCE AREA REDUCED TO 3.4 HECTARES
C	GA	27/06/2014	COORDINATES FROM AGD AMG 84 TO GDA MGA 94
B	GA	12/11/2013	REISSUED FOR CLEARING PERMIT
A	GA	31/07/2013	ISSUED FOR CLEARING PERMIT

DESIGNED GA 07/2013
DRAWN AS 07/2013
CHECKED GA 07/2013
APPROVED
GA
MANAGER, ENG & WASTE SERVICES

SCALES
1:1250 (A1)
1:2500 (A3)

COORDINATES SYSTEM
GDA MGA 94
ALL LEVELS IN AHD

ADDRESS
1094 TOODYAY ROAD
RED HILL

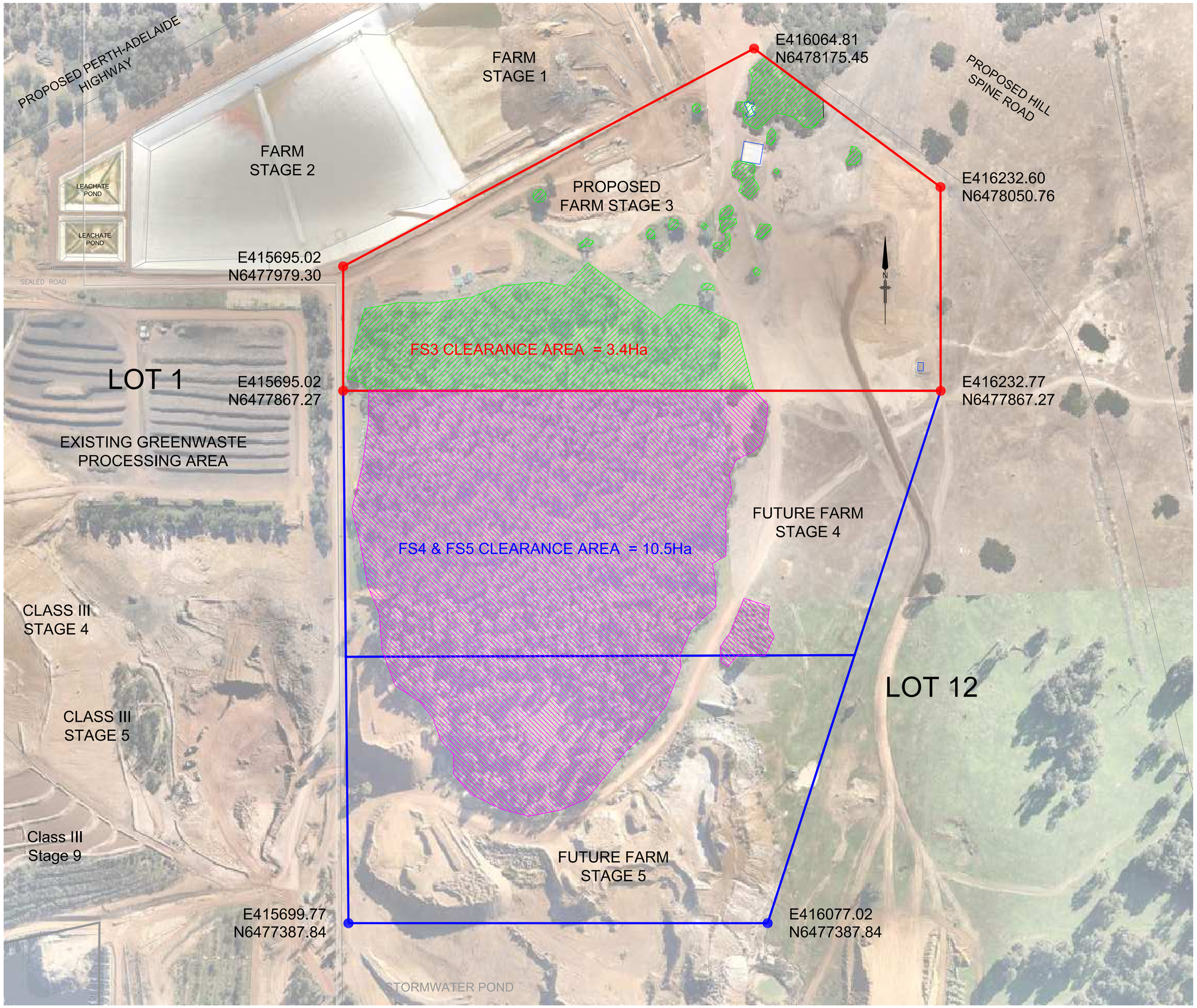
COORDINATES AT ADDRESS MAIN ENTRY GATE
EASTING: 414819.50
NORTHING: 6477981.65

RED HILL WASTE
MANAGEMENT FACILITY

FARM STAGE 3
CLEARING PLAN

Eastern Metropolitan Regional Council
1st Floor Ascot Place, 226 Great Eastern Hwy
Belmont, Western Australia 6104
PO Box 234 Belmont Western Australia 6984

DRAWING NO. 2014-01-FS3-09 (formerly 2014-01-FS3-02)
AMENDMENT D
A1



NOT FOR CONSTRUCTION

NO.	INT.	DATE	REVISION
A	GA	01/07/2014	ISSUED FOR CLEARING PERMIT

DESIGNED GA 07/2014
DRAWN AS 07/2014
CHECKED GA 07/2014

APPROVED

GA
MANAGER, ENG & WASTE SERVICES

SCALES
1:2000 (A1)
1:4000 (A3)

COORDINATES SYSTEM
GDA MGA 94
ALL LEVELS IN AHD

ADDRESS
1094 TOODYAY ROAD
RED HILL

COORDINATES AT ADDRESS MAIN ENTRY GATE
EASTING: 414819.50
NORTHING: 6477981.65

RED HILL WASTE MANAGEMENT FACILITY

FS3, FS4 & FS5 CLEARANCE PLAN

Eastern Metropolitan Regional Council
1st Floor Ascot Place, 226 Great Eastern Hwy
Belmont, Western Australia 6104
PO Box 234 Belmont Western Australia 6984

DRAWING NO. 2014-01-FS3-10
AMENDMENT A
A1

Flora and Vegetation Assessment
Site 2, Lot 12 within the Red Hill Waste Management Facility.

Prepared for:
EASTERN METROPOLITAN REGIONAL COUNCIL
1st Floor/226 Great Eastern Highway
BELMONT WA 6104

By:
HELENA HOLDINGS WA Pty Ltd
12 Marnie Road
GLEN FORREST WA 6071

May 2010
REF: EMRC 09-01

Report Details

Proposal no.	Report version	Issued to	Issue date	Issue format
HH009P	v1 - draft	Rachael Lovegrove	18/01/2010	Electronic
	v2 - final	Rachael Lovegrove	2/5/2010	Electronic

File Name	EMRC09-01 Red Hill drf_v2_final
Contact person	Anne Harris
Client	Eastern Metropolitan Regional Council
Survey personnel	Anne Harris & Diana Papenfus
Report preparation	Anne Harris & Diana Papenfus
Photographs taken by	Diana Papenfus

DISCLAIMER

Table of Contents

Executive Summary

Helena Holdings Pty Ltd was commissioned by the Eastern Metropolitan Regional Council (EMRC) to conduct a flora and vegetation assessment of Site 2, Lot 12 within the Red Hill Waste Management Facility, 24 kilometres north east of Perth in the Shire of Swan. This assessment is a requirement for a clearing application currently being sought by the EMRC.

A clearing permit for Site 1 of Lot 12 was obtained in December 2007, and site works for the first landfill cell in this Lot is currently under way. An extension into Site 2 (the project area) of Lot 12 is now being planned. A previous survey, encompassing Sites 1 and 2, was undertaken in November 2003 by ATA Environmental. No conservation significant flora or vegetation was found during the survey at that time.

Site 2 is comprised of two distinctly different areas. Area 1 is 13.5 hectares of remnant native vegetation in the highest elevation and Area 2 is 36.5 ha of grazing pasture with isolated or scattered groups of predominantly *Corymbia calophylla* (Marri) trees.

A Level 1 survey was undertaken on October 27th 2009. A total of 72 taxa were recorded from the project area; 39 native taxa from a diverse range of 18 Families, and 33 weed taxa from 17 Families. Two occurrences of a Priority 4 plant, *Templetonia drummondii*, were recorded from within Area 1.

The potential for clearing vegetation within Site 2, Lot 12 to adversely impact on the conservation status of *Templetonia drummondii*, was determined to be low. However, low plant numbers per population recorded to date increase the likelihood of population decline due to habitat fragmentation. The number of populations and plants recorded from secure land tenure is also low at 12.82% and 13.04% respectively.

Two of the weed species are listed under the Agriculture and Related Resources Protection Act 1976, as a Declared Plant or a Pest Plant. *Echium plantagineum* (Paterson's curse) is a Declared Plant, and *Citrullus lanatus* (Pie Melon) is a Pest Plant.

No Threatened Ecological Communities were recorded. The vegetation community occurring in Area 1 with minimal variation was Forest to Woodland of *Corymbia calophylla, Eucalyptus marginata* and *Allocasuarina fraseriana* over Thicket of *Banksia sessilis* var. *sessilis* over occasional shrubs and herbs on fine to medium grained sandy gravel with scattered to numerous laterite outcropping. The remaining extent of the pre-European vegetation type mapped on Site 2 is 72.1%. Therefore, the regional impact of the EMRC proposal on the vegetation type is low.

The project area has been subjected to major disturbances including clearing, logging, burning and grazing. These have resulted in the remnant of native vegetation becoming isolated from the closest linkage being the northern boundary of John Forrest National Park, 350 m to the south. Modification of all plant strata has occurred, however the vegetation within the central portion of Area 1 was determined to be in Good condition with evidence of the ability to regenerate. Condition of Area 2 is Completely Degraded. No expression of *Phytophthora* spp. induced dieback was evident.

The *Banksia sessilis* var. *sessilis* (Parrot bush) occurring within the remnant vegetation of Area 1 was mostly in good condition and as such can contribute to the food sources for the Endangered Species of *Calyptorhynchus latirostris* (Carnaby's Black-Cockatoo). Although Banksia species in general have been documented as one of the food sources, three other species recorded for the project area, *Corymbia calophylla* (Marri), *Banksia grandis* and *Allocasuarina fraseriana* are known food sources for another species, *Calyptorhynchus baudinii* (Baudin's Black-Cockatoo), listed as Vulnerable.

Marri trees have also been documented as habitat for Carnaby's Black-Cockatoo. Large Marri trees were recorded from within the Area 1 remnant vegetation and also as isolated or scattered groups of trees within Area 2. EMRC's proposal to clear Site 2 will contribute to the reduction of these trees, thereby reducing possible food sources and potential habitat for both species of Black Cockatoos.

1.0 Introduction

Helena Holdings Pty Ltd was commissioned by the Eastern Metropolitan Regional Council (EMRC) to conduct a flora and vegetation assessment of Site 2, Lot 12 within the Red Hill Waste Management Facility. Lot 12 is 24 kilometres north east of Perth in the locality of Gidgegannup and the Shire of Swan, in the South-West region of Western Australia (Figure 1). The southwest boundary adjoins the John Forrest National Park. This assessment is a requirement for a clearing application currently being sought by the EMRC.

Background

The EMRC owns the Red Hill Waste Management Facility, utilised by the Shires of Bassendean, Bayswater, Belmont, Swan, Kalamunda and Mundaring. The Facility has been in operation for 25 years with waste management activities undertaken in Lots 1, 2 and 11. A clearing permit for Site 1 of Lot 12 was obtained in December 2007, and site works for the first landfill cell in this Lot is currently under way. An extension into Site 2 (the project area) of Lot 12 is now being planned.

The entire project area of 50 hectares was utilised for grazing with 36.5 ha cleared for pasture and 13.5 ha of the highest elevation retained as remnant native vegetation. This remnant is now isolated from the surrounding land-uses including rural, semi-rural and conservation purposes.

Regional Environment and Vegetation

The project area is situated on the Darling Plateau of the Darling Region to the east of the Darling Scarp. The plateau is an ancient erosion surface capped by an extensive lateritic duricrust, which has been dissected by later drainage. It overlies Archaean granite and metamorphic rocks and has an average elevation of about 300m (Beard 1981). Soils are yellow-brown to reddish brown gravels, loose, fine to coarse, ferruginous pisolites that are poorly sorted with variable amounts of sand and silt in matrix of colluvial origin and minor re-cementation (Smurthwaite 1986).

The project area lies in the higher rainfall western sector of the Dale Subdistrict of the Darling Botanical District, within South West Botanical Province. The climate is classified as Dry Warm Mediterranean, with 5-6 dry months per year. Regional vegetation of the area was mapped under the Darling Vegetation System within the major catena of 'Jarrah/Marri Forest' ($E^2/_3$ Mc) (Beard 1976).

Minor catenas of the Darling Vegetation System were recognised and described as Vegetation Complexes by Heddle *et al*. (1980) and Site Vegetation Types by Havel (1975). The project area is situated within the Dwellingup Complex of 'Open Forest of *Eucalyptus marginata* and *E. calophylla'* (now known as *Corymbia calophylla*) and has characteristics consistent with the Havel site type S.

Flora and Vegetation of Conservation Significance

A previous survey of the entirety of Lot 12, encompassing Sites 1 and 2 was undertaken in November 2003 by ATA Environmental. Four species of Priority status flora were reported to be known from the vicinity; *Halgania corymbosa* and *Nemcia acuta* Priority 3, *Darwinia pimelioides*, and *Templetonia drummondii* Priority 4. However, no conservation significant flora or vegetation was found during the survey at that time.

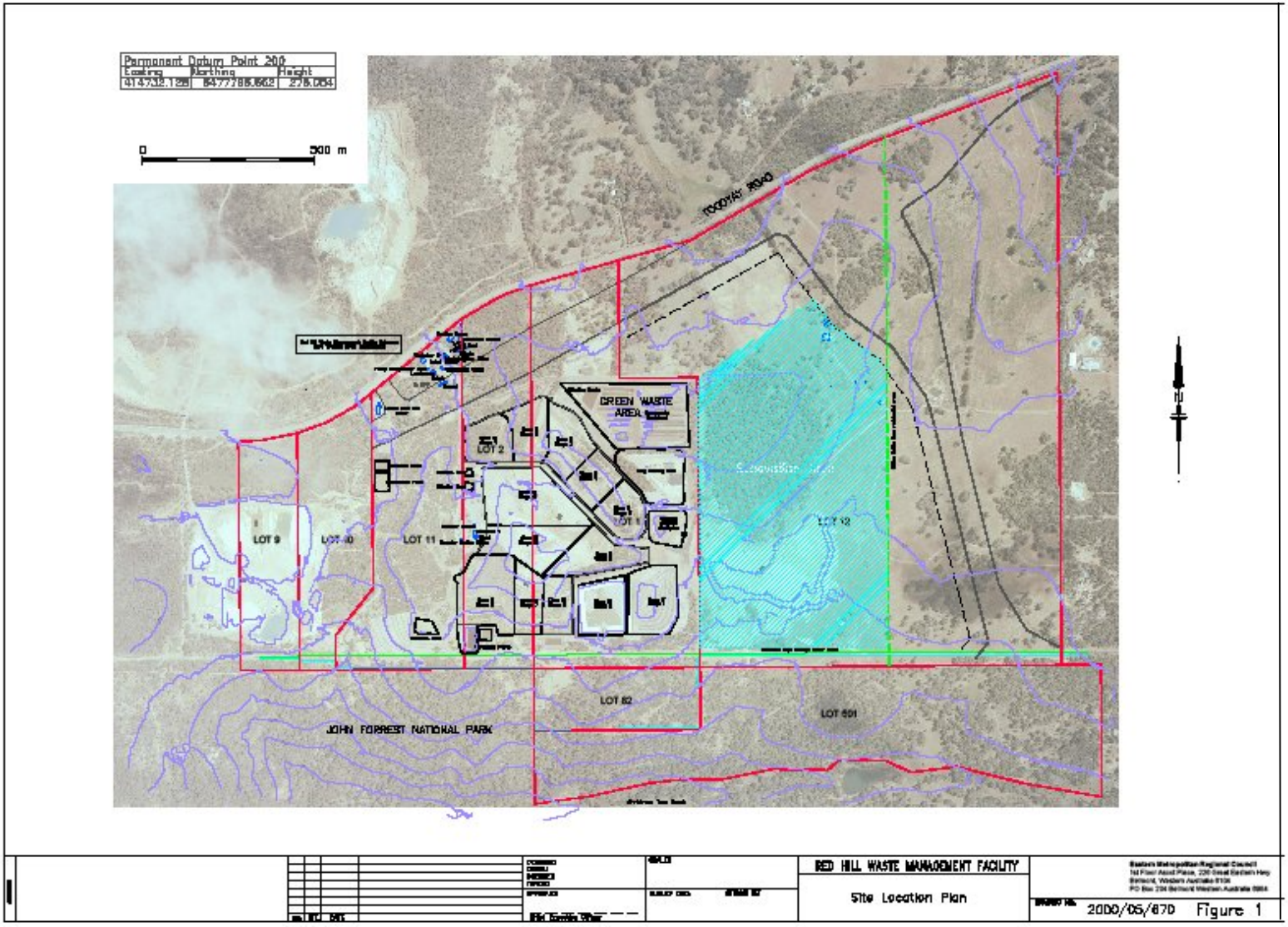


Figure 1. Location Map of the project area Site 2, Lot 12, Red Hill Waste Management Facility.

2.0 Project Objective

The primary objective of this project was to undertake a flora and vegetation survey of Site 2, Lot 12 within the Red Hill Waste Management Facility. Three additional requests were detailed under Scope of Works heading within the Request for Quotation document (DM-102349) supplied by EMRC. These are:

- Information needs to be included in regards to the potential for numerous priority flora and DRF records to occur within the study area,
- Assessment made of the extent and condition of the (Dryandra) *Banksia sessilis* (Parrot Bush) stands as this vegetation type is considered the preferred feeding plants for the Carnaby's Black Cockatoo,
- An assessment of the potential impact of clearing on flora and vegetation.

3.0 Level of Survey

A Level 1 survey was undertaken for this project in accordance with the directions given by the client (EMRC) under Scope of Works heading within the Request for Quotation document (DM-102349).

The project area is located within Bioregion Group 2, (Jarrah Forest). Native vegetation within this Bioregion remains extensive and/or largely contiguous but is used as a commercial resource. The Scale and Nature of Impact was determined as Low and Moderate for all of the Area Characteristics listed in Table 3 (EPA 2004). The majority of the project area (36.5 ha) has been cleared for agriculture with a remnant (13.5 ha) of modified native forest retained on rocky ground at the highest elevation. The entire area is to be cleared for waste management operations.

4.0 Method

Desktop

A search for conservation significant flora for the survey area including a 5 km radius buffer was obtained from the Department of Environment and Conservation (DEC). A reference herbarium of the species was then compiled using images sourced from *Florabase* website (DEC 2009), and notes taken while reviewing the plants held at the Western Australian Reference Herbarium. Current information on plant taxonomy, habitat preference and nomenclature were also researched.

Field Survey

The survey was undertaken on October 27th 2009 by Diana Papenfus and Anne Harris. Site 2, Lot 12 is comprised of two distinctly different areas and were therefore, surveyed differently. Area 1 is 13.5 hectares of remnant bushland and Area 2 is predominantly cleared grazing pasture with isolated or scattered groups of trees (Appendix 1). Within Area 1 transects were walked as close as possible to 20 m apart in order to locate as many plants as possible. Locally distinct vegetation communities were described using the method of Muir (1977) with brief descriptions of soils and rock outcropping. Site-based vegetation condition was determined in accordance with the scale used in Keighery (1994). Criteria used to determine vegetation communities and condition are presented in Appendices 2 and 3.

All native flora was collected under flora licence SL8571, and Declared Rare Flora permit 180-0809. Locations were marked by using a 12 channel Garmin GPS set at WGS84 datum. In the event of locating conservation significant taxa, information required for the

completion of Rare Flora Report forms, for the DEC database, was recorded in accordance with conditions of the collection license. Specimens identified as having conservation status and those requiring further determination were confirmed by using the Reference collection at the WA Herbarium and by consulting with the relevant taxonomic experts.

Survey Limitations

No constraints were identified as limiting the results of this survey. Information sources; survey and sampling intensity; mapping reliability; timing of survey; level of access and experience level of personnel were all determined to be adequate for the project.

5.0 Results

Flora

A search by the Department of Environment and Conservation (DEC) of their *Threatened (Declared Rare) Flora* database and *Declared Rare* and *Priority Flora* list and also the *Western Australian Herbarium specimen* database, identified 21 plant taxa of conservation significance as occurring within a 5 km radius of the survey site (Appendix 4). Three taxa are Declared Rare plants while the remainder have varying levels of Priority status. One of the Priority 3 plants, *Nemcia acuta,* (now known as *Gastrolobium acutum*) reported in ATA (2003) as known to occur within the surrounding area, has since been taken off the list of conservation status flora. Definitions of the Rare and priority flora categories are presented in Appendix 5.

A total of 72 taxa were recorded from the project area; 39 native taxa from a diverse range of 18 Families, and 33 weed taxa from 17 Families. A complete list of taxa is presented in Appendix 6. Two occurrences of the Priority 4 plant *Templetonia drummondii*, were recorded from within Area 1 and are shown on the Priority Flora Location map in Appendix 1. This plant is a prostrate or ascending shrub that can grow to 0.4 m high. Yellow-brown and purple flowers are borne in late winter to late spring. (Figures 2a, 2b). Locations are shown on the botanical survey map in Appendix 1.

Figure 2a. *Templetonia drummondii* (P4) from Area 1. 2b. Image from Florabase (DEC 2009) showing an open flower. Accessed on Monday November 30, 2009.

Two of the weed species are listed under the Agriculture and Related Resources Protection Act 1976, as a Declared Plant or a Pest Plant. *Echium plantagineum* (Paterson's curse) is a Declared Plant, and *Citrullus lanatus* (Pie Melon) is a Pest Plant (Hussey *et al*. 1997). Both plants were found within the cleared Area 2.

Vegetation

No Threatened Ecological Communities were recorded for the project area. The dominant community occurring in Area 1 with minimal variation was Forest of *Corymbia calophylla, Eucalyptus marginata* and *Allocasuarina fraseriana* over Thicket of *Banksia sessilis* var. *sessilis* over occasional shrubs and herbs (Figure 3) on fine to medium grained sandy gravel with scattered to numerous laterite outcropping. Variations occurred relative to the presence of laterite, the depth of soil and level of soil-moisture retention. These variations influenced the density of cover (*i.e.* Forest to Woodland or Thicket to Dense Thicket) and the diversity of species within the middle and understorey strata. *Banksia grandis* and *Persoonia elliptica* were recorded as only occasional components, predominantly in the southern section, while the understorey stratum of low shrubland, that normally occurs within this community, was largely missing due to past clearing and grazing.

Figure 3. The dominant community within the remnant bushland of Area 1.

Vegetation occurring on Area 2 (36.5 ha) is isolated or scattered groups of trees, predominantly *Corymbia calophylla* (Marri), or completely cleared land with a dense covering of pasture weeds. These weeds dominated the edges of the remnant bushland and have infiltrated to a modest extent into the centre of the remnant vegetation.

Condition of the remnant bushland in Area 1 varied from Good (*i.e.* Vegetation structure significantly altered by very obvious signs of multiple disturbances) to Degraded at the edges (*i.e.* Basic vegetation structure severely impacted by disturbance). The impacts of past logging, animal grazing and middle storey shrub deaths due to senescence were evident within the area. However, recruitment of tree species was also noted with seedlings of *Allocasuarina fraseriana*, *Banksia sessilis* var. *sessilis*, *Eucalyptus marginata* and *Persoonia elliptica* observed. No expression of *Phytophthora* spp. induced dieback was evident. All data recorded for the survey site is presented in Appendix 7.

Banksia sessilis var. *sessilis* stand assessment

Banksia sessilis var. *sessilis* was recorded from within the remnant vegetation of Area 1 as a dominant component of the vegetation structure (Figure 4). The majority of plants were mature, healthy and flowering and occurred as a Thicket to Dense Thicket in over 50% of the vegetated area.

Figure 4. Dense Thicket of *Banksia sessilis* var. *sessilis* within Area 1 of Site 2.

Collapse of mature *Banksia sessilis* var. *sessilis* shrubs were observed in a small localised patch in the south-east portion of the remnant. The cause is unknown however, is more likely to be due to natural senescence or drought conditions.

Figure 5. Localised stand of *Banksia sessilis* var. *sessilis* senescence.

As the majority of *B. sessilis* var. *sessilis* plants were mature, healthy and flowering, it is reasonable to determine that this stand of *B. sessilis* var. *sessilis* can contribute to the food

sources for the Endangered Species of *Calyptorhynchus latirostris* (Carnaby's Black-Cockatoo). However, it must be emphasised that no germinants and a low number of juvenile recruits were observed within Area 1. As *B. sessilis* var. *sessilis* is a known disturbance opportunist and coloniser, it is likely that this stand is a senescing population.

6.0 Impact Assessment

Flora

The potential for clearing vegetation within Site 2, Lot 12 to adversely impact on the conservation status of the *Templetonia drummondii*, has been assessed considering the proportion of populations and plants to be affected, in relation to the total number known regionally.

A population is regarded as a recorded location for a plant, or a number of plants, which are separated by 500 m or more from the next recorded location (Brigitte Long[1] *pers. comm.*). Plant numbers are often not given for populations in the WA Herbarium and DEC databases, as many populations are found opportunistically; and limited data is recorded. In these instances only a single plant can be given for the population. In instances where descriptions, instead of plant numbers are recorded (*eg* common, scattered, occasional, locally abundant etc.) a precautionary approach has been taken and low plant numbers have been ascribed to these populations as follows:

rare = 1
occasional, scarce = 2
few, uncommon, sparse = 3
scattered, several = 5
common frequent, numerous, moderate = 10
abundant, very common, locally dense.

As a result of this process, the number of plants is almost certainly underestimated.

Table 1 presents data on the impact assessment of the EMRC proposal on populations and plant numbers collated for *Templetonia drummondii*. Table 5 presents information on the security of those populations and plants.

Table 1. *Templetonia drummondii* (P4) impact assessment.

Total no. of known pop^{ns}	No. of pop^{ns} to be impacted by EMRC proposal	% of pop^{ns} to be impacted by EMRC proposal	Total no. of known plants	Total no. of plants to be impacted by EMRC proposal	% of total plants to be impacted
39	1	2.56	69	2	2.89

Results of the analysis indicate a low level of impact on the *Templetonia drummondii* by the EMRC proposal. However, only five of the 39 populations (12.82%) are located within lands that have secure tenure and are managed for conservation purposes such as John Forrest National Park. Nine plants from a total of 69 known (13.04%) have security of reservation.

Vegetation

Vegetation occurring within Area 1 of Site 2, Lot 12 was mapped by Beard (1976) as $E^2/_3$ Mc, Jarrah/Marri Forest and is located within Bioregion Group 2, (Jarrah Forest) which has extensive and/or largely contiguous native vegetation remaining. Mapping of current extents

[1] Brigitte Long, Database officer, DEC, Threatened Species and Communities Unit

of remaining pre-European vegetation was undertaken over a number of years and reported on by Shepherd *et al.* (2001). The corresponding vegetation type identified by Shepherd *et al.* (2001) for Beard's Association of $E^2/_3$ Mc is Vegetation Type 3 of which 72.1% of its original extent remains (as at 2001). Ten percent of this is reserved for conservation within Class 1-1V reserves, while 67.9% is located within 'other reserves' (Shepherd *et al.* 2001). Therefore, from this data it is determined that the regional impact of the EMRC proposal on the vegetation type is low.

7.0 **Discussion**

The project area has been subjected to major disturbances including clearing, logging and fire especially on the mid-slopes within Area 2 (Figure 7). This has resulted in the remnant native vegetation on the highest elevation of Area 1, becoming fragmented from the northern boundary of John Forrest National Park by 350 m. Modification of all plant strata has occurred through previous land practices, which has altered the original vegetation composition of the upperstorey from the 'Jarrah/Marri Forest' mapped by Beard (1976) to varying density of Forest to Woodland, of *Corymbia calophylla* (Marri) and *Eucalyptus marginata.* Localised patches within this community now occur including dominance of *Allocasuarina fraseriana* and dense regrowth of *Banksia sessilis* var. *sessilis.*

Significant reductions in the diversity and cover of understorey species have occurred and there is weed invasion into the edges of the remnant. There is scope for regeneration but not to a state approaching good condition without intensive management (*i.e.* Degraded). Grazing by native and exotic fauna is evident throughout, with indigenous species not able to achieve sufficient growth for favourable establishment or recruitment. However, the central portion of Area 1 was determined to be in Good condition (Keighery 1994) as it retains the basic vegetation structure, and as seedlings of several species were observed, it has the ability to regenerate.

The Priority 4 species, *Templetonia drummondii* was recorded twice within Area 1. It has been well recorded locally from John Forrest National Park, the Red Hill area, Kalamunda, Glen Forrest, Mundaring Weir, Parkerville, Chidlow and Lesmurdie. The preferred habitat is under Forest or Woodland of predominantly Eucalyptus species including, *E. marginata*, *E. accedens*, *E. wandoo* and *E. decurva* on lateritic soils. Although many populations are documented, the number of plants within each population is low.

Templetonia drummondii currently has a known range extent of 12,350 km^2 and as such narrowly falls outside the nominated 10,000 km^2 area of a Short Range Endemic. The distribution is reasonably linear, and is approximately 300 km from its northern extent near Bindoon, to its southern extent near Kojonup. *T. drummondii* is endemic to two Biogeographic Regions of Australia, the Swan Coastal Plain and Jarrah Forest, both within the South-West Botanical Province.

Plants recorded from lands under reservation are afforded some protection from the threat of disturbance and are buffered from the effects of land degradation. The number of populations and plants recorded from secure land tenure (WAHERB and DEFL databases) were low at 12.82% and 13.04% respectively. As stated under heading 6.0 Impact Assessment, the plant numbers are almost certainly underestimated. However, low plant numbers per population recorded so far, indicate that this species either does not readily recruit, requires a disturbance event or plants are short-lived. Therefore, habitat fragmentation is an important threat, especially where the range extent narrowly falls outside that of a Short Range Endemic.

Two species of weeds recorded for the project area are listed under the Agriculture and Related Resources Protection Act 1976, as plants that are, or may become, a problem to agriculture or the environment. *Echium plantagineum* (Paterson's curse) is a Declared Plant, and *Citrullus lanatus* (Pie Melon) is a Pest Plant (Hussey *et al*. 1997). Declared Plants are placed in categories according to the control strategies required and administered by the Department of Agriculture and Food. Local Government Authorities are responsible for enforcing control of plants that are declared as Pest Plants.

No Threatened Ecological Communities were recorded from the project area. The remaining extent of the mapped vegetation type is 72.1% (Shepherd *et al*. 2001). This amount is well over the 30% pre-clearing threshold level, below which species loss appears to accelerate exponentially (EPA 2000). Although the vegetation type is not under threat, Site 2, Lot 12 has large Marri trees present that are known habitat and/or food sources for two species of threatened Black-Cockatoos. Additional values of the remnant bushland include a refuge for migratory species and also as a seed source that is from the same provenance for regeneration projects on the Red Hill Waste Management Facility.

An assessment of the extent and condition of the *Banksia sessilis* (Parrot Bush) stand within the project area was requested within the Scope of Works, with regard to food sources for Carnaby's Black-Cockatoo. Results of the field survey have been detailed under heading 5.0 within this report. It is not the intention of the authors to determine whether this stand of *B. sessilis* var. *sessilis* is important enough to the Black-Cockatoo's to retain. However, relevant information was obtained that is worth highlighting.

Documentation shows that the seeds of *Banksia sessilis* var. *sessilis* are a food source for Carnaby's Black-Cockatoo in the Mundaring area. Interestingly, they were found to occur in equal proportions as Marri seeds (*Corymbia calophylla*) within the crops of Cockatoos from studies undertaken from 1965 to 1970 (Saunders 1974). This study also found seeds of *Banksia grandis* within their crops, although to a lesser extent. *Allocasuarina fraseriana*, also recorded from Area 1, is known to be a minor food source for Carnaby's Cockatoo (Mitchell 2003).

Further information highlights the importance of *Corymbia calophylla* trees for breeding. Johnstone *et al*. (2006) states, The Carnaby's Black-Cockatoo is currently expanding its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain. During the breeding season, the Black-Cockatoo mainly forages in native vegetation, and particularly in Proteaceous shrubs in kwongan heathlands. It occasionally forages in Marri forests, and may also seek food in or near altered habitat (Department of Environment 2009).

Marri seeds are the preferred food for another conservation status species, *Calyptorhynchus baudinii* Baudin's Black-Cockatoo. This bird is listed as Vulnerable under the *EPBC Act 1999*. Carnaby's Black-Cockatoo has been identified as associating with Baudin's Black-Cockatoo at sites where food is abundant (Department of Environment 2009).

Large Marri trees were recorded from within the Area 1 remnant vegetation (Figure 6) and as isolated or scattered groups of trees within Area 2. The EMRC proposal to clear Site 2 will therefore, contribute to the reduction of habitat and possible food sources for both species of Black Cockatoo.

Figure 6. One of the large *Corymbia calophylla* (Marri) trees within Area 1.

8.0 References

ATA (2003). *Red Hill Farm PT Loc 1317 Toodyay Road Flora, Vegetation and Fauna Report.* An unpublished report prepared for Eastern Metropolitan Regional Council, Belmont, Western Australia.

Beard J.S. (1976). *Vegetation Survey of Western Australia. The Vegetation of the Geraldton Area Western Australia.* Map and Explanatory Memoir, 1:250,000 Series. Vegmap Publications, Perth.

Beard J.S. (1981). *Vegetation Survey of Western Australia. Swan.* 1:1,000,000 Vegetation Series, Explanatory Notes to Sheet 7.

Beard J.S. (1990). *Plant Life of Western Australia.* Published by Kangaroo Press Pty Ltd, Kenthurst NSW.

DEC (2009). Western Australian Herbarium Florabase 2 – Information on the Western Australian Flora. Department of Environment and Conservation, Western Australia. http://florabase.dec.wa.gov.au.

Department of the Environment, Water, Heritage and the Arts (2009). *Calyptorhynchus latirostris* in Species Profile and Threats Database, Department of the Environment, Water, Heritage and the Arts, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 2009-12-05T02:24:26.

Environmental Protection Authority (2000). *Environmental Protection of Native Vegetation in Western Australia.* Position Statement No. 2.

Environmental Protection Authority (2004). Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. In Statement No. 51. *Guidance for the Assessment of Environmental Factors.*

Havel, J.J. (1975). Site-Vegetation Mapping in the Northern Jarrah Forest (Darling Range). In Bulletin 86. *Definition of Site-Vegetation Types.* Forests Department, Perth.

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

Hussey B.M.J., Keighery G.J., Cousens R.D., Dodd J. and Lloyd S.G. (1997). *Western Weeds. A guide to the weeds of Western Australia.* A Plant Protection Society of Western Australia (Inc.) publication. Victoria Park, WA.

Johnstone, R.E., C. Johnstone, T. Kirkby & G. Humphreys (2006). *Perth-Bunbury Highway (Kwinana Freeway Extension and Peel Deviation): Targeted Threatened Fauna Survey*. Unpublished Report to Main Roads Western Australia.

Keighery B. (1994). *Bushland Plant Survey. A Guide to Plant Community Survey for the Community.* A Wildflower Society of WA (Inc.) Publication.

Mitchell D. (2003). *Conserving Carnaby's Black-Cockatoo, Future Directions.* Proceedings from a conservation symposium held in Perth. Western Australia by Birds Australia & the Department of Conservation and Land Management on 2/7/2003.

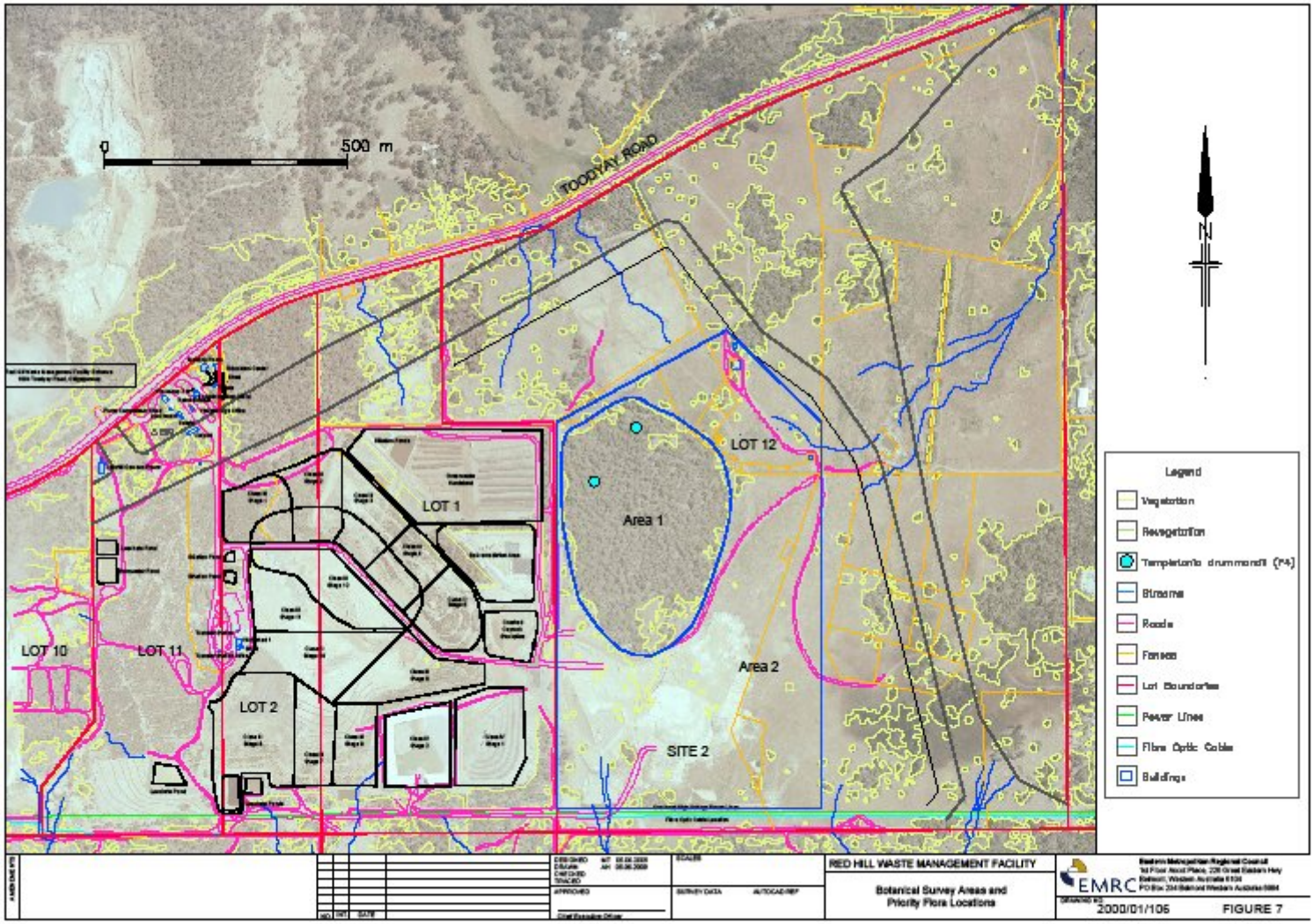
Muir B.G. (1977). *Biological survey of the Western Australian Wheatbelt*. Part 2: Vegetation and habitats of Bendering Reserve. Records of the Western Australian Museum Supplementary Series, 3: 1–142.

Saunders D.A., (1974). The Occurrence of the White-tailed Black Cockatoo*, Calyptorhynchus baudinii,* in *Pinus* Plantations in Western Australia in *Australian Wildlife Research*, 1974, Volume 1, pp. 45-54. Division of Wildlife Research, CSIRO, Clayton Road, Helena Valley, W.A. 6056.

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

Smurthwaite A.J. (1986). *Mundaring Part Sheets 2134 II & 2134 III.* Perth Metropolitan Region, Environmental Geology Series, Geological Survey of Western Australia.

9.0 Appendix 1. Figure 7. Map of Site 2, Lot 12 showing areas of survey and locations of *Templetonia drummondii* (P4)



10.0 **APPENDIX 2. Table 1. Vegetation Classification (B.G. Muir 1977)**

FORM/HEIGHT	CANOPY COVER			
	DENSE (**d**) 70-100%	MID-DENSE (**c**) 30-70%	SPARSE (**i**) 10-30%	VERY SPARSE (**r**) 2-10%
T Trees>30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
M Trees 15-30m	Dense Forest	Forest	Woodland	Open Woodland
LA Trees 5-15m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
LB Trees <5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
KT Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
KS Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
S Shrubs >2m	Dense Thicket	Thicket	Scrub	Open Scrub
SA Shrubs 1.5-2.0m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
SB Shrubs 1.0-1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
SC Shrubs 0.5-1.0m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
SD Shrubs 0.0-0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
P Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
H Hummock Grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
GT Bunch grass >0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
GL Bunch grass <0.5m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
J Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
VT Sedges >0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
VL Sedges <0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
X Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, Liverwort	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

11.0 APPENDIX 3. Vegetation Condition Scale (B.J. Keighery 1994)

1 = Pristine

Pristine or nearly so, no obvious signs of disturbance.

2 = Excellent

Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

For example damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.

3 = 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.

4 = Good

Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate to 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.

5 = 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 to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

6 = 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 composing weed or crop species with isolated native trees or shrubs.

12.0 **APPENDIX 4. DEC list of Conservation Significant Flora for the area surrounding the Red Hill Waste Management Facility.**

22/10/2009 **DEPARTMENT OF ENVIRONMENT AND CONSERVATION** Page 1

DECLARED RARE AND PRIORITY FLORA LIST

6 October 2008

SPECIES / TAXON	CONS CODE	DEC REGION	DISTRIBUTION	FLOWER PERIOD
Acacia oncinophylla subsp.	3	SW,MW	Mogumber, Mundaring, John Forrest NP, Serpentine, Mt Lennard, Dwellingup	
Anthocercis gracilis	R	SW	Mundaring Weir, Dandalup, John Forrest NP	Sep-Oct,Apr
Aotus cordifolia	3	SR,SW	Red Hill, Byford, Witchcliffe, Upper Swan, Dwellingup, Helena Valley, Forrestdale, Dunsborough, Jarrahdale, Banjup, Wellard	Aug-Dec
Calothamnus rupestris	4	WB,SW	Red Hill, Gosnells, St Ronans N.R., Boyagin Rock	Aug-Oct
Darwinia pimelioides	4	SW	John Forrest N.P., Walyunga, Darlington, Red Hill	Oct
Diplolaena andrewsii	2	SW	Swan View, Wooroolloo Brook, John Forrest N.P.	Jul-Oct
Lepyrodia heleocharoides	3	SR,(SW)	Alexander Bridge, Scott River, Chester Block, (Parkerville)	Dec
Millotia tenuifolia var. laevis	2	SW,SR	Dunsborough, Cape Naturaliste,Collie, Red Hill	Sep-Oct
Persoonia sulcata	4	SW,WB, MW	John Forrest N.P., Wongamine N.R., Bindoon, Dardadine, Calingiri	Sep-Nov
Pithocarpa corymbulosa	3	SW,SR	John Forrest NP, Lesmurdie NP, Helena Valley, Dardanup, Busselton	Apr
Tetratheca pilifera	3	SW	Two Rocks, Chidlow, John Forrest NP	Aug-Sep
Thelymitra dedmaniarum	R	SW	Gidgegannup, Red Hill	Oct-Nov
Thelymitra magnifica	3	SW	Red Hill, Darling Range, Forrestfield	Oct,Nov
Thysanotus anceps	3	MW,SW	John Forrest, Brookton Highway, Coomallo Creek, Mt Lesueur	Dec

Additional species provided by DEC from the Threatened Species database and the WA Herbarium database.

Calytrix sylvana (P4)
Cyanicula ixioides subsp. ixioides (P4)
Cyathochaeta teretifolia (P3)
Grevillea christineae (Rare)
Halgania corymbosa (P3)
Templetonia drummondii (P4)
Thysanotus isantherus (P3)

13.0 APPENDIX 5. Priority Flora Categories and their Definitions.

From: Ken Atkins. 31/5/95. CALM Wildlife Branch (ref: KJA 14/9/94)

R: **Declared Rare Flora - Extant taxa**

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.

X: **Declared Rare Flora - Presumed Extinct Taxa**

Taxa which have not been collected or otherwise verified over the past 50 years despite thorough searching, or of which all known populations have been destroyed more recently, and have been gazetted as such.

Priority One **Poorly Known Taxa**

Taxa which are known from one or a few (generally < 5) populations which are under threat either due to small population size or being on lands under immediate threat, eg: road verges, urban areas, active mineral leases etc, or the plants are under threat eg: from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora' but are in need of urgent further survey.

Priority Two **Poorly Known Taxa**

Taxa which are known from one or a few (generally < 5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are urgent need of further survey.

Priority Three **Poorly Known Taxa**

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

Priority Four **Rare Taxa**

Taxa which are considered to have been adequately surveyed which whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 - 10 years.

Notes:

* = species which also occur outside Western Australia.

x = species presumed to be the result of hybridisation.

ms = manuscript names. These names have not been published and must be indicated as being manuscript names whenever used either by the standard format of the addition of ms after the name, or the inclusion in inverted commas.

14.0 **APPENDIX 6. Total List of Taxa Recorded for Site 2, Lot 12 Red Hill Waste Management Facility.**

*denotes weed species

ZAMIACEAE

Macrozamia riedlei

POACEAE

*Aira cupaniana (Hairgrass)

*Briza minor (Shivery grass)

*Bromus diandrus (Great Brome)

*Ehrharta longiflora (Annual veldt grass)

*Hordeum leporinum (Barley grass)

*Lolium perenne (Perennial ryegrass)

*Vulpia bromoides (Squirrel's tail fescue)

Amphipogon amphipogonoides

Austrodanthonia setacea

Neurachne alopecuroidea

ASPARAGACEAE

*Asparagus asparagoides (Bridal creeper)

Chaemascilla corymbosa

Dichopogon capillipes

Lomandra hermaphrodita

Lomandra micrantha

Lomandra preissii

Thysanotus thyrsoideus

COLCHICACEAE

Burchardia congesta

HEMEROCALLIDACEAE

Caesia micrantha

HAEMODORACEAE

Conostylis setosa

Haemodorum laxum

IRIDACEAE

*Gladiolus caryophyllaceus (Pink gladiolus)

*Hesperantha falcata

*Romulea rosea (Guildford/onion grass)

ORCHIDACEAE

*Disa bracteata (South African orchid)

Caladenia flava subsp. flava

Thelymitra graminea

CASUARINACEAE

Allocasuarina fraseriana

MORACEAE

*Ficus carica (Edible fig)

PROTEACEAE

Banksia grandis

Banksia sessilis var. sessilis

Persoonia elliptica

PHYTOLACCACEAE

*Phytolacca octandra (Inkweed)

DROSERACEAE

Drosera callistos

Drosera erythrorhiza

PITTOSPORACEAE

Billardiera fusiformis

PAPILIONACEAE

*Chamaecytisus palmensis (Tagasaste)

*Lotus angustissimus (Narrowleaf trefoil)

*Trifolium campestre (Hop clover)

Hovea trisperma var. trisperma

Kennedia coccinea

Templetonia drummondii **Priority 4**

GERANIACEAE

*Erodium cicutarium (Common storksbill)

DILLENIACEAE
Hibbertia huegelii
Hibbertia ovata

MYRTACEAE
Corymbia calophylla
Eucalyptus marginata

APIACEAE
*Galium murale (Bedstraw)
Trachymene pilosa
Xanthosia candida

EPACRIDACEAE
Leucopogon nutans
Leucopogon nutans

PRIMULACEAE
*Anagallis arvensis var. arvensis (Scarlet pimpernel)

BORAGINACEAE
*Echium plantagineum (Paterson's curse) **Declared Plant**

SOLANACEAE
*Solanum nigrum (Black berry nightshade)

CUCURBITACEAE
*Citrullus lanatus (Pie melon) **Pest Plant**

CAMPANULACEAE
*Wahlenbergia capensis (Cape bluebell)

STYLIDIACEAE
Levenhookia pusilla
Stylidium calcaratum
Stylidium ciliatum

ASTERACEAE
*Arctotheca calendula (Capeweed)
*Hypochaeris glabra (Smooth catsear)
*Senecio diaschides
*Sonchus oleraceus (Sowthistle)
Lagenophora huegelii
Millotia tenuifolia var. tenuifolia
Trichocline spathulata

15.0 **APPENDIX 7. Site based data – Site2, Lot 12 Red Hill Waste Management Facility.**

Date of survey – 27/10/2009

Photo #	GPS coordinates (WGS84)		Species	Reproductive stage	Community descriptions	Community condition	Comments
808, 809, 810	415882	6477952	Corymbia calophylla	Vegetative	Community 1 - Forest of Corymbia calophylla, Eucalyptus marginata and Allocasuarina fraseriana over Banksia sessilis var. sessilis Thicket over occasional shrubs and herbs on fine to medium grained sandy gravel with scattered to numerous laterite outcropping.	4 - Good	80% leaf litter. Rabbit activity. Recruitment of Banksia and Jarrah occurring at this site. Higher cover of weed species invading the west end of the bushland on this transect.
			Eucalyptus marginata	Vegetative			
816, 817			Hibbertia ovata	In bud			Numerous Hibbertia ovata at the north-west end of the bushland. Often associated with the laterite outcropping.
			Macrozamia riedlei	Vegetative			Macrozamia is heavily grazed.
			Dichopogon capillipes	Vegetative			
			Trichocline spathulata	Flowering			
			Banksia grandis	Vegetative			Occasional Banksia at west end of transect.
			Trachymene pilosa	Flowering			
	415859	6477954	Templetonia drummondii	Vegetative			Priority 4 plant.
812-815, 824			Thelymitra graminea	Flowering			
			Caesia micrantha	Flowering			
			Haemodorum laxum	Old flower scape			
811	415859	6477954	Caladenia flava var. flava	Flowering			
			Kennedia coccinea	Vegetative			
	415848	6477947	*Vulpia bromoides	Flowering			
			Chaemascilla corymbosa	Flowering			
818	415829	6477957	Thysanotus thyrsoideus	In bud			Growing predominantly on the leeward side of fallen logs.
			Lomandra preissii	Old flower scape			
			Conostylis setosa	Old flower scape			Conostylis is grazed.
			Neurachne alopecuroidea	Vegetative			
829	415808	6477845	Stylidium calcaratum	Flowering			
819-822	415756	6477926	Drosera callistos	Flowering			
			Leucopogon nutans	Vegetative			

Photo #	GPS coordinates (WGS84)		Species	Reproductive stage	Community descriptions	Community condition	Comments
			Lomandra micrantha	Old flower scape			
			Lagenphora huegelii	Vegetative			
			*Sonchus oleraceus	Flowering			
823			*Galium murale	Flowering			
			*Arctotheca calendula	Flowering			
			*Bromus diandrus	Flowering			
			*Lolium perenne	Flowering			
			*Solanum nigrum	Vegetative			
	415721	6477909	Billardiera fusiformis	Vegetative			Billardiera is heavily grazed.
			*Gladiolus caryophyllaceus	Vegetative			
			*Asparagus asparagoides	Vegetative			
			*Lotus angustissimus	Flowering			
			*Ehrharta longiflora	Flowering			
			*Disa bracteata	Flowering			
			*Hypochaeris glabra	Vegetative			
	415721	647783	Xanthosia candida	In bud	Community 1		Vegetation on this transect is still the same community. Laterite outcropping is more numerous.
825-828	415774	6477843	Templetonia drummondii	In bud			Templetonia drummondii is a Priority 4 plant. Hundreds of Drosera callistos at this site.
			Levenhookia pusilla	Flowering			
			Lomandra hermaphrodita	Vegetative			
			Austrodanthonia setacea	Flowering			
			*Aira cupaniana	Flowering			
832, 833			Caladenia flava subsp. flava	Flowering			
			Thelymitra graminea	Vegetative			
			Thysanotus thyrsoideus	Vegetative			
			Stylidium ciliatum	Flowering	Community 1a - Forest of Corymbia calophylla and Eucalyptus marginata over Dense Thicket of Banksia sessilis var. sessilis with occasional Persoonia elliptica and Banksia grandis over occasional shrubs and herbs on shallow depths of fine to medium grained sandy gravel with laterite outcropping.	4 - Good	The vegetation is a mosaic of Communities 1 and 1a with patches of more open middle storey and 30-70% upperstorey.

Photo #	GPS coordinates (WGS84)		Species	Reproductive stage	Community descriptions	Community condition	Comments
			Amphipogon amphipogonoides	Flowering			
			Hibbertia ovata	Flowering			
			*Senecio diaschides	Vegetative			
			Hibbertia commutata	Flowering			
	415946	6477846	Hibbertia huegelii	Vegetative			
834						5 - Degraded	Photo 834 is of open understorey and weed patch on the eastern edge of the remnant bushland.
835, 836							Photos 835 & 836 are of pasture weeds.
837						4 - Good	Photo 837 is a vegetation community photo where Banksia sessilis var. sessilis cover is <2%.
838, 839			Hibbertia ovata	Flowering			
840						4- Good	Photo 840 is of vegetation community variation - Higher cover of Allocasuarina fraseriana and less cover of Banksia sessilis var. sessilis under Corymbia calophylla and Eucalyptus marginata.
			*Ficus carica	Vegetative			
			Hovea trisperma var. trisperma	Vegetative			
						4 - Good	Areas of shrub collapse at the south-eastern end of the remnant bushland. Predominantly Banksia sessilis var. sessilis. Not dieback, most likely senescence. Persoonia elliptica still healthy
			Burchardia congesta	Fruiting			
			Drosera erythrorhiza	Vegetative			
843-845	415848	647768	Hibbertia huegelii	Flowering			
			*Briza minor	Fruiting			
			*Romulea rosea	Vegetative			
846, 847			Thelymitra graminea	Flowering			

Photo #	GPS coordinates (WGS84)		Species	Reproductive stage	Community descriptions	Community condition	Comments
848-852					Small area of Community 1b. Open Woodland of Corymbia calophylla and Eucalyptus marginata over Dense Thicket of Banksia sessilis var. sessilis with occasional Allocasuarina fraseriana and Banksia grandis over occasional shrubs and herbs.	5 - Degraded	There is a less diverse layer of shrubs and herbs in the southern portion of the remnant bushland and less overall cover.
			Macrozamia riedlei	Vegetative			
			Persoonia elliptica seedlings	Vegetative			Seedlings are under dense Banksia sessilis var. sessilis.
			Allocasuarina fraseriana seedlings	Vegetative			
858-860						5 - Degraded	Photos 858-860 are of a stand of Allocasuarina fraseriana over dense weeds dominated by Poaceae species.
			*Avena fatua (Wild oat)		Pasture	6 - Completely Degraded	Additional pasture weeds of the Completely Degraded areas of cleared land.
			*Poa annua (Winter grass)		Remaining area of Site 2 is isolated trees or scattered groups of trees (predominantly Corymbia calophylla) over pasture weeds.	6 - Completely Degraded	
			*Raphanus raphanistrum (Wild radish)				
			*Orobanche minor (Lesser broomrape)				
			*Lupinus cosentinii (WA blue lupin)				

EMRC Red Hill Waste Management Facility
Black-Cockatoo Assessment

Red-tailed Black-Cockatoo feeding on Marri fruit.

Prepared for: Eastern Metropolitan Regional Council
PO Box 234
BELMONT, WA 6984

Prepared by: Mike Bamford and Gillian Basnett
Bamford Consulting Ecologists
23 Plover Way, Kingsley, WA 6026

7th April 2014

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The Eastern Metropolitan Regional Council (EMRC) operates the Red Hill Waste Management Facility on Toodyay Road, Red Hill, and is seeking to expand the area used for landfill. As part of the environmental review requirements for this expansion, Bamford Consulting Ecologists (BCE) was commissioned by EMRC to undertake investigations into the use and habitat quality of the proposed new landfill site by Black-Cockatoos (Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*, Baudin's Black-Cockatoo *C. baudinii*, and Carnaby's Black-Cockatoo *C. latirostris*) and the potential for a neighbouring section of bush to be used as an offset.

This fauna assessment evaluates the potential of the anticipated landfill site to provide significant habitat for the Black-Cockatoos and whether the proposed offset area provides a similar or greater quality and quantity of habitat. In particular, the focus was on identifying the potential nesting and foraging values for Black-Cockatoos. Surveys on the potential for the study area to be a roosting site weres not undertaken, although the BirdLife Great Cocky Count was used to determine local roosting sites for Carnaby's Black-Cockatoos.

1.1 Background

1.1.1 Description of Project Area

The project area consists of the proposed future landfill site (Lot 12) and the proposed offset site (Lots 82 and 501) and is situated approximately 27 km north east of the Perth Central Business District and 8 km south of Gidgegannup (Figure 1). The proposed future landfill site (hereafter landfill area) is bounded by Toodyay Road to the north, existing cleared pastoral areas to the east, the current waste dump to the west and bushland of the proposed offset area to the south. The possible offset area (hereafter offset area) has existing residential areas within bushland to the south and east and John Forrest National Park to the west (Figure 2).

The landfill area is approximately 71 ha in size. Most of the site has been cleared for quarry and pastoral purposes with few to no trees; the patches of remnant bushland cover approximately 18 ha, about 25% of the landfill area (Figure 2). The offset area is 56 ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads (Figure 2).

The proposed development is two phase, with clearing of approximately 7.4 ha of remnant bush in the landfill area under the current clearing permit application and the remaining 10.6 ha in future clearing for landfill (Figure 3). EMRC has proposed to offset this clearing by protecting the bush within the offset area, currently a buffer zone for the waste management facility, beyond the life of the rubbish tip. The native vegetation of the site is described as scattered to open Jarrah-Marri forest with an understorey dominated by Parrot Bush (*Banksia sessilis*), Sheoak (*Allocasuarina fraseriana*), *Xanthorrhoea preissii*, Egg and Bacon Bush (*Eutaxia obovata*) and *Grevillea wilsonii*, and scattered *Calothamnus sanguineus* and *Hakea undulata*.

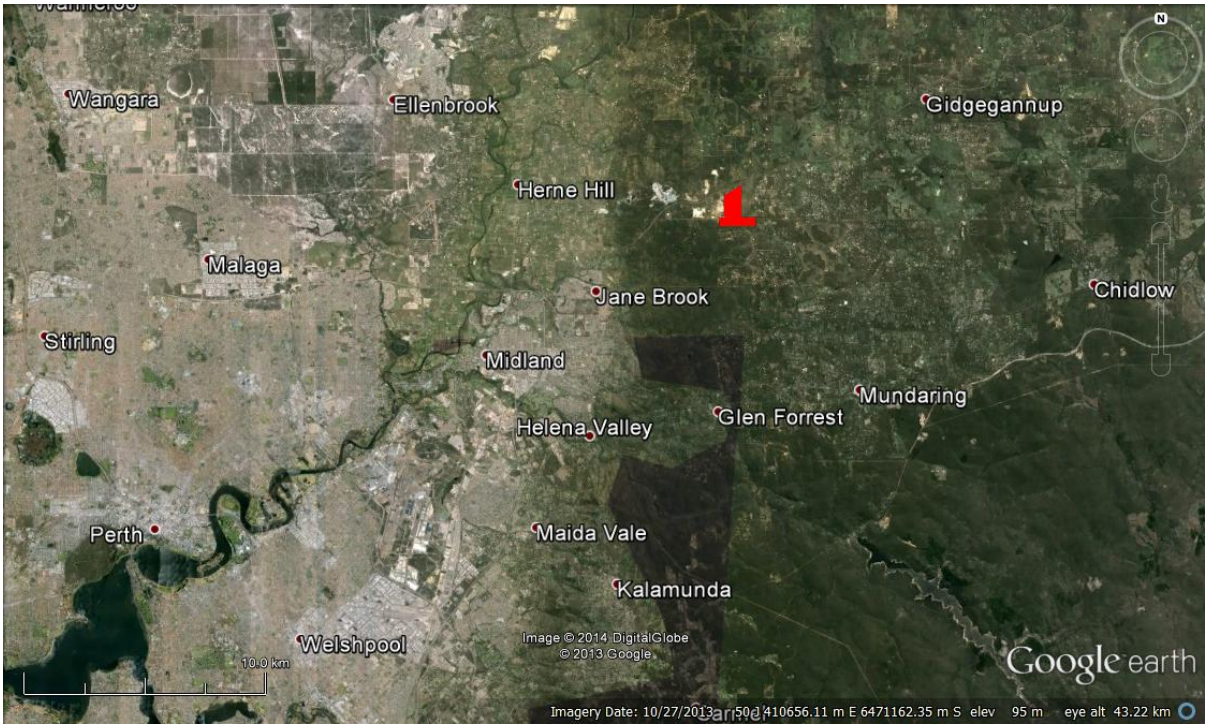


Figure 1. Location of the study area (red).

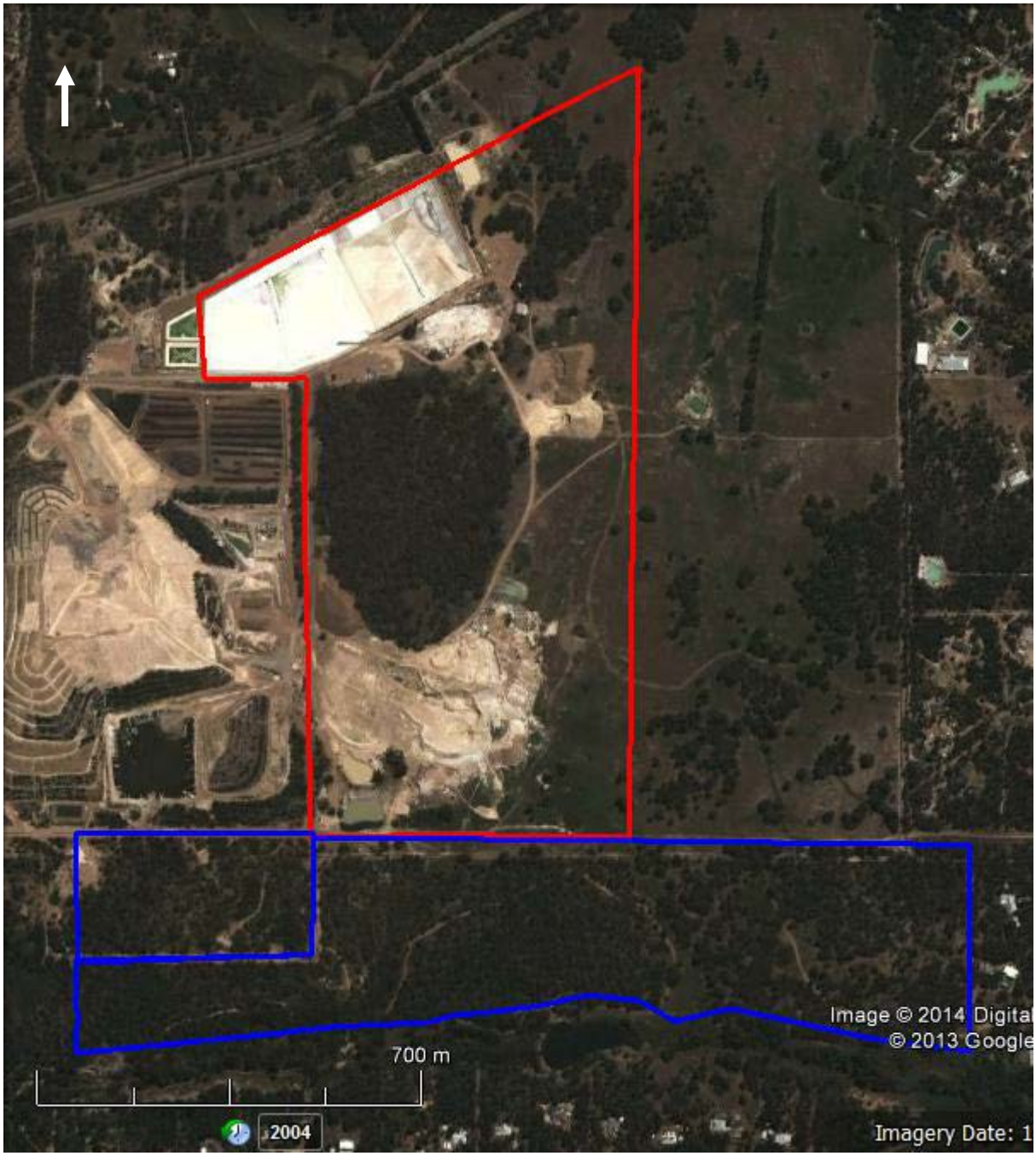


Figure 2. The study site (landfill area red, offset area blue).

Figure 3. Proposed clearing areas for landfill. North of the purple line is the current clearing permit application, south of the purple line is planned future clearing cells for landfill.

1.1.2 Black-Cockatoos

1.1.1.1 Species, Ecology, Habitat Requirements and Threats

The three south-western Western Australian taxa of Black-Cockatoo are listed in Table 1. All species are listed under both the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* and the Western Australian *Wildlife Conservation Act 1950*, as indicated in Table 1. All are likely to occur in the vicinity of the project area.

Table 1. Black-Cockatoos likely to occur in the vicinity of the project area.

The status of each species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA 1999) and the Western Australian *Wildlife Conservation Act 1950* (WCA 1950) is shown.

Species		EPBCA 1999	WCA 1950
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable	Schedule 1 (Vulnerable)
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Schedule 1 (Endangered)
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	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.* 2010);
- Recovery plans (Cale 2003; DEC 2008);
- EPBC guidelines (DEWHA 2010);
- Commonwealth listing and conservation advice (DEWHA 2009a, b);
- The federal Department of Sustainability, Environment, Water, Population and Communities' (DSEWPaC; 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, 2010); and
- Major reports (Johnstone *et al.* 2011; Kabat *et al.* 2012 a).

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 project 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 residents and 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).
- 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 Appendix 1).

Key threats

- Key threatening processes include illegal shooting, habitat loss and degradation leading to shortages in food, nest hollow shortage, competition for available nest hollows from other parrots and feral Honeybees (*Apis mellifera*), and illegal trade.

1.1.1.2 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 are at least 230 years old, and the majority of nests are found in 300-500 year old trees (Johnstone 2006).

DSEWPaC (2010, 2011, 2012a, b, c, d) recommends 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).

2 METHODS

2.1 Survey Date and Personnel

The study area was inspected on 4th March 2014 by Gillian Basnett (B.Sc. (REM), M.Env.Sc., M.Env.Sc. (res)) and Peter Orell (B.Sc. Hons. M.Sc.). Data analysis and report preparation were by Mike Bamford (B.Sc. Hons. Ph.D.) and Gillian Basnett. Foraging habitat, including signs of feeding debris, and breeding habitat were assessed. A roost survey was not undertaken but Kabat *et al.* (2012 b) was investigated to determine any local Carnaby's Black-Cockatoo Roost sites.

2.2 Black-Cockatoo Surveys

2.2.1 Foraging Habitat

The suitability of the study site for Black-Cockatoo foraging was assessed by walking transects and inspecting 24 (12 in each of the landfill and offset areas, Table 2), 20 metre by 20 metre (400 m^2) quadrats, to determine the presence and quantity of preferred forage plants (as set out in Appendix 1) and any signs of foraging (such as chewed nuts). The total number of each species of foraging plant was recorded for every quadrat and coordinates for feeding debris were taken. All sightings of Black-Cockatoos in the area were noted.

Plant information within the quadrats were then used to calculate the number of each species per quadrat within landfill and offset areas (total plant number/12), then per hectare (plant per quadrat / 400 X 10000) and therefore across each site (plants per ha x 18 for landfill and 56 for offset).

Table 2. Coordinates for the quadrats surveyed in March 2014.

Landfill Site		Easting	Northing	Offset Site		Easting	Northing
Landfill 01	50J	415822	6477904	**Offset 01**	50J	415376	6477031
Landfill 02	50J	415826	6477823	**Offset 02**	50J	4155523	6477049
Landfill 03	50J	415826	6477743	**Offset 03**	50J	415758	6476981
Landfill 04	50J	415830	6477650	**Offset 04**	50J	415863	6476981
Landfill 05	50J	415833	6477593	**Offset 05**	50J	415973	6476983
Landfill 06	50J	415974	6477631	**Offset 06**	50J	416074	6476981
Landfill 07	50J	415967	6477711	**Offset 07**	50J	416173	6476985
Landfill 08	50J	415960	6477791	**Offset 08**	50J	416276	6476986
Landfill 09	50J	415954	6477870	**Offset 09**	50J	416402	6476987
Landfill 10	50J	415930	6477952	**Offset 10**	50J	416513	6476988
Landfill 11	50J	416139	6478239	**Offset 11**	50J	416610	6476989
Landfill 12	50J	416132	6478382	**Offset 12**	50J	416721	6476986

2.2.2 Breeding Habitat

Consistent with the recommendations of DSEWPaC (2010, 2011, 2012a, b, c, d), a survey for potential hollow-bearing (nest) trees was conducted within the study area. Time constraints meant the entire study area could not be examined. Therefore each of the foraging quadrats was inspected for the presence of suitable nest trees: tree species known to be used for nesting in the area (e.g. Marri and Jarrah) with a diameter-at-breast-height (DBH) greater

than 500 mm (see Section 1.1.1.2). While walking the transects, any large tree with potential Black-Cockatoo hollows seen outside the quadrats were also recorded. Tree information within the quadrats were then used to calculate the number trees greater than 500 DBH per quadrat within landfill and offset areas (total tree number/12), then per hectare (tree per quadrat / 400 X 10000) and therefore across each site.

For any tree that met these criteria:

- DBH was measured;
- trees were assessed (from the ground) for presence of hollows suitable for Black-Cockatoos (entrance diameter greater than 100 mm, see Section 1.1.1.2);
- 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 with a DBH > 500mm to reflect their likely value for breeding has been developed by BCE and ranges from 1 to 5. 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.
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. Potential to become a nest tree in the future.

2.2.3 Roost Site Information

A roost survey was not undertaken as there are no records from EMRC staff of the landfill or offset areas being used for roosting by black-cockatoos. However, data collated from the Great Cocky Count run by BirdLife Australia in 2011 and 2012 (Kabat *et al.* 2012 a and b) were used to determine regional roost sites for Carnaby's Black-Cockatoo, Red-tailed and Baudin's Black-Cockatoos are not included in the Great Cockatoo Count although aggregations of these species tend to be noted.

2.3 Comparison of Landfill and Offset Sites

The survey was to both determine the value of the project area to Black-Cockatoos for foraging and breeding, and whether the vegetation within the offset area is comparable to that in the landfill area and is enough to offset the potential loss of Black-Cockatoo habitat should the landfill area be cleared for the expansion of the waste dump. Calculations of the types and number of foraging plants and large potential current and future nest trees in both areas will be compared to determine whether the offset area contains similar or more foraging and

breeding habitat than the landfill area. This information will then be used to determine the suitability of the proposed offset area.

3 RESULTS AND DISCUSSION

3.1 Black-Cockatoos

3.1.1 Cockatoo Presence and Foraging Habitat

1.1.1.3 Landfill Area

The native vegetation of the landfill area was open Marri / Jarrah forest with scattered Sheoak. The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, Parrot Bush and Sheoak, with scattered Bull Banksia (*Banksia grandis*) and Snottygobble (*Persoonia longifolia*).

Assessment of the quadrats (Table 3) show the western two thirds of the large block of vegetation (about half the total native vegetation within the landfill area) contained a dense understorey of Parrot Bush with scattered Bull Banksia (Figure 4 and 5). The remainder of the large block and the smaller blocks to the northeast had an open understorey with scattered Parrot Bush, Bull Banksia and the occasional Snottygobble (Figure 6). In most quadrats, Jarrah was the dominant tree species but there were few large trees. The entire site, particularly the areas with dense Parrot Bush, is thus considered quality foraging habitat for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos.

No Black-Cockatoos were seen of heard in the landfill area during the survey, although this was a very short time period: 3 hours. The only sign of foraging was recorded in the southeast of the larger vegetation block, where very old signs of Forest Red-tailed Black-Cockatoos feeding on Marri were found (Figure 7). Despite the lack of evidence of Black-Cockatoos using the site, the continued clearing of habitat is a key threatening process for all three species (Garnett and Crowley 2000). All Marri and Jarrah woodlands and remnants in the south-west of Western Australia are critical for survival of Black-Cockatoos (DEC 2008).

Table 3. Number of individual Black-Cockatoo foraging plants in each quadrat in the landfill area.

Site	Marri	Jarrah	Parrot Bush	Sheoak	Bull Banksia	Snottygobble	Hakea	Grasstree
Landfill 01	2	6	300	2	0	0	0	0
Landfill 02	4	2	150	0	0	0	0	0
Landfill 03	0	9	100	1	0	0	0	0
Landfill 04	2	2	150	0	0	0	0	0
Landfill 05	3	3	50	0	1	0	0	0
Landfill 06	4	5	0	5	0	0	0	0
Landfill 07	5	8	5	1	1	1	0	0
Landfill 08	2	5	25	0	0	0	0	0
Landfill 09	1	7	0	2	0	0	0	0
Landfill 10	3	7	0	0	0	0	0	0
Landfill 11	1	8	6	5	0	0	0	0
Landfill 12	7	6	0	6	0	0	0	0
Total	34	68	786	22	2	1	0	0
Plants / quadrat	3	6	66	2	0.005	0.0025	0	0
Plants / ha	75	150	1650	50	0.1250	0.0625	0	0
Plants in landfill	1350	2700	29700	900	2.25	1.125	0	0

Figure 4. Example of the Marri/Jarrah forest with dense Parrot Bush in the Landfill area.

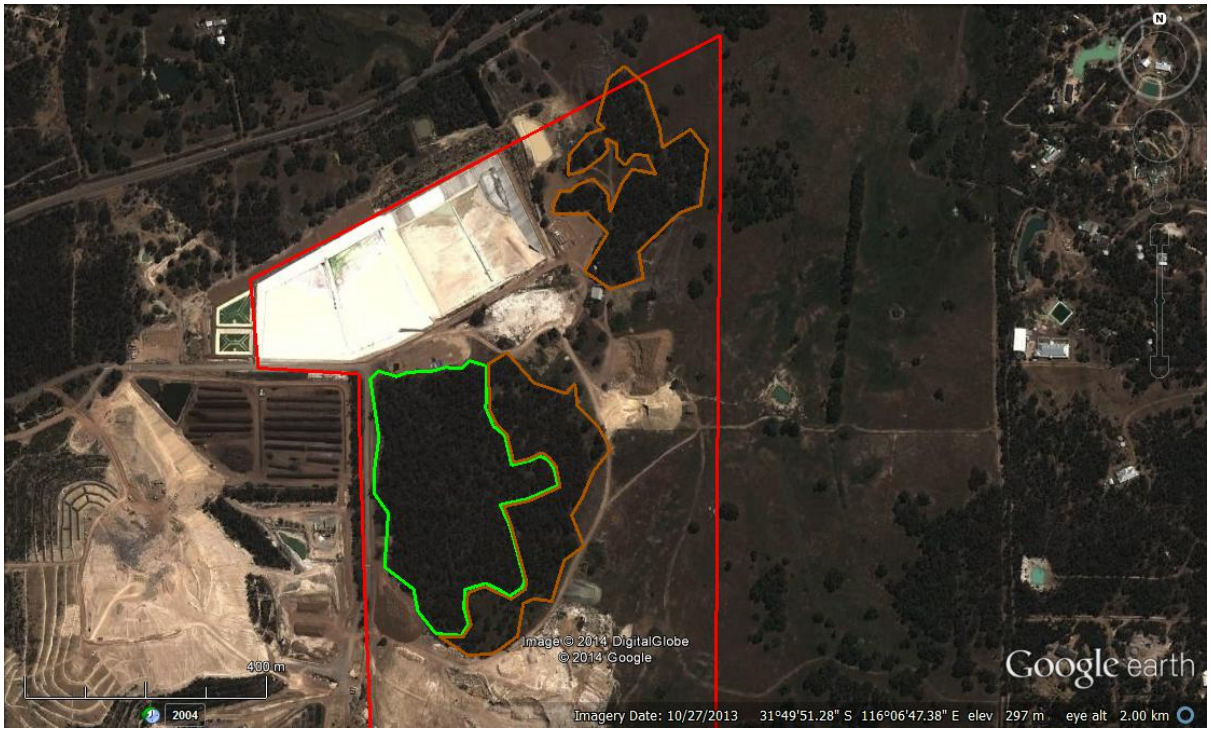


Figure 5. Vegetation with thick parrot bush understorey (green) and open understorey (brown) in the landfill area.

Figure 6. Example of the Marri/Jarrah forest with open understorey in the Landfill area.

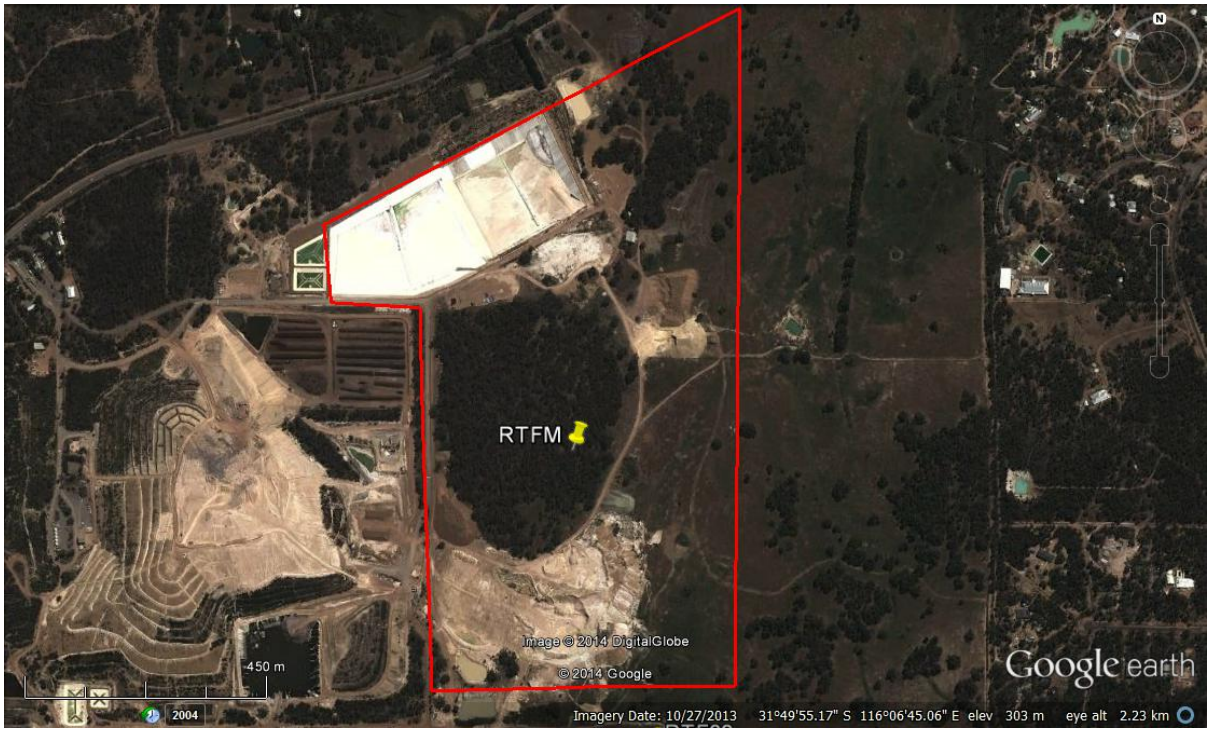


Figure 7. Location of very old Forest Red-tailed Black-Cockatoo foraging signs on Marri in the landfill area.

1.1.1.4 Offset Area

The native vegetation in the offset area was Marri / Jarrah woodland with a mostly open low understorey of proteaceous shrubs (Figure 8-10). The area included several species of value as foraging habitat for Black-Cockatoos such as Marri, Jarrah, pockets of *Hakea undulata* and occasional Parrot Bush, Sheoak, Grasstree (*Xanthorrhea preissii*), Bull Banksia and Snottygobble.

Assessment of the quadrats show the offset area quadrats contained a greater number of trees than the same number of quadrats in the landfill site (153 compared with 102), but far fewer understorey plants suitable for foraging by Black-Cockatoos (Table 4). Two species of foraging plants, *H. undulata* and *X. preisii*, were recorded in the offset area which were not in the landfill site. In most quadrats, Marri was the dominant tree species and there were a greater number of larger trees identified (Section 3.1.2). Although only small pockets of suitable feeding understorey plants were recorded, the entire site is considered quality foraging habitat for Carnaby's, Baudin's and Forest Red-tailed Black-Cockatoos due to the cover of Marri and Jarrah trees.

No Black-Cockatoos were seen in the offset area during the survey but a small flock of Carnaby's was heard to the south. BCE studies south of the site have recorded extensive foraging by all three species of Black-Cockatoos and potential breeding sites. Feeding debris between two and six months old was recorded under two Marri trees (Figure 11). One Marri nut with Carnaby's chew marks was also found but it was not near a Marri tree (likely dropped by a bird flying over) and so its origin could not be identified. Despite the lack of evidence of Black-Cockatoos using the site at the moment, the continued clearing of habitat is a key threatening process for all three species (Garnett and Crowley 2000). All Marri and

Jarrah woodlands and remnants in the south-west of Western Australia are critical for survival of Black-Cockatoos (DEC 2008).

Table 4. Number of individual Black-Cockatoos foraging plants in each quadrat within offset area.

Site	Marri	Jarrah	Parrot Bush	Sheoak	Bull Banksia	Snotty gobble	Hakea	Grasstree	Comments
Offset 01	7	5	4	0	0	0	0	0	
Offset 02	5	3	1	2	0	0	0	0	
Offset 03	2	7	2	0	0	0	3	0	
Offset 04	14	0	0	0	0	0	6	0	
Offset 05	11	4	0	0	0	0	0	0	
Offset 06	7	10	1	0	0	0	0	3	
Offset 07	7	13	0	0	0	0	0	4	
Offset 08	8	4	0	0	0	0	0	0	
Offset 09	5	0	0	0	0	0	0	0	2 trees just under DBH 500
Offset 10	11	3	0	0	0	0	0	0	Small trees DBH 50-100
Offset 11	6	3	0	0	0	0	2	0	
Offset 12	8	10	0	0	0	0	1	0	
Total	91	62	8	2	0	0	12	7	
Plants/quadrat	8	5	0.67	0.17	0	0	1	0.58	
Plants / ha	200	125	16.75	4.25	0	0	25	14.5	
Plants / offset	11200	7000	938	238	0	0	1400	812	

Figure 8. Example of Marri/Jarrah forest with open low proteaceous understorey in the offset area.

Figure 9. Example of the Marri/Jarrah forest with dense small trees in the offset area.

Figure 10. Example of Marri/Jarrah forest with sparse proteaceous understorey in the offset area.

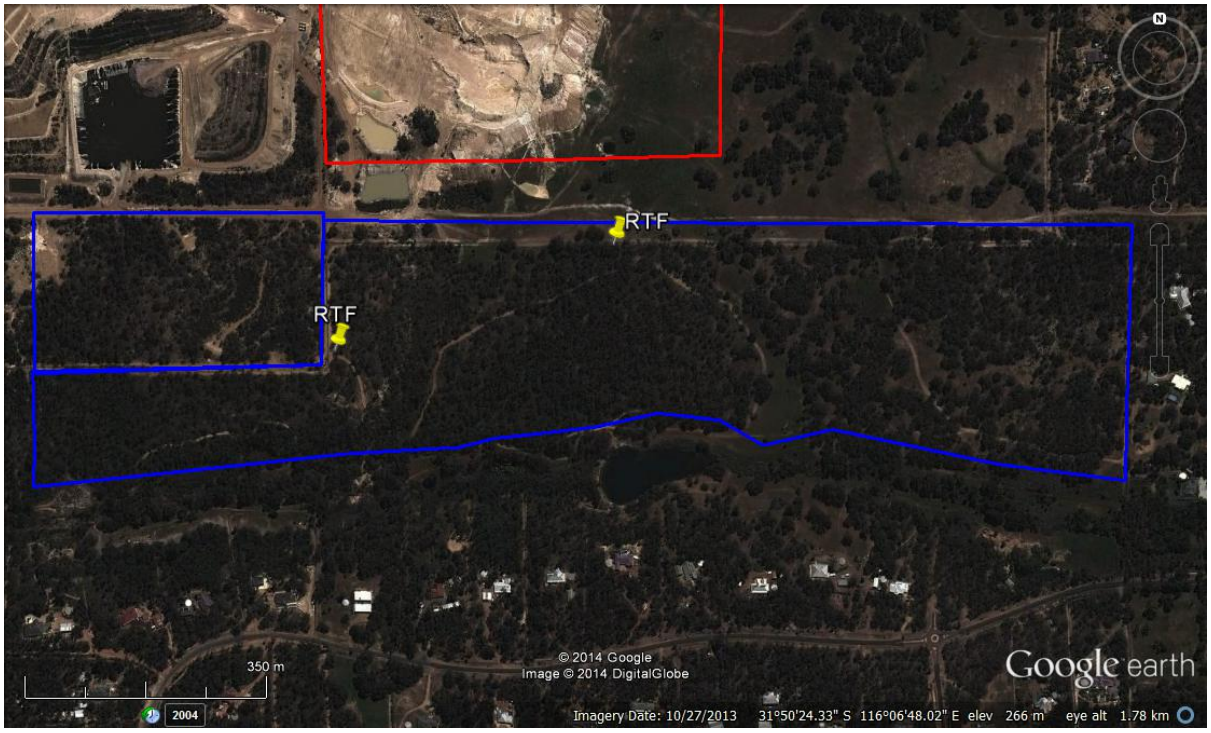


Figure 11. Locations of Forest Red-tailed Black-Cockatoo foraging debris recorded in offset area, March 2014.

3.1.2 Breeding Habitat

1.1.1.5 Landfill Area

A total of 11 trees with DBH of greater than 500 mm was recorded in the landfill area, eight within quadrats and three large, opportunistic trees (see Table 5, Appendix 2, Figure 12 and 13). Within the quadrats, no active nests were found, however one potential nesting tree (BCE Tree Score 3) was recorded. The other seven trees recorded within the quadrats did not appear to have suitable structure or hollows (BCE Tree Score 5), although it should be noted that any large tree could have a concealed suitable hollow, or may develop such a hollow and become an important nest tree in the coming decades or centuries.

Using the tree records in the quadrats, calculations of trees/quadrat, trees/ha and trees within the landfill area have been estimated for each of the BCE Tree Scores (Table 6). It is estimated that there are 45 potential nesting trees and 270 future nesting trees within the landfill area. Although no active nests were found, a thorough investigation of the area was not undertaken.

The majority of trees measured had a DBH of between 500 – 850 mm. One tree (12.5 % of trees measured) had a DBH of 950 mm; no trees within the quadrats had a DBH greater than 1000 mm. There were, however, two Marri trees recorded opportunistically outside the quadrats with a DBH between 1100 and 1200 mm (Appendix 2, Figure 13). One of these had a BCE Tree Score of 3 and one of 5. Another opportunistic tree with a BCE Tree Score of 3 had a DBH of 850 mm. Such large trees were formerly more widespread in the region but

have been reduced in number through logging. The larger and potential nesting trees were dispersed throughout the study area.

Table 5. Potential breeding trees in the landfill area.

BC score*	Number of trees			DBH			
	Marri	Jarrah	Total		Marri	Jarrah	Total
1	0	0	0	500 mm	1	1	2
2	0	0	0	501 mm – 850 mm	5	0	5
3	1	0	1	801 mm – mm 1000	1	0	1
4	0	0	0	1001 mm +	0	0	0
5	6	1	7				
Total	7	1	8	Total	7	1	8

*BC Score:
1 – Tree with active nest.
2 – Tree with large, suitable hollow bearing recent chew-marks.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout).
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout.
5 – Tree meets DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollows.

Table 6. Estimated number of trees with BCE Tree Scores 1-5 within the landfill area.

Tree Score	1	2	3	4	5	Total
Total Trees > 500	0	0	1	0	7	8
Trees/Quadrat	0	0	0.1	0	0.6	0.7
Trees/ha	0	0	2.5	0	15	17.5
Trees in landfill	0	0	45	0	270	315

Figure 12. Example of large Marri tree (left) and Jarrah tree (right) recorded within landfill area. The Marri had a score of 3, indicating that there were suitable hollows present but no indication of chewing. The Jarrah had a score of 5 indicating that while large, there were no hollows.

Figure 13. Trees recorded with DBH measurements greater than 500 mm within the landfill area. Trees recorded in quadrats (green) and outside quadrats (purple).

1.1.1.6 Offset Area

A total of 21 trees with DBH of greater than 500 mm was recorded in the offset area, 15 within quadrats and six large opportunistic trees (see Table 7, Appendix 2, Figure 14 - 16). Within the quadrats, no active nests were found, however eight potential nesting trees (BCE Tree Score 3 or 4) were recorded. The other seven trees recorded did not appear to have suitable structure or hollows (BCE Tree Score 5), although it should be noted that any large tree could have a concealed suitable hollows, or may develop such a hollow and become an important nest tree in the coming decades or centuries.

Using the tree records in the quadrats, calculations of trees/quadrat, trees/ha and trees within the offset area have been estimated for each of the BCE Tree Scores (Table 8). It is estimated that there are 896 potential nesting trees and 840 future nesting trees within the offset area. Another five potential nesting trees were recorded opportunistically outside the quadrats. Although no active nests were found, a thorough investigation of the area was not undertaken.

The majority of trees measured had a DBH of between 500 – 850 mm. One tree within the quadrats (6.7 % of trees measured) had a DBH of 1000 mm, and one tree had a DBH greater than 1000 mm. There were, however, two Marri trees recorded opportunistically outside the quadrats with a DBH between 1000 and 1150 mm (Appendix 2, Figure 15 and 16). One of these had a BCE Tree Score of 3 and one of 4. Another three opportunistic trees had BCE Tree Scores of 3 and a DBH between 700 and 800 mm. Such large trees were formerly more widespread in the region but have been reduced in number through logging. The larger and potential nesting trees were dispersed throughout the study area.

Table 7. Potential breeding trees in the offset area.

BC score*	Number of trees			DBH			
	Marri	Jarrah	Total		Marri	Jarrah	Total
1	0	0	0	500 mm	3	0	3
2	0	0	0	501 mm – 850 mm	11	2	13
3	3	0	3	851 mm – mm 1000	1	0	1
4	4	1	5	1001 mm +	1	0	1
5	6	1	7				
Total	13	2	15	Total	13	2	15

*BC Score:
1 – Tree with active nest.
2 – Tree with large, suitable hollow bearing recent chew-marks.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout).
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout.
5 – Tree that meets the DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollow.

Table 8. Estimated number of trees with BCE Tree Scores 1-5 within the offset area.

Tree Score	1	2	3	4	5	Total
Total Trees > 500	0	0	3	5	7	15
Trees/Quadrat	0	0	0.25	0.40	0.60	1.25
Trees/ha	0	0	6	10	15	31
Trees in landfill	0	0	336	560	840	1736

Figure 14. Example of large Marri trees recorded within offset area.
These trees had a score of 5, indicating they had a very low likelihood of concealed hollows.

Figure 15. Trees recorded with DBH greater than 500 mm within the offset area Lot 82. Trees recorded in quadrats (green) and outside quadrats (purple).

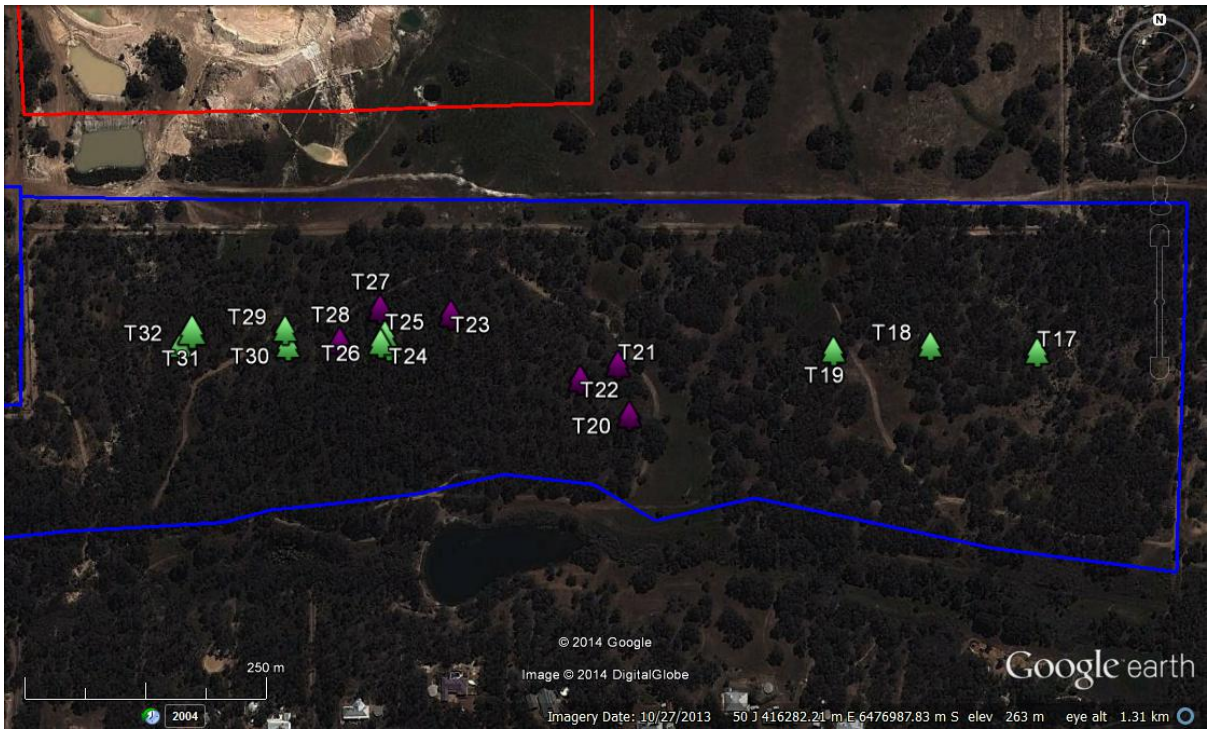


Figure 16. Trees recorded with DBH greater than 500 mm within the offset area Lot 501. Trees recorded in quadrats (green) and outside quadrats (purple).

3.1.3 Roost Site Information

According to Kabat *et al.* (2012a and b), there are no recorded roost sites in the project area. The closest recorded roost site for Carnaby's Black-Cockatoo is 3.5 kilometres to the south east on Beacon Hill Road in Parkerville.

3.2 Suitability of the Offset Area

3.2.1 Foraging Habitat

The landfill area is approximately 71 ha in size, however only 18 ha of it contains remnant vegetation which is isolated due to clearing for agriculture, quarry and landfill. The offset area is 56 ha and the majority of the site is remnant vegetation. The offset area is connected to John Forest National Park to the west and smaller patches of unprotected bush to the south within a residential area.

Both survey areas provide quality foraging habitat for Black-Cockatoos as they contain Marri/Jarrah forest. According to calculations from quadrat information (Table 9 and Figures 17), the offset area contains a higher density of Marri than the landfill area (200 trees/ha *cf.* 75 trees/ha), but a lower density of Jarrah (125 *cf.* 150). However, the size of the remnant vegetation in the offset area is larger, so it has a greater total number of both Marri and Jarrah trees (Table 9, Figure 18).

The landfill site had a much more dense understorey than the offset area consisting primarily of Parrot Bush (1650 plants/ha *cf.* 16.75 plants/ha) and Sheoak (50 *cf.* 4.25); both Black-Cockatoo foraging plants. The number of plants/ha was so much higher that despite the smaller size, the landfill site had a greater total number of both plant species (Table 9, Figure 18). Although at lower densities, the offset area had a greater diversity of understorey plants some of which were suitable as food species for Black-Cockatoos, *H. undulata*, Grasstrees, Parrot Bush, Sheoak and Banksia (Table 9, Figure 17). There were scattered Bull Banksia and Snottygobble in the landfill area but the densities of these were very small (0.125/ha and 0.0625/ha respectively, Table 3) and are unlikely to contribute to the foraging habitat of the site.

Table 9. Estimated densities of plant species suitable for foraging by Black-Cockatoos within the landfill (LF) and offset (OS) areas.
Plant species with very low densities were not included in this table.

Site	Marri		Jarrah		Parrot Bush		Sheoak		Hakea		Grasstree	
	LF	OS	LF	OS	LF	OS	LF	OS	LF	OS	LF	OS
Total	34	91	68	62	786	8	22	2	0	12	0	7
Plants/quadrat	3	8	6	5	66	0.67	2	0.17	0	1	0	0.58
Plants / ha	75	200	150	125	1650	16.75	50	4.25	0	25	0	14.5
Plants in Site	1350	11200	2700	7000	29700	938	900	238	0	1400	0	812

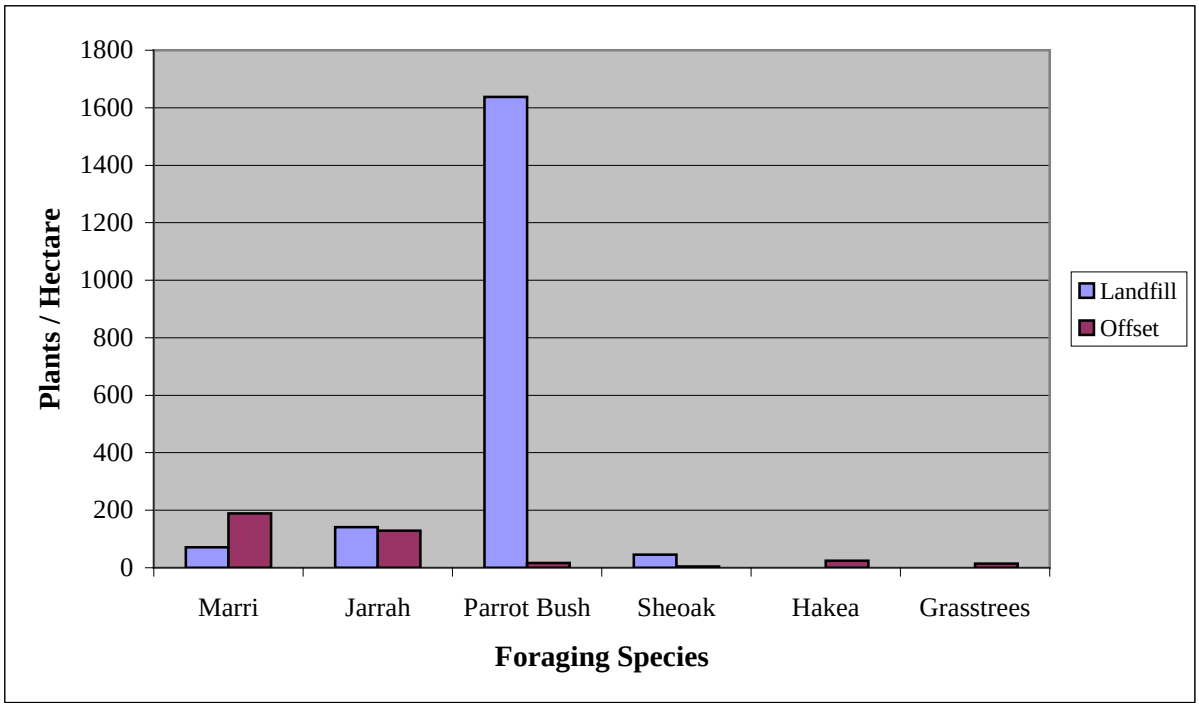


Figure 17. Estimated densities of suitable foraging plant species per ha within the landfill and offset areas.
Species with very low densities were not included in this graph.

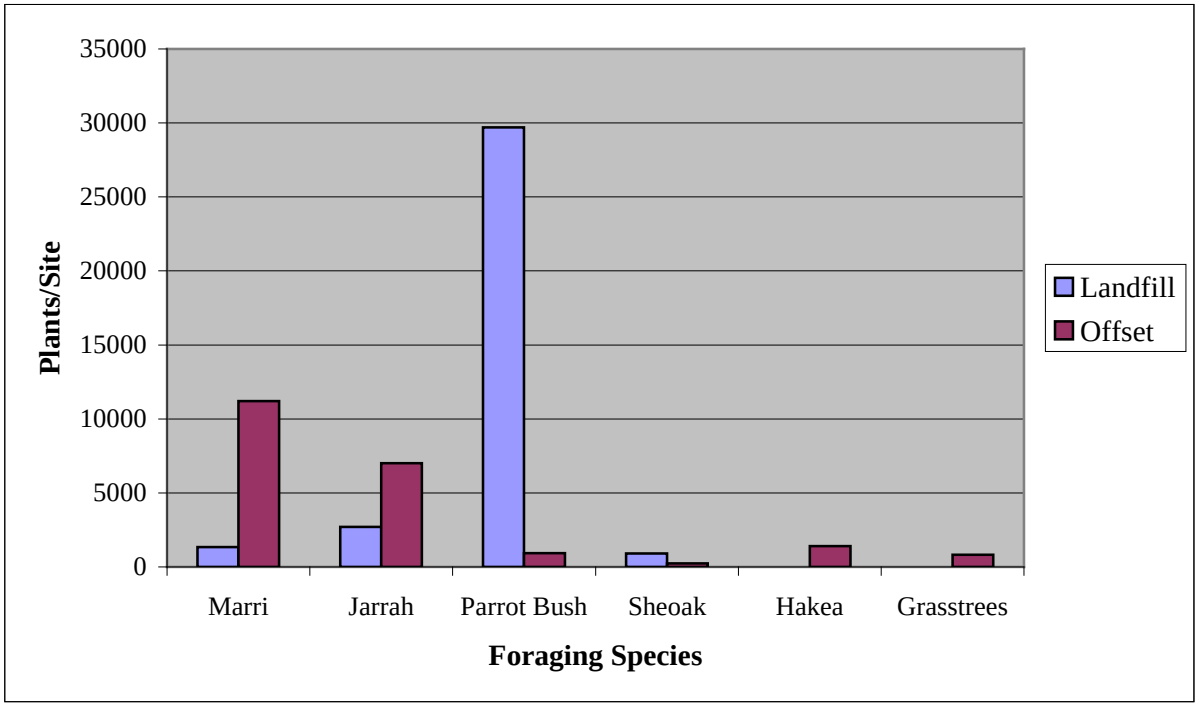


Figure 18. Estimated numbers of suitable foraging plant species per site within the landfill and offset areas.
Species with very low densities were not included in this graph.

3.2.2 Breeding Habitat

Both survey sites had trees with DBH measurements greater than 500 mm, some of which had a BCE Tree Score of 3 or 4, meaning they are potentially suitable of Black-Cockatoo nest sites but did not show signs of use. Out of the five categories, most of the trees scored a BCE Tree Score of 5. No current nests or suitable hollows with signs of use such as chew marks were recorded in either site.

Calculations from quadrat data showed the offset area contained more large trees (DBH greater than 500 mm) and potential hollows per ha and per site than the landfill area (Table 10, Figure 19 and 20). The offset area contains an estimated 336 trees with a Tree Score 3, 560 with a Tree Score 4 and 840 with a Tree Score 5 (Table 10). The landfill area contains an estimated 45 trees with a Tree Score 3, no trees with a Tree Score 4 and 270 with a Tree Score 5 (Table 10).

Table 10. Number of trees with BCE Tree Scores 1-5 and with a DBH greater than 500 mm within the landfill (LF) and offset (OS) areas.

	1		2		3		4		5		> 500 mm	
	LF	OS	LF	OS	LF	OS	LF	OS	LF	OS	LF	OS
Recorded	-	-	-	-	1	3	-	5	7	7	8	15
Estimated trees / quadrat	-	-	-	-	0.1	0.25	-	0.4	0.6	0.6	0.7	1.25
Estimated trees / ha	-	-	-	-	2.5	6	-	10	15.0	15	17.5	31
Estimate trees / site	-	-	-	-	45	336	-	560	270	840	315	1736

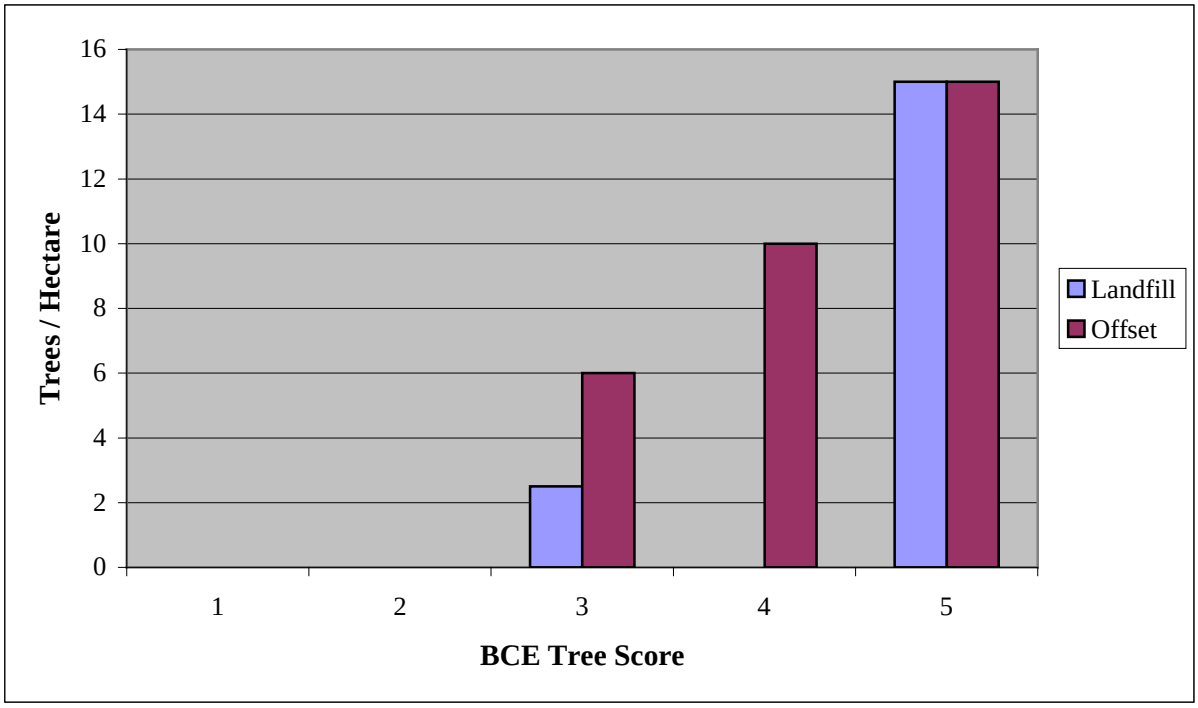


Figure 19. Estimated trees per hectare with BCE Tree Scores of 1-5 within landfill and offset areas.

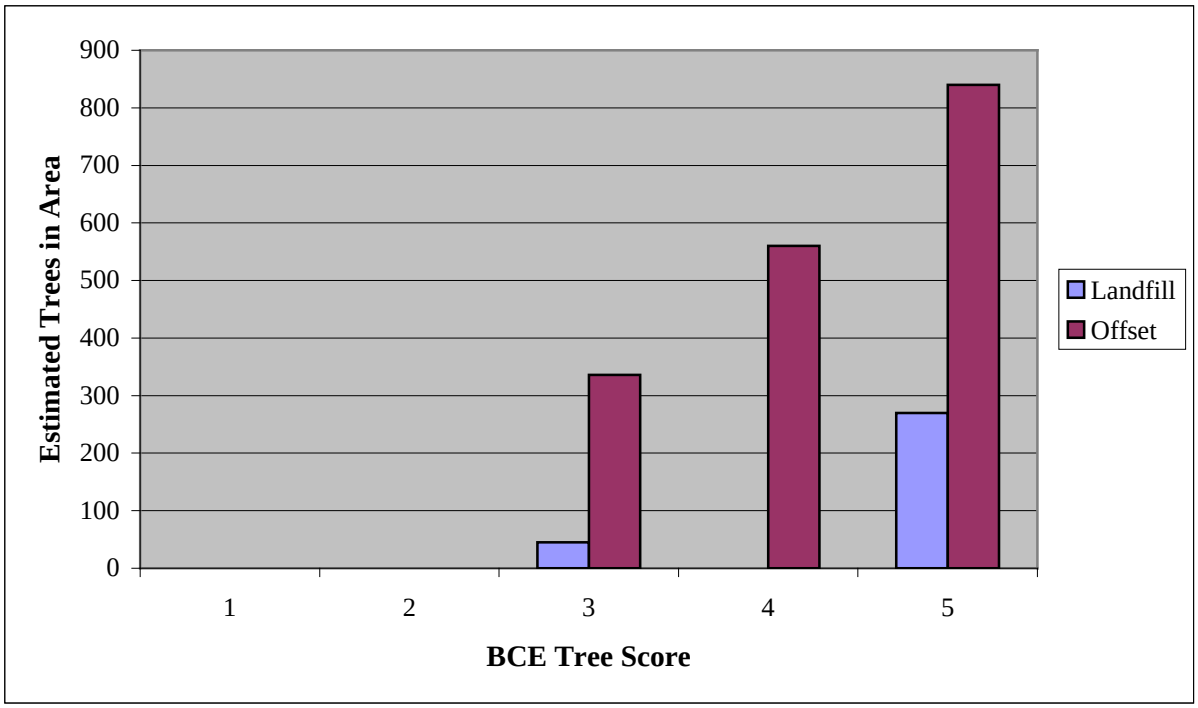


Figure 20. Estimated trees per site with BCE Tree Scores of 1-5 within the landfill and offset areas.

3.2.3 Summary

The proposed offset area provides suitable compensation for breeding habitat planned to be cleared within the landfill area, as there were more large trees within the offset site compared with the landfill area that provide potential for both current and future Black-Cockatoo nest trees. No current nest trees were recorded within the landfill site, although it must be noted that the whole site was not surveyed due to time constraints.

While nesting habitat is confined to tall eucalypt forests, foraging habitat is more extensive than this. Along with Marri and Jarrah, it includes several of the understorey species recorded on both sites (Sheoak, Grevilleas, Hakeas and Banksias). As such, the entire survey area contains potential foraging habitat for all three species of Black-Cockatoo. Calculations of understorey species showed that the landfill site contained a higher density of suitable foraging plants but the offset area contained a higher diversity. Although mostly covered in Parrot Bush, a coloniser plant with a relatively short lifespan, the landfill area provided greater foraging potential in the understorey than the offset site. In the overstorey, however, the offset area provided more trees (Marri in particular) at a higher density than the landfill area. Marri is a food-plant for all three black-cockatoo species, whereas Parrotbush is used primarily by Carnaby's Black-Cockatoo.

In summary, the proposed area to be used as an offset to the clearing of native vegetation within the planned new waste disposal area is similar to or better than the landfill area as potential breeding habitat and in the provision of canopy foraging habitat. However, the proposed offset area provides less foraging habitat in the understorey than the landfill area. This foraging habitat in the understorey consist largely of Parrotbush that is used mainly by Carnaby's Black-Cockatoo. Replanting some of the cleared agricultural land with native

understorey plants suitable for Black-Cockatoos would provide future foraging habitat to increase the value of the proposed area to be used as an offset.

3.3 Referral Requirements under EPBC Act

Under the EPBC Act and the referral guidelines for Baudin's, Carnaby's and Forest Red-tailed Black-Cockatoos, "actions that has, will have or is likely to have a significant impact on any of the three species of Black-Cockatoo" in the south-west must be referred to the federal minister for environment (DSEWPaC 2012d).

Referral is recommended if there will be:

- Clearing of any known nesting tree. **NO**
- Clearing or degradation of any part of a vegetation community known to contain breeding habitat. **NO**
- Clearing of more than 1 ha of quality foraging habitat. **YES**
- Clearing or degradation (including pruning the top canopy) of a known night roosting site. NO
- Creating a gap of greater than 4 km between patches of black cockatoo habitat (breeding, foraging or roosting). **NO**
- Clearing or disturbance in areas surrounding black cockatoo breeding, foraging or night roosting habitat that has the potential to degrade habitat through introduction of invasive species, edge effects, hydrological changes, increased human visitation or fire. (DSEWPaC 2012d) **NO**

As approximately 18 ha of quality foraging habitat is to be cleared it is recommended that the proposed works be referred to the federal Environment Minister as outlined in DSEWPaC 2012d.

3.4 Recommendations

1. Legally designate proposed area as an Offset so that it can not be cleared in the future.
2. Revegetate as much of the cleared agricultural land with local native species, with particular focus on plants suitable for foraging by Black-Cockatoos (see Appendix 1).
3. Retain native vegetation where possible within the development site.
4. Further survey the offset area for potential and current Black-Cockatoo nests and if they are lacking, install Black-Cockatoo nest boxes within the offset area to provide further nesting opportunities, particularly for Forest Red-Tailed and Carnaby's Black-Cockatoos (Turpin and Cherriman 2013).

4 REFERENCES

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.

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.

DEC. (2008). Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Redtailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan. Prepared by the Department of Environment and Conservation, Perth, Western Australia.

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 threaterened birds. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DSEWPaC. (2010). Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory.

DSEWPaC. (2011). *Environment Protection and Biodiversity Conservation Act 1999* [draft] referral guidelines for three 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, Canberra, Australian Capital Territory.

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). *Environment Protection and Biodiversity Conservation Act 1999* referral guidelines for three 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, Canberra, Australian Capital Territory.

Garnett, S. T. and Crowley, G. M. (2000). The Action Plan for Australian Birds. Australian National Parks and Wildlife Service: Canberra.

Garnett, S. T., Szabo, J. and Dutson, G. (2010). *The Action Plan for Australian Birds 2010*. CSIRO Publishing, Melbourne, Victoria.

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.

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., 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 Kirkby, T. (2010). Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) on the Swan Coastal Plain (Lancelin–Dunsborough), Western Australia. Studies on distribution, status, breeding, food, movements and historical changes. Report for the WA Department of Planning.

Johnstone, R. E. and Storr, G. M. (1998). *Handbook of Western Australian birds. Volume 1: Non-passerines (Emu to Dollarbird)*. Western Australian Museum, Perth, Western Australia.

Kabat, A. P., Scott, R., Kabat, T. J. and Barrett, G. (2012a). 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.

Kabat, T. J., Barrett, G., Kabat, A. P. (2012b). Great Cocky Count: Identification of roost sites for Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) and population count for the DEC Swan Region

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.

Turpin, J.M. and Cherriman, S.M. (2013). Nesting Records of Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), from the Porongurup Range, South-west Western Australia. The Western Australian Naturalist. Vol. 29. No. 1. July 2013.

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.

5 APPENDICES

Appendix 1. 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 et al. 1982; Saunders 1986; Johnstone and Storr 1998; Higgins 1999; Johnstone and Kirkby 1999, 2008, 2010; Groom 2011; Johnstone et al. 2011; DSEWPaC 2012a, b; c, R. Johnstone pers. comm.).

FRTBC = Forest Red-tailed Black-Cockatoo, CBC = Carnaby's Black-Cockatoo, BBC = Baudin's Black-Cockatoo (see Table 1 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	
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	

Plant Species	Plant Status	FRTBC	CBC	BBC
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	
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	

Plant Species	Plant Status	FRTBC	CBC	BBC
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	
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	

Plant Species	Plant Status	FRTBC	CBC	BBC
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	
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

Appendix 2. Notes on potential habitat trees within the study area.

UTM Zone 50J. Datum WGS84.

DBH – Diameter at breast height

BC Score:
1 – Tree with active nest.
2 – Tree with large hollow showing recent chewing around entrance.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout)
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout
5 – Tree meets DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollows.

Tree No.	Easting	Northing	Tree Species	DBH (mm)	Score	Height (m)	Comments
T01	415821	6477867	*Corymbia calophylla*	850	3	25	Bees in the hollow
T02	415815	6477823	*Corymbia calophylla*	700	5	20	Small hollows
T03	415805	6477790	*Corymbia calophylla*	1200	3	25	Small and large hollows
T04	415822	6477638	*Corymbia calophylla*	950	3	25	
T05	415826	6477571	*Corymbia calophylla*	550	5	20	
T06	415958	6477626	*Corymbia calophylla*	500	5	20	
T07	415988	6477703	*Corymbia calophylla*	1100	5	25	
T08	415962	6477783	*Corymbia calophylla*	850	5	10	
T09	415949	6477856	*Eucalyptus marginata*	500	5	15	
T10	416132	6478381	*Corymbia calophylla*	550	5	15	
T11	416117	6478368	*Corymbia calophylla*	620	5	15	
T12	415398	6477047	*Corymbia calophylla*	600	4	15	
T13	415392	6477026	*Corymbia calophylla*	500	5	10	
T14	415375	6477052	*Corymbia calophylla*	600	5	20	
T15	415376	6477031	*Corymbia calophylla*	750	4	15	
T16	415408	6477050	*Corymbia calophylla*	1050	3	20	
T17	416714	6476987	*Corymbia calophylla*	500	5	10	Old feeding debris
T18	416608	6476993	*Corymbia calophylla*	550	5	15	
T19	416511	6476987	*Corymbia calophylla*	500	5	15	
T20	416307	6476920	*Corymbia calophylla*	900	5		
T21	416296	6476972	*Corymbia calophylla*	750	3	20	Spout
T22	416257	6476956	*Corymbia calophylla*	700	3	20	3 Spouts
T23	416127	6477021	*Corymbia calophylla*	1000	4	30	Hollows
T24	416065	6476988	*Eucalyptus marginata*	800	4	20	Possible Spout
T25	416061	6476999	*Corymbia calophylla*	1000	4		
T26	416056	6476991	*Corymbia calophylla*	850	3	20	Spout
T27	416057	6477026	*Corymbia calophylla*	800	3	25	Hollow, possible oldchew marks
T28	416015	6476992	*Corymbia calophylla*	1150	3	25	Hollow
T29	415959	6477004	*Eucalyptus marginata*	550	5	10	Dead
T30	415962	6476987	*Corymbia calophylla*	700	4	20	Struggling
T31	415862	6476998	*Corymbia calophylla*	800	3	20	
T32	415850	6476987	*Corymbia calophylla*	750	5	25	

EMRC Red Hill Waste Management Facility
Black-Cockatoo Habitat Tree Assessment

Hollow-bearing Jarrah, Red Hill Waste Management Facility (P. Orell).

Prepared for: Eastern Metropolitan Regional Council
PO Box 234
BELMONT, WA 6984

Prepared by: Mike Bamford and Peter Orell
Bamford Consulting Ecologists
23 Plover Way, Kingsley, WA 6026

11th March 2015

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The Eastern Metropolitan Regional Council (EMRC) operates the Red Hill Waste Management Facility on Toodyay Road, Red Hill, and is seeking to expand the area used for landfill. As part of the environmental review requirements for this expansion, Bamford Consulting Ecologists (BCE) was commissioned by EMRC to undertake investigations into the use and habitat quality of the proposed new landfill site by Black-Cockatoos (Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*, Baudin's Black-Cockatoo *C. baudinii*, and Carnaby's Black-Cockatoo *C. latirostris*) and the potential for a neighbouring section of bush to be used as an offset.

This habitat tree assessment is an extension of the initial habitat assessment undertaken by BCE in March 2014 (Bamford and Basnett 2014) and further evaluates the potential of the anticipated landfill site and offset area to provide nesting habitat for the Black-Cockatoos.

1.1 Background

1.1.1 Description of Project Area

The project area consists of the proposed future landfill site (Lot 12) and the proposed offset site (Lots 82 and 501) and is situated approximately 27 km north east of the Perth Central Business District and 8 km south of Gidgegannup (Figure 1). The proposed future landfill site (hereafter landfill area) is bounded by Toodyay Road to the north, existing cleared pastoral areas to the east, the current waste dump to the west and bushland of the proposed offset area to the south. The possible offset area (hereafter offset area) is bounded by residential areas within bushland to the south and east and John Forrest National Park to the west (Figure 2).

The landfill area is approximately 71 ha in size. Most of the site has been cleared for quarry and pastoral purposes with few to no trees; the patches of remnant bushland cover approximately 18 ha, about 25% of the landfill area (Figure 2). The offset area is 56 ha and is mostly remnant bushland with only a few small cleared areas to the east and access roads (Figure 2).

The proposed development is two phase, with clearing of approximately 7.4 ha of remnant bush in the landfill area under the current clearing permit application and the remaining 10.6 ha in future clearing for landfill (Figure 3). EMRC has proposed to offset this clearing by protecting the bush within the offset area, currently a buffer zone for the waste management facility, beyond the life of the rubbish tip. The native vegetation of the site is described as scattered to open Jarrah-Marri forest with an understorey dominated by Parrot Bush (*Banksia sessilis*), Sheoak (*Allocasuarina fraseriana*), *Xanthorrhoea preissii*, Egg and Bacon Bush (*Eutaxia obovata*) and *Grevillea wilsonii*, and scattered *Calothamnus sanguineus* and *Hakea undulata*.

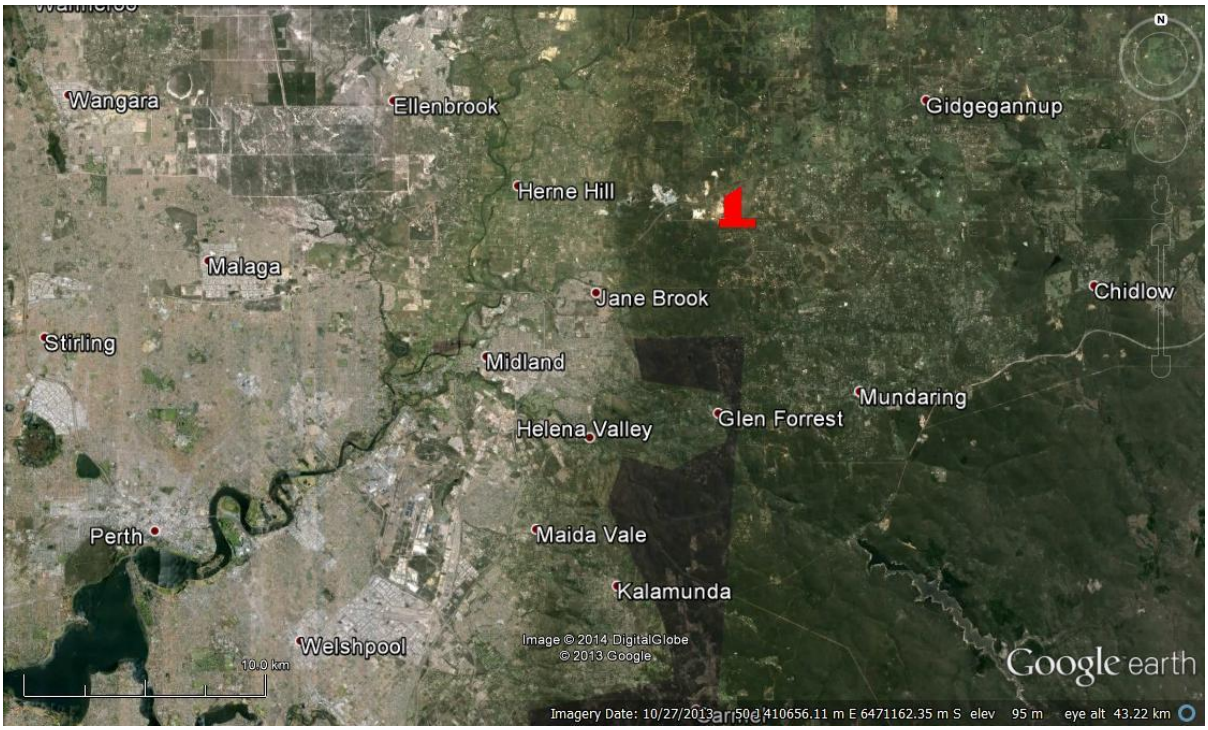


Figure 1. Location of the study area (red).

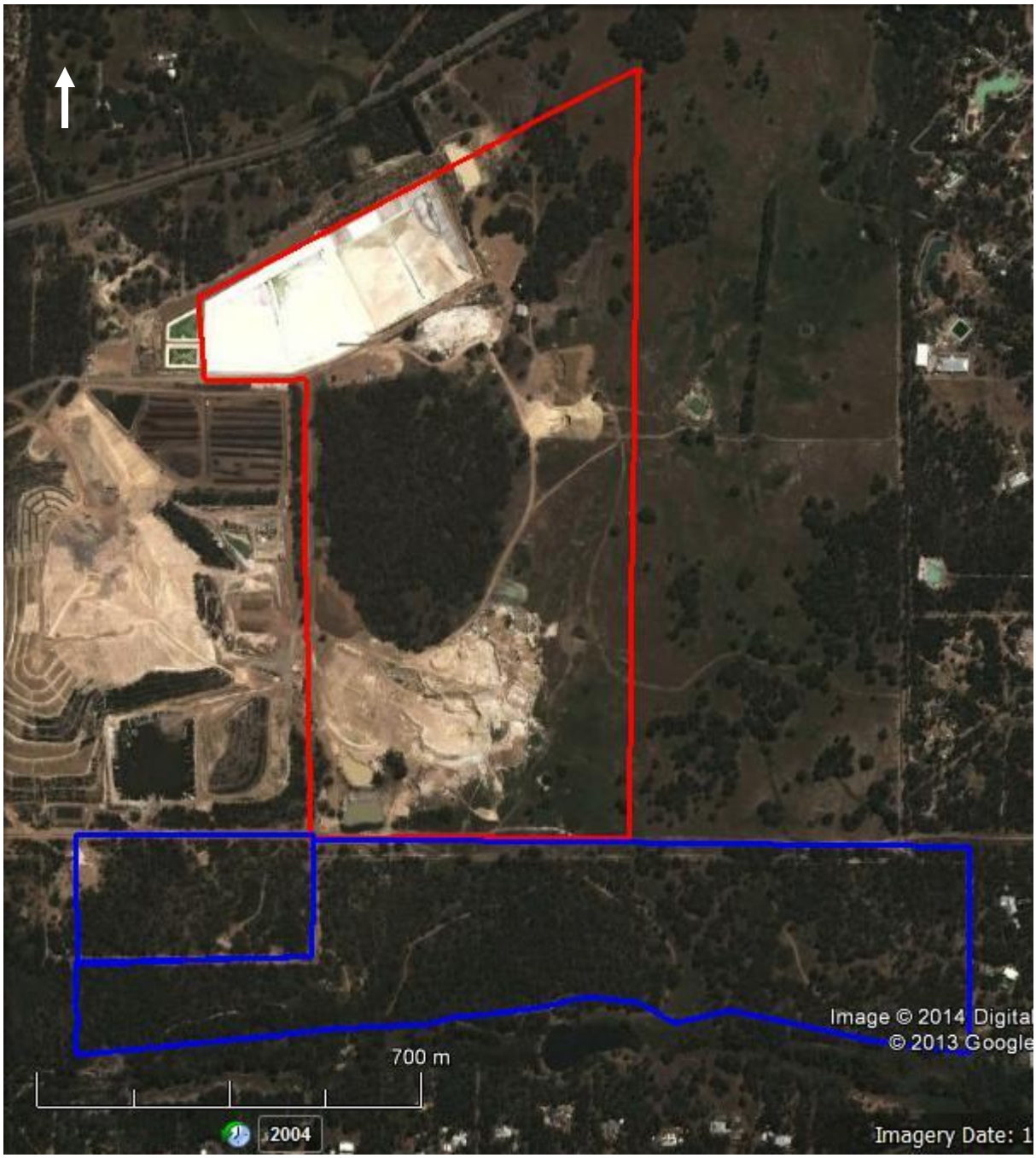


Figure 2. The study site (landfill area red, offset area blue).

Figure 3. Proposed clearing areas for landfill. North of the purple line is the current clearing permit application, south of the purple line is planned future clearing cells for landfill.

1.1.2 Black-Cockatoos

1.1.1.1 Species, Ecology, Habitat Requirements and Threats

The three south-western Western Australian taxa of Black-Cockatoo are listed in Table 1. All species are listed under both the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* and the Western Australian *Wildlife Conservation Act 1950*, as indicated in Table 1. All are likely to occur in the vicinity of the project area.

Table 1. Black-Cockatoos likely to occur in the vicinity of the project area.

The status of each species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA 1999) and the Western Australian *Wildlife Conservation Act 1950* (WCA 1950) is shown.

Species		EPBCA 1999	WCA 1950
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Vulnerable	Schedule 1 (Vulnerable)
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Schedule 1 (Endangered)
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	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.* 2010);
- Recovery plans (Cale 2003; DEC 2008);
- EPBC guidelines (DEWHA 2010);
- Commonwealth listing and conservation advice (DEWHA 2009a, b);
- The federal Department of Sustainability, Environment, Water, Population and Communities' (DSEWPaC; 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, 2010); and
- Major reports (Johnstone *et al.* 2011; Kabat *et al.* 2012 a).

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 project 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 residents and 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).
- 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 Appendix 1).

Key threats

- Key threatening processes include illegal shooting, habitat loss and degradation leading to shortages in food, nest hollow shortage, competition for available nest hollows from other parrots and feral Honeybees (*Apis mellifera*), and illegal trade.

1.1.1.2 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 are at least 230 years old, and the majority of nests are found in 300-500 year old trees (Johnstone 2006).

DSEWPaC (2010, 2011, 2012a, b, c, d) recommends 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).

2 METHODS

2.1 Survey Date and Personnel

The landfill area was inspected on 19th December 2014 by Gillian Basnett (B.Sc. (REM), M.Env.Sc., M.Env.Sc. (res)) and Peter Orell (B.Sc. Hons. M.Sc.) and the offset area was inspected on 29th January 2015 by Andrew Moore (B.Sc,, B.A.Sc, M.Sc.) and Peter Smith (Assoc. Dip). Data analysis and report preparation were by Peter Orell and Mike Bamford (B.Sc. Hons. Ph.D.). Potential nesting trees within the proposed landfill site (further referred to as the 'study site') were assessed.

2.2 Black-Cockatoo Habitat Tree Surveys

Consistent with the recommendations of DSEWPaC (2010, 2011, 2012a, b, c, d), a survey for potential hollow-bearing (nest) trees was conducted within the study area. During the March 2014 assessment (Bamford and Basnett 2014) the survey of habitat trees was restricted to selected sampling quadrats and the area walked between quadrats. During this survey, the entire landfill area (18 ha) was inspected for the presence of suitable nest trees. The offset area was surveyed by sampling trees within 25m wide transects aligned west to east. Four of these transects were within Lot 82 and totalled 4.07 ha and two longer transects were across Lot 501 and totalled 7.92 ha giving a total sample area of 11.99 ha. Suitable nest trees were defined as tree species known to be used for nesting in the area (e.g. Marri and Jarrah) with a diameter-at-breast-height (DBH) greater than 500 mm (see Section 1.1.1.2).

For any tree within the study area that met these criteria:

- DBH was measured;
- trees were assessed (from the ground) for presence of hollows suitable for Black-Cockatoos (entrance diameter greater than 100 mm, see Section 1.1.1.2);
- 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).

In this way, all trees greater than 500 DBH within the landfill area and all those within the sampling transects in the offset area were assessed.

Table 2. Coordinates of the transects surveyed within the offset area in January 2015

Transect	Area Ha	NW Corner			SE Corner		
			Easting	Northing		Easting	Northing
1 (Lot 82)	1.018	50J	415273	6477050	50J	415680	6477025
2 (Lot 82)	1.018	50J	415273	6477075	50J	415680	6477050
3 (Lot 82)	1.018	50J	415273	6477025	50J	415680	6477000
4 (Lot 82)	1.018	50J	415273	6477100	50J	415680	6477075
5 (Lot 501)	3.96	50J	415273	6476925	50J	416857	6476900
6 (Lot 501)	3.96	50J	415273	6476900	50J	416857	6476875

The score given to trees with a DBH > 500mm to reflect their likely value for breeding has been developed by BCE and ranges from 1 to 5. 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.

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. Potential to become a nest tree in the future.

2.3 Foraging activity

Litter beneath the canopies of measured trees were examined for signs of Black-Cockatoo chew marks on seed capsules and other potential indications of foraging activity.

3 RESULTS AND DISCUSSION

3.1 Habitat trees in landfill area

A total of 207 trees with DBH of greater than 500 mm were recorded in the landfill area. As in the March 2014 survey, no active nests were found, however twelve potential nesting trees (BCE Tree Score 3) were recorded with no signs of use by Black-Cockatoos. Two other trees were recorded with possible large hollows but no vertical spout (BCE Tree Score 4). The other 193 trees recorded within the landfill area did not appear to have suitable structure or hollows (BCE Tree Score 5), although it should be noted that any large tree could have a concealed suitable hollow, or may develop such a hollow and become an important nest tree in the coming decades or centuries. Two hollow-bearing trees (BCE Tree Score 5) were hosts to other species of cockatoo: one had a nesting pair of Galahs (*Cacatua roseicapilla*) and the other had a nesting pair of Little Corellas (*Cacatua sanguinea*). One Marri tree had a hollow with apparent signs of use (recent bark wear around the opening) from something other than a cockatoo species, possibly a mammal

The majority of trees measured had a DBH of between 500 – 850 mm. Fifty trees (24.2 % of all trees measured) had a DBH greater than 850 mm; of these, 29 trees (14 % of all trees measured) had a DBH greater than 1000 mm. Of the twelve potential nesting trees recorded, four (all Marri) had a DBH of between 500 – 850 mm, three (two Marri and one Jarrah) had a DBH of between 850 – 1000 mm and five (four Jarrah and one Marri) had a DBH of greater than 1000 mm. The two trees recorded with a BCE Tree Score of 4 both had a DBH greater than 1000 mm.

Table 3. Potential breeding trees in the landfill area.

BC score*	**Number of trees**				**DBH**			
	Marri	Jarrah	Total			Marri	Jarrah	Total
1	0	0	0		500 mm	17	5	22
2	0	0	0		501 mm – 850 mm	103	32	135
3	7	5	12		851 mm – mm 1000	14	7	21
4	2	0	2		1001 mm +	11	18	29
5	136	57	193					
Total	145	62	207		Total	145	62	207

*BC Score:
1 – Tree with active nest.
2 – Tree with large, suitable hollow bearing recent chew-marks.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout).
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout.
5 – Tree meets DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollows.

Table 4. Estimated number of trees with BCE Tree Scores 1-5 within the landfill area.

Tree Score	1	2	3	4	5	Total
Total Trees > 500	0	0	12	2	193	207
Recorded trees/ha	0	0	0.7	0.1	10.7	11.5
Estimated trees/ha March 2014 survey	0	0	2.5	0	15	17.5

The survey undertaken by BCE in March 2014 (Bamford and Basnett 2014) was based on measurements within 20 metre by 20 metre (400 m^2) quadrats and the results of that survey were used to calculate an estimate of the total number of trees per hectare. The results of the survey reported herein gave a direct measure of the number of trees per hectare and it was significantly less than the March estimate (see Table 3). The estimated number of potential nesting trees per hectare was 3.75 times greater than the number of trees recorded in this survey (or the recorded number of trees is 27 % of the March estimate). Such a large discrepancy is not unexpected for a small number of observations, in this case one tree out of eight recorded in the initial March 2014 survey. The estimated total number of trees with a DBH greater than 500 mm was 1.5 times greater than the number of trees recorded in this survey (or the number of trees recorded is 71 % of the March estimate).

3.2 Habitat trees in offset area

A total of 230 trees with DBH of greater than 500 mm were recorded within the sampling transects in the offset area. No active nests were found but two trees with chew marks (BCE Tree Score 2) indicating recent use by Black-Cockatoos plus 25 potential nesting trees with vertical spouts (BCE Tree Score of 3), including four dead trees, were observed, as well as 33 other trees with hollows but no vertical spout (BCE Tree Score 4). The estimated number of used nesting trees (BCE Tree Score 2) per hectare was 0.17 giving an estimated total of nine trees within the offset area. The estimated number of potential nesting trees (BCE Tree Score 3) per hectare was 2.09 giving an estimated total of 117 trees within the offset area.

As in the landfill area, the majority of trees measured had a DBH of between 500 – 850 mm. Thirty four trees (14.8 % of all trees measured) had a DBH greater than 850 mm; of these, 15 trees (6.5 % of all trees measured) had a DBH greater than 1000 mm. Both of the two used nesting trees were Marri, one with a DBH between 850 – 1000 mm and the other with a DBH greater than 1000 mm. Of the 25 potential nesting trees recorded, twelve (eleven Marri and one Jarrah) had a DBH of between 500 – 850 mm, four (three Marri and one Jarrah) had a DBH of between 850 – 1000 mm and nine (seven Marri and two Jarrah) had a DBH of greater than 1000 mm. Of the 33 trees recorded with a BCE Tree Score of 4, 22 (fifteen Marri and seven Jarrah) had a DBH of between 500 – 850 mm, seven (five Marri and two Jarrah) had a DBH of between 850 – 1000 mm and three (two Marri and one Jarrah) had a DBH of greater than 1000 mm.

Table 5. Potential breeding trees recorded in the offset area.

BC score*	Number of trees				DBH			
	Marri	Jarrah	Total			Marri	Jarrah	Total
1	0	0	0		500 mm	17	5	22
2	0	0	0		501 mm – 850 mm	103	32	135
3	7	5	12		851 mm – mm 1000	14	7	21
4	2	0	2		1001 mm +	11	18	29
5	136	57	193					
Total	145	62	207		Total	145	62	207

Table 6. Estimated number of trees with BCE Tree Scores 1-5 and DBH within the offset area

DBH		BCE Tree Score 1	2	3	4	5	Total
500	Recorded	0	0	0	1	71	72
	Trees/ha	0	0	0	0.1	5.9	6.0
	Offset total	0	0	0	5	331	336
501-850	Recorded	0	0	12	22	90	124
	Trees/ha	0	0	1.0	1.8	7.5	10.3
	Offset total	0	0	56	103	420	579
851-1000	Recorded	0	1	4	7	7	19
	Trees/ha	0	0.1	0.3	0.6	0.6	1.6
	Offset total	0	5	19	32	32	88
>1000	Recorded	0	1	9	3	2	15
	Trees/ha	0	0.1	0.8	0.3	0.2	1.2
	Offset total	0	5	42	14	9	70
Total >500	Recorded	0	2	25	33	170	230
	Trees/ha	0	0.2	2.1	2.7	14.2	19.2
	Offset total	0	9	117	154	794	1074
	March 2014	0	0	336	560	840	1736

A transect design was used in this survey covering a larger area than the quadrat design used in March 2014. The estimated total number of trees with a DBH greater than 500 mm within the offset area was 1074, about 62% of the March 2014 estimate of 1736. The new estimate of the total number of potential nesting trees (BCE Tree Score 3) is 117, about 35% of the March 2014 estimate of 336 trees. These differences are similar to those observed in the landfill area where all trees were surveyed, suggesting that the estimates obtained via the transect survey design are more accurate than the March 2014 estimate.

3.3 Breeding habitat

While both sites had potential nesting trees suitable for Black-Cockatoos only the offset had trees that showed signs of use by Black-Cockatoos.

Calculations from transect data showed the offset area contained more large trees (DBH greater than 500 mm) and potential hollows per ha and per site than the landfill area (Table 6, Figure 4 and 5). The offset area contains an estimated 9 trees with a Tree Score of 2, 117 trees with a Tree Score 3, 154 with a Tree Score 4 and 794 with a Tree Score 5 (Table 6).

The landfill area contains 12 trees with a Tree Score 3, 2 trees with a Tree Score 4 and 193 with a Tree Score 5 (Table 4).

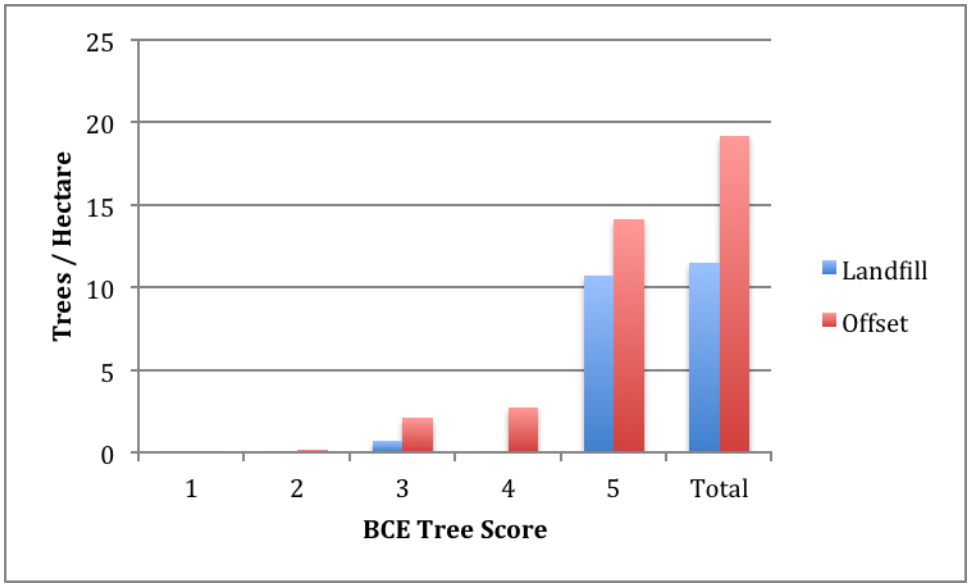


Figure 4. Estimated trees per hectare with BCE Tree Scores of 1-5 within landfill and offset areas.

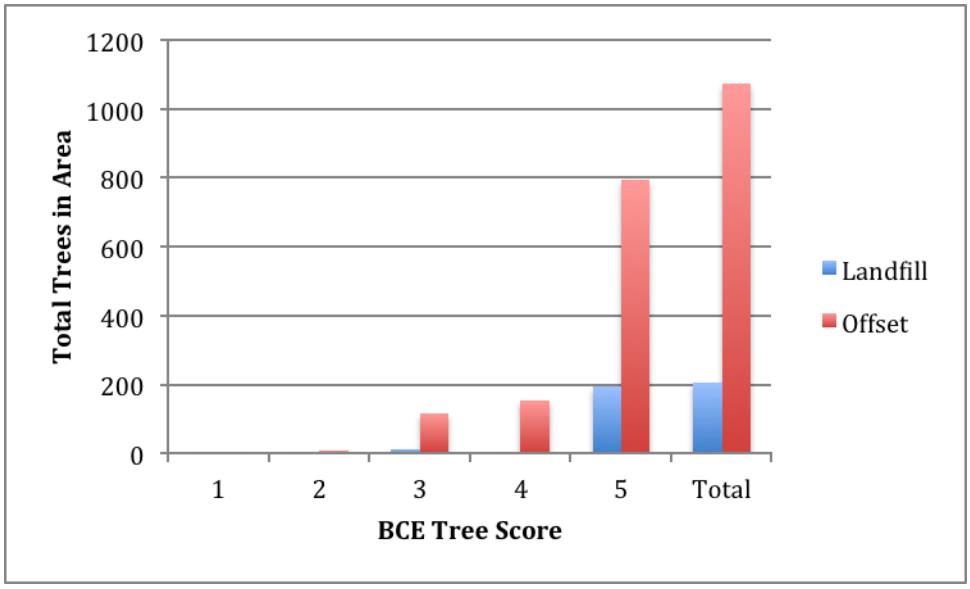


Figure 5. Total number of trees per site with BCE Tree Scores of 1-5 within the landfill (recorded) and offset areas (estimated).

3.4 Foraging activity

No signs of active foraging were observed in the landfill area during the 19th December 2014 survey. Many of the trees recorded were Marri trees with considerable litter of seed capsules (honky nuts) beneath the canopy but none showed signs of Black-Cockatoo chewing.

Signs of foraging, some recent but mostly intermediate age, were observed in the offset area around eleven of the surveyed trees (all Marri). These were attributed to both Carnaby's and Forest Red-tailed Black-Cockatoos, and calls of Forest Red-tailed Black-Cockatoos were heard nearby during the survey.

3.5 Summary

The results of this survey confirm that there is currently no Black-Cockatoo breeding activity and no known nest trees within the proposed landfill area however there is current and future potential breeding habitat. The actual number of potential nesting trees and future nesting trees within the proposed landfill area is smaller than estimated from the March 2014 survey: about 27 % of the original estimate for potential nesting trees (BCE Tree Score 3) and 71 % of the original estimate for future nesting trees (BCE Tree Score 4 and 5). No signs of foraging were observed though there is potential foraging habitat within the area.

Two used nest trees (BCE Tree Score 2) were observed in the offset area during the January 2015 survey, Forest Red-tailed Black-Cockatoos were heard in the area and signs of foraging attributed to both Carnaby's and Forest Red-tailed Black-Cockatoos were observed indicating that this area is currently used by Black-Cockatoos and is a suitable offset to the proposed landfill area. The area contains more large trees (>500 mm DBH) and more potential hollows per hectare than the landfill site, even after the revised data analyses from the December 2014 and January 2015 surveys results. The total number of trees within the offset area with a DBH of 500 mm or more was estimated at 1074, about 62% of the original March 2014 estimate of 1736 trees. The total number of potential nesting trees with spouts (BCE Tree Score 2 and 3) was estimated at 126, about 38% of the original March 2014 estimate of 336 trees.

3.6 Recommendations

The results and conclusion of this survey support the recommendations given previously in Bamford and Basnett (2014), namely:

1. Legally designate proposed Offset area (blue area, Figure 2) as an Offset so that it can not be cleared in the future.
2. Revegetate as much of the cleared agricultural land with local native species, with particular focus on plants suitable for foraging by Black-Cockatoos (see Appendix 1).
3. Retain native vegetation where possible within the development site.
4. Further survey the offset area for potential and current Black-Cockatoo nests and if they are lacking, install Black-Cockatoo nest boxes within the offset area to provide further nesting opportunities, particularly for Forest Red-Tailed and Carnaby's Black-Cockatoos (Turpin and Cherriman 2013).

4 REFERENCES

Bamford, M. and Basnett, G. (2014). EMRC Red Hill Waste Management Facility Black-Cockatoo Assessment. Unpubl. report to Eastern Metropolitan Regional Council by Bamford Consulting Ecologists, Kingsley.

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.

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.

DEC. (2008). Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Redtailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan. Prepared by the Department of Environment and Conservation, Perth, Western Australia.

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 threaterened birds. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DSEWPaC. (2010). Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory.

DSEWPaC. (2011). *Environment Protection and Biodiversity Conservation Act 1999* [draft] referral guidelines for three 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, Canberra, Australian Capital Territory.

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). *Environment Protection and Biodiversity Conservation Act 1999* referral guidelines for three 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, Canberra, Australian Capital Territory.

Garnett, S. T. and Crowley, G. M. (2000). The Action Plan for Australian Birds. Australian National Parks and Wildlife Service: Canberra.

Garnett, S. T., Szabo, J. and Dutson, G. (2010). *The Action Plan for Australian Birds 2010*. CSIRO Publishing, Melbourne, Victoria.

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.

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., 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 Kirkby, T. (2010). Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) on the Swan Coastal Plain (Lancelin–Dunsborough), Western Australia. Studies on distribution, status, breeding, food, movements and historical changes. Report for the WA Department of Planning.

Johnstone, R. E. and Storr, G. M. (1998). *Handbook of Western Australian birds. Volume 1: Non-passerines (Emu to Dollarbird)*. Western Australian Museum, Perth, Western Australia.

Kabat, A. P., Scott, R., Kabat, T. J. and Barrett, G. (2012a). 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.

Kabat, T. J., Barrett, G., Kabat, A. P. (2012b). Great Cocky Count: Identification of roost sites for Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) and population count for the DEC Swan Region

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.

Turpin, J.M. and Cherriman, S.M. (2013). Nesting Records of Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), from the Porongurup Range, South-west Western Australia. The Western Australian Naturalist. Vol. 29. No. 1. July 2013.

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 (*Jarrah*) and marri (*Marri*) 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 (*Jarrah*) and marri (*Marri*) trees II. Selecting trees to retain for hollow dependent fauna. *Forest Ecology and Management* **160**: 215-232.

5 APPENDICES

Appendix 1. Notes on potential habitat trees within the proposed landfill area, 19 December 2014 survey.

UTM Zone 50J. Datum WGS84.

DBH – Diameter at breast height

Marri = *Marri*
Jarrah = *Jarrah*

BCE Score:
1 – Tree with active nest.
2 – Tree with large hollow showing recent chewing around entrance.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout)
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout
5 – Tree meets DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollows.

Tree No.	Easting	Northing	Tree Species	DBH (mm)		BCE Score	Notes
1	415722.755	6477934.553	Marri	500	Alive	5	
2	415715.732	6477925.405	Marri	600	Alive	5	
3	415748.125	6477922.123	Marri	750	Alive	3	1 hollow spout on one of the larger branches
4	415734.818	6477917.58	Marri	730	Alive	5	
5	415727.219	6477909.426	Marri	860	Alive	5	Galahs breeding in smaller hollow
6	415710.275	6477886.894	Jarrah	1010	Alive	5	
7	415718.372	6477868.892	Marri	500	Alive	5	
8	415720.012	6477865.025	Marri	580	Alive	5	
9	415727.504	6477851.674	Marri	550	Alive	5	
10	415746.802	6477852.608	Marri	1200	Alive	5	
11	415751.989	6477843.339	Marri	680	Alive	5	
12	415742.644	6477817.212	Marri	750	Alive	5	
13	415730.212	6477809.904	Marri	850	Alive	5	
14	415749.945	6477804.08	Marri	800	Alive	5	
15	415701.75	6477760.785	Jarrah	1150	Alive	5	Possible spout. Marked as 5 as spout unlikely to be hollow.
16	415717.046	6477742.065	Jarrah	550	Alive	5	
17	415742.602	6477741.609	Marri	500	Alive	5	
18	415754.633	6477751.685	Jarrah	1500	Alive	5	
19	415746.571	6477719.139	Jarrah	500	Alive	5	
20	415764.633	6477709.31	Jarrah	600	Alive	5	
21	415770.374	6477690.069	Jarrah	750	Alive	5	
22	415770.249	6477670.779	Jarrah	650	Alive	5	
23	415748.678	6477623.823	Jarrah	520	Alive	5	
24	415768.145	6477615.668	Marri	500	Alive	5	
25	415784.616	6477603.609	Marri	750	Alive	5	

26	415801.106	6477623.809	Jarrah	1500	Alive	3	Possible hollow spout
27	415808.884	6477621.655	Marri	700	Alive	5	
28	415817.81	6477641.128	Marri	900	Alive	3	1 possible hollow but not vertical or near vertical. 1 possible hollow on trunk but only 6 m from the ground.
29	415783.784	6477566.578	Marri	1100	Alive	5	
30	415811.016	6477557.822	Jarrah	850	Alive	5	
31	415817.061	6477559.201	Jarrah	900	Alive	5	
32	415820.834	6477560.784	Marri	600	Alive	5	
33	415821.056	6477568.324	Marri	530	Alive	5	
34	415839.315	6477569.028	Jarrah	840	Alive	5	
35	415844.224	6477570.509	Marri	500	Alive	5	
36	415846.743	6477563.324	Marri	550	Alive	5	
37	415848.797	6477566.778	Marri	500	Alive	5	
38	415872.008	6477552.113	Marri	900	Alive	5	
39	415878.798	6477520.354	Marri	600	Alive	5	
40	415919.781	6477508.052	Marri	850	Alive	5	
41	415932.968	6477527.227	Marri	650	Alive	5	
42	415934.603	6477535.665	Marri	580	Alive	5	
43	415912.475	6477533.599	Marri	850	Alive	5	
44	415920.567	6477550.848	Marri	550	Alive	5	
45	415856.968	6477597.551	Jarrah	1400	Alive	5	
46	415856.587	6477597.88	Jarrah	900	Alive	5	
47	415875.349	6477629.627	Marri	850	Alive	5	
48	415879.057	6477650.608	Marri	500	Alive	5	
49	415843.667	6477684.794	Marri	560	Alive	5	
50	415831.952	6477716.956	Jarrah	650	Alive	5	
51	415817.355	6477754.416	Marri	550	Dead	3	Possible hollow spout on main trunk. Only 7 metres above ground.
52	415788.372	6477780.451	Jarrah	1100	Alive	5	
53	415806.002	6477788.687	Marri	1150	Alive	3	1 possible hollow
54	415793.69	6477801.334	Marri	850	Alive	5	
55	415781.592	6477799.462	Jarrah	650	Alive	5	
56	415779.805	6477809.646	Jarrah	750	Alive	5	
57	415794.371	6477822.18	Jarrah	2100	Dead	5	
58	415789.367	6477832.338	Jarrah	650	Alive	5	
59	415793.4	6477836.694	Marri	750	Alive	5	
60	415781.101	6477847.79	Jarrah	720	Alive	5	
61	415820.806	6477864.632	Marri	900	Alive	5	
62	415821.426	6477846.679	Jarrah	750	Alive	5	
63	415821.625	6477845.461	Marri	600	Alive	5	
64	415840.523	6477837.634	Marri	550	Alive	5	

65	415856.51	6477826.902	Jarrah	650	Alive	5	
66	415869.117	6477835.984	Marri	550	Alive	5	
67	415868.861	6477821.017	Marri	900	Alive	5	
68	415876.619	6477798.134	Jarrah	600	Alive	5	Large trunk with one live stem 600mm
69	415845.476	6477787.459	Marri	680	Alive	5	
70	415925.032	6477676.037	Jarrah	1300	Alive	5	
71	415923.051	6477663.716	Marri	500	Alive	5	
72	415918.45	6477636.076	Jarrah	800	Alive	5	
73	415933.537	6477596.514	Marri	550	Alive	5	
74	415945.31	6477580.315	Jarrah	600	Alive	5	
75	415929.679	6477570.654	Marri	550	Alive	5	
76	415975.014	6477581.778	Jarrah	1500	Dead	3	3 Possible hollows
77	415990.162	6477592.543	Marri	900	Alive	5	
78	415976.365	6477601.631	Marri	520	Alive	5	
79	415988.577	6477612.816	Marri	650	Alive	5	
80	415995.487	6477612.54	Marri	600	Alive	5	
81	415990.38	6477623.806	Marri	550	Alive	5	
82	415993.77	6477637.468	Marri	600	Alive	5	
83	415981.296	6477635.26	Marri	700	Alive	5	
84	415977.154	6477655.623	Marri	500	Alive	5	
85	415960.611	6477688.079	Jarrah	600	Alive	5	
86	415942.127	6477749.673	Marri	550	Alive	5	
87	415924.396	6477765.269	Jarrah	620	Alive	5	
88	415924.59	6477764.716	Marri	580	Alive	5	
89	415944.895	6477793.039	Marri	560	Alive	5	
90	415959.067	6477784.397	Jarrah	850	Alive	5	
91	415906.931	6477829.531	Marri	780	Alive	5	
92	415885.519	6477855.517	Marri	750	Alive	5	
93	415887.262	6477862.294	Jarrah	650	Alive	5	
94	415887.354	6477862.516	Jarrah	500	Alive	5	
95	415868.421	6477851.609	Marri	700	Alive	5	
96	415860.584	6477907.193	Jarrah	1500	Alive	5	
97	415880.015	6477938.28	Marri	1150	Alive	5	
98	415902.251	6477950.434	Jarrah	1300	Alive	5	Resprouted from roots
99	415919.958	6477937.609	Marri	550	Alive	5	
100	415904.541	6477913.427	Marri	850	Alive	5	
101	415947.581	6477858.021	Marri	500	Alive	5	
102	415941.157	6477845.109	Jarrah	650	Alive	5	
103	415963.463	6477837.088	Marri	650	Alive	5	
104	415971.038	6477836.596	Marri	750	Dead	5	
105	415972.68	6477809.34	Marri	700	Alive	3	3 hollows. 1 hollow with worn patches around edges with bees

106	415994.7	6477789.899	Jarrah	500	Alive	5	
107	415994.389	6477758.525	Marri	500	Alive	5	
108	415990.499	6477701.847	Marri	1000	Alive	5	
109	415992.858	6477679.474	Jarrah	950	Alive	5	
110	416024.389	6477677.404	Marri	600	Alive	5	
111	416022.274	6477704.656	Marri	1000	Alive	3	Hollow on main trunk
112	416028.758	6477710.252	Marri	600	Alive	5	
113	416019.158	6477715.384	Marri	650	Alive	5	
114	416016.835	6477744.852	Marri	600	Alive	5	
115	416030.421	6477761.59	Marri	550	Alive	5	
116	416043.494	6477771.563	Marri	550	Alive	5	
117	416042.189	6477780.753	Marri	650	Alive	5	
118	416045.801	6477778.787	Marri	600	Alive	5	
119	416018.165	6477790.534	Marri	900	Alive	5	
120	416041.815	6477814.893	Marri	700/650	Alive	5	2 trunks
121	416069.047	6477829.415	Marri	1400	Alive	5	
122	416068.554	6477843.49	Marri	850	Alive	5	
123	416070.866	6477850.049	Marri	850	Alive	5	
124	416068.469	6477853.909	Jarrah	1500	Dead	3	2 Possible hollows
125	416055.998	6477874.426	Marri	580	Alive	5	
126	416053.02	6477868.194	Marri	650	Alive	5	
127	416022.364	6477855.86	Marri	580	Alive	5	
128	416026.642	6477864.985	Marri	1000	Alive	5	
129	416035.471	6477884.789	Marri	700	Alive	5	
130	416027.34	6477895.476	Jarrah	1500	Dead	3	2 Possible hollows
131	416017.788	6477906.261	Marri	850	Alive	3	Large hollow in main trunk where it has been broken off. Resprouting around hollow
132	415979.598	6477889.21	Jarrah	1700	Alive	5	
133	415975.071	6477864.12	Jarrah	100	Alive	5	Large spout too big and too low for Black-Cockatoos
134	415954.299	6477904.523	Jarrah	700	Dead	5	
135	416104.006	6478230.655	Marri	800	Alive	5	
136	416075.683	6478164.245	Marri	1000	Alive	5	
137	416066.857	6478143.998	Jarrah	1100	Alive	5	
138	416068.063	6478123.832	Marri	520	Alive	5	
139	416079.693	6478101.978	Marri	1200	Alive	5	Pair of Corellas nesting
140	416098.067	6478111.884	Marri	500	Alive	5	
141	416108.81	6478105.985	Marri	700	Alive	5	
142	416112.134	6478104.46	Marri	600	Alive	5	
143	416122.359	6478115.629	Marri	650	Alive	5	
144	416121.608	6478161.294	Marri	500	Alive	5	
145	416140.313	6478165.438	Marri	500	Alive	5	

146	416158.094	6478178.442	Marri	900	Alive	5	
147	416173.051	6478201.288	Marri	600	Alive	5	
148	416183.204	6478232.853	Marri	950	Alive	5	
149	416177.979	6478258.418	Marri	900	Alive	5	
150	416218.007	6478247.548	Marri	650	Alive	5	
151	416220.706	6478241.584	Jarrah	650	Alive	5	
152	416218.392	6478281.583	Marri	3x500	Alive	5	
153	416222.036	6478287.377	Marri	500	Alive	5	
154	416239.776	6478305.479	Marri	530	Alive	5	
155	416238.739	6478316.556	Marri	650	Alive	5	
156	416234.614	6478323.396	Marri	1000	Alive	5	
157	416207.795	6478339.251	Marri	750	Alive	5	
158	416193.751	6478332.263	Marri	550	Alive	5	
159	416188.817	6478322.135	Marri	750	Alive	5	
160	416166.419	6478295.016	Marri	540	Alive	5	
161	416128.961	6478280.854	Jarrah	750	Alive	5	
162	416109.392	6478243.336	Jarrah	600	Alive	5	
163	416104.869	6478298.948	Marri	600	Alive	5	
164	416099.313	6478318.634	Jarrah	550/700	Alive	5	
165	416105.001	6478329.101	Jarrah	500	Alive	5	
166	416112.078	6478331.708	Jarrah	500	Alive	5	
167	416106.726	6478349.733	Jarrah	600	Alive	5	
168	416166.659	6478323.618	Marri	750	Alive	5	
169	416118.389	6478370.225	Marri	650	Alive	5	
170	416107.423	6478357.055	Jarrah	650	Alive	5	
171	416084.291	6478350.215	Jarrah	1000	Alive	5	
172	416063.731	6478364.569	Jarrah	550	Alive	5	
173	416122.865	6478389.994	Jarrah	650	Alive	5	
174	416129.204	6478425.075	Marri	750	Alive	5	
175	416074.092	6478405.448	Jarrah	600	Alive	5	
176	416052.026	6478407.152	Marri	3x500	Alive	5	
177	416051.635	6478350.725	Marri	550	Alive	5	
178	416038.206	6478326.338	Marri	600	Alive	5	
179	416034.749	6478320.878	Marri	800	Alive	5	
180	416026.861	6478313.276	Marri	600	Alive	5	
181	416063.666	6478326.214	Marri	550	Alive	5	
182	416074.804	6478318.323	Marri	750	Alive	5	
183	416019.231	6478285.611	Marri	600	Alive	5	
184	416016.877	6478284.151	Marri	700	Alive	5	
185	416017.263	6478283.267	Marri	550	Alive	5	
186	415990.903	6478289.37	Marri	700	Alive	5	
187	415970.084	6478265.81	Marri	800	Alive	5	
188	415959.294	6478265.944	Marri	1200	Dead	4	

189	415968.447	6478257.705	Marri	1050	Alive	5	
190	415961.579	6478241.132	Marri	1100	Alive	5	
191	415975.008	6478196.013	Marri	600	Alive	5	
192	416001.424	6478229.485	Marri	600	Alive	5	
193	416005.46	6478233.62	Marri	620	Alive	5	
194	416007.814	6478235.08	Marri	550	Alive	5	
195	416010.505	6478218.474	Marri	550	Alive	5	
196	416035.854	6478243.512	Marri	550	Alive	5	
197	416036.415	6478255.932	Marri	700	Alive	5	
198	416064.279	6478251.171	Marri	850	Alive	5	
199	416073.832	6478228.635	Jarrah	1300	Alive	5	
200	416066.172	6478216.268	Marri	1300	Alive	4	
201	416078.998	6478210.276	Jarrah	1000	Alive	5	
202	416050.127	6478071.807	Marri	800	Alive	5	
203	416057.405	6478061.446	Jarrah	1300	Alive	5	
204	416011.747	6478020.058	Jarrah	1000	Alive	3	
205	416027.618	6477954.119	Marri	700	Alive	5	
206	416070.481	6477966.774	Marri	750	Alive	5	
207	416080.146	6477976.94	Jarrah	1500	Alive	5	

Appendix 2. Notes on potential habitat trees within the proposed offset area, 29 January 2015 survey.

UTM Zone 50J. Datum WGS84.

DBH – Diameter at breast height

Marri = *Marri*
Jarrah = *Jarrah*

BCE Score:
1 – Tree with active nest.
2 – Tree with large hollow showing recent chewing around entrance.
3 – Tree with possible suitable hollow visible, or assumed from structure of tree (such as a high, vertical spout)
4 – Tree that is large with some small hollows, possibly some concealed larger hollows but no vertical spout
5 – Tree meets DBH criterion but has an intact crown and is therefore unlikely to have current suitable hollows.

Block	Trans	Tree no.	Species	Easting	Northing	DBH	BCE Score		comments
Lot82	1	1	Marri	415263.76	6477037.91	550	5	Alive	
Lot82	1	2	Jarrah	415286.21	6477052.98	600	5	Alive	
Lot82	1	3	Marri	415296.52	6477041.23	700	5	Alive	large broken branch but not hollow
Lot82	1	4	Jarrah	415307.61	6477036.84	500	5	Alive	
Lot82	1	5	Jarrah	415308.78	6477027.63	650	5	Alive	
Lot82	1	6	Marri	415318.38	6477037.25	650	3	Alive	
Lot82	1	7	Marri	415333.85	6477027.99	750	3	Dead	
Lot82	1	8	Marri	415348.8	6477037.5	500	5	Alive	
Lot82	1	9	Jarrah	415354.3	6477039.36	650	5	Alive	
Lot82	1	10	Marri	415365.37	6477023.48	700	5	Alive	
Lot82	1	11	Marri	415374.62	6477033.9	850	4	Alive	
Lot82	1	12	Marri	415386.68	6477029.45	800	5	Alive	
Lot82	1	13	Marri	415390.58	6477045.38	650	5	Alive	
Lot82	1	14	Marri	415391.68	6477046.83	500	4	Alive	
Lot82	1	15	Marri	415405.85	6477048.8	1100	3	Alive	large hollow vertical spout
Lot82	1	16	Jarrah	415404.04	6477050.95	500	5	Alive	
Lot82	1	17	Jarrah	415423.19	6477045.9	550	5	Alive	
Lot82	1	18	Jarrah	415424.73	6477046.56	950	5	Alive	
Lot82	1	19	Marri	415445.35	6477050.55	500	5	Alive	
Lot82	1	20	Marri	415501.8	6477049.63	750	5	Alive	fallen but shooting
Lot82	1	21	Marri	415499.24	6477028.32	500	5	Dead	
Lot82	1	22	Marri	415512.36	6477028.64	900	5	Alive	many flat possibly broken limbs
Lot82	1	23	Jarrah	415633.14	6477039.93	700	4	Alive	
Lot82	1	24	Jarrah	415638.13	6477040.73	800	5	Dead	
Lot82	1	25	Jarrah	415628.74	6477050.55	950	4	Alive	
Lot82	1	26	Marri	415650.97	6477049.9	1200	3	Alive	many openings much forest red tailed Black foraging sign
Lot82	2	27	Marri	415634.36	6477066.31	1000	3	Dead	huge broken spout at 5m
Lot82	2	28	Marri	415617.02	6477078.42	990	4	Alive	
Lot82	2	29	Marri	415596.68	6477083.07	750	3	Alive	

Lot82	2	30	Marri	415561.49	6477062.23	500	5	Alive	
Lot82	2	31	Marri	415540.2	6477066.86	500	5	Alive	
Lot82	2	32	Marri	415476.71	6477076.28	600	5	Alive	
Lot82	2	33	Marri	415436.83	6477078.08	659	5	Alive	
Lot82	2	34	Marri	415424.21	6477067.46	700	4	Alive	
Lot82	2	35	Marri	415405.81	6477065.27	750	4	Alive	
Lot82	2	36	Jarrah	415409.14	6477075.63	650	5	Alive	
Lot82	2	37	Jarrah	415396.9	6477074.21	500	5	Alive	
Lot82	2	38	Jarrah	415386.43	6477067.86	550	5	Alive	
Lot82	2	39	Marri	415377.46	6477072.05	700	5	Alive	
Lot82	2	40	Marri	415362.31	6477066.51	850	3	Dead	
Lot82	2	41	Marri	415319.52	6477058.87	750	3	Alive	
Lot82	2	42	Marri	415322.06	6477048.3	700	4	Alive	
Lot501	1	43	Jarrah	415255.44	6476897.23	1000	3	Alive	
Lot501	1	44	Jarrah	415277.16	6476896.58	700	3	Alive	
Lot501	1	45	Jarrah	415299.46	6476911.09	1250	3	Dead	
Lot501	1	46	Marri	415313.27	6476905.36	500	5	Alive	
Lot501	1	47	Marri	415319.12	6476908.36	500	5	Alive	
Lot501	1	48	Jarrah	415319.17	6476908.41	550	5	Alive	
Lot501	1	49	Marri	415322.94	6476910.62	500	5	Alive	
Lot501	1	50	Marri	415324.8	6476915.32	500	5	Alive	
Lot501	1	51	Marri	415323.69	6476916.38	500	5	Alive	
Lot501	1	52	Jarrah	415326.08	6476917.49	550	5	Alive	
Lot501	1	53	Jarrah	415332.01	6476916.32	600	5	Alive	
Lot501	1	54	Jarrah	415342.92	6476920.5	600	5	Alive	
Lot501	1	55	Marri	415344.43	6476913.25	500	5	Alive	
Lot501	1	56	Jarrah	415340.05	6476908.41	500	5	Alive	
Lot501	1	57	Jarrah	415375.09	6476919.19	550	5	Alive	
Lot501	1	58	Jarrah	415371.63	6476909	600	5	Alive	
Lot501	1	59	Jarrah	415379.98	6476905.33	500	5	Alive	
Lot501	1	60	Jarrah	415401.62	6476904.12	700	4	Alive	
Lot501	1	61	Jarrah	415406.96	6476903.56	600	4	Alive	
Lot501	1	62	Marri	415503.36	6476907.27	1000	4	Alive	
Lot501	1	63	Marri	415534.17	6476912.8	600	5	Alive	
Lot501	1	64	Marri	415587.45	6476906.72	500	5	Alive	
Lot501	1	65	Marri	415615.54	6476911.01	550	5	Alive	
Lot501	1	66	Marri	415650.33	6476926.69	600	4	Alive	
Lot501	1	67	Marri	415670.35	6476917.35	750	5	Alive	
Lot501	1	68	Marri	415694.76	6476918.85	500	5	Alive	
Lot501	1	69	Marri	415727.58	6476899.78	1050	3	Alive	
Lot501	1	70	Marri	415737.44	6476906.11	750	5	Alive	
Lot501	1	71	Marri	415739.61	6476915.97	800	4	Alive	
Lot501	1	72	Marri	415743.95	6476936.36	950	3	Alive	much forest rtb forage sign
Lot501	1	73	Marri	415794.35	6476923.32	500	5	Alive	
Lot501	1	74	Marri	415834.08	6476900.56	11150	3	Alive	many broken spouts
Lot501	1	75	Jarrah	415892.2	6476921.4	600	5	Alive	
Lot501	1	76	Jarrah	415896.71	6476926.78	600	5	Alive	
Lot501	1	77	Marri	415910.07	6476922.44	700	4	Alive	
Lot501	1	78	Marri	415924.57	6476911.33	750	5	Alive	
Lot501	1	79	Jarrah	415943.68	6476923.14	800	5	Alive	
Lot501	1	80	Jarrah	415955.24	6476922.18	1100	4	Alive	

Lot501	1	81	Jarrah	415953.4	6476904.91	600	5	Alive	
Lot501	1	82	Jarrah	415963.73	6476907.04	550	5	Alive	frtb heard nearby
Lot501	1	83	Marri	415993.29	6476907.81	1300	3	Alive	
Lot501	1	84	Marri	415998.56	6476927.69	800	3	Alive	
Lot501	1	85	Marri	416001.29	6476926.76	550	5	Alive	
Lot501	1	86	Jarrah	416024.59	6476912.25	550	4	Alive	
Lot501	1	87	Marri	416047.5	6476923.08	600	5	Alive	
Lot501	1	88	Marri	416062.67	6476928.79	600	5	Alive	
Lot501	1	89	Marri	416076.6	6476937.4	600	5	Alive	
Lot501	1	90	Jarrah	416078.59	6476938.52	500	5	Alive	
Lot501	1	91	Jarrah	416118.79	6476921.42	700	5	Alive	
Lot501	1	92	Jarrah	416121.52	6476927.01	700	5	Alive	
Lot501	1	93	Jarrah	416133.17	6476911.46	500	5	Alive	
Lot501	1	94	Marri	416155.38	6476915.01	700	5	Alive	
Lot501	1	95	Marri	416165.27	6476908.2	600	5	Alive	
Lot501	1	96	Marri	416171.22	6476907.53	500	5	Alive	
Lot501	1	98	Marri	416263.46	6476910.08	800	4	Alive	
Lot501	1	99	Marri	416284.9	6476914.73	750	5	Alive	
Lot501	1	100	Marri	416306.44	6476918.5	1200	4	Alive	
Lot501	1	101	Marri	416308.01	6476923.74	500	5	Alive	
Lot501	1	102	Marri	416331.29	6476909.5	700	5	Alive	
Lot501	1	103	Marri	416338.43	6476919.35	650	5	Alive	
Lot501	1	104	Marri	416396.7	6476935.36	500	5	Alive	
Lot501	1	105	Marri	416400.26	6476925.83	500	5	Alive	
Lot501	1	106	Marri	416399.16	6476918.26	500	5	Alive	
Lot501	1	107	Marri	416414.14	6476917.77	900	5	Alive	
Lot501	1	108	Marri	416423.52	6476918.5	550	5	Alive	
Lot501	1	109	Marri	416426.21	6476919.4	900	5	Alive	
Lot501	1	110	Marri	416431.15	6476911.67	850	5	Alive	lot of frtb forage sign
Lot501	1	111	Marri	416494.09	6476908.05	600	5	Alive	all forage sign recent/intermediate age
Lot501	1	112	Marri	416501.4	6476905.96	750	5	Alive	
Lot501	1	113	Marri	416504.65	6476907.3	600	5	Alive	
Lot501	1	114	Marri	416505.04	6476908.05	550	5	Alive	carnaby and frtb forage sign, intermediate age
Lot501	1	115	Marri	416516.3	6476910.49	700	5	Alive	carnaby and frtb forage sign, intermediate age
Lot501	1	116	Marri	416512.66	6476896.78	600	5	Alive	carnaby and frtb forage sign, intermediate age
Lot501	1	117	Marri	416517.94	6476899.83	500	5	Alive	carnaby and frtb forage sign, intermediate age
Lot501	1	118	Marri	416522.21	6476898.62	550	5	Alive	carnaby and frtb forage sign, intermediate age
Lot501	1	119	Marri	416530.22	6476909.53	650	5	Alive	
Lot501	1	120	Marri	416531.72	6476909.99	650	5	Alive	
Lot501	1	121	Marri	416537.63	6476907.39	700	5	Alive	
Lot501	1	122	Marri	416550.44	6476909.25	700	5	Alive	
Lot501	1	123	Marri	416556.36	6476903.21	500	5	Alive	

Lot501	1	124	Marri	416584.82	6476920.42	900	5	Alive	
Lot501	1	125	Marri	416602.97	6476918.59	1100	5	Alive	
Lot501	1	126	Marri	416611.41	6476911.55	650	5	Alive	
Lot501	1	127	Marri	416623.74	6476899.6	700	5	Alive	
Lot501	1	128	Marri	416642.39	6476908.67	500	5	Alive	
Lot501	1	129	Marri	416674.21	6476913.78	500	5	Alive	
Lot501	1	130	Marri	416675.59	6476931.66	550	5	Alive	much frtb forage nuts
Lot501	1	131	Marri	416703.56	6476916.69	650	5	Alive	
Lot501	1	132	Marri	416725.15	6476907.2	650	5	Alive	
Lot501	1	133	Marri	416732.87	6476909	650	5	Alive	masses of frtb forage nuts
Lot501	1	134	Marri	416783.8	6476910.84	500	5	Alive	nuts for 100m
Lot501	1	135	Marri	416793.08	6476907.82	500	5	Alive	
Lot501	1	136	Marri	416799.11	6476913.93	500	5	Alive	
Lot501	1	137	Jarrah	416828.9	6476921.4	550	5	Alive	
Lot82	3	290	Marri	415247.8338	6477007.35	500	5	Alive	
Lot82	3	291	Jarrah	415255.5569	6477000.32	600	5	Dead	
Lot82	3	292	Marri	415270.333	6476998.66	900	2	Alive	Hollows and spouts
Lot82	3	293	Marri	415275.3705	6477007.46	900	3	Alive	
Lot82	3	294	Marri	415276.1129	6477009.24	600	5	Alive	
Lot82	3	295	Jarrah	415311.6397	6477015.85	500	5	Alive	
Lot82	3	296	Marri	415341.1438	6477006.9	600	4	Alive	
Lot82	3	297	Jarrah	415343.4093	6477007.58	800	5	Alive	
Lot82	3	298	Jarrah	415363.6787	6477016.84	700	5	Dead	
Lot82	3	299	Jarrah	415383.3473	6477007.13	600	5	Dead	Spouts
Lot82	3	300	Marri	415422.3719	6477002.69	500	5	Alive	
Lot82	3	301	Marri	415444.4714	6476996.55	500	5	Alive	
Lot82	3	302	Marri	415456.4327	6477026.47	600	5	Alive	
Lot82	3	303	Marri	415483.3047	6477003.85	600	3	Alive	Hollows and spouts
Lot82	3	304	Jarrah	415485.9587	6477003.32	700	4	Alive	Spouts
Lot82	3	305	Jarrah	415580.5742	6477005.21	1100	3	Alive	Hollows and spouts
Lot82	3	306	Marri	415654.5052	6477013.8	900	4	Alive	Spouts
Lot82	4	307	Marri	415687.3302	6477084.46	700	5	Alive	
Lot82	4	308	Marri	415657.6269	6477106.16	700	3	Alive	Hollows and spouts
Lot82	4	309	Marri	415541.6698	6477098.67	600	5	Alive	
Lot82	4	310	Marri	415429.2836	6477105.73	600	5	Alive	
Lot82	4	311	Marri	415404.8833	6477092.45	600	5	Alive	
Lot82	4	312	Jarrah	415402.5989	6477082.56	600	5	Alive	
Lot82	4	313	Marri	415330.6029	6477103.25	500	5	Alive	
Lot82	4	314	Marri	415332.6629	6477071.45	800	3	Alive	Spouts
Lot82	4	315	Marri	415279.5483	6477063.15	900	4	Alive	Spouts
Lot501	2	316	Marri	415236.1457	6476898.5	900	4	Dead	Spouts
Lot501	2	317	Marri	415251.3285	6476893.42	700	4	Alive	Spouts
Lot501	2	318	Jarrah	415284.6762	6476888.82	700	4	Alive	
Lot501	2	319	Jarrah	415297.4348	6476890.81	500	5	Alive	Spouts
Lot501	2	320	Jarrah	415311.9543	6476885.83	600	5	Alive	
Lot501	2	321	Jarrah	415358.5703	6476878.78	600	5	Dead	
Lot501	2	322	Jarrah	415386.7979	6476886.89	1000	4	Alive	Spouts
Lot501	2	323	Jarrah	415400.1377	6476898.75	900	5	Alive	

Lot501	2	324	Jarrah	415456.0778	6476885.57	500	5	Alive	
Lot501	2	325	Jarrah	415466.7103	6476881.45	600	5	Alive	
Lot501	2	326	Marri	415465.2684	6476872.68	800	3	Alive	Hollow
Lot501	2	327	Marri	415469.2307	6476874.15	500	5	Alive	
Lot501	2	328	Jarrah	415521.0306	6476881.12	1100	5	Dead	
Lot501	2	329	Jarrah	415555.2514	6476896.92	500	5	Alive	
Lot501	2	330	Marri	415570.8615	6476897.38	500	5	Alive	
Lot501	2	331	Marri	415571.4785	6476891.4	500	5	Alive	
Lot501	2	332	Marri	415725.884	6476872.05	900	5	Alive	
Lot501	2	333	Marri	415759.7464	6476873.88	500	5	Alive	
Lot501	2	334	Marri	415784.5535	6476895.25	500	5	Alive	
Lot501	2	335	Marri	415811.4029	6476898.36	500	5	Dead	
Lot501	2	336	Marri	415864.0844	6476890.14	1100	4	Dead	
Lot501	2	337	Marri	415888.3246	6476899.87	800	3	Alive	
Lot501	2	338	Marri	415934.137	6476898.47	500	5	Alive	
Lot501	2	339	Jarrah	415970.5951	6476895.34	700	5	Alive	
Lot501	2	340	Jarrah	415970.8863	6476894.45	600	4	Alive	
Lot501	2	341	Jarrah	415971.6224	6476897.01	600	5	Alive	
Lot501	2	342	Marri	416012.8752	6476886.15	700	4	Alive	
Lot501	2	343	Marri	416056.8551	6476888.95	500	5	Dead	
Lot501	2	344	Jarrah	416070.5067	6476897.48	500	5	Alive	
Lot501	2	345	Marri	416072.7759	6476897.72	500	5	Alive	
Lot501	2	346	Marri	416101.3314	6476900.5	1200	3	Alive	Hollows and spouts
Lot501	2	347	Marri	416104.875	6476895.32	700	5	Alive	
Lot501	2	348	Marri	416109.4916	6476897.8	600	5	Alive	
Lot501	2	349	Marri	416123.1509	6476893.81	500	5	Alive	
Lot501	2	350	Marri	416131.2975	6476892.77	800	4	Dead	Spouts
Lot501	2	351	Marri	416138.4956	6476880.41	800	5	Alive	
Lot501	2	352	Marri	416136.8304	6476875.74	700	4	Alive	Spouts
Lot501	2	353	Marri	416190.4098	6476908.22	500	5	Alive	
Lot501	2	354	Marri	416224.3977	6476906.28	1100	2	Alive	Hollow
Lot501	2	355	Marri	416242.0896	6476906.75	700	5	Alive	
Lot501	2	356	Marri	416256.3521	6476886.8	600	4	Alive	Hollow
Lot501	2	357	Marri	416258.7276	6476885.6	1100	3	Alive	Hollows and spouts
Lot501	2	358	Marri	416288.6125	6476876.2	600	5	Alive	
Lot501	2	360	Marri	416401.1834	6476904.17	700	5	Alive	
Lot501	2	361	Marri	416408.9228	6476895.03	500	5	Alive	
Lot501	2	362	Marri	416462.4517	6476898.9	500	5	Alive	
Lot501	2	363	Marri	416487.3773	6476894.23	500	5	Alive	
Lot501	2	364	Marri	416515.7508	6476884.48	800	5	Alive	
Lot501	2	365	Marri	416538.9138	6476898.75	500	5	Alive	
Lot501	2	366	Marri	416541.83	6476900.88	700	5	Alive	
Lot501	2	367	Marri	416550.5938	6476893.74	600	5	Alive	
Lot501	2	368	Marri	416559.8408	6476897.03	500	5	Alive	
Lot501	2	369	Marri	416573.7388	6476898.59	500	5	Alive	
Lot501	2	370	Marri	416603.4261	6476890.18	500	5	Alive	
Lot501	2	371	Marri	416633.5226	6476889.65	500	5	Alive	
Lot501	2	372	Marri	416634.5626	6476889.77	500	5	Alive	
Lot501	2	373	Marri	416635.7243	6476898.2	500	5	Alive	
Lot501	2	374	Marri	416638.6424	6476900.11	600	5	Alive	
Lot501	2	375	Marri	416648.4814	6476900.41	500	5	Alive	

Lot501	2	376	Marri	416658.9783	6476901.27	500	5	Alive	
Lot501	2	377	Marri	416666.3677	6476888.59	500	5	Alive	
Lot501	2	378	Marri	416673.2656	6476901.5	500	5	Alive	
Lot501	2	379	Marri	416699.3088	6476910.69	500	5	Alive	
Lot501	2	380	Marri	416699.7619	6476901.49	500	5	Alive	
Lot501	2	381	Marri	416707.5363	6476899.67	500	5	Alive	
Lot501	2	382	Marri	416759.9694	6476898.66	500	5	Alive	
Lot501	2	383	Marri	416823.3245	6476892.74	700	4	Alive	Hollow
Lot501	2	384	Marri	416823.4738	6476885.98	600	5	Alive	

Draft Plan 5743/21b

31.832016°S

31.832016°S

116.094408°E

116.11918°E

116.094408°E

116.11918°E

31.844999°S

31.844999°S

Legend

Imagery

Clearing Instruments Conditions

N

0 500m

1:12,420

(Approximate when reproduced at A4)

GDA 94 (Lat/Long)

Geocentric Datum of Australia 1994

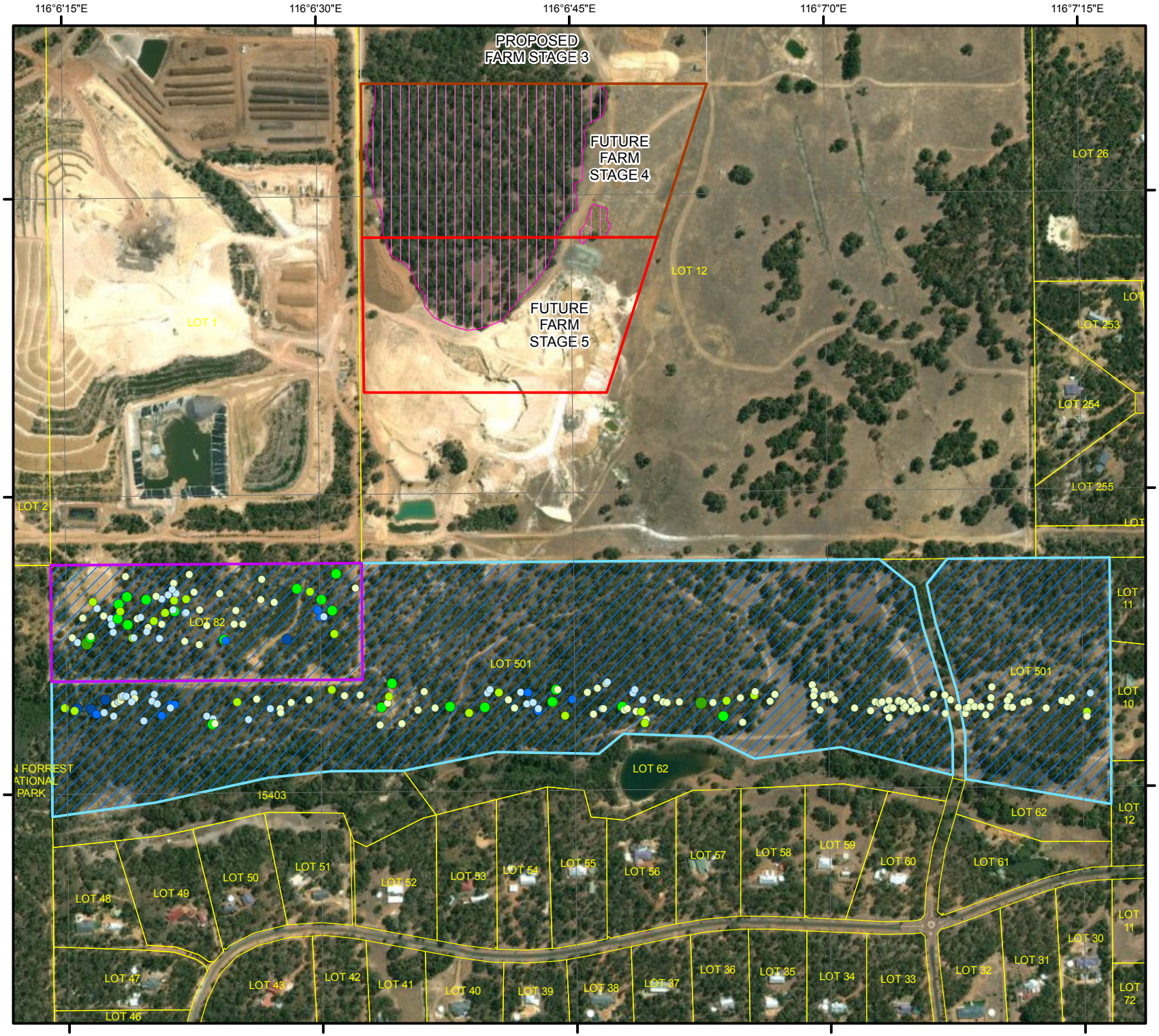
..... Date .....

DRAFT

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

GOVERNMENT OF WESTERN AUSTRALIA



KD.1 PTY LTD

EMRC

PO Box 4336
Mosman Park South
WA 6012
+61 (0) 8 9481 7880

PROJECT: Offset Proposal Plan

TITLE: Tree Survey

DATE: 15/05/2015

SCALE: 1:8,000 (A4) MGA Zone 50

0 100 200 400
Metres

Tree Species (Score)

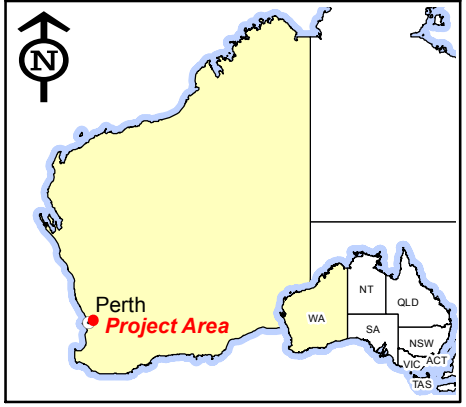
- Corymbia calophylla (2)
- Corymbia calophylla (3)
- Corymbia calophylla (4)
- Corymbia calophylla (5)
- Eucalyptus marginata (3)
- Eucalyptus marginata (4)
- Eucalyptus marginata (5)
- Proposed Farm
- Future Farm Stage 4 (11.9ha)
- Future Farm Stage 5 (10.1ha)
- LOT 82 (8.7ha)
- LOT 501 (43.8ha)
- Maximum Offset Area (52.5ha)
- Farm Stage 4 & 5 Disturbance Footprint (10.5ha)
- Cadastral Boundaries

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Cadastre - Landgate 2014

PREPARED BY:

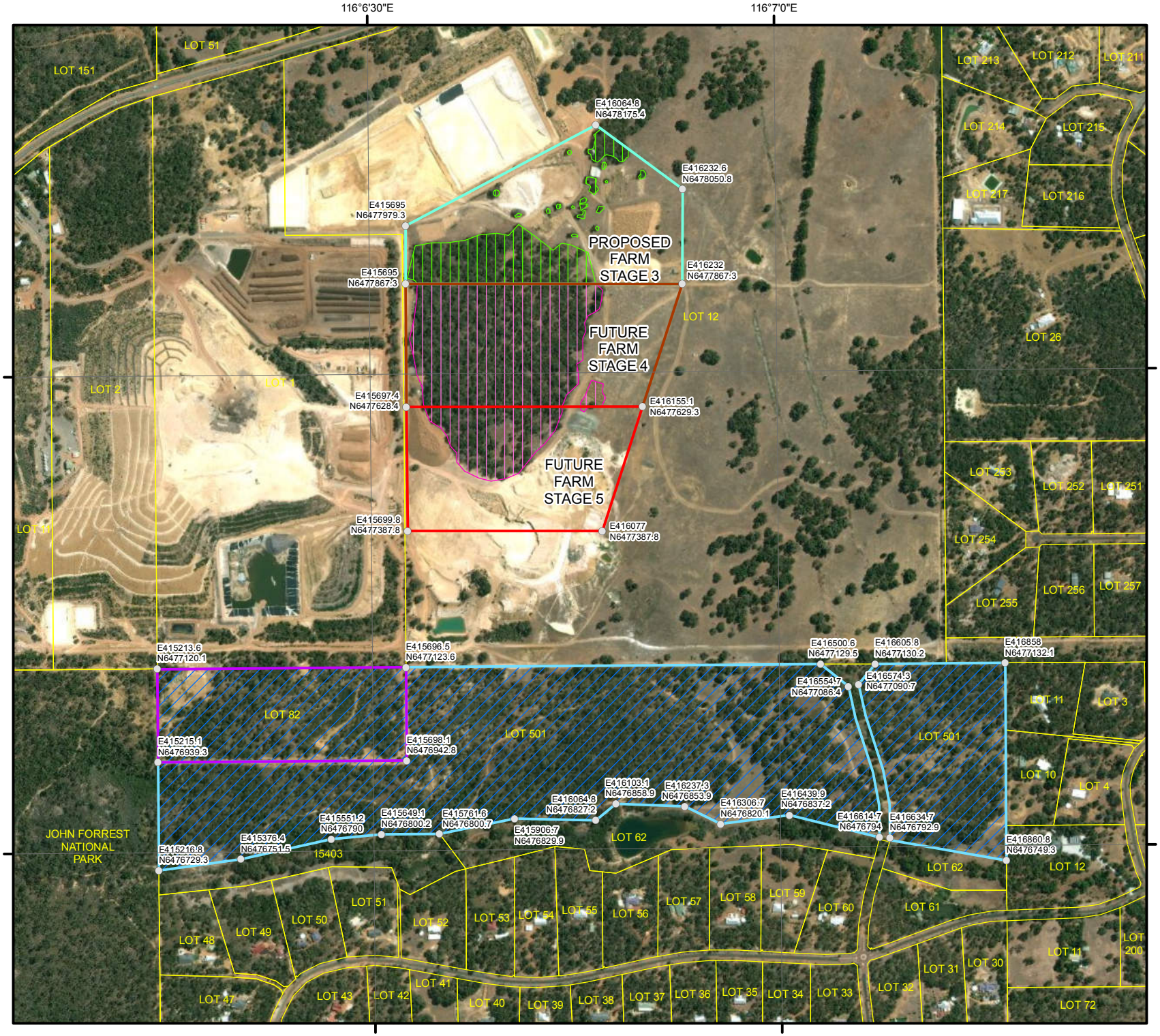
Phone: 1300 807 770
Phone: +61-7-3252 5589
Web: www.mipela.com.au
Email: support@mipela.com.au

mipela GeoSolutions



T:\Projects\KD001 KD 1 XIC TSC\Work Request\W_026_25114 - Offset plan\W_026_25114_OffsetPlan_TreeSurvey_RevD.mxd
15/05/2015

Rev D



KD.1 PTY LTD
PO Box 4336
Mosman Park South
WA 6012
+61 (0) 8 9481 7880

EMRC

PROJECT: Offset Proposal Plan

TITLE: Offest Areas : Stage 3, 4 & 5

DATE: 14/05/2015

SCALE: 1:10,000 (A4) MGA Zone 50

0 100 200 400
Metres

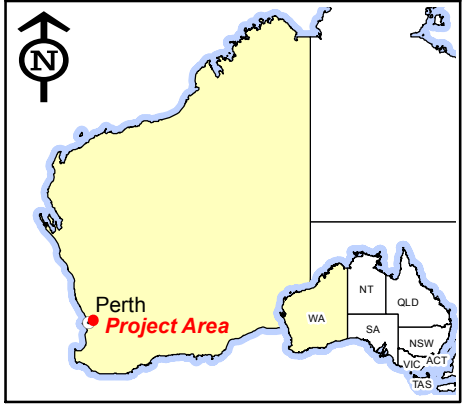
Legend

- Border Coordinates
- Proposed Farm Stage 3 (11.9ha)
- Future Farm Stage 4 (11.9ha)
- Future Farm Stage 5 (10.1ha)
- LOT 82 (8.7ha)
- LOT 501 (43.8ha)
- Maximum Offset Area (52.5ha)
- Farm Stage 3 Disturbance Footprint (3.4ha)
- Farm Stage 4 & 5 Disturbance Footprint (10.5ha)
- Cadastral Boundaries

PREPARED BY:

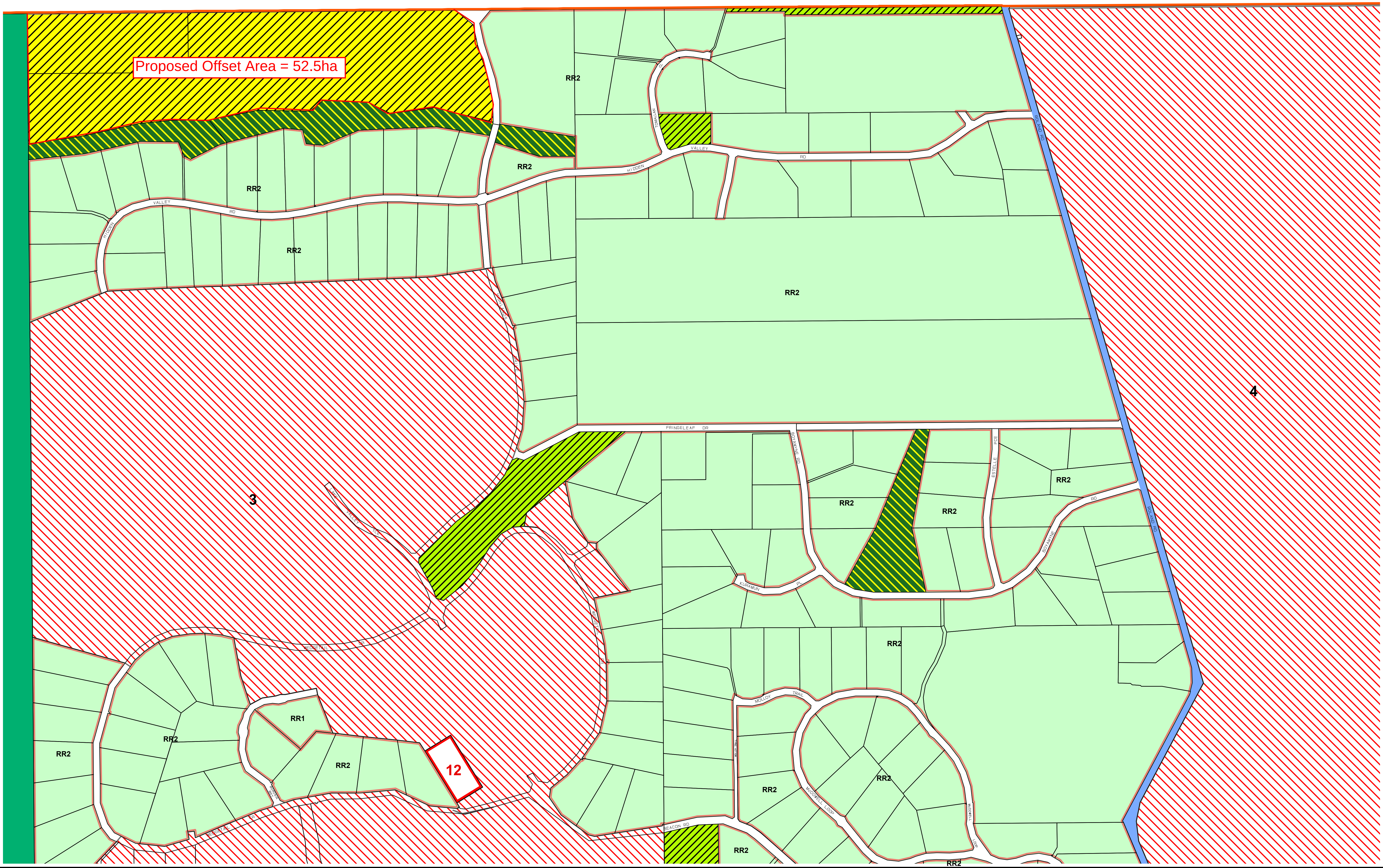
Phone: 1300 807 770
Phone: +61-7-3252 5589
Web: www.mipela.com.au
Email: support@mipela.com.au

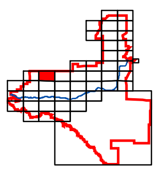
mipela GeoSolutions



T:\Projects\KD001 KD 1 XIC TSC\Work Request\W_026_25114 - Offset plan\W_026_25114_OffsetPlan_D.mxd
14/05/2015

Rev D





Map No. 9 of 46

LPS 4
Zones and Reserves

500 250 0 500 1,000
Meters