2014 COMPLIANCE REPORT FOR EPBC APPROVAL 2008/4250

AVON RIDGE ESTATE, BRIGADOON

Project Number EP13-041

Prepared for Peet Ltd.
October 2014

Document Control

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Executive Summary

Peet Limited (Peet) received approval pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2008/4250) from the Department of Environment, Water, Heritage and the Arts (DEWHA), now the Department of Environment (DoE) on the 8th October 2009. The approval relates to Peet's special rural development (the Development) on Lots 1010 and 1022 Campersic Road, Brigadoon in Western Australia. The Development, known as Avon Ridge Estate is located approximately 30 km northeast of the Perth Central Business District and is approximately 450 hectares (ha) with approximately 411 ha for Parks and Recreation reserve.

Emerge Associates (Emerge) have been appointed by Peet to prepare an annual compliance report (this report) to satisfy Condition 12 of the approval. In addressing Condition 12 of the approval, this document outlines the current level of compliance with the conditions of the approval for the Development thus far. The intent of this document is to:

- detail the actions undertaken within the Development from the 2nd September 2013 to 1st September 2014
- demonstrate the level of compliance with the conditions of approval
- identify any further actions which are required to meet the conditions of the approval.

Compliance has been achieved throughout the reporting period through the ongoing implementation of Protective Covenants, Notifications on Title, management plans, revegetation and other works as detailed in this report.

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1 Proposal and Proponent Details

PROPOSAL TITLE	Brigadoon Estate (Avon Ridge Estate) Special Rural Development, Brigadoon Western Australia
EPBC REFERENCE NUMBER	EPBC 2008/4250
PROPONENT NAME	Peet Limited
REPORTING PERIOD	2nd September 2013 - 1st September 2014
IMPLEMENTATION PHASE(S) DURING REPORTING PERIOD	Construction

1.1 Proposal Background

Avon Ridge Estate Special Rural Development (the Development) is located in Brigadoon, approximately 12 kilometres north of the Midland Regional Centre and 30 kilometres northeast of the Perth Central Business District (CBD). The Development consists of a special rural subdivision of 214 lots over 450 hectares, with lot sizes ranging from 1.5 hectares (ha) to 5.1 ha. The Development also includes a 411 ha area reserve for "Parks and Recreation" under the Metropolitan Region Scheme (MRS).

The Development is located on the Darling Scarp and Darling Range and is bound to the north by Walyunga National Park. The Development is also in close proximity to the Swan River to the west.

Peet Limited (Peet) submitted a referral pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the special rural development of Avon Ridge Estate in May 2008. The proposal was deemed to be a "Controlled Action" development on the 2nd July 2008 and was assessed by "Preliminary Documentation".

Additional information to inform the Preliminary Documentation assessment was prepared by Cardno (WA) Pty Ltd and was released for public comment in November 2008. A number of public comments were received and these were addressed in Response to Submissions: Brigadoon Estate Special Rural Development, Brigadoon Western Australia, EPBC Reference 2008/4250 (Cardno 2009).

The Department of Environment, Water, Heritage and the Arts (DEWHA) (now Department of Environment (DoE) also referred to as the Department) issued an environmental approval for the Development in October 2009 subject to 16 conditions. In October 2011 and January 2012, variations to approval conditions were approved by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the current list of 17 conditions is provided in **Table 1**.

1.2 Purpose of Report

This document has been prepared to satisfy the requirements of Condition 12 of the EPBC approval (2008/4250), which states:

"Within three months of every annual anniversary of commencement of the action, the person taking the action must submit to the Department a report addressing compliance with the conditions of this

approval. Annual Reports must be provided until the Minister is satisfied that the proponent has complied with all conditions of the approval."

In accordance with this condition, the compliance report is to be submitted by the 5th October each year based on the commencement of construction on the 5th July 2010. On behalf of Peet, Emerge Associates (Emerge) has prepared this compliance report to demonstrate the current level of compliance with conditions of approval under the EPBC Act. The objectives of this report are to:

- detail the actions undertaken within the Development from 2nd September 2013 to 1st September 2014
- demonstrate compliance with conditions of approval
- identify further actions which are required to meet conditions of approval.

This compliance report covers the 2013/14 reporting period and focuses on actions undertaken within the Development during the reporting period. Previous compliance reports (Cardno 2011, Cardno 2012a, Emerge 2013) provided numerous appendices to demonstrate compliance and in the interest of efficiency, this information has not been repeated, unless it is necessary to demonstrate compliance over the reporting period. This compliance report should be read in conjunction with the Approval Conditions under EPBC 2008/4250.

Details of compliance with each condition under EPBC 2008/4250 is presented in **Table 1** and the definition of compliance status terms used is shown in **Table 2**.

2 Approvals under the Environmental Protection and Biodiversity Conservation Act 1999

Peet received approval from DEWHA pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* for the special rural development of 450 ha of land at Campersic Road in Brigadoon on the 8th October 2009 (EPBC 2008/4250).

The 2009 approval was subject to 16 conditions. In October 2011 and January 2012 two separate variations to the approval conditions were approved by the DSEWPaC which superceded DEWHA (now DoE). A summary of the changes to the approval conditions was provided in the 2012 Compliance Report for EPBC Approval Conditions (Cardno 2012a).

The current list of 17 approval conditions is provided in **Table 1**.

2.1 Summary of Approval Conditions

Details of compliance with each condition under EPBC Act Approval, EPBC 2008/4250 is presented in **Table 1** and the definition of compliance status terms is shown in **Table 2.**

Table 1: Audit Table for EPBC 2008/4250 – Avon Ridge Estate

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
1	The person taking the action must not clear more than 63 hectares of native vegetation within the project area (**Attachment 1**) comprising: (a) up to 30 hectares for the purpose of constructing roads; (b) up to 27 hectares of the purpose of constructing boundary firebreaks on individual lots as identified in **Attachment 2**; (c) up to 6 hectares for the purposes of constructing strategic firebreaks and dams.	Construction Environmental Management Plan (CEMP).	Audit/record keeping of CEMP.	Construction Phase.	C	CEMP previously provided to the Department for approval (24th June 2010).
2	The person taking the action must put in place measures to ensure that clearing undertaken by future landowners within the project area (**Attachment 1**) will not exceed 37.4 hectares of native vegetation comprising: (a) up to 31.4 hectares for the purposes of constructing house sites, infiltration areas and buffers around the house sites; and (b) up to 6 hectare for the purpose of constructing driveways.	Protective Covenants placed on each lot to restrict clearing to permitted areas and require use of Fire Management Consultant (FMC). Local Structure Plan to restrict size of Building Envelopes.	Protective Covenants placed on titles.	During development.	C	Revised versions of the Protective Covenants has been approved by the Department in August 2014 and will be applied to Stage 1 (Release 2) and Stage 2 of the Development.
3	Revegetation and Fire Management Plan The person taking the action must prepare a Revegetation and Fire Management Plan that applies to the 100 ha within the Park and Recreation Reserve and 450 ha for the subdivision (as identified at	Revegetation and Fire Management Plan (RFMP),	Approved RFMP.	Prior to construction.	C	The existing RFMP (Cardno 2010b) is in effect. The 2014 RFMP

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
	Attachment 5) including all 214 individual lots. The proponent must obtain written approval from FESA prior to submission to the Department for approval. The person taking the action must not commence clearing or construction within the project area until the Department has approved the Revegetation and Fire Management Plan in writing. Once approved this plan must be implemented. The person taking the action must ensure that the Revegetation and Fire Management Plan includes (but is not restricted to):	approved by FESA (May 2010).				comprised of the revised RFMP (Cardno 2012b) and Addendum report (Emerge 2014) was approved by DFES in August 2014 and has been provided to the Department for approval (see **Appendix A**).
	a. fuel reduction measures (including cool burn measures) specifying the timing and frequency of fuel reduction measures to minimise impacts on Black Cockatoo habitat.	Implement RFMP.	Burn prescriptions. Photos.	Construction and Development Phase.	C	Fuel reduction based on the existing RFMP timeline (Cardno 2010b) was not undertaken due to unsuitable prescribed burning conditions and timing. Based on the 2014 RFMP, the proposed prescribed burn area for 2014 has partially been completed and will be completed by the end of 2014.

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
	b. Revegetation measure to create additional Black Cockatoo habitat across the project sites, including in Parks and Recreation Reserve, specifically: **i.** revegetation for all condition classes (excluding pristine and excellent classes) and vegetation complexes (including maps) **ii.** mix, numbers and density of species to be planted; **iii.** timing of proposed planting (must be during or following the annual winter rain period and generally between 1 June and 30 November; **iv.** weed management measures; **v.** the survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead tress must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years; **vi** annual monitoring measures within the project area undertake by an appropriate qualified and experience ecologist an must commence within 12 months of the completion of revegetation and continue for at least three year after the initial revegetation planting in any particular area (given that revegetation will be staged across the development); **vii.** annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Parks and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial revegetation planted in the Parks and Recreation Reserve for the purposes of establishing the survivorship rates and replanting efforts within the project area;	Implement RFMP.	Revegetation biannual monitoring reports including monitoring photographs. Documentation of site inspections. Aerial photography.	Development Phase.	C	Biannual monitoring reports (**Appendix B**).

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
	viii. mapping of all potential Black Cockatoo habitat trees of 500 mm dbh or greater on individual lots and information on how these will be retained for permanent conservation.	Implement RFMP.	Protective Covenants. Trees 500dbh (diameter at breast height) or greater within lots identified by GPS coordinates and marked with flagging tape.	Construction and Development Phase.	C	
4	Building Protection Zone. The person taking the action may thin native vegetation within the Building Protection Zone (**Attachment 2**) on each housing lot (**Attachment 3**). The total thinning within the Building Protection Zones of the 214 housing lots (**Attachment 3**) must not exceed 112,350 plants suitable for foraging for Black Cockatoos. The thinning process must be managed under the terms of the approved Revegetation and Fire Management Plan, and be personally supervised (pre and post thinning inspection for individual lots) by a qualified Fire Management Consultant. The person taking the action must obtain written approval from FESA of the first appointed Fire Management Consultant prior to the provision of any Building Protection Zone thinning advice. Any subsequent appointment of Fire Management Consultants will be based on that consultant having similar qualification as the initially appointed consultant. The Building Protection Zone must be implemented on each of the 214 housing lots in the dimensions specified in **Attachment 2**. The location of each Building Protection Zone and house site must be chosen in consultation with the Fire Management Consultant for the purpose of maximizing the retention of trees as specified in Condition 4. The person undertaking the action must ensure that all native vegetation that provides habitat for Black Cockatoos is retained outside of the Building Protection Zones within 214 housing lots. This excludes	Protective Covenant and use of FMC throughout the lot clearing process.	Protective Covenant and Sustainable Living Guidelines.	Development Phase.	C	Revised versions of the Protective Covenants has been approved by the Department in August 2014 and will be applied to Stage 1 (Release 2) and Stage 2 of the Development.

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
	native vegetation that is specifically managed under the Revegetation and Fire management Plan.					
5	The person taking the action must ensure that all potential breeding habitat trees for Black Cockatoos (as designated at **Attachment 4** and **4A**) are protected in perpetuity via a Notification on Title. The person taking the action must ensure that all other trees within the lot area (**Attachment 1**) with a diameter by breast height (dbh) of 500 mm or greater are retained unless: a. They are located within a house site; b. They are located within the Building Protection Zone; c. they are required to be removed for fire management purposes as advised by a qualified Fire Management Consultant(s).	Notification on Title and Protective Covenants.	Notification on Title and Protective Covenants.	During development.	C	Revised versions of the Protective Covenants has been approved by the Department in August 2014 and will be applied to Stage 1 (Release 2) and Stage 2 of the Development.
6	The person taking the action must ensure at the 411 ha Park and Recreation reserve as highlighted in green at **Attachment 5** be ceded to the WA State Government. The Department must be notified in writing once this has occurred.	Park and Recreation (P & R) reserve ceded to WA State Government.	Deposited Plan and Certificate of Title for P & R reserve.		CLD	Reported in previous Compliance Report (Cardno 2012a).
7	Revegetation Measures for individual lots. The person taking the action must ensure that the following the sale and settlement each individual lot owner will be offered at least 1000 seedlings suitable for foraging and breeding habitat for Black Cockatoos to be permanently planted on their purchased lot. This planting must be undertaken under the direct supervision of a Revegetation Specialist at the proponent's expense.	Protective Covenants.	Protective Covenants.		C	The 2014 RFMP comprised of the revised RFMP (Cardno 2012b) and Addendum report (Emerge 2014) was approved by DFES in August 2014 and has been provided to the Department for approval (see **Appendix A**).
	The person taking the action must ensure that any seedlings allocated for individual lots that cannot be planted because of Fire management or other reasons, must be planted in the Parks and Recreation Reserve as identified in **Attachment 7.** Planting must be undertaken following the sale and settlement of the individual lots so that the planting under this condition total at least 214,000 plants on either individual lots or in the Parks and Recreation Reserve.	RFMP	Biannual revegetation monitoring reports (see **Appendix B**) detailing plant survival, monthly site inspections and Progress	Ongoing through the development.	C	

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
			Certificates outline the number and species of seedlings planted.			
	The person taking the action must ensure that all purchasers of lots within the project area, prior to sale and settlement: a. Are aware of the existence of potential and actual breeding habitat trees on the individual lots, Notifications on Title and the requirements that these must be conserved into perpetuity and not be cleared b. Are aware of the Protective Covenant; c. Are aware of restriction relating to clearing of i. Potential breeding habitat trees over 500 mm dbh ii. Area within and outside of the Building Protection Zone. d. Are aware of the proposed revegetation measures for their individual lot by person(s) as outlined in Condition 3; e. Are provided with species related information on all Black Cockatoos, their presence in the area, ecology, species range and details on habitat.	Notification on Title. Protective Covenant. Sustainable Living Guidelines.	Notification on Title. Protective Covenant. Sustainable Living Guidelines.	Ongoing through the development.	C	Revised versions of the Protective Covenants has been approved by the Department in August 2014 and will be applied to Stage 1 (Release 2) and Stage 2 of the Development.
8	The person taking the action must provide a final version of the Protective Covenant in writing to the Department for approval prior to the sale and settlement of any lot. The person taking the action must ensure that the approved Protective Covenant is in place for each of the 214 lots.	Protective Covenant.	Letter from DSEWPaC and DoE endorsing Protective Covenant.	Ongoing through the development.	C	Revised versions of the Protective Covenants has been approved by the Department in August 2014 and will be applied to Stage 1 (Release 2) and 2 of the Development.
9	All elements specified in Attachment 6 must be incorporated in either the Structure Plan, approved subdivision conditions or approved Protective Covenants. These must be complied with. The Department must be notified in writing on how all the elements in **Attachment 6**	Incorporate all elements in the Structure Plan, Western	Structure Plan, WAPC conditions of subdivision and Protective	Ongoing through the development.	C	Structure Plan was endorsed by the WAPC on the 27th March 2014

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
	have been incorporated and complied with. If any of the elements in **Attachment 6** are not incorporated, to the Department's satisfaction, the person taking the action must negotiate an outcome to the Department's satisfaction, prior to commencing construction.	Australian Planning Commission (WAPC) conditions of subdivision and Protective Covenants.	Covenants.			(**Appendix C**). Mechanism to implement Attachment 6 reported in previous Compliance reports (Cardno 2011, Cardno 2012a).
10	The person taking the action must prepare and implement a Construction Management Plan. This plan must be submitted and approved by the Department prior to any clearing taking place.	CEMP approved by DSEWPaC (24th June 2010).	Approved CEMP.	Prior to clearing.	CLD	
	The Construction Management Plan must clearing demonstrate that: **a.** All habitat trees at **Attachment 4 and 4A** are to be retained in perpetuity; **b.** All trees to remain that are greater than 300mm dbh within the subdivision area (as at **Attachment 3**) and within 10 meters of an area proposed to be cleared (excluding those in the Building Protection Zone) are clearly marked and retained. **c.** Area of vegetation that are Black-Cockatoo habitat and not for clearance (including roadside vegetation, streamline vegetation and Public Open Space area) are clearly marked and retained; **d.** If clearing outside of stipulate area occurs by other contract parties, then the person taking the action must notify the Department in writing and will ensure that these areas will be revegetated to the same density (following the annual winter rain period and between 1 October – 30 November); and **e.** All contracted parties will undergo an induction programme prior to commencement of construction and/or clearing. This programme will include information on EPBC listed species and measure employed within the project areas to protect Black Cockatoo habitat.	Implement Construction Environment Management Plan (CEMP).	Habitat trees GPS locations recorded, mapped and marked. Habitat trees recorded on Notifications on Title. Trees >500mm dbh GPS locations recorded, mapped and marked. Trees >300mm dbh within 10 meters of an area proposed to be cleared are marked. Completed land clearing forms and	Ongoing through the development.	C	Prior to civil construction, location of habitat trees and trees greater than 300mm were confirmed on site. Remarking of the trees was also undertaken. CEMP previously provided to the Department for approval (24th June 2010).

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
			contractor contracts. Completed induction forms.			
11	Within 30 days of commencement of construction, the person taking the action must advise the Department in writing the actual date of commencement.	Advise DoE.	Letter to DSEWPaC advising date of commencement of construction.	Prior to construction.	CLD	
12	Within three months of every annual anniversary of commencement of the action, the person taking the action must submit to the Department a report addressing compliance with the condition of this approval. Annual Reports must be provided until the Minister is satisfied that the proponent has complied with all conditions of the approval.	Compliance report demonstrating compliance and providing evidence.	Compliance reports.	Annually through the development.	C	This compliance report.
13	If, at any time five years from the date of this approval, the Minister notified the person taking the action in writing that the Minster is not satisfied that there has been substantial commencement of the construction of the rural residential development at Brigadoon, Western Australia, the action must not thereafter be commenced without the written agreement of the Minister.	Commencement of construction within 5 years from date of approval.	Project has been commenced substantially within 5 years of the project's approval. See Condition 11.	Five years following granting of approval.	CLD	
14	If the person taking the action wishes to carry out any activity otherwise than in accordance with the plans, reports or strategies referred to in these condition, the person taking the action must submit for the Minister's approval a revised version of any such plan, report or strategy for the Minister's approval. The person taking the action must comply with any such request. The revised approved plan, report or strategy must be implemented in place of the plan, report or strategy originally approved.	Submit for Minister's approval of revised version of plan, report or strategy.	The Revised RFMP and addendum, referred to as the 2014 RFMP has been approved by DFES. The 2014 RFMP has been submitted to the Department for approval. The	Ongoing through the development.	C	The 2014 RFMP has been submitted and awaiting for approval from the Department (see **Appendix A**).

CONDITION	REQUIREMENT	HOW	EVIDENCE	TIMEFRAME	STATUS	INFORMATION
			current RFMP will remain in effect until the revised version is approved.			
15	If the Minister believes that it is necessary or desirable for the better protection of threatened species and threatened ecological communities (s18 and s18A) to do so, the Minister may request that the person taking the action make specified revision to the plan, reports or strategies approved pursuant to Condition 2 and submit the revised plan, report or strategy for the Minister's approval. The person taking the action must comply with any such request. The revised approved plan, report or strategy must be implemented in place of the plan, report or strategy originally approved.	Not applicable.	Not applicable.	Ongoing through the development.	NR	
16	The person taking the action must maintain accurate records of all activities associated with or relevant to the above conditions of the approval, and make them available on request by the Department. Such document may be subject to audit by the Department and used to verify compliance with the condition of approval. Summaries of audits may be posted on the Department website. The results of audits may also be publicised through the general media.	Maintain accurate records of all activities associated with or relevant to the above conditions.	Accurate records of all activities described in this table.	Ongoing through the development.	C	
17	In order to offset the impact of clearing of Black Cockatoo habitat, before June 30 2012, the person taking the action must: **a.** Provide funds to the Western Australian Department of Environment and Conservation for the acquisition and management of one or more properties that contain at least 150 hectares of high quality foraging habitat for Black Cockatoos to be protected in perpetuity. The offset property must be approved in writing by the Department. **b.** Provide documentary evidence to the Department that funds have been provided to the Western Australian Department of Conservation as required by approval condition 17a.	Transfer of funds to DPaW for an offset site.	Letters from DSEWPaC approving variation to conditions and approving the offset site and regarding Peet's remuneration and clearance of conditions. Remittance from Peet to DSEWPaC.	Prior to 30 June 2012.	CLD	

Table 2: Definition of Compliance status terms

COMPLIANCE STATUS TERMS	ABBREVIATION	DEFINITION	NOTES
Compliant	C	Implementation of the proposal has been carried out in accordance with the requirements of the audit element.	This term applies to audit elements with: • ongoing requirements that have been met during the reporting period; and • requirements with a finite period of application that have been met during the reporting period, but whose status has not yet been classified as 'completed'.
Completed	CLD	A requirement with a finite period of application has been satisfactorily completed.	This term may only be used where: • audit elements have a finite period of application (e.g. construction activities, development of a document) • the action has been satisfactorily completed • the Department of Environment (DoE) has provided written acceptance of 'Completed' status for the audit element.
Not required at this stage	NR	The requirements of the audit element were not triggered during the reporting period.	This should be consistent with the 'Timeframe' column of the audit table.
Potentially Non-compliant	PNC	Possible or likely failure to meet the requirements of the audit element.	This term may apply where during the reporting period the proponent has identified a potential non-compliance and has not yet finalised its investigations to determine whether non-compliance has occurred.
Non-compliant	NC	Implementation of the proposal has not been carried out in accordance with the requirements of the audit element.	This term applies where the requirements of the audit element have not been met during the reporting period.

2.2 Compliance Details

2.2.1 Condition 1

Clearing is managed through the implementation of the Construction Environmental Management Plan (CEMP) (Cardno 2010a) (Condition 10). Clearing is restricted to discrete areas for the purpose of constructing roads, boundary firebreaks and strategic firebreaks.

Calculation of clearing over the 2013/14 reporting period is based on the engineering construction drawings (provided by Development Engineering Consultants (DEC)) and aerial imagery (comparing 29th June 2013 and 3rd August 2014).

Table 3 shows the current level of clearing, the balance of area that can be cleared and the percentage of cleared area.

Table 3: Areas cleared under EPBC Condition 1

CONDITION 1 CLEARING RESTRICTIONS	CURRENT LEVEL OF CLEARING (HA)	REMAINING CLEARING (HA)	PERCENTAGE CLEARING (%)
Up to 30 hectares for the purpose of constructing roads	11.2	18.8	37.3
Up to 27 hectares of the purpose of constructing boundary firebreaks on individual lots	12.5	14.5	46.2
Up to 6 hectares for the purposes of constructing strategic firebreaks	2.1	3.9	35.0

Between the 2nd September 2013 and 1st September 2014, there has been civil construction works within the Avon Ridge Estate in Stages 2 and 3 including road construction and clearing of boundary firebreaks.

2.2.2 Condition 2

Clearing within lots (by landowners) is managed through the Contract of Sale and Protective Covenants. The revised versions of the Protective Covenants has been approved by the Department in August 2014 and will be applied to Stage 1(Release 2) and Stage 2 of the Development (refer to **Section 2.2.8** for more details). Calculation of clearing over the 2013/14 reporting period is based on the engineering construction drawings (provided by DEC) and aerial imagery (comparing 29th June 2013 and 3rd August 2014).

Previously cleared areas within the Development (June 2009) prior to any civil construction were compared with cleared areas from the 3rd August 2014 to calculate the areas of clearing within lots. These areas were then separated into driveways and house sites based upon the location of the driveway crossover from the road reserve.

Table 4 shows the current level clearing, the balance of area that can be cleared and the percentage of allowable area currently cleared.

Table 4: Areas cleared under EPBC Condition 2

CONDITION 2 CLEARING RESTRICTIONS	CURRENT LEVEL OF CLEARING (HA)	REMAINING CLEARING (HA)	PERCENTAGE CLEARING (%)
up to 31.4 hectares for the purposes of constructing house sites and buffers around the house sites	4.2	27.2	13.3
up to 6 hectare for the purpose of constructing driveways.	0.6	5.4	10.0

Between the start of the Development and 1st September 2014, there has been 4.8 ha cleared by individual landowners within the Avon Ridge Estate.

2.2.3 Condition 3

The existing Revegetation and Fire Management Plan (RFMP) (Cardno 2010b) was approved by the Department of Fire and Emergency Services (FESA) (now Department of Fire and Emergency Services (DFES)) in May 2010 and DEWHA in June 2010.

Since 2010, significant changes relating to the revegetation strategy and the prescribed fuel reduction program at Avon Ridge Estate had occurred. A revised RFMP was prepared (Cardno 2012b) to reflect these changes. Subsequent to the preparation of the revised RFMP, several further changes to the revegetation approach and bushfire planning within the City of Swan followed. To achieve the support of DFES of the revised RFMP and to reflect the changes to revegetation and bushfire management, an addendum to the revised RFMP (Emerge 2014) was prepared. These two documents form the 2014 RFMP and are to be read together.

The 2014 RFMP was submitted to and has been approved by DFES and is attached as **Appendix A**. The 2014 RFMP has been submitted to and is awaiting approval by DoE.

An overview of compliance of Condition 3 is shown in **Table 5** based upon the existing approved RFMP (Cardno 2010b).

Table 5: Compliance overview of Condition 3

CONDITION 3	STATUS OF COMPLIANCE	STATUS
Preparation, approval and implementation of a RFMP	Compliant	For the purposes of compliance reporting, the existing RFMP (Cardno 2010b) is in effect.
The person taking the action must ensure that the Revegetation and Fire Management Plan includes (but is not restricted to):		
Fuel reduction measures (including cool burn measures) specifying the timing and frequency of fuel reduction measures to minimise impacts on Black Cockatoo habitat.	Compliant	A prescribed burn has taken place during the 2013/14 reporting period but did not follow the timeline described in the existing RFMP (Cardno 2010b). Due to unsuitable weather and timing, the prescribed burns were either not conducted as proposed or if the burn was conducted, it was partially completed. Therefore, there has been a delay in the timing of the proposed

		prescribed burn plan as described in the existing RFMP. A prescribed burn was undertaken during the 2013/14 reporting period and follows the updated timeline outlined in the 2014 RFMP. The proposed prescribed burn area for 2014 has partially been completed and will be completed by the end of 2014
Revegetation measures to create additional Black Cockatoo habitat, specifically: i. revegetation for all condition classes (excluding Pristine and Excellent), and vegetation complexes ii. mix, numbers and density of species to be planted iii. timing of proposed planting iv. weed management measures v. the survivorship rate of all revegetation measures must be at least 90% after three years vi. annual monitoring measures within the project area vii. annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the P & R Reserve	Compliant	Revegetation has been focused in the P&R reserve. Revegetation and weed control within the P& R Reserve has been undertaken and included a wide range of suitable Black Cockatoo habitat species as per the RFMP. The three year anniversary for the 90% survival rate has been reached for one site. Results of the survival rate is not yet available and will be provided in the 2014/15 report. Biannual monitoring reports **(Appendix B**) and regular inspections have been undertaken by Tranen (a qualified and experienced specialist). During the 2013/14 reporting period, additional planting of 37,900 seedlings of up to 20 species was undertaken in existing revegetation sites.
viii. mapping of all potential Black Cockatoo habitat trees of 500 mm dbh or greater on individual lots and information on how these will be retained for permanent conservation	Compliant	All trees of 500mm dbh or greater have been mapped and marked with white flagging tape. These trees have been included in the Protective Covenants and must be retained unless located within the house site, Building Protection Zone (BPZ) or required to be removed for fire management purposes. Prior to civil construction in Stage 2 and 3 during the reporting period, updated mapping and marking of habitat trees was undertaken to ensure habitat trees were clearly identified on the Development and mapped.

2.2.4 Condition 4

Purchasers of lots are assisted by a Fire Management Consultant (FMC), engaged by Peet to prepare Building Protection Zones (BPZ) and Hazard Separation Zones (HSZ) for their lots. The FMC provides guidance to new landowners regarding acceptable vegetation modification practices prior to any lot clearing in accordance with the Protective Covenants.

The role of the FMC is to perform pre-thinning and post-thinning site checks to ensure that landowners understand what is required, and evaluate whether their clearing actions are compliant with the RFMP and Condition 4 of the approval. These site checks are documented by the FMC in a Pre-Clearing and Post-Clearing Checklist. The retention of vegetation outside of the BPZ is also monitored by the FMC for compliance with the RFMP, and documented in the Post-Clearing Checklist. Landowners are required to sign the pre-clearing checklist in acknowledgment that they understand the clearing requirements and advice provided by the FMC, and also enables them to nominate a date for a post-thinning inspection.

The Post-Clearing Checklist confirms whether clearing and vegetation modification has been undertaken in a manner that is consistent with the advice provided, including the retention of habitat

trees and trees with a diameter breast height (dbh) greater than 500 mm outside the BPZ. The pre-clearing and post-clearing inspection procedures of individual lots will be continued by the FMC as the sales and construction phases of the Development progresses.

As a total of 65 lots have either been sold or settled, the total thinning of the combined BPZs throughout the Development is not significant and on target to not exceed 112,350 plants.

Thinning of the BPZ (Building Protection Zone) has been undertaken in approximately 34 lots.

2.2.5 Condition 5

Protective Covenants have been finalised and approved by DSEWPaC (31st August 2010). Revised versions of the Protective Covenants has been approved by the Department in August 2014 for Stage 1 (Release 2) and Stage 2 as shown in **Figure 1**. Future stages will use Stage 2 Protective Covenants (unless subsequent versions are approved).

The proponent will satisfy Condition 5 of the approval through the application of Notifications on Titles as they are created on a stage by stage basis. An overview of compliance for Condition 5 is shown in **Table 6.**

With the exception of a fallen habitat tree, no disturbance to significant trees has been recorded to date. The fallen tree was located on the outside of the northern boundary of Stage 3 (co-ordinates: 413188 E; 6485536 N), within land for “community purpose” (Lot 182). Based on the condition of the fallen tree, the most likely cause of the fatality of the tree is the impact of historical fire(s) and subsequent natural decline (**Figure 1**). Monitoring will continue throughout the future stages of construction.

Figure 1: Fallen habitat tree on the outside of the northern boundary of Stage 3

Table 6: Compliance overview of Condition 5

CONDITION 5	STATUS OF COMPLIANCE	STATUS
All potential breeding habitat trees protected in perpetuity via a Notification on Title.	Compliant	As the Development progresses, the Notifications on Title will apply to each newly released lot which displays potential habitat trees.
All trees with a dbh of 500 mm or greater are retained unless they are: • located within the house site • located within the BPZ • required to be removed for fire management purposes .	Compliant	Protective (Restrictive) Covenants apply to all lots in the Development area. These include notification of trees with a dbh of 500 mm or greater.

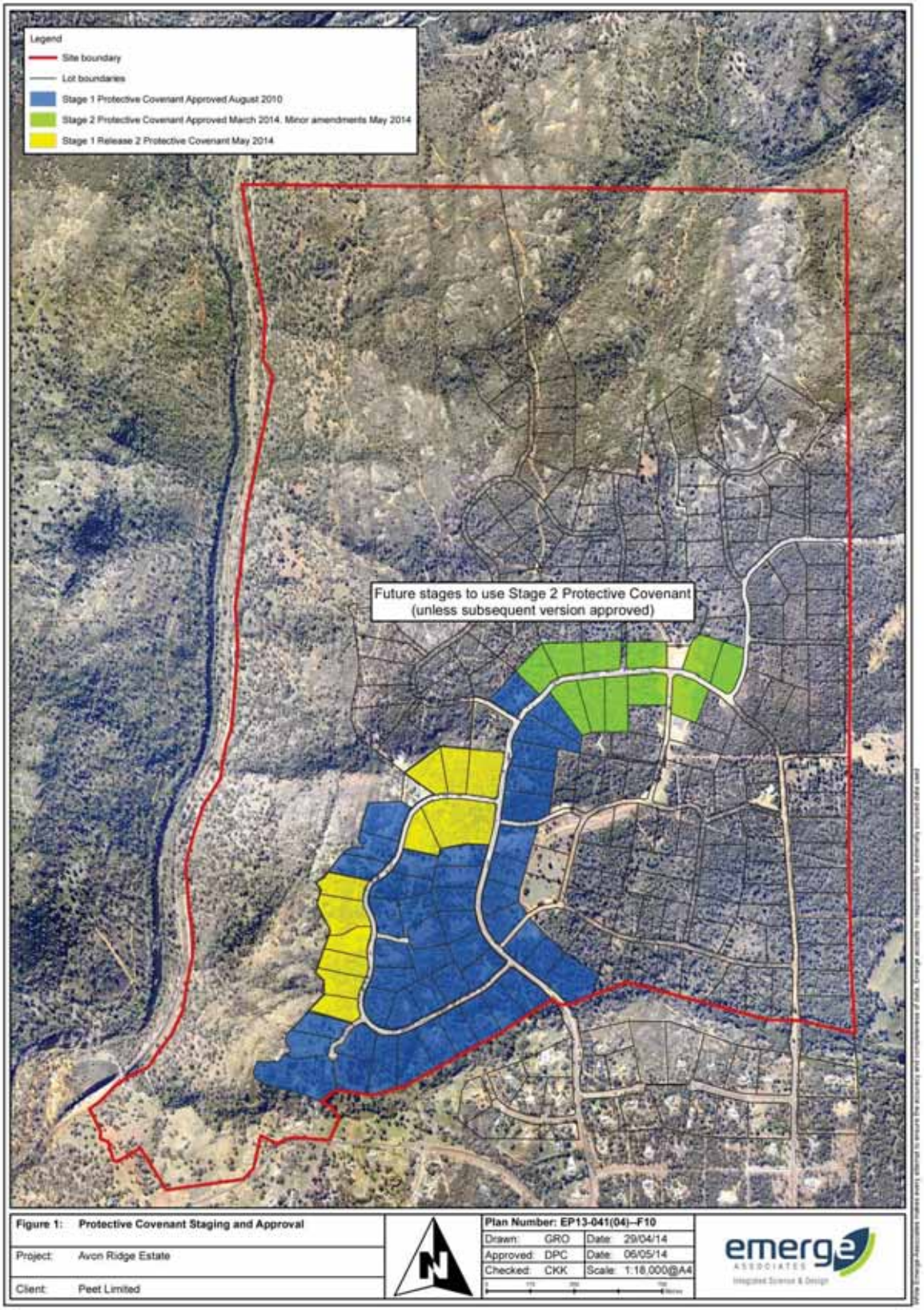

Figure 2: Protective Covenant Staging and Approval

2.2.6 Condition 6

On 5th July 2012, the Parks and Recreation (P & R) Reserve was ceded to the WA State Government. This action completes Condition 6. The Deposited Plan and Certificate of Crown Land Title was included in the 2013 Compliance report (Emerge 2013).

2.2.7 Condition 7

Due to fire management requirements within lots, revegetation has been focused on the P & R reserve. The 2013 Compliance Report (Emerge 2013) incorrectly included infill or additional plantings in existing revegetation sites and reported that 106,775 plants had been planted at the end of the 2012/13 reporting period. To date, 88,225 plants out of a total 214,000 required under the approval have been planted in the P & R reserve.

The three year anniversary for 90% survival rate has been reached for one site in the Development. Survival rate results are not yet available and will be provided in the 2014/15 report after spring monitoring has been undertaken.

Over the 2013/14 reporting period, 37,900 seedlings were planted as infill plantings in existing revegetation sites. Biannual revegetation monitoring reports (**Appendix B**) and regular inspections have been undertaken which outline the survival rates and Progress Certificates outline the number and species of seedlings planted.

Due to the site conditions of the P & R reserve (slope, soil condition and existing vegetation), there will be a limitation on additional plantings within the reserve. Currently, the number of plants planted exceeds the requirement of plants based on the number of lots created (based on 1000 plants per lot). Ongoing investigations on finding a suitable alternative to this revegetation is underway and will be discussed with the Department in the near future.

2.2.8 Condition 8

Approval of the Protective Covenants was granted by DSEWPaC in August 2010. This version of the Protective Covenants (Version 1) was applied to Stage 1 of the Development. Protective Covenants for Stage 2 (Version 2) and for Stage 1 (Release 2) (Version 3) was approved by the Department in August 2014. The protective covenant staging and approval is shown in **Figure 1.**

During the 2013/14 reporting period, an error in the definition for the Protective Covenants was identified. The amendment was approved by the Department in March 2014.

2.2.9 Condition 9

All elements specified in Attachment 6 of the approval have been incorporated in either the Structure Plan, conditions of subdivision approval or approved Protective Covenants. Previous compliance reports (Cardno 2011, Cardno 2012b) have provided details on how the different elements contained within Attachment 6 of the Approval were included in the above processes.

The Structure Plan has been endorsed by the Western Australian Planning Commission (WAPC) on the 27th March 2014 (see **Appendix C**). **Table 7** shows mechanisms from Attachment 6 used to implement Condition 9.

Table 7: Summary of mechanisms from Attachment 6 used to implement Condition 9

MECHANISM	DOCUMENT	REFERENCE
All habitat trees identified in Attachment 4 must be conserved in perpetuity via a Memorial on Title.	Protective Covenants via Notification on Title.	Protective Covenants, Section 3.6 and Section 7.1.
The restriction on building envelopes is a maximum of 10% of the gross lot area.	Structure Plan (**Appendix C**).	Structure Plan, Provision 1.
Requirement for protective covenants to restrict clearing, including the use of a DFES approved Fire Management Consultant must be included.	Protective Covenants.	Protective Covenants, Section 2.1 and Section 3.5.
Building development envelopes must not impinge on any areas identified by the Bush Forever vegetation condition classification as the following unless approved by Council: a. Areas determined to be in "pristine" condition; and b. Areas determined to be in an "excellent" condition. This includes driveways or other points of access	Structure Plan (**Appendix C**)and Protective Covenants.	Structure Plan, Provision 5. Protective Covenants, Section 3.1.
No additional clearing for access roads or other community infrastructure within the project area unless approved by Council	Structure Plan (**Appendix C**).	Clearing is limited to the areas stipulated in the WAPC Subdivisions Conditions of Approval and demonstrated in the Structure Plan.
A Construction Management Plan must be prepared and applied to all stages of development within the project area.	Condition of Subdivision.	WAPC Subdivision Conditions; Condition 14.
A Revegetation and Fire Management Plan must be prepared and applied to all stages of development within the project area.	Condition of Subdivision and Structure Plan (**Appendix C**).	WAPC Subdivision Conditions; Condition 29. Structure Plan; Structure Plan Condition J.
There should be no clearing outside the Building Protection Zone areas on the 214 lots, excluding those required for fire management purposes and approved driveway purposes.	Protective Covenants.	Protective Covenants, Condition 2.1 and Condition 7.1.
There should be no clearing within the Building Protection Zone after the construction of the first house on each lot.	Protective Covenants.	Protective Covenants, Condition 2.8.

2.2.10 Condition 10

Within individual lots, habitat trees have been clearly marked and retained. Habitat trees are included within Notifications on Title and Protective Covenants.

All trees greater than 300mm dbh have been mapped. These trees will be retained unless within a building envelope, BPZ, strategic and lot firebreaks and road areas. Trees greater than 300mm dbh

and within 10m of any proposed clearing areas will be marked and retained. Protective Covenants will include the requirement to protect these trees on individual lots.

Prior to civil construction of new stages during the 2013/14 reporting period, a botanist and field assistant reviewed and confirmed locations of habitat trees and trees greater than 300mm dbh. Global Position System (GPS) locations of habitat trees and trees greater than 300mm dbh were confirmed and clearly labelled with flagging tape if the tape had deteriorated over time. The review identified nine habitat trees which were not flagged or mapped previously and therefore are assumed to have been missed during the earlier survey and the two habitat trees recorded in 2010 (Cardno 2010a) could not be located. The survey also recorded a fallen habitat tree (most likely of natural causes) located on the outside of the northern boundary of Stage 3 and is described in more detail in **Section 2.2.5**.

2.2.11 Condition 11

This condition has been completed and reported in the 2011 Compliance Report (Cardno 2011).

2.2.12 Condition 12

This condition is addressed through the preparation of this Compliance Report.

2.2.13 Condition 13

This condition is completed and reported in the 2011 Compliance Report (Cardno 2011).

2.2.14 Condition 14

The 2014 RFMP which is comprised of the revised RFMP and addendum (refer to **Section 2.2.3** for more details of the 2014 RFMP) has been approved by DFES and is included in this document in **Appendix A**. The current RFMP will remain in effect until the 2014 RFMP is approved by the Department.

2.2.15 Condition 15

No request has been received by the Minister requiring better protection for environmental features and this condition is therefore not applicable.

2.2.16 Condition 16

Peet has maintained accurate records of all activities associated with or relevant to the conditions of approval. Copies of records are available upon request.

2.2.17 Condition 17

This condition is completed and reported in the 2011 Compliance Report (Cardno 2011).

3 Conclusion

This report has been prepared to satisfy Condition 12 of the EPBC Act Approval which was granted by the Department on the 8th October 2009. The report addresses Condition 12 by outlining the level of compliance with conditions of the approval for the Development in the reporting period of the 2nd September 2013 to 1st September 2014.

A high level of compliance with the approval conditions has been demonstrated in the reporting period. This is due to the implementation of environmental management measures prescribed by the following documents and mechanisms:

- Construction Environment Management Plan (CEMP)
- Revegetation and Fire Management Plan (RFMP)
- Protective Covenants
- Notification on Titles
- use of Fire Management Consultant (FMC).

Ongoing monitoring and evaluation of environmental management works has and continues to ensure continued compliance with approval conditions.

As outlined in this report, a compliance mechanism expected to be reviewed over the next compliance reporting period (2014/15) includes alternatives to revegetation within the P & R reserve.

These items will be addressed separately with the Department and have not impacted upon compliance within this reporting period.

4 References

Cardno 2009. Response to Submissions: Brigadoon Estate Special Rural Development, Brigadoon Western Australia (EPBC Reference 2008/4250).

Cardno 2010a. Brigadoon Estate Construction Environment Management Plan. Unpublished Report prepared for Peet Limited.

Cardno 2010b. Brigadoon Estate Revegetation and Fire Management Plan (Parts 1-3). Unpublished Report prepared for Peet Limited.

Cardno 2011. Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Cardno 2012a. 2012 Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Cardno 2012b. Revegetation and Fire Management Plan Revised, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Emerge Associates (Emerge) 2013. Compliance Report for EPBC Approval 2009/4250, Avon Ridge, Brigadoon. Unpublished Report prepared for Peet Limited.

Emerge Associates (Emerge) 2014. Avon Ridge Estate, Brigadoon Addendum to revegetation and fire management plan (Revised 2012). Unpublished Report prepared for Peet Limited.

5 Glossary

TERM	DEFINITION
Notifications on Title	Are created under Section 70A of the Western Australian Transfer of Land Act 1893 to notify landowners of factors that may interfere with the use of their land. The person taking the action must put these titles in place to alert future purchasers if their lot contains habitat trees that must be retained in perpetuity and are not to be cleared in line with fire management procedures
Protection in perpetuity	A tenure or a conservation status on a notification attached to individual land titles that guarantees permanent preservation of vegetation into the future and ensures there will no clearing will be undertaken.

APPENDIX A

emerge ASSOCIATES
Integrated Science & Design

2014 REVEGETATION AND FIRE MANAGEMENT PLAN (RFMP)

AVON RIDGE ESTATE, BRIGADOON

ADDENDUM TO REVEGETATION AND FIRE MANAGEMENT PLAN (REVISED 2012)

Project Number EP13-041

Prepared for Peet Limited
July 2014

Document Control

DOC NAME	AVON RIDGE ESTATE, BRIGADOON ADDENDUM TO REVEGETATION AND FIRE MANAGEMENT PLAN (REVISED 2012)				
DOC NO.	EP13-041(04)—018 AT				
REVISION	DATE	AUTHOR		REVIEWER	
1	January 2014	Anle Tieu	AT	Chrystal King	CKK
A	May 2014	Anle Tieu	AT	Chrystal King	CKK
	Changes following DFES review				
B	July 2014	Chrystal King	CKK	Jason Hick	JDH
	Changes following DFES review				
C					
D					

Executive Summary

A Revegetation and Fire Management Plan (RFMP) for Avon Ridge Estate (Cardno 2010) was originally prepared by Cardno in 2010 to satisfy Condition 3 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act) approval (EPBC Approval No. 2008/4250). In August 2012, the RFMP was updated and revised (Cardno 2012a) to reflect changes to the revegetation strategy, fire hazard reduction measures and revised prescribed fuel reduction burning times and areas at Avon Ridge Estate.

Since the completion of the revised RFMP, several further changes relating to fire management and bushfire planning imposed by the City of Swan have occurred. The purpose of this addendum report is to provide supplementary information, clarification and to update changes made to the revised RFMP. Additional information and an update on revegetation management is also provided. This addendum should be read in conjunction to the revised RFMP (attached as **Appendix A**) to form the 2014 RFMP.

This addendum to the revised RFMP revises the following management objectives and respective sections from the revised RFMP:

- Revegetation Areas – Section 2.1 of revised RFMP.
- Revegetation Management – Section 3 of revised RFMP.
- Monitoring – Section 4 of revised RFMP.
- Fire Management – Section 5 of revised RFMP.

The key information and updated information contained within this addendum to the revised RFMP include:

- No revegetation in accordance to Condition 7 of the EPBC Act approval will be undertaken within the Avon Ridge Estate and instead all revegetation works by Peet Limited (Peet) will be completed in the adjacent Parks and Recreation Reserve (Reserve 51076).
- The three year monitoring period applies from the date plants are initially planted and survival rate is monitored to inform infill planting in order to achieve 90% survival rate.
- A summary of existing revegetation works to date and the revegetation sucess:
    - 106,775 plants have been planted within the adjacent Reserve 51076 from 2011 to 2013 and the balance of plants (107,225) will be planted across 12.3 ha of possible new revegetation areas and infill planting within existing revegetated sites.
    - Deep ripping was used to prepare the soil for revegetation in 2011 to 2013, which followed by weed control did not lead to excessive natural regeneration from the soil seed bank.
    - A mix of trees, shrubs and ground covers were planted in Reserve 51076 at an average density of 0.6 plants per m^2.
    - Revegetation has been moderately successful ranging from 89 – 66% success in the initial year of monitoring.
- The definition of fuel load is revised to “oven dry weight of fine fuel (< 6 mm in diameter for live fuel and < 3 mm for dead fuel) per unit area—commonly expressed as tonnes per hectare” (Fire and Emergency Services Authority (FESA) 2012).
- Measured fuel loads in areas of Public Open Space adjacent to the site ranging from 2 – 15 tonnes/ ha.
- Assessment of potential fire behaviour and the fire management approach for areas of Public Open Space adjacent to the site.
- A revision to the prescribed burn plan showing burns to be undertaken from 2014 to 2016 (**Figure 7**).

- Revision and additional information regarding bushfire planning and management including:
  - Onsite inspections by the Fire Management Consultant (FMC) and description of the landowner information package.
  - A description of the role of the FMC in installing the Building Protection Zone (BPZ) and Hazard Separation Zone (HSZ) in accordance with the existing Fire Management Plan (Cardno 2012a).
  - Additional resources provided by the FMC to the landowner for ongoing fuel hazard reduction within lots.
- Information regarding the land management of the P and R Reserve.

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Appendices

1 Background

The Revegetation and Fire Management Plan (RFMP) for Avon Ridge Estate was prepared by Cardno in 2010 to satisfy Condition 3 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act) approval (EPBC Approval No. 2008/4250). The original RFMP was approved by the City of Swan, Department of Parks and Wildlife (DPaW) (then the Department of Environment and Conservation), Department of Fire and Emergency Services (DFES) (then Fire and Emergency Services Authority (FESA)) and lastly by the Department of Environment (then Department of Sustainability, Environment, Water, Population and Communities) on the 24th of June 2010.

In August 2012, the RFMP was updated and revised (Cardno 2012a) to reflect changes to the revegetation strategy and revised prescribed fuel reduction burning times at Avon Ridge Estate. The revised RFMP is also a more simplified document and compiles the original RFMP three part document into one single comprehensive document (**Appendix A**).

Since the completion of the revised RFMP, several further changes relating to the revegetation approach and bushfire planning within the City of Swan has occurred. To reflect these changes, this addendum has been prepared and should be read in conjunction with the revised RFMP (Cardno 2012a, **Appendix A**) to form the 2014 RFMP.

The purpose of this addendum report is to provide supplementary information, clarification and update revegetation and fire management changes made to the revised RFMP (Cardno 2012a). Where the revised RFMP is in conflict with this addendum, this addendum shall supercede the 2012 revised RFMP.

The structure of this addendum includes the following management areas and refers to the respective sections from the revised RFMP:

- Revegetation areas – ***Section 2.1*** of revised RFMP.
- Revegetation management – ***Section 3*** of revised RFMP.
- Monitoring – ***Section 4.2*** of revised RFMP.
- Fire management – ***Section 5*** of revised RFMP.

Information on bush fire fuels and calculations on the rates of spread of a bush fire have been provided by Bill Harris of Fireplan WA.

2 Revegetation Areas (refers to Section 2.1 of revised RFMP)

The total number of seedlings (214,000) to be planted as required by Condition 3 of EPBC Approval No. 2008/4250 was based on the number of lots created and an allocation of 1000 plants per lot (***Section 2.1*** of the revised RFMP). The revised RFMP (Cardno 2012a) described that planting would occur in the Parks and Recreation (P and R) Reserve, in road reserves and Public Open Space (POS) areas within the Avon Ridge Estate. Therefore no planting is proposed within lots, which is a change to the original RFMP.

Revegetation commenced in 2011 and the majority of plantings have been undertaken within flatter, degraded areas within the P and R Reserve shown in **Figure 1**. These flatter areas do not contain gravel which would inhibit revegetation. Revegetation areas within the P and R Reserve have been mapped as "Completely Degraded" or "Degraded" vegetation based on the Keighery (1994) vegetation condition scale for the original RFMP (Cardno 2010) as shown in **Figure 2**. These areas proposed for revegetation have previously been cleared for grazing. Therefore the sparse vegetation within revegetation areas is generally characterised by relatively low fuel level. Furthermore, the regeneration ability of areas in "Completely Degraded" or "Degraded" condition is low and therefore the fuel loads are unlikely to significantly increase over time.

From 2011 to 2013, 106,775 plants were planted across six sites over 24.3 ha, leaving a balance of 107,225 plants to be planted. Based upon the species planted, the resulting vegetation classification is likely to be:

- Revegetation Area 1A – Woodland (20–30% cover) over Tall Shrubland (30% cover)
- Revegetation Area 2 – Woodland (20% cover) over Tall Shrubland (30% cover)

The future vegetation classification based upon the revegetation is shown in **Figure 3.** Revegetation within Area 3 and 4 have few remaining seedlings and therefore the future cover has not be determined.

Maintenance and monitoring of revegetation has been ongoing and will continue for three years post planting in each revegetation site. Maintenance includes biannual weed control in spring and autumn which helps to reduce weed competition and also reduces fuel loads within revegetation sites. Dead plants will also be replaced to achieve 90% tubestock survival after three years in accordance with the EPBC Act condition.

At a planting density of 1 plant per m^2, approximately 10.7 ha is required to accommodate the outstanding plants. An assessment to determine possible areas for future revegetation was undertaken by Cardno in 2012 (Cardno 2012b) which identified flatter and mostly cleared areas within the P and R Reserve as possible revegetation areas. Following revegetation from 2011 to 2013, an area of 12.3 ha of possible future areas for revegetation remains and is shown in **Figure 4** and slightly exceeds the area required to plant the remainder of plants (based on 1 plant per m^2).

In existing revegetated sites, plants were planted along 1.8 m rip lines. The width of rip lines will be reduced to 1 m by reducing the width of tynes used to achieve a planting density of 1 plant per m^2. There is also potential to undertake infill planting in existing and fenced revegetation sites which provides additional areas for future possible revegetation. Pockets of bare areas where machinery is unable to access may also be planted using petrol powered hand augers.

Due to kangaroo herbivory, a high rate of plant mortality has resulted in low success of revegetation within the road reserves and Public Open Space areas which were not fenced within Avon Ridge Estate. Therefore these plantings will not be included in the total revegetation and future revegetation will be focused on the P and R Reserve.

3 Revegetation Management (refers to Section 3 of revised RFMP)

3.1 Ripping

Section 3.4 in the revised RFMP refers to soil scarification, ploughing and ripping to prepare the site for revegetation. Scarification and deep ripping are cultivation techniques to treat hard, poorly structured soils which may have poor water infiltration and therefore could lead to poor plant vigour. Scarification involves the use of non-inversion cultivation (using narrow points) to a depth of 15 to 20 cm whereas deep ripping involves the cultivation (over 20 cm depth) using a tyne, normally on the back of a bulldozer (Department of Primary Industries NSW 2013). For example, deep ripping by Alcoa involves ripping returned soil to a depth of 1.5 m using a tyne with wings, which creates mounds and furrows approximately 1.5 m wide (Gardner 2001).

A combination of grazing and other forms of land disturbance in revegetation sites within the P and R Reserve have resulted in soil compaction and varying levels of weed infestation. Deep ripping was considered essential to prepare the soil for revegetation due to soil compaction. The existing revegetation sites were deep ripped to 1 m depth with a tyne, 1.8m apart.

Deep ripping can lead to increased regeneration of the existing soil seedbank of both weed seeds and native species. Due to the potential stimulation of the weed soil seedbank following ripping, a pre-emergent herbicide was applied by Tranen (revegetation contractor) along the rip lines to reduce competition with seedlings. This has proven effective at reducing weed competition but may also have prevented native seeds germinating. Monitoring of revegetation installed in 2011 following deep ripping did not record significant germination or establishment of native species along the rip line from the soil seed bank. It is highly likely that given the degraded nature of the P and R Reserve that the native soil seed bank has been heavily depleted over time.

3.2 Parks and Recreation Reserve planting

Section 3.5 in the revised RFMP describes that the planting densities will be determined by revegetation contractors based on “existing canopy cover, site characteristics and tubestock species physiology”. Between 2011 and 2013, six sites were revegetated and are shown in **Figure 1**. Revegetation was targeted in bare areas classified as “Completely Degraded” followed by “Degraded” condition based on the Keighery vegetation condition scale (see **Table 1**) (Keighery 1994) as shown in **Figure 2**.

Table 1: *Vegetation Condition Scale (Keighery 1994).*

VEGETATION CONDITION	DEFINITION
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive

VEGETATION CONDITION	DEFINITION
	weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

The species and lifeform (groundcover, shrub or tree) selected for each site was dependent on the availability of seedlings of each species. The species selected for revegetation were derived from a flora and vegetation survey undertaken over Avon Ridge Estate (Siemen and Associates 2006), included within the regional vegetation complexes over Avon Ridge Estate (Heddle *et al.* 1978) and recorded as providing foraging, roosting or breeding habitat for Black Cockatoos. The species used are also included within the Plant *Guide within the Building Protection Zone for the Swan Coastal Plain of Western Australia* (FESA 2011a).

The species and number of seedlings planted, spacing and density within each revegetation site is shown in **Appendix B**. Plant species were categorised into the following plant lifeforms: trees, shrubs and groundcover in accordance with the "Plant Guide within the Building Protection Zone" (FESA 2011a). Whilst it is acknowledged that the guide was designed for the Swan Coastal Plain and not specifically for the Jarrah forest, the guide was used to categorise plant lifeforms and therefore an applicable tool for this purpose. The average planting density across the six revegetation sites was 0.6 plants per m^2. The species planted were a mix of trees, shrubs and ground cover and were randomly planted along the rip line. The plant density for tree species (based on calculations of sites which have been monitored over the longest period) is 1 tree per 6.9 m^2 to 16.3 m^2. Tree species included *Allocasuarina fraseriana, Banksia grandis, B. ilicifolia, B. menziesii, B. prionotes, Corymbia calophylla, Eucalyptus marginata, E. rudis* and *E. wandoo*. Based upon the completed vegetation, the future vegetation classification has been calculated for revegetation sites 1A and 2 and is shown in **Figure 3**.

The vegetation structure planning for new revegetation sites will aim for a stem density of 500 - 800 stems/ha of trees and 8,200 - 8,500 stems/ ha for shrubs and ground cover. It is anticipated that tree cover will be in the vicinity of 30 - 75%; shrub and ground cover in the range 30 - 80% with a grassy understorey. Future revegetation sites will also use plant species which have been successful at the revegetation sites and will not use sandy soil banksia species (*Banksia ilicifolia, B. menziesii* and *B. prionotes*) which have not been successful within the P and R Reserve.

For example, the revegetation species proposed for 2014 revegetation include:

- *Acacia lasiocarpa.*
- *Acacia pulchella.*
- *Allocasuarina humilis.*
- *Banksia lindleyana.*
- *Banksia nivea.*
- *Banksia sessilis.*
- *Callistemon phoeniceus.*
- *Calothamnus quadrifidus.*
- *Corymbia callophylla.*

- *Eucalyptus wandoo.*
- *Gompholobium tomentosum.*
- *Grevillea bipinnatifida.*
- *Hakea lissocarpa.*
- *Hakea prostrata.*
- *Hakea undulata.*
- *Hibbertia subvaginata.*
- *Hypocalymma robustum.*
- *Kennedia coccinea.*
- *Kennedia prostrata.*

The revegetation species outlined above, should be considered to replace the revegetation species list provided in the revised RFMP (Cardno 2012a). This will remove some of the species originally planted which were not suitable for the site and have not been successful.

The P and R Reserve is noted as an “extreme” fire risk on the Fire Management Plan (Fireplan 2013) and therefore the existing fire management plan has been developed to account for this “extreme” hazard. Therefore the proposed revegetation within the P and R Reserve is not considered to significantly increase the bushfire risk.

As the revegetation spacings and density achieves an Open Woodland vegetation classification (20%-30% with an understorey of shrubland (30%) the fuel loads of the site will be similar to the existing vegetation (**Figure 3**). The slopes of the land from the Avon River eastward to the Avon Ridge Estate varies between 10°- 20°. It is known that the rate of forward spread of bushfires in this landscape double for every 10° increase in slope. As some areas are 15 - 20° slope, the rate of spread is up to 4 times that of flat land. Therefore the greatest factor influencing the rate of spread in this landscape is the slope and not the increase in vegetation in the areas that are being revegetated. Overall revegetation is targeted for a relatively small area (24.3 ha) of the P and R Reserve (393 ha). Therefore the proposed revegetation within the P and R Reserve is not considered to significantly increase the bushfire risk.

4 Monitoring (Refers to Section 4.2 in revised RFMP)

Section 4.2 of the revised RFMP describes that revegetation will be assessed on an annual basis for a period of three years after initial planting to ensure the required 90% survival rate is met in order to satisfy EPBC approval conditions. The three year monitoring timeframe applies to the date that plants are initially planted and dead plants are replaced with infill planting within the three year period to achieve a 90% survival rate.

Evaluation of transects at each revegetation site monitored percentage survival of total number of plants but did not record the specific species survival. Due to the monitoring approach adopted, some assumptions and general observations were made regarding the survival of species but this was not quantified.

Survival and species richness results have been monitored on a biannual basis. Based upon the first revegetation site (Site 1A) planted in 2011, the survival rate after the first year was 89% (Tranen 2012). In the second revegetation site (Site 2), the survival rate was 66% after one year (Tranen 2013). Species richness remained high for both sites after one year of planting. Of the 21 species planted in Site 1A, all species were recorded (Tranen 2012) and in Site 2, 17 out of 18 species were recorded (Tranen 2013) after one year of planting. The distribution of plants was even and fairly consistent throughout the site. Low plant survival rates were recorded in close proximity to remnant vegetation compared to areas where there was less or no remnant vegetation. Natural recruitment of native plants occurred within the revegetation site but at this stage (2.5 years after installation) does not constitute a large proportion of the biomass.

Recruitment is patchy within Site 1A and minor native recruitment has also been observed within Site 2. The species that were observed germinating from the soil seed bank ranged from tree species (predominantly *Eucalyptus rudis*) to shrubs (predominantly *B. sessilis* and *Hibbertia* spp.) and grasses (*Austrostipa flacescens*) (Tranen 2013 and Roy Wittkuhn (Tranen) 2013, *pers comm*. December 17 2013).

5 Fire Management (refers to Section 5 of revised RFMP)

5.1 Bush fire fuel loading

The definition of fuel load within the revised RFMP (Cardno 2012) is described as “dry weight of fine fuel (<10mm in diameter) per unit area – commonly expressed as tonnes per hectare”. The definition of fuel load by the DFES (previously FESA) has since been revised. FESA’s *Visual Fuel Load Guide for the shrub vegetation of the Swan Coastal Plain and Darling Scarp* (FESA 2012) defines fuel load as the “oven dry weight of fine fuel (< 6 mm in diameter for live fuel and < 3 mm for dead fuel) per unit area—commonly expressed as tonnes per hectare”. This addendum serves to update the definition of fuel load in accordance with DFES requirements.

Additional fuel load assessments were carried out in specific areas of Public Open Space over the site including the Wetland and Creekline Conservation Area and the Southern Public Open Space creekline area. These are discussed in further detail below.

5.1.1 Wetland and Creekline Conservation Area

The vegetation in the Wetland and Creekline Conservation Area was classified in accordance with Australian Standard (AS) 3959 *Construction of buildings in bushfire-prone areas*. The vegetation classification mapping for this area is shown in **Figure 5** and is described as Open Woodland over Closed Heath in the creekline to Open Forest moving upslope to the west and east.

Using the *Prescribed Burning Methodologies for Safe and Effective Burning* (FESA and Conservation and Land Management (CALM) 2004), fuel loads in the Open Forest were calculated at 15 tonne/ha as at July 2014.

5.1.2 Southern Public Open Space

The vegetation in the Southern Public Open Space area was classified in accordance with AS 3959 *Construction of buildings in bushfire-prone areas*. The vegetation classification mapping for this area is shown in **Figure 6** and the vegetation in the western portion of the Southern Public Open Space varies from Open Grassland with small areas of Woodland over Grassland. Generally this vegetation is considered to be “Degraded” in accordance with the Keighery scale (1994) and using the *Prescribed Burning Methodologies for Safe and Effective Burning* (FESA and CALM 2004), fuel loads can be calculated. Fuel loads in the Grassland would be approximately 4.5 tonnes/ ha at the peak but are heavily grazed by kangaroos and would be approximately 2 - 3 tonnes/ha during the summer months. Given the vegetation condition of this area (being “Degraded”), the fuel load is not expected to change significantly over time.

The vegetation in the eastern portion of the Southern Public Open Space (east of the western arm of Connemara Drive) varies from Low Shrubland, Woodland over Sparse Shrubland to Open Forest. In the Open Forest fuel loads are a total of 14 tonnes/ha (as at July 2014).

5.2 Hazard reduction burning

The revised RFMP outlined a prescribed burn plan over the Avon Ridge Estate in ***Section 5.2***. The prescribed burn plan is comprised of three proposed prescribed annual burns to be undertaken from 2012 to 2014. Due to unsuitable weather and timing, the prescribed burns were either not conducted as proposed or if the burn was conducted, it was partially completed. Therefore, there has been a

delay in the timing of the proposed prescribed burn plan as described in the revised RFMP. The table below (**Table 2**) describes the proposed burn plan in the revised RFMP, a record of a burn if it was conducted and the revised prescribed burn plan for the 2014 RFMP.

Table 2 Proposed prescribed burn plan (Cardno 2012a), record of burn conducted and revised prescribed burn plan

PROPOSED PRESCRIBED BURN PLAN TIMING IN THE REVISED RFMP (CARDNO 2012A)	RECORD OF BURN	UPDATED PRESCRIBED BURN PLAN TIMING
2012	A partial burn conducted on 19th - 23rd June, 2013	Partial burn (19th -23rd June, 2013) Complete remainder of burn area in 2014
2013	Not conducted	2015
2014	Not conducted	2016

The prescribed burn proposed for 2012 was undertaken between the19th – 23rd June, 2013 by the East Swan Volunteer Bushfire Brigade who were contracted by Peet Limited (Peet). The weather conditions during the burn period ranged from 18°C to 20°C and 32 to 49% RH at 3pm. Edge burns were conducted on the northern, western and eastern sides at night on the 19th and 20th of June (**Figure 7**). Pockets of areas were burnt out during the day over the period as required. The prescribed burn resulted in a patchy burn with 80% fuel reduction achieved over approximately half of the proposed burn area.

A revised prescribed burn plan proposes that the remainder of the 2012 burn be undertaken in 2014. The burn proposed for 2013 was not conducted and will be delayed to 2015 and the 2014 burn will also be further delayed to 2016. The revised prescribed burn plan is shown in **Figure 7**). The Fire Management Consultant (FMC) will inform DFES and the City of Swan when prescribed burns have been undertaken and prescribed burns will continue to be implemented by the East Swan Volunteer Bushfire Brigade (or other volunteer brigade). DFES and the City of Swan will also be informed if prescribed burns will be delayed or not undertaken as proposed for the year by the end of each year and revised prescribed burn plan forwarded to DFES.

In addition to prescribed burns as proposed, fuel loads within the Avon Ridge Estate are also maintained in compliance with the City of Swan Bushfire hazard regulations. These include:

- Maintenance of fire service access routes on an annual basis.
- Maintenance of firebreaks by land owners of purchased individual lots or by Peet of unsold created lots on an annual basis.
- Maintenance of existing access tracks within undeveloped areas to current standards (4 – 6 m) to enable fire appliance access and separation of areas of remnant vegetation.
- Hazard reduction in compliance with Building Protection Zone (BPZ) and Hazard Separation Zone (HSZ) requirements in lots with established dwellings undertaken by landowners on an annual basis.

Should unforeseen circumstances such as unsuitable weather conditions and unavailable personnel to conduct prescribed burns lead to a delay in the proposed prescribed burns, hazard reduction across the estate on a regular and annual basis will be undertaken as described above.

The 2013/2014 City of Swan annual firebreak notice (**Appendix C**) specifically outlines the requirements for landowners with regards to:

- Installation of firebreaks.
- Grass heights.
- Installation and maintenance of the BPZ including acceptable bushfire fuel loads.
- Installation and maintenance of the HSZ including acceptable bushfire fuel loads.
- Adherence to measures outlined within an approved Fire Management Plan.

The firebreak notice also outlines the City of Swan options for enforcing compliance with the notice including entering onto the land to carry out the requirements of the notice at the expense of the landowner, plus financial penalties. A similar notice is expected to be provided in coming years to provide landowners and the general community information regarding the City of Swan's expectations with regards to fire management.

5.3 Wetland and Creekline Conservation Area

All habitable buildings in lots that are located adjacent to the Wetland and Creek Line Conservation area of the site are to be setback a minimum of 60 m to the edge of the Wetland and Creek Line Conservation area boundary. This will be implemented in the Detailed Area Plan (DAP) for this stage of land release.

A 60 m zone of modified vegetation will be created around each habitable dwelling (in accordance with the Fire Management Plan (Fireplan WA 2013)), which will include a 20 - 30 metre wide BPZ (determined by onsite assessment by a Fire Consultant, as discussed further in **Section 5.5**) and a 20 – 40 metre HSZ. In accordance with the Fire Management Plan, fuel loads are to be below 2 tonnes/ha in the BPZ and 4-6 tonnes/ha in the HSZ and are to be maintained by the Landowner in perpetuity. Management of the BPZ and HSZ to the standards detailed in a Fire Management Plan are enforceable by the City of Swan through the City of Swan Firebreak Notice (**Appendix C**).

In accordance with the Fire Management Plan (Fireplan WA 2013) habitable buildings within this location are to be constructed to BAL 29 (BAL 29 has a heat Flux of >19 Kw/m^2 to 29 Kw/m^2).

In order to understand the potential fire behaviour associated with the Wetland and Creekline Conservation Area, Fireplan WA undertook some fire behaviour calculations to demonstrate the acceptability of the proposed fire management measures.

Rates of spread and fire intensity were calculated for the Wetland and Creekline Conservation Area based upon inputs shown in **Table 3** with the results provided in **Table 4**.

Table 3 Fire behaviour calculation inputs for the Wetland and Creekline Conservation Area

INPUTS	RESULTS	SOURCE
Air Temperature (°C)	33	Bureau of Metrology (2014)
Relative Humidity (%)	30	Bureau of Metrology (2014)
Wind Speed (km /h)	20	Bureau of Metrology (2014)
Fuel Load (tonnes /ha)	15 Open Forest Vegetation	Fireplan WA See **Section 5.1.1**
Drought Factor	6	McArthur Forest Fire Danger Meter Mk5
Modifier	x1	McArthur Forest Fire Danger Meter Mk5

Table 4 Fire behaviour results for the Wetland and Creekline Conservation Area

SLOPE	RATE OF SPREAD OF BUSHFIRE	FIRE INTENSITY (FROM FIRE BEHAVIOUR FORMULAS – FESA 2013)
Flat ground	238 m/hr	
10°	476 m/hr	3,570 Kw/m
15°	666 m/hr	4,996 Kw/m

The outputs from **Table 4** can be used in conjunction with the fuel type (from FESA (now DFES) *Guide and Tables for Bushfire Management in Western Australia* (2011b)) to work out the acceptable firefighting methods. For a bushfire with an intensity of <2000 Kw/m and or a rate of spread <400 m/h in forest or woodland a direct machine and tanker attack would possibly be successful if the fire started in the morning or late afternoon of a day with the weather conditions detailed above. If the fire intensity was >4000 Kw/m then an indirect attack (such as a back burn) would possibly succeed.

Research conducted by Gould *et al.* (2003) noted that "*The relationship describing the effect of head fire width and wind speed on rate of spread in forest fires were similar to that for grass fires. The head fire width required to realise the potential rate of spread increases with increasing wind speed. At wind speeds in excess of 20 km/ hr the head fire width to achieve the potential rate of spread of forest fires is likely to be greater than required for fire in open grasslands or grassy woodlands and is probably in excess of 300 metres. Forest Fires during their build up period can maintain quasi-steady rates of spread that are well below their potential rates of spread for several hours …..*"

The Wetland and Creekline Conservation Area is 77 m at the widest point (**Figure 5**), with a creekline running north-south. The means that a bush fire starting to the north of the edge of the Avon Ridge Estate would first burn up the narrow creek line then upslope towards habitable buildings. The proposed 60 m setback to habitable dwellings and the implementation of a BPZ and HSZ in this area (minimum 60 m) means that the head fire width of 300 m is unlikely to be reached and therefore the rate of spread (and the fire intensity) is less than predicted in the calculations.

From AS 3959-2009 (Method 2 Section2.1) the heat flux onto building at 10° upslope and 10 tonnes /ha will be:

- 20 metres from the building – 20.33kw/m²
- 40 metres from the building – 8.83 kw/m²
- 60 metres from the building – 4.86 kw/m²

As previously discussed building construction of habitable building in lots adjoining the Wetland and Creeline Conservation Area is BAL 29 (heat flux of >19 Kw/m^2 to 29 Kw/m^2 (AS 3959-2009 Table 3.1)) and the 60 metres down slope from the habitable building is managed to 2 tonnes/ha in the BPZ and 4-6 tonnes/ha in the HSZ. Based upon the above, it is unlikely that the heat flux of a bush fire will exceed that of which the dwellings has be designed to withstand (as the fuel loads surrounding the house will be reduced through the implementation of a BPZ and HSZ) and that the bushfire strategies and fire mitigation requirements detailed in the Fire Management Plan (Fireplan 2013) are sound and effective.

5.4 Southern Public Open Space

All habitable buildings in lots that are located adjacent to the P and R Reserve to the west and north and the Southern Public Open Space area to the south are to be setback a minimum of 60 metres from the Strategic Firebreak/Fire Service Access Way and habitable building are to be constructed to BAL 29 (BAL 29 has a heat Flux of >19 Kw/m^2 to 29 Kw/m^2). This is detailed in the Fire Management Plan (Fireplan WA).

A 60 m zone of modified vegetation will be created around each habitable dwelling (in accordance with the Fire Management Plan (Fireplan WA 2013), which will include a 20 - 30 metre wide BPZ (determined by onsite assessment by a Fire Consultant, as discussed further in **Section 5.5**) and a 20 – 40 metre HSZ. In accordance with the Fire Management Plan, fuel loads are to be below 2 tonnes/ha in the BPZ and 4 - 6 tonnes/ha in the HSZ and are to be maintained by the Landowner in perpetuity. Management of the BPZ and HSZ to the standards detailed in a Fire Management Plan are enforceable by the City of Swan through the City of Swan Firebreak Notice (**Appendix C**).

In order to understand the potential fire behaviour associated with the Southern Public Open Space, Fireplan WA undertook some fire behaviour calculations to demonstrate the acceptability of the proposed fire management measures.

Rates of spread and fire intensity were calculated for the Southern Public Open Space based upon inputs shown in **Table 5** with the results provided in **Table 6.**

Table 5 Fire behaviour calculation inputs for the Southern Public Open Space

INPUTS	RESULTS	SOURCE
Air Temperature (°C)	33	Bureau of Metrology (2014)
Relative Humidity (%)	30	Bureau of Metrology (2014)
Wind Speed (km /h)	20	Bureau of Metrology (2014)
Fuel Load (tonnes /ha)	14 Open Forest Vegetation	Fireplan WA See **Section 5.1.2**
Drought Factor	6	McArthur Forest Fire Danger Meter Mk5
Modifier	x1	McArthur Forest Fire Danger Meter Mk5

The outputs from **Table 6** can be used in conjunction with the fuel type (from *Guide and Tables for Bushfire Management in Western Australia* (FESA (now DFES) 2011b)) to work out the acceptable firefighting methods. For a bushfire with an intensity of <2000 Kw/m and or a rate of spread <400 m/h in forest or woodland a direct machine and tanker attack would be possibly successful if the fire started in the morning or afternoon of a day with the weather conditions detailed above. If the fire intensity was >2000Kw/m then an indirect attack (such as a back burn) would possibly succeed. It is also worthwhile noting that aerial water bombers are successful when fire intensity is <2000Kw/m when backed up by ground forces.

Table 6 Fire behaviour results for the Southern Public Open Space

SLOPE	RATE OF SPREAD OF BUSHFIRE	FIRE INTENSITY (FROM FIRE BEHAVIOUR FORMULAS – FESA 2013)
Flat ground	222 m/hr	
5°	310 m/hr	2,170Kw/m
10°	444 m/hr	3,108 Kw/m

As outlined above, research conducted by Gould *et al.* (2003) noted that to achieve a maximum rate of spread a head fire width in excess of 300 m is potentially required. The Southern Public Open Space is 227 metres at the western edge measured from Campersic Road (**Figure 6**) and a creekline runs east-west through the centre of this area. The means that a bush fire starting on the edge of Campersic Road would first burn downslope before burning upslope toward the Avon Ridge Estate. On this basis, it is unlikely that a 300 m fire head width would be reached (before the fire enters a low fuel environment such as a BPZ or HSZ).

Figure 8 shows that the BPZ and HSZs proposed for lots adjacent to this Southern POS area are overlapping creating an almost continuous low fuel area 60 metres wide protecting habitable buildings.

From AS 3959-2009 (Method 2 Section2.1) the heat flux onto building at 10° upslope and 10 tonnes /ha will be:

- 20 metres from the building – 20.33kw/m²
- 40 metres from the building – 8.83 kw/m²
- 60 metres from the building – 4.86 kw/m²

As previously discussed building construction of habitable building in lots adjoining the southern Public Open Space is BAL 29 (heat flux of >19 Kw/m^2 to 29 Kw/m^2 (AS 3959-2009 Table 3.1)) and the 60 metres down slope from the habitable building is managed to 2 tonnes/ha in the BPZ and 4-6 tonnes/ha in the HSZ. Given the implementation of a BPZ and HSZ on lots, it is unlikely that the heat flux of a bush fire will exceed that of which the dwellings has be designed to withstand and that the bushfire strategies and fire mitigation requirements detailed in the Fire Management Plan (Fireplan WA 2013) are sound and effective.

5.5 Fire management consultant inspection process

Section 5.3 in the RFMP refers to the role of the FMC to assess and advise the landowner on the level of vegetation modification outlined in the FMP including the BPZ and HSZ standards. Several measures and processes are in place to ensure the vegetation modification is undertaken and maintained in the long term by the landowner. These include:

- Site specific assessment by the FMC to:
  - undertake a BAL (bushfire attack level) rating assessment in accordance to Australian Standard (AS) 3959.
  - complete a pre-clearing checklist to identify trees and shrubs requiring vegetation modification.
  - complete a post-clearing checklist to confirm vegetation modification has been undertaken

- Provide the landowner DFES bushfire ready publications and contact details of the local bushfire brigade who can undertake burns on the landowner's behalf.
- Explain bushfire hazard regulations imposed and enforceable by the City of Swan on an annual basis.
- Raise awareness of the establishment of the Avon Ridge Estate Bushfire Ready Action Group (BRAG) and encourage landowners to participate.

The combination of site specific inspections and advice provided by the FMC followed by equipping landowners with resources to install and maintain the BPZ and HSZ results in a high level of preparedness of landowners to reduce fuel hazard within lots. Peet also provides landowners a landowner information package which highlights sustainable home design and the building approval process including the requirement for BPZs and HSZs and other bushfire hazard planning information.

The site specific fuel hazard assessment undertaken by the FMC is summarised in a flowchart (**Appendix D**) and is described in more detail below.

The landowner firstly informs Peet of the proposed house design and building envelope. Peet arranges the initial inspection by the FMC to inspect the lot to determine if the building envelope is in the correct location. The landowner is encouraged to be present during the inspection to familiarise themselves to and attain knowledge of the BAL assessment process and fuel hazard reduction requirements. If the building envelope is determined to be in the correct location by the FMC, a BAL assessment will be undertaken in accordance with AS 3959 and the landowner can proceed with the application of the building license at the City of Swan.

The BAL rating assessment determines the type of building construction is required to withstand a bushfire attack. The BAL takes into account a number of factors including the Fire Danger Index, the slope of the land, types of surrounding vegetation and its proximity to any building. Specific advice on modification of vegetation within the BPZ and the HSZ is prepared and the information recorded in a pre-clearing checklist. During the site assessment and in adherence to the Protective Covenant, the FMC identifies and labels individual trees and identifies areas of leaf litter and fuel load to remove to attain the fuel load levels in the BPZ and HSZ as well advises landowners on ongoing maintenance requirements to maintain low fuel load levels.

The landowner submits to the City of Swan the position of building envelope, location of vegetation and completed BAL assessment. If the inspection by the FMC determines that the building envelope is not in a correct position, a suitable building envelope will be chosen by the landowner in consultation of the FMC and a pre-clearing site check and BAL assessment will follow. The landowner can then proceed with the building licence application at the City of Swan as described above.

In addition to providing site specific advice to the landowner, the FMC will also equip the landowner with knowledge for ongoing maintenance of fuel loads and fire management requirements by providing (i) resources to maintain hazard reduction and (ii) information on bushfire hazard regulations imposed by the City of Swan.

Resources provided to the landowner include:

- DFES produced and supplied publications and DVDs such as *Homeowners Bushfire Survival Manual* and *Winter Burning Guide – Controlled burns in winter may help to protect your home this summer*.

- Referral to the East Swan Volunteer Bushfire Brigade for further information and to engage them to undertake hazard reduction burns on their lot if they are not comfortable in conducting the burning.
- Awareness of the establishment of the Avon Ridge Estate Bushfire Ready Action Group (BRAG).

BRAG is a DFES program aimed at increasing the resilience of a community to bushfire risk and will be initially established by Peet. In the forthcoming three years in spring and prior to the oncoming summer, Peet will organise and fund barbeque information sessions for Avon Ridge Estate residents attended by the FMC and representatives from DFES, the East Swan Volunteer Bushfire Brigade and City of Swan. During the session, information on how to form the Avon Ridge Estate BRAG as well as fuel hazard reduction and bushfire readiness training and support by the agencies will be provided.

It is envisaged that following the initial support of Peet in organising the information barbeque, the Avon Ridge Estate BRAG will be established, driven by residents of Avon Ridge Estate and supported by DFES, the East Swan Volunteer Bushfire Brigade and the City of Swan.

In addition to providing bushfire hazard reduction resources, the FMC will also inform the landowner the City of Swan's bushfire hazard regulations. These include:

- The requirement to implement and maintain the BPZ and HSZ in accordance to the Firebreak Notice for the City of Swan under Section 33 of the *Bushfires Act 1954*. See **Appendix C** for the 2013/14 Notice. The FMC provides practical advice to landowners on how to adhere to the bushfire hazard requirements.
- Notification of proposed Amendment No. 99 (Bushfire Amendment) to the City of Swan council Local Planning Scheme No. 17 which will, amongst other amendments identify bushfire prone areas (BPA) within the City of Swan and designate all bushfire prone areas into the Special Control Area under the City's Local Planning Scheme No 17. Currently, the entire Avon Ridge Estate falls within a proposed BPA and under Clause 6.5.6 of the proposed amendment (Development and subdivision of land within a BPA) (City of Swan, 2013) the local government may apply conditions of planning approval including "*implementation of specific fire protection measures*" which may include the BPZ and HSZ within landowners' lots.

BAL assessments of new dwellings, a requirement within BPAs are already a requirement within the Avon Ridge Estate in accordance with the FMP.

Following approval of the building licence by the City of Swan, the land owner undertakes vegetation modification in adherence to the completed pre-clearing checklist and Protective Covenant. Following vegetation modification, the FMC conducts another site inspection prior to occupancy and completes a post-clearing checklist to confirm that the vegetation modification has been completed in accordance with the advice provided in the pre-clearing checklist and onsite inspection.

The extensive use of the FMC goes beyond site inspections providing landowners with fuel reduction advice as part the building process. The FMC role also extends to providing landowners additional resources, raises awareness of local government hazard reduction requirements, provides advice and encouragement to join the Avon Ridge Estate BRAG and will contribute to ongoing reduction of fuel loads over the estate.

5.6 Fire management in the Parks and Recreation Reserve

On 5th July 2012, the P and R Reserve (Reserve 51076) was ceded to the WA State Government as part of the Stage 1 subdivision approval. The P and R Reserve is currently managed by the Department of Lands and fire management is undertaken by DFES in accordance with a Memorandum of Understanding (MoU) that exists between the two departments.

6 Conclusion

This addendum should be read in conjunction with the revised RFMP to form the 2014 RFMP and in summary the key points of this addendum includes:

- All revegetation works will be completed in the adjacent P and R Reserve (Reserve 51076) and no revegetation will be undertaken within the Avon Ridge Estate.
- 106,775 plants have been planted in the P and R Reserve from 2011 to 2013 at an average density of of 0.6 plants per m^2.
- Deep ripping was used to prepare soil for revegetation, which followed by weed control did not lead to excessive natural regeneration from the soil seed bank.
- Revegetation has been moderately successful, with 89% success recorded at Revegetation Site 1A in 2012 and 66% at Site 2 in 2013.
- The definition of fuel load is revised to reflect the update from DFES publications (FESA 2012).
- Measured fuel loads in areas of Public Open Space adjacent to the site range from 15 tonnes /ha to 2 tonnes/ ha.
- The prescribed burn plan is revised showing burns to be undertaken from 2014 to 2016 (**Figure 7**).
- An assessment of potential fire behaviour and the fire management approach for areas of Public Open adjacent to the site, which demonstrates that the bush fire strategies and fire mitigation requirements detailed in the Fire Management Plan (FIreplan WA 2013) are sound and effective. Specifically:
    - The creation of a 60 m separation between areas of Public Open Space and habitable dwellings
    - The creation of a 60 m BPZ/HSZ which will reduce fuel loads in the areas around a habitable dwellings.
- A description of the inspection process undertaken by the FMC to install the BPZ and HSZ in addition to the resources and advice provided by the FMC and Peet to the landowner for ongoing fuel hazard reduction within lots.
- Information regarding the land management of the P and R reserve.

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FIGURES

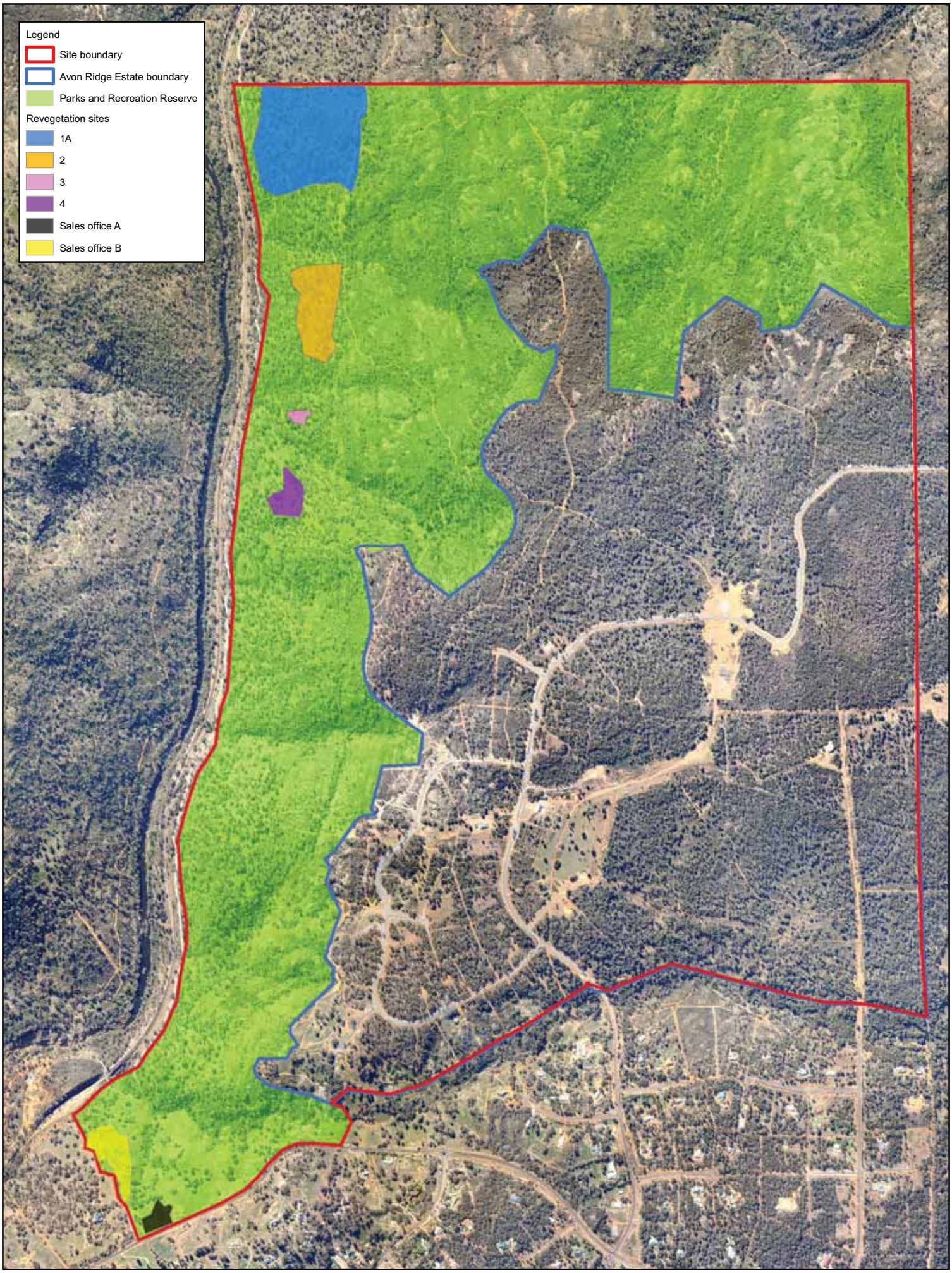

Figure 1: **Revegetation sites within the Parks and Recreation Reserve**

Project: Avon Ridge Estate RFMP Addendum

Client: Peet Limited

Plan Number: EP13-041(04)--F03

Drawn:	GRO	Date:	06/12/13
Approved:	CKK	Date:	22/01/14
Checked:	AT	Scale:	1:17,000@A4

0 150 300 600 Metres

emerge ASSOCIATES Integrated Science & Design

Sources: The following datasets were used in the production of this map: Parks and Recreation Reserve - DoP (2013)

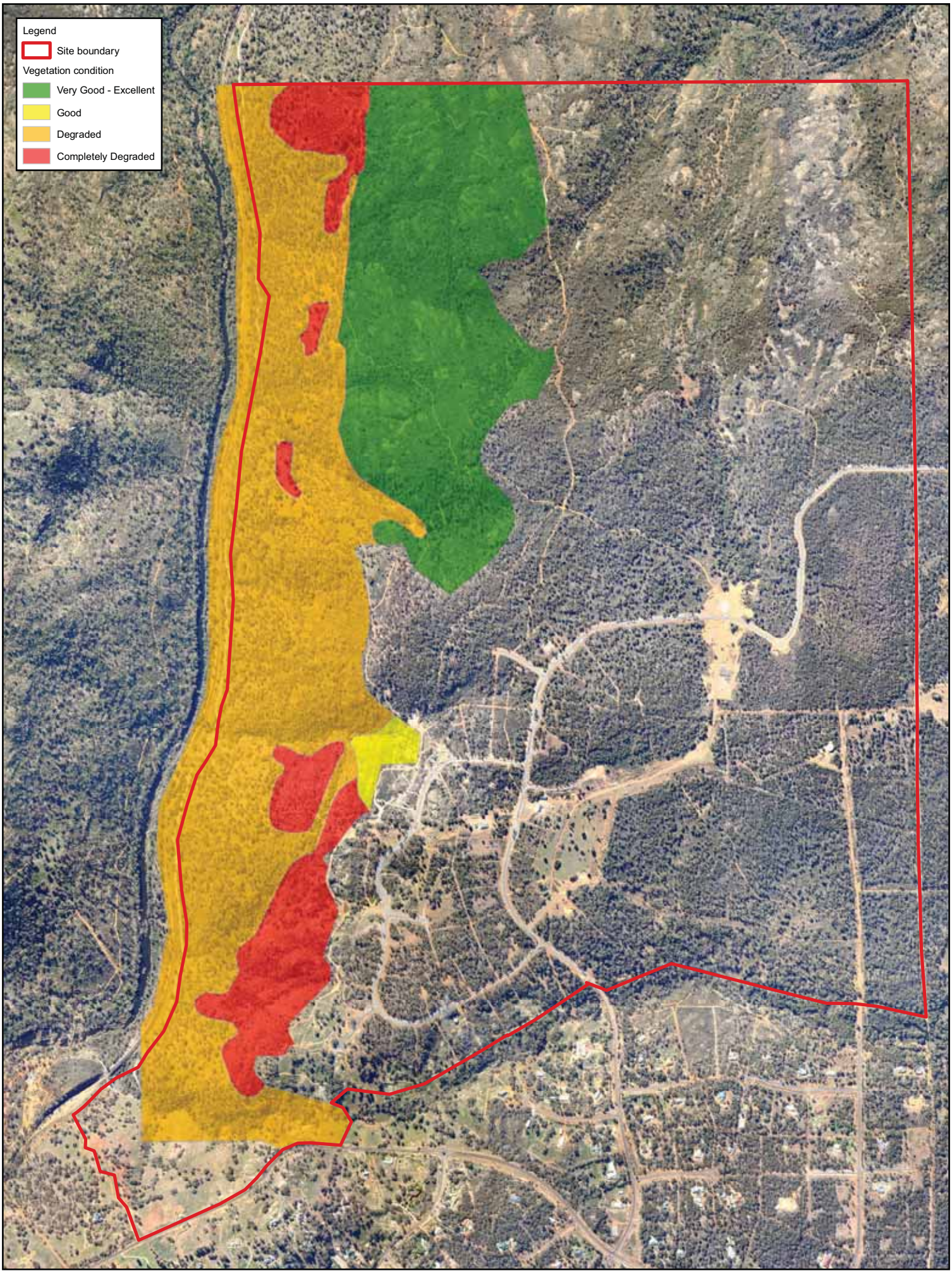

Figure 2: **Vegetation Condition within the Parks and Recreation Reserve**

Project: Avon Ridge Estate RFMP Addendum

Client: Peet Limited

Plan Number: EP13-041(04)--F09

Drawn:	GRO	Date:	21/01/14
Approved:	CKK	Date:	22/01/14
Checked:	AT	Scale:	1:17,000@A4

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emerge ASSOCIATES Integrated Science & Design

Sources: The following datasets were used in the production of this map: Vegetation Condition - Cardno (2010)

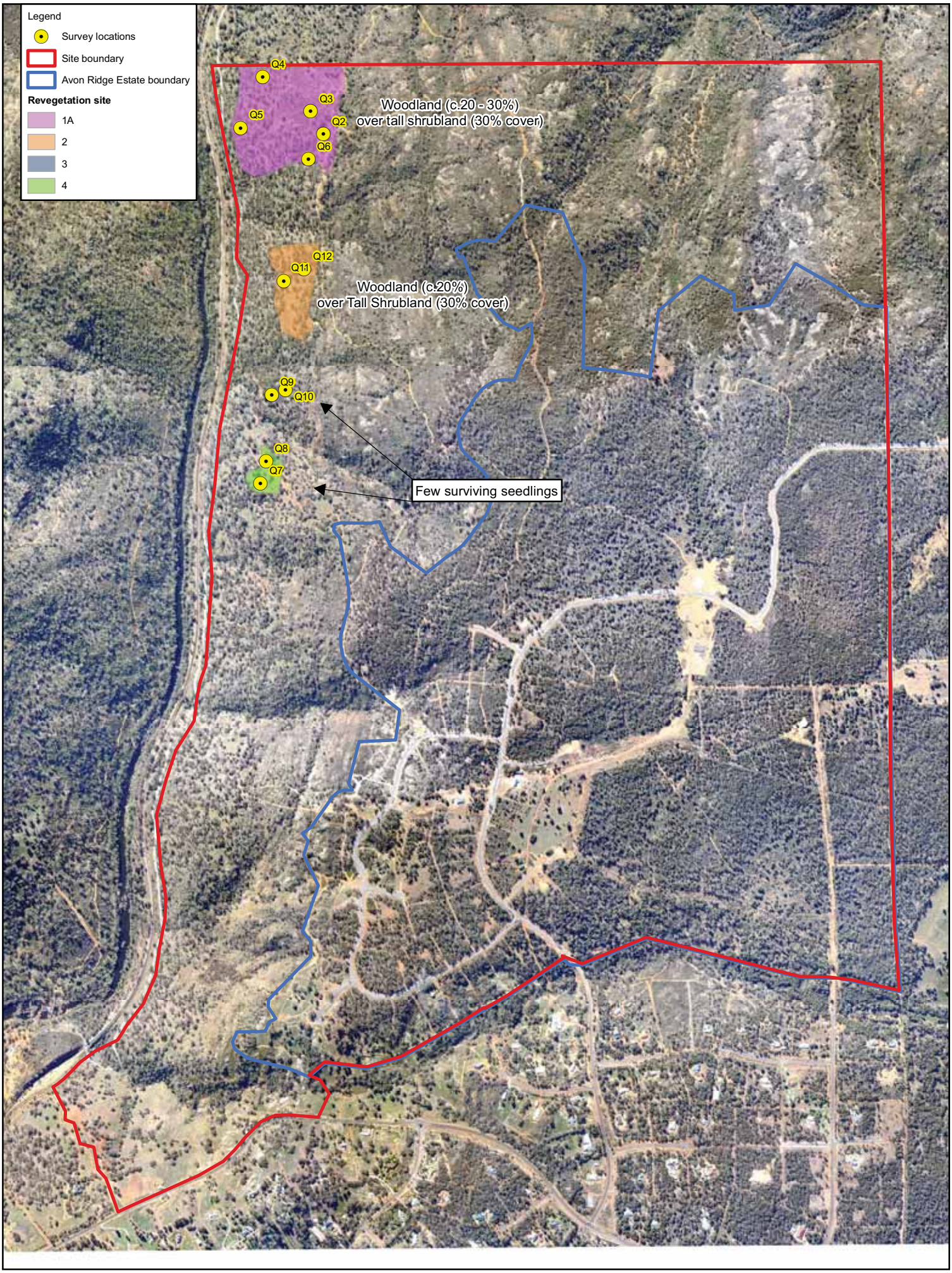

Figure 3:	**Future Vegetation Classification of Revegetation Areas**	**Plan Number: EP13-041(04)--F15**	
Project:	Avon Ridge Estate RFMP Addendum	Drawn: GRO	Date: 22/07/14
		Approved: CKK	Date: 29/07/14
Client:	Peet Limited	Checked: SKP	Scale: 1:17,140@A4

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emerge ASSOCIATES
Integrated Science & Design

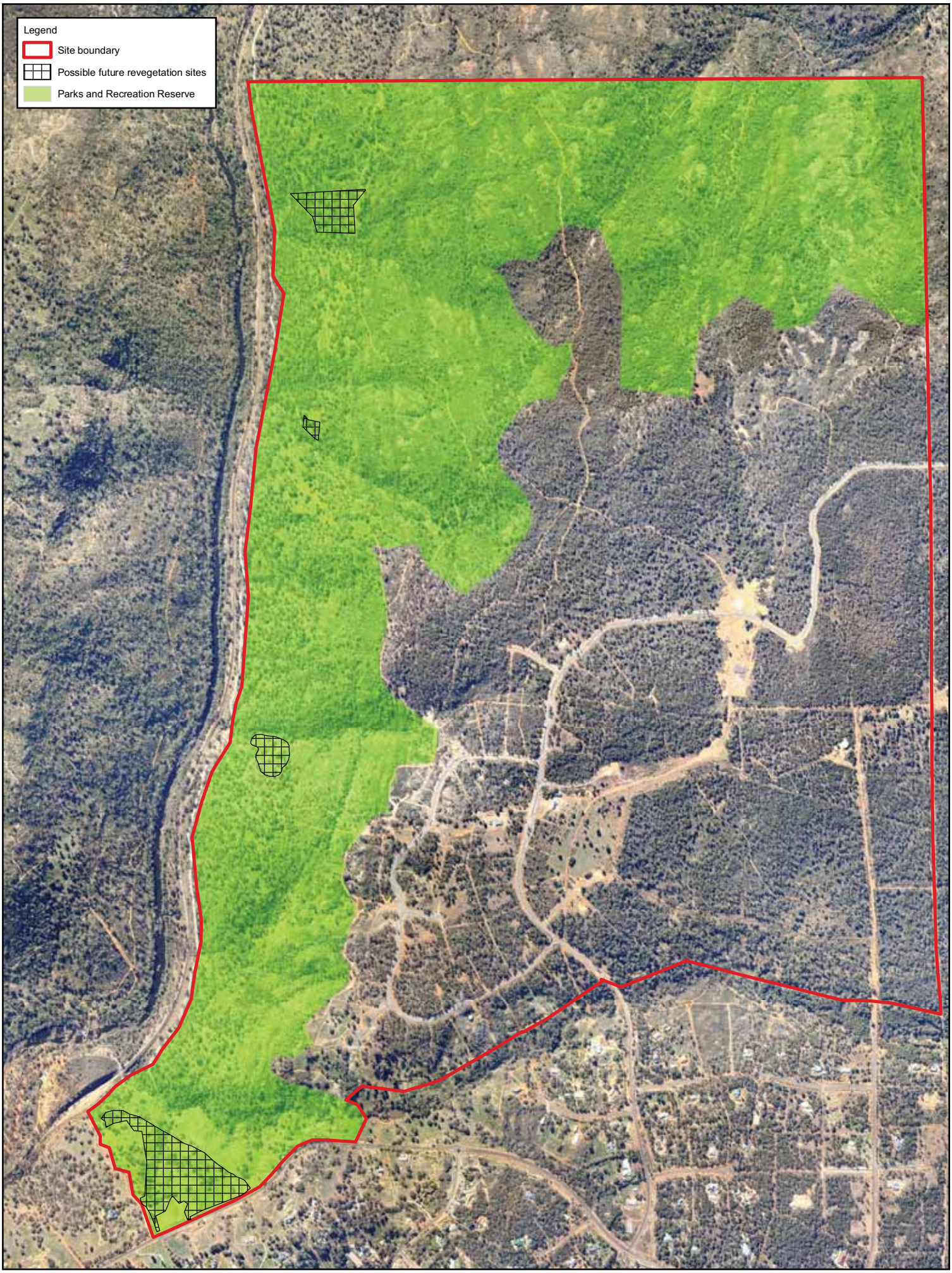

Figure 4:	**Future Revegetation Sites within the Parks and Recreation Reserve**
Project:	Avon Ridge Estate RFMP Addendum
Client:	Peet Limited

Plan Number: EP13-041(04)--F08a			
Drawn:	GRO	Date:	10/01/13
Approved:	CKK	Date:	22/07/14
Checked:	AT	Scale:	1:17,000@A4

0 150 300 600 Metres

emerge ASSOCIATES
Integrated Science & Design

Sources: The following datasets were used in the production of this map: Parks and Recreation Reserve - DoP (2013)

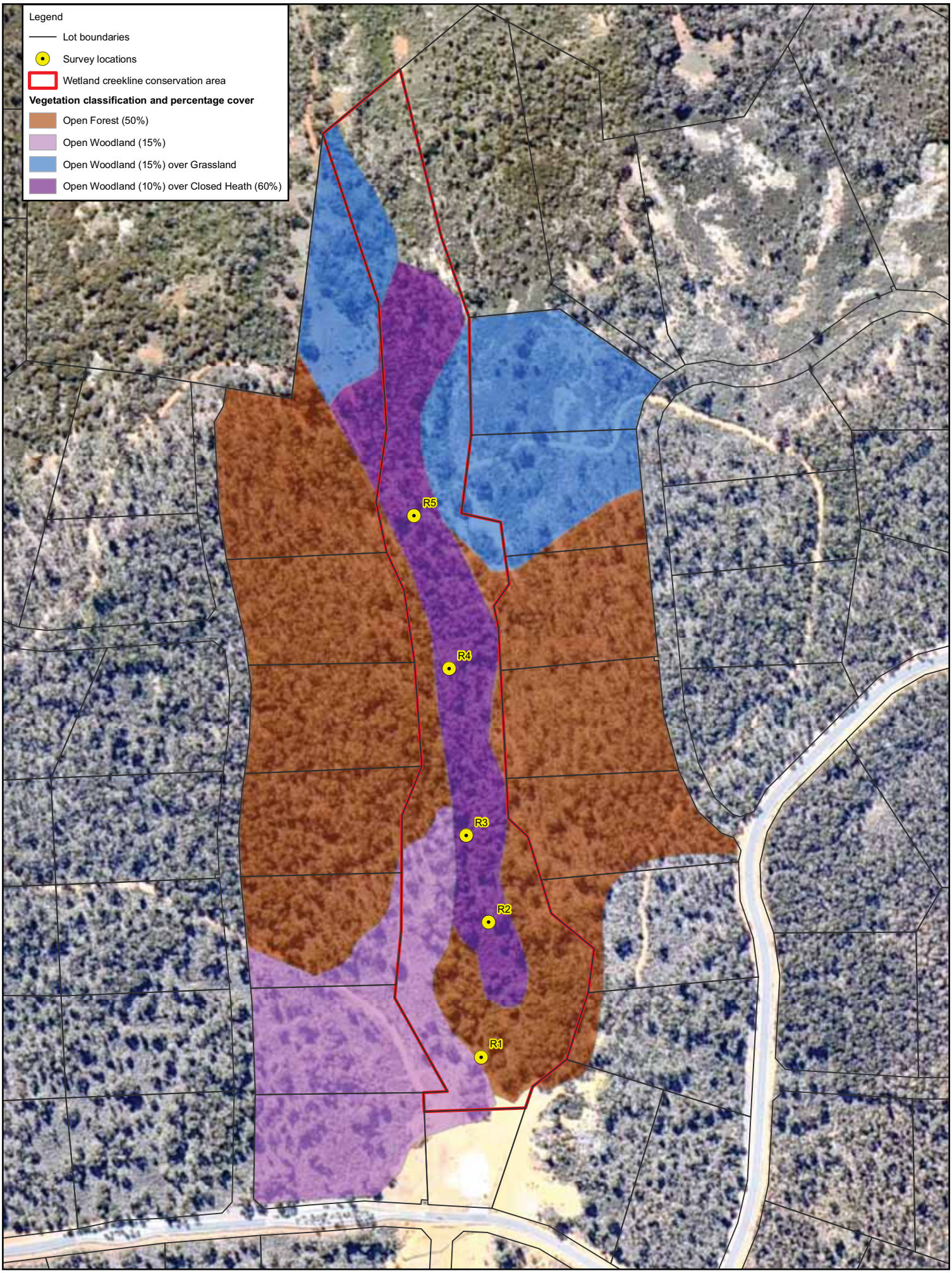

Figure 5:	**Wetland and Creekline Conservation Area Vegetation Classification**
Project:	Avon Ridge Estate RFMP Addendum
Client:	Peet Limited

Plan Number: EP13-041(04)--F13

Drawn:	GRO	Date:	09/05/14
Approved:	CKK	Date:	29/07/14
Checked:	SKP	Scale:	1:4,500@A4

0 25 50 100 150 Metres

emerge ASSOCIATES
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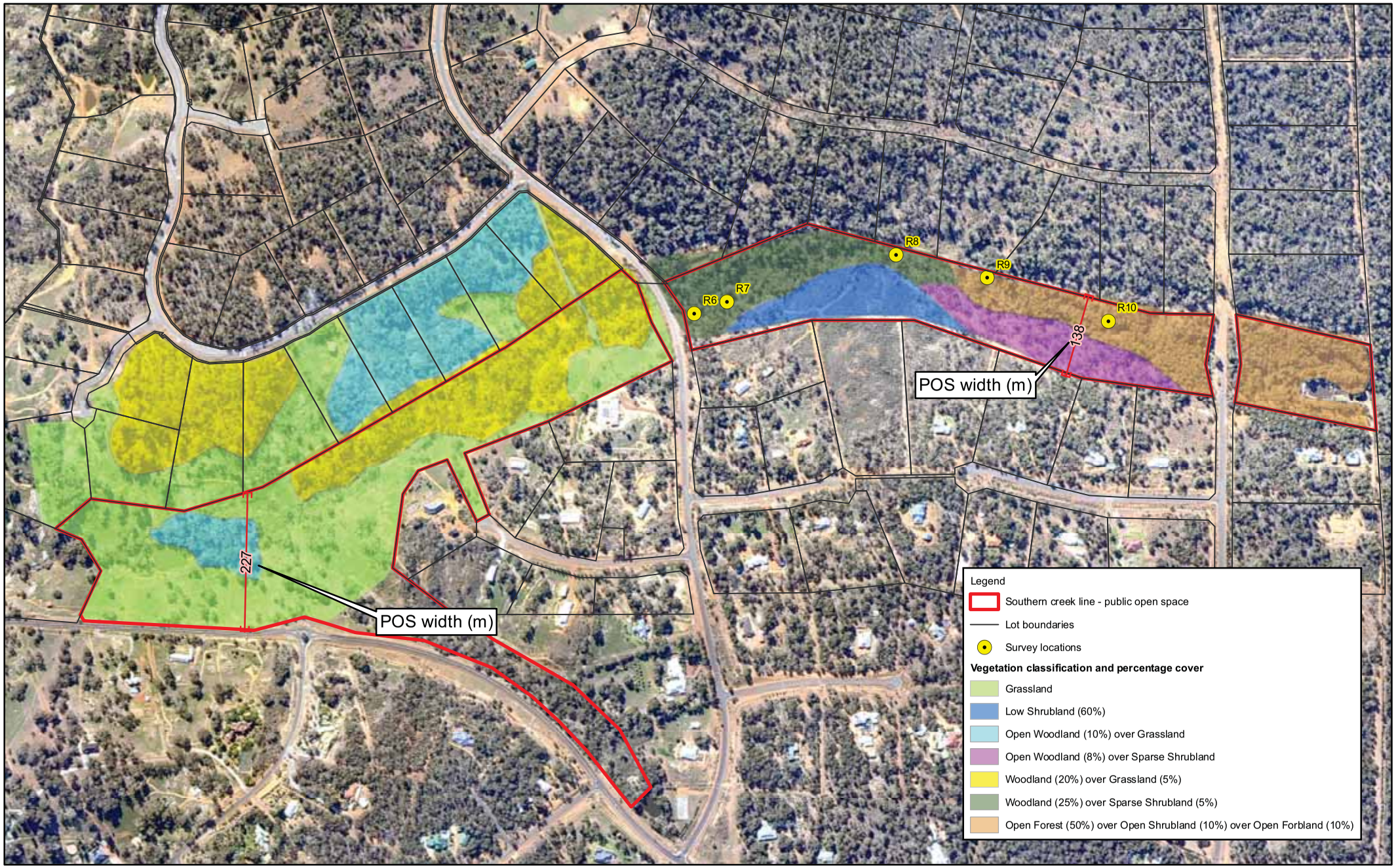

Figure 6: Southern Public Open Space Vegetation Classification

Project:	Avon Ridge Estate RFMP Addendum
Client:	Peet Limited

Plan Number: EP13-041(04)--F14			
Drawn:	GRO	Date:	09/07/14
Approved:	CKK	Date:	29/07/14
Checked:	SKP	Scale:	1:8,000@A4

0 75 150 300 Metres

emerge ASSOCIATES Integrated Science & Design

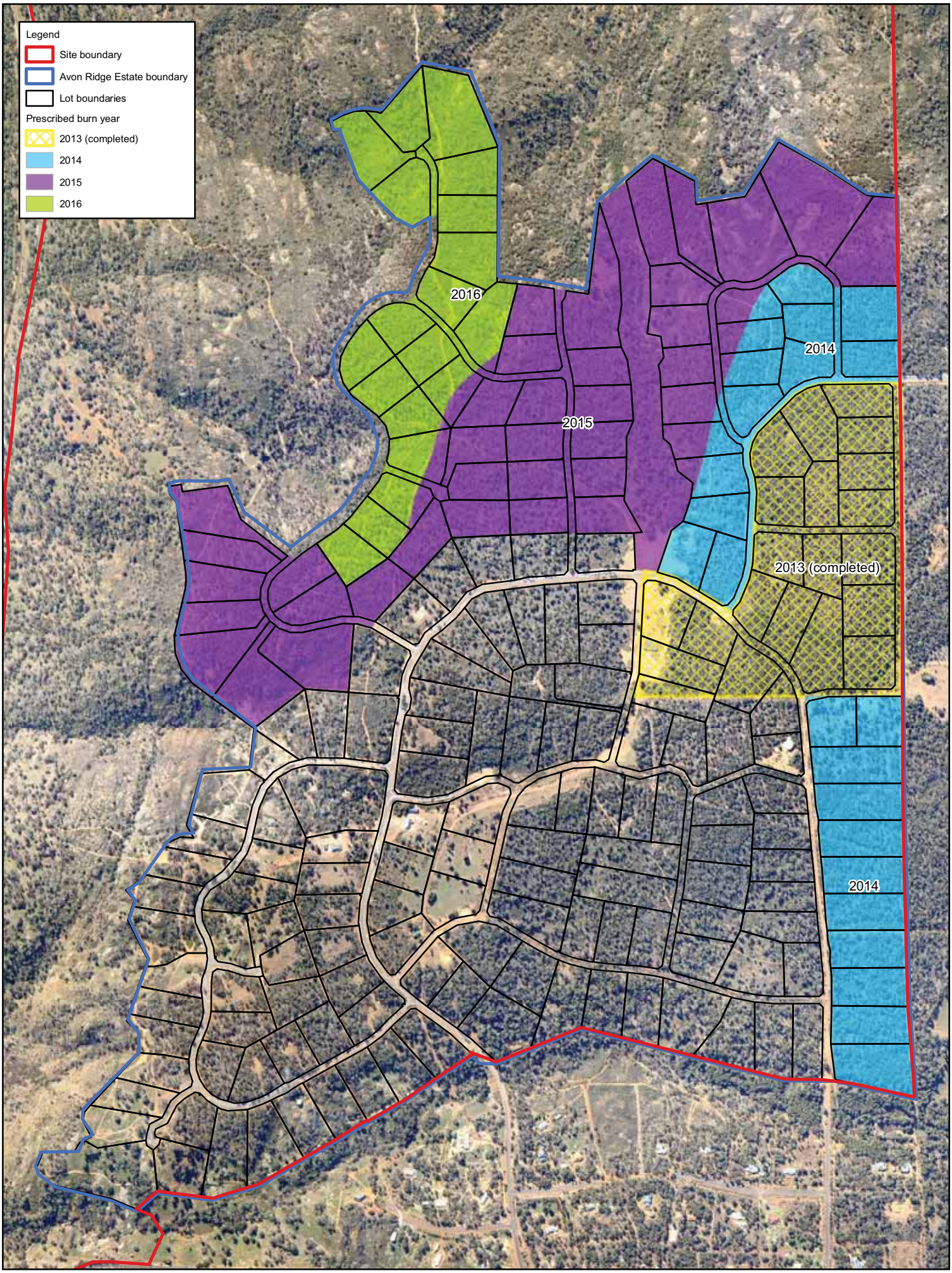

Figure 7: Prescribed Burn Plan

Project: Avon Ridge Estate RFMP Addendum

Client: Peet Limited

Plan Number: EP13-041(04)--F04a

Drawn:	GRO	Date:	12/12/13
Approved:	CKK	Date:	22/01/14
Checked:	AT	Scale:	1:13,000@A4

0 125 250 500 Metres

emerge ASSOCIATES Integrated Science & Design

Figure 8: Indicative Building Protection and Hazard Separation Zones

Project: Avon Ridge Estate

Client: Peet Limited

Legend

- Indicative house
- Hazard Separation Zone
- Building Protection Zone
- Lot boundaries

Plan Number: EP13-041(04)--F16			
Drawn:	GRO	Date:	09/07/14
Approved:	CKK	Date:	29/07/14
Checked:	CKK	Scale:	1:8,000@A4

0 50 100 200 300 Metres

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Sources: The following datasets were used in the production of this map: Layer - CUSTODIAN (date)

APPENDIX A

REVEGETATION AND FIRE MANAGEMENT PLAN (REVISED 2012)

Cardno 2012

Avon Ridge Estate, Brigadoon
Revegetation and Fire Management Plan (Revised 2012)

V7068

Prepared for
Peet Pty Ltd

June 2012

Cardno
Shaping the Future

Document Information

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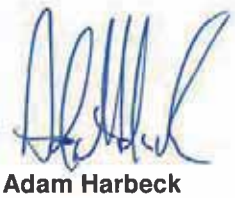
Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
1	28/06/2012	Adam William Harbeck	AWH	Barbara Pedersen	BP



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Executive Summary

Peet Limited (Peet) are proposing to develop the Avon Ridge Estate, Brigadoon (Lots 1010 and 1022 Campersic Road, Brigadoon) for special rural purposes, which will involve the creation of 214 special rural lots, plus an area of public open space and a creekline and wetland reserve. In order to reduce the potential impacts on the endangered Black Cockatoos which utilise the remnant vegetation onsite, and to reduce the risk of bush fire for future Avon Ridge Estate residents, Peet have prepared a comprehensive Revegetation and Fire Management Plan (RFMP) for the site. This plan is based largely on the "Fire Management Plan" prepared by an external bush fire planning consultant that has been a key consideration guiding the design and construction of Avon Ridge Estate.

The preparation of this RFMP has since become a Condition 29 of the approval under the *Environment and Biodiversity Protection Act 1999* (EPBC Approval No. 2008/4250) and Condition 29 of Western Australian Planning Commission (WAPC) Subdivision approval (WAPC 137383) and notification J on the Structure Plan (currently under consideration by the WAPC).

This document provides the overarching principles and objectives for revegetation and bush fire management within the Brigadoon Estate and these objectives are summarised below.

Revegetation and Bush Fire Management Objectives

Component	Sub-component	Objectives
Fire Management	Fuel Loading	Quantify the fuel loading over the site via a fuel assessment and use the results of this assessment to identify where hazard reduction burning is required.
	Hazard Reduction Burning	Outline where hazard reduction burning is required. Prescribe burn times for fuel reduction within identified areas. Outline the procedure to conduct a hazard reduction burn.
Revegetation	Parks and Recreation Reserve	Prescribe how and where seedlings will be planted within the Parks and Recreation Reserve.
Revegetation Management	Weed management	Outline how weeds will be managed throughout the revegetation program.
	Species selection	Confirm the species used for revegetation will provide enhanced foraging and potential breeding habitat for endangered Black Cockatoo species.
	Topsoil management	Outline how topsoil will be managed over the site during construction.
	Dieback management	Outline what dieback hygiene measures and dieback resistant species will be used as part of revegetation works.
	Planting	Clarify the timing for planting. Clarify the use of contractors.
	Fertiliser installation	Clarify the use of fertiliser.
	Pest control	Outline how pests will be controlled.
Maintenance, Monitoring and Management	Monitoring	Outline the overall monitoring and replacement program for the revegetation works.
	Completion criteria	Outline the completion criteria for the revegetation program.

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1 Introduction

1.1 Background

Peet Proprietary Limited (Peet) is developing a special rural development over Lots 1010 and 1022 Campersic Road, Brigadoon in Western Australia to be marketed as Avon Ridge Estate (**Figure 1**). This encompasses a total area of approximately 861 hectares which includes:

> a rural subdivision of 214 lots on 454 hectares (ha). Lots within the subdivision area range in size from 1.5 ha to 5.05 ha;
> a 406 ha area was ceded to the Crown in 2011 to preserve its landscape and ecological values. This Metropolitan Region Scheme (MRS) "Parks and Recreation Reserve" (P and R reserve) incorporates the Darling Scarp face down to the western boundary of the site and the steeper portions of the site to the north;
> an area of "Public Open Space" (POS) (1 ha) within the subdivision area; and
> a "Creekline and Wetland Conservation Area" (10 ha) within the subdivision area.

The site has been subjected to numerous degrading influences and land uses prior to purchase by Peet. These land uses include logging, grazing, gravel extraction and clearing for an airstrip. Consequently, the vegetation condition across the site is extremely variable and in some areas is completely cleared and degraded (**Figure 2** and **Figure 3).**

1.2 Purpose

Peet submitted a Referral of Proposed Action pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to the Department of Environment, Water, Heritage and the Arts (DEWHA), now the Department of the Sustainability, Environment, Water, Population and Communities (DSEWPaC) on the 5th of June 2008. The referral outlined how development of the special rural development on a portion of Lots 1010 and 1022 Campersic Road Brigadoon, Western Australia was proposed to be implemented to reduce threats to and protect Black Cockatoo habitat. On the 2nd of July 2008, the proposal was deemed a 'Controlled Action' by DEWHA due to potentially significant impacts on "listed threatened species and ecological communities", being:

> Carnaby's Black Cockatoo;
> Forest Red Tailed Black Cockatoo; and
> Baudin's Black Cockatoo.

As part of this process, Peet have formulated a comprehensive mitigation and offsets package to minimise impacts on the listed threatened species. A significant component of this mitigation and offsets package is the replacement of habitat for threatened Black Cockatoo species. This includes comprehensive revegetation over the site, with plant species that are suitable for use by Black Cockatoo species, for foraging, roosting and potentially breeding.

Peet received conditional consent for the proposed development on the 8th of October 2009 (EPBC 2008/4250). One of the conditions of the approval (Condition 3) was to prepare a "Revegetation and Fire Management Plan" to be approved by the Fire and Emergency Services Authority (FESA), prior to any clearing or construction on the site.

Specifically, Condition 3 states:

The person taking the action must prepare a Revegetation and Fire Management Plan that applies to the 100 ha within the Parks and Recreation Reserve and 450 ha for the subdivision (as identified at Attachment 5) including all 214 individual lots. The proponent must obtain written approval from FESA prior to

submission to the Department for approval. The person taking the action must not commence clearing or construction within the project until the Department has approved the Revegetation and Fire Management Plan in writing. Once approved this plan must be implemented.

The person taking the action must ensure that the Revegetation and Fire Management Plan includes (but is not restricted to):

a. Fuel reduction measures (including cool burn measures) specifying the timing and frequency of fuel reduction measures to minimise impacts on Black Cockatoo habitat.

b. Revegetation measures to create additional Black Cockatoo habitat across the project sites, including in the Parks and Recreation Reserve, specifically:

i) revegetation for all condition classes (excluding pristine and excellent classes) and vegetation complexes (including maps);

ii) mix, numbers and density of species to be planted;

iii) timing of proposed planting (must be during or following the annual winter rain period and generally between 1 June and 30 November);

iv) weed management measures;

v) the survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead trees must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;

vi) annual monitoring measures within the project area undertaken by an appropriately qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three years after the initial revegetation planting in any particular area (given that revegetation will be staged across the development);

vii) annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Park and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial revegetation planted in the Parks and Recreation Reserve for the purposes of establishing the survivorship rates and replanting efforts within the project area;

viii) mapping of all potential Black Cockatoo habitat trees of 500 mm dbh or greater on individual lots and information on how these will be retained for permanent conservation.

This Revegetation and Fire Management Plan (RFMP) provides the principles and methods to undertake the revegetation over the site, including details on species selection and planting densities for proposed revegetation works in order to satisfy this condition.

In addition to meeting the requirements of the EPBC approval, this RFMP also provides a mechanism to satisfy Structure Plan provision:

"a (sic) updated fire and revegetation management plan is to be prepared at the time of subdivision. This is to ensure that revegetation and fire management outcomes are consistent with the requirements of FESA, City of Swan, DEC, EPA and DEWHA";

And Condition 29 of the Western Australian Planning Commission (WAPC) 2010 Subdivision approval (WAPC 137383) for Lots 1010 and 1022 Campersic Road, Brigadoon.

"a Fire and Revegetation Management Plan is to be prepared and approved on the advice of the Fire and Emergency Services Authority (City of Swan)".

1.3 Management plans and the planning process

Avon Ridge Estate is currently being developed in accordance with the approved Structure Plan and Subdivision (137383) for the southern portion of Avon Ridge Estate, and the Structure Plan and Subdivision application currently being finalised for the northern area of the estate. The Structure Plans outline the intended pattern of development and land use within Avon Ridge, whilst the Subdivision plans demarcate proposed Lots and the internal road network and is consistent with the approved Structure Plan. The preparation of a RFMP for Avon Ridge Estate has been required by the WAPC via a notification on the Structure Plan and as a condition of Subdivision approval.

This 2012 revision of the RFMP has been prepared to reflect changes in the EPBC approval conditions and the revised burn prescription. As part of the adoption of the next Structure Plan and Subdivision Approvals for the estate, it is likely that the requirement for a RFMP will be included as a condition of WAPC and City of Swan (CoS) approvals.

The plan provides the overarching objectives and principles for the revegetation over the site, as well as details on the proposed revegetation programs to be undertaken and requirements for hazard reduction burning. This plan does not specify the location and density of revegetation plantings, which will vary according to specific site conditions within the broader revegetation area. Instead, an adaptive management approach to revegetation and fire management is being taken to maximise the effectiveness of management actions within the development area.

1.4 Objectives

The objectives of this revised RFMP are to ensure that:

> Foraging habitat for Black Cockatoo species is replaced through revegetation of flatter areas along the lower slopes of the P and R Reserve, such that the species do not significantly alter their use of the site and a net benefit for Black Cockatoo species is achieved;
> Revegetation within the P and R Reserve does not increase the bush fire risk and is consistent with the approved *Brigadoon Estate Fire Management Plan* (FirePlan WA 2009 [as revised]) (**Appendix A**) by maintaining a separation between restoration areas and private lots supported by strategic and in-lot firebreaks;
> Within the development area, the risk and severity of any potential wildfire is reduced within Lots by landowners undertaking mitigation works (such as vegetation modification and hazard reduction burning), in a manner that does not unnecessarily impact or reduce Black Cockatoo foraging habitat;
> Revegetation and fire management actions are undertaken in accordance with *Planning for Bush Fire Protection* Guidelines (WAPC and FESA, 2010) and the outcomes 2011 inquiry into the hill's fires which recommended more attention be paid to local authority and landowner responsibilities for risk management;
> A network of strategic firebreaks is established to minimise the requirements for in-lot firebreaks and protect native vegetation;
> Hazard reduction is undertaken is such a manner that significant vegetation within the estate is not adversely impacted; and
> Revegetation is undertaken within degraded portions on the lower slopes and flatter areas of the adjoining P and R Reserve.

2 Revegetation

The revegetation program is proposed to be undertaken at the site as required by EPBC Approval No. 2008/4250, to offset the native vegetation lost as a result of the development process. Revegetation works will consist of site preparation and the planting of 214,000 seedlings (1000 plants per created lot) within flatter, degraded areas of the P and R Reserve which adjoin the Railway Reserve. Additionally, there will also be revegetation carried out within road reserves and POS areas within the Avon Ridge Estate. These works will be guided by the Landscaping Plan for the development and will include a mixture of indigenous and non-local native ornamental plant species.

2.1 Revegetation areas

There are large areas of the 406 ha P and R Reserve which have been seriously degraded through previous land uses. Although the P and R Reserve has not been subject to a specific Flora and Vegetation Survey, Cardno ecologists have confirmed (based upon aerial photography and site visits) that there are large patches of “Completely Degraded” and “Degraded” areas, which would support revegetation. The broad scale vegetation condition mapping of the P and R Reserve is shown in **Figure 6**. Revegetation works commenced in 2011.

The revegetation works within the P and R Reserve are being targeted to those areas where the vegetation is degraded (i.e. with a vegetation condition of “Completely Degraded” or “Degraded” based on the Bush Forever Vegetation Condition Rating Scale (Government of Western Australia 2000) (**Plate 1**).

The proposed site selection area for revegetation over the Parks and Recreation Reserve has been shown on **Figure 7.** This Figure shows an area of approximately 188 hectares inside the P and R Reserve within which revegetation works will be undertaken. The delineation of a larger area provides flexibility to enable the revegetation to account for the site-specific conditions within the revegetation areas (**Section 3.1.1**). Adaptive management is being used to plan for future revegetation areas, with survivorship, species mix, types of planting locations and, vulnerability to grazing, potential for vandalism and site safety and accessibility guiding future activities.

Ongoing revegetation within the P and R Reserve will consist of infill planting within cleared and parkland cleared areas. This revegetation will occur in the flatter portions of the P and R Reserve, which are closer to the Avon River and several hundred metres from the boundary of the proposed development (**Figure 7**). The large area of completely cleared land at the northern end of the P and R Reserve was chosen as the site for initial revegetation works in 2011 The cleared valley slopes at the southernmost end of the reserve have also been identified as potential future planting locations.

Plate 1: 'Completely Degraded' or parkland cleared area within Parks and Recreation Reserve identified for revegetation works.

Fencing will be erected around revegetation areas to protect seedlings from grazing and trampling by kangaroos and feral animals as well as theft and vandalism by unauthorised off-road vehicles.

Given the minimum 100m separation between revegetation sites and building envelopes within lots and the location of the strategic firebreak, the revegetation will not compromise community safety and this is an overarching principle of the RFMP.

2.2 Management of existing vegetation

In addition to the management of revegetation, the management of remnant vegetation within Avon Ridge Estate will be strictly controlled through a Construction Environmental Management Plan for the construction stage of development. Restrictive Covenants will be used to control any clearing by future landowners.

In addition, all potential Black Cockatoo breeding trees of 500 mm Diameter Breast Height (DBH) or greater will be retained. These trees (*Eucalyptus marginata, E. wandoo* and *Corymbia callophylla*) have been mapped and marked with white (or pink) flagging tape to notify contractors and construction personnel that these trees cannot be cleared. The locations of these trees are listed in Appendix C. Under the Restrictive Covenants, landowners will not be able to clear vegetation other than what is required for dwellings, driveways, outbuildings and fire management. In addition, prior to any thinning or clearing of vegetation for fire management by purchasers, the bush fire planning consultant is required to undertake a pre-clearing and post-clearing inspection and complete a Fire Management Vegetation Monitoring form.

2.3 Dieback assessment and adaptation

Many of the plant species which provide foraging habitat for Black Cockatoo species are susceptible to infection by *Phytophthora cinnamomi.* The loss of foraging, breeding and roosting habitat by Phytophthora dieback has been identified as a primary threat to Black Cockatoos (*Environment Protection and Biodiversity Conservation Act 1999 Draft Referral Guidelines for Three Threatened Black Cockatoo Species: Carnaby's*

Cockatoo (Calyptorhynchus latirostris) (endangered), *Baudin's Cockatoo (Calyptorhynchus baudinii)* (vulnerable) and *Forest Red Tailed Black Cockatoo (Calyptorhynchus banksii naso)* (vulnerable) DSEWPAC, 2011). In June 2012, Cardno ecologists undertook a dieback assessment of Lots within the southern area adjoining the P and R Reserve to determine the presence and extent of Phytophthora dieback infestation to determine the risks to potential future areas of revegetation.

Infestation of Phytophthora into restoration areas has the potential to significantly reduce the success of revegetation works. As part of the adaptive management principles guiding this RFMP, if any area proposed for revegetation are determined to be infested with dieback or susceptible to Phytophthora infestation, the suite of species selected for revegetation will be chosen from lists of species known to show resistance to dieback infection. Cockatoo foraging or habitat species local to Brigadoon which are listed as being resistant to infection by *Phytophthora cinnamomi* dieback include:

> Golden Wattle (*Acacia saligna*);
> Marri (*Corymbia calophylla*);
> Flooded gum (*Eucalyptus rudis*);
> Wandoo (*Eucalyptus wandoo*);
> Honey Bush (*Hakea lissocarpha*); and
> Urchin Hakea (*Hakea petiolaris*).

The results of the 2012 dieback assessment revealed that dieback was not present within the area surveyed. However, the naturally occurring honey fungus (*Armillaria luteobubalina)* which affects the roots of eucalypt trees is suspected to be present. Correct hygiene practices for the prevention of dieback will assist in reducing the spread of this disease at Avon Ridge.

3 Revegetation Management

3.1 Weed management

The Brigadoon Vegetation Survey (Nicole Siemon and Associates, 2006) identified a number of weed species present within the subdivision area. The dominant weed species and their environmental weed potential are outlined in the **Table 1** below.

Table 1: : Dominant weed species and environmental weed potential (Nicole Siemon and Associates 2006)

Common name	Scientific Name	Environmental Weed Priority
Cape weed	*Arctotheca calendula*	Moderate
Pennyroyal	*Mentha pulegium*	Moderate
One-leaf cape tulip	*Moraea flaccida*	High
Guildford grass	*Romulea rosea*	High
Victorian coastal teatree	*Leptospermum laevigatum*	High
Wild Gladioli	*Gladiolus caryophyllaceus and G. undulatus*	Moderate
Paterson's curse	*Echium plantagineum*	High
Rose pelargonium	*Pelargonium capitatum*	High
Fennel	*Foeniculum vulgare*	Low
Flatweed	*Hypochaeris glabra*	Low
Annual ryegrass	*Lolium rigidum*	Moderate
Geraldton wax	*Chamaelaucium uncinatum*	Moderate
Rose flowering gum	*Eucalphtus leucoxylon rosea*	Low

Both Paterson's curse and One-leaf Cape Tulip are listed as Declared under the *Agriculture and Related Resources Protection Act 1976* as Priority 1 (P1) species. These species, as well as infestations of non-declared weeds such as stinkweed (*Dittrichia graveolens*) and wild olives (*Olea europeana*) will be controlled within restoration areas through the application of herbicides prior to planting and during the three year maintenance period.

During the revegetation program, weeds will be controlled by the revegetation contractor through the targeted application of glyphosate spray during autumn and/or spring (as required) for two years following planting to reduce competition for light, water and nutrients.

Herbicides such as Glyphosate and Fusillade ® will be used to control the majority of broadleaf and grassy weeds, while more resilient weeds such as Cape Tulip (*Moraea flaccida)* and Paterson's Curse (*Echium plantagineum)* would need to be controlled through the addition of stronger herbicides such as such as Metsulphuron or Chlorosulphuron to this mix. Glyphosate is generally applied at a rate of 1 - 2% with mixes of chlorosulphuron and metsulphuron added at a rate of 0.01 – 0.05ml/L. Fusillade ® would generally be applied at a rate of between 0.1 – 0.5ml/L (100 – 500ml/ha) but for hardier weed species such as Perennial Veldt grass (*Ehrharta calycina)* this rate would increase to approximately 8ml/L (4L/ha). All herbicide application mixes will include a wetting agent which will enhance the uptake of the chemical by breaking down any repellent waxy substances on the leaves of the target plants.

In larger completely cleared areas, weed control can be undertaken using machine operated spraying vehicles, however the majority of the spray application will be applied using backpacks or vehicle mounted retractable hoses. In areas with proposed planting densities lower that 3000 seedlings/ha, the application of

herbicides will be undertaken in a spot spraying method rather than a blanket application to control weeds in the specific area for seedling planting.

The revegetation contractor is required to provide the Material Safety Data Sheets for all chemicals brought onto the site to comply with occupational health and safety regulations.

3.2 Seed collection and species selection

3.2.1 Seed collection and seedling propagation

Where possible, seedling propagation for the revegetation program is undertaken using local provenance seed. Seedlings are propagated in 100mm growing tubes, which are suitable for establishing a seedling to a size capable of withstanding the pressures of initial establishment. All nurseries that supply tubestock for this project are required to hold a current accreditation under the Nursery Industry Accreditation Scheme Australia (NIASA).

The seedling requirements are determined well in advance of the revegetation season (seedling planting usually occurs between the months of May to July depending on rainfall) with orders being finalised in October to November the previous year. This allows adequate seedlings to be ordered for the proposed revegetation and for seedlings to establish to a size required for planting. Natural recruitment from the soil seed bank has also been encouraged through deep ripping and weed spraying, supplementing seedling planting.

3.2.2 Species

The species proposed for the revegetation across the Avon Ridge Estate site are species that are:

> Already present over the site and have been identified within the plant communities identified in the *Brigadoon Vegetation Survey* (Siemon and Associates) (**Figure 6**); or
> Species that are included within the regional vegetation complexes (Heddle *et al.* 1978) present over the site and would be expected to occur there prior to degrading land uses; and
> Recorded as providing foraging, roosting or breeding habitat for Black Cockatoos

The emphasis of revegetation works is on the augmentation of local Black Cockatoo foraging habitat. The bulk of the species to be planted as part of revegetation works shall be species that are known to provide foraging, roosting or nesting habitat for Black Cockatoo species. Consideration has also been given to the resistance of particular species to dieback, with a dieback resistant plant species utilised for revegetation in infested or suspected areas. The revegetation species are listed in **Table 2**, which also indicates the value of each of these species to the habitat of the Black Cockatoo species.

Table 2: Proposed revegetation species

Scientific Name	Common name	Form	Habitat for Black Cockatoo species		
			Nesting	Roosting	Feeding
Acacia lasiocarpa	Panjang	shrub 0.5 – 1.5 m			
Acacia saligna	Orange Wattle	shrub to 6m			X
Allocasuarina fraseriana	Sheoak	tree 5 to 15m			X
Allocasuarina humulis	Dwarf sheoak	shrub 1 to 4m			
Banksia armata	Prickly Dryandra	Shrub to 3m			X
Banksia grandis	Bull Banksia	tree 1.5 to 10m			X
Banksia ilicifolia	Holly-leaved Banksia	tree to 12 m			X
Banksia lindleyana	Porcupine Banksia	shrub 1 to 3m			
Banksia menziesii	Firewood Banksia	tree to 6m			X
Banksia nivea	Honeypot Banksia	groundcover to 0.2 m			X
Banksia prionotes	Acorn Banksia	Tree to 10m			X
Banksia sessilis	Parrotbush	Shrub to 3m			X
Banksia undata	Urchin Dryandra	Shrub to 3m			X
Callistemon phoeniceus	Lesser Bottlebrush /Toobada	Small tree to 6m			X
Calothamnus quadrifidus	One sided bottlebrush	shrub 1 to 4m			
Calothamnus hirsutus	Hawkeswood	shrub 0.3 – 1.5m			
Calytrix angulata	Yellow Star-Flower	shrub 0.2 – 1m			
Calytrix glutinosa		shrub to 1m			
Corymbia callophylla	Marri	tree to 40m	X	X	X
Daviesia decurrens	Prickly Bitter Pea	shrub to 1m			
Eucalyptus marginata	Jarrah	tree to 40m		X	X
Eucalyptus wandoo	Wandoo	tree 3 to 25m	X	X	X
Gastrolobium calycinum	York Road Poison	shrub to 1.5m			
Gastrolobium dilatatum		shrub to 1m			
Gompholobium tomentosum	Hairy Yellow Pea	shrub 0.3 to 1m			
Grevillea bipinnatifida	Fuchsia Grevillea	shrub 0.2 to 1m			X
Grevillea wilsonii	Native fuchsia	shrub 1 to 3m			
Hakea cyclocarpa	Curved Fruit Hakea	spindly shrub 1 to 2.5m			X
Hakea incrassata	Golf ball or Marble Hakea	spreading shrub to 1.5m			X
Hakea lissocarpha	Honeybush	shrub to 1.5m			X
Hakea prostrata	Harsh Hakea	Shrub to 3m			X

Scientific Name	Common name	Form	Habitat for Black Cockatoo species		
			Nesting	Roosting	Feeding
Hakea ruscifolia	Candle Hakea	shrub 1 to 3m			X
Hakea undulata	Wavy-leaved Hakea	shrub 1 to 2m			X
Hakea varia	Variable-leaved Hakea	Shrub to 2m			X
Hibbertia hypericoides	Yellow Buttercups	shrub to 1m			
Hibbertia subvaginata		shrub to 1.2m			
Hypocalymma angustifolium	White myrtle	shrub 1 to 3m			
Hypocalymma robustum	Swan River Myrtle	shrub 0.4 to 1m			
Kennedia coccinea	Coral vine	shrub to 0.5m			
Kennedia prostrata	Scarlet Runner	shrub to 0.5m			
Lambertia multiflora	Many-flowered Honeysuckle	Shrub to 2.5m			X
Leucopogon propinquus		shrub 1 to 2m			
Leptospermum erubescens	Roadside teatree	shrub 1 to 3m			
Macrozamia riedlei	Zamia	tree 0.5 to 3m			
Persoonia longifolia	Snottygobble	tree 3 to 10m			X
Petrophile linearis	Pixie mops	shrub 1 to 3m			
Verticordia acerosa var acerosa	Yellow featherflower	shrub 0.2 – 1m			
Xanthorrhoea preissii	Grass Tree (Balga)	tree to 5m			X

The species list provided in **Table 2** is not exhaustive and other native species found within the site may be used for revegetation. It is important to note that there are a variety of plant forms proposed to be included within the revegetation species mix (i.e. the species are not all trees) and these species are of varying sizes (and canopy densities) at maturity.

In view of the largely parkland cleared nature of the site, the majority of the species proposed for use as part of revegetation works are proteaceous shrub or understorey species which have been lost through degrading processes (clearing, grazing by livestock).

3.3 Dieback management

During initial flora surveys it was recognised that dieback was present within the site. A dieback survey was undertaken by Cardno ecologists in June 2012 to guide revegetation activities within the P and R Reserve. Dieback has been mapped in numerous locations within the South West region and similar vegetation community types. Therefore the potential for this pathogen to be spread during the revegetation is being given consideration during planning for future revegetation.

As a precautionary approach, general dieback hygiene measures are being employed over the site during the revegetation phase, to ensure that any potential spread of dieback is minimised. This includes:

> A requirement that vehicles, tools equipment and machinery be free of mud and soil on entry into and exit from areas of bushland;
> Ensuring that additional offsite soil, gravel or sand required for construction is free of Dieback (where possible) by selecting appropriate providers and discussing Dieback concerns with each provider;

> Topsoil stockpile areas should be located close to the topsoil removal areas as possible and should be located downhill from topsoil removal areas (to avoid moving dieback infested soil up hill);
> Minimise revegetation activity when soil is either wet or muddy;
> Avoid moving soil over ridges (where possible); and
> Ensure that vehicle tracks are well drained.

These recommendations are in accordance with the *Guide for landholders and community conservation groups for managing Phytophthora Dieback in Bushland* (Kilgour, 2009) an initiative of the Dieback Working Group, and the advice available from the Dieback Response Group.

3.4 Site preparation

In the large open pasture and parkland cleared areas, the soil is scarified or ploughed to increase rainfall infiltration and soil porosity as well as help in softening the soil for seedling planting (**Plate 2**). This is undertaken using either a bulldozer or grader during the summer months (when the soils are their driest) to enable the best fracturing of the soil.

In accordance with the *Aboriginal Heritage Act 1972 (WA)* Regulation 10 Consent granted on the 19th April, 2012 (DIA reference: 12/0377) for rehabilitation and restoration of bushland at Lots 1010 and 1022 Campersic Road, Brigadoon, Aboriginal monitors are required to be present on site during any ripping activities ripping or earth works within the P and R Reserve.

Plate 2: Ripping of open areas to facilitate revegetation.

3.5 Planting

3.5.1 Tubestock

Tubestock for the project are grown from local provenance seed (where possible) that has been collected from within 30 km of the site. Most seedlings are grown in 100 mm root training pots which provides a good growing medium and enable them to establish to a size required to be able to sustain the pressures of transplanting into bushland areas.

3.5.2 Seedling installation

The seedlings will be planted using a hand-held planting device and a fertiliser tablet will be placed with each seedling. These fertiliser tablets provide essential nutrients and trace elements to assist with establishment of the seedlings. The seedlings will be installed between the winter months of May through to July to take advantage of seasonal rainfall which aids establishment. Planting densities are determined by revegetation contractors based on existing canopy cover, site characteristics and tubestock species physiology.

As discussed in **Section 3.5** and **Section 4**, the revegetation contractors will be responsible for documenting the number, species and location of seedlings planted within the site.

3.5.3 Timing of revegetation works

The installation of seedlings is undertaken between the months of May through to July dependent on rainfall. The seedlings are ordered with nurseries in October to November in the year prior to planting to ensure there is enough time for these seedlings to grow to a sufficient size for planting.

3.5.4 Revegetation densities

All revegetation works carried out over the site are undertaken by revegetation contractors engaged by Peet, and have experience in the local area and with large scale revegetation projects.

The revegetation contractors are responsible for documenting the number, species and location of seedlings planted within the site. The revegetation contractors provide bi-monthly updates to Cardno about the revegetation program and the requirement for any additional management measures, such as weed control, fence repair or signage.

Although large areas of the P and R Reserve are degraded, there are still a number of large remnant trees present and therefore the proposed revegetation concentrates on replacing understorey species, such as groundcovers and shrubs which provide additional foraging habitat for black cockatoos. Planting densities are determined based on existing canopy cover and the physiology of tubestock species to be planted.

3.6 Pest control

Grazing and trampling by kangaroos, emus and introduced herbivores, such as deer, rabbits, horses and goats, can significantly impact the success of restoration activities. In order to eliminate the potential impact of these animals on restoration works, as well as the impacts of native grazers such as Western Grey Kangaroos, 1.8m ring-lock fencing with a rabbit-proof skirt is erected along the perimeter of restoration areas. This prevents access by grazers and illegal access by four wheel drive vehicles and dirt bikes.

In addition to this, Peet has engaged a pest controller to undertake the control of rabbits, goats and pigs within the estate as part of the implementation of a Pest Management Strategy for Avon Ridge. This pest control work will continue intermittently throughout the development period as and when required. This will help reduce the continued degradation or remnant vegetation through feral animal grazing.

3.6.1 Illegal access

Illegal access into the P and R Reserve by four wheel drives and dirt bikes is an ongoing issue at Avon Ridge and poses a serious risk to restoration activities. Vehicles gain access into the reserve by breaking through or knocking down the locked gates which permit access the strategic firebreaks by fire and emergency vehicles and revegetation contractors (**Figure 10**). Off-road vehicle use is not permitted within the Reserve, and the relevant authorities have been made aware of this activity.

4 Monitoring, Maintenance and Management

4.1 Monitoring

Monitoring of restoration activities within the P and R Reserve is undertaken by the revegetation subcontractor on a monthly and bi-annual basis. This comprises of monthly inspections to identify immediate factors affecting vegetation establishment, and bi-annual reports to demonstrate the success of the revegetation against the completion criteria specified by the EPBC approval conditions. This approach to monitoring supports the adaptive management of restoration, enabling potential issues to be identified and addressed early to reduce potential impacts on survivorship. The revegetation monitoring is based on transects, counting the number of seedlings surviving along the rip lines (**Plate 3**), and opportunistically identifying any potentially problematic weeds, pathogens or other problems affecting plant growth.

Plate 3: Planting within rip lines.

4.2 Monitoring objectives

In order to satisfy the EPBC approval conditions, the overall success of revegetation will be assessed on an annual basis for a period of three years after initial planting to ensure the required 90% survival rate. The first two years after revegetation are seen as the most critical as this is the period when vegetation is becoming established and is the most susceptible to death or failure. This monitoring takes place in the spring of each year. This enables the planning of maintenance works and the replacement of dead seedlings in the following autumn/winter. Dead plants will be replaced in order to achieve 90% tubestock survival after three years. Annual reporting to the DSEWPaC on the success of the revegetation program has commenced and

shall continue until the completion criteria have been met at the end of the monitoring and maintenance period.

In accordance with the Environmental Protection Authority (EPA) Guidance Statement No. 6 *Rehabilitation of Terrestrial Ecosystems* (2006) the revegetation program incorporates completion criteria to measure the success of the proposed revegetation. Specific targets (defined by measured outcomes or milestones) are required for monitoring and reporting of rehabilitation projects. Completion criteria must be sufficiently stringent to ensure that the overall objectives of rehabilitation have been met. These criteria must also be designed to allow effective reporting and auditing to define an endpoint for rehabilitation activities.

At the end of the three year maintenance period, the following completion criteria are required to be met:

> Survivorship rate must be at least 90% (nb: this is a condition of the EPBC Act approval);
> Plants are healthy in appearance and diverse in species with no mass losses;
> Species diversity is ≥65% (i.e. 65% of the species planted have survived);
> The average seedling height has increased between assessments; and
> Weed presence is minimal and not inhibiting native plant survival and growth.

These criteria are considered practical and realistic based on other rehabilitation works in the area and the seedling planting rates provided. These expectations are for a period of average weather conditions with no extreme events (including bush fire). Additionally, if dieback appears to impact on the survival of the revegetation species, changes may need to be made to the species list to accommodate a larger number of dieback resistant species. Revegetation monitoring will assist in the establishment of survivorship rates and replanting efforts required within the site. Where survival rates are not meeting the required targets, infill planting is taking place in order to achieve the required 90% survival.

A report will be compiled for the P and R Reserve revegetation works at the end of the monitoring and maintenance period which will state whether the project has met the completion criteria and, if not, what actions are proposed to rectify this**.**

4.3 Methods

All monitoring is being undertaken by an appropriately qualified and experienced ecologist familiar with the site and the species diversity of the revegetation.

Formal monitoring is conducted by traversing the rip lines in which the tubestock is installed and counting the number of alive and dead tubestock to enable an accurate assessment of survival rates. Every tenth rip line is assessed in this manner to ensure a minimum of 10% of the installed tubestock is monitored.

All monitored transects are photographed to provide a visual record of revegetation development, and other general information is recorded, including:

> Date;
> Quadrat number;
> GPS location;
> Surveyor initials; and
> General comments on weeds and pest attack.

Survival assessment within revegetation sites is conducted to enable comparison of revegetation success in differing landscape elements. This assessment involves a stem count of alive and dead tubestock until the number of living plants reached 2000. The results of this data are then used to determine the survival percentage for each area.

4.3.1 Seedling health ratings

Revegetation health is assessed on a 0 to 5 rating system, which categorises seedlings health based on several key factors. These include evidence of stress, weed impacts, natural growth rates and herbivorous damage. Seedling stress can be caused by a variety of factors, including drought, waterlogging, mineral deficiencies and disease. Evidence of stress includes yellowing of the leaves, loss of leaves and stunted growth. Vegetation health ratings allow the state of seedlings in the overall revegetation project to be quantitatively assessed, and serves to identify species or areas of poor performance. This will help inform species selection for future revegetation areas.

The health ratings of seedlings for the revegetation project are listed as follows:

0 – **Dead** (loss of all leaves from the seedling and dry woody stems);
1 – **Barely alive** (a very small amount of life only just visible on the steams and some leaves that are mostly discoloured);
2 – **Stressed** (some to many leaves that are yellow and discoloured with potential signs of pest attack);
3 – **Good** (plants are relatively healthy with no chlorosis, nutrient deficiency and limited evidence of pest attack);
4 – **Very good** (plant healthy with good growth and no pest attack); and
5 – **Excellent** (plant very healthy with lots of new growth and flowering and/or fruiting).

5 Fire Management

Fire management is required to protect people, property and native flora and fauna from the effects of uncontrolled bush fire. Within the Avon Ridge Estate, fire management actions will be balanced with the need to retain and protect native vegetation and undertake revegetation and restoration works within the P and R Reserve (**Figure 4, Figure 5 and Figure 6**). The preparation of a Fire Management Plan (FMP) was a requirement of the WAPC Structure Plan and Subdivision Approvals for the development of Avon ridge Estate. This RFMP serves to integrate the FMP prepared by FirePlan WA for the estate in accordance with the *Planning for Bush Fire Protection Guidelines* jointly produced by the WAPC and FESA, with the revegetation requirements required by DSEWPaC to offset the impacts of the development on Black Cockatoos, under EPBC approval No. 2008/4250.

The FMP (Appendix A), is being implemented across the site and all revegetation activities will be undertaken in accordance with this plan so as not to create an unacceptable fire risk. The aim of this FMP is to reduce the threat to residents and fire fighters in the event of bush fire within or near the site (FirePlan WA 2009). The FMP has been developed to incorporate the following fire management methods:

> Road systems (including the construction of a public road connection between the northern portion of the subdivision and O'Brien Road);
> Strategic and internal firebreak systems;
> Dwelling construction (all dwellings constructed within Avon Ridge Estate will be required to be designed and constructed to Australian Standard *AS3959, 2009 - Construction of buildings in bush fire prone areas.* Those abutting reserves shall be constructed to "Level 2", whilst all other dwellings shall be constructed to "level 1" or as determined in the standard);
> Building Protection Zones;
> Hazard Separation Zone;
> Hazard Reduction; and
> Driveways.

These fire management methods are discussed at length in the FMP included as Appendix A.

This section of the RFMP discusses the elements of the FMP which are relevant to vegetation retention and regeneration activities within the estate. These are Bush Fire Fuel Loading, Hazard Reduction Burning and Vegetation Modification.

5.1 Bush Fire Fuel Loading

Bush Fire Fuel loading is the amount of fuel present in any given area and is the material that is consumed in a fire. Within FESA's *Visual Fuel Load Guide* (2007), fuel load is expressed as the "dry weight of fine fuel (<10mm in diameter) per unit area – commonly expressed as tonnes per hectare". Respecting fire behaviour, this document states:

"Many factors influence fire behaviour but none is more significant than fuel. Fuel is the availability, size, arrangement, moisture content and type of flammable material available. Understanding the different aspects of fuels can help predict the likelihood of fire and how a fire will behave under certain conditions, which can in turn help manage the risks and assess the best fire suppression options. As fuel load increases the potential run (fire spread) and heat output (fire intensity) increases thus increasing the risk to life, property, the environment and fire fighter safety." (FESA Visual Fuel Load Guide 2007).

Fuel assessments include a measure of existing fuel and are measured in accordance with the *Forest Fire Behaviour Table of Western Australia* (Sneeuwjagt and Peet 1985) and the *National Fire Curriculum Learning Manual 3.17* (FESA and DEC, 2000). Existing fuel loads are measured by assessing litter depth and using the FESA *Visual Fuel Load Guide* (2007) to identify the vegetation structure/community present.

Fuel assessments have been made across different vegetation community types present with Avon Ridge Estate to calculate the fuel loading (total fuel - measured in tonnes per hectare). The results of the fuel assessments are provided in **Figure 8,** with fuel loadings ranging from 4 tonnes per hectare in grassland and heathland areas to 9 tonnes per hectare in more densely vegetated areas.

Managing and reducing fuel loads within Lots to reduce the severity of wild fires assists fire fighting crews to control fires and defend properties. Fuel management also reduces the impact a fire has on property and lives of the owners and surrounding neighbours. High fuel loads result in hotter, faster moving fires and crown fires (combustion of tree canopies) which have a more significant impact on native flora and fauna. Generally, a wildfire burning with an intensity of not more than 2000 kilowatts per metre can be extinguished by fire fighters using direct machine and water tanker attack. This fuel loading will be maintained throughout the site, in accordance with the approved FMP (**Appendix A**).

5.2 Hazard Reduction Burning

Hazard reduction burning is defined as the planned application of fire, under pre-determined environmental conditions and within defined geographical boundaries to achieve specific land management objectives. Hazard reduction (or prescribed burning) is one of the tools that can be used to help achieve fire management objectives (FESA and DEC 2000). All of Western Australia's primary fire suppression agencies use hazard reduction burning to achieve management objectives. These management objectives include:

> Protection of human life, private property and assets from the effects of wildfire;
> Environmental management (flora and fauna habitat);
> Regeneration of degraded sites; and
> Management of land (silviculture/forest revegetation).

It is proposed to undertake hazard reduction burning in across the northern and eastern sections of Avon Ridge Estate to reduce fuel loads prior to the sale of Lots. The approximate dates for this hazard reduction burning (based on the current staging plan) are shown in **Figure 9.** The hazard reduction burn boundaries within **Figure 9** are based on the constructed firebreaks (both in-lot and strategic) firebreaks and the boundary between the two subdivision applications.

The hazard reduction burning has been scheduled to provide new landowners with a block of land that has a reduced fuel loading and complies with the FMP at the time of sale.

Planning for the burning includes the preparation of a burning prescription including:

> fuel loadings;
> forecast weather conditions (taking into consideration smoke management);
> fire management resources;
> traffic control and access;
> notification of nearby landowners and residents; and
> a post burn review.

This burning prescription has been developed in consultation with the City of Swan. Experienced fire fighters and fire appliances will be used to carry out the hazard reduction burns. The preference would be that Bush Fire Brigades from the City of Swan are used; however this will depend on personnel and equipment availability. The Brigades will be coordinated by an experienced fire manager acting on behalf of Peet. Discussions with the DEC officers will be undertaken to ensure burn prescriptions for the site minimise impacts on Black Cockatoo habitat. An example FESA burn prescription has been provided as **Appendix B**. Additionally, smoke management guidelines are required be prepared and implemented.

Generally the objectives for a hazard reduction burn will be to reduce fuel loads by 60% over 80% across the burn area. The burn will be primarily confined to the understorey layer, with the intention to cause no more than 20% overstorey crown scorch. A hazard reduction burn will also encourage natural recruitment of native

plants and avoid any potential impacts caused by landowners undertaking cool burns in an ad-hoc manner in the first few years of being on their property which could potentially degrade remnant vegetation. Completing a hazard reduction burn prior to development will provide a high level of community protection as fuel loads will be significantly reduced prior to people living in the area.

Following development and sale of lots, fuel reduction management will need to be undertaken by the individual landowners in accordance with the FMP (**Appendix A**). The FMP will be supplied to all landowners and landowners will receive a notification on the title that the FMP must be adhered to and complied with.

Following Lot development, subsequent fuel reduction measures may include landowners undertaking their own hazard reduction burning. The need for and timing of any future fuel reduction burns will be based upon the rate of fuel accumulation which will differ across the site based on the type and density of vegetation. In accordance with the FMP, landowners will need to maintain their fuel loadings within Lots as follows (see also **Figure 11**):

> within the Building Protection Zone at 2 tonnes per hectare;
> within the Hazard Separation Zone at 4-6 tonnes per hectare; and
> beyond the Hazard Separation Zone at 6-8 tonnes per hectare.

Therefore, the frequency of fuel reduction measures will be based on the need to meet the fuel loading targets as outlined in the FMP, and given the variation in vegetation condition and density across the site, and the fact that different fuel reduction methods may be adopted, it is extremely unlikely that significant areas of the Avon Ridge Estate will be subjected to fuel reduction measures (including cool burns) in the same year. It is more likely that this will be undertaken across different years and with different temporal frequency to create an overall mosaic of fuel loads across the development.

With regards to the timing of prescribed burning, burning is prohibited during the Prohibited Burning Times, pursuant to the *Bush Fires Act 1954* (for 20012/2013 this is December 1st to March 31st inclusive) and also on days when the Fire Danger Index reaches 'Very High' to 'Catastrophic'. In addition, permits are required from the local Fire Control Officer for any burning between the Restricted Burning Time pursuant to the *Bush Fires Act 1954* (currently for 20012/2013 1st October to the 30th November and the 1st April to the 31st May inclusive). Therefore the timing for hazard reduction burning within the development site will need to comply with these requirements.

Additionally, landowners can reduce fuel loads through mechanical methods including:

> controlling environmental weeds;
> mowing or slashing of grass weeds;
> pruning of vegetation;
> raking and disposal of dead leaves and branches; and
> utilising green waste collection services.

Landowners will be required to reduce their fire hazards prior to the summer fire season and it is recommended that landowners undertake their fuel reduction in conjunction with the maintenance of firebreaks, which are required to be cleared under Section 33 of the *Bush Fires Act 1954* (for 20011/2012 from November 2nd until March 31st). Peet will provide purchasers of Lots with an information pack, including a copy of *"Survive: The Homeowners Bush Fire Survival Manual*" (FESA) and "*Prepare. Act. Survive: your guide to preparing for and surviving the bushfire season"* (FESA) as well as information on the various methods available to manage fuel loads across the site and the requirements and restrictions should hazard reduction burning be preferred.

The hazard reduction burns are planned over a number of years, to create a mosaic of differing fuel ages and loads. This is appropriate for biodiversity retention, as it allows fauna to disperse and maintains the diversity within the plant communities over the site. The creation of this mosaic of differing fuel ages and loads will also allow Black Cockatoo species to continue to use the site as the cool nature of the burns will

not affect the majority of the foraging species. Advice from the Western Australian Museum has noted that properly conducted hazard reduction burns have not reduced foraging habitat at Department of Defence training areas at Bindoon situated north of the site (Office of the Appeals Convenor 2008).

Where hazard reduction burning is unable to be performed prior to the creation of lots, alternative fire management measures to reduce fuel loading will be prescribed by the bush fire planning consultant prior to Lot development. These alternative fire management measures may include the clearing of accumulated woody debris, removal of leaf litter and dead plant material, the use of grass-selective herbicides or the slashing of parkland cleared areas. These fire management measures are described within the FMP provided as **Appendix A.**

5.2.1 Proposed Burning Times

FirePlan has prepared a schedule of proposed fuel control burns for the development area in liaison with FESA and the City of Swan. It is proposed that fuel control burns be undertaken in 3 stages, to reduce the direct impact on local fauna and minimise landscape impacts. The map indicating the location and timing of each burn is provided in **Figure 9**.

The lots along the eastern edge of the development area and those lots in the westernmost portion of the estate which abuts the P and R Reserve will be the first to be burnt in spring 2012, with the central area being burnt in spring 2013 and the remainder of the western portion being burnt in spring 2014. It is intended to commence edge burning within the 2012 burn area between 15th -28th August (weekends only) and the remainder of the burn on the 8th and 9th of September depending on weather conditions.

It was previously proposed that these burns be undertaken earlier in the development process (see previous version of RFMP dated 2010). However as a result of unfavourable weather conditions over 2009/2010 and 2011/2012 summers, these burns were cancelled. The delay in the undertaking of these burns will not impact the achievement of bush fire management objectives, as lots will not be released until such time as fuel loads have been suitably reduced through controlled burning or manual vegetation management.

5.3 Vegetation Modification

As part of private Lot development, landowners will be required to have their Lot assessed by a representative from FirePlan WA to determine what trees and vegetation are to be cleared or trimmed in order to meet the requirements of the Fire Management Plan, as well as which trees can be safely retained within the Building Protection Zone (BPZ) (**Plate 4, Figure 11**).

Plate 4: Identification of trees to be retained within HSZ as part of Lot development.

Landowners are permitted to clear vegetation (excluding identified habitat and significant trees identified for retention) within the prescribed Building Envelope to facilitate dwelling and outbuilding construction, as well as modify vegetation within the Building Protection Zone and Hazard Separation Zones in accordance with the FMP (See **Figure 10** and **Figure 11**).

Peet intends to provide a service to purchasers to have the Building Protection Zone and Hazard Separation zones within their Lot inspected by a qualified bushfire protection consultant (at Peet's cost) to ensure compliance prior to the commencement of any in Lot clearing .

6 Conclusion

This RFMP has been prepared in order to meet the conditions of approval under the EPBC Act (EPBC Approval 2008/4250) as well as the WAPC Structure planning requirements and Subdivision Conditions for the initial stages of the Avon Ridge Estate, Brigadoon development.

The objectives of revegetation and bush fire management actions at Avon Ridge are:

> Foraging habitat for Black Cockatoo species is replaced through revegetation, such that the species do not significantly alter their use of the site;
> Revegetation does not increase the bush fire risk and is consistent with the approved *Brigadoon Estate Fire Management Plan* (FirePlan WA, 2009 [as revised]) (**Appendix A**) by maintaining a separation between restoration areas and private lots;
> The impacts and severity of any wildfire in the subdivision area is reduced by undertaking mitigation works (such as vegetation modification and hazard reduction burning), in a manner that does not unnecessarily impact or reduce Black Cockatoo foraging habitat;
> Revegetation and fire management actions are undertaken in accordance with *Planning for Bush Fire Protection Guidelines* (WAPC and FESA, 2010) and the outcomes 2011 inquiry into the hill's fires which pertain to local authority and landowner responsibilities;
> A network of strategic firebreaks is established to minimise the requirements for in-lot firebreaks and protect native vegetation;
> Hazard reduction is undertaken is such a manner that significant vegetation within the estate is not adversely impacted; and
> Revegetation is undertaken within degraded portions of the adjoining P and R Reserve.

This plan outlines the actions which are being undertaken as part of revegetation and bush fire management activities at Avon Ridge to ensure that these objectives are achieved. Adaptive management processes are being used so that the methods, species planted and areas proposed for revegetation can be adjusted based on the outcomes of previous planting and monitoring, allowing continuous improvements to our understanding and management of the site.

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Avon Ridge Estate, Brigadoon

FIGURES

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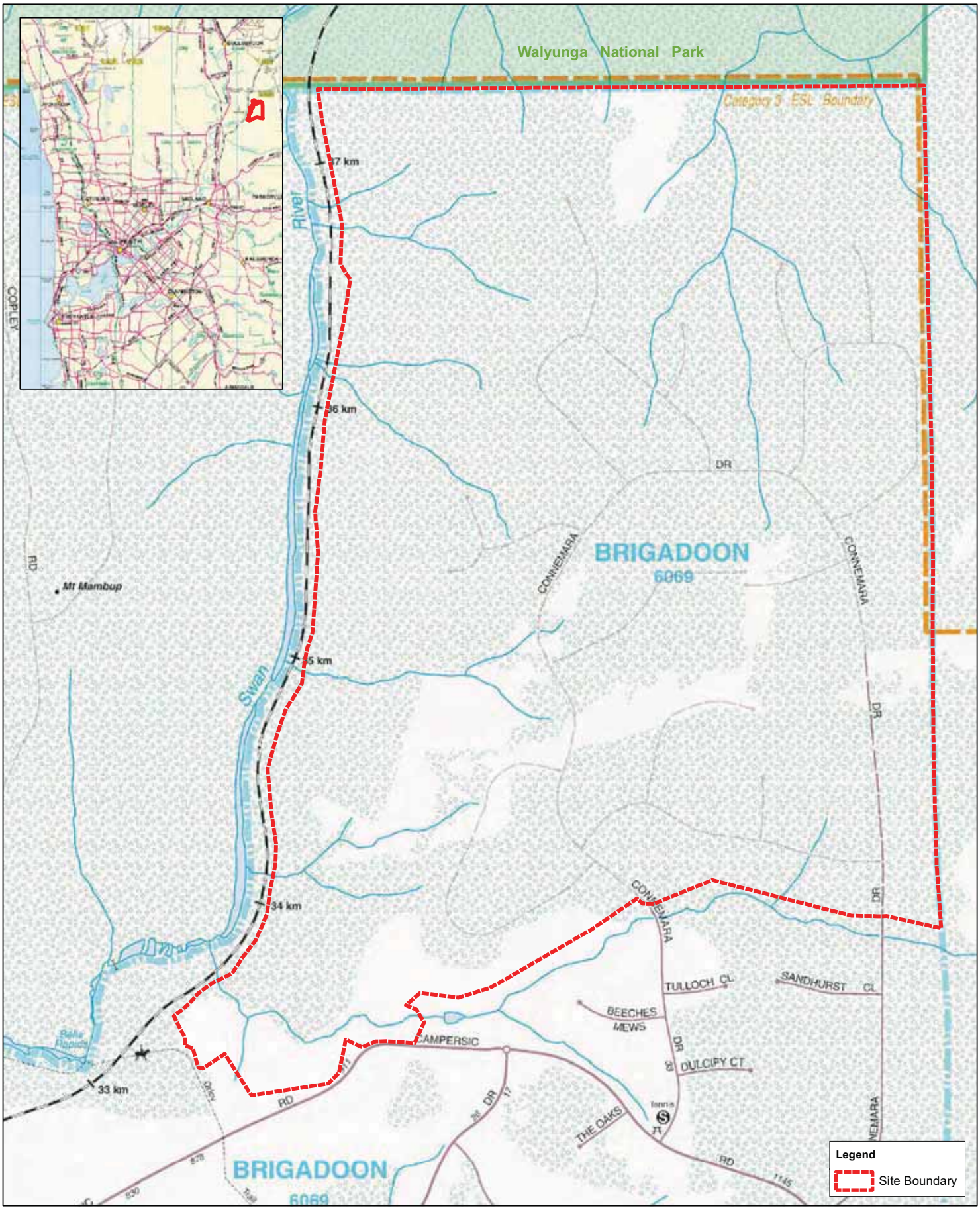
Shaping the Future



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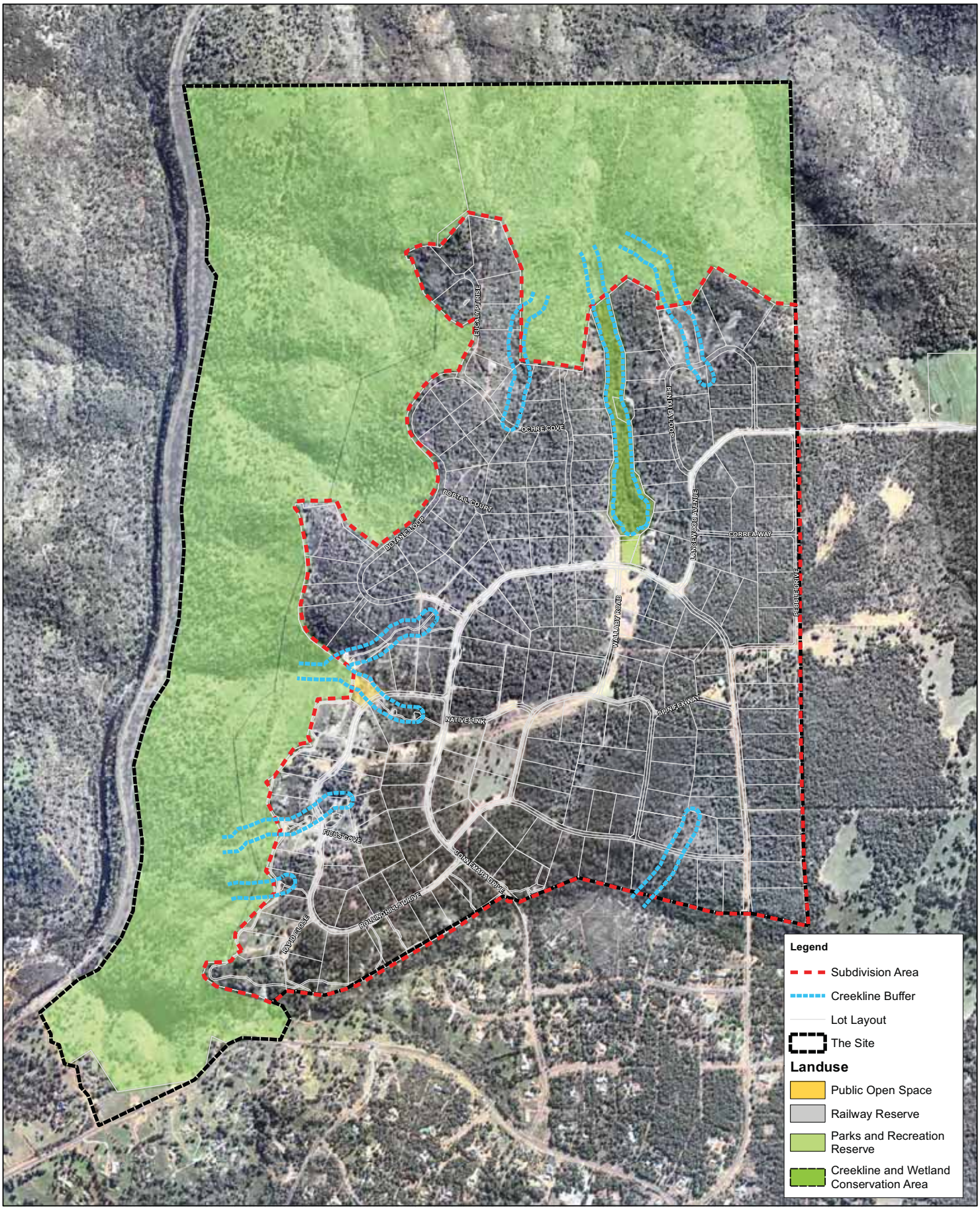
Scale: **1:14,000** 0 250 500 1,000 1,500 2,000 Metres

PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 1 : Locality Plan**

PRINCIPAL **PEET Limited**

Project Number **V7068_004**
Original **A3**
Drawing Number **SK01**
Revision **00**
Designed AH
Checked AH
Drawn ECF
Approved
Local Authority: City of Swan
Sheet 1 of 1
Date:24/07/2012



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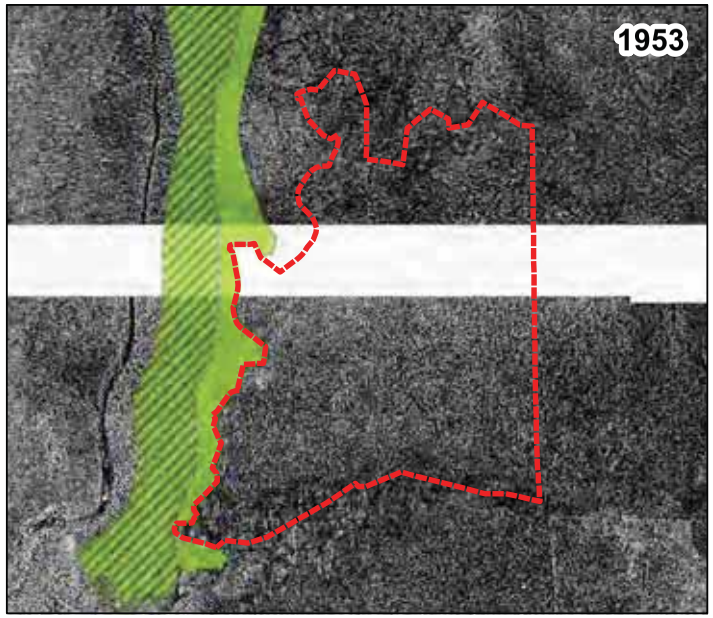
Scale: **1:14,000** 0 250 500 1,000 1,500 2,000 Metres

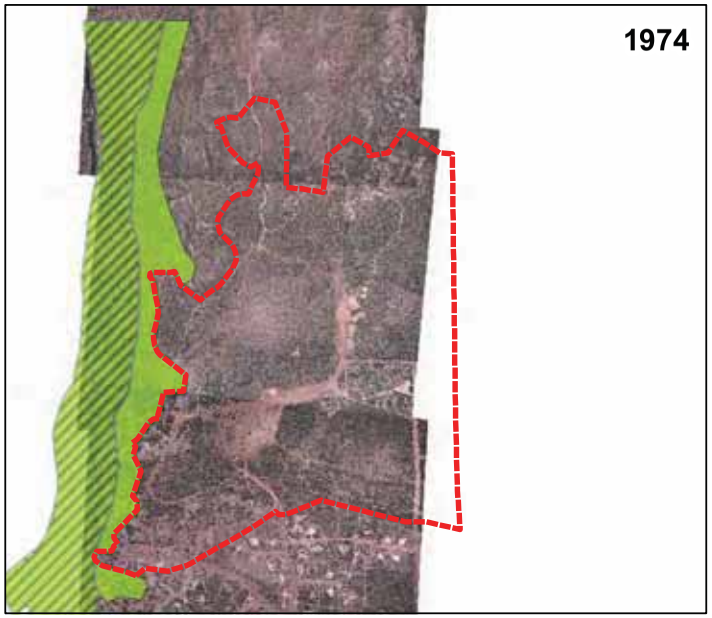
PROJECT **Avon Ridge Estate, Brigadoon**

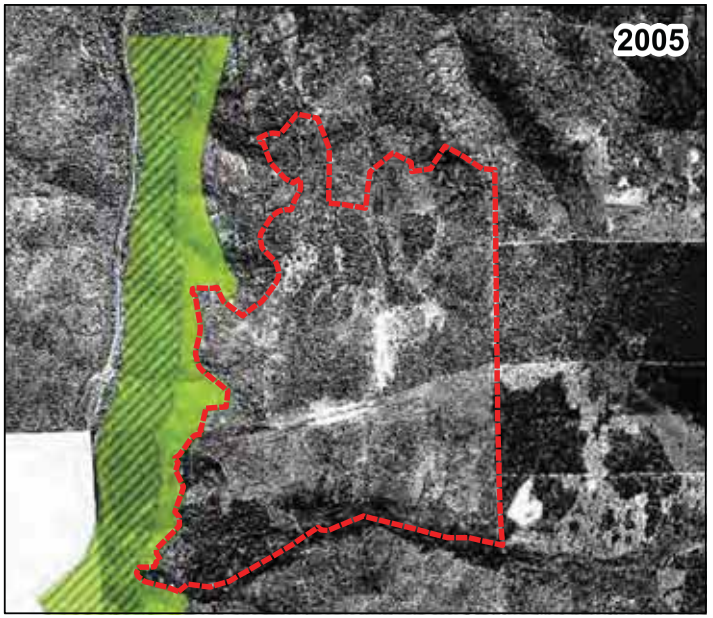
DRAWING TITLE **FIGURE 2 : Current Aerial 30th June 2012**

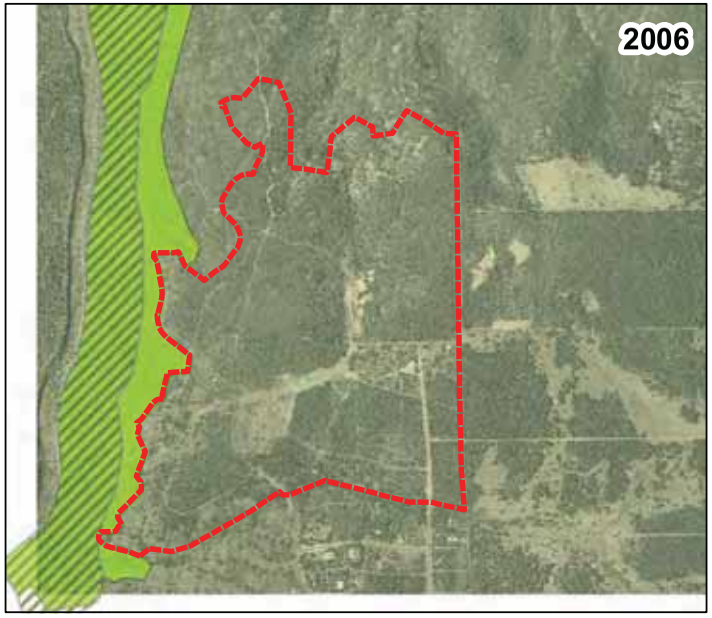
PRINCIPAL **PEET Limited**

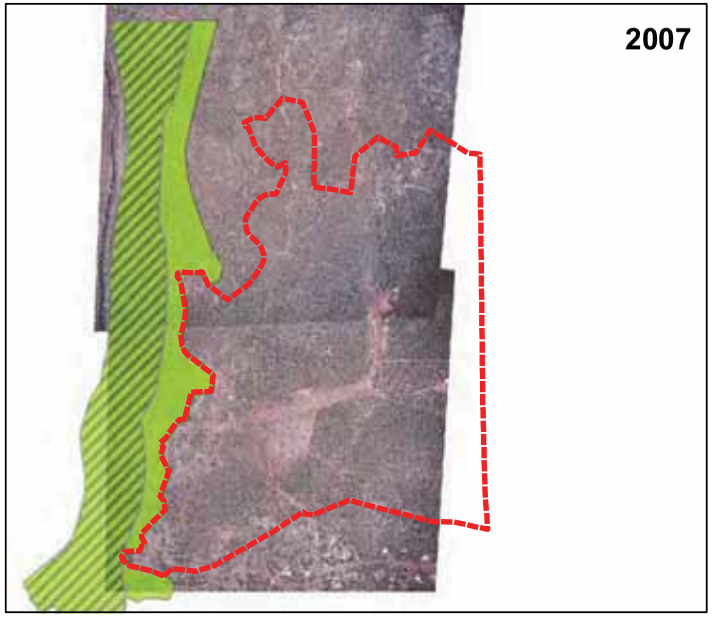
Project Number **V7068_004**
Original **A3**
Drawing Number **SK02**
Revision **00**
Designed AH
Checked AH
Drawn ECF
Approved
Local Authority City of Swan
Sheet 1 of 1
Date 24/07/2012

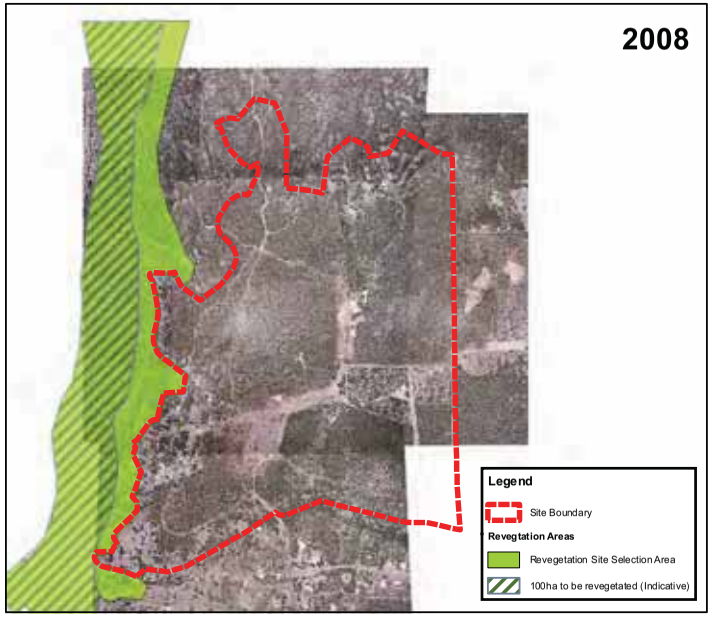












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PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 3 : Historic Aerial Photography**

PRINCIPAL **PEET Limited**

Scale: **1:35,000**

0 500 1,000 2,000 3,000 4,000 5,000 Metres

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Project Number	Drawing Number	Revision	Original
V7068_004	SK03	00	A3

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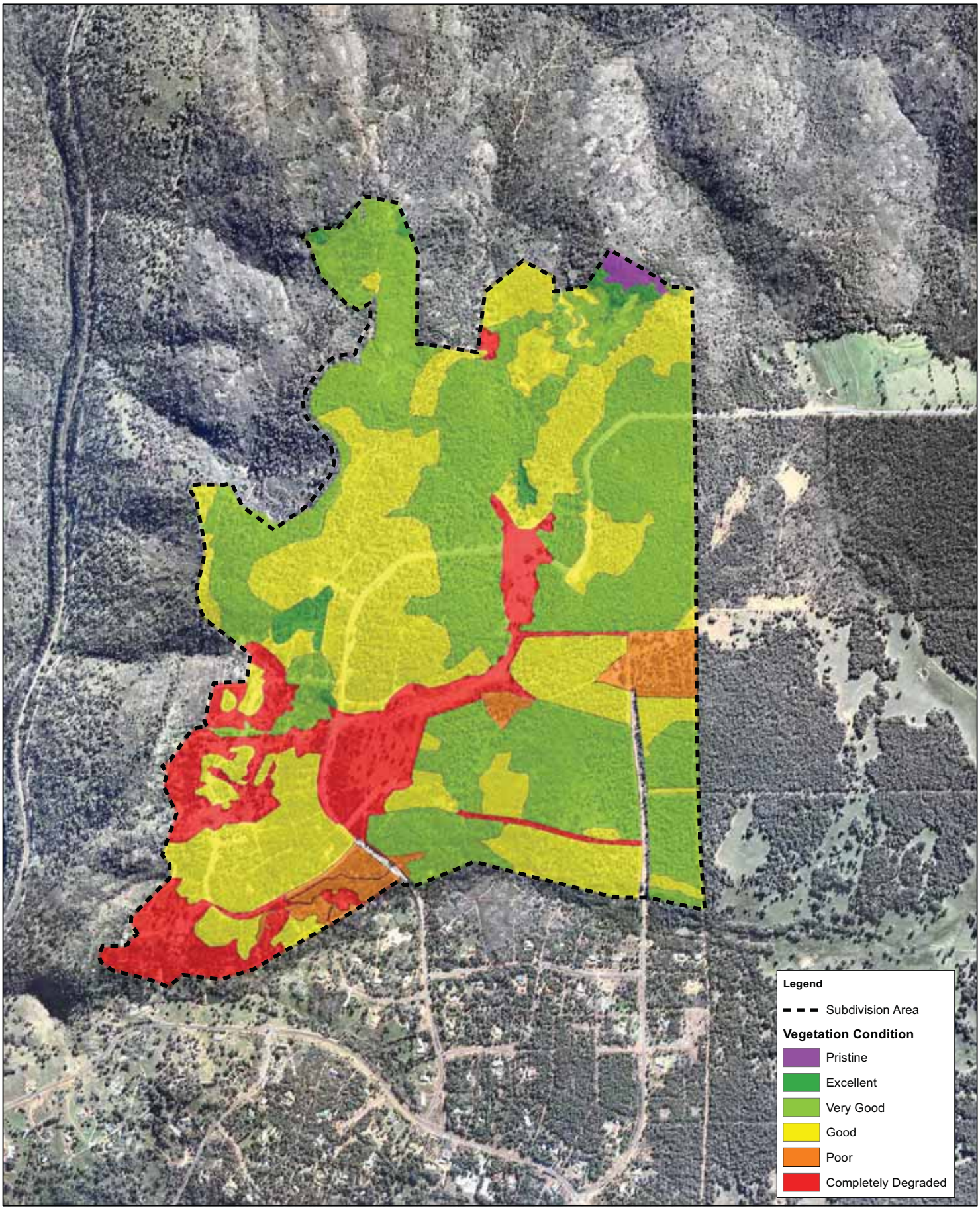

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PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 4 : Avon Ridge Estate Vegetation Condition**

PRINCIPAL **PEET Limited**

Project Number **V7068_004**
Original **A3**
Drawing Number **SK05**
Revision **00**
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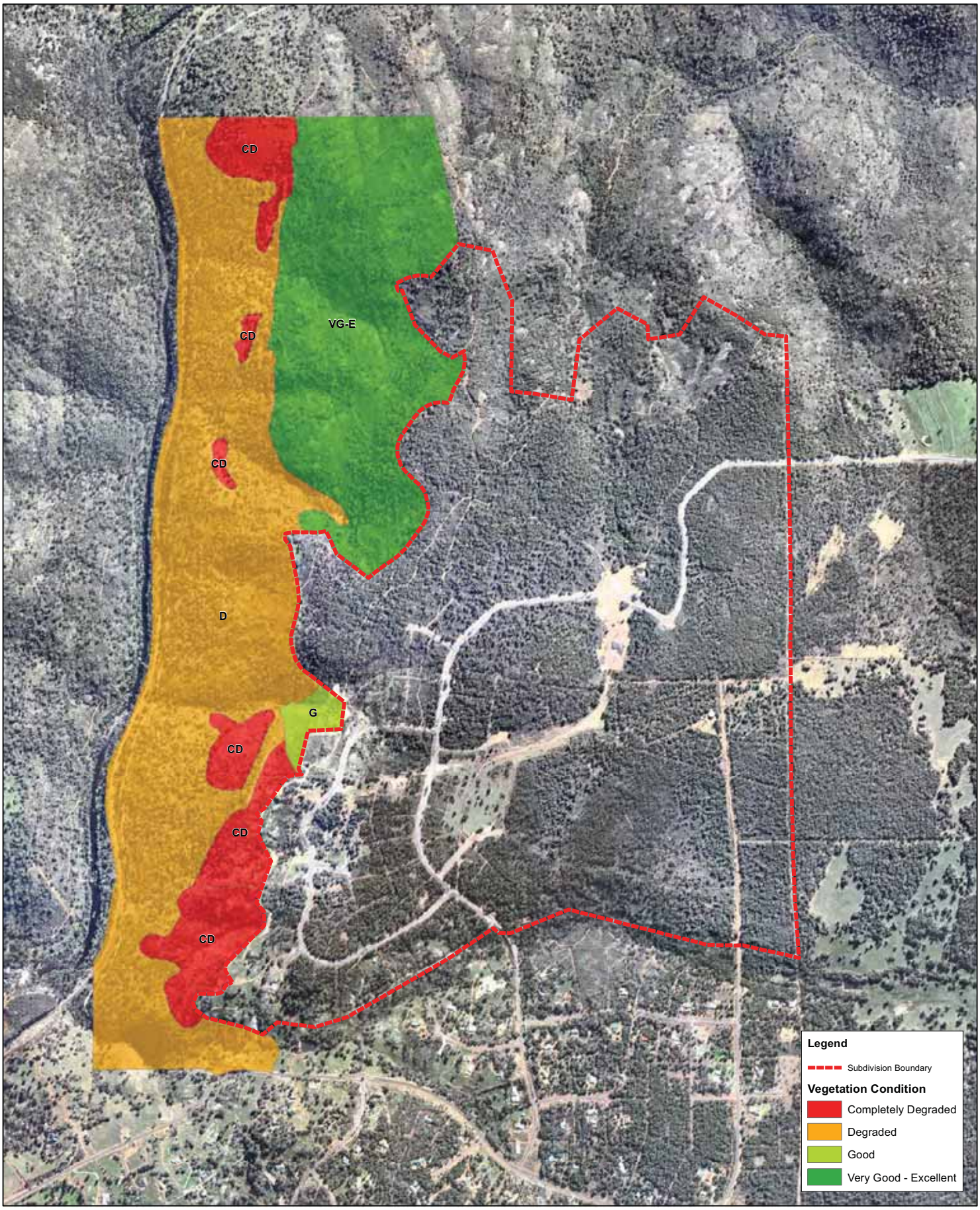
Date 24/07/2012



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PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 5 : Parks and Recreation Reserve Vegetation Condition**

PRINCIPAL **PEET Limited**

Project Number **V7068_004**

Original **A3**

Drawing Number **SK04**

Revision **00**

Designed AH

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Drawn ECF

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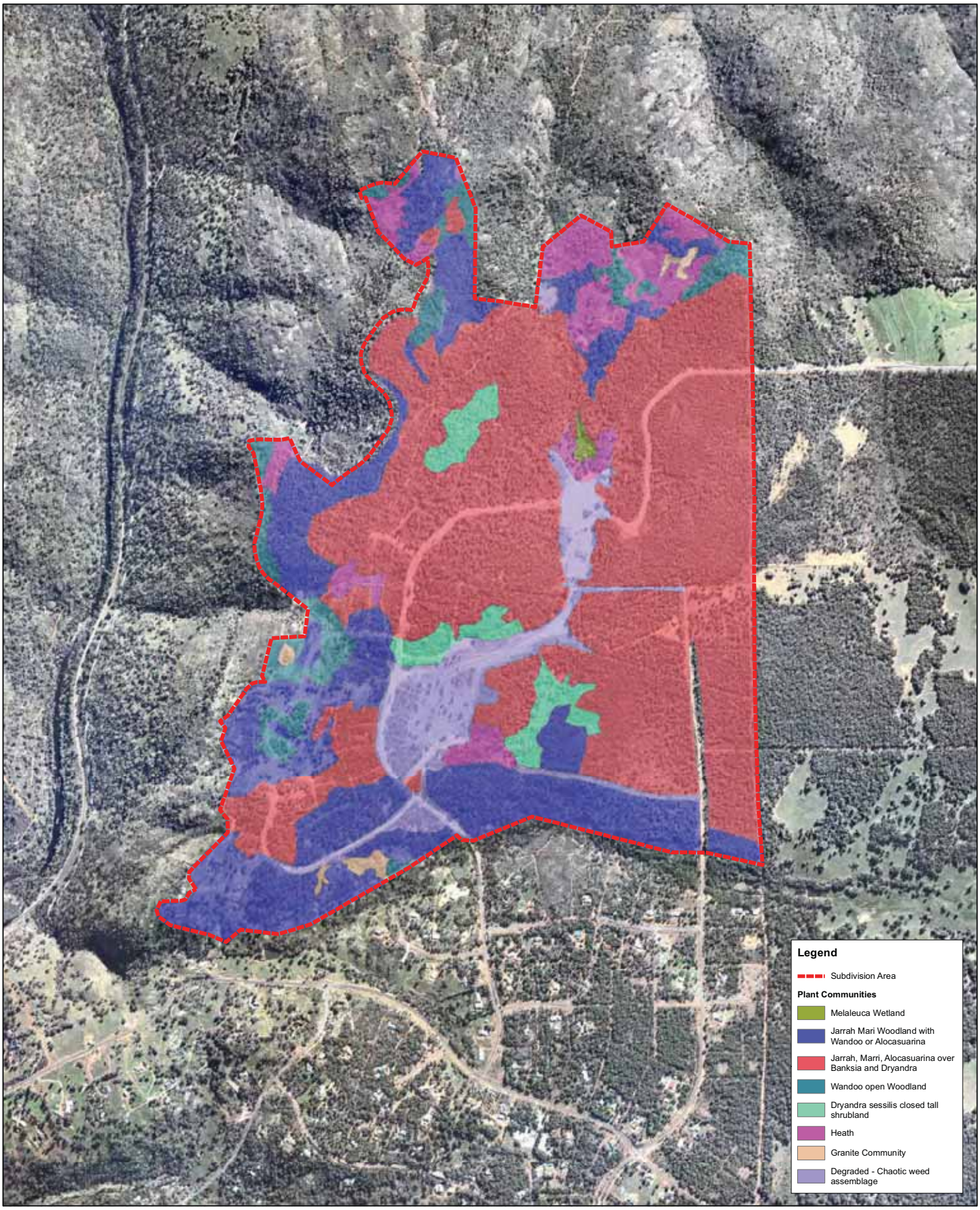

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PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 6 : Avon Ridge Estate Vegetation Communities**

PRINCIPAL **PEET Limited**

Project Number **V7068_004**
Original **A3**
Drawing Number **SK06**
Revision **00**
Designed AH
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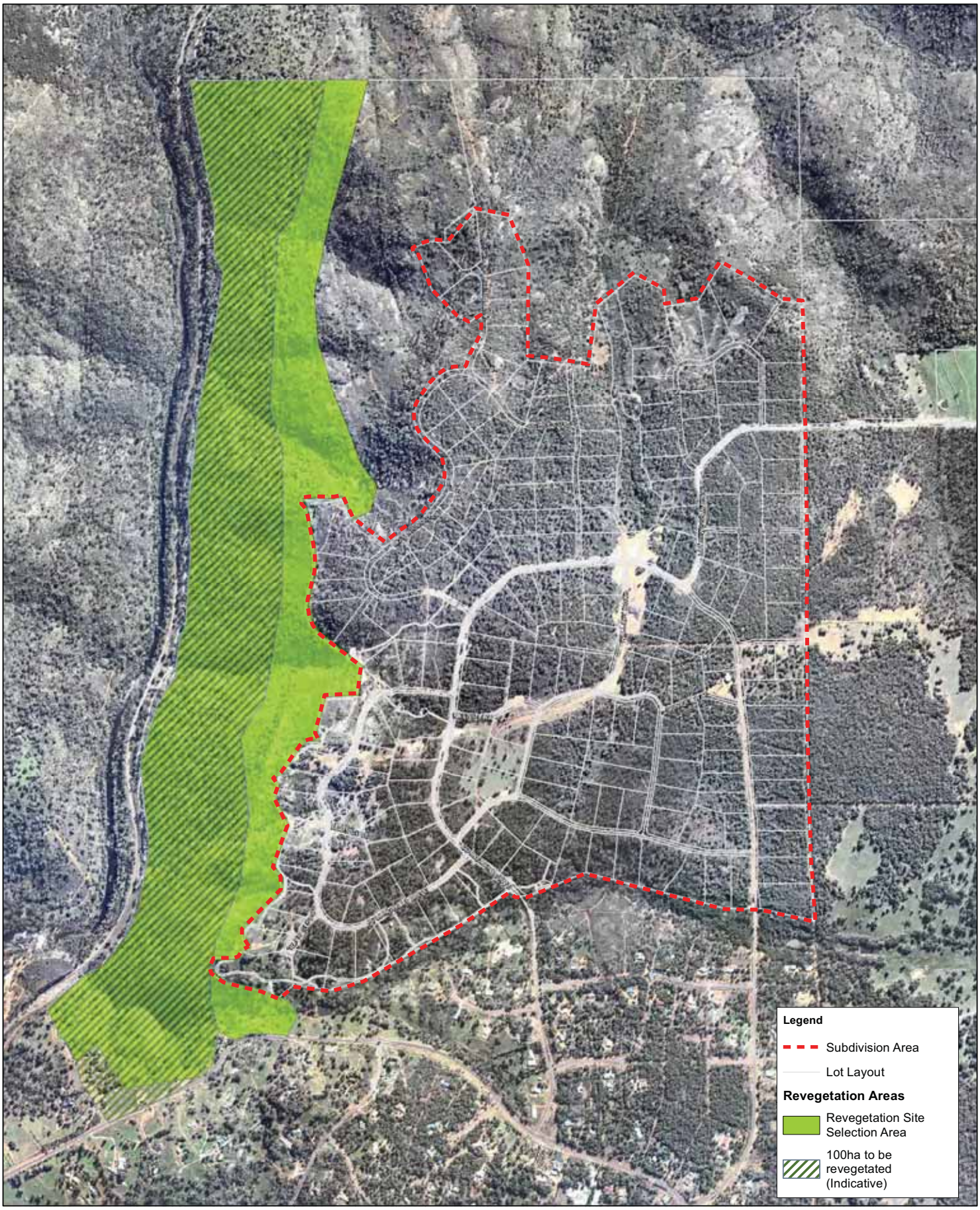
Local Authority City of Swan
Sheet 1 of 1
Date 24/07/2012



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PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 7 : Revegetation Areas**

PRINCIPAL **PEET Limited**

Project Number **V7068_004**
Original **A3**
Drawing Number **SK07**
Revision **00**
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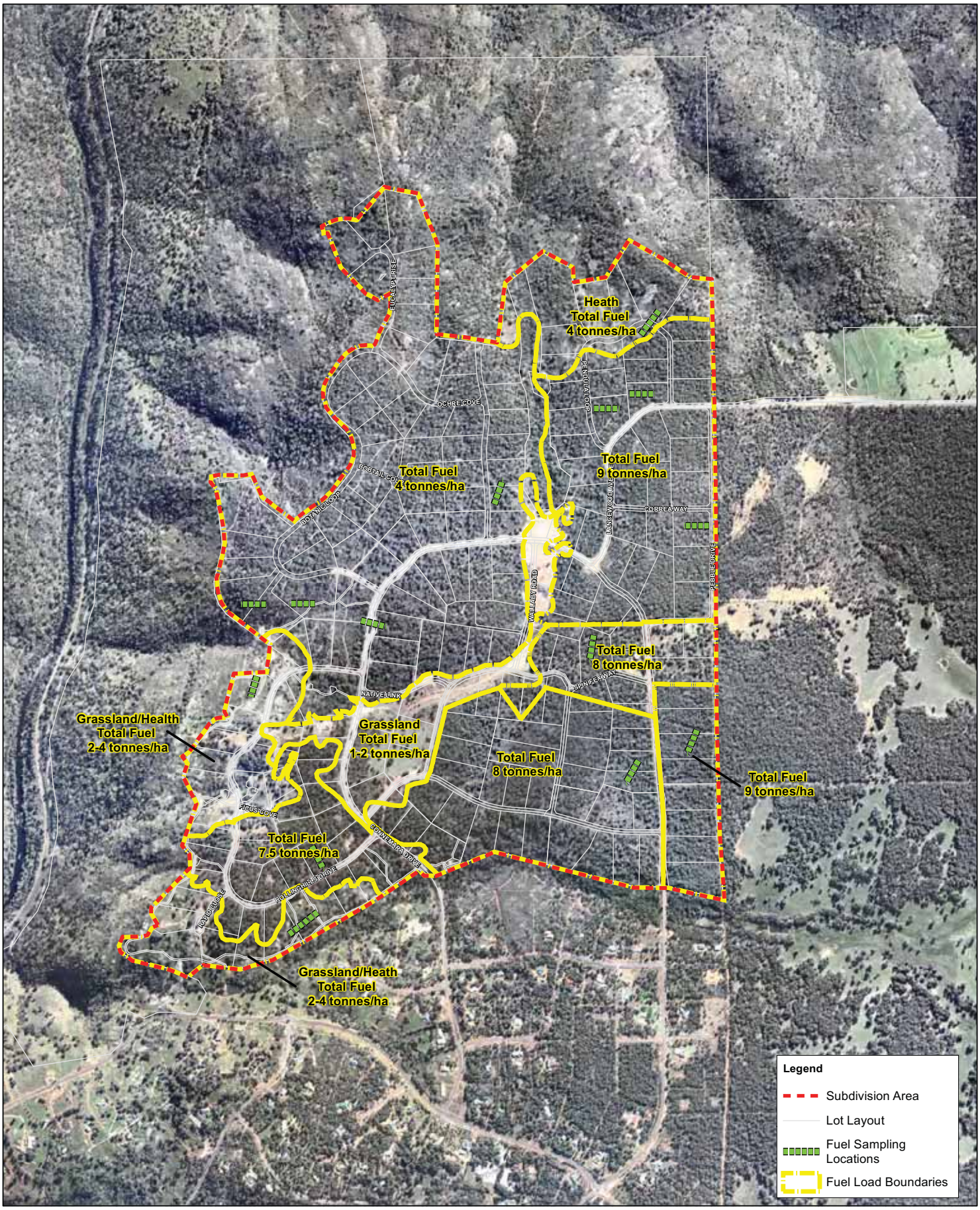

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PROJECT Avon Ridge Estate, Brigadoon

DRAWING TITLE FIGURE 8 : Avon Ridge Estate Bush Fire Fuel Loads

PRINCIPAL PEET Limited

Project Number V7068_004

Original A3

Drawing Number SK09

Revision 00

Designed AH Checked AH

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Local Authority City of Swan

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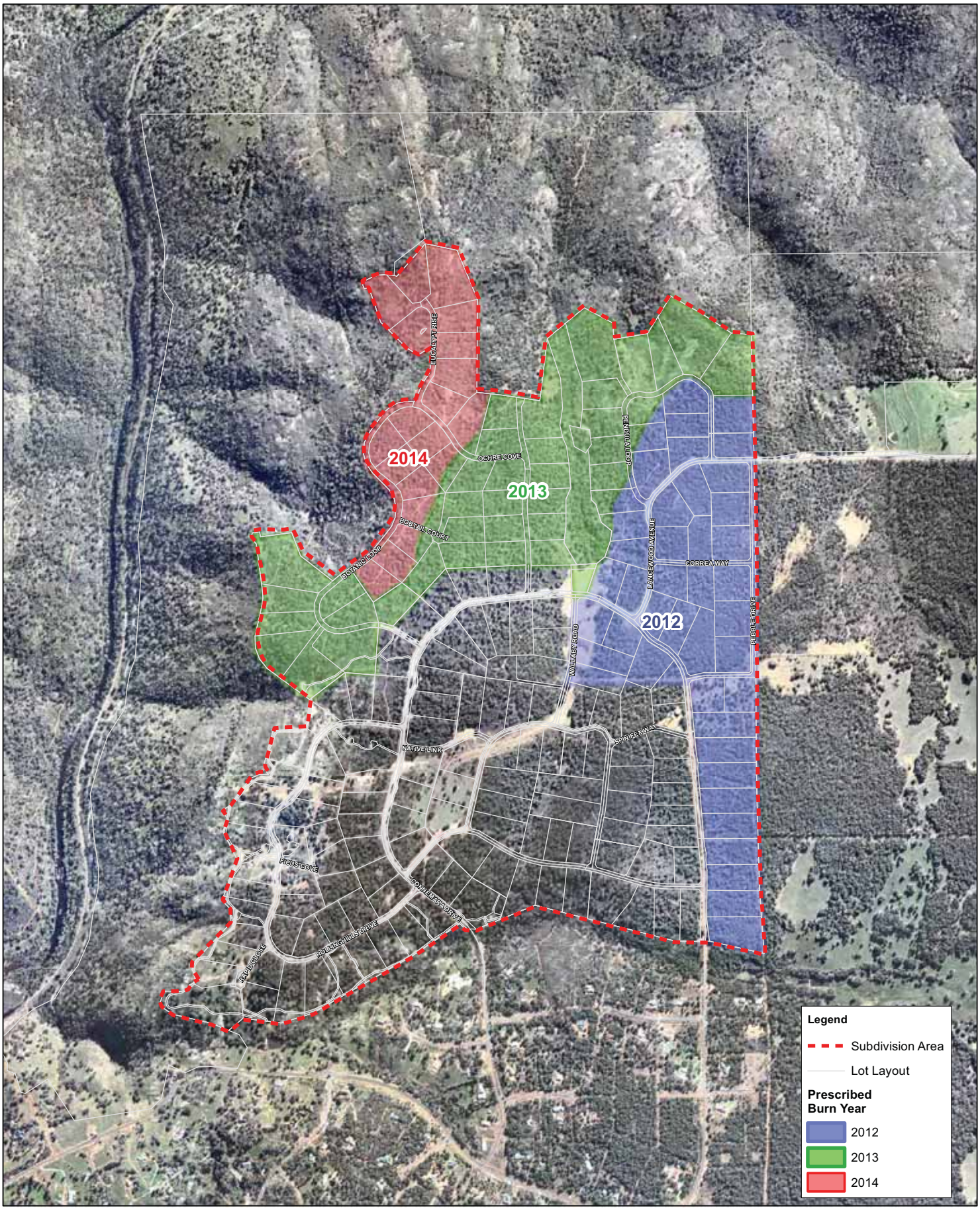

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Scale: 1:14,000

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PROJECT Avon Ridge Estate, Brigadoon

DRAWING TITLE FIGURE 9 : Prescribed Burn Plan

PRINCIPAL PEET Limited

Project Number V7068_004

Original A3

Drawing Number SK10

Revision 00

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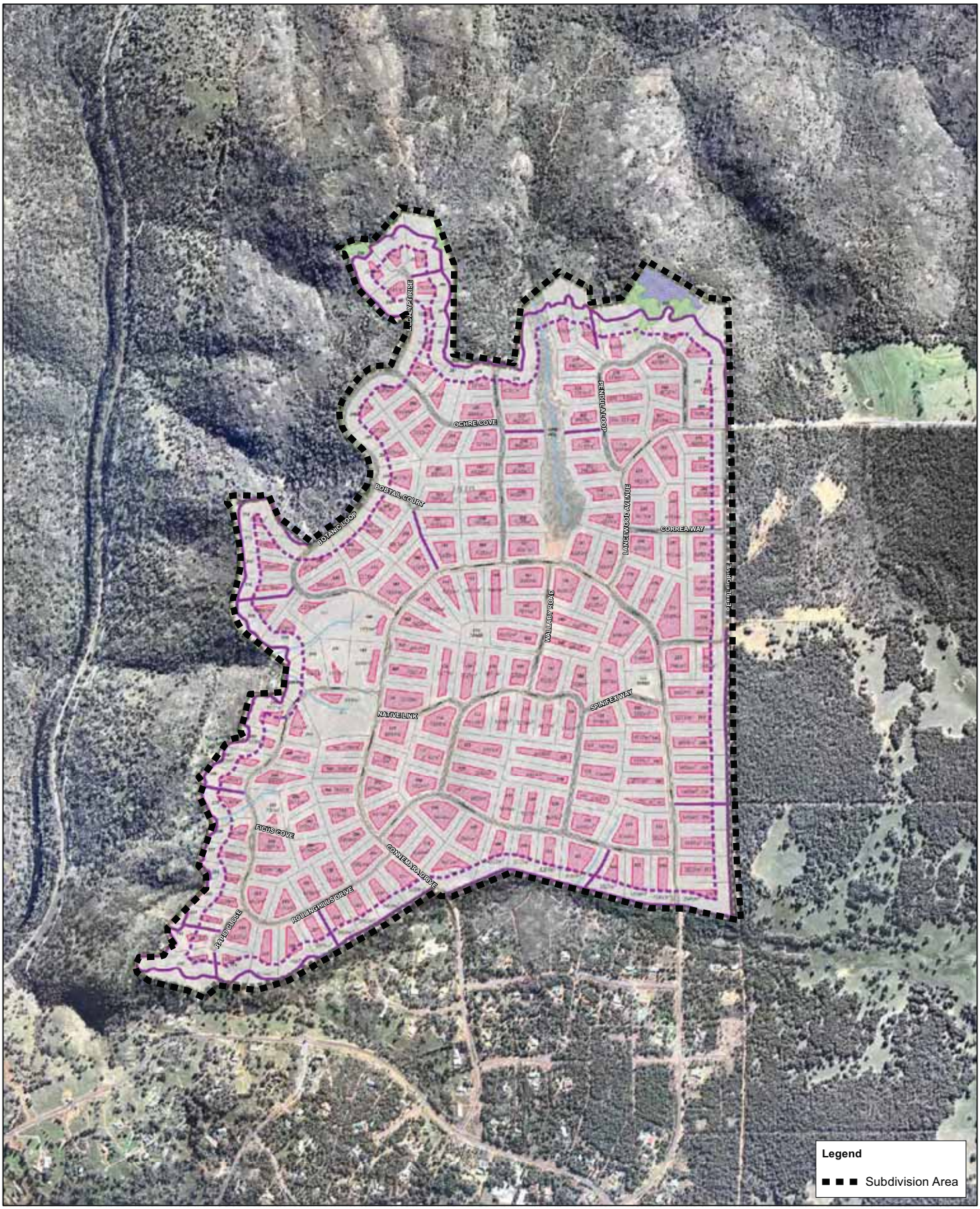

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PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 10 : Strategic Firebreak and Building Envelope Plan**

PRINCIPAL **PEET Limited**

Project Number **V7068_004**
Original **A3**
Drawing Number **SK12**
Revision **00**
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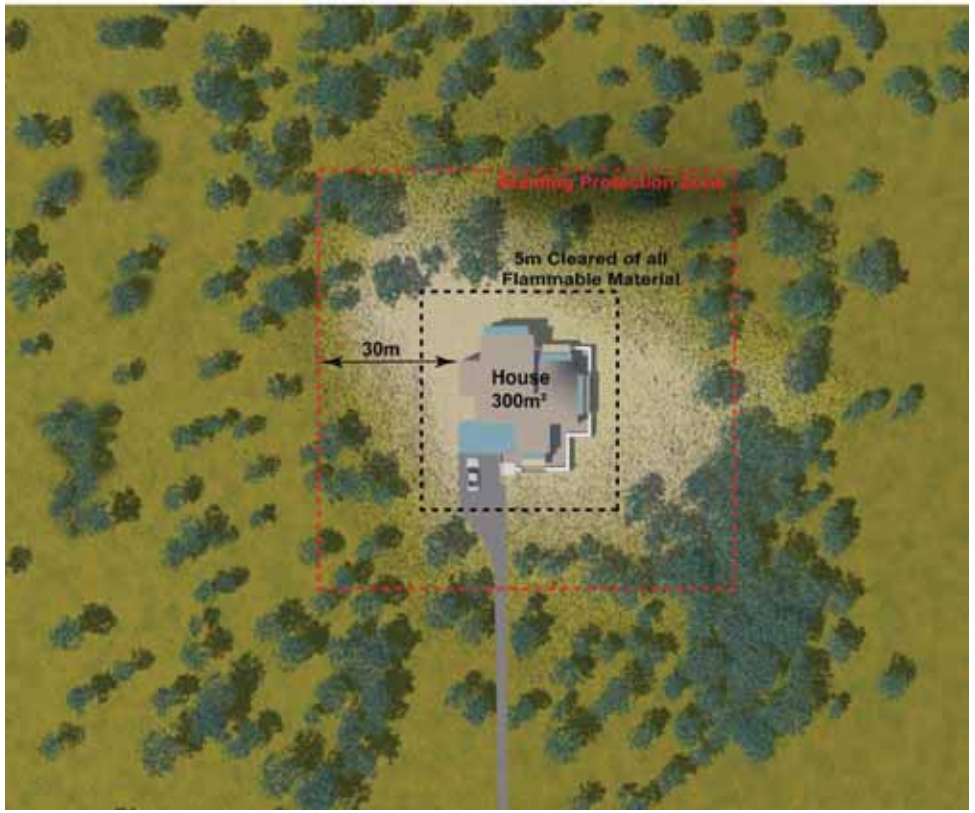

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DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

PROJECT **Avon Ridge Estate, Brigadoon**

DRAWING TITLE **FIGURE 11 : In-Lot Clearing for Fire Management**

PRINCIPAL **PEET Limited**

Scale: **NA**

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Project Number	Drawing Number	Revision	Original
V7068_004	SK011	00	A3

Designed AH | Checked AH | Date 24/07/2012
Drawn ECF | Approved
Local Authority City of Swan

Avon Ridge Estate, Brigadoon

APPENDIX A

BRIGADOON ESTATE FIRE MANAGEMENT PLAN.

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Shaping the Future

FIRE MANAGEMENT PLAN

Lot 1010 Brigadoon Estate

CITY OF SWAN

Prepared by: FirePlan WA

July 2009

Amended June 2011.

Amended August 2013

TABLE OF CONTENTS

1.0 PURPOSE OF THE MANAGEMENT PLAN

The purpose of this Bushfire Management Plan is to detail the Fire Management methods and requirements that will be implemented within the proposed subdivision. The aim of the Bushfire Management Plan is to reduce the threat to residents and fire fighters in the event of a fire within or near the subdivision.

2.0 SUBDIVISION LOCATION AND DETAILS

The subject land comprises Lot 1010 Brigadoon Estate and is located approximately 12 kms northeast of Midland (refer Diagram 1). It is proposed to subdivide the remaining portion of the Brigadoon estate into 214 Lots varying in size from 1.5ha to 5 ha.

3.0 SITE DETAILS

The proposed site is located in the plateau area of the remaining portion of the original Brigadoon estate. The land sloping to the north and west into Avon River is proposed to be handed over to the Western Australian Planning Commission as a Reserve.

The proposed development site is undulating with the eastern and northern edge roughly following the 225 metre AHD contour rising to 290 metre AHD along the eastern boundary.

In the south the site adjoins the previously developed portion of the Brigadoon Estate. Along the eastern boundary is cleared and partly cleared land used for stock grazing.

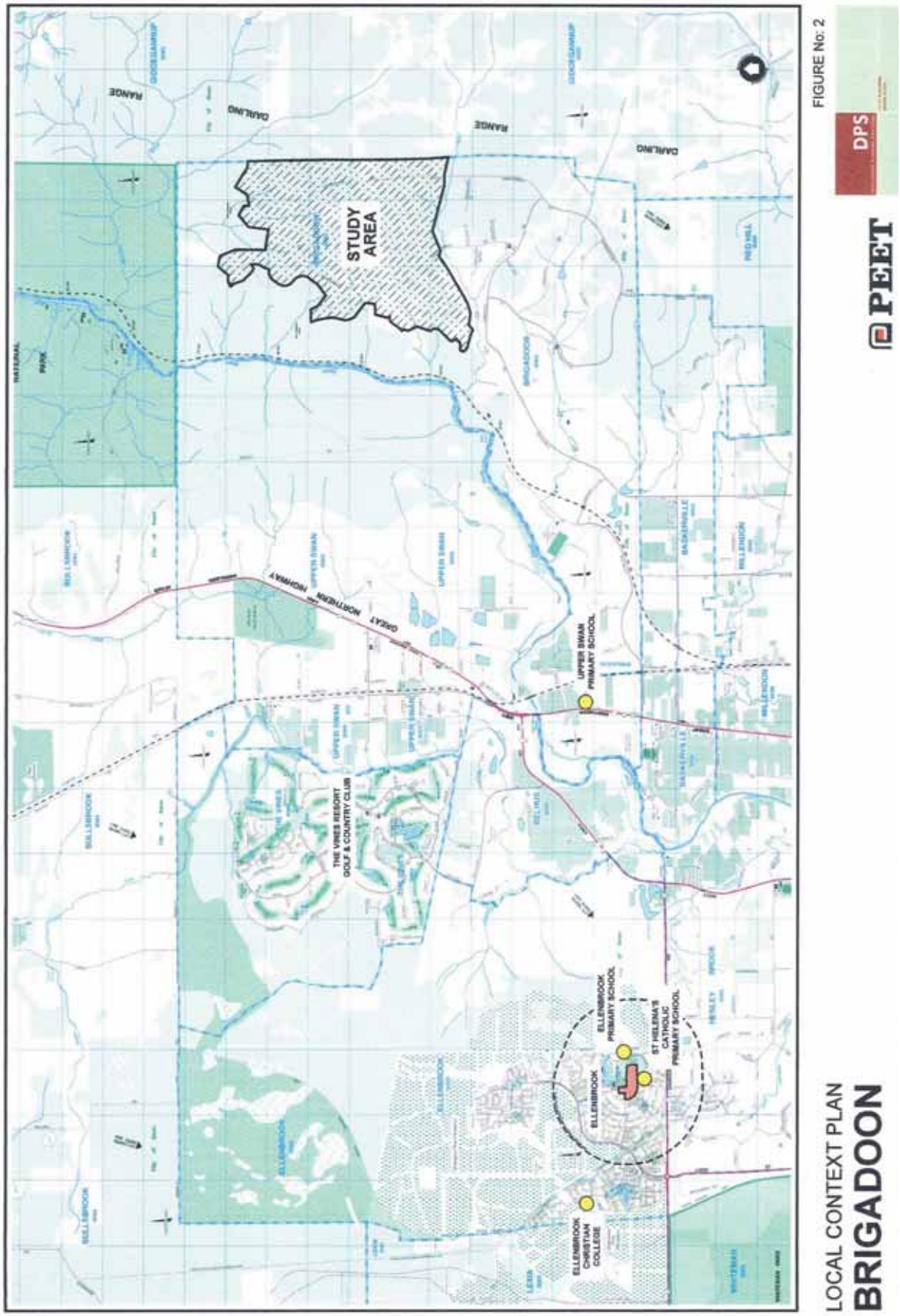
There are no creek or river systems running through this portion of the Brigadoon Estate.

4.0 STATUTORY CONDITIONS

The Western Australian Planning Commission requires the preparation of a ‘Bushfire Management Plan’ for the proposed development as part of the Development Application. This document has been prepared to satisfy that requirement.

As fire management strategies may require altering to meet changing environment and land use needs, it is advised that provisions of the Bush Fires Act 1954 may still be enforced in addition to this Fire Management Plan.

Diagram 1 Locality of Proposed Subdivision Not to Scale



5.0 BUSH FIRE HAZARD ASSESSMENT

The assessment of fire risk takes into account existing site conditions which include:

- Topography with particular reference to ground slopes and accessibility;
- Vegetation cover – both remnant and likely revegetation; and
- Relationship to surrounding development.

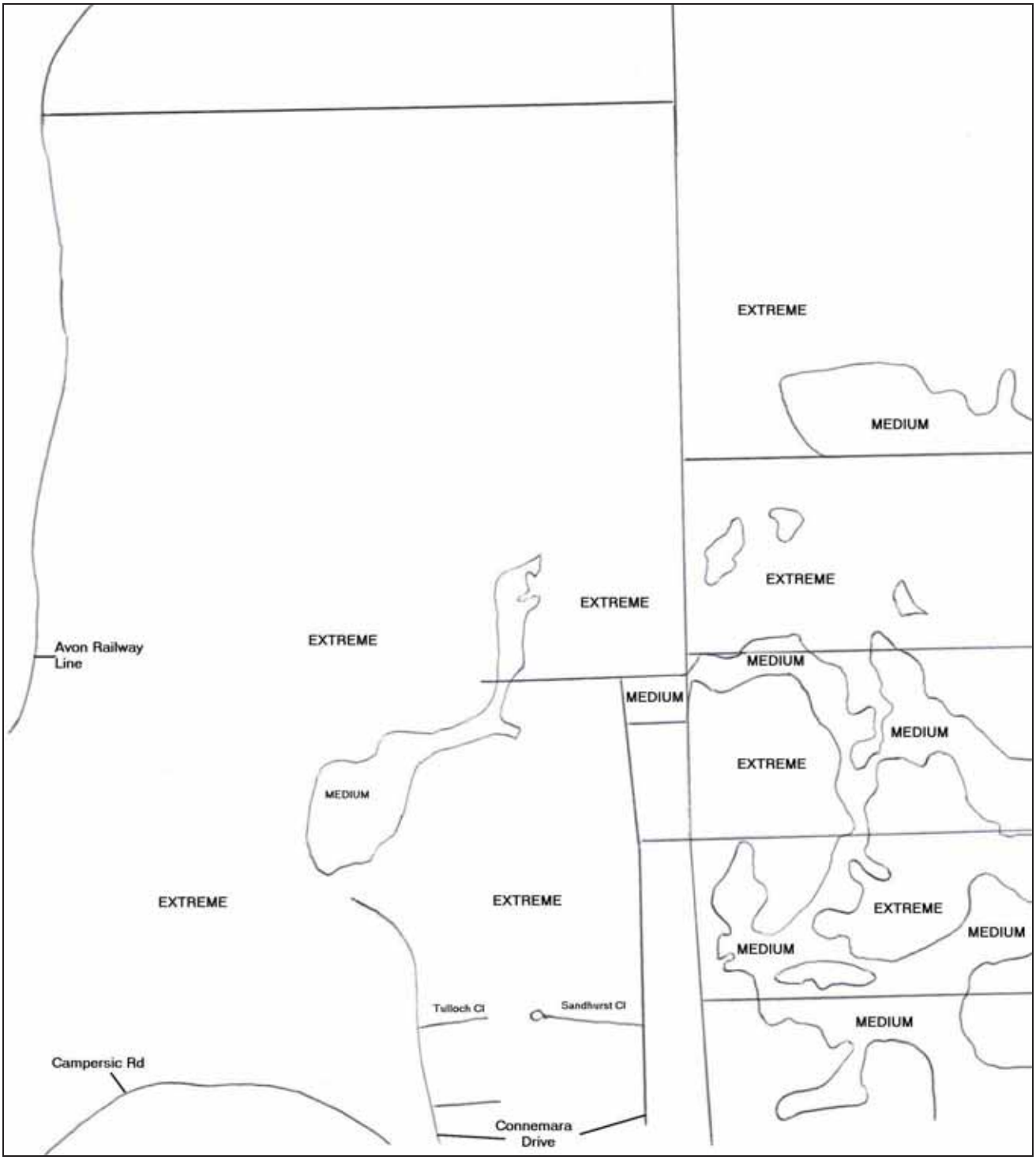
The Bush Fire Hazard Assessment for the proposed Lots is Extreme in remnant vegetation and Medium in cleared areas. See Diagram 2.

The Bush Fire Hazard assessment for the adjoining properties is Extreme in remnant vegetation and is Medium in cleared areas.

The Mediterranean climate experienced by this area is such that the majority of rain falls in late autumn through to early spring. This rainfall supports substantial vegetation growth which dries off in Summer/Autumn.

The combination of prevailing winds and dry vegetation poses a fire risk and bush fire control is considered essential for the protection of life and property, and to ensure that frequently and uncontrolled burning does not degrade existing and replanted vegetation.

Diagram 2 Bush Fire Hazard Assessment – Not to scale



6.0 FIRE MANAGEMENT PLAN

The aim of the Fire Management Plan is to reduce the threat to residents and fire fighters in the event of bush fire within or near the site.

The Fire Management Plan has been developed to incorporate fire management methods.

- Road Systems
- Strategic and Internal Firebreaks systems;
- Dwelling Construction;
- Building Protection Zones;
- Hazard Separation Zone;
- Hazard Reduction; and
- Driveways.

6.1 Road System

The current developed Brigadoon area has very poor access being Campersic Road. This provides one access/egress to the developed area. Recently an additional access has been provided.

In the proposed development a link from Connemarra Drive to O'Brien Road will be provided. This will provide an alternative emergency egress for the proposed residents but also for the existing residents of Brigadoon.

6.2 STRATEGIC FIREBREAK SYSTEMS

A strategic firebreak is to provide access for fire appliances and on their own would not stop a fire. The strategic firebreak provides a location where fire fighters can carryout a back burn operation if safe to do. The strategic firebreak is to be cleared to 6 metres wide with a 4 metre trafficable surface. In some areas such as steep slopes, a clearing width of 8 metres may be required in order to achieve a trafficable surface of 4 metres. In steep slopes a 4 metre wide one coat seal will make the surface trafficable.

Where necessary passing bays 6 metres wide will be installed every 200 metres and turn around areas every 500 metres. See Diagram 3 for Standards.

Strategic firebreaks linking the outer break with the outer road system will be installed at regular intervals of between 4 and 6 lots. These linking strategic firebreaks can be a part of the access within each lot or an internal firebreak and do not necessarily have to be located on the lot boundary. Rural gates (minimum width 4.1 metres) will be installed in the rear fence line to provide access from the strategic firebreak within the lot to the outer strategic firebreak. The fence is to be truncated to allow fire appliances to turn into the outer strategic firebreak

The strategic firebreaks would be placed in an easement on the title in favour of Council.

Gates and fencing will not be allowed across the boundary strategic firebreak and rural gates (minimum width 4.1 metres) would be erected where the strategic firebreak accesses a public road. Standard Council key system would prevent vehicle access. Signs "Fire Access Only" will be placed on the gates by the developer.

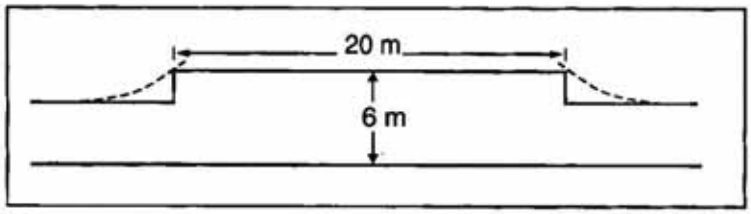
On the strategic firebreak located within the lots linking the outer strategic firebreak and the inner road system, rural gates with standard Council locks will be provided at the time of fencing.

A special area rating system could be implemented to cover the cost of the strategic firebreak maintenance. Peet & Co will establish and maintain the boundary strategic firebreaks until all lots are sold.

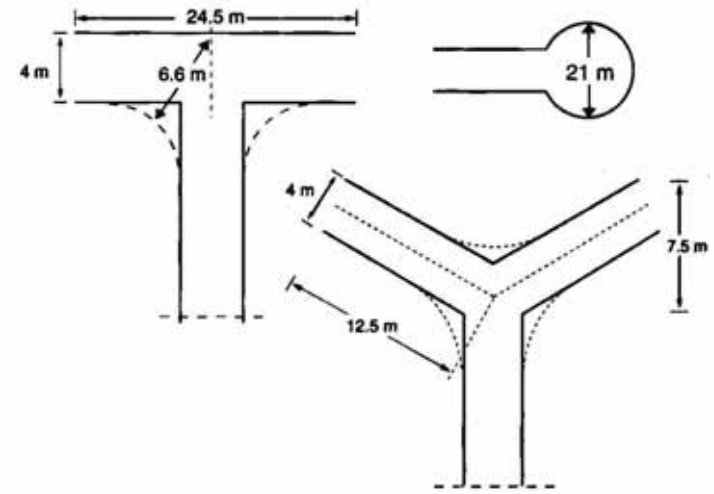
By that time the cost of maintenance would have been established by Peet & Co.

This strategic firebreak system is consistent with the previous development in Brigadoon and meets the standards of the City of Swan.

Diagram 3 Passing Bay and Turn around areas Specifications



Passing bay measurements.



Turn around area measurements.

6.3 INTERNAL FIREBREAKS

All lots are to comply with the firebreak requirements of the City of Swan Firebreak Notice in addition to this fire management plan. Firebreaks may be constructed to avoid soil erosion and trees of significance and may be located away from the Lot boundary as agreed with the City of Swan.

Internal Firebreaks are to be installed by the developer in all P.O.S. areas to the standard as detailed in the Firebreak Notice. The developer will maintain these firebreaks until all lots are sold and would be funded by rating system detailed in Section 6.2.

6.4 DWELLINGS

6.4.1 Dwelling Construction

Individual dwellings on each lot shall be designed and built to conform with:

- Building Code Of Australia (BCA); and
- Australian Standards AS 3959-2009.

All dwellings immediately adjoining the Parks and Recreation reserve are required to comply with the Australian Standard AS 3959-2009 "Construction of Buildings in Bush Fire Prone areas "BAL-29" as a minimum requirement. All other dwellings on the site are to be constructed to AS 3959-2009 BAL 19 as a minimum or as determined by individual Building Site Assessments by a Fire Planning Consultant provided free to the landowner by the Developer. A copy of this site assessment report would be forwarded to the City of Swan Fire Officer (emailed after inspection completed) and the City of Swan Building Department (as part of the Building License Application)

Copies of *The Homeowners Bush Fire Survival Manual, Prepare Act Survive* and the City of Swan Firebreak Notice or other suitable documentation will be issued to each property owner by the Developer on the sale of an allotment.

6.4.2 Dwelling Setbacks

All dwellings are to be setback 60 metres from the boundary strategic firebreak.

6.4.3 Evaporative Air conditioning

To improve building safety evaporative air conditioners will not be allowed to be installed in dwellings adjoining Regional or Public Open Space. Further advice on evaporative airconditioners is available on the FESA website www.fesa.wa.gov.au → Publications → Safety Information →Fire (Home)

6.5 BUILDING PROTECTION ZONE

The aim of the Building Protection Zones is to reduce bush fire intensity close to dwellings, and to minimise the likelihood of flame contact with buildings.

The Building Protection Zone is a low fuel area immediately surrounding a building.

Non flammable features such as driveways, vegetable patches, lawn, or landscaped gardens (including deciduous trees) should form part of building protection zones. Isolated trees and shrubs may be retained within building protection zones. A Building Protection Zone of minimum of 20 metres is to be constructed around all buildings and must be within the Lot boundaries. It must fulfil the following conditions:

- Bush Fire fuels and dry grass must be maintained below a height of 50mm and a maximum of 2 tonnes/ha.

- The first 5m around all building is to be cleared of all flammable material. Reticulated gardens may be located in this zone.

- For the next 25 metres (i.e. from 5-30metres surrounding any buildings) the spacing of trees should be such that crowns are spaced 10 metres apart (when tree reaches maturity). Prune lower branches so that they are at least two metres off the ground to stop a surface fire spreading into the trees. Isolated shrubs and understorey species can be retained but dense understorey vegetation should be thinned. Remove dead leaves and branches from shrubs and trees.

- Branches, must be removed at least 2 metres back from the eaves of all buildings.

- All leaves, tall grass, and clearing slash of trees must be removed from within the building protection zone area to maintain the low fuel zone prescribed above.

- Building Protection Zone and Hazard Separation Zones are to be installed prior to any dwelling construction commencing and is to be part of the Building Licence approval.

- Building Protection Zones are to be maintained in perpetuity by the Landowner.

Example of Compliant Building Protection Zone

Example of Compliant canopy Tree crowns not touching

6.6 HAZARD SEPARATION ZONE

There must be physical separation between bush fire hazards and development. Hazard Separation Zones assist in reducing fire intensity when a bush fire impacts on buildings within a subdivision.

It is essential that owners maintain the building protection and hazard separation zones to have any degree of safety.

- The Hazard Separation Zone should extend at least a further 30 metres beyond the building protection zone. The width of the Hazard Separation Zone will be determined at the stage of the Building Site Assessment and depends on the Slope and distance to unmodified vegetation.

- Bush fire fuel loadings must be maintained within the Hazard Separation Zone to a maximum of 4-6tonnes/ha.

- Remove all leaves, tall dead grass (in cleared areas), twigs and tree branches periodically by burning, heaping, carting away or mulching to achieve reduced fuel loading as prescribed above.

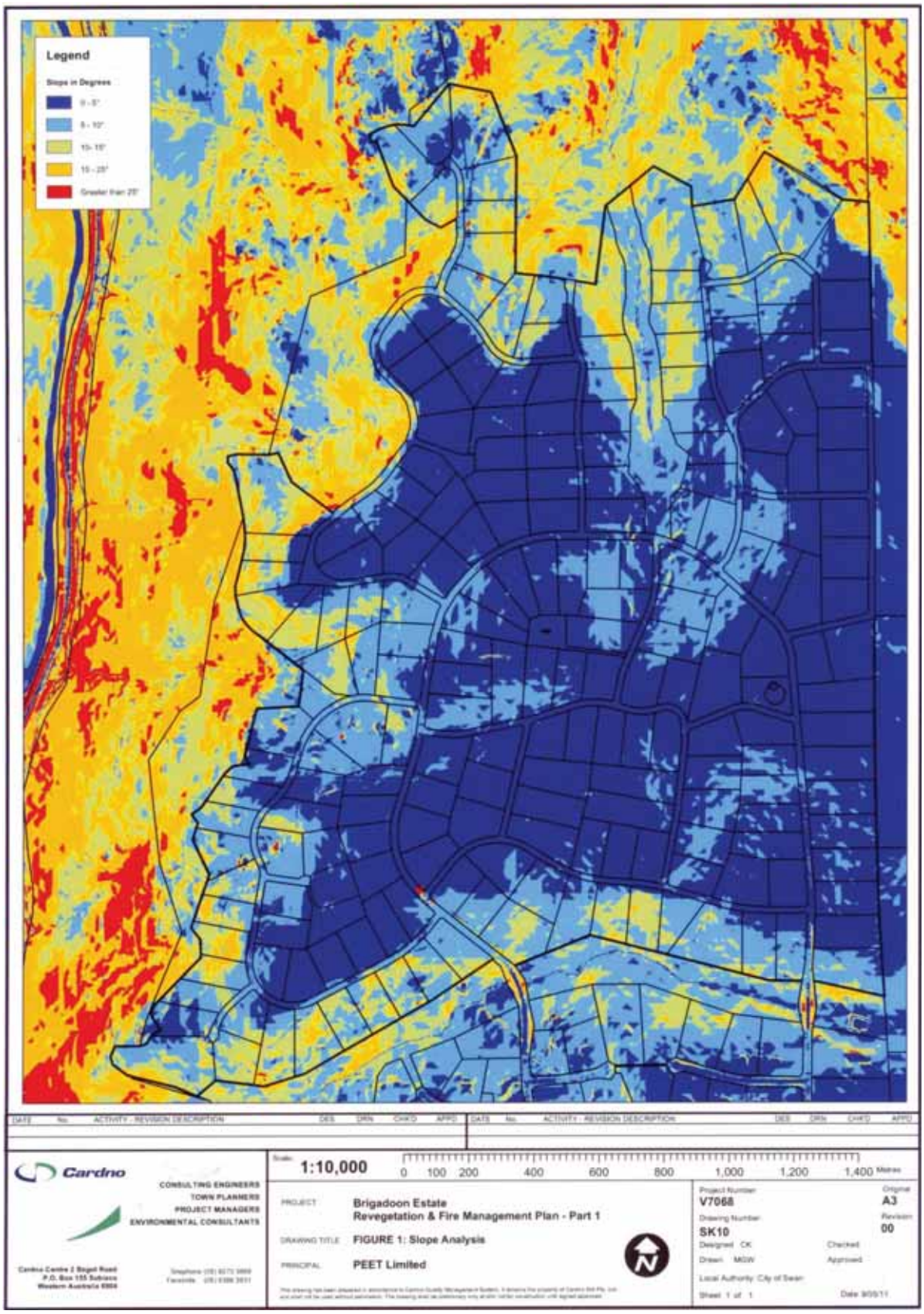
- Tree crowns are to be a minimum of 10 metres apart. Groups of 2-3 trees will be permitted provided no trunks are more than 6 metres apart and that there is a separation of 10 metres between crowns of tree clumps.

- The Hazard Separation Zone is to be installed by the landowner prior to construction of a dwelling on the site and maintained by the landowner to the detailed standard above in perpetuity

  If bush fire fuel is removed from small areas say about a quarter of the hazard separation zone each year then the impact on the vegetation within the lot is minimised.

Compliant Hazard Separation Zone Bush Fire Fuels to be maintained below 4-6 tonnes/ha

Figure 1 Slope Map
To assist with determining Construction Standard and Hazard Separation Zone width



6.7 HAZARD REDUCTION

In remnant vegetation bush fuels outside hazard separation zones, must be maintained below 6-8 tonnes/ha. City of Swan can provide advice on appropriate techniques to achieve this.

Dry grass fuels must be maintained below 50mm over the whole of each lot and can be achieved by mowing, grazing and slashing.

6.8 DRIVEWAYS

Driveways are to be constructed with a trafficable width of 4 metres. Where the driveways are more than 50 metres from a public road, driveway standards are to be as follows:-

- Minimum Trafficable surface: 4 metres
- Horizontal clearance: 6 metres
- Maximum Grades: 1 in 8
- Maximum grade over <50 m: 1 in 5
- Maximum average grade: 1 in 7
- Minimum weight capacity: 15tonnes
- Maximum crossfall: 1 in 33
- Curves minimum inner radius12 metres
- Passing Bays every 200 metres
- Turn Around areas: every 500 metres and within 50 metres of a house.

6.9 PLANTING OF TREES

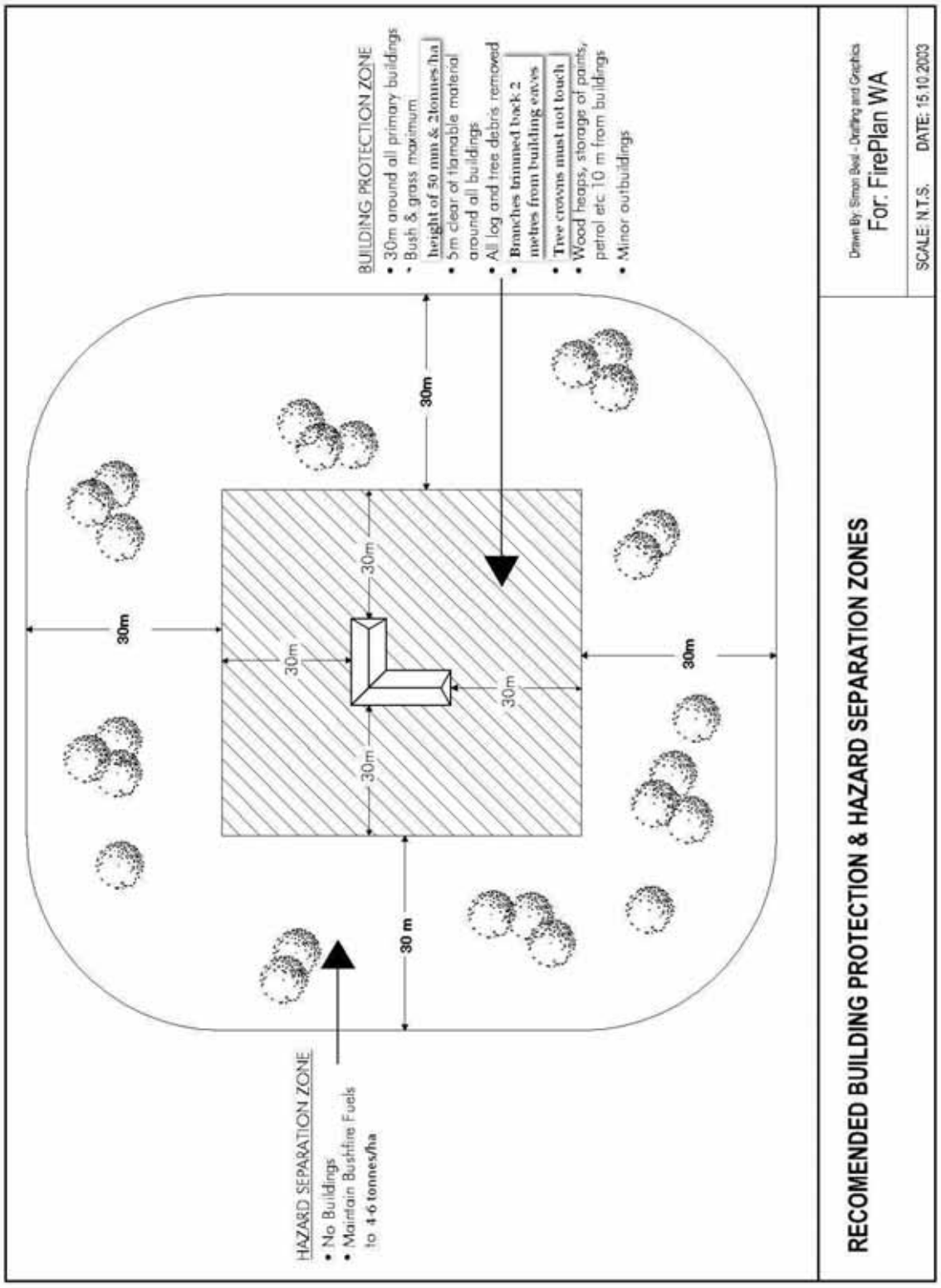
Planting of trees is not permitted within 6 metres of the centre of any firebreak. Trees planted within the Building Protection Zone must comply with the standard outlined in Section 6.5.

7.0 FIRE FIGHTING FACILITIES

Reticulated water will be supplied from the Water Corporation mains. Fire hydrants are to be installed every 200 metres along internal roads and marked with standard fire hydrant markings as detailed in Appendix B.

To improve fire suppression capability fire hydrants will be installed at 100 metre intervals on the outer road system interfacing with Regional Open Space (that is to the west and north of the development).

Diagram 4 Sample Building Protection Zone and Hazard Separation Zone.
Actual BPZ & HSZ widths will be determined at time of Building Site Assessment see Section 6.4.1



8.0 SUMMARY

8.1 Overall Fire Threat

The design of this development and the facilities constructed at the time of development are such that with implementation of this Fire Management Plan, fire threat to persons and property within the subdivision is significantly reduced.

8.2 Property Owner's Responsibilities

To maintain the reduced level of risk and threat of fire, the owners/occupiers of lots created by this proposal will be responsible for undertaking, complying and implementing measures protecting their own assets from the threat and risk of bush fire.

- Maintain internal firebreaks (clear of flammable material) on their property by the dates shown on the City of Swan Firebreak Notice as detailed in Section 6.2 & 6.3
- Maintain in good order and condition all property fencing and gates ensuring that overgrown vegetation does not encroach over the firebreak;
- Ensure all domestic dwellings are designed and constructed in full compliance with the requirements of the City of Swan. It is a requirement that homes are built to the AS3959 "Construction of Buildings in Bush Fire Prone Areas" as detailed in Section 6.4
- Implement and maintain Building Protection Zone as detailed in Section 6.5;
- Implement and maintain Hazard Separation Zone as detailed in Section 6.6.
- The owners of Lots 188, 189, 190, 245, 246, 262, 263, 286, 288, 372 and 373 are to liaise with the Department of Parks and Wildlife with respect to ensuring minimisation of Clearing associated with implementation and maintenance of Hazard Separation Zones and for hazard reduction outside of these however within each Lot;
- Implement hazard reduction as detailed in Section 6.7;
- Install and maintain driveways as detailed in Section 6.8;
- Planting of trees is to be carried out as detailed in Section 6.9.
- Infill revegetation species that have been introduced according to the Revegetation Plan *may* exceed and contradict this Fire Management Plans requirement for HSZ and possibly BPZ. Initially to ensure a level of survival rate depending on future conditions and climate, it will be the property owner's responsibility to ensure that the HSZ and BPZ continue to comply with the requirements outlined within this FMP by retaining selected successful vegetation while maintaining HSZ and BPZ. Property owners may need to seek advice from the City of Swan and DEC in future years to effectively achieve the requirements of this Fire Management Plan while ensuring the survival of retained vegetation species.

8.3 Developer's Responsibilities

Prior to subdivision being given final approval by the W. A. Planning Commission the developer shall be required to carry out works as described below. Subsequent to final approval to subdivide, the developer shall have no further responsibilities to provision of fire fighting facilities on lots which pass from there ownership.

- Lodging a section 70A Notification on each Certificate of Title proposed by this subdivision. The Notification shall alert purchasers of land and successors in Title of the responsibilities of this Fire Management Plan;
- Install alternative egress to O'Brien Road prior to Stage 1 land releases.
- Construction of strategic firebreaks as detailed in Section 6.2;
- Install internal firebreaks in accordance with City of Swan Firebreak Notice.
- Peet Limited is to provide a service to purchasers to have the Building Protection Zone and Hazard Separation Zone on their Lot inspected by a qualified Bushfire Protection Consultant (at Peet Limited's cost) to ensure compliance prior to clearing occurring and to ensure compliance after clearing has been undertaken. At the same time a Building Site Assessment will be carried out to determine the Construction standard of a dwelling.
- Install fire hydrants and mark fire hydrants as detailed Section 7.0
- Supply a copy of this Fire Management Plan, The Homeowners Bush Fire Survival Manual and Prepare Act Survive to each property owner on sale of the allotment;
- Maintain strategic firebreaks as detailed in Section 6.2 until all lots are sold.

8.4 City of Swan Responsibilities

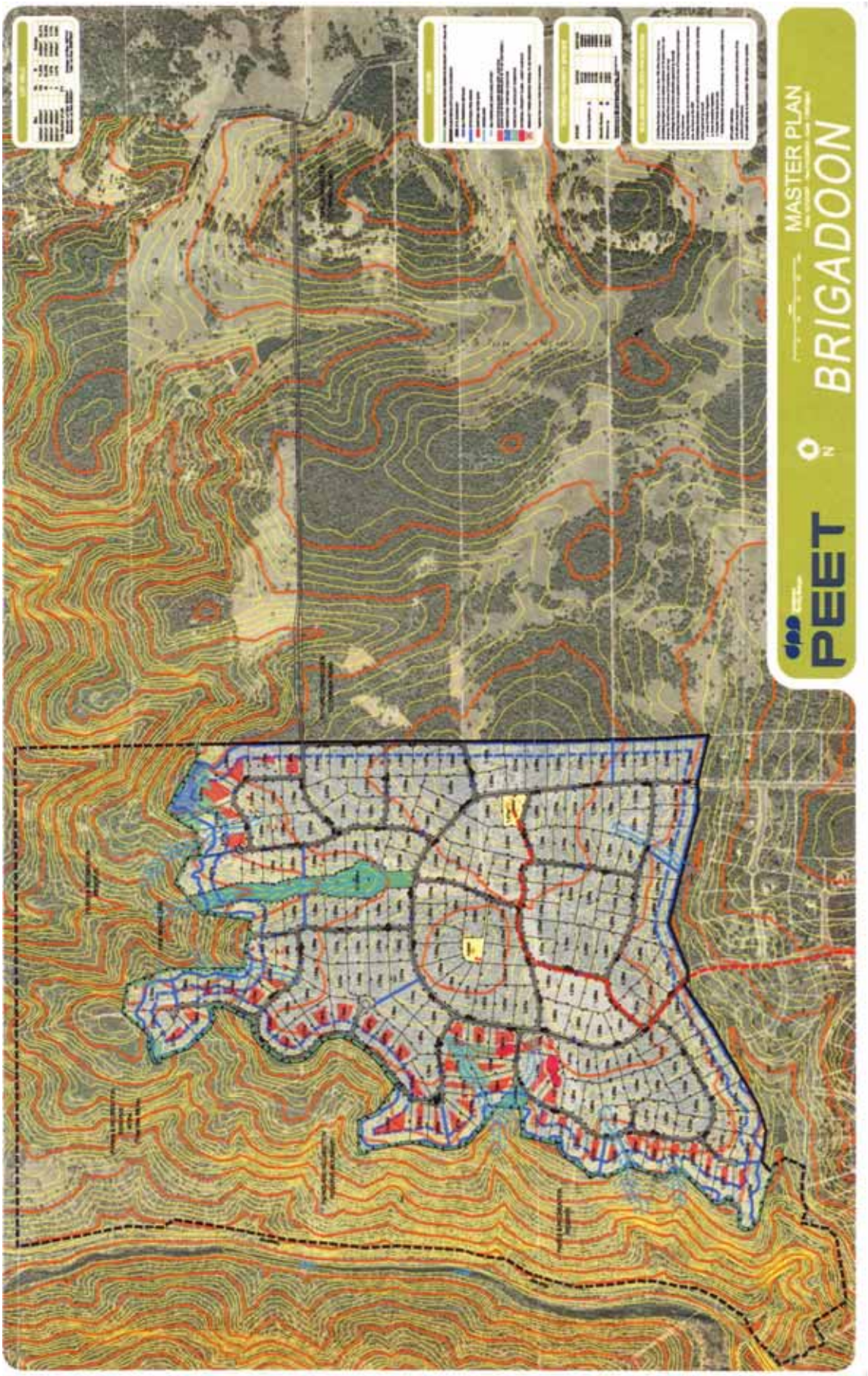
The responsibility for compliance with the law rests with individual property owners and occupiers and the following conditions are not intended to unnecessarily transfer some to the responsibilities to the City of Swan.

The City of Swan shall be responsible for:

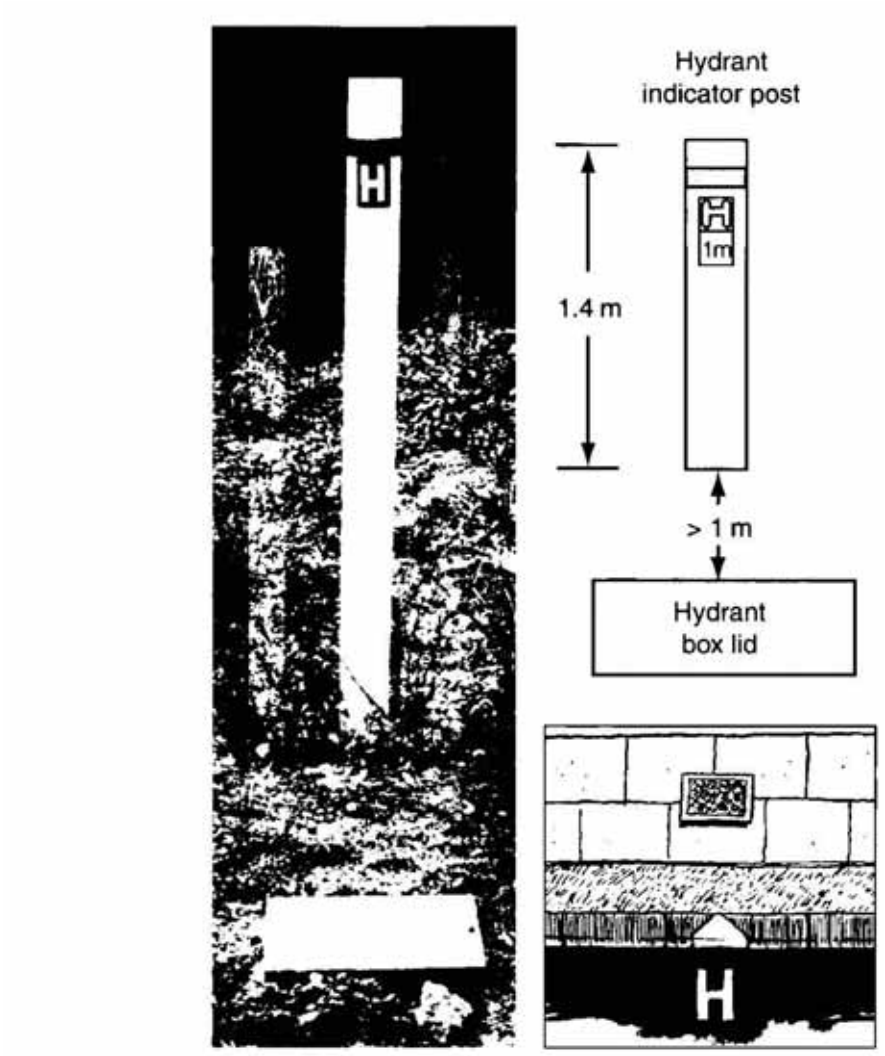
- Endorsing a Section 70A Notification on each Certificate of Title affected by this Fire Management Plan.
- Developing and maintaining District Fire Fighting Facilities.
- Maintaining in good order the condition of the district water tanks and the apparatus for fire fighting purposes.

- Maintaining a supply of gate locks to be made available at cost to relevant landowners on request.
- Maintain strategic firebreaks with funding provided by a differential rating system imposed on all new Lot owners by the City of Swan once all lots are sold within the development.

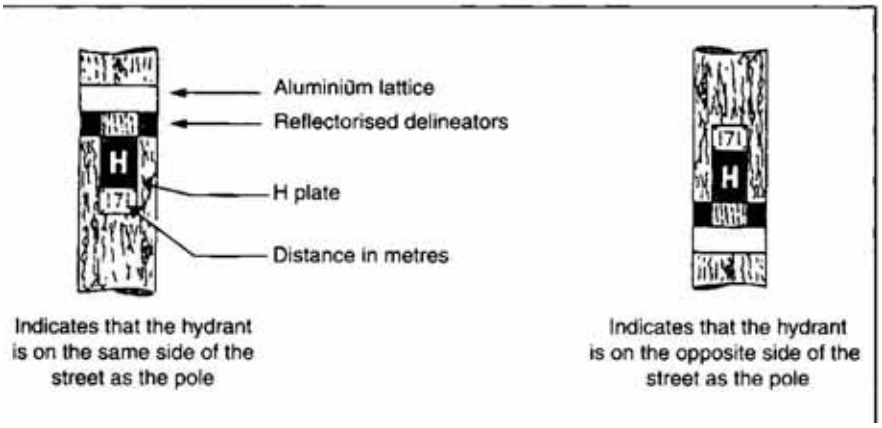
Appendix A Strategic Firebreak Location – Not to Scale.


MASTER PLAN
BRIGADOON
PEET
N

Appendix B Fire Hydrant Markings.

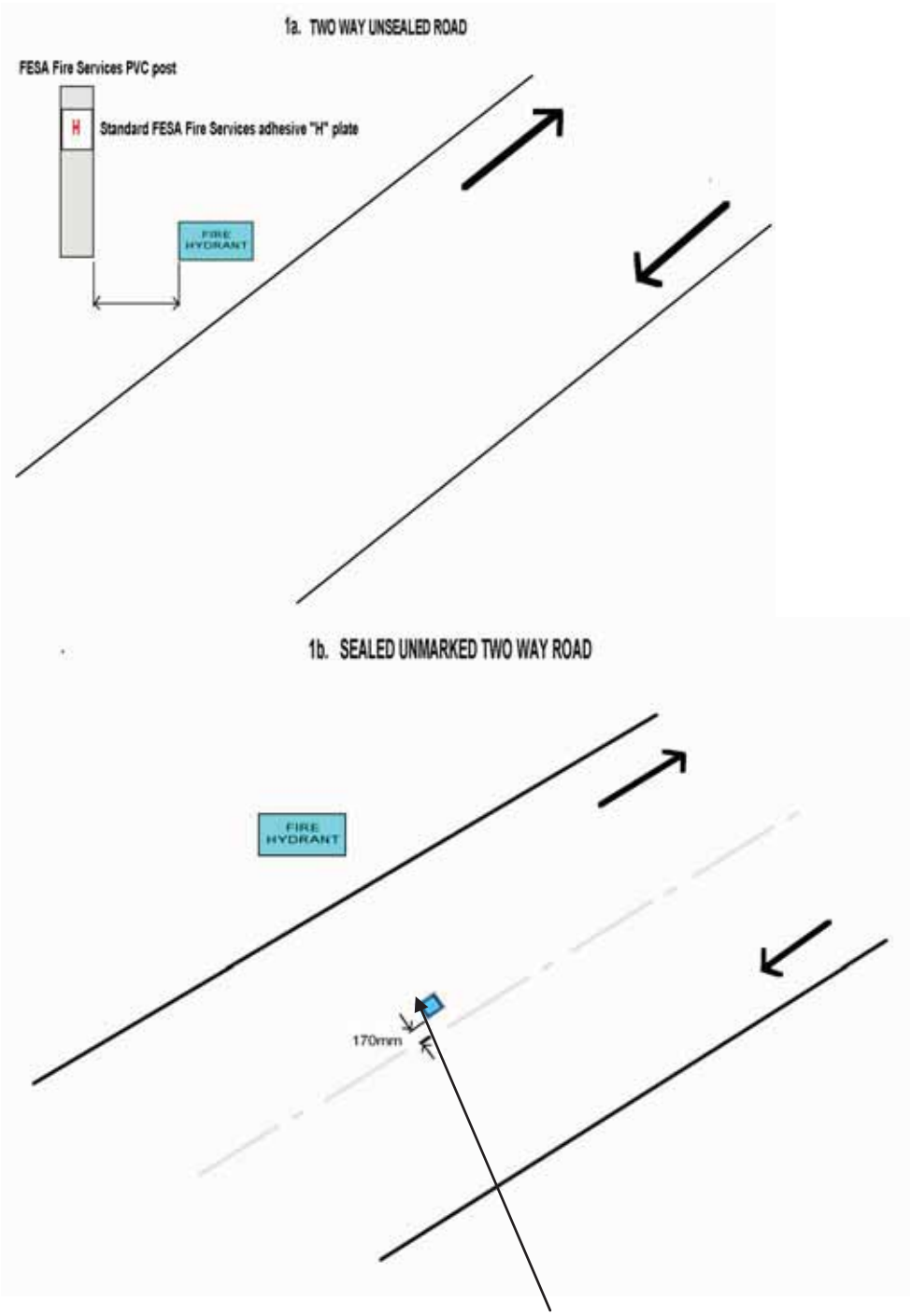


Hydrant indicators post.



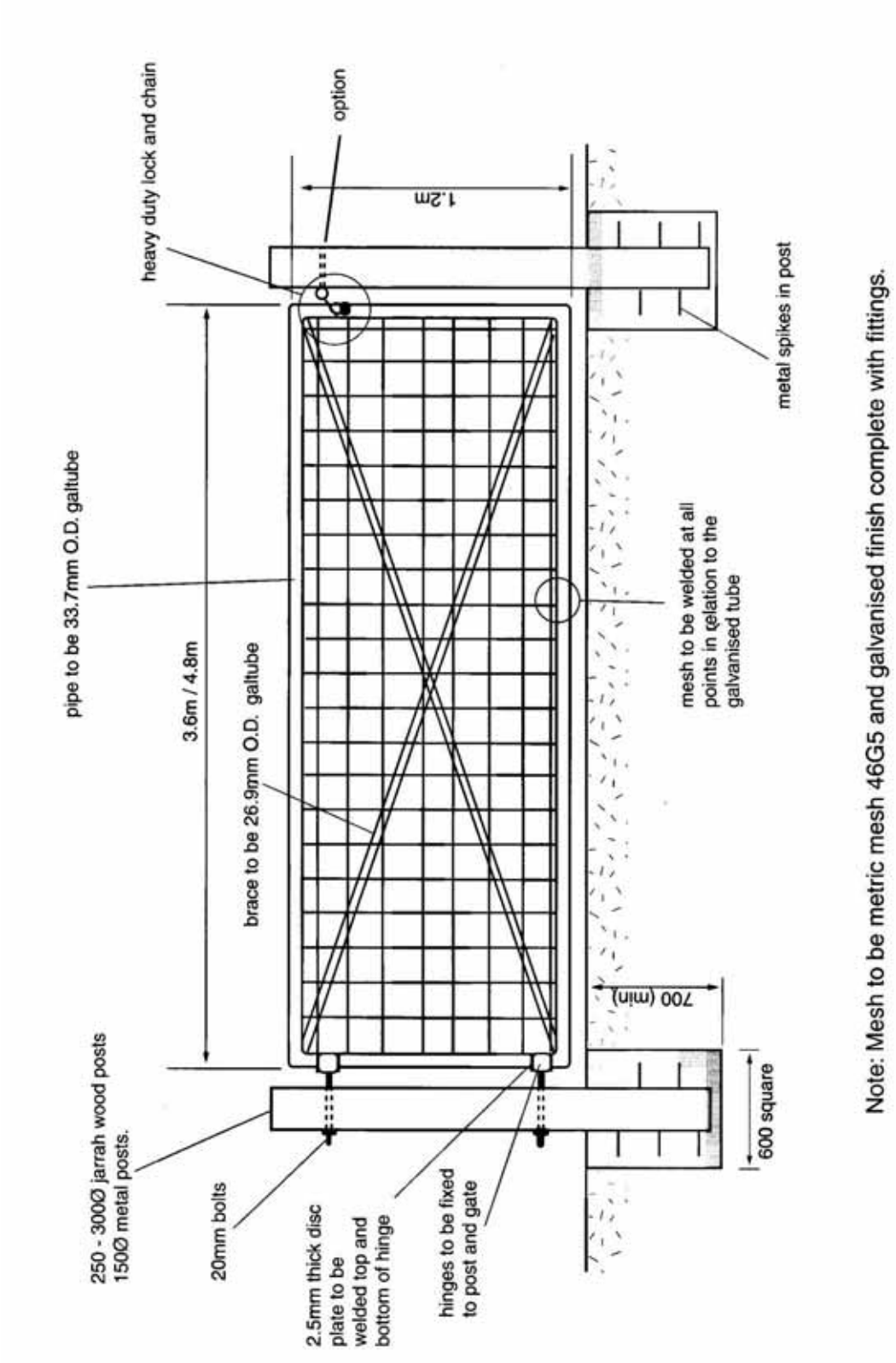
BLUE RAISED RETROREFLECTIVE PAVEMENT MARKER & HYDRANT INDICATING GUIDLINES

The implementation of the blue raised retro reflective pavement marker (RRPM's) and new hydrant indicating regime is designed to provide greater ability for fire fighters to readily identify fire hydrant locations, particularly at night or where smoke affects visibility.



Blue raised retro-reflective pavement marker

Appendix C Gate Standard



Avon Ridge Estate, Brigadoon

APPENDIX B

EXAMPLE OF A FESA PRESCRIPTION FOR A PRESCRIBED BURN IN FOREST AND WOODLAND AREAS

Cardno
Shaping the Future

Prescription for a

Prescribed burn

in forest and woodland areas

All tables referred to are the FESA Guide and Tables for Bush Fire Management in Western Australia and the FESA Visual Fuel Load Guide

FESA
Fire & Emergency Services Authority of Western Australia

Location: ……Brigadoon…… Brigade: …… Brigadoon .

Burn coordinator: …… Fire Management Consultant and Head of Brigadoon Bush Fire Brigade……. Prescribed burn No. ……

Intended season of burn: ……Spring……..……Burn area: …20… ha

Permit required: Yes / (No) If Yes - Permit Number: ……XYZ……

OBJECTIVE

…… To reduce bush fire fuels to below hazard separation zone standards prior to release for sale lots within the Brigadoon development. Carry out low intensity burn to minimise overstorey crown scorch.

……

STANDARDS REQUIRED …Reduce fuel load by 60% over 80% of the burn area. Less than 20% overstorey crown scorch. ……

PRE-PLANNING

A. Burn map (should include the following) scale = 1: …….

1.Burn history 2. Access 3. Power lines / utilities 4. Buildings/improvements
5. Vegetation types 6. Hazards 7. Location of signage 8. Water points / hydrants
9. Plantations / orchards 10. Historical / cultural sites 11. Declared rare flora / priority flora
12. Dieback

Other features / values that need consideration

……

……

B. Breaks

Break identification	Accessibility	Condition
Western – Private Road	(4WD Truck / 2WD Truck / 4WD LT)	Gravel Road
Eastern - 6 metre firebreak	(4WD Truck / 2WD Truck / 4WD LT)	Gravel Road
Southern - 6 metre firebreak	(4WD Truck / 2WD Truck / 4WD LT)	Dirt Road
Northern - 6 metre firebreak	(4WD Truck / 2WD Truck / 4WD LT)	Dirt Road

Comments Firebreaks to be maintained prior to burn. No traffic plan required as the burn will be on private property and there will be no smoke over any public roads.

INPUTS

A. Vegetation

Vegetation type (overstorey) ……Jarrah and Marri ……

Height of the overstorey ……15 ……..m

Scrub fuel load (from the visual fuel load guide) …3….. t/ha Level of grass curing …90…….%

Leaf fuel loads (if applicable) …6-8…..… t/ha **Total fuel load .....9-11..... t/ha**

B. Weather

Temperature range …20…….. - …25….. degrees Relative humidity range …30... - …50……%

Wind speed (at 10m) range ……12-19…….km/hr Wind direction …SW- SE. No burn to be conducted on E-NE winds. This will help minimise smoke over nearby residences and the city.

Drought factor range ……6…… - ……..

OUTPUTS

	Highest T / Lowest RH	Lowest T / Highest RH
Temp / RH		/
FFDI		
HFRoS from Tables		
DF x HFRoS (m/hr)		

Note: The DF is recorded as a whole number and multiplied as a tenth e.g. DF 3 is multiplied as 0.3 in the above table.

Slope - Adjust the HFRoS for slope (multiply by the appropriate conversion) X… = ……m/hr

Estimated strip width (HFRoS x hours of burning - …….. hrs) - ……. m

Estimated spot widths (strip width x 0.5) ……..m

CONTROL RESOURCES REQUIRED

L/T ……2……. 2.4 ……1…….. Tanker ……

1.4 …….. 3.4 ……. Personnel ……6……

LIGHTING RESOURCES REQUIRED

Personnel ……

NOTIFICATIONS REQUIRED

Local Govt - (YES) / NO FESA - YES / NO DEC - (YES) / NO Others - YES / NO

… Notification to neighbours will be carried out in accordance with the requirements of the *Bush Fires Act 1954* & Regulations.

Owners/Occupiers of adjoining land – (YES) / NO - **for smoke management reasons neighbours who may be affected by smoke must be advised 3 days prior to the burn**

……

……

SIGNAGE ON THE DAY OF THE BURN

Safety signs deployed – Done / N/A

BURN

Mop up and Patrol standards have been met – YES / NO If not, Why ……

Unburnt pockets do not pose a threat – YES / NO **<u>If YES - Do not leave the burn until safe</u>**

POST BURN REVIEW

Burn result – objectives met – YES / NO If not, Why ……..

Other comments ……..

Actual conditions on the burn day

Date of burn …….. Actual HFRoS range … …… - ....…….m/hr

Actual temperature …….degrees Actual RH …….%

Wind direction and strength at 10 m ……..

Signed off by (name) ……. **Signature** …… **Date** ……..

Burn prescription completed by (name) …….. Signature …….. date ……

APPENDIX B

PLANTING SUMMARY WITHIN THE PARKS AND RECREATION RESERVE, AVON RIDGE ESTATE

Planting summary within the Parks and Recreation Reserve, Avon Ridge

Site	1A	2	3	4	Sales Office A	Sales Office B	Subtotal
Installation date	8/08/2011	9/08/2012	9/07/2013	19/07/2013	5/06/2013	8/07/2013	
Number of seedlings planted	30,775	24,000	2,610	10,340	6,150	14,380	88,255
Installation date (infill)	12/07/2012	11/06/2013					
Number of seedlings planted	12,000	6,520					18,520
Planting spacing (lm) along rip lines 1.8m apart	2	1	1	1	1	1	
Area (ha)	13.4	4.7	0.3	2.8	0.8	2.3	
Planting density (m^2)	0.32	0.65	0.87	0.37	0.77	0.63	
Number of species	30	20	12	16	11	15	
Total							**106,775**
Species list	*Acacia lasiocarpa* *Acacia saligna* *Allocasuarina fraseriana* *Allocasuarina humilis* *Banksia grandis* *Banksia illicifolia* *Banksia menziesii* *Banksia prionotes* *Callistemon phoeniceus* *Calothamnus hirsutus* *Calothamnus quadrifidus* *Corymbia calophylla* *Eucalyptus marginata* *Eucalyptus rudis* *Eucalyptus wandoo* *Gastrolobium calycinum* *Gompholobium tomentosum* *Hakea cyclocarpa* *Hakea incrassata* *Hakea lissocarpha* *Hakea prostata* *Hakea ruscifolia* *Hakea trifurcata* *Hakea undulata* *Hakea varia* *Hypocallymma robustum* *Kennedia coccinea* *Kennedia prostrata* *Leptospermum erubescens* *Macrozamia redlei*	*Acacia saligna* *Allocasuarina fraseriana* *Banksia grandis* *Banksia menziesii* *Banksia prionotes* *Banksia sessilis* *Callistemon phoeniceus* *Corymbia calophylla* *Eucalyptus marginata* *Eucalyptus rudis* *Eucalyptus wandoo* *Hakea cyclocarpa* *Hakea incrassata* *Hakea lissocarpha* *Hakea prostrata* *Hakea ruscifolia* *Hakea trifurcata* *Hakea undulata* *Hakea varia* *Hypocallymma robustum*	*Acacia saligna* *Banksia nivea* *Banksia sessilis* *Callistemon phoeniceus* *Calothamnus quadrifidus* *Corymbia calophylla* *Eucalyptus rudis* *Eucalyptus wandoo* *Hakea lissocarpha* *Hakea trifurcata* *Hakea ruscifolia* *Hakea undulata*	*Acacia saligna* *Banksia grandis* *Banksia nivea* *Banksia sessilis* *Hakea undulata* *Callistemon phoeniceus* *Calothamnus quadrifidus* *Corymbia calophylla* *Eucalyptus marginata* *Eucalyptus rudis* *Hakea prostrata* *Eucalyptus wandoo* *Hakea lissocarpha* *Hakea ruscifolia* *Hakea trifurcata* *Hakea varia*	*Acacia saligna* *Banksia grandis* *Callistemon phoeniceus* *Corymbia calophylla* *Eucalyptus wandoo* *Hakea lissocarpha* *Hakea prostrata* *Hakea ruscifolia* *Hakea trifurcata* *Hakea varia* *Hakea undulata*	*Acacia saligna* *Banksia grandis* *Banksia nivea* *Banksia sessilis* *Callistemon phoeniceus* *Calothamnus quadrifidus* *Corymbia calophylla* *Eucalyptus marginata* *Eucalyptus marginata* *Eucalyptus rudis* *Eucalyptus wandoo* *Hakea prostrata* *Hakea ruscifolia* *Hakea trifurcata* *Hakea undulata*	

APPENDIX C

emerge ASSOCIATES
Integrated Science & Design

CITY OF SWAN 2013-2014 FIREBREAK NOTICE

BUSHFIRES ACT 1954

City of Swan

FIREBREAK NOTICE

Notice to Owners and/or Occupiers of land situated within the City of Swan.
As a measure to assist in the control of bush fires, and pursuant to Section 33 of the Bush Fires Act 1954, all owners and occupiers of land within the City of Swan are required on or before **2 November 2013**, or within 14 days of becoming an owner or occupier of land if after that date, to clear firebreaks or take measures in accordance with this notice and maintain those firebreaks and measures to the required condition up to and including the **30th day of April, 2014**.

1. All Land with an area under 5,001m2 (land under 1/2 Hectare)

1) Maintain grass to a height of no greater than 5cm.
2) Install and maintain a Building Protection Zone, in accordance with the requirements specified in clause 12 of this notice.
3) Any parcel of land having an area less than 5,001m2 that is substantially developed that may include land that:
    a) Predominantly consists of non-flammable managed vegetation, reticulated lawns and gardens and other non-flammable features; or
    b) Areas that are sufficiently Parkland Cleared

   may maintain grass to a height of no greater than 5cm, or remove all flammable materials in lieu of clearing firebreaks.
4) Areas of natural vegetation to be maintained at or below 8 tonnes per hectare.

2. All land with an area of 5,001m2 or greater (land over ½ Hectare)

1) Install a 3 metre firebreak immediately inside and adjacent to all external property boundaries.
2) Properties over 100 hectares require additional firebreaks to divide the land into areas not exceeding 100 hectares.
3) Slash or mow unmanaged grass (grass that is 50cm or higher) to a height no greater than 10cm immediately adjacent firebreaks to a minimum width of 3 metres.
4) Install and maintain a Building Protection Zone, in accordance with the requirements specified in clause 12 of this notice.
5) Hazard Separation Zones - Properties that are affected by a Fire Management Plan approved in writing by the City, that outlines the requirement and dimensions of a Hazard Separation Zone area in addition to and extending from a Building Protection Zone, must install and maintain this area to the standard specified within the Fire Management Plan. Fuel loads within Hazard Separation Zones must not exceed 6 tonnes per hectare.
6) Areas of natural vegetation to be maintained at or below 8 tonnes per hectare.

3. Plantations

1) Install and maintain external and internal firebreaks, firebreaks that form compartments (cells), firebreaks and hazard reduction measures that protect neighbouring communities and essential infrastructure in accordance with the requirements of a Fire Management Plan approved in writing by the City; or
2) Where no such approved Fire Management Plan exists,
    a) Unless the City approves an alternative plan in writing in accordance with clause 3(2)(b), install and maintain external and internal firebreaks and firebreaks that form compartments (cells), and carry out all other firebreaks and hazard reduction measures which are required in accordance with the requirements and specifications within the

Department of Fire & Emergency Services 'Guidelines for Plantation Fire Protection' 2011 publication; or

b) If it is considered impractical for any reason to carry out the plantation requirements outlined above in clause 3(2)(a), plantation owners and managers may apply in writing to the City to implement an alternative plan or measures in accordance with clause 4 of this notice. A Fire Management Plan may be required to be developed and submitted as part of the application.

4. Application to Vary Firebreak and Hazard Reduction Requirements

1) If it is considered impractical for any reason to clear firebreaks in a manner or location required by this notice, or to carry out on the land any fire hazard reduction work or measures required by this notice, you may apply in writing on or before the **15th day of October, 2013** for approval to provide firebreaks in alternative positions or to take alternative measures to abate fire hazards on the land.
2) If permission is not granted in writing by the City prior to the **2nd day of November, 2013** you shall comply with the requirements of this notice.
3) When permission to provide alternative firebreaks or fire hazard reduction measures has been granted, you shall comply with all conditions on the endorsed permit and maintain the land to the required standard throughout the period specified by this notice.
4) Where the City has in writing approved a Fire Management Plan as a condition of subdivision and the Fire Management Plan depicts an array of alternative firebreak positions and alignments, a property owner may, as an alternative to general boundary firebreaks, elect to provide an alternative firebreak(s) depicted on the Fire Management Plan. However, if the alternative firebreak is not constructed by the date required by this notice, then general firebreak requirements shall apply.

5. Fuel Dumps and Depots

Remove all inflammable material within 10 metres of fuel dumps, fuel ramps or where fuel drums, whether containing fuel or not, are stored.

6. Hay Stacks

Clear and maintain a firebreak completely surrounding any haystack on the land, within 60 metres of the haystack.

7. Strategic Firebreaks

1) Where under a written agreement with the City, or where depicted on an approved Fire Management Plan strategic firebreaks are required on the land, you are required to clear and maintain strategic firebreaks a minimum of 6 metres wide along the agreed alignment to provide restricted vehicular access to emergency and authorised vehicles, unimpeded by obstructions including boundary fences unless fitted with gates and signage approved in writing by the City.
2) Gates may only be secured with City of Swan Fire Service padlocks.
3) Strategic firebreaks shall be graded to provide a continuous 4 wheel drive trafficable surface a minimum of 4 metres wide.
4) All branches must be pruned and obstacles removed to maintain a 4 metre vertical height clearance above the full 6 metre width of the firebreak.

8. Emergency Access Ways

1) Where under a written agreement with the City, or where depicted on a Fire Management Plan Emergency Access Ways are required on private land, you are required to clear and maintain a vehicular access way a minimum of 6 metres wide along the agreed alignment.
2) Emergency access ways must be unimpeded by obstructions including boundary fences unless fitted with gates and signage approved in writing by the City.
3) Gates on Emergency Access Ways must remain unlocked at all times.
4) Emergency Access Ways shall be graded and have suitable drainage to provide a minimum 6 metre wide continuous trafficable surface suitable for all types of 2 wheel drive vehicles.
5) All branches must be pruned and obstacles removed to maintain a 4 metre vertical height clearance above the full 6 metre width of the trafficable surface.

9. Firebreak Construction

1) Firebreaks are to be developed and maintained clear of all obstacles and flammable materials to create a minimum of 3 metre wide trafficable surface suitable for 4 wheel drive vehicles.
2) Overhanging branches must be pruned to provide a 4 metre vertical clearance above the full width of the firebreak surface.
3) Boundary Firebreaks must be aligned immediately inside and adjacent to the external property boundaries.
4) Alternative Firebreaks that are approved in writing by the City, or as depicted within a Fire Management Plan approved in writing by the City, are to be constructed to the same standard as general firebreaks and must be constructed along the specified alignment.
5) Firebreaks must not terminate in a dead end.
6) Firebreaks may be constructed by ploughing, grading, raking, burning, chemical spraying or any other approved method that achieves the required standard.

10. Fuel Reduction - Unmanaged Grasses

1) All grass within Building Protection Zones, and on all land less than 5,001m2 in area, is required to be mowed and maintained under 5cm in height over the entire area.
2) On land 5,001m2 or greater, and not including Building Protection Zones,
    a) Maintain grass under 10cm within Hazard Separation Zones.
    b) Slash or mow unmanaged grass (grass that is 50cm or higher) to a height no greater than 10cm immediately adjacent firebreaks to a minimum width of 3 metres.
    c) If the land described above in 10(2)(b) is stocked, the grass must be reduced to a height of no greater than 10cm high by the **1st day of December 2013.**

Subject to clause c), all grassed areas required by this notice to be maintained at or below a required height must be maintained in that condition between **2 November until the 30 April the following year.**

11. Fuel Reduction - Natural Vegetation

1) Available bushfire fuels must be maintained at or below:
    a) Building Protection Zones - 2 tonnes per hectare
    b) Hazard Separation Zones - 6 tonnes per hectare **This requirement only applies where HSZs are depicted within a Fire Management Plan approved in writing by the City.*
    c) Natural Vegetation - 8 tonnes per hectare
2) Fuel Reduction within natural vegetation may be achieved by burning, raking, pruning, weed management, removal of dead materials and any other approved method.
3) Permanent removal or partial clearing of natural vegetation may only be carried out in accordance with the minimum requirements of this notice.
4) Permanent clearing of natural vegetation structures including individual plants, shrubs or trees, that exceeds the requirements of this notice or the specifications outlined within an

fire management plan approved in writing by the City, is only permitted in accordance with the provisions and exemptions outlined within the Environmental Protection Act 1986, or with the approval of the Department of Environment Regulation and the City of Swan.

Note: Advice and resources on how to measure and manage native vegetation fuel loads are available from the Department of Fire and Emergency Services or the City of Swan.

12. Building Protection Zones Specification

The Building Protection Zone for habitable buildings and related structures must meet the following requirements:

1) Building Protection Zones for habitable buildings must extend a minimum of 20 metres out from any external walls of the building, attached structures, or adjacent structures within 6 metres of the habitable building, unless varied under an approved Bushfire Management Plan.
2) On sloping ground the Building Protection Zone distance shall increase at least 1 metre for every degree in slope on the sides of the building/structure that are exposed to down slope natural vegetation.
3) Building Protection Zones predominantly consist of non-flammable managed vegetation, reticulated lawns and gardens and other non-flammable features.
4) All grass is maintained to or under 5cm.
5) Fuel loads must be reduced and maintained at 2 tonnes per hectare or lower.
6) The crowns of trees are to be separated where possible to create a clear separation distance between adjoining or nearby tree crowns, the separation distance between tree crowns is not required to exceed 10 metres.
7) A small group of trees within close proximity to one another may be treated as one crown provided the combined crowns do not exceed the area of a large or mature crown size for that species.
8) Trees are to be low pruned (or under pruned) to at least a height of 2 metres from ground.
9) No tree, or shrub over 2 metres high is planted within 2 metres of a building, especially adjacent to windows.
10) There are no tree crowns or branches hanging over buildings.
11) Tall shrubs over 2 metres high are not planted in groups close to the building and ensure there is a gap of at least 3 times the height (at maturity) of the shrub away from the building.
12) Clear and prune scrub to reduce to a sparse density (able to walk through vegetation with relative ease with minimal deviation around trees and shrubs).
13) Install paths and non-flammable features immediately adjacent to the building.
14) Wood piles and flammable materials stored a safe distance from buildings.

13. Burning

If the requirements of this notice are carried out by burning, such burning must be carried out in accordance with the relevant provisions of the Bush Fires Act 1954.

14. Compliance

1) In addition to the requirements of this notice, further works which are considered necessary by an Authorised Officer of the City may be required as specified in writing in a subsequent notice addressed to the land owner.
2) Where the owner or occupier of the land fails or neglects to comply with the requirements of this notice or a subsequent notice addressed to the land owner, the City of Swan may enter onto the land with workmen, contractors, vehicles and machinery to carry out the requisitions of the notice at the expense of the land owner.

3) Failure to comply with this notice and subsequent written notices may result in a penalty not exceeding $5,000, or the issue of a $250 infringement notice and liability for any costs incurred by the City in relation to works undertaken on behalf of the land owner.
4) Adherence to measures outlined within an approved Fire Management Plan developed as a condition of subdivision does not provide land owners and occupiers with any exemptions to the requirements of this notice unless this notice specifically states otherwise.

15. Definitions

'Alternative Firebreak' is a firebreak that is in an alternative position or alignment to the external boundaries of a property.

'Alternative Firebreak Application' is an application that may be made by a land owner to install firebreaks in an alternative position, or to carry out an alternative measures in lieu of general firebreaks.

'Available Fuel' is the fuel that will actually burn under prevailing conditions. Fuel available for burning depends on temperature, moisture in the air and within the vegetation and curing of vegetation. In summer there is a significant rise in available fuel.

'City' means the City of Swan

'Buildings, Attached and Adjacent Structures' means habitable buildings that are used as a dwelling, workplace, place of gathering or assembly, a building that is a car park, or a building used for the storage or display of goods or produce for sale by whole sale in accordance with classes 1-9 of the Building Code of Australia. The term building includes attached and adjacent structures like garages, carports verandas or similar roofed structure(s) that are attached to, or within 6 metres of the dwelling or primary building.

'Building Protection Zone (BPZ)' is a low fuel area that is reduced of flammable vegetation and materials surrounding buildings and essential infrastructure to minimise the likelihood and impact that direct flame contact, radiant heat or ember attack may have on buildings and assets in the event of a bushfire. This area must extend out from the external walls of a building or asset a minimum of 20 metres.

'Emergency Access Way' is a two wheel drive trafficable, 6 metre wide access route to provide local residents, general public and emergency services alternative links to road networks at the end of cul-de-sacs or areas where access is limited during an emergency incident.

'Essential Infrastructure' or Critical Infrastructure means assets, infrastructure, systems and networks that provide essential services necessary for social and economic wellbeing and is typically public infrastructure. Assets and infrastructure, usually of a public nature, that generate or distribute electricity, water supply, telecommunications, gas and dams are typical assets that are essential to society and are often located in, or traverse areas that are prone to bushfires.

'Firebreak' is an area of land cleared of flammable material to minimise the spread or extension of a bushfire. For the purpose of this notice the term firebreak is a strip of land 3 metres wide that also provides a trafficable surface and 4 metres vertical clearance for emergency and authorised vehicle access. Boundary firebreaks are installed immediately adjacent the external boundaries of a property.

'Fire Hazard or Bushfire Hazard' means accumulated fuel (living or dead) such as leaf litter, twigs, trash, bush, dead trees and scrub capable of carrying a running fire, but excludes standing living trees and isolated shrubs.

'Fire Management Plan' is a comprehensive plan that may be placed on the certificate of title(s) of land, that has been developed as a condition of development or subdivision primarily for the purpose of determining the land suitability, design features and infrastructure that will increase bushfire safety within the location. Fire Management Plans may become outdated with regards to property owner fire safety advice and responsibilities due seasonal changes and evolving fire safety strategies. Up to date advice and strategies are administered within local government areas as a legal requirement through the annual firebreak notice regulation. Fire Management Plans are not a

legal requirement unless specifically referenced as a requirement within this notice, or a written notice addressed directly to a land owner.

'Hazard Separation Zone (HSZ)' if required by this notice and in accordance with a Fire Management Plan, means an area extending out from a Building Protection Zone a distance of 80 metres unless otherwise specified, to create a graduated fuel reduction and separation from natural vegetation that is unmodified in structure and density.

'Natural Vegetation' means natural areas of forest, woodland, shrubland, scrub, mallee and mulga.

'Parkland Clearing' means areas of natural vegetation that has been significantly cleared of understory and tree density reduced to create a grassland or low vegetation area that can be walked through unimpeded with isolated, grouped or well spaced trees.

'Plantation' is any area of native or exotic planted trees that exceeds three hectares in a gazetted town site, or elsewhere a stand of trees of 10 hectares or larger that has been planted and managed intensively for their commercial and environmental value. A plantation includes roads, firebreaks and small areas of native vegetation.

'Strategic Firebreak' is a firebreak that is 6 metres wide established to provide strategic access and links to road networks whilst providing a wider control/containment line to protect town sites, estates and similar exposures during bushfire operations.

'Unmanaged Grasses' is undisturbed or very lightly grazed grasses with a height of 50cm or greater.

By order of the Council,

MJ Foley
CHIEF EXECUTIVE OFFICER
CITY OF SWAN

APPENDIX D

emerge ASSOCIATES
Integrated Science & Design

ROLE OF FIRE MANAGEMENT CONSULTANT IN THE VEGETATION MODIFICATION PROCESS


Peet
Clears vegetation for roads. services, strategic firebreaks and lot firebreaks
Road centrelines are investigated to retain significant vegetation including foraging habitat and habitat trees for Black Cockatoos.
Vegetation is preserved where possible within the 20-23m road reserves.
Construction Management Plans are prepared and implemented.
Peet
Creates lots and places Notification on Title showing:
Location of habitat trees.
Protective Covenants over the Title.
Landowner
Purchases Lot
Notification on Title alerts owner of habitat trees.
Protective Covenants restrict clearing on the lot (other than what is required for the building envelope and fire management).
Landowner
Informs Peet of house design and proposed building envelope on the lot.
Peet arranges inspection by the Fire Management Consultant.
Peet
Inspection by Fire Management Consultant
Deems building envelope is in the correct location, completes BAL assessment and
Identifies vegetation modification required for the Building Protection Zone (pre-clearing checklist).
Quantifies vegetation clearing required (estimated no. trees) (pre-clearing checklist).
Peet
Inspection by Fire Management Consultant
Deems building envelope is not in correct location.
Landowner
Chooses building envelope in consultation with the Fire Management Consultant and undertakes house design if necessary .
Peet
Inspection by Fire Management Consultant
Deems building envelope is in correct location and completes assessment and
Identifies vegetation modification required for Building Protection Zone (pre-clearing checklist).
Quantifies vegetation clearing required (estimated no. trees) (pre-clearing checklist).
Landowner
Submits application for Building Licence to the City of Swan and must show the
Position of building envelope.
Location of vegetation.
Adherence to the Fire Management Plan.
Completed BAL assessment.
City of Swan
Considers the Building License and ensures its consistency with
The approved Local Structure Plan (including building envelopes which restricts building to a maximum of 10% of the gross lot area).
Australian Standard 3959 as per Fire Management Plan.
Landowner
Receives approval
From City of Swan and the Landowner commences building.
Clears vegetation
In accordance with Building Licence Approval, adherence to the Protective Covenants and advice from the Fire Management Consultant.
City of Swan
Building Inspector/ Fire Control Officer
Inspects compliance with Building Licence.
Any additional clearing
Requires a clearing permit from Department of Environment Regulation.
Landowner
Additional buildings requires building licence applications.
Peet
Inspection by Fire Management Consultant
Confirms vegetation modification has been completed in accordance with advice (post-clearing checklist).
Peet
Inspects compliance with Protective Covenants.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APPENDIX B

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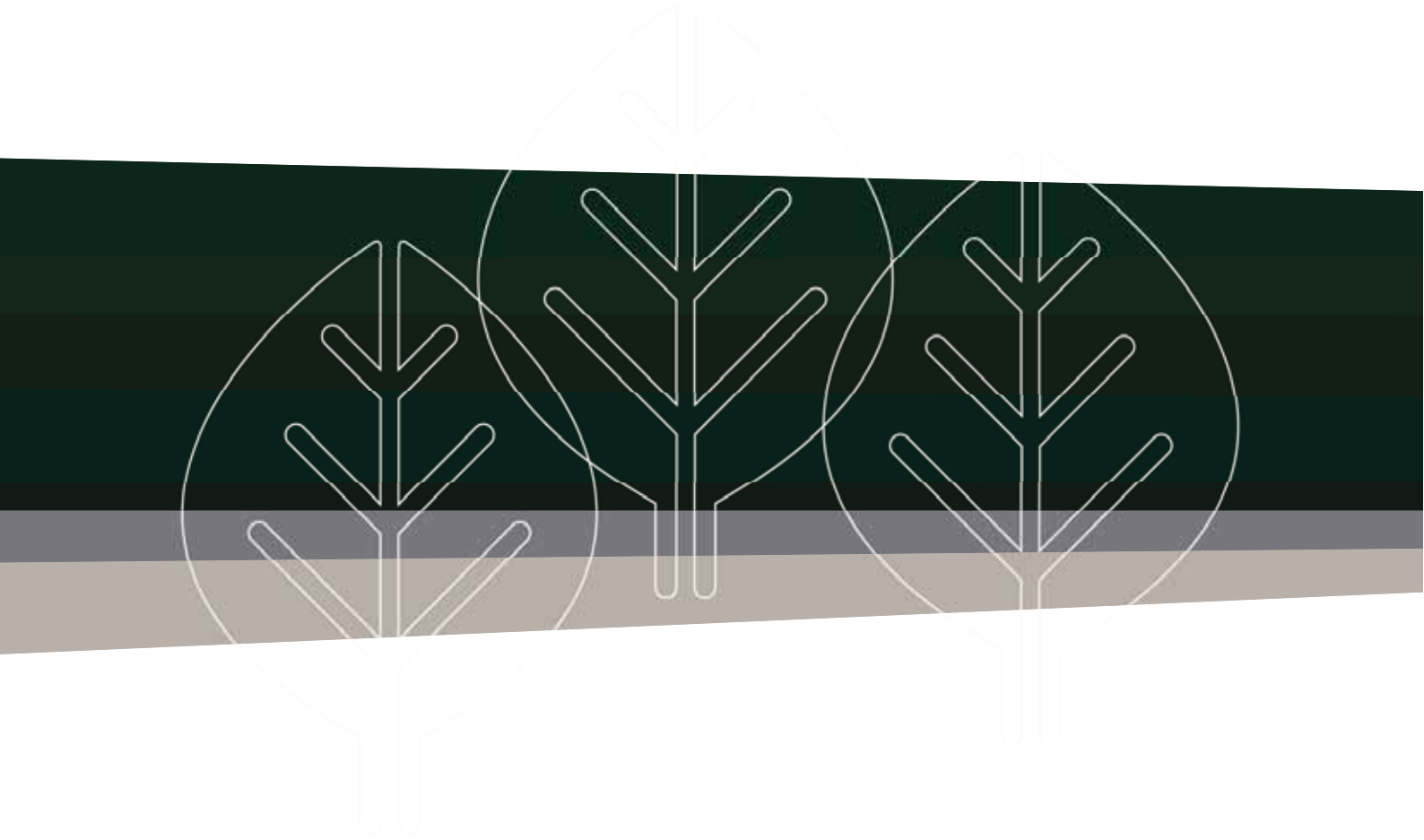
BIANNUAL REVEGETATION MONITORING REPORTS

revegetating
rehabilitating
restoring

tranen
revegetation systems



Avon Ridge Estate
Bi-annual Monitoring Report – Spring 2013

Emerge Associates

P496-02-Rev00

February 2014

Disclaimer

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Rev	**Date**	**Description**	**Author**	**Director Review**
00	28/02/14	Bi-annual monitoring report first draft (spring 2013)	RSW	DG

Table of Contents

1 SUMMARY

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012 and 2013 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development.

A total of 106,775 seedlings have been installed over 2011, 2012 and 2013. These have been installed across six sites:

- Site 1A: 42,775 seedlings installed in 2011 and 2012;
- Site 2: 30,520 seedlings installed in 2012 and 2013;
- Site 3: 2,610 seedlings installed in 2013;
- Site 4: 10,340 seedlings installed in 2013;
- Sales Office A (SO-A): 6,150 seedlings installed in 2013; and
- Sales Office B (SO-A): 14,380 seedlings installed in 2013.

The approval given to PEET under the *Environment Protection Biodiversity Conservation Act 1999* requires a survivorship rate of 90% of all installed seedlings at the end of the three year maintenance period.

Following the spring 2013 monitoring, the following survival rates have been observed:

- Site 1A: 81% of original numbers planted in 2011 (± 34% standard deviation); 67% (± 30%) of total numbers planted;
- Site 2: 129% (±69%) or original numbers planted in 2012; 74% (± 7%) of total numbers planted;
- Site 3: 36% (± 18%);
- Site 4: 55% (± 21%);
- Sales Office A (SO-A): 51% (± 17%); and
- Sales Office B (SO-A): 58% (± 17%).

Infill planting is therefore required in 2014 to increase plant densities in the sites. This is a pro-active approach which aims to achieve the 90% survivorship criteria by replacing dead plants before the end of the three year monitoring period. The infill plants do not count towards the 214,000 seedlings required to be planted, and future survivorship observations are calculated against the original number of seedlings planted.

This report contains details of the number of infill plants recommended for each site, as well as a recommended species list from which the plants could be drawn. The species list contains mainly shrub and ground cover species from the list proposed in the *Revegetation and Fire Management Plan* (Cardno 2012) so that tree density is not increased further, and to allow higher plant densities to be achieved during the infill planting.

In 2013, two sites were trialled as non-fenced areas to determine whether the fences are effective at protecting seedlings from herbivores. Site 3 and Sales Office A did not have fences installed, and monitoring observations and survivorship counts demonstrated that fences were a crucial protective measure for the seedlings. It is recommended that Site 3 be fenced to protect 2014 infill plants, and that the fence at Site 4 is altered to reduce the likelihood of members of the public opening gates and allowing kangaroos on to the site, which was a problem throughout the first year of managing this site.

It is not recommended that a fence be installed at Sales Office A, owing to it being a highly visible site to neighbours and potential buyers of lots for the development. On this site, the eucalypt seedlings are not being grazed by kangaroos, and should continue to grow without protection. Infill seedlings for this site may have to be re-directed to other sites.

2 INTRODUCTION

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012 and 2013 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development as per the conditions under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2.1 EPBC Approval Conditions (Section 2b)

The revegetation measures to create additional Black Cockatoo habitat across the project site, including in the Parks and Recreation Reserve, specifically are:

- Revegetating all vegetation condition classes (excluding pristine and excellent classes) and vegetation complexes;
- Designing species mix: numbers and density to be planted;
- Timing the proposed planting (must be following the annual winter rain period);
- Implementing weed management measures;
- The survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead trees must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;
- Annual monitoring measures within the project area undertaken by an appropriately qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three years after the initial revegetation planting in any given area (given that revegetation will be staged across the development); and
- Annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Parks and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial planting in the Parks and Recreation reserve for the purpose of establishing the survivorship rates and replanting efforts within the project area.

2.2 Monitoring Program Objectives

The main objectives of the bi-annual monitoring program are to:

- Demonstrate the success of the revegetation against the completion criteria specified by the EPBC approval conditions; and
- Identify issues affecting the revegetation program, such as weeds, pathogens or acts of vandalism.

2.3 Completion Criteria

At the end of the three year maintenance period, the following completion criteria are required to be met (from the *Revegetation and Fire Management Plan*, Cardno 2012):

- Survivorship rate must be at least 90% (nb: this is a condition of the EPBC Act approval);
- Plants are healthy in appearance and diverse in species with no mass losses;
- Species diversity is ≥ 65% (i.e. 65% of the species planted have survived);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

3 REVEGETATION SITES AND WORKS TO DATE

Six revegetation sites have been established (for a map of their locations, refer to Appendix 1):

- Site 1A: established in 2011;
- Site 2: established in 2012;
- Site 3: established in 2013 as an unfenced trial site;
- Site 4: established in 2013;
- Sales Office A: established in 2013 as an unfenced trial site; and
- Sales Office B: established in 2013.

A summary of the planting years, total area and number of seedlings for each revegetation site is presented in Table 1. The total number of seedlings planted to date is 106,775.

Table 1 Revegetation Sites

Site Name	Area (ha)	Fenced or Unfenced	2011 Seedlings	2012 Seedlings	2013 Seedlings	Total Seedlings
1A	13.4	Fenced	30,775	12,000	-	**42,775**
2	4.7	Fenced	-	24,000	6,520	**30,520**
3	0.3	Unfenced	-	-	2,610	**2,610**
4	2.8	Fenced	-	-	10,340	**10,340**
Sales Office A	0.8	Unfenced	-	-	6,150	**6,150**
Sales Office B	2.3	Fenced	-	-	14,380	**14,380**
					TOTAL	**106,775**

3.1 Site 1A

The 2011 initial revegetation program at Site 1A consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a 1,545 m long, 1.8 m high, kangaroo fence with rabbit proof skirt;
- Pre-planting weed control program of herbicide application (glyphosate and simazine) in July 2011 and manual removal of olive trees (August 2011); and
- Planting of 30,775 seedlings into rip lines between July and August 2011.

Since the initial installation the following maintenance activities have been undertaken at Site 1A:

- Additional planting: 12,000 seedlings in August 2012;
- Fencing repair (2013);
- Weed control maintenance:
  - Spring 2011;
  - Summer, autumn and spring 2012; and
  - Winter 2013.

Figure 1 Site 1A – Transect #24 Shows the Developing Plants Installed in 2011

3.2 Site 2

The 2012 revegetation program at Site 2 consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a 1,000 m long, 1.8 m high, kangaroo fence with rabbit proof skirt;
- Pre-planting weed control program of herbicide application (glyphosate and Simazine) in July 2012; and
- Planting of 24,000 seedlings in August 2012.

Since the initial installation the following maintenance activities have been undertaken at Site 2:

- Fencing repair (2012);
- Additional planting: 6,520 seedlings in June and July 2013;
- Weed control maintenance:
    - Spring 2012;
    - Summer 2012/13; and
    - Autumn 2013.

Figure 2 Site 2 – Transect # 19 Showing Strong Growth of 2012 Plants (Background) and New Seedlings Installed 2013 (Foreground)

3.3 Site 3

Site 3 was established without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings.

The 2013 revegetation program at Site 3 consisted of:

- Deep ripping (not undertaken by Tranen);
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 2,610 seedlings in July 2013.

No further maintenance works have been required.

Figure 3 Site 3 – Transect # 4 Showing Few Seedlings and no Growth

3.4 Site 4

The 2013 revegetation program on Site 4 consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a 572 m long, 1.8 m high, kangaroo fence with rabbit proof skirt;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 10,340 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 4:

- Fence repairs (August 2013).

Figure 4 Site 4 – Transect # 10 Showing Little Growth and Few Seedlings

3.5 Sales Office A

Sales Office A was established without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings.

The 2013 revegetation program on Sales Office A consisted of:

- Deep ripping (not undertaken by Tranen);
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 6,150 seedlings in June 2013.

Since the initial installation the following maintenance activities have been undertaken at Sales Office A:

- Weed control maintenance:
  - Winter 2013; and
  - Spring 2013.

Figure 5 Sales Office A – Quadrat # 5 Showing Low Density of Plants

3.6 Sales Office B

The 2013 revegetation program at Sales Office B consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a 825 m long, 1.8 m high, kangaroo fence with rabbit proof skirt;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 14,380 seedlings in July 2013.

No further maintenance works have been required.

Figure 6 Sales Office B – Quadrat # 3 Showing Good Plant Growth

4 MONITORING METHODOLOGY

This report presents results from the field survey conducted between 14 and 22 November 2013 (spring 2013).

4.1 Plant Survival

Plant survival was assessed in each of the six sites using transects along rip-lines, or within quadrats where rip-lines were short and / or in multiple directions over a small area. The initial survey for each site, undertaken in spring following seedling installation, determines the baseline data which is a count of the number of seedlings planted within the monitoring plot. Percentage survival is assessed against this figure for future monitoring events.

Sites 1A and 2 have both received additional planting in the winter after their initial establishment (Table 1. Survivorship has been calculated against the initial planting numbers, and therefore can be greater than 100% where the additional planting has increased plant numbers above the original number installed.

4.2 Monitoring Plot Establishment and Survival Calculations

Transects, quadrats or a combination of both, were used to assess percentage survival of seedlings at each site. The method employed for assessing survival was dependent on the characteristics of each site, as described below. Different methods were necessary because of the nature of the rip-lines (i.e. long, easily identifiable rip-lines compared with short rip-lines in multiple directions), and difficulties with being able to observe dead plants during the first survey after planting (because of herbivory or rapid decay).

In some transects, there are seedlings that appear to have germinated naturally (i.e. natural recruitment). These have been included in total seedling counts because they contribute to the total number of plants that are present at the site, and are a direct result of the site preparation activities (i.e. soil cultivation, weed management, etc.).

4.2.1 Site 1A

Fifty transects were established at Site 1A in spring 2011. These permanent transects have been surveyed in spring and autumn since the initial survey.

Results are presented for each rip-line showing the number of plants originally planted in 2011 and the total number planted (2011 + 2012 seedlings). Percentage survival is calculated based on the original number planted.

4.2.2 Site 2

The initial survey at Site 2 was a random sample of rip-lines throughout the site, and this was continued until the current survey was undertaken. Being

random, there was no baseline data against which survival could be assessed. During the previous monitoring survey in autumn 2013, it became clear that for future surveys it was no longer going to be possible to identify how many dead plants there were, and therefore not be possible to calculate survival from total number planted along a transect.

It was therefore decided during the current survey (spring 2013) that permanent transects should be established. Twenty transects were established across the site to obtain a representative sample of percentage survival. For each transect, it was assumed that 66% of the original number of seedlings planted in 2012 had survived, based on the mean percentage survival that was calculated during the autumn 2013 survey (Tranen 2013). It was possible during the spring 2013 survey to identify new seedlings planted in 2013, from the original seedlings planted in 2012. Thus, a count was made of live and dead seedlings from 2013 planting, and all other living plants were counted (survivors from 2012). To determine the original number planted in 2012, the number of survivors from 2012 was divided by 0.66 to estimate the original number of plants installed.

Results are presented for each rip-line showing the total number of plants originally planted in 2012 (calculated using the assumption of 66% survival) and the total number planted (2012 + 2013 seedlings). Percentage survival is calculated based on the original number planted.

4.2.3 Site 3

Nine transects were established along rip-lines in Site 3 during the spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

4.2.4 Site 4

Fifteen transects were established along rip-lines in Site 4 during the spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

4.2.5 Sales Office A

Six quadrats measuring 10 x 10 m were established across the site during the spring 2013 survey. Quadrats were used instead of transects as this site had been ripped in multiple directions, rather than having parallel rip-lines installed across the slope.

Due to impacting factors at the site, the most severe being kangaroo herbivory, it was not possible to obtain counts of dead plants, as there was little evidence of any dead plants remaining. To determine the baseline data and enable future calculations of percentage survival, the following steps were undertaken for each quadrat:

- Number of living plants was counted;

- The density of plants was calculated as (number of living plants) / 100 m^2;
- The density in each quadrat was compared against the average density calculated for the site, which was calculated as:
    - Total number of seedlings planted for the site divided by the area of the site = 6,150 seedlings / 8,000 m^2 = 0.77 plants / m^2;
- Seedling survival was therefore calculated as: quadrat density / 0.77.

4.2.6 Sales Office B

A combination of quadrats and transects was employed at Sales Office B, as there were wide areas with clear rip-lines in some places, and small areas where multiple rip-lines had been installed in several directions. Ten transects and five 10 x 10 m quadrats were established during the spring 2013 survey to obtain a representative survey of the site. Baseline data were collected of live and dead plants on each transect or in each quadrat to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

4.3 Other Observations

At each revegetation site, observations were made of weed species and cover, seedling health (including pest attack, drought stress etc.), species richness, maximum plant height along transects, occurrence of erosion or soil disturbance, and the health or occurrence of remnant vegetation.

Species richness was determined by observations of whether each species planted into the site was present. This was done by observations on the transects and by a walk-through across the site.

5 RESULTS

Monitoring data are summarised in Table 2with raw data for each transect presented in Appendix 2. Descriptions for each site are presented in the sections below.

Table 2presents the data for both autumn and spring 2013 for Sites 1A and 2 to demonstrate the changes that occur between seasons, and to allow the completion criteria to be assessed.

Table 2 Summary of Monitoring Data – Autumn and Spring 2013

Measurement	Season & Year	Site					
		1A	2	3	4	SO-A	SO-B
% Survival	Aut 2013	74%	66%	-	-	-	-
	Spr 2013	81%	129%	36%	55%	51%	58%
Species Richness[A]	Aut 2013	87%	94%	-	-	-	-
	Spr 2013	80%	90%	58%	100%	100%	100%
Maximum Height (m)	Aut 2013	3.2	1.0	-	-	-	-
	Spr 2013	3.9	2.0	0.3	0.3	0.4	0.5

[A] Species richness is calculated as the number of species observed divided by the total number planted

5.1 Site 1A (Planted in 2011 and 2012)

5.1.1 Survival and Condition of Revegetation

Mean survival rate across the 48 transects at Site 1A was 81% (± 34% standard deviation) of original numbers planted in 2011, which is an increase from the 74% recorded in autumn 2013. Survival of all seedlings planted into the transects (i.e. 2011 seedlings + 2012 seedlings) was 67% (± 30% standard deviation) with a range of 21–214%. This has increased from 60% recorded in autumn 2013 due to more natural recruitment in some transects. Survival rates of > 100% occur on transects where there is natural recruitment within the sampling unit which is above the total number of seedlings installed into that transect. Eight transects had natural recruitment which was mainly *Eucalyptus rudis*.

Plants installed in open areas of the site (i.e. without any influence from remnant vegetation) appear to be growing faster than plants installed near remnant *E. rudis* trees. Survival rates do not appear to differ between open areas and those under canopy, though the natural germination of *E. rudis* has likely contributed to the high survival rates observed in transects under canopy (Figure 7).

Figure 7 Site 1A – Multiple *Eucalyptus rudis* Seedlings Observed on or Near Transect 36

5.1.2 Plant Heights

Maximum plant heights along transects at Site 1A were as high as 5.5 m, and as low as 2.5 m. Of the 48 transects that were surveyed in spring 2013, *Acacia saligna* was the tallest species for 40 of them, with *E. rudis* the tallest in the remainder.

Maximum plant height has increased 0.7 m on average between autumn and spring 2013.

5.1.3 Remnant Vegetation

Site 1A contained a number of pockets of remnant vegetation, mainly *E. rudis* and *E. wandoo* trees, as well as a shrubland of *Leptospermum erubescens* in the north-eastern corner of the site.

A number of seedlings have germinated from the soil-stored seed bank since the beginning of the project, and these plants are further increasing the number of plants in the area. *Eucalyptus rudis* dominates the natural recruits, while *Hibbertia commutata* and *Banksia sessilis* recruitment has also been observed. The *B. sessilis* was only observed outside the rip-lines and the *H. commutata* throughout the site including on rip-lines.

5.1.4 Weeds

Weed cover was generally low throughout the site, with the survey taking place after most annual winter weeds have completed their life cycle. Mean weed cover was 21%, but this was strongly influenced by a few transects having high weed cover (maximum cover was 80%). The median weed cover was 5%, which is a better reflection of the site condition.

While weed cover was as high as 80% on some transects, the biomass was a mixture of live and dead leaves as the weeds were mainly annual grasses that were dying off.

5.1.5 Species Richness

In Site 1A, 21 species were planted in 2011 and an additional 9 species planted in 2012. Of these 30 species, 24 were observed (80% of the total) either during the transect scoring or while walking across the site (Appendix 2). Species richness has decreased from 87% in autumn 2013.

5.1.6 Fauna

No signs of herbivory, digging or utilisation by birds was observed during the monitoring.

5.1.7 Surface Stability and Erosion

Soil surface was stable across the site, with little or no sign of erosion.

5.2 Site 2 (Planted in 2012 and 2013)

5.2.1 Survival and Condition of Revegetation

Mean survival rate across the 20 transects installed during this survey at Site 2 was estimated at 129% (± 7% standard deviation) of the original number of seedlings planted in 2012, indicating the infill planting in 2013 has increased plant numbers above that originally planted.

Survivorship is not strictly comparable between autumn and spring 2013 because no permanent transects had been established and therefore no baseline data exists. In addition, the average 66% survival rate from autumn was used to estimate the original number of seedlings on each newly installed permanent transect during the spring survey. However, an increase in survival would be expected because the site received additional planting in 2013.

Plant distribution was fairly even across the site, with bare areas having received additional planting in winter 2013. However, plant growth appeared better in the more open areas that did not have a tree canopy.

5.2.2 Plant Heights

Plant heights varied across the site according to the species that were observed in the transects. *Acacia saligna* were the tallest plants observed at heights of up to 3.5 m, while the tallest species in other transects were only 0.5 m tall. Some of these were *Hakea undulata* from 2012 while others were *Acacia saligna* which were most likely only planted in 2013.

Maximum plant heights increased by 1.0 m on average since autumn 2013.

Plant heights were lower where canopy trees were within close proximity.

5.2.3 Remnant Vegetation

Site 2 contained several patches of remnant vegetation, with *Corymbia calophylla* and *Eucalyptus wandoo* trees scattered throughout the site.

Seedlings of *E. wandoo* and *C. calophylla* were observed on site, while the native grass *Austrostipa flavescens* occurred in high densities in some areas.

5.2.4 Weeds

Weed cover was low across the whole site, with mean weed cover 2% and a maximum cover observation of 5%. Most weeds observed were annual grasses that were completing their life cycle following winter, and would be shallow-rooted species. There were some populations of the summer weed *Dittrichia graveolens* (Stinkwort) and the perennial *Solanum nigrum* (Black Berry Nightshade) germinating in a few locations, but these were small populations.

5.2.5 Species Richness

In 2012, 18 species were planted at Site 2, with an additional 2 species planted in 2013. Of these 20 species, all but two were observed either on transects or during a walk-through of the site (90% of the total species). The percentage of species observed has reduced from 94% in autumn 2013.

Two species recorded in autumn 2013 were not observed in this assessment: *Hakea cyclocarpa* and *H. incrassata*. However, one previously unrecorded species, *Banksia prionotes*, was observed.

5.2.6 Fauna

No signs of herbivory, digging or utilisation by birds was observed during the monitoring.

5.2.7 Surface Stability and Erosion

Soil surface was stable across the site, with little or no signs of erosion.

5.3 Site 3 (Planted in 2013)

5.3.1 Survival and Condition of Revegetation

Mean survival of seedlings installed into Site 3 was 36% (± 18%) across the nine transects. Survival ranged from 0% to 55% across the transects.

The condition of surviving plants was poor, with many having been eaten or in poor condition. No new growth was observed on any of the surviving plants.

5.3.2 Plant Heights

Maximum plant heights at Site 3 ranged between 0.2 m and 0.5 m.

5.3.3 Remnant Vegetation

Site 3 was established within a clearing surrounded by *E. wandoo* and *C. calophylla* trees. The site contains a few seedlings and saplings of *E. wandoo*.

No natural germinants were observed in the transect lines in spring 2013.

5.3.4 Weeds

Weed cover was very low in Site 3, with all transects having weed cover ≤ 1%. Dead annual grasses were evident between the rip-lines, as well as the occasional *Echium plantagineum* (Paterson's Curse) individual.

5.3.5 Species Richness

Twelve species were planted at Site 3. Of these, five species were not observed during the monitoring, leaving seven remaining (58% of the total species) (Table 2; Appendix 2).

5.3.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through dung and resting sites. There was no evidence that rabbits had been on the site, but it is possible. Many surviving plants have been adversely affected by herbivory, with *Acacia saligna* in particular being heavily grazed.

5.3.7 Surface Stability and Erosion

The site showed only minor evidence of erosion. All rip-lines have been installed across the slope parallel to the contours, and therefore reduce surface runoff flows and the erosion potential.

5.4 Site 4 (Planted in 2013)

5.4.1 Survival and Condition of Revegetation

Mean survival of seedlings installed into Site 4 was 55% (± 21%) across the 15 transects. Survival ranged from 25% to 90% across the transects (Appendix 2).

The condition of surviving plants was poor, with many being eaten or in poor condition, even though a fence had been constructed around the site.

5.4.2 Plant Heights

Maximum plant heights at Site 4 ranged between 0.1 m and 0.5 m.

5.4.3 Remnant Vegetation

Site 4 contains patches of remnant vegetation which consists almost entirely of *E. wandoo* mature trees. These are scattered throughout the site, but are only small in area.

No natural germination was observed on the transects in spring 2013.

5.4.4 Weeds

Weed cover was very low throughout the site, with all transects recording weed cover of ≤ 1%.

5.4.5 Species Richness

Sixteen species were plated at Site 4, all of which were observed during the spring 2013 assessment.

5.4.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through the presence of dung. There was no evidence that rabbits had been on the site, but it is possible. Many surviving plants have been adversely affected by herbivory, with *Acacia saligna* in particular being heavily grazed.

This site had been fenced but when visiting the site during the monthly inspections, the gates were frequently found open, and the fencing had been ripped down in places. This allowed kangaroos access to the site.

5.4.7 Surface Stability and Erosion

The slopes on the eastern side of the site do have some erosion channels forming, some of which may be a result of the direction of ripping that was undertaken on the site. The erosion has affected plant survival, with some plants having had the soil washed away from the root ball.

5.5 Sales Office A (Planted in 2013)

5.5.1 Survival and Condition of Revegetation

Mean survival of seedlings installed at Sales Office A was 51% (± 17%) across the six quadrats. Survival ranged from 25% to 75% across the quadrats.

The condition of most surviving plants was poor, with many being eaten or in poor condition. The Eucalypt species were growing the best, and these did not seem to be getting grazed by herbivores.

5.5.2 Plant Heights

Maximum plant heights at Sales Office A ranged between 0.2 m and 0.5 m.

5.5.3 Remnant Vegetation

There is no remnant vegetation within Sales Office A. This was a bare paddock prior to revegetation works commencing.

A naturally-recruited seedling of *Acacia pulchella* was observed in Quadrat 3 during the spring 2013 monitoring survey, and another *A. pulchella* seedling was observed outside the quadrats.

5.5.4 Weeds

Weed cover was low throughout the site at the time of survey, with an average weed cover of 3% (maximum recorded was 5%).

Sales Office A has the potential to be very weedy given the large population of *Gomphocarpus fruticosus* (Narrow-leaf Cotton Bush) on the road verge immediately up-hill of the site. Some seedlings were recorded during the survey, as well as a few Black Berry Nightshade and Paterson's Curse plants.

5.5.5 Species Richness

All 11 species that were planted into Sales Office A were observed during the survey. Many of these were severely grazed upon, while *E. wandoo* and *C. calophylla* were the healthiest species remaining.

5.5.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through the presence of dung. There was no evidence that rabbits had been on the site, but it is possible. All surviving plants have been adversely affected by herbivory, though *E. wandoo* and *C. calophylla* were less affected and appear to have reached a stage where they are no longer being grazed.

5.5.7 Surface Stability and Erosion

There was some erosion occurring on this site. The site occurs on a relatively steep hillside, and when ripped, some rip-lines were installed perpendicular to the contours rather than parallel (by contractors not organised by Tranen), which channels and increases the speed and volume of surface flows, rather than reducing it.

5.6 Sales Office B (Planted in 2013)

5.6.1 Survival and Condition of Revegetation

Mean survival of seedlings installed at Sales Office B was 58% (± 17%) across the five quadrats and ten transects. Survival ranged from 26% to 84% across the plots.

The condition of surviving plants was generally very good, with strong growth and few signs of stress.

5.6.2 Plant Heights

Maximum plant heights at Sales Office B ranged between 0.3 m and 0.6 m. The tallest species in 12 of the quadrats or transects was *A. saligna*, with three transects having *E. rudis* being the tallest species.

5.6.3 Remnant Vegetation

Sales Office B contains patches of remnant vegetation which consists almost entirely of *E. wandoo* mature trees. These are scattered throughout the site, but mainly occur on rocky breakaways.

No natural germination was observed on the transects or quadrats in spring 2013.

5.6.4 Weeds

Weed cover was low throughout the site at the time of survey, with an average weed cover of 2.3% (maximum recorded was 8%).

5.6.5 Species Richness

All 15 species planted at Sales Office B were observed during the survey.

5.6.6 Fauna

There was little evidence of plants being grazed at Sales Office B, with most being healthy plants. Kangaroos were found in the site during one of the monthly visits, but these were able to leave through opened gates.

5.6.7 Surface Stability and Erosion

There was minor erosion evident in some of the rip-lines that were installed with a slight downhill orientation, and this erosion may have led to some plant deaths. It is not a great concern across this site.

6 DISCUSSION

6.1 Plant Survival

To date, 106,775 seedlings have been planted for the Avon Ridge project out of a total of 214,000 stipulated in the offset package prepared by Peet. Of these, 88,255 seedlings are original plantings into the sites, and 18,520 have been infill planting into sites 1A and 2. These have been planted across six separate revegetation sites over a three year time frame beginning in 2011. Survivorship of plants installed into the revegetation sites must be 90% or greater after three years to meet Condition 3 of the EPBC approval.

The survival of planted tubestock as assessed during the spring 2013 monitoring survey is:

- 81% at Site 1A (two years after initial planting);
- 129% at Site 2 (one year after initial planting);
- 36% at Site 3 (four months after initial planting);
- 55% at Site 4 (four months after initial planting);
- 51% at Sales Office A (five months after initial planting); and
- 58% at Sales Office B (four months after initial planting).

These figures are currently all below the 90% required of the EPBC conditions for all sites except Site 2.

6.2 Plant Health, Species Richness and Growth of Revegetation

The condition and growth of revegetation works is good for the areas that have been fenced to exclude kangaroos, with the exception of Site 4 which has often had gates left open and has had members of the public remove sections of fence through vandalism. Sites 1A, 2 and Sales Office B have healthy looking plants, strong growth rates and generally very good survival rates.

Plant heights have increased at Sites 1A and 2 between the autumn and spring surveys for 2013, meeting one of the completion criteria outlined in the *Revegetation and Fire Management Plan*, Cardno 2012) (see Section 2.3). Plant heights are up to 5.5 m tall at Site 1A (two year old plants), 3.5 m tall at Site 2 (one year old plants), and 0.6 m at Sales Office B (four month old plants). By contrast, Sites 3 and Sales Office A (the two unfenced sites), have very unhealthy looking plants, little to no growth of new foliage, and poor survival rates. Plant heights are less than 0.5 m at these sites.

Site 3, in particular, has had very poor results. This site is small and surrounded by woodland. Kangaroos are likely to have grazed the fresh, nutrient-rich seedlings in preference to other fodder in the surrounding area (Figure 8). Grazing pressures are also notable at Site 4 where the fence has been breached by kangaroos.

The Eucalypt seedlings at Sales Office A have survived and grown reasonably well compared with all the other species planted at this site, and also compared with the eucalypts planted at Site 3. Eucalypts are less-palatable to kangaroos than the shrub species which explains the better survival and growth of these species at Sales

Office A. The death of Eucalypts at Site 3 is harder to explain, as many of these did not appear to have been grazed. There was a high proportion of *E. rudis* at this site (none at Sales Office A) which may not have been suitable to the area. *Eucalyptus rudis* is the Flooded Gum, and occurs in wetter parts of the landscape such as valley floors and along water courses. It is possible that Site 3 is too dry for *E. rudis* to persist. At Site 4, which is located 170 m from Site 3, *E. rudis* has also not performed well. It is recommended that *E. rudis* is not included in future planting lists unless the planting site is near watercourses or the surrounding trees include mature *E. rudis.*

Figure 8 *Acacia saligna* seedling Showing Signs of Grazing at Site 3

Species richness was high for all sites except Site 3. Based on the total number of species planted into each site, only 58% of the species were observed at Site 3, compared with 80% – 100% of all species at the other sites. It must be noted that the observation of species is largely dependent on what is observed on the transect and during a random meander through the site. It is therefore possible that the species that were not observed during the survey may occur but not have been sighted.

6.3 Weeds

Weed cover was negligible across most of the sites at the time of survey. November is a time when annual winter weeds are close to completing their life cycle; hence there was little living weed biomass in the rip-lines. Some summer weeds were

noted, such as Black Berry Nightshade and Stinkwort, but these populations were very small and generally outside of the rip-lines.

Site 1A had the highest mean weed cover of 21%. However, plants at Site 1A are now over two years old and have established a deep root system such that the shallow-rooted annual weeds (mostly grasses at Avon Ridge) are unlikely to compete for resources. Similarly, plants installed during 2012 at Site 2 are unlikely to be significantly affected by weeds, though this site now has received seedlings during 2013 and these may still be susceptible to competition.

Three of the four new revegetation sites established in 2013 (Sites 3 and 4, and Sales Office B) were sprayed with a pre-emergent herbicide prior to revegetation works. The rip-lines have been generally weed-free since, as observed during monthly visits to the sites.

Sales Office A was not treated with a pre-emergent herbicide prior to seedling planting, and this site has required weed control in winter and spring 2013. There was a population of Narrow-leaf Cotton Bush on the roadside uphill of the site which was physically removed by Tranen prior to planting. A large number of seedlings have emerged, and will continue to emerge as this revegetation site develops. Narrow-leaf Cotton Bush is a serious invader of agricultural and bush land, and will require on-going control at this site. Paterson's Curse and other serious weeds will also require monitoring and treatment.

6.4 Remnant Vegetation and Natural Recruitment

Sites 1A and 2 have both shown improvement in condition through natural recruitment. Hundreds of *E. rudis* seedlings have been observed at Site 1A, including in the transects where they have been counted towards the plant numbers and therefore the survival figures. This explains the increase in survival rates for some transects compared with last year, and the increased overall mean survival rate for the site from 74% in autumn to 81% in spring 2013. Other species that have been observed germinating at Site 1A are *Corymbia calophylla, Banksia sessilis, Hibbertia commutata, Allocasuarina fraseriana* and *Ficinia nodosa*, of which *C. calophylla, B. sessilis* and *A. fraseriana* are all Black Cockatoo foraging species (Valentine and Stock, 2008; Groom, 2011).

Species that have been observed germinating at Site 2 include *C. calophylla, E. rudis*, *H. commutata* and *Hypocalymma* sp. A large population of the native grass *Austrostipa flavescens* has also established in the centre of Site 2, and in less dense populations in other areas throughout the site. It is likely that the natural recruitment of these species has benefitted significantly from the exclusion of kangaroos, particularly the native grass and shrub species.

For the four sites established in 2013 it is too early to see any positive benefit of the revegetation works on the remnant vegetation. However, at Sales Office A, two seedlings of *Acacia pulchella* were observed to have germinated from the soil seed bank, indicating there is a dormant seed bank that could contribute to species diversity in future years.

6.5 Fauna

Establishment of four new sites in 2013 included a trial to determine the effectiveness of fencing on success of the revegetation. Site 3 and Sales Office A were established without fences, while Site 4 and Sales Office B were fenced with 1.8 m chainmesh. Unfortunately, the fence at Site 4 was damaged by vandals, and the gates across the track were frequently left open, which most likely resulted in herbivores gaining access to the seedlings. However, the fence at Sales Office B remained intact.

Growth rates and plant health were better at Sales Office B than the other sites, with plants displaying fresh new leaves and all plants growing well. By contrast, Site 3 and Sales Office A displayed no fresh growth of understorey plants, with only the Eucalypts at Sales Office A growing significantly. Survival of seedlings also appeared to be affected by grazing pressure, with the fenced Sales Office B having the highest survival rate of 58%, compared with 51% at Sales Office A, 36% at Site 3 and 55% at Site 4.

Kangaroos were presumed to be the most likely herbivore grazing at all sites, with kangaroo dung observed on all sites. The presence of rabbits and other herbivores could not be confirmed, with no evidence that they had impacted the sites. Figure 9shows the grazing pressure that occurs in the area, with grasses outside the fence for Site 1A heavily grazed, while grasses inside the fenced area are tall.

No other native fauna was observed on site, apart from birds, lizards and ants. No Carnaby's Black Cockatoos were observed utilising the sites during any of the monthly visits.

Figure 9 Impact of Herbivore Grazing. Left of the Fence is Outside the Revegetation Site 1A, Right of the Fence is Inside the Revegetation Site.

6.6 Surface Stability and Erosion

Surface erosion was noted at Sales Office A and B, and at Site 4, all of which have relatively steep slopes. Erosion at Sales Office B was minimal, but it is more severe at Sales Office A and Site 4. The erosion has affected plant survival, with soil washed away from the root ball of seedlings.

7 CONCLUSIONS

In conclusion, revegetation at Avon Ridge is progressing well but requires on-going maintenance works to reach completion criteria.

Table 3summarises the progress of revegetation against completion criteria and the actions required to achieve targets.

Table 3 Revegetation Progress Against the Completion Criteria

Completion Criteria	Revegetation Progress	Actions Required
Survivorship rate must be at least 90%	Not meeting criteria	Infill planting required 2014
Plants are healthy in appearance and diverse in species with no mass losses	Most sites meeting criteria. Where fencing not done or inadequate, sites not meeting criteria	Erection (Site 3) or alteration (Site 4) of fence required
Species diversity is ≥ 65%	Only Site 3 not meeting target	Infill planting in Site 3 to replant species
The average seedling height has increased between assessments	Meeting criteria	Continue monitoring
Weed presence is minimal and not inhibiting native plant survival and growth	Meeting criteria	Continue weed control as needed

Other observations within the sites that are significant to the overall revegetation effort and success rates are:

- Kangaroo grazing significantly affects survival – unfenced sites have had very low survivorship;
- Natural recruitment has been observed in significant numbers within the older sites, which has been promoted by non-planting site preparation activities such as fencing, ripping and weed control;
- There has not been significant erosion observed in areas where ripping is parallel with contours, and minor erosion where ripping is perpendicular to contours.

8 FUTURE WORK AND RECOMMENDATIONS

8.1 Achieving Survival Targets

Further planting is required on existing revegetation sites in 2014 to obtain the target of 90% survival of seedlings after three years.

Based on the numbers already planted, and survival rates obtained through this monitoring survey, Tranen has determined a recommended number of seedlings for infill planting in 2014, resulting in a total number of around 27,000 – 44,000 seedlings (Table 4).

Table 4 Recommended Infill Planting for 2014

Site	No. Planted	Survival Rate A	No. Surviving B	No. Equating to 90% Target C	Number Required to meet 90% C - B	No. Required to Meet 90% Allowing for Attrition at Each Site (C – B) / A
1A	42,775	67%	28,659	38,498	9,839	14,684
2	30,520	74%	22,585	27,468	4,883	6,599
3	2,610	36%	940	2,349	1,409	3,914
4	10,340	55%	5,687	9,306	3,619	6,580
SO-A	6,150	51%	3,137	5,535	2,398	4,702[A]
SO-B	14,380	58%	8,340	12,942	4,602	7,934
TOTAL	**106,775**		**69,348**	**96,098**	**26,750**	**44,413**

[A] No further planting is recommended at Sales Office A – these plants are to be reallocated elsewhere

No further planting is recommended for Sales Office A. There are three reasons for this:

1. The site would require a fence which would not be aesthetically pleasing and potentially upset neighbouring property owners;
2. The poor survival results indicate it will be difficult to establish more plants without a fence, and most likely would be impossible to achieve the 90% survival target; and
3. Planting a higher density of plants increases the fire hazard to surrounding properties.

It is recommended that plants required to meet survival targets for Sales Office A be redirected to increase the plant densities in other revegetation sites.

The seedling estimates provided above are based on the results from spring monitoring, and represent a minimum number of seedlings required to assist with achieving the survival targets. These estimates can be revised depending on the results of monitoring in autumn 2014.

8.2 Species List for 2014 Infill Planting

A recommended species list for planting into the revegetation sites is provided in Appendix 3. The following considerations have been made in devising this list:

- Year 1 (2011) contained a high proportion of *Acacia saligna* and tree species;
- Year 2 (2012) contained a high proportion of species in the Proteaceae family (e.g. *Hakea* and *Banksia*);
- Year 3 (2013) contained a high proportion of trees;
- Survival of some species has been better than others over the first three years of planting; and
- Infill planting must account for the potential for competition from existing plants.

With these considerations in mind, the species list has been designed towards predominantly installing shrubs and ground covers that can be planted at relatively high densities (i.e. spacing of < 1m along rip-lines). *Eucalyptus wandoo* and *Corymbia calophylla* have been included in the list as the survival at Sites 3 and 4 was poor for all species and these trees should be included in the infill planting in low numbers.

The species mix recommended for infill in 2014 would provide a 'whole-of-ecosystem' approach to restoring Black Cockatoo habitat, rather than just planting foraging trees which was the focus in the first three years of revegetation. In Tranen's opinion, this would provide a long-term benefit to Black Cockatoo conservation because it provides support to the overall ecosystem, with the potential to be self-sustaining.

8.3 Plant Protection

It became clear within a month of planting the seedlings in 2013 that grazing of seedlings in the unfenced areas was having a deleterious impact on growth and survival. Therefore, to achieve the survival target of 90% of the number of seedlings originally planted after three years, Site 3 must be fenced, and the fence at Site 4 must be altered to reduce the likelihood of further vandalism.

Figure 10 Fence Damage by Vandals at Site 4 During August 2013

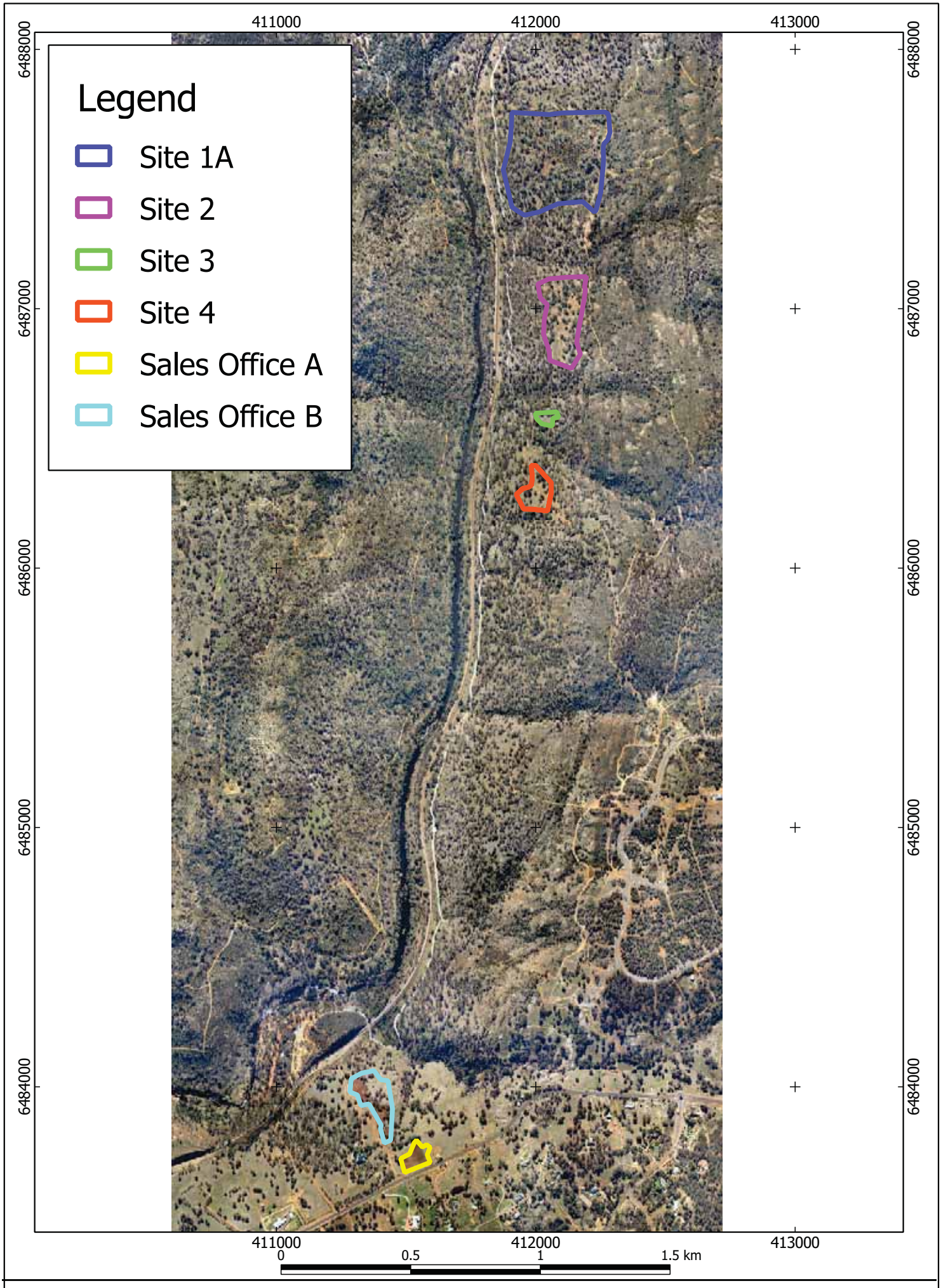
9 REFERENCES

Cardno (2012) *Avon Ridge Estate, Brigadoon: Revegetation and Fire Management Plan* (Revised 2012). Report prepared for Peet Pty Ltd, June 2012.

Groom, C. (2011) *Plants Used by Carnaby's Black Cockatoo*. List prepared by Christine Groom, Department of Environment and Conservation, 15 April 2011.

Valentine, L.E. and Stock, W. (2008) *Food Resources of Carnaby's Black Cockatoo (Calyptorhynchus latirostris) in the Gnangara Sustainability Strategy Study Area*. http://ro.ecu.edu/ecuworks/6147

Appendix 1 Revegetation Site Locations



tranen revegetation systems

Project: Avon Ridge Revegetation
Project Number: P496
Client: Emerge Associates

Drawing: Revegetation Sites
Drawing Number: P496A-02
Revision: 0

Date: 10/02/2014
Drawn By: RSW

Appendix 2 Raw Data

Avon Ridge Site 1A 30,775 seedlings planted in 2011

Planted in Winter 2011, winter 2012 12,000 planted in 2012

SPRING 2013 MONITORING - DATE: **14/11/2013**

Transect No.	New in '12	Original no planted in '11 (Baseline)	Total no. planted 11+12	No. alive Aut 13	No. alive Spr 13	% Survival of Total Number Planted	% Survival of Original Number	Tallest spp observed	Height (m)	Weed cover (%)	Comments
1		31	31	20	23	**74%**	**74%**	*Acacia saligna*	3.5	1	No. alive includes 3 native germinants: *Ficinia nodosa, Allocasuarina fraseriana, E. rudis*
2		39	39	28	28	**72%**	**72%**	*Acacia saligna*	3.5	1	
3		26	26	22	22	**85%**	**85%**	*Acacia saligna*	3.5	1	
4		44	44	28	27	**61%**	**61%**	*Acacia saligna*	2.5	50	High weed cover but mainly annuals starting to die back
5		73	73	55	53	**73%**	**73%**	*Acacia saligna*	5.0	5	
6		26	26	26	31	**119%**	**119%**	*Acacia saligna*	4.5	1	Includes five native germinants. Annual winter weeds dead.
7		34	34	28	30	**88%**	**88%**	*Acacia saligna*	3.5	5	Includes five native germinants of *E. rudis*. Annual winter weeds dying.
8		41	41	27	27	**66%**	**66%**	*Acacia saligna*	4.5	1	
9		50	50	33	30	**60%**	**60%**	*Acacia saligna*	4.0	5	Annual winter weeds dying.
10		42	42	27	27	**64%**	**64%**	*Eucalyptus rudis*	4.5	1	
11		40	40	22	28	**70%**	**70%**	*Eucalyptus rudis*	4.5	1	Includes 6 *Corymbia calophylla* seedlings
12	14	20	34	16	15	**44%**	**75%**	*Eucalyptus rudis*	4.5	1	
13	8	20	28	12	13	**46%**	**65%**	*Eucalyptus rudis*	4.0	1	Inludes 1 native germinant of *Corymbia calophylla*
14	17	55	72	28	27	**38%**	**49%**	*Acacia saligna*	4.5	20	Weeds all dying off
15	23	35	58	29	29	**50%**	**83%**	*Acacia saligna*	4.5	5	Patch of Paterson's Curse (*Echium plantagineum*)
16	8	94	102	72	68	**67%**	**72%**	*Eucalyptus rudis*	5.5	1	Includes seedling of *Leptospermum erubescens*
17	7	69	76	44	43	**57%**	**62%**	*Acacia saligna*	4.0	2	
18	14	94	108	66	66	**61%**	**70%**	*Acacia saligna*	4.0	2	Patch of Paterson's Curse (*Echium plantagineum*)
19	18	136	154	88	88	**57%**	**65%**	*Acacia saligna*	4.5	1	
20	31	51	82	41	39	**48%**	**76%**	*Eucalyptus rudis*	4.0	1	Patch of Paterson's Curse (*Echium plantagineum*)
21	12	36	48	32	32	**67%**	**89%**	*Acacia saligna*	3.5	5	
22	25	55	80	40	43	**54%**	**78%**	*Acacia saligna*	4.0	1	
23	31	37	68	30	34	**50%**	**92%**	*Acacia saligna*	4.0	1	
24	42	49	91	43	43	**47%**	**88%**	*Eucalyptus rudis*	5.0	1	
25	17	14	31	17	18	**58%**	**129%**	*Acacia saligna*	4.5	1	Includes *E. rudis* natural germinants
26	5	23	28	20	20	**71%**	**87%**	*Acacia saligna*	4.0	75	Weed cover dying off - mainly annual grasses
27	29	41	70	63	55	**79%**	**134%**	*Acacia saligna*	4.5	75	Weed cover dying off - mainly annual grasses
28	15	37	52	28	28	**54%**	**76%**	*Acacia saligna*	4.0	5	
29	14	42	56	40	40	**71%**	**95%**	*Acacia saligna*	4.0	5	
30	21	44	65	29	29	**45%**	**66%**	*Acacia saligna*	4.0	25	Weed cover dying off - mainly annual grasses
31	17	35	52	20	18	**35%**	**51%**	*Acacia saligna*	3.5	25	Weed cover dying off - mainly annual grasses
32	28	46	74	39	85	**115%**	**185%**	*Acacia saligna*	3.5	25	Includes 46 *E. rudis* natural germinants
33	43	52	95	44	46	**48%**	**88%**	*Acacia saligna*	3.5	50	Includes *E. rudis* natural germinants
34	31	55	86	28	56	**65%**	**102%**	*Acacia saligna*	2.5	75	Includes *E. rudis* natural germinants. Annual weeds dying off.
35	15	46	61	58	65	**107%**	**141%**	*Acacia saligna*	2.5	80	Includes *E. rudis* natural germinants
36	9	59	68	21	50	**74%**	**85%**	*Acacia saligna*	3.0	75	Includes *E. rudis* natural germinants. Annual weeds dying off.
37	8	26	34	12	12	**35%**	**46%**	*Eucalyptus rudis*		75	Weed cover dying off - mainly annual grasses
38	11	31	42			**-**	**-**				Transect could not be located
39		30	30	29	28	**93%**	**93%**	*Acacia saligna*	3.5	5	Weed cover dying off - mainly annual grasses
40		42	42	33	33	**79%**	**79%**	*Acacia saligna*	3.5	1	

Transect No.	New in '12	Original no planted in '11 (Baseline)	Total no. planted 11+12	No. alive Aut 13	No. alive Spr 13	% Survival of Total Number	% Survival of Total Number	Tallest spp observed	Height (m)	Weed cover (%)	Comments
41		25	25	13	11	44%	44%	*Acacia saligna*	4.0	5	
42		27	27	17	17	63%	63%	*Acacia saligna*	3.5	1	
43		22	22	13	10	45%	45%	*Acacia saligna*	3.5	5	
44		14	14	9	30	214%	214%	*Acacia saligna*	3.5	25	Includes many *E. rudis* natural germinants. Annual weeds dying off.
45		22	22	8	8	36%	36%	*Acacia saligna*	3.0	15	Weed cover dying off - mainly annual grasses
46		24	24	4	5	21%	21%	*Acacia saligna*	4.0	15	Includes *E. rudis* natural germinants
47		10	10	8	8	80%	80%	*Acacia saligna*	3.5	75	Weed cover dying off - mainly annual grasses
48		4	4	2	2	50%	50%	*Acacia saligna*	3.5	80	Weed cover dying off - mainly annual grasses
49		17	17	16	16	94%	94%	*Acacia saligna*	4.0	75	Weed cover dying off - mainly annual grasses
50		32	32			-	-				Transect could not be located
Total	**513**	**2,017**	**2530**	**1428**	**1556**						
					Mean	**67%**	**81%**	**Mean**	**3.9**	**21**	
					Median	**62%**	**75%**	**Median**	**4.0**	**5.0**	
					Min	**21%**	**21%**	**Min**	**2.5**	**1**	
					Max	**214%**	**214%**	**Max**	**5.5**	**80**	
					St. dev.	**30%**	**34%**	**St. dev.**	**0.6**	**29**	

Avon Ridge Site 1A

Original 21 spp (2011 planting):

Species	Observed?
Acacia lasiocarpa	Y
Acacia saligna	Y
Allocasuarina humilis	Y
Banksia grandis	Y
Banksia illicifolia	N
Calothamnus hirsutus	Y
Calothamnus quadrifidus	Y
Corymbia calophylla	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Gastrolobium calycinum	Y
Gompholobium tomentosum	Y
Hakea cyclocarpa	N
Hakea lissocarpha	Y
Hakea ruscifolia	Y
Hakea undulata	Y
Kennedia coccinea	Y
Kennedia prostrata	Y
Leptospermum erubescens	Y
Macrozamia redlei	N
Hypocallymma robustum	N

Total no. spp planted:	30
No. spp observed:	24
% spp observed:	80%

Additional spp - Infill 2012

Allocasuarina fraseriana	Y
Banksia menziesii	Y
Banksia prionotes	N
Callistemon phoeniceus	Y
Eucalyptus marginata	Y
Hakea incrassata	N
Hakea prostrata	Y
Hakea trifurcata	Y
Hakea varia	Y

Avon Ridge Site 2 — 24,000 seedlings planted in 2012

Planted in Winter 2012+2013 — 6520 planted in 2013

SPRING 2013 MONITORING - DATE: 22/11/2013

Rip line No	No. alive from 2012	No. alive from 2013 infill	No. dead from 2013 infill	Est. Total no. planted in 2012	% survival of 2013 infill	% survival of total no.s planted	% survival of Original no.s planted	Tallest spp observed	Height (m)	Weed cover (%)
1	45	35	1	68	97%	**77%**	**118%**	*Eucalyptus wandoo*	2.0	5
2	6	24	4	9	86%	**81%**	**333%**	*Eucalyptus wandoo*	1.0	5
3	5	16	2	8	89%	**81%**	**263%**	*Acacia saligna*	1.8	2
4	24	0	0	36	-	**67%**	**67%**	*Eucalyptus wandoo*	2.5	1
5	24	0	0	36	-	**67%**	**67%**	*Eucalyptus wandoo*	2.0	1
6	12	0	0	18	-	**67%**	**67%**	*Eucalyptus wandoo*	2.0	0
7	15	11	4	23	73%	**68%**	**113%**	*Acacia saligna*	1.5	2
8	10	5	3	15	63%	**65%**	**100%**	*Eucalyptus wandoo*	1.8	1
9	57	36	6	86	86%	**73%**	**108%**	*Acacia saligna*	3.0	2
10	28	30	2	42	94%	**78%**	**138%**	*Acacia saligna*	3.0	2
11	95	33	16	144	67%	**66%**	**89%**	*Acacia saligna*	2.5	2
12	81	67	11	123	86%	**74%**	**120%**	*Acacia saligna*	2.5	5
13	47	84	11	71	88%	**79%**	**185%**	*Acacia saligna*	2.0	2
14	24	29	5	36	85%	**76%**	**147%**	*Hakea undulata*	0.6	2
15	8	10	0	12	100%	**82%**	**150%**	*Acacia saligna*	2.5	2
16	6	68	4	9	94%	**91%**	**822%**	*Acacia saligna*	0.5	2
17	27	31	1	41	97%	**79%**	**141%**	*Corymbia calophylla*	0.6	1
18	130	20	3	197	87%	**68%**	**76%**	*Corymbia calophylla*	1.2	1
19	77	17	4	117	81%	**68%**	**80%**	*Acacia saligna*	3.0	1
20	38	11	6	58	65%	**65%**	**84%**	*Acacia saligna*	3.5	1
Total	**759**	**527**	**83**	**1,149**						
				Mean:	**85%**	**74%**	**163%**	**Mean**	**2.0**	**2.0**
				St. dev.	**11%**	**7%**	**169%**	**st dev**	**0.9**	**1.4**
				Min.	**63%**	**65%**	**67%**	**min**	**0.5**	**0.0**
				Max.	**100%**	**91%**	**822%**	**max**	**3.5**	**5.0**
						Mean:	**129%**	**Outlier removed**		
						St. dev.	**69%**			
						Min.	**67%**			
						Max.	**333%**			

Note: estimated total number planted is based on average survival from autumn 2013 of 66%

Avon Ridge Site 2

2012 planting

Species	Observed?
Acacia saligna	y
Allocasuarina fraseriana	y
Banksia grandis	y
Banksia menzeisii	y
Banksia prionotes	y
Callistemon phoeniceus	y
Corymbia calophylla	y
Eucalyptus marginata	y
Eucalyptus wandoo	y
Hakea cyclocarpa	N
Hakea incrassata	N
Hakea lissocarpha	y
Hakea prostrata	y
Hakea ruscifolia	y
Hakea trifurcata	y
Hakea undulata	y
Hakea varia	y
Hypocalymma robustum	y

Additional 2013 spp.	Observed?
Banksia sessilis	y
Eucalyptus rudis	y

Total no. spp planted:	20
No. spp observed:	18
% spp observed:	90%

Avon Ridge Site 3 2,610 planted in 2013

Planted in 2013

SPRING 2013 MONITORING - DATE: 22/11/2013

Transect No.	Alive from'13	Dead from'13	Total No. planted 2013 (Baseline)	% Survival	Tallest spp observed	Height (m)	Weed cover (%)	Comments
1	0	23	23	0%	-	-	1	Causes: herbivory and unknown plant deaths
2	22	28	50	44%	*Eucalyptus rudis*	0.2	1	Kangaroo resting spot within the transect
3	11	45	56	20%	*Eucalyptus wandoo*	0.5	1	Tallest appears to be a root sucker from *E. wandoo*
4	18	37	55	33%	*Acacia saligna*	0.3	1	Those that are alive are being severely impacted by herbivory
5	26	23	49	53%	*Acacia saligna*	0.4	1	Those that are alive are being severely impacted by herbivory
6	16	39	55	29%	*Acacia saligna*	0.2	1	
7	27	39	66	41%	*Acacia saligna*	0.2	1	
8	21	19	40	53%	*Acacia saligna*	0.3	0	Tallest *Acacia saligna* is only a stem - leaves eaten off
9	23	19	42	55%	*Eucalyptus rudis*	0.4	0	
Total	164	272	436					
			Mean	36%	Mean	0.3	0.8	
			Min	0%	Min	0.2	0.0	
			Max	55%	Max	0.5	1.0	
			St. dev.	18%	St. dev.	12%	0.4	

Avon Ridge Site 3

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia nivea	N
Banksia sessilis	N
Callistemon phoeniceus	Y
Calothamnus quadrifidus	N
Corymbia calophylla	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea ruscifolia	Y
Hakea trifurcata	N
Hakea undulata	N

Total no. spp planted:	12
No. spp observed:	7
% spp observed:	58%

Avon Ridge Site 4 10,340 planted in 2013

Planted in 2013

SPRING 2013 MONITORING - DATE: 14/11/2013

Transect No.	Alive from'13	Dead from'13	Total No. planted 2013 (Baseline)	% Survival	Tallest spp observed	Height (m)	Weed cover (%)	Comments
1	30	39	69	43%	*Corymbia calophylla*	0.3	1	
2	86	39	125	69%	*Hakea lissocarpha*	0.4	1	Some Paterson's Curse (*Echium plantagineum*)
3	33	17	50	66%	*Corymbia calophylla*	0.3	0	
4	26	36	62	42%	*Eucalyptus wandoo*	0.3	1	
5	39	11	50	78%	*Corymbia calophylla*	0.3	0	
6	85	13	98	87%	*Eucalyptus wandoo*	0.3	0	
7	45	5	50	90%	*Hakea lissocarpha*	0.3	0	
8	36	10	46	78%	*Eucalyptus wandoo*	0.3	0	
9	16	16	32	50%	*Eucalyptus wandoo*	0.3	0	
10	24	20	44	55%	*Eucalyptus rudis*	0.4	1	
11	13	21	34	38%	*Eucalyptus rudis*	0.5	0	
12	20	22	42	48%	*Eucalyptus wandoo*	0.3	0	
13	26	76	102	25%	*Corymbia calophylla*	0.3	0	
14	6	16	22	27%	*Callistemon phoeniceus*	0.1	0	
15	14	30	44	32%	*Eucalyptus rudis*	0.3	0	
Total	499	371	870					
			Mean	55%	Mean	0.3	0.3	
			Min	25%	Min	0.1	0.0	
			Max	90%	Max	0.5	1.0	
			St. dev.	21%	St. dev.	0.1	0.5	

Avon Ridge Site 4

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia grandis	Y
Banksia nivea	Y
Banksia sessilis	Y
Callistemon phoeniceus	Y
Calothamnus quadrifidus	Y
Corymbia calophylla	Y
Eucalyptus marginata	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea prostrata	Y
Hakea ruscifolia	Y
Hakea trifurcata	Y
Hakea undulata	Y
Hakea varia	Y

Total no. spp planted:	16
No. spp observed:	16
% spp observed:	100%

Avon Ridge Site Sales Office A 10 x 10 m quadrats 6,150 planted in 2013

Planted in 2013

SPRING 2013 MONITORING - DATE: 22/11/2013

Quadrat #	Alive from'13 plants	Density (plants / m2)	Expected density (plants/m2) (Baseline)	% survival	Height (m)	Weed cover (%)	Tallest spp observed	Comments
1	19	0.19	0.77	25%	0.2	3	*Corymbia calophylla*	Erosion & deposition; Herbivory, Pat curse and cotton bush
2	36	0.36	0.77	47%	0.5	2	*Eucalyptus wandoo*	Erosion & deposition; Herbivory, Pat curse and cotton bush
3	45	0.45	0.77	59%	0.5	5	*Eucalyptus wandoo*	Count includes *Acacia pulchella* seedling; Cotton bush
4	32	0.32	0.77	42%	0.5	3	*Corymbia calophylla*	Pat curse, Avena; Rocky site
5	58	0.58	0.77	75%	0.4	5	*Eucalyptus wandoo*	Pat curse, Avena; Blackberry
6	43	0.43	0.77	56%	0.3	2	*Corymbia calophylla*	Rocky area - light granite
Total	233							
			Mean	51%	0.4	3.3		
			Min	25%	0.2	2.0		
			Max	75%	0.5	5.0		
			St. dev.	17%	0.1	1.4		

Expected density based on 6,150 seedlings planted into 0.8 ha

No. planted	6150
Area	0.8
Expected density	0.77

Avon Ridge Sales Office A

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia grandis	Y
Callistemon phoeniceus	Y
Corymbia calophylla	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea prostrata	Y
Hakea ruscifolia	Y
Hakea trifurcata	Y
Hakea undulata	Y
Hakea varia	Y

Total no. spp planted:	11
No. spp observed:	11
% spp observed:	100%

Avon Ridge Site Sales Office B Transects and quadrats 14,380 planted in 2013

Planted in 2013

SPRING 2013 MONITORING - DATE: 22/11/2013

Transect / Quadrat #	Alive from'13	Dead from'13	Total No. planted 2013 (Baseline)	% Survival	Tallest spp observed	Height (m)	Weed cover (%)	Comments
SOBQ1	87	25	112	78%	*Acacia saligna*	0.6	8	Avena barbata dominant, mostly dying off
SOBQ2	97	19	116	84%	*Acacia saligna*	0.6	3	Avena barbata dominant, mostly dying off
SOBQ3	138	30	168	82%	*Acacia saligna*	0.6	2	Avena barbata dominant, mostly dying off
SOBQ4	77	37	114	68%	*Acacia saligna*	0.6	5	Avena barbata dominant, mostly dying off
SOBQ5	90	33	123	73%	*Acacia saligna*	0.6	5	Avena barbata dominant, mostly dying off
SOBT6	41	24	65	63%	*Acacia saligna*	0.5	1	Avena barbata dominant, mostly dying off
SOBT7	35	36	71	49%	*Acacia saligna*	0.4	1	
SOBT8	18	48	66	27%	*Eucalyptus rudis*	0.3	0	Erosion and deposition may be cause of some deaths
SOBT9	33	30	63	52%	*Acacia saligna*	0.4	1	
SOBT10	11	11	22	50%	*Eucalyptus rudis*	0.4	1	
SOBT11	22	18	40	55%	*Acacia saligna*	0.4	1	Rocky site
SOBT12	38	28	66	58%	*Acacia saligna*	0.4	5	Rocky site
SOBT13	22	17	39	56%	*Acacia saligna*	0.5	1	Rocky site
SOBT14	19	17	36	53%	*Acacia saligna*	0.5	0	Rocky site and exposed to srong easterly winds, north aspect
SOBT15	23	67	90	26%	*Eucalyptus rudis*	0.5	1	Rocky site and exposed to srong easterly winds, north aspect
Total	**751**	**440**	**1,191**					

Mean	58%	Mean	0.5	2.3
Min	26%	Min	0.3	0.0
Max	84%	Max	0.6	8.0
St. dev.	17%	St. dev.	0.1	2.4

Avon Ridge Site Sales Office B

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia grandis	Y
Banksia nivea	Y
Banksia sessilis	Y
Callistemon phoeniceus	Y
Calothamnus quadrifidus	Y
Corymbia calophylla	Y
Eucalyptus marginata	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea prostrata	Y
Hakea ruscifolia	Y
Hakea trifurcata	Y
Hakea undulata	Y

Total no. spp planted:	15
No. spp observed:	15
% spp observed:	100%

Appendix 3 Recommended Species List for 2014

The species list for infill planting at Avon Ridge revegetation sites is recommended to come from the list shown in Table 5. This list has been compiled using the proposed revegetation list provided in the *Revegetation and Fire Management Plan* (Cardno 2012). The final species list and number of seedlings of each for 2014 infill will depend on the availability of each species from nurseries.

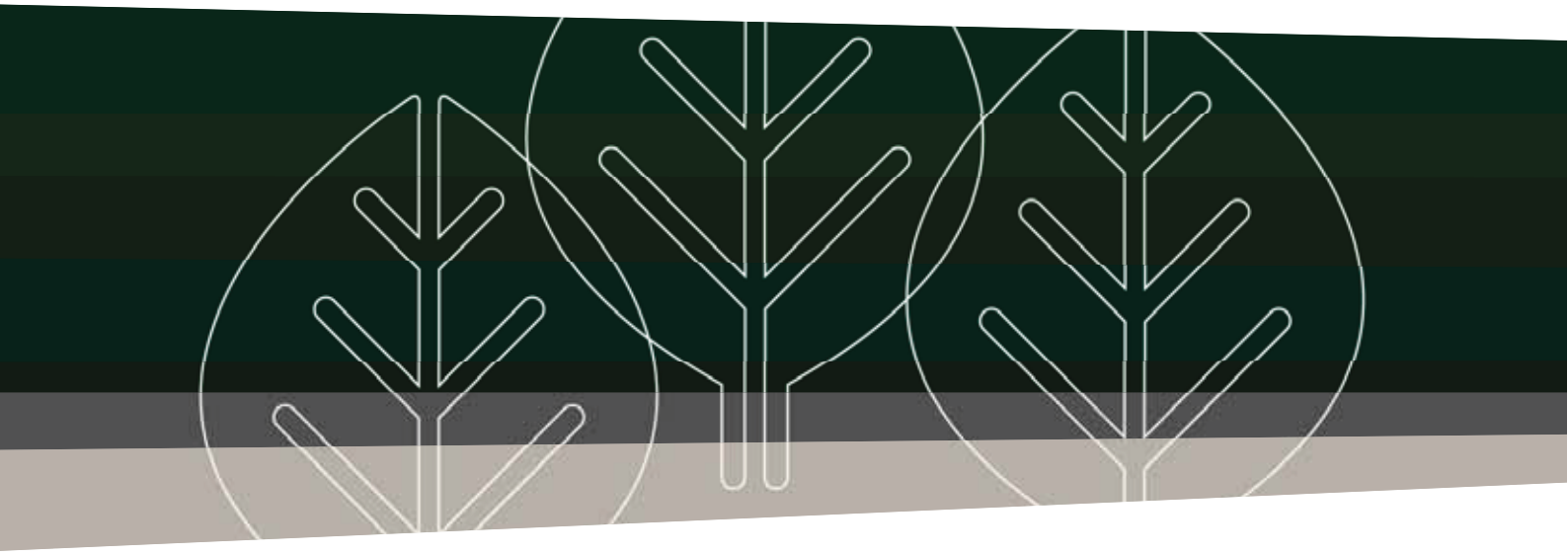
Table 5 Recommended Species List for 2014 Infill at Avon Ridge

Scientific Name	Common Name	Black Cockatoo Species?[A]	Growth Form
Acacia lasiocarpa	Panjang	No	Shrub 0.5 – 1.5 m
Allocasuarina humilis	Dwarf sheoak	No	Shrub 1 to 4m
Banksia armata	Prickly Dryandra	Yes	Shrub to 3 m
Banksia lindleyana	Porcupine Banksia	No	Shrub 1 – 3 m
Banksia nivea	Honeypot Banksia	Yes	Groundcover to 0.2 m
Banksia sessilis	Parrotbush	Yes	Shrub to 3 m
Callistemon phoeniceus	Lesser Bottlebrush / Toobada	Yes	Small tree to 6m
Calothamnus quadrifidus	One sided bottlebrush	No	Shrub 1 to 4m
Calothamnus hirsutus	Hawkeswood	No	Shrub 0.3 – 1.5m
Corymbia calophylla	Marri	Yes	Tree to 40 m
Daviesia decurrens	Prickly Bitter Pea	No	Shrub to 1m
Eucalyptus wandoo	Wandoo	Yes	Tree 3 to 25m
Gastrolobium calycinum	York Road Poison	No	Shrub to 1.5m
Gastrolobium dilatatum		No	Shrub to 1m
Gompholobium tomentosum	Hairy Yellow Pea	No	Shrub 0.3 to 1m
Grevillea bipinnatifida	Fuchsia Grevillea	Yes	Shrub 0.2 to 1m
Grevillea wilsonii	Native fuchsia	No	Shrub 1 to 3m
Hakea lissocarpha	Honeybush	Yes	Shrub to 1.5m
Hakea prostrata	Harsh Hakea	Yes	Shrub to 3m
Hakea undulata	Wavy-leaved Hakea	Yes	Shrub 1 to 2m
Hibbertia subvaginata		No	Shrub to 1.2m
Hypocalymma angustifolium	White myrtle	No	Shrub 1 to 3m
Hypocalymma robustum	Swan River Myrtle	No	Shrub 0.4 to 1m
Kennedia coccinea	Coral vine	No	Climber / ground cover
Kennedia prostrata	Scarlet Runner	No	Climber / ground cover
Leptospermum erubescens	Roadside teatree	No	Shrub 1 to 3m

[A] Black Cockatoo species may be nesting, roosting and / or feeding species. Classifications as per Table 2 in the *Revegetation and Fire Management Plan* (Cardno 2012)

revegetating
rehabilitating
restoring

tranen
revegetation systems



Avon Ridge Estate
Bi-annual Monitoring Report – Autumn 2014

Emerge Associates

P496-03-Rev00

August 2014

Disclaimer

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Table of Contents

1 SUMMARY

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012 and 2013 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development.

Six revegetation sites were established between 2011 and 2013. A total of 88,255 seedlings were initially installed into these six sites. Infill planting has also occurred in 2012 and 2013 to replace dead plants, which is a pro-active approach to achieve the 90% survivorship criteria before the end of the three-year monitoring period. The infill plants do not count towards the 214,000 seedlings required to be planted, and future survivorship observations are calculated against the original number of seedlings planted. Hence, prior to the autumn 2014 monitoring, a total of 106,775 seedlings (initial plantings plus infill) had been installed in the six sites.

- Site 1A: 42,775 seedlings installed in 2011 and 2012;
- Site 2: 30,520 seedlings installed in 2012 and 2013;
- Site 3: 2,610 seedlings installed in 2013;
- Site 4: 10,340 seedlings installed in 2013;
- Sales Office A (SO-A): 6,150 seedlings installed in 2013; and
- Sales Office B (SO-A): 14,380 seedlings installed in 2013.

The approval given to PEET under the *Environment Protection Biodiversity Conservation Act 1999* requires a survivorship rate of 90% of all installed seedlings at the end of the three year maintenance period.

Following the autumn 2014 monitoring, the following survival rates have been observed (based on original numbers planted into each site):

- Site 1A: 60% (± 21% standard deviation);
- Site 2: 92% (±47%);
- Site 3: 7% (± 4%);
- Site 4: 6% (± 6%);
- Sales Office A (SO-A): 28% (± 12%); and
- Sales Office B (SO-A): 33% (± 23%).

Infill planting was therefore undertaken in winter 2014 to increase plant densities in the sites and bring survival numbers above 90%.

2 INTRODUCTION

Tranen was engaged to undertake revegetation work at PEET's Brigadoon Park and Recreation Reserve in winter 2011. Further revegetation works have been undertaken in 2012 and 2013 with the aim of contributing to the target of 214,000 seedlings required as part of the offset package for the development as per the conditions under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2.1 EPBC Approval Conditions (Section 2b)

The revegetation measures to create additional Black Cockatoo habitat across the project site, including in the Parks and Recreation Reserve, specifically are:

- Revegetating all vegetation condition classes (excluding pristine and excellent classes) and vegetation complexes;
- Designing species mix: numbers and density to be planted;
- Timing the proposed planting (must be following the annual winter rain period);
- Implementing weed management measures;
- The survivorship rate of all revegetation measures must be at least 90% after three years. If after three years of the date of the planting, a survival rate of 90% of the planted trees is not achieved, all dead trees must be replaced with other Black Cockatoo habitat species within 12 months and maintained for at least an additional two years;
- Annual monitoring measures within the project area undertaken by an appropriately qualified and experienced ecologist and must commence within 12 months of the completion of revegetation and continue for at least three years after the initial revegetation planting in any given area (given that revegetation will be staged across the development); and
- Annual monitoring measures undertaken by an appropriately qualified and experienced specialist must commence in the Parks and Recreation Reserve within 12 months of completion of revegetation and continue for at least three years after the initial planting in the Parks and Recreation reserve for the purpose of establishing the survivorship rates and replanting efforts within the project area.

2.2 Monitoring Program Objectives

The main objectives of the bi-annual monitoring program are to:

- Demonstrate the success of the revegetation against the completion criteria specified by the EPBC approval conditions; and
- Identify issues affecting the revegetation program, such as weeds, pathogens or acts of vandalism.

2.3 Completion Criteria

At the end of the three year maintenance period for each revegetation area, the following completion criteria are required to be met (from the *Revegetation and Fire Management Plan*, Cardno 2012):

- Survivorship rate must be at least 90% (nb: this is a condition of the EPBC Act approval);
- Plants are healthy in appearance and diverse in species with no mass losses;
- At least 65% of the species planted have survived (a measure of species diversity);
- The average seedling height has increased between assessments; and
- Weed presence is minimal and not inhibiting native plant survival and growth.

3 REVEGETATION SITES AND WORKS TO DATE

Six revegetation sites have been established (for a map of their locations, refer to Appendix 1):

- Site 1A: established in 2011;
- Site 2: established in 2012;
- Site 3: established in 2013 as an unfenced trial site;
- Site 4: established in 2013;
- Sales Office A: established in 2013 as an unfenced trial site; and
- Sales Office B: established in 2013.

A summary of the planting years, total area and number of seedlings planted up until the end of winter 2013 for each revegetation site is presented in Table 1. The total number of seedlings planted to date is 106,775.

Table 1 Revegetation Sites

Site Name	Area (ha)	Fenced or Unfenced	2011 Seedlings	2012 Seedlings	2013 Seedlings	Total Seedlings
1A	13.4	Fenced	**30,775**	12,000	-	**42,775**
2	4.7	Fenced	-	**24,000**	6,520	**30,520**
3	0.3	Unfenced	-	-	**2,610**	**2,610**
4	2.8	Fenced	-	-	**10,340**	**10,340**
Sales Office A	0.8	Unfenced	-	-	**6,150**	**6,150**
Sales Office B	2.3	Fenced	-	-	**14,380**	**14,380**
		Blue = initial planting number for each site			**TOTAL**	**106,775**
		Black = infill planting numbers			**TOTAL of initial planting**	**88,255**

3.1 Site 1A

The 2011 initial revegetation program at Site 1A consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 1,545 m long and 1.8 m high,
- Pre-planting weed control program of herbicide application (glyphosate and simazine) in July 2011 and manual removal of olive trees (August 2011); and
- Planting of 30,775 seedlings into rip lines between July and August 2011.

Since the initial installation the following maintenance activities have been undertaken at Site 1A:

- Additional planting: 12,000 seedlings in August 2012;
- Fencing repair (2013);
- Weed control maintenance:
  - Spring 2011;
  - Summer, autumn and spring 2012; and

- Winter 2013.

Figure 1 Site 1A – Transect #24 Shows the Developing Plants Installed in 2011

3.2 Site 2

The 2012 revegetation program at Site 2 consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 1,000 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Simazine) in July 2012; and
- Planting of 24,000 seedlings in August 2012.

Since the initial installation the following maintenance activities have been undertaken at Site 2:

- Fencing repair (2012);
- Additional planting: 6,520 seedlings in June and July 2013;
- Weed control maintenance:
  - Spring 2012;
  - Summer 2012/13; and
  - Autumn 2013.

Figure 2 Site 2 – Transect # 19

3.3 Site 3

Site 3 was established without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings.

The 2013 revegetation program at Site 3 consisted of:

- Deep ripping (not undertaken by Tranen);
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 2,610 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 3:

- Installation of a kangaroo fence with rabbit proof skirt measuring 259 m long and 1.8 m high in autumn 2014.

Figure 3 Site 3 – Transect # 4 Showing Few Seedlings and no Growth

3.4 Site 4

The 2013 revegetation program on Site 4 consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 572 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 10,340 seedlings in July 2013.

Since the initial installation the following maintenance activities have been undertaken at Site 4:

- Fence repairs (August 2013); and
- Additional fencing was erected on both sides of the middle track during April 2014. This was necessary because members of the public were leaving the gates open on the middle track through which kangaroos were entering the site.

Figure 4 Site 4 – Transect # 10 Showing Few Surviving Seedlings

3.5 Sales Office A

Sales Office A was established without a kangaroo-proof fence as a trial to determine whether grazing by kangaroos was an impacting factor on the seedlings.

The 2013 revegetation program on Sales Office A consisted of:

- Deep ripping (not undertaken by Tranen); and
- Planting of 6,150 seedlings in June 2013.

Since the initial installation the following maintenance activities have been undertaken at Sales Office A:

- Weed control maintenance:
  - Winter 2013;
  - Spring 2013; and
  - Summer 2013/14 (two events).

Figure 5 Sales Office A – Quadrat # 5 Showing Strong Growth of Eucalypts

3.6 Sales Office B

The 2013 revegetation program at Sales Office B consisted of:

- Deep ripping (not undertaken by Tranen);
- Installation of a kangaroo fence with rabbit proof skirt measuring 825 m long and 1.8 m high;
- Pre-planting weed control program of herbicide application (glyphosate and Oust® pre-emergent) in July 2013; and
- Planting of 14,380 seedlings in July 2013.

No further maintenance works have been required.

Figure 6 Sales Office B – Quadrat # 3 Showing Good Plant Growth

4 MONITORING METHODOLOGY

This report presents results from the field survey conducted between 26 February and 29 April 2014 (autumn monitoring).

4.1 Plant Survival

Plant survival was assessed in each of the six sites using quadrats or transects along rip-lines. The initial survey for each site, undertaken in the spring following seedling installation, determines the baseline data which is a count of the number of seedlings planted within the monitoring plot. Percentage survival is assessed against this figure for future monitoring events.

Sites 1A and 2 have both received additional planting in the winter after their initial establishment (Table 1). Survivorship has been calculated against the initial planting numbers, and therefore can be greater than 100% where the additional planting has increased plant numbers above the original number installed.

4.2 Monitoring Plot Establishment and Survival Calculations

Transects, quadrats or a combination of both, were used to assess percentage survival of seedlings at each site. The method employed for assessing survival was dependent on the characteristics of each site, as described below. Different methods were necessary because of the nature of the rip-lines (i.e. long, easily identifiable rip-lines compared with short rip-lines in multiple directions), and difficulties with being able to observe dead plants during the first survey after planting (because of herbivory or rapid decay).

In some transects, there are seedlings that appear to have germinated naturally (i.e. natural recruitment). These have been included in total seedling counts because they contribute to the total number of plants that are present at the site, and are a direct result of the site preparation activities (i.e. soil cultivation, weed management, etc.).

4.2.1 Site 1A

Fifty transects were established at Site 1A in spring 2011. These permanent transects have been surveyed in spring and autumn since the initial survey.

Results are presented for each transect showing the number of plants originally planted in 2011 and the total number planted (2011 + 2012 seedlings). Percentage survival is calculated based on the original number planted.

4.2.2 Site 2

The initial survey at Site 2 was a random sample of rip-lines throughout the site, and this was continued until the spring 2013 survey was undertaken when permanent transects were established. With previous surveys being

random, there was no baseline data against which survival could be assessed.

Twenty transects were established in spring 2013 across the site to obtain a representative sample of percentage survival. For each transect, it was assumed that 66% of the original number of seedlings planted in 2012 had survived, based on the mean percentage survival that was calculated during the autumn 2013 survey (Tranen 2013).

Results are presented for each rip-line showing the total number of plants originally planted in 2012 (calculated using the assumption of 66% survival) and the total number planted since revegetation commenced (2012 + 2013 seedlings). Percentage survival is calculated based on the original number planted.

4.2.3 Site 3

Nine transects were established along rip-lines in Site 3 during the spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

The same rip-lines were assessed in autumn 2014 to determine the percentage survival.

4.2.4 Site 4

Fifteen transects were established along rip-lines in Site 4 during the spring 2013 survey. Baseline data were collected of live and dead plants on each transect to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

The same rip-lines were assessed in autumn 2014 to determine the percentage survival.

4.2.5 Sales Office A

Six quadrats measuring 10 x 10 m were established across the site during the spring 2013 survey. Quadrats were used instead of transects as this site had been ripped in multiple directions, rather than having parallel rip-lines installed across the slope.

Due to impacting factors at the site, the most severe being kangaroo herbivory, it was not possible to obtain counts of dead plants during the baseline survey, as there was little evidence of any dead plants remaining. To determine the baseline data and enable future calculations of percentage survival, the following steps were undertaken for each quadrat:

- Number of living plants was counted;
- The density of plants in each quadrat was calculated as:
    - [number of living plants] / 100 m^2;

- The density in each quadrat was compared against the average density calculated for the site, which was calculated as:
    - Total number of seedlings planted for the site divided by the area of the site = 6,150 seedlings / 8,000 m^2 = 0.77 plants / m^2;
- Seedling survival was therefore calculated as: [quadrat stem density] / 0.77.

In the autumn 2014 survey, the quadrats were re-assessed for number of surviving plants to determine % survival.

4.2.6 Sales Office B

A combination of quadrats and transects was employed at Sales Office B, as there were wide areas with clear rip-lines in some places, and small areas where multiple rip-lines had been installed in several directions. Ten transects and five 10 x 10 m quadrats were established during the spring 2013 survey to obtain a representative survey of the site. Baseline data were collected of live and dead plants on each transect or in each quadrat to determine the total number of seedlings planted, and to enable percentage survival to be calculated.

In the autumn 2014 survey, the quadrats and transects were re-assessed for number of surviving plants to determine % survival.

4.3 Other Observations

At each revegetation site, observations were made of weed species and cover, seedling health (including pest attack, drought stress etc.), species richness, maximum plant height along transects, occurrence of erosion or soil disturbance, and the health or occurrence of remnant vegetation.

Species richness was determined by observations of whether each species planted into the site was present. This was done by observations on the transects and by a walk-through across the site.

5 RESULTS

Monitoring data are summarised in Table 2 with raw data for each transect presented in Appendix 2. Descriptions for each site are presented in the sections below.

Table 2 presents a summary of all monitoring data collected since the commencement of the revegetation activities against the three measureable completion criteria.

Table 2 Summary of Monitoring Data Over the Life of the Project

Measurement	Season & Year	Site					
		1A	2	3	4	SO-A	SO-B
% Survival	Spr 2011	93%	-	-	-	-	-
	Aut 2012	89%	-	-	-	-	-
	Spr 2012	114%	94%	-	-	-	-
	Aut 2013	74%	66%	-	-	-	-
	Spr 2013	81%	129%	36%	55%	51%	58%
	Aut 2014	60%	92%	7%	6%	28%	33%
Species Richness[A]	Spr 2011	100%	-	-	-	-	-
	Aut 2012	100%	-	-	-	-	-
	Spr 2012	100%	100%	-	-	-	-
	Aut 2013	87%	94%	-	-	-	-
	Spr 2013	80%	90%	58%	100%	100%	100%
	Aut 2014	80%	90%	33%	50%	36%	93%
Maximum Height (m)	Spr 2011	0.6	-	-	-	-	-
	Aut 2012	1.5	-	-	-	-	-
	Spr 2012	2.0	0.5	-	-	-	-
	Aut 2013	3.2	1.0	-	-	-	-
	Spr 2013	3.9	2.0	0.3	0.3	0.4	0.5
	Aut 2014	4.0	2.1	0.3	0.2	0.8	1.0

[A] Species richness is calculated as the number of species observed divided by the total number of species planted

5.1 Site 1A (Planted in 2011 and 2012)

5.1.1 Survival and Condition of Revegetation

Mean survival rate across the 48 transects measured at Site 1A was 60% (± 21% standard deviation) of original numbers planted in 2011, which is a decrease from the 81% recorded in spring 2013. Survival rates of > 100% occur on transects where there is natural recruitment within the sampling unit which is above the total number of seedlings installed into that transect. Twenty-four transects had natural recruitment of seedlings which consisted

mainly *Eucalyptus rudis*, but also recruits of *Corymbia calophylla, Hibbertia commutata, H. subvaginata, Juncus pallidus,* and *Daviesia* spp.

Plants installed in open areas of the site (i.e. without any competition from remnant vegetation) appear to be growing faster than plants installed near remnant *E. rudis* trees. Survival rates do not appear to differ between open areas and those under canopy, though the natural germination of *E. rudis* has likely contributed to the high survival rates observed in transects under canopy.

Both the planted seedlings and the remnant vegetation were significantly affected by the severe drought that occurred over the 2013/14 summer. Several plant deaths were noted along the transects, surviving plants were wilting and dying back in sections of the canopy, and even tall remnant trees several years old were dying back (Figure 7).

Figure 7 Site 1A – Dead Saplings and Remnant Vegetation

5.1.2 Plant Heights

Maximum plant heights along transects at Site 1A were as high as 5.5 m, and as low as 1.0 m. Of the 48 transects that were surveyed in autumn 2014, *Acacia saligna* was the tallest species for 39 of them, with *E. rudis* the tallest in most others.

Mean maximum plant height across the transects has increased 0.1 m between spring 2013 and autumn 2014 (Table 2).

5.1.3 Remnant Vegetation

Site 1A contained a number of areas of remnant vegetation, mainly *E. rudis* and *E. wandoo* trees, as well as a shrubland of *Leptospermum erubescens* in the north-eastern corner of the site.

A number of seedlings have germinated from the soil-stored seed bank since the beginning of the project, and these plants are further increasing the density of plants in the area. *Eucalyptus rudis* dominates the natural recruits, while *Corymbia calophylla, Hibbertia commutata*, *Hibbertia subvaginata, Daviesia ?triflora, Daviesia* sp., *Juncus pallidus* and *Banksia sessilis* recruitment has also been observed. All but *B. sessilis* were observed along the rip-lines, while *E. rudis* and *H. commutata* are common recruits throughout the site (including on and off the riplines).

5.1.4 Weeds

Weed cover was generally low throughout the site, with the survey taking place after the annual winter weeds have completed their life cycle. Mean weed cover was 0%, with maximum weed cover recorded at 1%.

5.1.5 Species Richness

In Site 1A, 21 species were planted in 2011 and an additional 9 species planted in 2012. Of these 30 species, 24 were observed (80% of the total) either during the transect scoring or while walking across the site (Appendix 2). Species richness has decreased from 87% in autumn 2013, but is the same as was last recorded in spring 2013, and is above the completion criteria.

5.1.6 Fauna

Minor signs of herbivory were observed during the monitoring, but are of no great concern.

5.1.7 Surface Stability and Erosion

Soil surface was stable across the site, with little or no sign of erosion.

5.2 Site 2 (Planted in 2012 and 2013)

5.2.1 Survival and Condition of Revegetation

Mean survival rate across the 20 transects installed during this survey at Site 2 was estimated at 92% (± 47% standard deviation) of the original number of seedlings planted in 2012. This has been calculated with the omission of data from one transect that had survival calculated at 556% (Appendix 2), which is considered an outlier.

Plant distribution was fairly even across the site, with bare areas having received additional planting in winter 2013. However, plant growth appeared better in the more open areas that did not have a tree canopy to compete with.

5.2.2 Plant Heights

Plant heights varied across the site according to the species that were observed in the transects. *Acacia saligna* was the tallest species observed at heights of up to 4.0 m, while the tallest species in other transects were only 0.6 – 1.0 m tall. Some of these were *Hakea undulata* from 2012 while others were *Acacia saligna* which were most likely planted in 2013.

Maximum plant heights increased by 0.1 m on average since spring 2013.

5.2.3 Remnant Vegetation

Site 2 contained several patches of remnant vegetation, with *Corymbia calophylla* and *Eucalyptus wandoo* trees scattered throughout the site.

Seedlings of *E. wandoo* and *C. calophylla* were observed on site, while the native grass *Austrostipa flavescens* occurred in high densities in some areas.

5.2.4 Weeds

Weed cover was low across the whole site, with mean weed cover 0.8% and a maximum cover observation of 1%. Most weeds observed were annual summer weeds that occurred in low densities and had a patchy distribution across the site. The majority of these were *Dittrichia graveolens* (Stinkwort).

5.2.5 Species Richness

In 2012, 18 species were planted at Site 2, with an additional 2 species planted in 2013. Of these 20 species, all but two were observed either on transects or during a walk-through of the site (90% of the total species). The percentage of species observed has not changed since spring 2013 and is above the completion criteria.

5.2.6 Fauna

No signs of herbivory, digging or utilisation by birds was observed during the monitoring.

5.2.7 Surface Stability and Erosion

The soil surface was stable across the site, with little or no signs of erosion.

5.3 Site 3 (Planted in 2013)

5.3.1 Survival and Condition of Revegetation

Mean survival of seedlings installed into Site 3 was 7% (± 4%) across the nine transects. Survival ranged from 0% to 14% across the transects. Survival has reduced from 36% recorded in spring 2013 (Table 2).

The condition of surviving plants was poor, with many having been eaten or in poor condition. No new growth was observed on any of the surviving plants.

5.3.2 Plant Heights

Maximum plant heights at Site 3 ranged between 0.2 m and 0.4 m, with a mean height of 0.3 m. This represents no change from spring 2013.

5.3.3 Remnant Vegetation

Site 3 was established within a clearing surrounded by *E. wandoo* and *C. calophylla* trees. The site contains a few seedlings and saplings of *E. wandoo*.

No natural germinants were observed in the transect lines in autumn 2014.

5.3.4 Weeds

No living weeds were observed in Site 3, with all transects having weed cover 0% (Table 2).

5.3.5 Species Richness

Twelve species were planted at Site 3 in winter 2013. Only four species were observed in autumn 2014 (33% of the total species) (Table 2; Appendix 2). This is below the completion criteria of 65%.

5.3.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through dung and resting sites. There was no evidence that rabbits had been on the site, but it is possible. Many surviving plants have been adversely affected by herbivory, with *Acacia saligna* in particular being heavily grazed.

5.3.7 Surface Stability and Erosion

The site showed only minor evidence of erosion. All rip-lines have been installed across the slope parallel to the contours, which reduces the erosion potential from surface water runoff.

5.4 Site 4 (Planted in 2013)

5.4.1 Survival and Condition of Revegetation

Mean survival of seedlings installed into Site 4 was 6% (± 6%) across the 15 transects. Survival ranged from 0% to 18% across the transects (Appendix 2).

The condition of surviving plants was generally poor, even though a fence had been constructed around the site. Most surviving plants were Eucalypts.

5.4.2 Plant Heights

Maximum plant heights at Site 4 ranged between 0.1 m and 0.5 m, with a mean plant height of 0.2 m. This is a reduction from spring 2013, where plant heights were 0.3 m on average.

5.4.3 Remnant Vegetation

Site 4 contains patches of remnant vegetation which consists almost entirely of *E. wandoo* mature trees. These are scattered throughout the site, but are only small in area.

No natural germination was observed on the transects in autumn 2014.

5.4.4 Weeds

Weed cover was very low throughout the site, with all transects recording weed cover of ≤ 1%.

5.4.5 Species Richness

Sixteen species were planted at Site 4 in 2013. Half of these were observed during the autumn 2014 assessment, which is a significant reduction since the spring 2013 survey when all species were observed.

5.4.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through the presence of dung. There was no evidence that rabbits had been on the site, but it is possible. Many surviving plants have been adversely affected by herbivory, with *Acacia saligna* in particular being heavily grazed.

This site had been fenced, but when visiting the site during the monthly inspections, the gates were frequently found open, and the fencing had been ripped down in places. This allowed kangaroos to access the site.

5.4.7 Surface Stability and Erosion

The slopes on the eastern side of the site do have some erosion channels forming, some of which may be a result of the direction of ripping that was undertaken on the site. The erosion has affected plant survival in these areas, with some plants having had the soil washed away from the root ball.

5.5 Sales Office A (Planted in 2013)

5.5.1 Survival and Condition of Revegetation

Mean survival of seedlings installed at Sales Office A was 28% (± 12%) across the six quadrats. Survival ranged from 7% to 38% across the quadrats.

The condition of most surviving plants was good, with the majority being Eucalypts that appear to be left alone by the kangaroos

5.5.2 Plant Heights

Maximum plant heights at Sales Office A ranged between 0.3 m and 1.0 m, with a mean plant height of 0.8 m. This represents an increase of 0.4 m since spring 2013.

5.5.3 Remnant Vegetation

There is no remnant vegetation within Sales Office A. This was a bare paddock prior to revegetation works commencing.

5.5.4 Weeds

Weed cover was low throughout the site at the time of survey, with an average weed cover of 1%. Observed weeds were predominantly seedlings of the perennial *Gomphocarpus fruticosus* (Narrow-leaf Cotton Bush) and the summer active weed *Dittrichia graveolens* (Stinkwort).

Sales Office A has the potential to be very weedy given the large population of Narrow-leaf Cotton Bush that was previously on the road verge immediately up-hill of the site (removed by Tranen following planting).

5.5.5 Species Richness

Eleven species were originally planted into Sales Office A in 2013. Only four of these were observed during the survey: *Callistemon phoeniceus, Corymbia calophylla, Eucalyptus wandoo* and *Hakea lissocarpha*. The shrubs were severely grazed upon, while *E. wandoo* and *C. calophylla* were healthy and largely untouched by vertebrate herbivores.

5.5.6 Fauna

The site appears to have been significantly affected by vertebrate herbivores, with kangaroo presence at the site noted through the presence of dung. There was no evidence that rabbits had been on the site, but it is possible. All surviving plants have been adversely affected by herbivory, though *E. wandoo* and *C. calophylla* were less affected and appear to have reached a stage where they are no longer being grazed.

5.5.7 Surface Stability and Erosion

There was some evidence of erosion occurring on this site. The site occurs on a relatively steep hillside, and when ripped, some rip-lines were installed perpendicular to the contours rather than parallel (by contractors not organised by Tranen), which channels and increases the speed and volume of surface flows, rather than reducing it.

5.6 Sales Office B (Planted in 2013)

5.6.1 Survival and Condition of Revegetation

Mean survival of seedlings installed at Sales Office B was 33% (± 23%) across the five quadrats and ten transects. Survival ranged from 4% to 76% across the plots.

The condition of surviving plants was generally very good, with strong growth and few signs of stress.

5.6.2 Plant Heights

Maximum plant heights at Sales Office B ranged between 0.3 m and 1.5 m, with a mean height of 1.0 m. This represents a doubling of the mean maximum plant height since spring 2013. The tallest species in ten of the

quadrats or transects was *A. saligna*, with four transects having *E. rudis* being the tallest species and one with *E. wandoo* the tallest.

5.6.3 Remnant Vegetation

Sales Office B contains patches of remnant vegetation which consists almost entirely of *E. wandoo* mature trees. These are scattered throughout the site, but mainly occur on rocky breakaways.

No natural germination was observed on the transects or quadrats in autumn 2014.

5.6.4 Weeds

Weed cover was low throughout the site at the time of survey, with an average weed cover of < 1%.

5.6.5 Species Richness

Fourteen of the 15 species planted at Sales Office B were observed during the survey (93%), which is above the required 65% to meet completion criteria.

5.6.6 Fauna

There was little evidence of plants being grazed at Sales Office B, with most plants being healthy. Kangaroos scats were observed during the autumn 2014 survey, and a set of gates had been left open.

5.6.7 Surface Stability and Erosion

There was minor erosion evident in some of the rip-lines that were installed with a slight downhill orientation, and this erosion may have led to some plant deaths. It is not a great concern across this site.

6 DISCUSSION

6.1 Plant Survival

To date, 106,775 seedlings have been planted for the Avon Ridge project out of a total of 214,000 stipulated in the offset package prepared by Peet[1]. Of these, 88,255 seedlings are original plantings into the sites, and 18,520 have been infill planting into sites 1A and 2. These have been planted across six separate revegetation sites over a three year time frame beginning in 2011. Survivorship of plants installed into the revegetation sites must be 90% or greater after three years to meet Condition 3 of the EPBC approval.

The survival of planted tubestock as assessed during the autumn 2014 monitoring survey was:

- 60% at Site 1A (three years after initial planting);
- 92% at Site 2 (two years after initial planting);
- 7% at Site 3 (one year after initial planting);
- 6% at Site 4 (one year after initial planting);
- 28% at Sales Office A (one year after initial planting); and
- 33% at Sales Office B (one year after initial planting).

These figures are currently below the 90% required of the EPBC conditions for all sites except Site 2.

One of the main factors that contributed to the reduction in survival across the sites was likely to be the very long drought that occurred over summer 2013/14. Investigation of rainfall data using the Bureau of Meteorology (BoM) website indicated that just 1.6 mm of rain fell between December 2013 and the end of February 2014, compared with the long term average of 32 mm (data from the Midland weather station (station no. 009025) which is 12 km from the site). Looking at the data over the main growing season (October to the end of April), rainfall in 2013/14 was half the long-term average (81.0 mm compared with 161.2 mm). These low rainfall figures impacted on older plants as well as seedlings planted in 2013 (for example, see Figure 7).

6.2 Plant Health, Species Richness and Growth of Revegetation

The condition and growth of revegetation works is good for the areas that have been fenced to exclude kangaroos, with the exception of Site 4 which has often had gates left open and has had members of the public remove sections of fence through vandalism. Sites 1A, 2 and Sales Office B have healthy looking plants, strong growth rates and generally good survival rates.

Plant heights have increased at Sites 1A, 2, SO-A and SO-B between the spring 2013 and autumn 2014 surveys, meeting one of the completion criteria outlined in the *Revegetation and Fire Management Plan*, Cardno 2012) (see Section 2.3).

[1] Note that since the autumn 2014 monitoring has taken place, planting of a further 35,000 seedlings has occurred, taking the grand total of number of seedlings planted to 141,775

However, average maximum plant heights have reduced or not changed for Sites 3 and 4, therefore not meeting the completion criteria. These two sites appear to have been significantly affected by kangaroo herbivory, which would explain the lack of growth as well as the reduction in survivorship. The installation of a fence around Site 3 and an improvement of the fence to Site 4 prior to winter 2014 planting should prevent kangaroos from entering these sites.

Species richness currently meets the completion criteria of ≥ 65% for sites 1A, 2 and SO-B. Sites 3, 4 and SO-A are currently not meeting the completion criteria. These sites were the ones heavily impacted by kangaroos, which is the most likely explanation for the loss of palatable species. It is the Eucalypts that are surviving and growing the best at these sites. The kangaroos do not seem to be grazing the Eucalypts.

6.3 Weeds

Weed cover was negligible across most of the sites at the time of survey. Sites were surveyed in late summer through autumn during a significant drought year; hence there was little living weed biomass on the sites. Some summer weeds were noted, such as Narrowleaf Cotton Bush and Stinkwort, but these populations were very small and generally outside of the rip-lines.

Three of the four new revegetation sites established in 2013 (Sites 3 and 4, and Sales Office B) were sprayed with a pre-emergent herbicide prior to revegetation works. The rip-lines have been generally weed-free since, as observed during monthly visits to the sites.

6.4 Remnant Vegetation and Natural Recruitment

Sites 1A and 2 have both shown improvement in condition through natural recruitment. Hundreds of *E. rudis* seedlings have been observed at Site 1A, including in the transects, where they have been counted towards the plant numbers and therefore the survival figures. Other species that have been observed germinating at Site 1A are *Corymbia calophylla, Banksia sessilis, Hibbertia commutata, H. subvaginata, Allocasuarina fraseriana* and *Juncus pallidus*, of which *C. calophylla, B. sessilis* and *A. fraseriana* are all Black Cockatoo foraging species (Valentine and Stock, 2008; Groom, 2011).

Species that have been observed germinating at Site 2 over the course of the revegetation activities include *C. calophylla, E. rudis*, *H. commutata* and *Hypocalymma* sp. A large population of the native grass *Austrostipa flavescens* has also established in the centre of Site 2, and in less dense populations in other areas throughout the site. It is likely that the natural recruitment of these species has benefitted significantly from the exclusion of kangaroos, particularly the native grass and shrub species.

6.5 Fauna

As noted in the spring 2013 survey report, kangaroos appear to have been a significant impacting factor on seedling survival and plant health. The unfenced sites

established in 2013 as part of a trial showed particularly poor survival (Site 3: 7% survival, and SO-A: 28% survival). In addition, Site 4, which seemed to always have gates open, has very low survival as well (6%). All sites but SO-A have now been fenced to exclude kangaroos. Sales Office A will not have any further planting due to potential for fire danger to surrounding residents.

6.6 Surface Stability and Erosion

Surface erosion was noted at Sales Office A and B, and at Site 4, all of which have relatively steep slopes. Erosion at Sales Office B was minimal, but it is more severe at Sales Office A and Site 4. The erosion has affected plant survival, with soil washed away from the root ball of some seedlings.

7 CONCLUSIONS

In conclusion, revegetation at Avon Ridge is progressing well in areas that have been protected from kangaroos, but requires on-going maintenance works to reach completion criteria at most sites.

The severe drought experienced over the 2013/14 summer adversely affected all sites, and is likely the main factor reducing survival of plants in the fenced sites. Where kangaroos were able to enter the sites, there appears to have been a cumulative effect of drought and herbivory which has significantly reduced survival, most notably at Sites 3 and 4 where survival is less than 10%. Weeds do not seem to have been a major factor influencing plant survival or growth.

Table 3 summarises the progress of revegetation against completion criteria and the actions required to achieve targets.

Table 3 Revegetation Progress Against the Completion Criteria - Autumn 2014

Completion Criteria	Site 1A	Site 2	Site 3	Site 4	Sales Office A	Sales Office B	Actions Required
Survivorship rate must be at least 90%	X	✓	X	X	X	X	Infill planting required 2014[2]
Plants are healthy in appearance and diverse in species with no mass losses	✓	✓	X	X	X	✓	Fence to be Installed (Site 3) or altered (Site 4)[3]
Species diversity is ≥ 65%	✓	✓	X	X	X	✓	Infill planting to replant species[2]
The average seedling height has increased between assessments	✓	✓	X	X	✓	✓	Fence to be Installed (Site 3) or altered (Site 4)[4]
Weed presence is minimal and not inhibiting native plant survival and growth	✓	✓	✓	✓	✓	✓	Continue weed control as needed

[2] Infill planting has been done in winter 2014
[3] Fences have been installed or altered prior to planting in winter 2014
[4] Fences have been installed or altered prior to planting in winter 2014

Other observations within the sites that are significant to the overall revegetation effort and success rates are:

- The extremely dry summer of 2013/14 had a significant impact on the health of vegetation, including remnant native vegetation in the area. Significant plant deaths were noted both from planted individuals in the revegetation sites and in the surrounding native bushland;
- Kangaroo grazing significantly affects survival – unfenced sites have had very low survivorship;
- Natural recruitment has been observed in significant numbers within the older sites, which has been promoted by non-planting site preparation activities such as fencing, ripping and weed control;
- There has not been significant erosion observed in areas where ripping is parallel with contours, and minor erosion where ripping is perpendicular to contours.

8 FUTURE WORK AND RECOMMENDATIONS

8.1 Achieving Survival Targets

Infill planting was undertaken in winter 2014 following the autumn monitoring results reported in this document. At the time of writing this report, the 2014 planting has been completed, results of which will be reported on in the spring 2014 monitoring report.

A total of 37,900 seedlings were planted across the sites in 2014 (Table 4).

Table 4 Number of Plants Installed in 2014

Site	Original No. Planted 'A'	Survival Rate (Autumn 2014)	No. Surviving 'B'	No. Planted in 2014 'C'	Total No. on Site Following 2014 Infill 'B + C'	Current Survival Rate Following 2014 Infill '(B + C) / A' x 100%
1A	30,775	60%	18,465	9,300	27,765	90%
2	24,000	92%	22,080	2,000	24,080	100%
3	2,610	7%	183	3,800	3,983	153%
4	10,340	6%	620	14,800	15,420	149%
SO-A	6,150	28%	1,722	0	1,722	28%[A]
SO-B	14,380	33%	4,745	8,000	12,745	89%
TOTAL	**88,255**		**47,815**	**37,900**	**85,715**	

[A] No further planting is recommended at Sales Office A because of the potential for increasing bushfire risk

No infill planting was undertaken at Sales Office A in 2014. There are three reasons for this:

1. Planting a higher density of plants increases the fire hazard to surrounding properties;
2. The site would require a fence to protect seedlings which would not be aesthetically pleasing and potentially upset neighbouring property owners; and
3. The poor survival results indicate it will be difficult to establish more plants without a fence, and most likely it will not be possible to achieve the 90% survival target.

8.2 Species List for 2014 Infill Planting

The list of species and the number planted in winter 2014 in each revegetation site is provided in Appendix 3.

The species list was designed towards predominantly installing shrubs and ground covers that can be planted at relatively high densities (i.e. spacing of < 1m along rip-lines). *Eucalyptus wandoo* and *Corymbia calophylla* have been included in the list as the survival at Sites 3 and 4 was poor for all species.

8.3 Plant Protection

To achieve the survival target of 90% of the number of seedlings originally planted after three years, Site 3 was fenced prior to infill planting in winter 2014, and the fence at Site 4 was improved to reduce the likelihood of further vandalism.

9 REFERENCES

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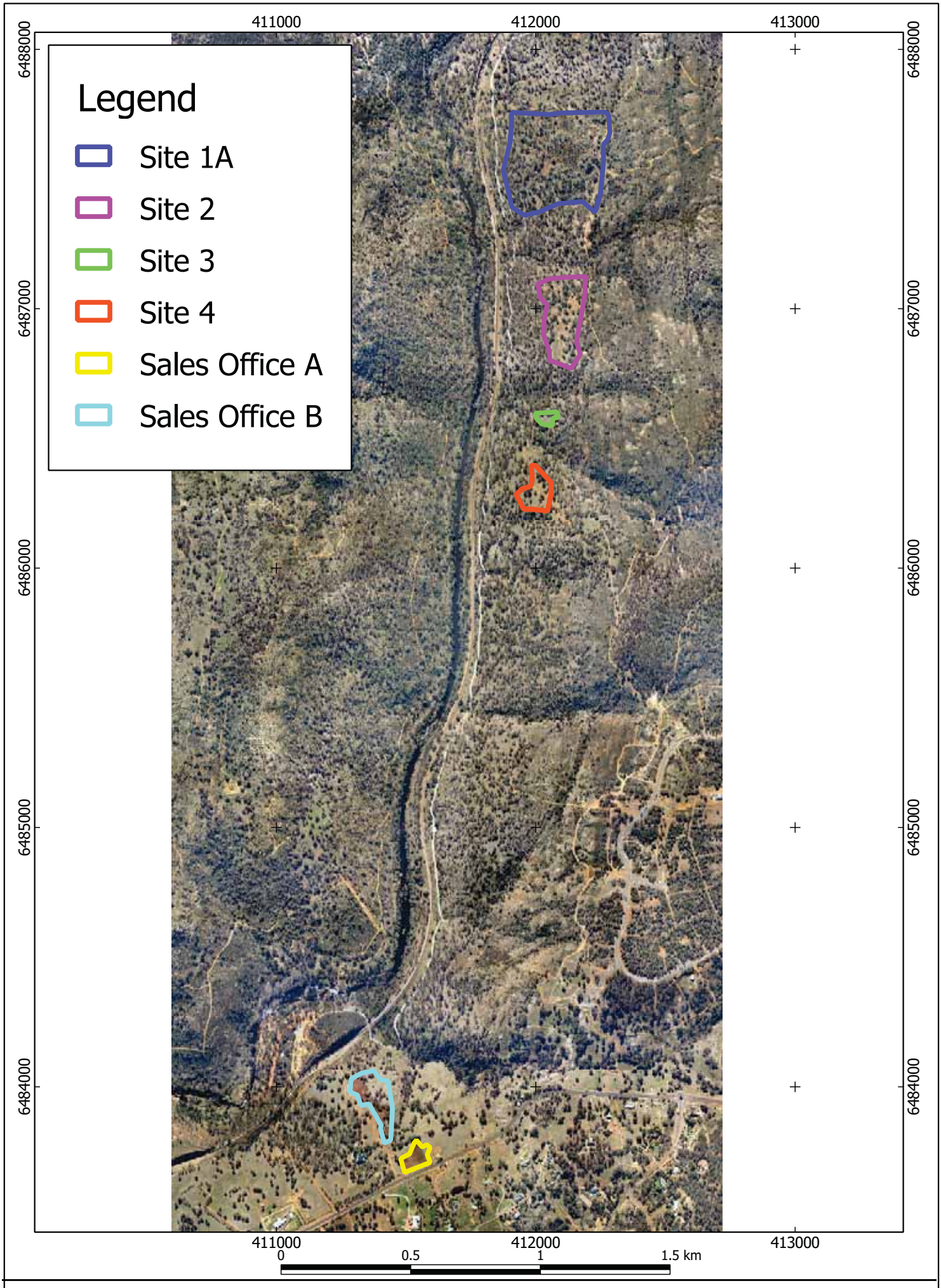
Appendix 1 Revegetation Site Locations



tranen revegetation systems

Project: Avon Ridge Revegetation
Project Number: P496
Client: Emerge Associates

Drawing: Revegetation Sites
Drawing Number: P496A-02
Revision: 0

Date: 10/02/2014
Drawn By: RSW

Appendix 2 Raw Data

Avon Ridge Site 1A — 30,775 seedlings planted in 2011

Planted in Winter 2011, winter 2012 — 12,000 planted in 2012

AUTUMN 2014 MONITORING - DATE: **3/04/2014**

Transect No.	New in '12	Original no planted in '11 (Baseline)	Total no. planted 11+12	No. alive Aut 13	No. alive Spr 13	No. alive Aut 14	% Survival of Original nos	Tallest sp. observed	Height (m)	Weed cover (%)	Comments
1		31	31	20	23	18	58%	*Acacia saligna*	3.5	0	Natural recruitment - *E. rudis* and *Juncus pallidus*
2		39	39	28	28	22	56%	*Acacia saligna*	3.5	0	
3		26	26	22	22	21	81%	*Acacia saligna*	2.5	0	
4		44	44	28	27	23	52%	*Acacia saligna*	3.0	0	
5		73	73	55	53	46	63%	*Acacia saligna*	4.5	0	Several dead plants including large *A. saligna* and *E. rudis*
6		26	26	26	31	25	96%	*Acacia saligna*	4.5	0	Four natural recruits - *E. rudis*
7		34	34	28	30	19	56%	*Acacia saligna*	4.0	0	Five natural recruits - *E. rudis*
8		41	41	27	27	24	59%	*Acacia saligna*	4.5	0	Two *E. rudis* recruits and one *C. calophylla* recruit
9		50	50	33	30	26	52%	*Acacia saligna*	4.0	0	A few *E. rudis* and shrub deaths
10		42	42	27	27	25	60%	*Eucalyptus rudis*	5.0	0	*Hibbertia commutata* recruit. Also dead plants
11		40	40	22	28	19	48%	*Eucalyptus rudis*	4.5	0	*Hibbertia subvaginata* recruit
12	14	20	34	16	15	15	75%	*Eucalyptus rudis*	4.5	0	Herbivory on transect
13	8	20	28	12	13	9	45%	*Acacia saligna*	4.0	0	Four deaths of plants
14	17	55	72	28	27	20	36%	*Eucalyptus rudis*	4.0	0	Some deaths
15	23	35	58	29	29	21	60%	*Acacia saligna*	4.0	1	Dead saplings
16	8	94	102	72	68	56	60%	*Eucalyptus rudis*	5.5	1	Dead shrubs
17	7	69	76	44	43	43	62%	*Acacia saligna*	4.5	1	
18	14	94	108	66	66	61	65%	*Eucalyptus rudis*	5.0	0	*Daviesia ?triflora* recruit. *Acacia lasiocarpa* dead or dying
19	18	136	154	88	88	92	68%	*Acacia saligna*	4.5	0	Six *E. rudis* recruits
20	31	51	82	41	39	24	47%	*Acacia saligna*	4.5	0	Lots of deaths - photo#5196 shows drought effects
21	12	36	48	32	32	20	56%	*Acacia saligna*	4.0	0	Five *E. rudis* recruits
22	25	55	80	40	43	39	71%	*Acacia saligna*	4.0	0	*E. rudis* recruits, other plants showing drought effects
23	31	37	68	30	34	30	81%	*Acacia saligna*	4.5	0	
24	42	49	91	43	43	32	65%	*Eucalyptus rudis*	3.5	0	Dead shrubs and saplings
25	17	14	31	17	18	11	79%	*Acacia saligna*	5.5	0	
26	5	23	28	20	20	12	52%	*Acacia saligna*	3.5	0	
27	29	41	70	63	55	42	102%	*Acacia saligna*	4.0	0	Six *E. rudis* recruits
28	15	37	52	28	28	24	65%	*Acacia saligna*	4.0	0	
29	14	42	56	40	40	30	71%	*Acacia saligna*	5.5	0	Canopy dying back of planted shrubs/trees. *Daviesia* sp. recruit
30	21	44	65	29	29	25	57%	*Acacia saligna*	5.5	0	
31	17	35	52	20	18	16	46%	*Acacia saligna*	4.0	0	*Hibbertia subvaginata* recruit
32	28	46	74	39	85	36	78%	*Acacia saligna*	3.5	0	42 recruited seedlings
33	43	52	95	44	46	31	60%	*Eucalyptus rudis*	3.5	0	Nine *E. rudis* recruits
34	31	55	86	28	56	22	40%	*Acacia saligna*	3.5	0	12 *E. rudis* recruits
35	15	46	61	58	65	45	98%	*Acacia saligna*	3.5	0	13 *E. rudis* recruits
36	9	59	68	21	50	30	51%	*Acacia saligna*	3.5	0	51 *E. rudis* recruit
37	8	26	34	12	12	8	31%	*Acacia pulchella*	1.0	0	Low growth rates of planted seedlings
38	11	31	42				-				
39		30	30	29	28	22	73%	*Acacia saligna*	4.0	0	Nine recruits
40		42	42	33	33	33	79%	*Acacia saligna*	3.5	0	

Transect No.	New in '12	Original no planted in '11 (Baseline)	Total no. planted 11+12	No. alive Aut 13	No. alive Spr 13	No. alive Aut 14	% Survival of Original nos	Tallest spp observed	Height (m)	Weed cover (%)	Comments
41		25	25	13	11	8	32%	*Acacia saligna*	4.5	0	All plants are browning off
42		27	27	17	17	8	30%	*Eucalyptus rudis*	2.0	0	Lots of plant deaths
43		22	22	13	10	7	32%	*Acacia saligna*	3.0	0	
44		14	14	9	30	16	114%	*Acacia saligna*	4.0	0	Ten recruits
45		22	22	8	8	5	23%	*Acacia saligna*	3.0	0	
46		24	24	4	5	3	13%	*Acacia saligna*	4.5	0	One *E. rudis* recruit
47		10	10	8	8	7	70%	*Acacia saligna*	4.0	0	One *E. rudis* recruit
48		4	4	2	2	2	50%	*Acacia saligna*	4.0	0	Five *E. rudis* recruit
49		17	17	16	16	15	88%	*Acacia saligna*	4.5	0	Two *E. rudis* recruit
50		32	32				-				
Total	**513**	**2,017**	**2530**	**1428**	**1556**						
					Mean		**60%**	**Mean**	**4.0**	**0**	
					Median		**60%**	**Median**	**4.0**	**0.0**	
					Min		**13%**	**Min**	**1.0**	**0**	
					Max		**114%**	**Max**	**5.5**	**1**	
					St. dev.		**21%**	**St. dev.**	**0.9**	**0**	

Avon Ridge Site 1A

Original 21 spp (2011 planting):

Species	Observed?
Acacia lasiocarpa	Y
Acacia saligna	Y
Allocasuarina humilis	Y
Banksia grandis	Y
Banksia illicifolia	N
Calothamnus hirsutus	Y
Calothamnus quadrifidus	Y
Corymbia calophylla	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Gastrolobium calycinum	Y
Gompholobium tomentosum	Y
Hakea cyclocarpa	N
Hakea lissocarpha	Y
Hakea ruscifolia	Y
Hakea undulata	Y
Kennedia coccinea	Y
Kennedia prostrata	Y
Leptospermum erubescens	Y
Macrozamia redlei	N
Hypocallymma robustum	N

Total no. spp planted:	30
No. spp observed:	24
% spp observed:	80%

Additional spp - Infill 2012

Allocasuarina fraseriana	Y
Banksia menziesii	Y
Banksia prionotes	N
Callistemon phoeniceus	Y
Eucalyptus marginata	Y
Hakea incrassata	N
Hakea prostrata	Y
Hakea trifurcata	Y
Hakea varia	Y

Avon Ridge Site 2 — 24,000 seedlings planted in 2012

Planted in Winter 2012+2013 — 6520 planted in 2013

AUTUMN 2014 MONITORING - DATE: 3/04/2014

Transect No	No. alive from 2012	No. alive from 2013 infill	No. dead from 2013 infill	Est. Total no. planted in 2012	No. alive Aut 14	% survival of 2013 infill	% survival of 2012 no.s planted	Tallest sp. observed	Height (m)	Weed cover (%)
1	45	35	1	68	62	97%	**91%**	*Acacia saligna*	2.5	1
2	6	24	4	9	19	86%	**211%**	*Acacia saligna*	1.5	1
3	5	16	2	8	14	89%	**175%**	*Acacia saligna*	1.5	1
4	24	0	0	36	17	-	**47%**	*Acacia saligna*	3.0	0
5	24	0	0	36	14	-	**39%**	*Eucalyptus rudis*	2.0	0
6	12	0	0	18	12	-	**67%**	*Eucalyptus rudis*	2.0	0
7	15	11	4	23	17	73%	**74%**	*Acacia saligna*	2.0	0
8	10	5	3	15	7	63%	**47%**	*Eucalyptus rudis*	2.0	1
9	57	36	6	86	62	86%	**72%**	*Acacia saligna*	2.5	1
10	28	30	2	42	43	94%	**102%**	*Acacia saligna*	2.5	1
11	95	33	16	144	87	67%	**60%**	*Acacia saligna*	3.0	1
12	81	67	11	123	113	86%	**92%**	*Acacia saligna*	2.5	1
13	47	84	11	71	105	88%	**148%**	*Acacia saligna*	1.0	1
14	24	29	5	36	40	85%	**111%**	*Hakea undulata*	0.6	1
15	8	10	0	12	15	100%	**125%**	*Acacia saligna*	2.5	1
16	6	68	4	9	50	94%	**556%**	*Acacia saligna*	0.6	1
17	27	31	1	41	48	97%	**117%**	*Eucalyptus rudis*	0.9	0
18	130	20	3	197	97	87%	**49%**	*Corymbia calophylla*	1.5	1
19	77	17	4	117	60	81%	**51%**	*Acacia saligna*	3.0	1
20	38	11	6	58	40	65%	**69%**	*Acacia saligna*	4.0	1
Total	**759**	**527**	**83**	**1,149**						
				Mean:		**85%**	**115%**	**Mean**	**2.1**	**0.8**
				St. dev.		**11%**	**113%**	**st dev**	**0.9**	**0.4**
				Min.		**63%**	**39%**	**min**	**0.6**	**0.0**
				Max.		**100%**	**556%**	**max**	**4.0**	**1.0**

Outlier removed

Mean:	**92%**
St. dev.	**47%**
Min.	**39%**
Max.	**211%**

Note: estimated total number planted is based on average survival from autumn 2013 of 66%

Avon Ridge Site 2

2012 planting

Species	Observed?
Acacia saligna	y
Allocasuarina fraseriana	y
Banksia grandis	y
Banksia menzeisii	y
Banksia prionotes	y
Callistemon phoeniceus	y
Corymbia calophylla	y
Eucalyptus marginata	y
Eucalyptus wandoo	y
Hakea cyclocarpa	N
Hakea incrassata	N
Hakea lissocarpha	y
Hakea prostrata	y
Hakea ruscifolia	y
Hakea trifurcata	y
Hakea undulata	y
Hakea varia	y
Hypocalymma robustum	y

Additional 2013 spp.	Observed?
Banksia sessilis	y
Eucalyptus rudis	y

Total no. spp planted:	20
No. spp observed:	18
% spp observed:	90%

Avon Ridge Site 3 2,610 planted in 2013

Planted in 2013

AUTUMN 2014 MONITORING - DATE: 26/02/2014

Transect No.	Total No. planted 2013 (Baseline)	Alive Spr 2013	% Survival Spr 2013	Alive Aut 2014	% Survival Aut 2014	Tallest spp observed Aut 2014	Height (m)	Weed cover (%)	Comments
1	23	0	**0%**	0	**0%**	-	-	0	
2	50	22	**44%**	2	**4%**	*Acacia saligna*	0.2	0	*Acacia saligna* grazed by herbivore
3	56	11	**20%**	1	**2%**	*Eucalyptus wandoo*	0.4	0	*Eucalyptus wandoo was possibly a natural recruit already there*
4	55	18	**33%**	3	**5%**	*Eucalyptus rudis*	0.3	0	
5	49	26	**53%**	5	**10%**	*Eucalyptus wandoo*	0.2	0	
6	55	16	**29%**	3	**5%**	*Eucalyptus wandoo*	0.2	0	
7	66	27	**41%**	5	**8%**	*Eucalyptus wandoo*	0.2	0	
8	40	21	**53%**	4	**10%**	*Acacia saligna*	0.2	0	
9	42	23	**55%**	6	**14%**	*Eucalyptus rudis*	0.4	0	
Total	**436**	**164**							
		Mean	**36%**		**7%**	**Mean**	**0.3**	**0.0**	
		Min	**0%**		**0%**	**Min**	**0.2**	**0.0**	
		Max	**55%**		**14%**	**Max**	**0.4**	**0.0**	
		St. dev.	**18%**		**4%**	**St. dev.**	**0.1**	**0.0**	

Avon Ridge Site 3

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia nivea	N
Banksia sessilis	N
Callistemon phoeniceus	Y
Calothamnus quadrifidus	N
Corymbia calophylla	N
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	N
Hakea ruscifolia	N
Hakea trifurcata	N
Hakea undulata	N

Total no. spp planted:	12
No. spp observed:	4
% spp observed:	33%

Avon Ridge Site 4 10,340 planted in 2013

Planted in 2013

AUTUMN 2014 MONITORING - DATE: 29/04/2014

Transect No.	Total No. planted 2013 (Baseline)	Alive Spr 2013	% Survival Spr 2013	Alive Aut 2014	% Survival Aut 2014	Tallest spp observed	Height (m)	Weed cover (%)	Comments
1	69	30	**43%**	0	**0%**	n/a	-	0	
2	125	86	**69%**	18	**14%**	*Eucalyptus wandoo*	0.3	1	
3	50	33	**66%**	3	**6%**	*Eucalyptus wandoo*	0.2		
4	62	26	**42%**	6	**10%**	n/a	-	0	
5	50	39	**78%**	8	**16%**	*Eucalyptus wandoo*	0.3	0	
6	98	85	**87%**	18	**18%**	*Eucalyptus wandoo*	0.2	0	
7	50	45	**90%**	5	**10%**	*Eucalyptus wandoo*	0.3	0	
8	46	36	**78%**	0	**0%**	n/a	-	0	
9	32	16	**50%**	1	**3%**	*Eucalyptus wandoo*	0.2	0	
10	44	24	**55%**	0	**0%**	n/a	-	0	
11	34	13	**38%**	1	**3%**	*Eucalyptus rudis*	0.5	0	
12	42	20	**48%**	0	**0%**	n/a	-	0	
13	102	26	**25%**	3	**3%**	*Callistemon phoeniceus*	0.1	0	
14	22	6	**27%**	0	**0%**	n/a	-	0	
15	44	14	**32%**	1	**2%**	*Eucalyptus wandoo*	0.1	0	
Total	**870**	**499**	**-**		**-**				
	Mean		**55%**		**6%**	**Mean**	**0.2**	**0.1**	
	Min		**25%**		**0%**	**Min**	**0.1**	**0.0**	
	Max		**90%**		**18%**	**Max**	**0.5**	**1.0**	
	St. dev.		**21%**		**6%**	**St. dev.**	**0.1**	**0.3**	

Avon Ridge Site 4

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia grandis	N
Banksia nivea	N
Banksia sessilis	N
Callistemon phoeniceus	Y
Calothamnus quadrifidus	N
Corymbia calophylla	Y
Eucalyptus marginata	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea prostrata	N
Hakea ruscifolia	N
Hakea trifurcata	Y
Hakea undulata	N
Hakea varia	N

Total no. spp planted:	16
No. spp observed:	8
% spp observed:	50%

Avon Ridge Site Sales Office A 10 x 10 m quadrats 6,150 planted in 2013

Planted in 2013

AUTUMN 2014 MONITORING - DATE: 29/04/2014

Quadrat #	Alive from'13 plants	Density Spr 2013 (plants / m2)	Expected density (plants/m2) (Baseline)	No. plants Aut 2014	Density Aut 2014 (plants / m2)	% Survival Aut 14	Height (m)	Weed cover (%)	Tallest spp observed	Comments
1	19	0.19	0.77	5	0.05	**7%**	0.3	1	*Corymbia calophylla*	Cotton bush. 3 Eucalypts, 2 *Callistemon phoeniceus*
2	36	0.36	0.77	28	0.28	**36%**	1.0	1	*Eucalyptus wandoo*	Stinkwort, 23 Eucalypts, 5 *C. phoeniceus*
3	45	0.45	0.77	29	0.29	**38%**	1.0	1	*Eucalyptus wandoo*	Cotton bush. 22 Eucalypts, 6 *C. phoeniceus*, 1 *Hakea lissocarpha*
4	32	0.32	0.77	19	0.19	**25%**	1.0	1	*Eucalyptus wandoo*	12 Eucalypts, 7 *C. phoeniceus*
5	58	0.58	0.77	27	0.27	**35%**	1.0	1	*Eucalyptus wandoo*	22 Eucalypts, 5 *C. phoeniceus*
6	43	0.43	0.77	22	0.22	**29%**	0.5	1	*Eucalyptus wandoo*	17 Eucalypts, 5 *C. phoeniceus*
Total	**233**									
			Mean			**28%**	**0.8**	**1.0**		
			Min			**7%**	**0.3**	**1.0**		
			Max			**38%**	**1.0**	**1.0**		
			St. dev.			**12%**	**0.3**	**0.0**		

Expected density based on 6,150 seedlings planted into 0.8 ha

No. planted	6150
Area	0.8
Expected density	0.77

Avon Ridge Sales Office A

2013 planting

Species	Observed?
Acacia saligna	N
Banksia grandis	N
Callistemon phoeniceus	Y
Corymbia calophylla	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea prostrata	N
Hakea ruscifolia	N
Hakea trifurcata	N
Hakea undulata	N
Hakea varia	N

Total no. spp planted:	11
No. spp observed:	4
% spp observed:	36%

Avon Ridge Site Sales Office B Transects and quadrats 14,380 planted in 2013

Planted in 2013

AUTUMN 2014 MONITORING - DATE: 29/04/2014

Transect / Quadrat #	Alive from'13	Dead from'13	Total No. planted 2013 (Baseline)	Alive Aut 14	% Survival Aut 14	Tallest spp observed	Height (m)	Weed cover (%)	Comments
SOBQ1	87	25	112	56	50%	*Acacia saligna*	1.2	0	25 Eucalypts, 20 *Acacia saligna* , 11 other
SOBQ2	97	19	116	88	76%	*Acacia saligna*	1.5	0	37 Eucalypts, 31 *A. saligna* , 20 other kangaroo scats
SOBQ3	138	30	168	103	61%	*Eucalyptus rudis*	1.5	0	55 Eucalypts, 34 *A. saligna,* 14 other
SOBQ4	77	37	114	64	56%	*Acacia saligna*	1.0	0	21 Eucalypts, 41 *A. saligna,* 2 other
SOBQ5	90	33	123	70	57%	*Acacia saligna*	1.5	0	26 Eucalypts, 39 *A. saligna,* 5 other
SOBT6	41	24	65	23	35%	*Acacia saligna*	1.5	0	15 Eucalypts, 6 *A. saligna* , 2 other
SOBT7	35	36	71	21	30%	*Acacia saligna*	1.0	0	12 Eucalypts, 8 *A. saligna,* 1 *Callistemon phoeniceus*
SOBT8	18	48	66	8	12%	*Eucalyptus wandoo*	0.5	0	6 Eucalypts, 2 *A. saligna*
SOBT9	33	30	63	11	17%	*Acacia saligna*	1.0	0	2 Eucalypts, 9 *A. saligna,* herbivory noted - nearby gate open
SOBT10	11	11	22	2	9%	*Eucalyptus rudis*	0.3	0	2 Eucalypts
SOBT11	22	18	40	4	10%	*Eucalyptus rudis*	0.6	0	1 Eucalypt, 2 *A. saligna,* 1 *Hakea ruscifolia*
SOBT12	38	28	66	24	36%	*Acacia saligna*	1.0	0	14 Eucalypts, 9 *A. saligna,* 1 *Hakea lissocarpha*
SOBT13	22	17	39	11	28%	*Acacia saligna*	0.7	0	1 *Eucalyptus rudis,* 10 *A. saligna*
SOBT14	19	17	36	3	8%	*Acacia saligna*	1.0	1	0 Eucalypts, 3 *A. saligna*
SOBT15	23	67	90	4	4%	*Eucalyptus rudis*	1.0	1	1 *E. rudis* , 2 *A. saligna,* 1 *Hakea lissocarpha*
Total	751	440	1,191						

Mean	33%	Mean	1.0	0.1
Min	4%	Min	0.3	0.0
Max	76%	Max	1.5	1.0
St. dev.	23%	St. dev.	0.4	0.4

Avon Ridge Site Sales Office B

2013 planting

Species	Observed?
Acacia saligna	Y
Banksia grandis	Y
Banksia nivea	Y
Banksia sessilis	Y
Callistemon phoeniceus	Y
Calothamnus quadrifidus	Y
Corymbia calophylla	Y
Eucalyptus marginata	Y
Eucalyptus rudis	Y
Eucalyptus wandoo	Y
Hakea lissocarpha	Y
Hakea prostrata	Y
Hakea ruscifolia	Y
Hakea trifurcata	N
Hakea undulata	Y

Total no. spp planted:	15
No. spp observed:	14
% spp observed:	93%

Appendix 3 Species Lists for 2014 Infill Planting

tranen revegetation systems

1/110 Jersey St Jolimont WA 6014
p 08 9284 1399 f 08 9284 1377
www.tranen.com.au email@tranen.com.au

Avon Ridge Estate - Emerge Associates

Post Activity Report - Planting and Weed Control - Site 1A

Installation Date:	1st and 2nd July		**Conducted By:**	Tranen	
Site Reference:	Site 1A	**Area (ha):**	13.4	**Slope:**	Flat to 1:4
Aspect:	Mostly west	**Soil Type:**	Clay-loam	**Soil pH:**	

Existing Site Conditions: Revegetation area from 2011. Established plants up to 3 years old. Some plants had died over the 2013/14 drought.

Weed Control Type:	Spot spray	**Weed Control Date:**	19th and 30th June 2014
Seedling Prep.:	Seedlings watered on day of planting to reduce transplant shock		
Planting Date:	1st and 2nd July	**Fertiliser Application:**	10 g native fertiliser tablet
Planting Method:	Potti putki and auger	**Mulch Application:**	None
Wetting Agent:	None	**Surface Preparation:**	Ripped in 2011

Species	Seedlings
Acacia lasiocarpa	100
Acacia pulchella	600
Allocasuarina humilis	600
Banksia nivea	500
Banksia sessilis	400
Callistemon phoeniceus	320
Calothamnus quadrifidus	400
Calothamnus hirsutus	240
Gompholobium tomentosum	240
Hakea lissocarpha	320
Hakea prostrata	560
Hibbertia subvaginata	320
Hypocalymma robustum	200
Kennedia prostrata	1600
Total Seedlings	**6400**

Additional Comments:
This site was first planted in winter 2011, with infill planting in 2012. Some plants installed into this site were from the infill required to meet completion criteria in Sales Office A. No further planting was to be done at Sales Office A so that the fire risk remained low. No trees were planted into Site 1A as there was already a high density of eucalypts and *Acacia saligna*.

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Post Activity Report - Additional Tubestock Planting - Site 1A

Installation Date:	28 August 2014			**Conducted By:**	Tranen
Site Reference:	Site 1A	**Area (ha):**	13.4	**Slope:**	Flat to 1:4
Aspect:	Mostly west	**Soil Type:**	Clay-loam	**Soil pH:**	

Existing Site Conditions: Revegetation area from 2011. Established plants up to 3 years old. Some plants had died over the 2013/14 drought.

Weed Control Type:	Spot spray	**Weed Control Date:**	19th and 30th June 2014
Seedling Prep.:	Seedlings watered on day of planting to reduce transplant shock		
Planting Date:	28 August 2014	**Fertiliser Application:**	None
Planting Method:	Potti putki and auger	**Mulch Application:**	None
Wetting Agent:	None	**Surface Preparation:**	Ripped in 2011

Species	Seedlings
Acacia lasiocarpa	504
Acacia pulchella	120
Allocasuarina humilis	331
Calothamnus quadrifidus	945
Hakea prostrata	1000
Total Seedlings	**2900**

Additional Comments:
This site was first planted in winter 2011, with infill planting in 2012. Some plants installed into this site were from the infill required to meet completion criteria in Sales Office A. No further planting was to be done at Sales Office A so that the fire risk remained low. No trees were planted into Site 1A as there was already a high density of eucalypts and *Acacia saligna*. In early July 2014, 6,400 seedlings were installed in Site 1A - these additional numbers increase plant numbers further.

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Post Activity Report - Planting and Weed Control - Site 2

Installation Date:	9 July 2014		**Conducted By:**	Tranen	
Site Reference:	2	**Area (ha):**	4.7	**Slope:**	Flat to 1:4
Aspect:	Mostly west	**Soil Type:**	Clay-loam	**Soil pH:**	

Existing Site Conditions: Revegetation area from 2012. Established plants up to 2 years old. Some plants had died over the 2013/14 drought.

Weed Control Type:	Spot spray	**Weed Control Date:**	3 July 2014
Seedling Prep.:	Seedlings watered on day of planting to reduce transplant shock		
Planting Date:	9 July 2014	**Fertiliser Application:**	10 g native fertiliser tablet
Planting Method:	Potti putki	**Mulch Application:**	None
Wetting Agent:	None	**Surface Preparation:**	Ripped in 2012

Species	Seedlings
Acacia pulchella	150
Allocasuarina humilis	120
Banksia nivea	100
Banksia sessilis	120
Callistemon phoeniceus	120
Calothamnus quadrifidus	120
Calothamnus hirsutus	80
Hakea lissocarpha	200
Hakea prostrata	120
Hakea undulata	40
Hibbertia subvaginata	120
Hypocalymma robustum	160
Kennedia prostrata	550
Total Seedlings	**2000**

Additional Comments:
This site was first planted in winter 2012, with infill planting in 2013. All plants installed into this site in 2014 were from the infill required to meet completion criteria in Sales Office A. No further planting was to be done at Sales Office A so that the fire risk remained low. No trees were planted into Site 2 in 2014 as there was already a high density of eucalypts and *Acacia saligna* .

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Post Activity Report - Planting and Weed Control - Site 3

Installation Date:	9 July 2014			**Conducted By:**	Tranen
Site Reference:	Site 3	**Area (ha):**	0.3	**Slope:**	Flat to 1:4
Aspect:	Mostly west	**Soil Type:**	Clay-loam	**Soil pH:**	

Existing Site Conditions: Revegetation area from 2013. This area was not fenced prior to planting in 2013 to assess the benefit of fencing on revegetation success. Survival was < 8%. The site was fenced in autumn 2014 prior to planting.

Weed Control Type:	Spot spray	**Weed Control Date:**	2 July 2014
Seedling Prep.:	Seedlings watered on day of planting to reduce transplant shock		
Planting Date:	9 July 2014	**Fertiliser Application:**	10 g native fertiliser tablet
Planting Method:	Potti putki	**Mulch Application:**	None
Wetting Agent:	None	**Surface Preparation:**	Ripped in 2013

Species	Seedlings
Acacia lasiocarpa	
Acacia pulchella	220
Allocasuarina humilis	160
Banksia lindleyana	80
Banksia nivea	160
Banksia sessilis	160
Callistemon phoeniceus	160
Calothamnus quadrifidus	160
Calothamnus hirsutus	160
Corymbia calophylla	300
Eucalyptus wandoo	500
Gompholobium tomentosum	80
Grevillea bipinnatifida	80
Hakea lissocarpha	140
Hakea prostrata	150
Hakea undulata	100
Hibbertia subvaginata	120
Hypocalymma robustum	120
Kennedia coccinea	200
Kennedia prostrata	750
Total Seedlings	**3800**

Additional Comments:
This site was first planted in winter 2013 as a trial site without a fence. Seedling mortality was very high, with autumn monitoring recording < 8% survival. Kangaroo herbivory, combined with the long summer drought, is the most likely explanation for poor survival. The site was subsequently fenced in 2014 to provide protection from kangaroos.

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Post Activity Report - Planting and Weed Control - Site 4

Installation Date:	4th and 8th July 2014			**Conducted By:**	Tranen
Site Reference:	Site 4	**Area (ha):**	2.8	**Slope:**	Flat to 1:4
Aspect:	Mostly west	**Soil Type:**	Clay-loam	**Soil pH:**	

Existing Site Conditions: Revegetation area established in 2013. This area was fenced as part of a trial to test the benefits of fencing on seedling survival. Unfortunately, fences were vandalised and gates frequently left open which allowed kangaroos to enter the site. The fence was modified in autumn 2014 to reduce the chance of gates being left open and therefore providing protection from herbivory.

Weed Control Type:	Spot spray	**Weed Control Date:**	2 July 2014
Seedling Prep.:	Seedlings watered on day of planting to reduce transplant shock		
Planting Date:	4th and 8th July 2014	**Fertiliser Application:**	10 g native fertiliser tablet
Planting Method:	Potti putki and auger	**Mulch Application:**	None
Wetting Agent:	None	**Surface Preparation:**	Ripped in 2013

Species	Seedlings
Acacia lasiocarpa	320
Acacia pulchella	820
Allocasuarina humilis	820
Banksia lindleyana	160
Banksia nivea	400
Banksia sessilis	560
Callistemon phoeniceus	640
Calothamnus quadrifidus	620
Calothamnus hirsutus	620
Corymbia calophylla	1,480
Eucalyptus wandoo	1,500
Gompholobium tomentosum	400
Grevillea bipinnatifida	320
Hakea lissocarpha	700
Hakea prostrata	700
Hakea undulata	400
Hibbertia subvaginata	280
Hypocalymma robustum	360
Kennedia coccinea	200
Kennedia prostrata	3,500
Total Seedlings	**14,800**

Additional Comments:
This site was first planted in winter 2013 as a trial site with a fence to compare seedling mortality against Site 3 without a fence. Seedling mortality was very high, despite being fenced. It is likely that kangaroo herbivory, combined with the long summer drought, led to the poor survival, as the gates were often left open allowing kangaroos access to the site. The site was subsequently fenced in 2014 to provide protection from kangaroos.

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Post Activity Report - Planting and Weed Control - Sales Office B

Installation Date:	3 July 2014		**Conducted By:**	Tranen	
Site Reference:	Sales Office B	**Area (ha):**	2.3	**Slope:**	Flat to 1:4
Aspect:	Mostly west	**Soil Type:**	Clay-loam	**Soil pH:**	

Existing Site Conditions: Revegetation area established in 2013. This area was fenced as part of a trial to test the benefits of fencing on seedling survival. Plant survival was highest in this site compared with unfenced sites established in 2013.

Weed Control Type:	Spot spray	**Weed Control Date:**	20 June & 1 July 2014
Seedling Prep.:	Seedlings watered on day of planting to reduce transplant shock		
Planting Date:	3 July 2014	**Fertiliser Application:**	10 g native fertiliser tablet
Planting Method:	Potti putki	**Mulch Application:**	None
Wetting Agent:	None	**Surface Preparation:**	Ripped in 2013

Species	Seedlings
Acacia lasiocarpa	0
Acacia pulchella	820
Allocasuarina humilis	800
Banksia lindleyana	120
Banksia nivea	320
Banksia sessilis	280
Callistemon phoeniceus	700
Calothamnus quadrifidus	500
Calothamnus hirsutus	460
Corymbia calophylla	0
Eucalyptus wandoo	0
Gompholobium tomentosum	240
Grevillea bipinnatifida	160
Hakea lissocarpha	300
Hakea prostrata	800
Hakea undulata	260
Hibbertia subvaginata	160
Hypocalymma robustum	80
Kennedia coccinea	0
Kennedia prostrata	2,000
Total Seedlings	**8,000**

Additional Comments:
This site was first planted in winter 2013 as a trial site with a fence to compare seedling mortality against Sales Office A without a fence. Seedling survival was higher than for Sales Office A, where kangaroo herbivory was a strong impacting factor.

APPENDIX C

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Integrated Science & Design

AVON RIDGE ESTATE LOCAL STRUCTURE PLAN

LOT YIELD

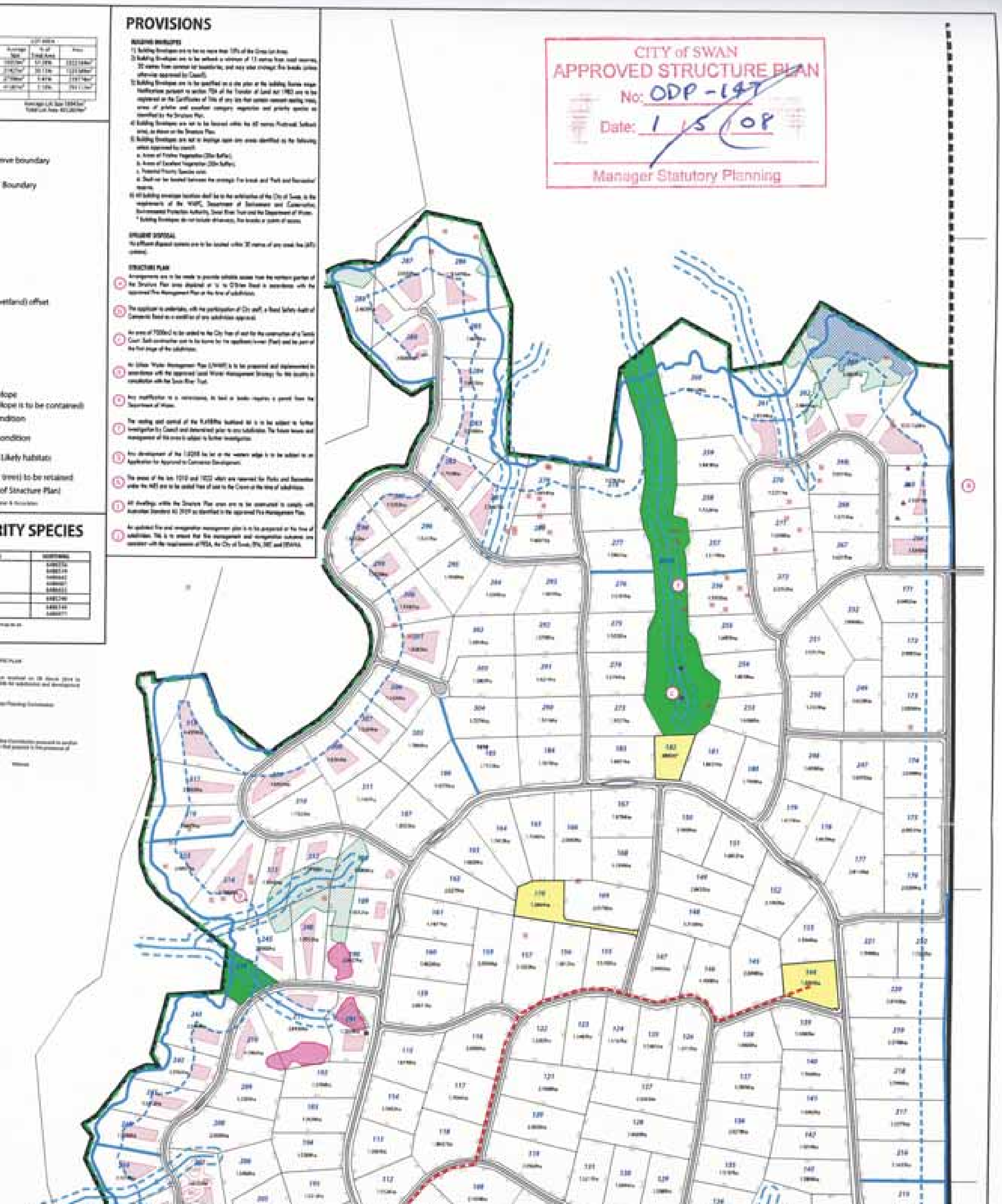
PROVISIONS

LEGEND

- Parks & Recreation Reserve boundary (WAPC Clause 42)
- Subdivision Application Boundary
- Site Boundary
- 60m Firebreak setback
- Strategic Firebreak
- Existing water main
- Creeklines
- 10/20/30m Creekline (wetland) offset
- Public Open Space
- Community Purpose
- Aboriginal Site
- Aboriginal Site Buffer
- Indicative Building Envelope (Location in which envelope is to be contained)
- Vegetation - Pristine Condition
- Vegetation - Excellent Condition
- Potential Priority Flora - Likely habitats
- Remnant Trees (nesting trees) to be retained (refer to attachment 18 of Structure Plan)

IDENTIFIED PRIORITY SPECIES

CITY of SWAN
APPROVED STRUCTURE PLAN
No: ODP - 147
Date: 1 / 5 / 08
Manager Statutory Planning



STRUCTURE PLAN

BRIGADOON

for: Peet Limited.

PEET

NORTH

Scale 1: 10 000 @ A3

0 100 200 300 400 500 metres

COMPILED: DPS, MAPS		DRAWN BY:	JHP
DATE:	10/8/2012	REVISED:	
GRID:	MGA 94	DATUM:	AHD
DRAWING NUMBER:	PACBR-2-001	JOBCODE:	PACBRSTP

FILE ID: M:\PACBR\BASE\Structure Plans\PACBR-2-001.dgn

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