NEWCASTLE SAND

EPBC 2016-7852

Cabbage Tree Road Quarry

Annual Compliance Report

14 August 2024 – 13 August 2025

Williamtown Sand Syndicate Pty Ltd

398 Cabbage Tree Road, Williamtown NSW

20 August 2025

Cabbage Tree Road Sand Quarry – Annual Compliance Report

Contents

Quality Information

Document: EPBC Annual Compliance Report for 2024-2025

Ref: 2024-2025_EPBC_2016-7852

Date: 15 August 2025

Revision History

Rev	Revision Date	Details	Comment
0	20 August 2025	Final	Initial Report

1. PURPOSE OF REPORT

This Annual Compliance Report has been prepared to satisfy the requirements of Condition 8 of the EPBC 2016-1785, Commonwealth Approval in accordance with the '*Annual Compliance Report Guidelines, Commonwealth of Australia 2023'*. The condition states "*the approval holder must prepare a compliance report for each 12-month period following the date of commencement of the action*".

The key dates are provided below in **Table 1**, this report will also be published on the Newcastle Sand (Cabbage Tree Road Sand Quarry) website within 60 days following the relevant 12-month period as per Condition 8a and provided to the provided to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) as required by Condition 8b.

Table 1 Key Dates of the EPBC Approval

Action	Key Date
Commonwealth Approval	12 December 2018
Commencement Date	14 August 2019
Expiry of Commonwealth Approval	31 December 2033

2. DESCRIPTION OF ACTIVITIES

2.1 PROJECT OVERVIEW

Williamtown Sand Syndicate Pty Ltd (WSS) was granted the following approvals to construct and operate a sand quarry at Cabbage Tree Road, Williamtown:

- Project Approval SSD-6125, issued by The Independent Planning Commission NSW on 9 May 2018.
- Project Approval EPBC 2016-7852, issued by the Department of the Environment and Energy on 12 December 2018.
- Hunter Water Regulation 2015 Clause 15(1) Approval for Cabbage Tree Road Quarry.
- NSW Environment Protection Authority, Environment Protection Licence No. 21264

Construction works were initiated on 14 August 2019 and sand extraction commenced in May 2020.

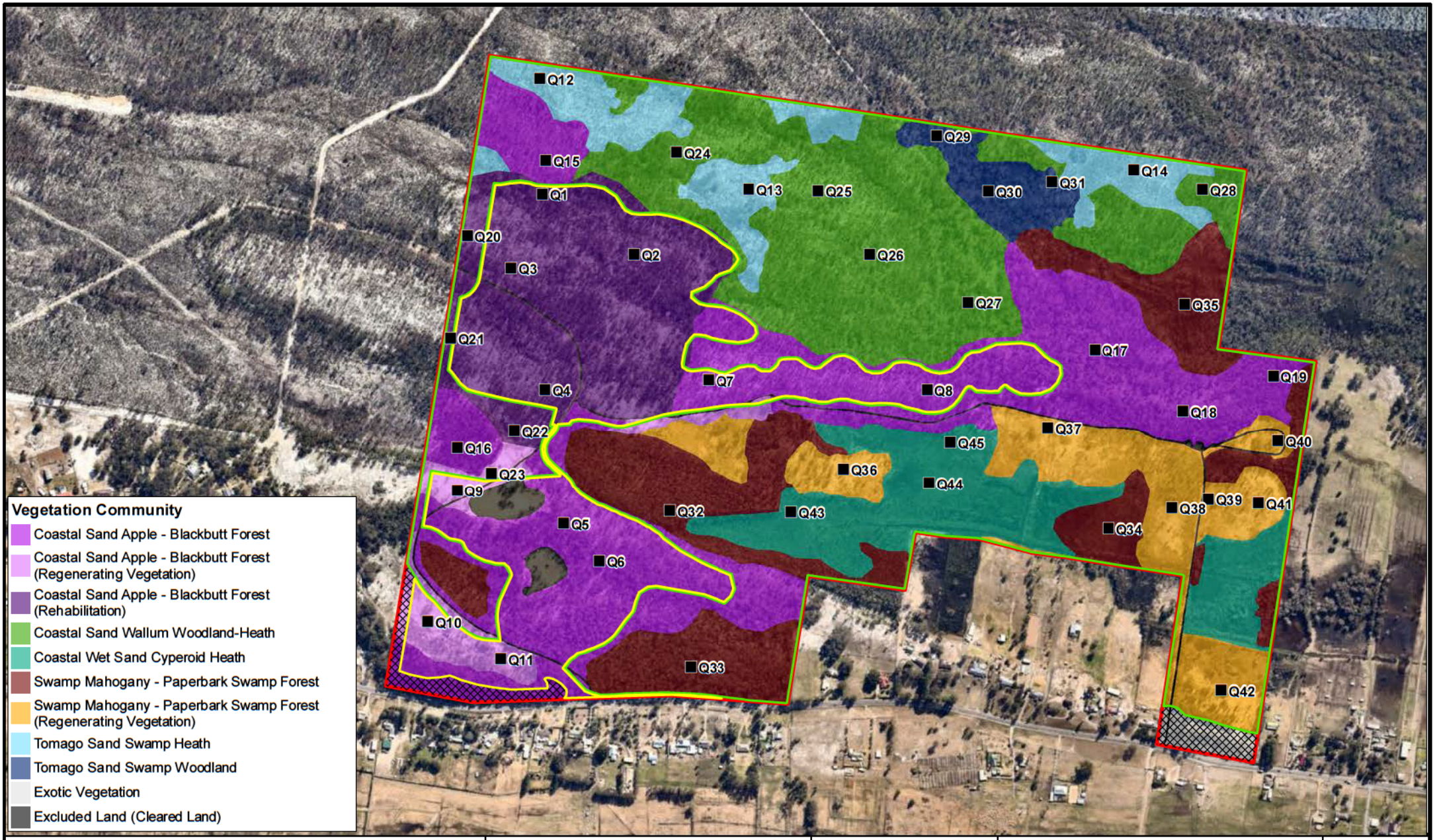
SSD-6125 has been modified on two occasions under Section 4.55 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Modifications that have been approved in the state consent

are consistent with the EPBC approval, requiring no modification of the EPBC approval. Outlined below are modification summaries of the state consent for context and approval history for the site:

- During the construction phase Modification 1 was requested to facilitate a glass sand trial, as the formal intersection with the quarry had not been completed. Modification 1 was granted on 26 March 2020.
- Modification 2 was approved in March 2021 to permit the inclusion of a sand washing plant and ancillary equipment onsite.
- Modification 3 was lodged for the third modification application (proposed MOD3) in December 2022 and withdrawn mid-2024 for the amendment of the resource boundary.
- Modification 4 has been submitted to the DPHI in early 2025 for assessment and approval. The proposed modification seeks increased on-site offset areas leading to a net gain, positive impact according to the BDAR report (Wedgetail, 2025). Others consent amendments include:
    - Extend the boundary of the approved resource area in a westerly direction to recover additional sand resources.
    - Expand road corridors for operational purposes.
    - Amend the development footprint so that areas of remnant vegetation, previously approved for development can be incorporated into the on-site offset area, and replace areas required for road corridors.

Figure 1, **Figure 2** and **Figure 3** have been provided for context on the locality, vegetation communities and the location of the onsite biodiversity offset area.


390000
6370000
BRISBANE
TAMWORTH
BROKEN HILL
Newcastle Sand
New South Wales
LITHGOW
NEWCASTLE
GRIFFITH
SYDNEY
CANBERRA
MELBOURNE
TILLIGERRY State Conservation Area
Lot 100 DP1263921
Lot 121 DP556403
Lot 11 DP629503
Lot 1012 DP814078
BARRIE CLOSE
CABBAGE TREE ROAD
LEGEND
Site Boundary
Lot Boundary
Road
Watercourse
NPWS Reserves
0 180 360 540 720 m
Scale: 1:20,000
GDA2020 MGA Zone 56
20/03/2024
Newcastle Sand
Site Locality
FIGURE 1
INTEGRATED ENVIRONMENTAL MANAGEMENT AUSTRALIA
www.iema.com.au
Sheet Size : A4
I:\A01_Clients_GIS\NEW_NewcastleSands\NEW01_002_ComplianceAssistance\NEW_01_002_ComplianceAssistance.aprx | NEW01_Site_Locality



Legend

- Subject Land (176.1 ha)
- Biobank Site Boundary (131.3 ha)
- Development Area Boundary (42.1 ha)
- Excluded Areas (2.7 ha)
- Plot Locations

Metres

0 50 100 200 300 400 500

N

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Bright People. Right Solutions.
www.kleinfelder.com

PROJECT REFERENCE: 20190803

DATE DRAWN: 4/01/2019 14:41 Version 1

DRAWN BY: gjoyce

DATA SOURCE:
NSW DFSI - 2017
Nearmap - 2018

Vegetation Communities Within the Subject Land

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:

2

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig02_VegComm.mxd

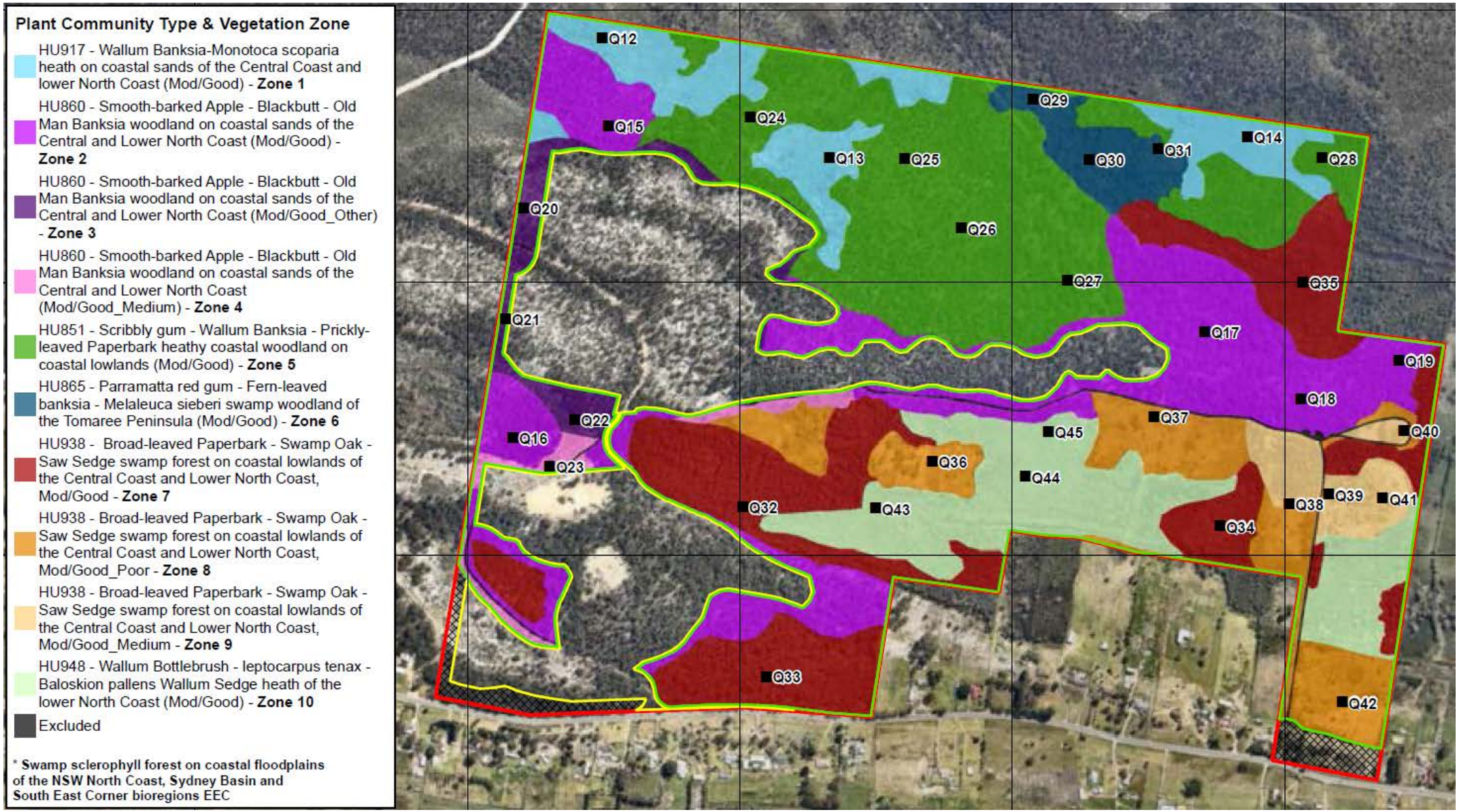

Figure 3: *Location of on-site Biodiversity Offset area*

APPENDIX 6
BIODIVERSITY OFFSET STRATEGY

3. ASSESSMENT OF COMPLIANCE

The terms used to describe the level of compliance of the site are outlined in **Table 2**. These are in accordance with the requirements listed in Appendix 2 of the Independent Audit and Audit report Guidelines (Commonwealth Department of the Environment and Energy, 2019). **Table 3** provides an assessment of the compliance of the project with the conditions of consent EPBC 2016/7852 to date.

Table 2: Compliance Assessment Criteria

Abbreviation	Assessment	Criteria
Y	Yes	A rating of 'compliance' is given when the auditee has complied with a condition, element of a condition, or measure required by a management plan, report or program etc.
N	Non-compliance	A rating of 'non-compliance' is given when the auditee has not met a condition, element of a condition, or measure required by a management plan, report or program etc.
NA	Not applicable	A rating of 'not applicable at the time of the audit' is given when the condition or element of a condition falls outside the scope of the audit e.g. if an activity has not yet commenced.

Table 3: 14 August 2024 – 13 August 2025 Newcastle Sand EPBC 2016/7852 Conditions and Compliance Assessment

Condition No.	Condition	Finding	2024-2025 Compliance Status	Action
Part A – Conditions specific to the action				
1	The person taking the action must:			
1a	Implement the following conditions identified in Schedule 3 of the State approval: • condition 34 Biodiversity Offset Strategy, • condition 35 Rehabilitation Objectives, • condition 37 Biodiversity and Rehabilitation Management Plan and • Appendix 6 Biodiversity Offset Strategy.	Context to Condition 34: Biodiversity Offset Strategy *34. The Applicant must implement the Biodiversity Offset Strategy as shown in Appendix 6 and described in the EIS, and acquire and retire biodiversity credits (within the meaning of the Biodiversity Conservation Act 2016) as set out in Tables 4 and 5 in accordance with the NSW Biodiversity Offsets Policy for Major Projects, to the satisfaction of the Secretary and BCD.* Compliant Component: The biodiversity credits prior to commencing quarrying operations have been retired – within 12 months of commencing quarrying operations. Newcastle Sand have satisfied the offsite portion of biodiversity offset obligations (as per Table 5) with the purchase and retirement of the required credits. Non-Compliant Component: The on-site Biodiversity Offset Strategy is currently in partial compliance. While formal agreement on the offset boundary is pending with BCS/NMO, the mapped offset areas (Appendix 6) remain undisturbed and are actively managed, including weed suppression, restricted access, and native species plantings. Repeated attempts to finalise the boundary with NMO have not yet been successful, but Newcastle Sand continues to manage these zones in accordance with offset intent. The 2024 Rehabilitation Monitoring Report provides evidence that biodiversity values are being protected in line with Commonwealth objectives.	**N**	Newcastle Sand are working toward completing the formal agreement to confirm offset boundary in consultation with BCD, NMO and DPHI. As of August 2025, site has been in contact with the Conservation Programs, Heritage & Regulation Division (CPHR) regarding the MOD 4 and offset update.
		Context to Condition 35: Rehabilitation Objectives *35. The Applicant must rehabilitate the site to the satisfaction of the Secretary. Rehabilitation must be generally consistent with the rehabilitation strategy in the EIS and the conceptual rehabilitation plan shown in Appendix 3 and must comply with the objectives in Table 6 of the State Consent.* Comment: Progressive rehabilitation is ongoing and has been designed to address the objectives outlined in Table 6 of the State Consent. • Rehabilitation activities include reshaping of exhausted areas, direct topsoil transfer, and revegetation to promote landform stability and native vegetation regeneration. • Further details, including monitoring results and site photos, are provided in the Annual Review available on the Newcastle Sand website. No non-compliances were identified for this condition. • Progressive rehabilitation is ongoing and consistent with the EIS rehabilitation strategy and Appendix 3 conceptual plan. • The 2024 Rehabilitation Monitoring Report confirms that performance objectives in Table 6 are progressing satisfactorily across all monitored blocks. • Photographic and data evidence are provided in the 2024 report, which satisfies the reporting obligations. • Weed management completed. Vegetation establishment shows positive trends in most sectors, with supplementary planting and targeted weed control recommended in areas of partial achievement.	**Y**	No further action required.
		Context to Condition 37: Biodiversity and Rehabilitation Management Plan – *refer to SSD for further details* 16 April 2019 the Biodiversity and Rehabilitation Management Plan was approved by the Director of Resource Assessments of the NSW Government Planning and Environment. The updated Version 4 is on the Newcastle Sand website available at: https://www.newcastlesand.com.au/wp-content/uploads/2024/09/Biodiv_Rehab_Plan_V4.2-1.pdf Comment for the Rehabilitation component of the BRMP: Rehabilitation management is compliant as per the Biodiversity and Rehabilitation Management Plan.	**Y**	No action this year

Condition No.	Condition	Finding	2024-2025 Compliance Status	Action
		Context to Condition 37: Biodiversity and Rehabilitation Management Plan – *refer to SSD for further details* Comment for the Biodiversity component of the BRMP: • The on-site Biodiversity Offset Strategy is currently in partial compliance with an issue related to the final offset boundary. • The formal agreement on the offset boundary is pending with BCS/NMO. • Retirement of credits has not been complete however the site has generally implemented the biodiversity component of the condition 37 Biodiversity and Rehabilitation Management Plan. • Repeated attempts to finalise the boundary with NMO have not yet been successful, but Newcastle Sand continues to manage these zones in accordance with offset intent. • The mapped offset areas (Appendix 6) remain undisturbed and are actively managed, including weed suppression, restricted access, and native species plantings. • While legal retirement of onsite credits has not occurred, the offset area is protected, weed-controlled, and undisturbed, mitigating ecological risk. • The 2024 Rehabilitation Monitoring Report provides evidence that biodiversity values are being protected in line with Commonwealth objectives.	**N**	
		Condition 1a point 4: Biodiversity management is completed in this area. The non-compliant component is covered in the points above.	**Y**	No action this year.
1b	Submit a copy of the Independent Environmental Audit report, identified in Schedule 5 condition 12 of the State approval, to the Department. Included with the report should be a response to any recommendations contained in the audit report and a timetable for the implementation of the recommendations as required.	Context to Condition 12: Independent Environmental Audit The IEA and the 2025 documentation have been provided to the DCCEEW and is available at: https://www.newcastlesand.com.au/independent-audits/	**Y**	No action this year.
1c	Notify the Department in writing of any proposed change to the conditions of the NSW Government approval for which conditions 1a – 1b apply, no later than 2 weeks after formally proposing a change or becoming aware of the NSW Government proposing a change.	Comment: No changes to the following state conditions have been proposed. There have been 2 MODS however these have not resulted in changes to biodiversity, rehabilitation management or audits. MOD 4 (currently with DPHI for assessment) would likely require an update to the Biodiversity and Rehabilitation Management Plan.	**Y**	No action this year.
1d	Notify the Department in writing of any change to the NSW Government approval for which conditions 1a - 1b apply, within 2 weeks of a change being finalised.	See above	**Y**	No action this year.

<table>
<tr><th>Condition No.</th><th>Condition</th><th>Finding</th><th>2024-2025 Compliance Status</th><th>Action</th></tr>
<tr><td>2</td><td>
<table>
<tr><th>Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) listed threatened species and ecological communities</th><th>Area of Maximum Disturbance</th></tr>
<tr><td>Potential habitat for Koala (Phascolarctos cinereus) (combined populations of Queensland, New South Wales and the Australian 40.38 ha Capital Territory) - Vulnerable</td><td>40.38 ha</td></tr>
<tr><td>Potential foraging habitat for the Grey-headed Flying-fox (Pteropus poliocephalus) - Vulnerable</td><td>40.38 ha</td></tr>
<tr><td>Camfield's Stringybark (Eucalyptus camfieldii) - Vulnerable</td><td>227 individuals</td></tr>
<tr><td>Earps' Gum (Eucalyptus parramattensis subsp. decadens) - Vulnerable</td><td>230 individuals</td></tr>
</table>
The person taking the action must not exceed the area of maximum disturbance, provided in Table 1, within the proposal location as per Maps 1-3, to protect the EPBC listed threatened species habitat and ecological communities.
Table 1. Area of Maximum Distance</td><td>Comment:
The action has not exceeded the area of maximum disturbance, provided in Table 1, within the proposal location as per Maps 1-3, to protect the EPBC listed threatened species habitat and ecological communities. Currently there has been 31.8 ha of disturbance since commencement.
Findings / Evidence:
• The annual survey submitted in the Annual Review provides the disturbance area of the project, maintained in the approved disturbance footprint.
• The 2024 rehabilitation report outlines Camfield's Stringybark and Earps' Gum individuals are within the limits of this condition.</td><td>Y</td><td>No action this year.</td></tr>
<tr><td colspan="5">Part B – Standard Administrative conditions</td></tr>
<tr><td>3.</td><td>The approval holder must notify the Department in writing of the date of commencement of the action within 10 business days after the date of commencement of the action.</td><td>Comment:
Historical condition.
The Department was notified by email on 14 August 2019, on the same day as quarry construction commenced.
Findings / Evidence:
• Email sent to the DCCEEW</td><td>Y</td><td>No action this year.</td></tr>
<tr><td>4.</td><td>If the commencement of the action does not occur within 5 years from the date of this approval, then the approval holder must not commence the action without the prior written agreement of the Minister.</td><td>Comment:
The quarry commenced construction on 14 August 2019 and sand extraction commenced in May 2020, less than two years following the date of the Commonwealth Approval (12/12/2018).</td><td>Y</td><td>No action this year.</td></tr>
<tr><td>5.</td><td>The approval holder must maintain accurate and complete compliance records.</td><td>Comment:
Comprehensive compliance records are maintained on-site.</td><td>Y</td><td>No action this year.</td></tr>
<tr><td>6.</td><td>If the Department makes a request in writing, the approval holder must provide electronic copies of compliance records to the Department within the timeframe specified in the request.</td><td>Comment:
No request to date. Compliance records available upon request.</td><td>NA</td><td>No further action required.</td></tr>
<tr><td>7.</td><td colspan="4">The approval holder must:</td></tr>
<tr><td>7a.</td><td>submit plans electronically to the Department within two months of their approval by the Secretary, or nominee, of the Department of Planning and Environment;</td><td>Comment
• See website: https://www.newcastlesand.com.au/management-plan/</td><td>Y</td><td>No action this year.</td></tr>
<tr><td>7b.</td><td>publish each plan on the website within two months of the date the plan is approved by the Secretary, or nominee, of the Department of Planning and Environment or the date a revised action management plan is submitted to the Secretary, or nominee, of the Department of Planning and Environment; and</td><td>Comment
All approved plans are available on the Newcastle Sand website.
• Available at: https://www.newcastlesand.com.au/management-plan/</td><td>Y</td><td>No action this year.</td></tr>
<tr><td>7c.</td><td>keep plans published on the website until the end date of this approval.</td><td>Comment:
All approved plans including updated versions are available on the Newcastle Sand website:
• Available at: https://www.newcastlesand.com.au/management-plan/</td><td>Y</td><td>No action this year.</td></tr>
</table>

Condition No.	Condition	Finding	2024-2025 Compliance Status	Action
8.	The approval holder must prepare a compliance report for each 12-month period following the date of commencement of the action, or as otherwise agreed to in writing by the Minister. The approval holder must:	Comment: The 2024-2025 report has been prepared. The report is from the 14 August 2024 to 13 August 2025.	**Y**	No action this year.
8a.	publish each compliance report on the website within 60 business days following the relevant 12 month period;	Comment: Annual compliance reports published on the Newcastle Sand website available at: https://www.newcastlesand.com.au/epbc-compliance-report/	**Y**	No action this year.
8b.	notify the Department by email that a compliance report has been published on the website within five business days of the date of publication;	Comment: The 2024/25 report has been submitted to the Department within 5 days of publishing on the website.	**Y**	No action this year.
8c.	keep all compliance reports publicly available on the website until this approval expires;	Comment: Compliance records have been prepared by Newcastle and publicly available on the website.	**Y**	No action this year.
8d.	exclude or redact sensitive ecological data from compliance reports published on the website; and	Comment: No sensitive ecological data included in the online compliance reports.	**NA**	N/A.
8e.	where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication.	Comment: Not triggered, no sensitive ecological data included.	**NA**	N/A.
9.	The approval holder must notify the Department in writing of any: incident; non-compliance with the conditions; or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify: a. the condition which is or may be in breach; and b. short description of the incident and/or non-compliance.	Comment: This annual compliance report outlines with the conditions of the commonwealth consent and indicates any non-compliances identified within it. The noncompliance regarding the biodiversity offset strategy has been outlined above in 1a).	**Y**	Newcastle Sand will provide by email correspondence of any incidents or noncompliance notifications to the Department in conjunction with the DPHI.
10.	The approval holder must provide to the Department the details of any incident or non-compliance with the conditions or commitments made in plans as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying: a. any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future; b. the potential impacts of the incident or non-compliance; and c. the method and timing of any remedial action that will be undertaken by the approval holder.	Comment: Biodiversity and rehabilitation measures have been implemented in accordance with the approved BRMP. Non-compliance with the offset strategy finalisation has been an ongoing issue outlined in Condition 1a) above.	**Y**	Increased correspondence to the Department. DCCEEW will be added to the email list when non compliances occur.
11.	The approval holder must ensure that independent audits of compliance with the conditions are conducted for the 12-month period following the date of commencement of the action and for every subsequent 12 month period, or as otherwise requested in writing by the Minister.	Comment: Independent audit has been endorsed and completed by The APP Group. Approval on 13 June 2025 for the audit criteria by the DCCEEW.	**Y**	Independent audit has been completed from August 2019 - August 2024. Continued independent audits every 12 months (14 August to 13 August).
12.	For each independent audit, the approval holder must: a. provide the name and qualifications of the independent auditor and the draft audit criteria to the Department;	Comment: Completed. The audit is being carried out and report will be submitted to the Department no later than the 12 September 2025.	**Y**	No further action required.

Condition No.	Condition	Finding	2024-2025 Compliance Status	Action
	b. only commence the independent audit once the audit criteria have been approved in writing by the Department; and c. submit an audit report to the Department within the timeframe specified in the approved audit criteria.			
13.	The approval holder must publish the audit report on the website within 10 business days of receiving the Department's approval of the audit report and keep the audit report published on the website until the end date of this approval.	Comment: The approved audit report will be submitted on the website in accordance with the timing specified in this condition.	**NA**	N/A.
14.	Within 30 days after the completion of the action, the approval holder must notify the Department in writing and provide completion data.	Comment: Not triggered.	**NA**	N/A.

4. COMPLIANCE ASSESSMENT

4.1 NON-COMPLIANCES

Noncompliance's are nominated by Newcastle Sand and a description of the non-compliance along with any corrective actions are outlined in **Table 3**. Assessment of the impacts of the non-compliances is provided in **Section 4.2** below.

4.2 CORRECTING NON-COMPLIANCES

Condition 1(a) is non-complaint with the biodiversity offsets, corrective action is described in **Table 3**.

5. NEW ENVIRONMENTAL RISKS

In accordance with compliance reporting requirements, the site investigated new environmental risks that have emerged during the current reporting period. No new risks have been identified in the reporting period, if emerging risks are identified - Newcastle Sand will notify and work in conjunction with the Department to resolve and mitigate risks.

6. CONCLUSION

This report indicates a high level of compliance with EPBC 2016-7852 during the 2024 – 2025 period with only one non – compliance identified. Compliance continues to improve relating to the administrative conditions.

Appendix A: Rehabilitation and Biodiversity Plan v4.2 (2024)

NEWCASTLE SAND

Biodiversity and Rehabilitation Management Plan

Williamtown Sand Syndicate Pty Ltd

Cabbage Tree Road Sand Quarry
Cabbage Tree Road, Williamtown

23 February 2024

Biodiversity and Rehabilitation Management Plan

Cabbage Tree Road Sand Quarry
Cabbage Tree Road, Williamtown

File Ref: Biodiv_Rehab_Plan_V4a.docx

Prepared for:

WILLIAMTOWN SAND SYNDICATE PTY LTD

Document Control:

Version	Description	Date	Author	Technical Reviewer
1	For consultation review	14 January 2019	J.Berry	N.Fisher
2	Draft for DPE review	12 March 2019	J.Berry	D.O'Brien
3	Updated following DPE review	1 April 2019	J.Berry	D.O'Brien
4	Contact details updated Update to koala fencing. Includes sections relating to the wash plant approved within Mod 2.	15 February 2023	J.Berry	N.Fisher & J.Berry
4.1	Updates to address DPE Comments on Version 4	15 December 2023	J.Berry	N.Fisher & J.Berry
4.2	Updates to address DPHI Comments on Version 4.1	23 February 2024	J.Berry	N.Fisher & J.Berry

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Appendices

Glossary

Abbreviation	Definition or Meaning
AEMR	Annual Environmental Management Report / Annual Review under Schedule 5, Condition 11
BCD	Biodiversity Conservation Division (superceded by BCS in DCCEEW)
BCS	Biodiversity Conservation and Science
DBH	Diameter at breast height (approximately 1.3m)
DCCEEW	Department of Climate Change Energy, Environment and Water
DPE	Department of Planning and Environment (superceded by DPHI)
DPHI	Department of Planning, Infrastructure, Housing and Industry
EPA	Environmental Protection Authority
PSC	Port Stephens Council
OEH	Office of Environment & Heritage (superceded by the BCD)
RMS	Roads and Maritime Authority (superceded by TfNSW)
TfNSW	Transport for NSW
WSS	Williamtown Sand Syndicate (the owner of Newcastle Sand)

1. INTRODUCTION

1.1 BACKGROUND

Williamtown Sand Syndicate Pty Ltd (WSS), trading as Newcastle Sand are proposing to construct and operate a sand quarry on four lots of land located at 398 Cabbage Tree Road, Williamtown, approximately 30 km from the Newcastle central business district. The Project would extract up to 530,000 tonnes per annum of sand products over a period of up to 15 years.

Development Consent (SSD-6125) was granted by the NSW Independent Planning Commission on 9 May 2018 for construction and operation of the quarry subject to a series of conditions. Condition 37 of Schedule 3 of the Development Consent requires the preparation and implementation of a Biodiversity and Rehabilitation Management Plan.

Potential biodiversity impacts from quarry construction and operation will include native vegetation clearance, temporary reduction in koala habitat, and fauna displacement. Impacts from rehabilitation methods may include weed and pest spread, erosion and sedimentation and loss of species diversity.

This plan has been prepared by Wedgetail Project Consulting Pty Ltd in conjunction with Newcastle Sand to satisfy water management Conditions of the Development Consent and provide improved environmental management of the quarry.

Construction of the quarry commenced in August 2019, the Cabbage Tree Road intersection was completed in May 2020 and the quarry became operational on 18 May 2020. In March 2021, Mod2 was approved enabling the inclusion of a wash plant onsite to improve sand processing.

1.2 PROJECT OVERVIEW

The key details of the Project are shown within **Table 1** below. The quarry operations plan is shown in **Figure 1.**

Table 1: Key Aspects of the Cabbage Tree Road Sand Project

Aspect	Key Aspects of the Project
Key elements	Sand quarry extracting up to 530,000 tonnes per annum over a period of 6 to 15 years including the construction of an intersection with Cabbage Tree Road, sealed and gravel access roads, site office, workshop and weighbridges. Progressive rehabilitation of quarried land returning to native vegetation communities with potential future use of the facilities area.
Location	398 Cabbage Tree Road, Williamtown, within the Port Stephens local government area.

Aspect	Key Aspects of the Project
Property Titles	Four titles within the Parish of Stockton, County of Gloucester including: • Lot 1 DP 224587 at 398 Cabbage Tree Road, Williamtown • Lot 121 DP 556403 at 282B Cabbage Tree Road, Williamtown. • Lot 11 DP 629503 at 282A Cabbage Tree Road, Williamtown. • Lot 1012 DP 814078 at 282 Cabbage Tree Road Williamtown.
Land Owner	Port Stephens Shire Council under lease to Williamtown Sand Syndicate Pty Ltd.
Proponent	Williamtown Sand Syndicate Pty Ltd, the owner of the quarry operator Newcastle Sand.
Area	Total Project Area of approximately 42.3 hectares from a Subject Land Area of approximately 176.2 hectares.
Project Life	Up to 15 years. At expected demand the quarry will have an eight (8) year life, or six (6) years at maximum extraction rates.
Extraction Rate	Maximum of 530,000 tonnes per annum, and maximum daily rate of 3,000 tonnes.
Operating Hours	Construction of intersection, access and workshop and office: • 7:00am to 5:00pm Monday to Friday. • 8:00am to 1:00pm Saturday. • No works on Sunday or public holidays. Quarrying Operations: • 7:00am to 5:00pm Monday to Friday. • 7:00am to 4:00pm on Saturday. • No quarrying on Sunday or a Public Holiday. Loading and dispatch of trucks: • 6:00am to 6:00pm Monday to Friday. • 7:00am to 4:00pm Saturday. • No works on Sunday or public holidays.
Transport Rate	• Up to 6 laden trucks per hour (12 trips per hour) during the hours of 6 am to 7 am Monday to Friday. • Up to 10 laden trucks per hour (20 trips per hour) during hours of 7 am to 6 pm Monday to Friday (i.e. all haulage hours excluding the morning peak). • Up to 10 laden trucks per hour (20 trips per hour) during hours of 7 am to 4 pm Saturdays. • Haulage between 5 am and 6 am is subject to agreement from adjacent landowners as per Schedule 3, Condition 1. • Up to 6 vehicles of employees would be expected to arrive from approximately 5:30 am to 7 am and leave between 5 pm and 7 pm.
Resource and products	Approximately 3.25 Mt of sand, comprising the following products to be extracted from site by truck onto Cabbage Tree Road for transport to markets: • Raw fill sand. • Screened sand. • Sandy loam. • Concrete sand. • Glass sand (estimated at about 16% of total resource). The Project covers approximately 42.3 hectares (including access roads) with extraction to a depth of not more than 0.7m above the highest predicted groundwater level.

Aspect	Key Aspects of the Project
Extraction	• Maximum extraction rate of 530,000 tonnes per annum. • Excavator and/or bulldozer to clear vegetation and strip topsoil. • Bulldozer or grader to windrow sand. • Front-end loader to feed conveyors to convey sand to the processing plant. • Front-end loader and haul truck to convey sand when conveyor unsuitable.
Processing Methods	• Raw sand product extracted directly from face with no processing. • Sand fed into electrically powered screen. • Screened sand sold as product or fed to electrically powered air separator. • Products stockpiled for loading directly into truck or fill bulker bags for removal from the site by truck. • Fines (wet or dry) blended with sand as sandy loam or blended in rehabilitation.
Support facilities and utilities	• Site office, workshop, stores, car parking. • Power supply from local network and diesel generator. • Water supply from local network.

1.3 PURPOSE AND SCOPE

This Biodiversity and Rehabilitation Management Plan (BRMP) outlines the key management controls to be implemented to minimise impacts to biodiversity during quarry construction and operation. It also details progressive rehabilitation plans for the site as works progress through each extraction area.

This document satisfies Development Consent Conditions 35 to 37 within Schedule 3 and the Statement of Commitments in Appendix 2 for the Project. A checklist of where each condition has been addressed in this document is provided in **Table 2,** and Table 3 provides a similar checklist where each of the Statement of Commitments has been addressed in this document.

1.4 PLAN PREPARATION AND CONSULTATION

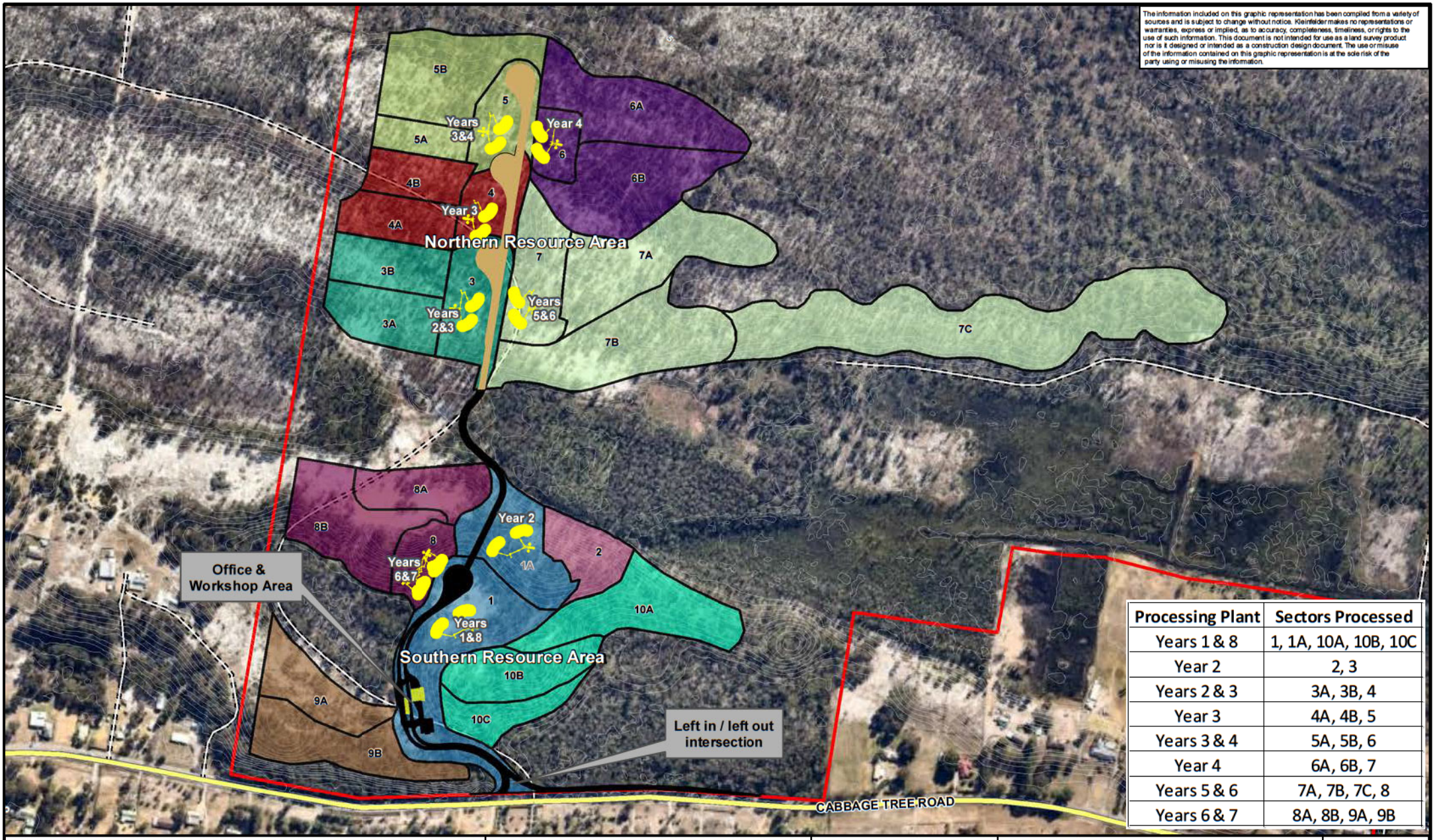
Pursuant to Schedule 3, Condition 37 the preparation of this plan is required to be prepared by a suitable qualified expert. This plan has been prepared by the following authors:

- Dr. Nigel Fisher. Nigel is a Restoration Ecologist with over 15 years experience in the restoration and rehabilitation of vegetation with particular emphasis on mining rehabilitation. Nigel has experience in designing and implementing monitoring programs for different mining rehabilitation requirements and has been project managing the revegetation monitoring program at the nearby Tanilba Bay Sand Mine for Sibelco Australia for the past 5 years.
- Jonathan Berry. Jonathan is an environmental advisor with over 19 years experience in environmental management, including the preparation of rehabilitation plans for resource and quarry operations.
- Daniel O'Brien. Daniel is a fauna ecologist (specialist herpetologist) with almost 12 years experience and was involved in the development of the Frog Fence and monitoring.

Copies of resumes for the authors are included within **Appendix 1**.

The plan is also required to be prepared in consultation with the Biodiversity Conservation Division (BCD) and Port Stephens Council (PSC). The plan was supplied to the OEH and PSC for review and comment, responses are included within **Appendix 2**.

This plan was first approved by the Secretary on 16 April 2019.



Processing Plant	Sectors Processed
Years 1 & 8	1, 1A, 10A, 10B, 10C
Year 2	2, 3
Years 2 & 3	3A, 3B, 4
Year 3	4A, 4B, 5
Years 3 & 4	5A, 5B, 6
Year 4	6A, 6B, 7
Years 5 & 6	7A, 7B, 7C, 8
Years 6 & 7	8A, 8B, 9A, 9B

Legend

- Subject Land
- Road - gravel
- Road - sealed
- Processing Plant & Infrastructure
- Arterial Road
- Track
- Contours (1m)

Sector: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Metres 0 25 50 100 150 200 250

N

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PROJECT REFERENCE: 20190803
DATE DRAWN: 4/01/2019 14:12 Version 1
DRAWN BY: gjoyce
DATA SOURCE: NSW DFSI - 2017, Nearmap - 2018

Quarry Operations Plan

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE: 1

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2. STATUTORY REQUIREMENTS

2.1 LEGISLATION AND GUIDELINES

Key environmental legislation relating to biodiversity and rehabilitation of the quarry include:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).
- NSW *Environment Planning and Assessment Act 1979* (EP&A Act 1979).
- NSW *Biodiversity Conservation Act 2016 (BC Act 2016).*
- NSW *Threatened Species Conservation Act 1995* (project commenced under this Act, subsequently superseded by the BC Act 2016)
- NSW *Biosecurity Act 2015.*
- NSW *Native Vegetation Act 2003*.

2.2 DEVELOPMENT CONSENT

Development Consent was granted for the Project under the *EP&A Act 1979* by the NSW Independent Planning Commission. Biodiversity and rehabilitation management must comply with conditions 35 to 37 of Schedule 3 of the Development Consent Conditions and Appendix 2 – Statement of Commitments.

Table 2 provides a summary of where each requirement of the consent relating to Biodiversity and Rehabilitation are addressed in this document.

Table 2: Development Consent Conditions

<table>
<tr><th>Condition</th><th>Description</th><th>Addressed in Section</th></tr>
<tr><td colspan="3">Schedule 3 – Specific Environmental Conditions</td></tr>
<tr><td>35</td><td>Rehabilitation Objectives
The Applicant must rehabilitate the site to the satisfaction of the Secretary. Rehabilitation must be generally consistent with the rehabilitation strategy in the EIS and the conceptual rehabilitation plan shown in Appendix 3 and must comply with the objectives in Table 6.

Table 6: Rehabilitation Objectives
<table>
<tr><th>Feature</th><th>Objective</th></tr>
<tr><td>All areas of the site affected by the development</td><td>• Safe
• Hydraulically and geotechnically stable
• Non-polluting
• Fit for the intended post-mining land use(s)
• Final landform integrated with surrounding natural landforms as far as is reasonable and feasible
• Minimise visual impacts when viewed from surrounding land
• Facilitate regional movement of Koalas and their occupation of the site</td></tr>
<tr><td>Surface Infrastructure</td><td>• Decommissioned and removed, unless otherwise agreed by the Secretary</td></tr>
<tr><td>Quarry extraction area</td><td>• Landform rehabilitated to 1.0 metres above the predicted maximum groundwater level
• Landscaped and vegetated using native tree and understorey species</td></tr>
</table></td><td>This plan / Section 5.1</td></tr>
</table>

Condition	Description		Addressed in Section
		• Tree species to include Koala feed species	
	Final Void	• No final void permitted	
36	**Progressive Rehabilitation** The Applicant must rehabilitate the site progressively, that is, as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim stabilisation measures must be implemented where reasonable and feasible to control dust emissions in disturbed areas that are not active and which are not ready for final rehabilitation. Note: It is accepted that parts of the site that are progressively rehabilitated may be subject to future re-disturbance.		Refer to Sections 5 6.9
37	**Biodiversity and Rehabilitation Management Plan** The Applicant must prepare a Biodiversity and Rehabilitation Management Plan for the development to the satisfaction of the Secretary. This plan must:		This Plan
	(a)	be prepared by a suitably qualified expert;	Section 1.4
	(b)	be prepared in consultation with OEH and Council;	Section 1.4
	(c)	be submitted to the Secretary for approval prior to commencing quarrying operations, unless the Secretary agrees otherwise;	Appendix 2
	(d)	provide details of the conceptual final landform and associated land uses for the site;	Section 5.3
	(e)	describe how the implementation of the on-site Biodiversity Offset Strategy will be integrated with the overall rehabilitation of the site;	Section 3.4.1
	(f)	include detailed performance and completion criteria for evaluating the performance of the progressive and final rehabilitation of the site, including triggers for any necessary remedial action;	Section 9
	(g)	describe the short, medium and long-term measures to be implemented to:	
		• manage remnant vegetation and habitat on site, including within the on-site Biodiversity Offset Strategy area; and	Section 6.8 and Biodiversity Stewardship Agreement
		• ensure compliance with the rehabilitation objectives and progressive rehabilitation obligations in this consent;	Sections 5.1 8
	(h)	include a detailed description of the measures described in paragraph (g) to be implemented over the next 3 years (to be later updated for each 3-year period following initial approval of the plan) including the procedures to be implemented for:	
		• maximising the salvage of environmental resources within the approved disturbance area, including tree hollows, vegetative and soil resources, for beneficial reuse in the enhancement of the offset area or site rehabilitation;	Sections: 6.6 0 6.7 6.9 6.11 6.13
		• restoring and enhancing the quality of native vegetation and fauna habitat in the rehabilitation areas through assisted natural regeneration, targeted vegetation establishment and the introduction of fauna habitat features;	Sections: 6.11 6.13 6.14 6.15 6.16 6.17

Condition	Description	Addressed in Section
	• protecting vegetation and fauna habitat outside the approved disturbance area on-site;	Section 0 and Biodiversity Stewardship Agreement
	• minimising the impacts on native fauna, including undertaking pre-clearance surveys;	Sections: 0 0 0 0
	• minimising the potential for Koalas to come into contact with development-related vehicles on the site and on public roads:	Section 0
	• establishing and/or retaining vegetation screening to minimise the visual impacts of the site on surrounding receivers;	Section 5
	• minimising impacts on threatened species, populations and their habitats, particularly Koalas;	Sections: 0 0 0 0
	• providing relevant biosecurity control measures, including measures to prevent and/or control the establishment or spread of Myrtle Rust, Root Rot Fungus and Chytrid Fungus on the site;	Section 6.18
	• collecting and propagating native seed;	Section 6.15
	• controlling weeds and feral pests;	Sections: 6.18 6.19
	• controlling erosion; and	Section 6.21 and *Soil and Water Management Plan*
	• managing bushfire risk;	Section 6.20
	(i) include a program to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria; and	Section 8 / Section 9
	(j) include details of who is responsible for monitoring, reviewing, and implementing the plan.	Section 4
	The Applicant must not commence quarrying operations until the Biodiversity and Rehabilitation Management Plan is approved by the Secretary. The Applicant must implement the Biodiversity and Rehabilitation Management Plan as approved from time to time by the Secretary.	
38	**Biodiversity and Rehabilitation Bond** Within 6 months of the approval of the Biodiversity and Rehabilitation Management Plan, the Applicant must lodge a Biodiversity and Rehabilitation Bond with the Department to ensure that the measures contained in the Biodiversity and Rehabilitation Management Plan are implemented in accordance with the performance and completion criteria set out in the plan and the relevant conditions of this consent. The sum of the bond must be determined by: (a) calculating the cost of implementing the measures contained in the Biodiversity and Rehabilitation Management Plan; (b) calculating the cost of rehabilitating all disturbed areas of the site, taking into account the likely surface disturbance over the next 3 years of quarrying operations; and (c) employing a suitably qualified quantity surveyor or other expert to verify the calculated costs, to the satisfaction of the Secretary. *Notes:*	Noted refer to **Appendix 3**.

Condition	Description	Addressed in Section
	• *If capital and other expenditure required by the Biodiversity and Rehabilitation Management Plan is largely complete, the Secretary may waive the requirement for lodgement of a bond in respect of the remaining expenditure.* • *If the rehabilitation of the site area is completed (or partially completed) to the satisfaction of the Secretary, then the Secretary will release the bond (or relevant part of the bond). If the rehabilitation of the site is not completed to the satisfaction of the Secretary, then the Secretary will call in all or part of the bond, and arrange for the completion of the relevant works.*	
39	Within 3 months of each Independent Environmental Audit (see condition 12 of Schedule 5), the Applicant must review, and if necessary revise, the sum of the Biodiversity and Rehabilitation Bond to the satisfaction of the Secretary. This review must consider the: (a) effects of inflation; (b) likely cost of implementing the measures contained in the Biodiversity and Rehabilitation Management Plan and rehabilitating all disturbed areas of the site (taking into account the likely surface disturbance over the next 3 years of the development); and (c) performance in implementing the rehabilitation of the site to date.	Noted
Appendix 2 – Statement of Commitments *The Statement of Commitments have been transferred in full to the management plans unless otherwise superceded by the Conditions of Approval.*		

Table 3 provides details of the Statement of Commitments that are relevant to biodiversity and rehabilitation, and notes where these commitments are addressed in this document. Note the caveat within the Approved Statement of Commitments: *"These measures shall apply, unless superseded or made redundant by an approved management plan or the Conditions of Approval."*

Table 3: Statement of Commitments

SoC Item	Action	Trigger/ Timing	Addressed in Section
8.3.3	**Access, Fencing, Gates and Signage**		
c)	• Construct a Koala fence on the Subject Land boundary adjoining Cabbage Tree Road for Lot 1 DP 224587 to limit movement of Koalas from the site onto Cabbage Tree Road. • Construct a Koala fence from the site entry to the weighbridge. • The fence is to be installed with regard to the design specifications outlined in the *Koala Sensitive Design Guideline* (DEHP 2012). One-way fauna gate installed along the fence for circumstances where fauna is trapped on the road side of the fence. Total of four gates; two along Cabbage Tree Road (one on either side of the site entrance) and two along the internal access road (one on either side of the road).	During construction	Section 6.5 This condition has been adapted in the BRMP, based on advice provided by Biolink (2019).
8.3.5	**Weed Control**		
a)	**<u>Vehicles and access tracks</u>** • All machinery used on the site will be cleaned of all soil and organic matter prior to entering the Project Area. Road registered haulage vehicles will be required to remain on the formed access roads. • Vehicle access to the rehabilitation will be restricted to authorised personnel. • Once access tracks are no longer required they will be revegetated to minimise their potential as weed vectors.	Ongoing	Section 6.18 A&B
b)	**<u>Weed-infested topsoil handling</u>** Pre-clearing surveys: • Pre-clearance survey to record approximate cover and abundance of environmental weeds within each area to be cleared.	Prior to clearing of each sector	Section 6.18E

SoC Item	Action	Trigger/ Timing	Addressed in Section
	• Where infestations of environmental weeds occur they will be mapped and pegged as a "weed area" prior to clearing to allow for separate stockpiling and re-spreading. For practicality purposes during clearing and topsoil stripping, weed infestations greater than 100 m2 (i.e. 10 m x 10 m) will be delineated and pegged.		
	• Topsoil containing environmental weeds (as delineated in pre-clearance) will stockpiled separately and will not be blended or stockpiled with "clean" (weed-free) topsoil. • Topsoil stockpiles containing environmental weeds will be respread within a mapped "weed area" similar to its pre-disturbance location to avoid weed spread across the site. • Weed containing topsoil will not be transported between the Southern and Northern Resource areas. • The extent of respread topsoil with environmental weeds will be delineated and recorded.	When clearing, stockpiling and respreading topsoil.	Section 6.18 F
c)	**Inspections** • During monitoring of the rehabilitation, annual monitoring will be conducted to identify any weeds, including non-local native species within the site. Inspections will include the outer perimeter of the current disturbance (i.e. interface with conservation areas) and the verges of internal access roads.	During monitoring of each sector	Section 6.18 C
d)	**Weed control** Weed management will be conducted by a suitably qualified contractor with a focus on the recommendations made as a result of rehabilitation monitoring and inspections. • Control of weeds will predominantly be through manual removal to limit the use of chemicals. Chemical controls will only be utilised where there are significant outbreaks.	When required, as identified during monitoring events	Section 6.18 G
8.3.6	**Vertebrate Pest Control**		
a)	• All putrescible waste bins to be securely covered and removed from the site on a weekly basis to remove potential food source for vermin.	Ongoing	Section 6.19 A
b)	Undertake monitoring for presence of pests through one of the following methods: • Conducting searches and spotlighting, and mapping evidence of pest species across Project Area (e.g. rabbit warrens, pig scratching, evidence of wild dogs). • Installing remote motion sensing camera traps at a minimum of five locations across the Project Area for a two-week period. • The presence of domestic or wild cats and dogs within the central wildlife corridor (consistent with PSC lease conditions) should be included within the program.	Annually	Section 6.19 B
c)	Recording of incidental observations for evidence of pests and where suspected to be domestic and (if considered safe to do so) are to be captured and reported to PSC and returned to the owner if known or animal shelter if unknown.	Opportunistically	Section 6.19 C
d)	Where detected during monitoring, implement a pest control program to reduce vertebrate pest numbers where there is potential for impacts on native wildlife and rehabilitation. The program is to have regard for the presence of domestic animals and return these to the owners where captured. The vertebrate pest control program is to be conducted: • In consultation with the LLS and adjoining landholders. • In accordance with Humane Pest Animal Control: Codes of Practice (DPI 2014). • By suitably qualified and experienced personnel. • Other control methods such as shooting or trapping can also be used if deemed necessary or appropriate with advice from BCD or the LLS. Given the proximity of residential properties baiting programs may not be appropriate.	Within three months of an observation with potential for impacts.	Section 6.19 D

SoC Item	Action	Trigger/ Timing	Addressed in Section
8.3.7	**Erosion, Sediment Control and Soil Management**		
c)	• Vegetation and soil excavated during the initial block construction will be stockpiled (vegetation and then topsoil) within an area adjacent to the processing plant. The initial area of cleared vegetation and topsoil will be used to supplement other extraction areas over the life of the project that are deficient in organic matter.	During construction/ Ongoing	Section 6.9 B
d)	• During excavation of each new extraction zone, vegetation and topsoil cleared will be laid over the previous extracted zone to encourage regrowth and rehabilitation.	Ongoing	Section 6.21
8.3.18	**Ecology and Rehabilitation Management**		
a)	**Seed Collection** • Seed will be collected by appropriately qualified contractor in advance of clearing activities for species determined likely to require direct seeding or propagation, and determined to be required for direct seeding and propagation based on monitoring results.	Annually, during appropriate season for target species	Section 6.6 A
b)	• Seed will be stored under appropriate conditions.	At all times	Section 6.6 B
c)	**Pre-clearing surveys** • Confirmation of resource boundaries and extent of clearing. • Habitat trees (containing hollows or nests) within the clearing area will be clearly marked using flagging tape or spray paint. Habitat trees are to be felled using the procedure outlined in Rehabilitation Plan. • Habitat trees (containing hollows or nests) within 3 m of the resource boundary will be marked for avoidance, including the delineation of the tree drip line to limit compaction and excavation that may affect the tree. • Areas of noxious weeds or environmental weeds will be marked to avoid mixing of weed containing soil with weed-free topsoil (refer to 8.3.5 Weed Control). • The following surveys will be conducted within the area proposed for removal within a one day period: o Nocturnal surveys will be conducted the night before clearing, and diurnal surveys will be conducted the morning of clearing, prior to commencement; and o The procedure for when a Koala is identified within the clearing area is outlined below. o All clearing will be supervised by a suitable qualified ecologist. • Any occupied trees will be clearly marked and will be left during clearing and managed according to the habitat tree removal protocol. Where a • Koala is identified in a tree, the procedure outlined below will be followed.	Prior to clearing each sector	Section 6.7 A
d)	**Koala Management Protocol** The following procedure will be used if a Koala is identified as occupying a tree within the proposed clearing area. The aim of this capture and relocation procedure is to ensure that no Koalas are harmed during the vegetation clearing activities within the extraction area: • The individual will be captured prior to the commencement of clearing. • The individual will be given a veterinary check for any disease or illness and a monitoring device will be attached (remote tracker). • Any Koalas captured will be relocated into an area of retained vegetation adjacent to where it was originally located. • All individuals will be monitored for a three-month period post relocation. • Where any Koalas are identified and captured for re-location, the following will be reported on: • Location identified within the disturbance area, and location of relocation; • Movement of the Koala will be mapped for the three-month period; • Any instances where the Koala enters areas proposed for future clearing will be identified, and the need for further monitoring/action determined. If there is the potential for the individual to occur within areas of future vegetation clearing, a plan to ensure the individual is not impacted will be developed; and	During clearing, if a Koala is identified	Section 6.7 B. Per comment received from the Koala Koalition Econetwork Port Stephens (KKEPS) during the submissions process for MOD3, it is proposed to remove the requirements to fit captured koalas with a remote tracker given the unnecessary stress caused.

SoC Item	Action	Trigger/ Timing	Addressed in Section
	• The health of the individual will be checked at the end of the three-month period and any impacts (i.e. dog attacks, vehicle strikes, bushfire impacts, or disease) will be identified.		
e)	**Vegetation Clearing** • A fully qualified, experienced and licenced ecologist will supervise clearing and encourage movement of any displaced animals into adjoining vegetation.	During clearing	Section 6.7 D
f)	• Clearing will be undertaken predominantly by bulldozer and may be conducted in conjunction with topsoil removal. • Vegetation should be cleared in a way that maintains habitat linkages and allows fauna living in or near the clearing site to move safely from the site to adjacent areas: o Clearing should occur towards connecting vegetation. o The direction of clearing should also ensure that fauna are directed away from Cabbage Tree Road and the quarry spine road. o Sequential clearing should not create an 'island' of habitat that is isolated from adjoining habitat by roads or cleared and disturbed areas. • Habitat trees will be left to stand for a period of two nights (also refer to Koala Protocol). • Habitat trees will be left to stand for a period of two nights (also refer to Koala Protocol and Habitat Tree Removal) and "soft-felled" under supervision of a suitably experienced fauna ecologist. • No clearing should occur during the early evening or at night (when fauna species are most likely to be on the move and are more vulnerable to injury). • Plants that are suitable for brush matting (and may be vulnerable to dropping seed during clearing) will be cut ahead of the quarry face and stockpiled on weed-matting or similar to ensure seed is not "lost" during clearing and can then be spread over topsoiled areas. • Large organic debris, and where possible, other vegetation cleared from the operational area will be stockpiled and spread on rehabilitated areas immediately after re-distribution of topsoil. • Vegetation stockpiling should maintain a minimum 10 m cleared asset protection zone around the stockpile to minimise fire risk in adjoining vegetation.	During clearing	Section 6.7E
g)	**Fauna Displacement Protocol** • Displacement of fauna may occur as part of the clearing process. All clearing will be supervised by a suitable qualified, experienced and licenced ecologist, the following protocol should be followed in case of an injured animal: • If possible any fauna fleeing the clearing area should be captured and relocated or directed to a safe area outside the extraction zone during the tree removal process. • All fauna are to be handled in such a way as to prevent injury to the animal or the handler. • Once the animal is safely handled it should be relocated or caged in a hessian bag or box and released at an appropriate time of day. • Any microbats or other nocturnal species captured during the tree removal process should be held in cotton or hessian bags and released at dusk on the same day as capture if possible. • If any animal is injured during the construction process, a veterinarian should be contacted immediately for professional advice on the best course of action. • If any native animal is injured during other operational/ construction processes while an ecologist, environmental representative or animal • handler is not present, they must be contacted immediately.	During clearing	Section 6.7 F
h)	**Habitat Tree Removal** Habitat trees will be removed according to the following protocol: • Hollow bearing trees will be left standing for two nights after the surrounding vegetation has been cleared to encourage any native fauna species utilising the habitat hollows to self-relocate. The actual felling of any habitat trees will be attended by a suitably experienced fauna ecologist in order to ensure the safety of any fauna found to be in the hollows.	During clearing of habitat trees	Section 6.7 G

SoC Item	Action	Trigger/ Timing	Addressed in Section
	• On all occasions, trees having potential habitat hollows will be 'soft felled' by an experienced machine operator. The recommended soft felling procedure is as follows: ○ The hollow-bearing tree is given several moderate nudges with an excavator to give a warning to any occupying native fauna. ○ The hollow-bearing tree is then surveyed and native fauna given an opportunity to self-relocate before the tree is actually felled. ○ The hollow-bearing tree is soft felled with the rate of the tree's fall controlled by the machinery operator to minimise impact. ○ All hollows will be inspected for fauna and if any are found, the animal should be relocated at an appropriate time of day (i.e. dusk for nocturnal species). If the animal is injured, it will be taken to a local veterinarian. ○ Suitable medium and large hollows should be cut from the tree at least one metre beyond the deepest point of the hollow and then stored in a dry safe place in size related categories for replacement in rehabilitated areas. • The number and size of hollows within each habitat tree will be recorded after each habitat is felled. This information will inform the nest box installation works that will occur post extraction.		
i)	**Topsoil Stripping and Placement** Areas of 'weed contaminated' topsoil: • Refer to Weed Control (Section 8.3.5).	Before and during topsoil removal and respreading of topsoil.	Section 6.19 A and Section 6.18
j)	Areas of 'clean' topsoil: • Topsoil is to be transferred and respread directly over the previously quarried area as soon as it is mined out and no longer required for access (exhausted area). • Once an area is exhausted and becomes available for rehabilitation the floor of the quarried area will be ripped, if it is hard and impenetrable, prior to redistribution of topsoil. • Direct topsoil transfer from an area ahead of the mining face, to the recently exhausted area, will be utilised to facilitate the natural regeneration of plant species and limit the degradation of soil microbes.	During topsoil removal and redistribution	Section 6.9 B
k)	• Strip topsoil to 100 mm minimum depth (having regard to final landform floor levels of the quarried area needing to meet the required 1 m above groundwater).	During topsoil removal and redistribution	Section 6.9 C
l)	• Where topsoil is stripped at more than 150 mm thickness, topsoil to be stripped in two paths and re-laid in correct order.		Section 6.9 D
m)	• Avoiding stockpiling topsoil enabling direct transfer to rehabilitation areas where feasible.		Section 6.9 E
n)	• Minimising stripping depths to avoid seed burial, and taking two strips where possible ensuring respreading is sequential.		Section 6.9 D
o)	• If a hard or indurated layer is present on the floor of the quarried area, the floor will be ripped prior to topsoil respreading.	Prior to topsoil placement	Section 6.9 F
p)	• Respread topsoil to a minimum thickness of 100 mm, noting the need to achieve a final land form of 1 m above groundwater).	During topsoil placement	Section 6.9 G
q)	**Operational Levels and Final Landform** • Quarry floor levels to be established on weekly basis.	Weekly	Section 6.10 A
r)	• Quarry floor levels to be reviewed on completion of quarrying to confirm required topsoil strip depth.	On completion of sector	Section 6.14 B
s)	• Independent registered surveyor to undertake audit	3 months	Section 6.10 B

SoC Item	Action	Trigger/ Timing	Addressed in Section
t)	• Operational floor of quarry to be no less than 0.7 m above highest predicted groundwater level. Level relative to thickness of topsoil removal, i.e. if topsoil stripping is less than 0.3 m than the operational floor level must be increased accordingly such that replacement of topsoil achieves final landform requirement of 1 m above highest predicted groundwater level.	At all times	Section 6.10 D
u)	• Final landform, including topsoil to be not less than 1 m above highest predicted groundwater level.	Upon completion of final landform shaping	Section 6.10 E
v)	**Nest Box Installations** • Hollows will be replaced with nest boxes at a ratio of 1:1 within the rehabilitation area. • Nest box design will be selected to replace the natural size of removed hollows. The number and type of next boxes to be installed will be determined for surveys of hollow-bearing trees felled during clearing. • Nest boxes will be installed on wooden poles at an approximate height of 3 m within the rehabilitation area where alternative trees are not avilable.	As required	Section 6.11 A&B
w)	**Placement of woody debris and brush matting** Where possible individual plant species (especially *Leptospermum*, *Melaleuca* and *Eucalyptus* species) will be harvested when they are bearing mature seed rather than immediately prior to clearing. Bradysporous (seed retaining) species are best harvested and spread in autumn whereas geosporous (seed shedding) species are best harvested immediately prior to annual seed release in late spring. • Experienced and qualified contractors to coordinate seed collection.	Annually in autumn and late spring.	Section 6.13 A
x)	• Distribution of all stockpiled vegetation will occur following the respreading of topsoil up to a maximum of 20% ground cover by woody debris (greater than 10 cm diameter). The re-laid vegetation will comprise branches and timber of all sizes including leaves and stems of shrubs and grasses. • The placement of large timber should have regard to its orientation for the purpose of the capture of wind-blown sand and delay of runoff. Generally, this means an orientation along the north-east to south-west vectors, perpendicular to dominant onshore and off-shore winds.	During placement of woody debris and brush matting.	Section 6.13 B
y)	**Direct Seeding** • Common pioneer species (i.e. *Acacia* species and *Actinotus helianthi*) and others will usually regenerate from topsoil or brush matting and direct seeding is not required. Where monitoring shows a deficiency in a particular species they will be introduced through direct seeding.	Where monitoring shows failure of species to regenerate by topsoil or brush matting.	Section 6.14 A
z)	• Locally sourced seed will be used, and will be sown in the soil rather than broadcast. Harvesting of mature seed and direct sowing into re-topsoiled areas at the most appropriate time of year (usually autumn or spring) will be undertaken for species that typically do not readily regenerate from the soil seedbank, such as *Eucalyptus*, *Angophora*, *Banksia* and *Xanthorrhoea*.	Annually in autumn and late spring as required.	Section 6.14 B
aa)	**Propagation and Replanting** The focus of propagation is to: • Introduce to the rehabilitation the dominant structural species that have difficulty establishing from topsoil, brush matting, or direct seeding or recalcitrant species. • Provide advanced species that are desired for establishment in strategic locations or densities to achieve the revegetation objectives. • Propagation will be undertaken by a local wholesale nursery.	Where monitoring shows failure of species to regenerate by direct seeding or other means.	Section 6.15 A
bb)	• Where targeted species do not regenerate through the topsoil seedbank or direct seeding, tubestock will be planted within the rehabilitation. Planted tubestock will be watered to ensure for initial establishment.	In autumn (for optimum success), as required	Section 6.15 B

SoC Item	Action	Trigger/ Timing	Addressed in Section
cc)	**Transplanting** • Transplanting will be used as a method of revegetation for certain species. • The plants will be excavated with a front-end loader (or similar) retaining as much soil around the roots as possible • The plant will then be moved to a prepared hole, water in where possible. • For mature *Xanthorrhoea* species (Grass Trees), these will be burnt (where weather and conditions permit). Burning the shirt of dead leaves and some of the lower green leaves is important to stimulate new growth and flowering.	As required, during rehabilitation	Section 6.16 A
dd)	**Species Composition and Structure** • Rehabilitation will aim to achieve the species composition and structure of the following communities: • Smooth-barked Apple – Blackbutt Forest and Coastal Sand Wallum Woodland-Heath. Canopy species of the adjoining Swamp Mahogany – Paperbark Swamp Forest will supplement rehabilitation in areas where this community adjoins the rehabilitation area. • The composition of the rehabilitation will aim to meet the performance and ultimately the completion criteria specified in the Rehabilitation Plan.	When undertaking rehabilitation	Section 6.17 A
ee)	• Landscaping Areas will include species composition and structure that will aim to establish native ground cover and shrub species that are consistent with requirements for fuel loads within Asset Protection Zones (e.g. maintained, minimal wood debris, discontinuous patches of the shrub layer, no canopy species within 10 m of building and where present do not • have connected canopy with adjoining vegetation).	For landscaped areas	Section 6.17 B
ff)	**Rehabilitation Monitoring** • Six monthly (bi-annual) monitoring of rehabilitation for the first three years and monitoring at years four, five and eight post-rehabilitation will be assessed against the performance criteria. The Eight year (or final) monitoring event will also be compared against the completion criteria, and where met will not require further monitoring.	As specified.	Section 6.22 H
8.3.20	**Offsets**		
a)	• Sufficient biodiversity offsets will be secured to satisfaction of BCS and DPHI prior to the commencement of construction.	Prior to commencement	Section 3.4

3. EXISTING ENVIRONMENT

3.1 BIODIVERSITY

An ecological assessment was undertaken by Kleinfelder Australia Pty Ltd in 2016 within the proposed development area and Subject Land (refer Kleinfelder, 2016). Field surveys identified a total of three threatened flora species listed as Vulnerable under both the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* and the NSW *Threatened Species Conservation Act 1995 (TSC Act)* within the Subject Land;

- Camfield's Stringybark *(Eucalyptus camfieldii*);
- Earp's Gum (Eucalyptus parramattensis subsp. *decadens*); and
- Small-flowered Grevillea *(Grevillea parviflora* subsp. *parviflora*).

A total of eight threatened fauna species listed as threatened under the TSC Act and/ or the EPBC Act were identified within the Subject Land;

- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Eastern Osprey (*Pandion cristatus*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Koala (*Phascolarctos cinereus*);
- Little Bentwing-bat (*Miniopterus australis*);
- Varied Sittella (*Daphoenositta chrysoptera*); and
- Wallum Froglet (*Crinia tinnula*).

Additionally, two species listed as migratory under the EPBC Act were identified; Eastern Osprey and Rufous Fantail (*Rhipidura rufifrons*).

Six native vegetation communities were identified within the Subject Land, including Swamp Mahogany – Paperbark Swamp Forest which is consistent with the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC, listed under the TSC Act:

- Coastal Sand Apple – Blackbutt Forest;
- Coast Sand Wallum Woodland-Heath;
- Coastal Wet Sand Cyperoid Heath;
- Swamp Mahogany – Paperbark Swamp Forest;
- Tomago Sand Swamp Heath; and
- Tomago Sand Swamp Woodland.

The project will directly impact on two threatened flora species (Camfield's Stringybark and Earp's Gum) and habitat for eight threatened fauna species (Eastern Bentwing-bat, Eastern Freetail-bat, Eastern Osprey, Grey-headed Flying-fox, Koala, Little Bentwing-bat, Varied Sittella and Wallum Froglet). In particular, the following impacts are noted:

- Earp's Gum: project estimated to impact 0.57% of local population, therefore unlikely to significantly impact on the species;
- Camfield's Stringybark: project estimated to impact approximately 10% of the identified local population. As impacts would be occurring to planted individuals, a large number

within the Subject Land will be retained (1,641), and the species will be rehabilitated within the disturbance area post extraction. The project is therefore unlikely to significantly impact on the local population;

- Koala: project estimated to impact approximately 1.01% of the preferred and 0.78% of the supplementary habitat within the Tomago Sandbeds Koala Management Unit. There is also potential to displace any Koala individuals whose home-range occurred within the extraction area. This impact was not assessed as significant as habitat availability is not considered a limiting factor on the Koala population. As such it is likely that there are areas of suitable habitat that are either un-occupied, or could support a higher density of Koalas, to which the individuals could self-relocate. Due to the relatively small area of habitat removal the project is unlikely to significantly impact on the local population. With the rehabilitation of the site including koala feed tree species, implementation of Biodiversity Stewardship Agreement on the Subject Land, the introduction of koala fencing adjacent to Cabbage Tree Road and feral animal control within the site during the project life, the project has the potential to provide long term benefit to the local koala population;
- Wallum Froglet: The relatively small removal of habitat (0.13 ha core (breeding) and 0.57 ha of supplementary (foraging)) for the species is not considered to be large enough to significantly impact on the long-term survival of the species. Additionally, the proposal will not fragment or isolate any areas of potential habitat for the species. The project will create a temporary barrier to some potential dispersal routes (through the proposed disturbance area).
- Mahony's Toadlet: The relatively small removal of habitat (0.13 ha core (breeding)) for the species is not considered to be large enough to significantly impact on the long-term survival of the species. Additionally, the proposal will not fragment or isolate any areas of potential habitat for the species. The project will create a temporary barrier to some potential dispersal routes (through the proposed disturbance area). The following key attributes are relevant to the species management:
    - During the day, terrestrial toadlets typically burrow several centimetres into the soil/sand or take refuge at the base of thick vegetation cover.
    - Migratory behaviour from non-breeding vegetated areas (including extraction zones) towards breeding habitats (outside the extraction footprint) is likely to take place in Spring.
    - Installation of barriers (e.g. fencing) during this period should be avoided as individuals may be excluded from breeding habitats, becoming trapped within the extraction areas.
    - Metamorphosis for *U. mahonyi* has been recorded in December (summer) and March (autumn) (Anstis, 2018) where post-metamorphic dispersal from the natal breeding sites occurs. Similarly, adults may attempt to take refuge in vegetated areas within the extraction footprint following breeding (late summer).

Management measures to protect biodiversity within the Subject Land is outlined in **Section 6**.

Refer to **Figures 3, 4, 5, 6, 7,** and **8** for the biodiversity attributes of the Subject Land.

3.2 WEEDS

The majority of the Subject Land has a low abundance of weeds. Within the Project Area weeds are restricted to areas within and adjoining the southern resource area and south eastern fringe of the northern resource area, within areas that have previously been disturbed and access tracks.

A list of environmental weed species identified within the Subject Land is provided in **Table 4**. This list will form the basis of a target weed species list for the Project. Other noxious or potential environmental weeds identified during the works will also be targeted. Not all target species are listed Noxious Weeds within Port Stephens control area or are listed as Weeds of National Significance but have been identified as environmental weeds within the Subject Land due to their dominance.

Table 4: Environmental Weeds within the Subject Land

Family	Scientific Name	Common Name	WoNS
Recorded within the Project Area			
Asteraceae	*Senecio madagascariensis*	Fireweed	Yes
Poaceae	*Eragrostis curvula*	African Love Grass	-
Poaceae	*Melinis repens*	Red Natal Grass	-
Verbenaceae	*Lantana camara*		
Additional Species Recorded Outside the Project Area (Offset Area)			
Asteraceae	*Chrysanthemoides monilifera* subsp. *rotundata*	Bitou Bush	Yes
Fabaceae – Mimosoideae	*Acacia saligna*	Golden Wreath Wattle	-
Pinaceae	*Pinus elliottii*	Slash Pine	-
Pinaceae	*Pinus radiata*	Radiata Pine	-
Poaceae	*Andropogon virginicus*	Whisky Grass	-
Poaceae	*Axonopus fissifolius*	Narrow-leaved Carpet Grass	-
Poaceae	*Setaria sphacelata*	South African Pigeon Grass	-

The high cover and abundance of exotic grasses within previously disturbed areas is likely the result of their introduction during past rehabilitation activities. Due to the abundance of these weeds in previously disturbed areas, complete eradication within the Project Area is unlikely. As such the management of topsoil and planting of canopy species are likely to be the most effective control measures.

The principle aim of weed control for the Project is to limit the spread of weeds (environmental and noxious weeds) from activities in the Project Area to adjoining conservation lands, and degrading the quality of proposed quarry rehabilitation. The adjoining conservation lands include:

- Lot 15 DP 1081085 located to the west of the Project Area that is subject to a Biobanking Agreement. Like the Project Area, a large portion of this lot was also subject to sand mining in the late 1970s.
- The Tilligerry State Conservation Area (SCA) shares a section of approximately 200 m with the western side of the resource area. A 50 m buffer separates the Project Area and this land.
- Biobank Land within the Subject Land outside the Project Area.

The retained habitat within the Subject Land is susceptible to the potentially harmful diseases Myrtle Rust and *Phytophthora cinnamomi.* Evidence of these two diseases was not identified within the Subject Land, however, they are known to occur in the region. It is not expected that the proposal will introduce or exacerbate any of these diseases that may cause the decline in native species. However, to limit the potential spread of these diseases, control measures will be implemented.

Management measures to control weed spread are outlined in **Section 6.18**, this includes pre-clearance surveys to identify and delineate weed infested areas.

3.3 PESTS

Pests (and non-native fauna species) recorded during surveys on the Subject Land included:

- House mouse.
- Black rat.
- Dog.
- European rabbit.
- Horse.

Pests of particular note are dogs and cats that are capable of predation of native wildlife, while European rabbit may present a risk to rehabilitation success. These pests are likely to be a combination of both feral and domestic pests recorded on the Subject Land and were not noted for their particular abundance or damage generated. Under the *Biosecurity Act 2015*, there are requirements for landholders to prevent, eliminate or minimise a biosecurity risk (including control of pests and weeds) so far as is reasonably practicable on their lands and Port Stephens Council has a requirement for the lessee to manage pests on the Subject Land particularly within the wildlife corridor area located between the northern and southern resource areas. Management is to include the capture and return of domestic pets to owners where identifiable or to an animal shelter where identification is not possible.

Management measures to control pests are outlined in **Section 6.19**.

3.4 BIODIVERSITY OFFSET STRATEGY

A Biodiversity Offset Strategy has been developed for the Project in consultation with OEH (Kleinfelder, 2016) that comprises the following biodiversity offsets:

- Onsite Offset: The majority of the residual subject land outside the Project disturbance area (approximately 131 hectares), to retire the following credits:
  - 1,189 ecosystem credits.
  - 11,651 species credits for *Camfield's Stringybark* (Eucalyptus camfieldii).
  - 4,501 species credits for Earp's Gum (*Eucalyptus parramattensis subsp. Decadens*).
  - 724 species credits for Small-flowered Grevillea (*Grevillia parviflora Parviflora*).
  - 717 species credits for Eastern Osprey.
  - 744 species credits for Koala.
  - 606 species credits for Wallum Froglet.
- Offsite Offset: The Offsite Offsets as per Condition 34 have been retired. The offsite offset resulted in the retiring of the following credits (note retired credits adjusted to current plant community type (PCT) and equivalence in consultation with the Biodiversity Conservation Division:
  - 687 to 1,018 ecosystem credits, of preferably HU860, and including other ecosystem credits generated by the application of variation criterion (f) for mitigated net loss (Tier 3) under the Interim Policy. Where ecosystem credits are generated concurrently in securing the required 306 Koala species credits, up to 1,018 ecosystem credits must be retired.
  - 306 species credits for Koala.

The Onsite and Offsite Offsets will be secured and managed under a Biodiversity Stewardship Agreement (previously called a biobanking agreement).

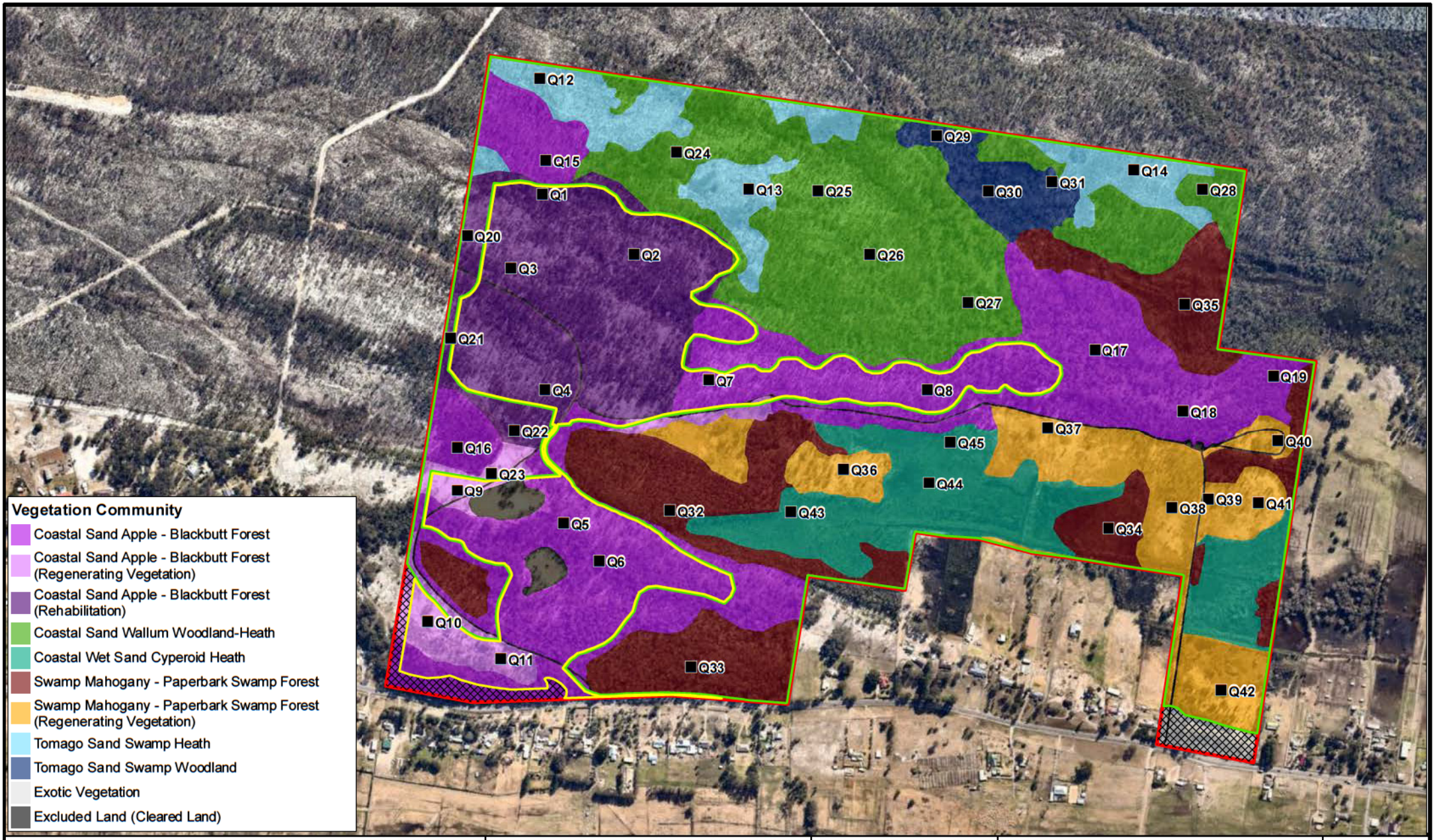
3.4.1 Onsite Offset and Revegetation Integration

The quarry area shares a common boundary with the proposed onsite Biodiversity Offset. To ensure the long term successful integration of these areas the following measures have been adopted and integrated within this plan, and within the Biodiversity Offset Agreement. Key measures include:

- Pre-clearance survey, including boundary definition and retention of hollow bearing trees close to the boundary (refer to **Section 6.7**).
- Revegetation of the quarried landform with vegetation communities consistent with surrounding vegetation communities at similar elevations (refer to **Section 5.3**).
- Implementation of weed and pest management measures as detailed within **Section** 6.18 and **Section 6.19**.
- Monitoring of revegetation success and correction as needed to meet completion criteria (refer to **Section 8**).

3.5 SITE BIODIVERSITY FEATURES

Figures 2 to 8 illustrate the biodiversity present on the disturbance area and Subject Land as described above.



Legend

- Subject Land (176.1 ha)
- Biobank Site Boundary (131.3 ha)
- Development Area Boundary (42.1 ha)
- Excluded Areas (2.7 ha)
- Plot Locations

Metres

0 50 100 200 300 400 500

N

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DRAWN BY: gjoyce

DATA SOURCE:
NSW DFSI - 2017
Nearmap - 2018

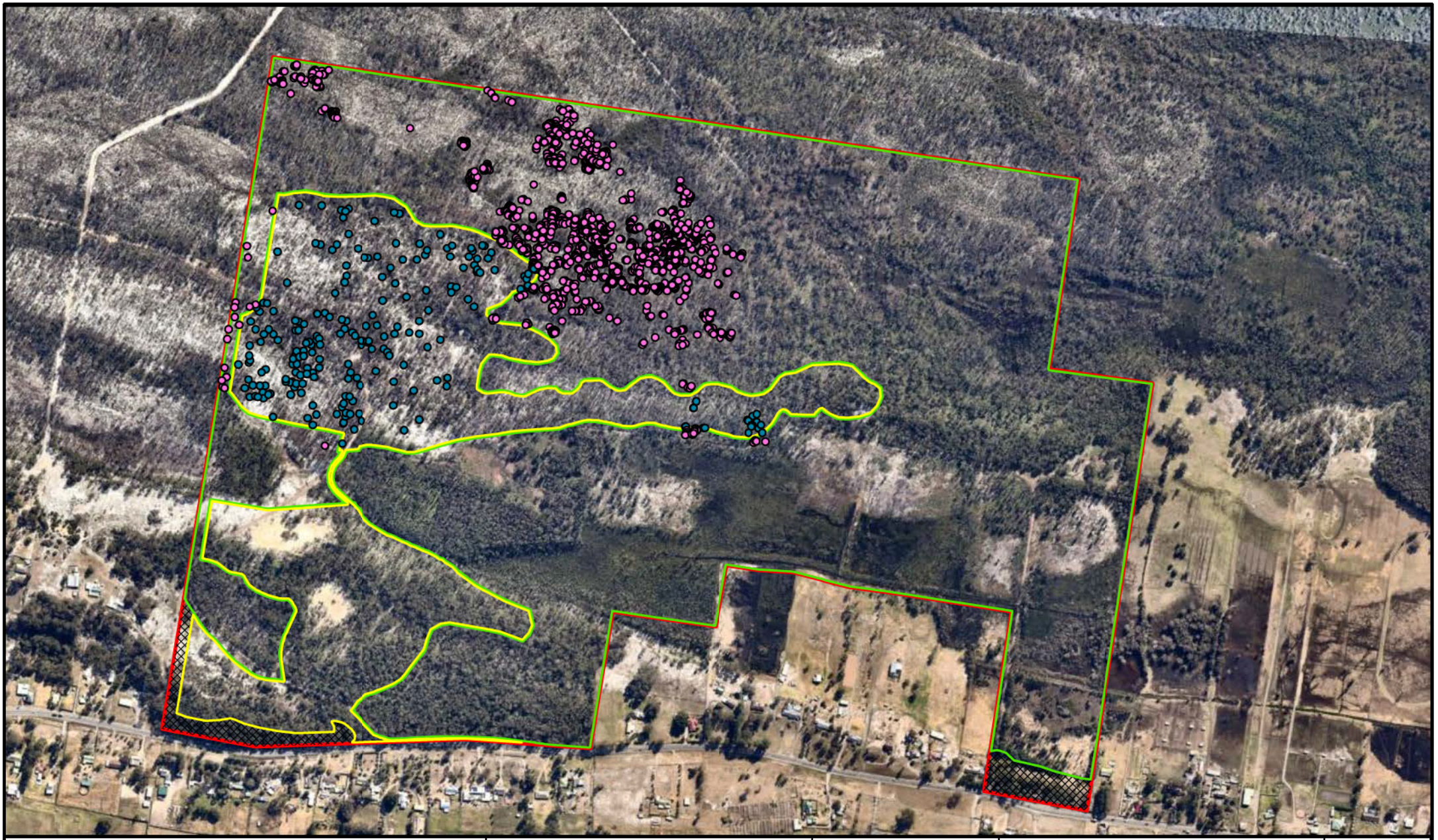
Vegetation Communities Within the Subject Land

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:

2

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig02_VegComm.mxd



Legend

- Subject Land (176.1 ha)
- Biobank Site Boundary (131.3 ha)
- Development Area Boundary (42.1 ha)
- Excluded Areas (2.7 ha)

***Eucalyptus camfieldii* Locations**

- Within Offset Site (1,641 individuals)
- Within Development Site (227 individuals)

km
0 0.05 0.1 0.2 0.3 0.4 0.5
N

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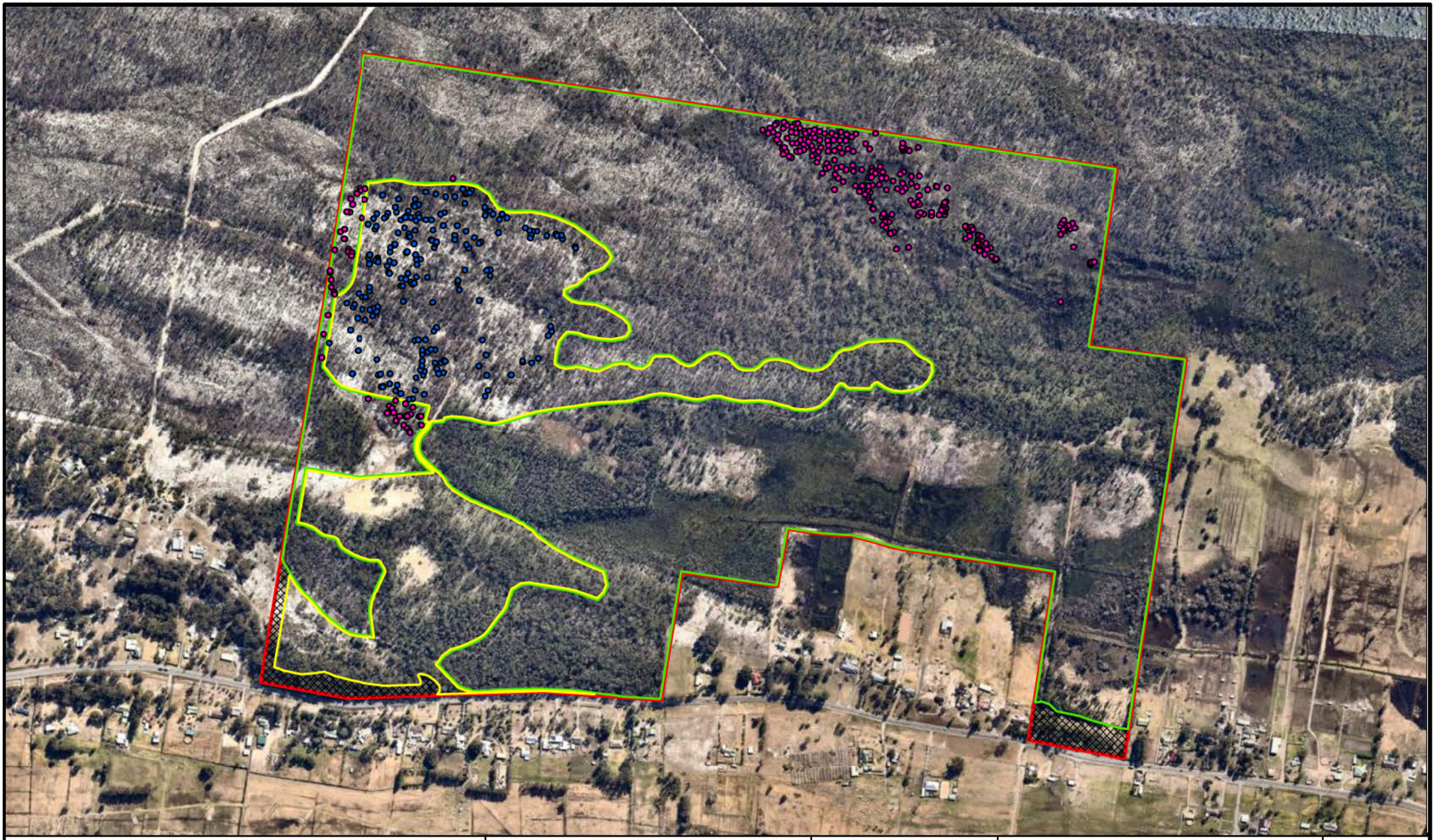
DRAWN BY: gjoyce
DATA SOURCE:
NSW DFSI - 2017
Nearmap - 2018

Eucalyptus camfieldii Within the Subject Land

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
3

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig03_CamfieldiiLocations.mxd



Legend

- Subject Land (176.1 ha)
- Development Area Boundary (42.1 ha)
- Biobank Site Boundary (131.3 ha)
- Excluded Areas (2.7 ha)

***E. parramattensis* subsp. *decadens* Locations**

- Offset (639)
- Development Area (230)

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:
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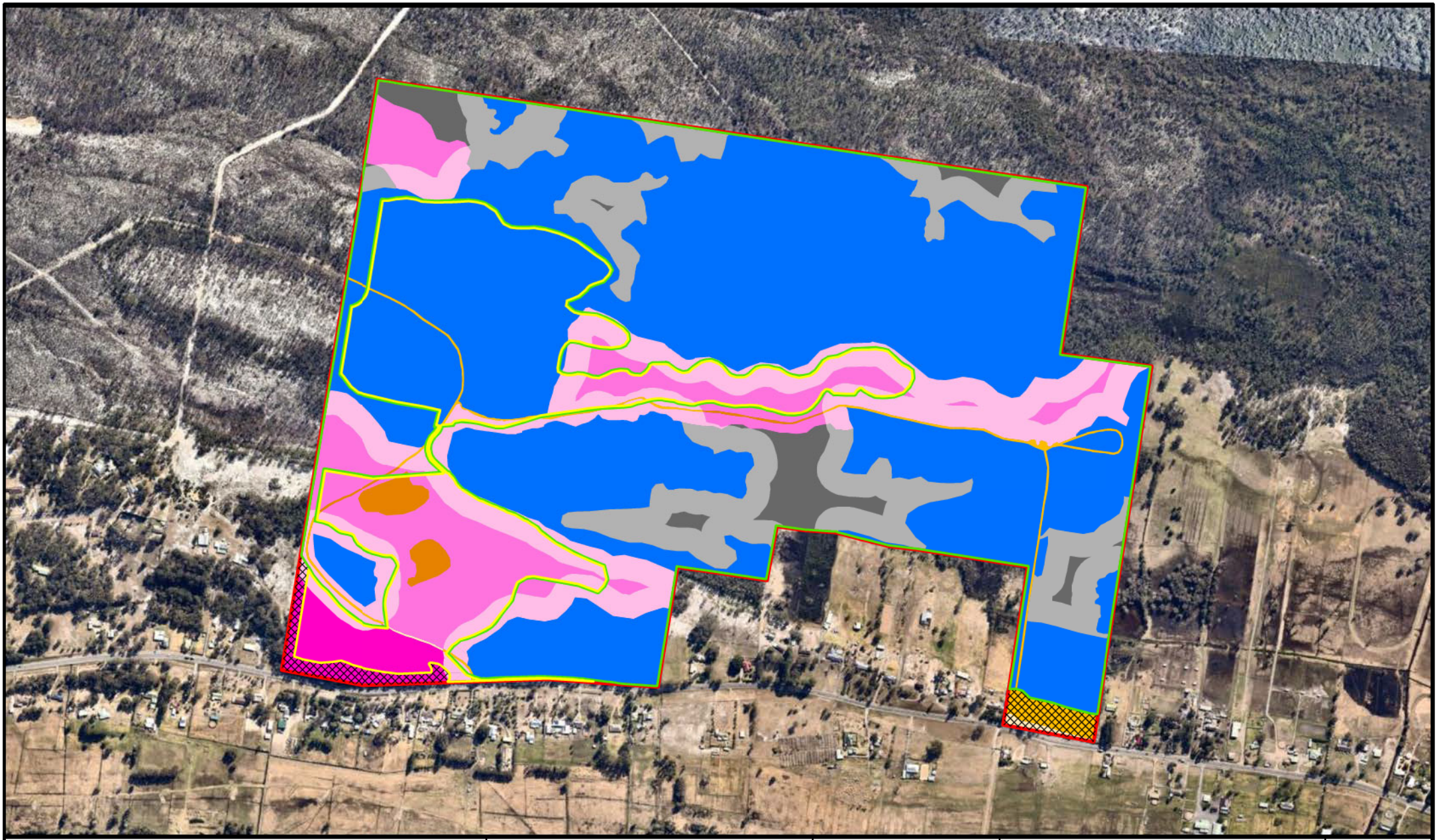
Eucalyptus parramattensis subsp. *decadens* within the Subject Land

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:

4

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig04_parramattensis.mxd


Legend
Subject Land (176.1 ha)
Biobank Site Boundary (131.3 ha)
Development Area Boundary (42.1 ha)
Excluded Areas (2.7 ha)
Koala Habitat Mapping
Preferred Koala Habitat
Supplementary Koala Habitat
Link Over Supplementary
50m Buffer Over Supplementary
50m Buffer Over Other
Link Over Other
Mainly Cleared
Link Over Cleared
50m Buffer Over Cleared
Metres
0 50 100 200 300 400 500
N
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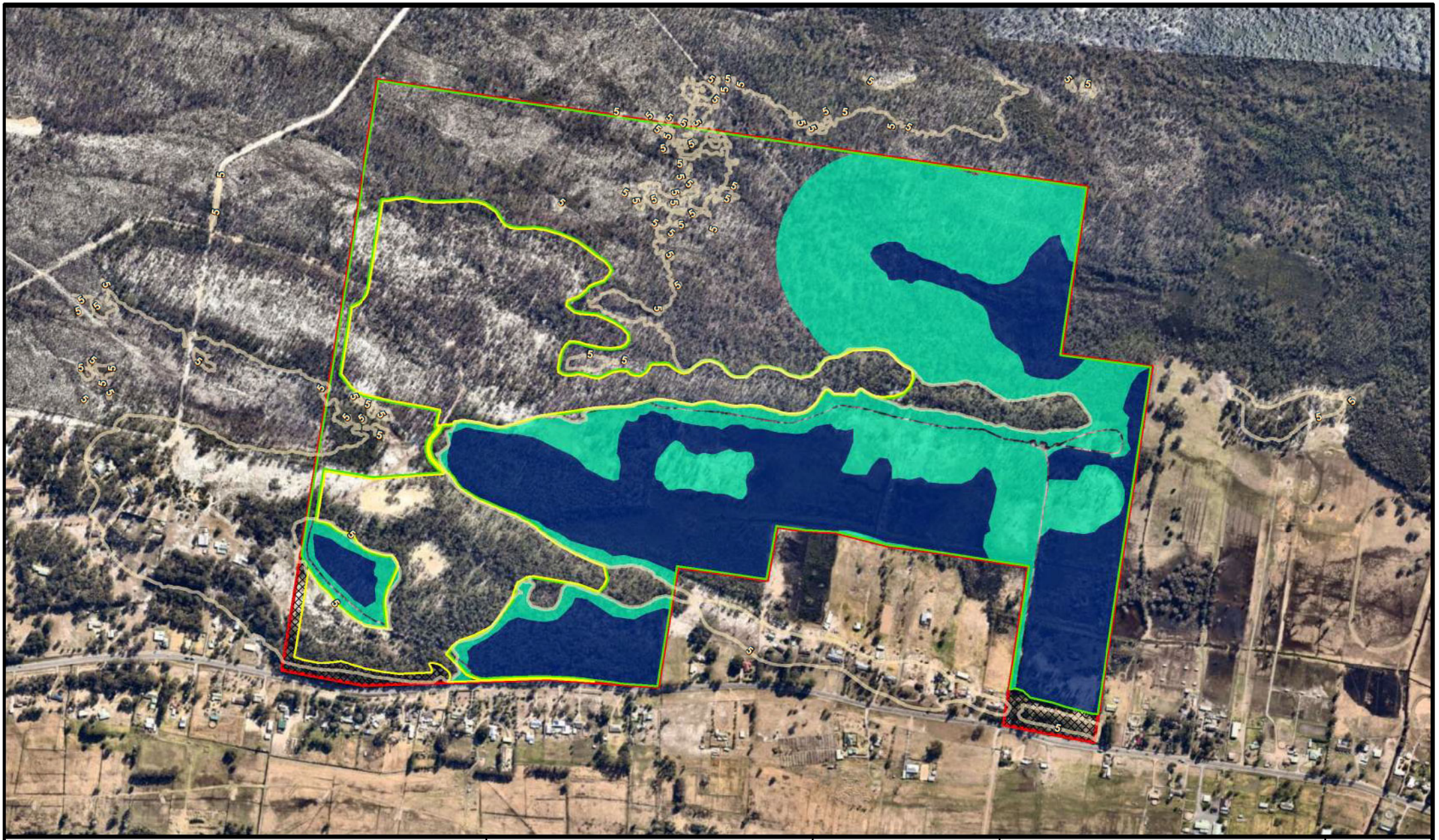
DRAWN BY: gjoyce
DATA SOURCE:
NSW DFSI - 2017
Nearmap - 2018
Revised Koala Habitat Mapping
Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW
FIGURE:
5
L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig05_KoalaHabitat.mxd



Legend

- Subject Land (176.1 ha)
- Biobank Site Boundary (131.3 ha)
- Development Area Boundary (42.1 ha)
- Excluded Areas (2.7 ha)
- 5m Contour Line

Wallum Froglet *(Crinia tinnula)* Habitat

- Core Habitat
- Supplementary Habitat

Metres
0 50 100 200 300 400 500
N

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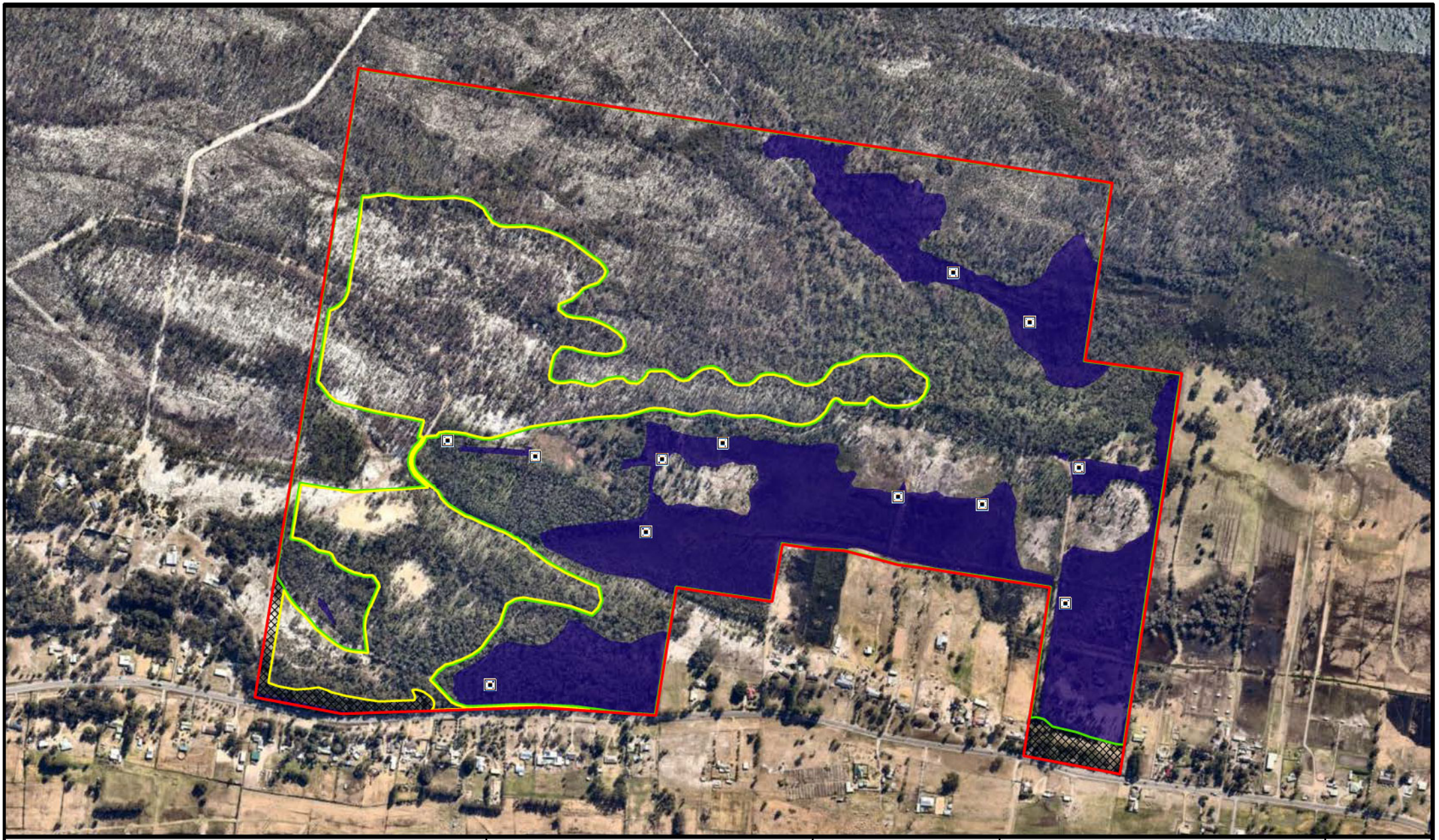
DATA SOURCE:	NSW DFSI - 2017 Nearmap - 2018

Wallum Froglet Habitat Within the Subject Land

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
6

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig06_WallumFroglet.mxd



Legend

- Subject Land (176.1 ha)
- Development Area Boundary (42.1 ha)
- Biobank Site Boundary (131.3 ha)
- Excluded Areas (2.7 ha)
- Breeding Habitat for Mahony's Toadlet
- Mahony's Toadlet detected (KLF)

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:

NSW DFSI - 2017
Nearmap - 2018

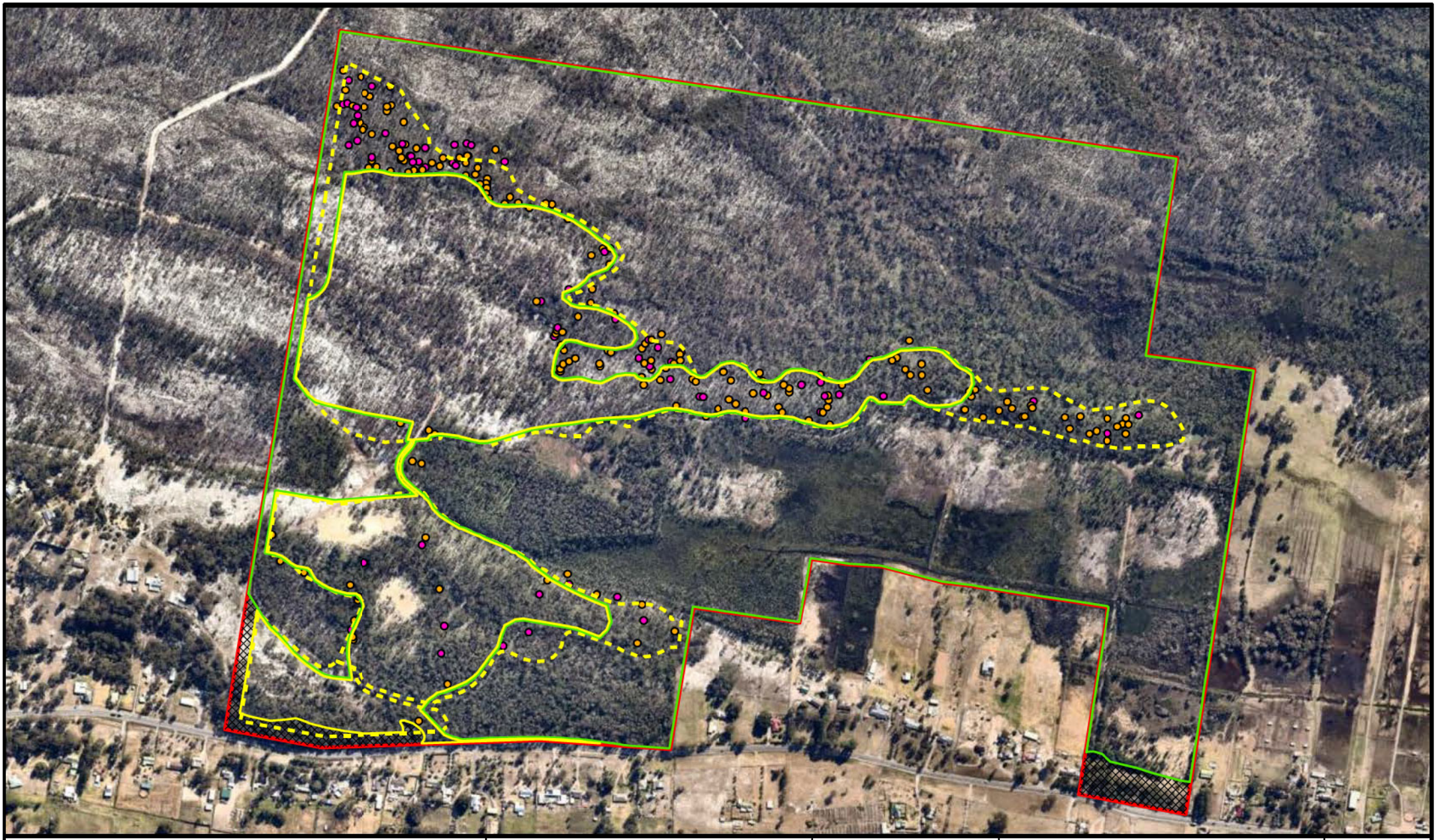
Mahony's Toadlet Habitat and Records Within the Subject Land

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:

7

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig07_Uperoleia_mahonyi.mxd



Legend

- Subject Land
- Biobank Site Boundary
- Current Extraction Area Boundary
- Previous Extraction Area Boundary
- Excluded Areas
- Hollow-bearing Tree
- Dead Stag

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:
NSW DFSI - 2017
Nearmap - 2018

Habitat Features Within and Immediately Surrouding the Extraction Area

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:

8

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig08_HabitatFeatures.mxd

4. ROLES AND RESPONSIBILITIES

Roles used within this plan are defined below, responsibilities are shown in **Section 6** or otherwise defined below.

4.1 EMERGENCY CONTACTS

The following contacts are available in the event of a compliant, enquiry or emergency.

Table 5: Key contacts for management of biodiversity and rehabilitation

Contact	Name	Phone	Email
Quarry Manager	Eliott Laver	0402 648 079	Eliott@newcastlesand.com.au
EPA – Incidents Line		131 555	
EPA - Newcastle Office		02 4908 6800	
DPHI – Regional Operations - Newcastle		1300 305 695; or email: compliance@planning.nsw.gov.au	
Orphaned or sick native wildlife	Port Stephens Koala Hospital	1800 775 625	
Injured animal	Noah's Ark Veterinary Service Shop 1, Medowie Shopping Village, 37 Ferodale Rd, Medowie	02 4982 9899	
	Motto Farm Veterinary Hospital 1 Motto Lane Heatherbrae	02 4987 5087	
Lost/ captured domestic animal without contact details	Domestic animals only Port Stephens Animal Refuge 157 Cabbage Tree Road Williamtown	02 4965 0100	

4.2 QUARRY OWNER

The Quarry Owner is WSS who operates the quarry under Newcastle Sand. The Quarry Owner is responsible for the development and assignment of a suitably qualified Quarry Manager and to provide sufficient support to the Quarry Manager to undertake the required actions defined in this plan.

4.3 QUARRY MANAGER

The Quarry Manager is the person who manages the Quarry and is responsible for the day to day activities on the site. The Quarry Manager reports to the Quarry Owner.

The Quarry Manager must read, understand and implement the practical application of this plan. All activities being undertaken on the quarry site are the responsibility of the Quarry Manager.

The responsibilities of the Quarry Manager are defined by **Section 6**.

4.4 SUITABLY QUALIFIED CONTRACTOR

The Quarry Manager must where required engage a suitably qualified contractor / person to undertake certain tasks. A suitably qualified contractor (including an Ecologist) must be able to demonstrate the following for the required task:

- Relevant qualifications.
- Relevant experience.
- In the case of flora and fauna, hold the relevant licences to handle threatened native flora and fauna.

The Quarry Manager should retain suitable information justifying the use of the contractor, and require all paperwork to include justification of contractor qualifications. An employee of Newcastle Sand may constitute a suitably qualified contractor if the above is satisfied.

4.5 ONSITE PERSONNEL

Onsite personnel constitute all employees and contractors working on the site.

5. REHABILITATION

5.1 OBJECTIVES

Rehabilitation objectives are provided in **Table 6** in accordance with Development Consent Condition 35:

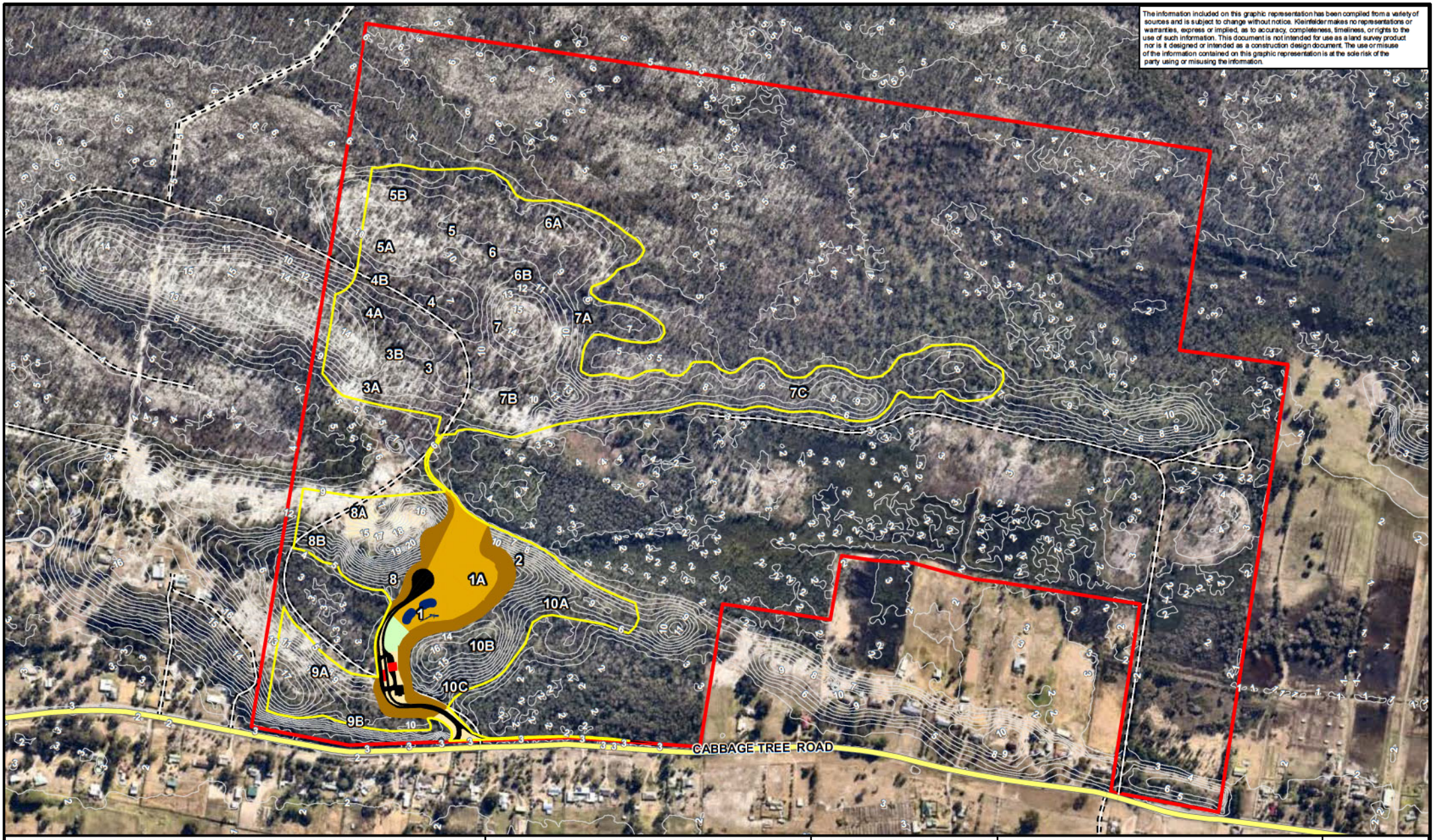
Table 6: Rehabilitation Objectives

Feature	Objective	Application to Project
All areas of the site affected by the development	1. Safe, stable, non-polluting and fit for the intended post-mining land use(s).	Intended long term purpose is the revegetation of the disturbance area with native species with exception to the office and facilities area including a bushfire asset protection zone. Final land use intended to utilise residual infrastructure consistent with PSC land zoning. As shown by **Figure 14**
	2. Final landform integrated with surrounding natural landforms as far as is reasonable and designed to minimise visual impacts when viewed from surrounding land.	Final land form will include batters along the portions of the extraction area boundary where extraction footprint is limited by constraints other than groundwater, and near level with surrounding lands where limited by groundwater. The access road is structured to limit visibility into the site from Cabbage Tree Road.
	3. Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna.	Site operations include installation of road side koala fences, feral animal control and revegetation including koala feed tree species.
Surface infrastructure	4. Decommissioned and removed, unless otherwise agreed by the Secretary.	As shown by **Figure 14**.
Quarry extraction area	5. Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds.	Refer to **Figures 9-14**.
	6. Landform rehabilitated to 1.0 metres above the predicted maximum groundwater level.	Measures to maintain correct quarry floor elevation developed in Maximum Extraction Depth and Groundwater Management Plans.
	7. Ensure there is no net loss of koala habitat or Camfield's Stringybark.	Site revegetation includes a variety of Koala feed trees and Camfield's Stringybark.
Biobank site	8. Protect onsite biobanking site.	Now referred to as Biodiversity Stewardship site. The site will be protected under an

Feature	Objective	Application to Project
		agreement ultimately funded by the WSS, and will include controls for its protection. Onsite management measures including revegetation and weeds and pest management will also provide for its protection.
Final void	9. No final void.	No void proposed.

5.2 STAGES OF REHABILITATION

Quarrying within the extraction area will utilise progressive rehabilitation methods to ensure areas where quarrying has been undertaken are quickly shaped and vegetated to provide a stable landform. Progressive rehabilitation will involve direct topsoil transfer onto exhausted areas to ensure direct transfer of topsoil is maximised and to aid in revegetation from the topsoil seedbank and stabilisation of disturbed areas. Proposed methods are detailed in **Section 6** and associated management controls in **Section 6**. Progressive rehabilitation plans are shown in **Figure 9** to **Figure 13**.



Legend

- Subject Land
- Development Area Boundary
- Arterial Road
- Local Road
- Track
- Contours (1m)

Year 1 Quarry Progress

- Extracted
- Batter
- <2 Year-old Rehab

- Building
- Landscaping
- Not Extracted
- Road - sealed
- Processing Plant

Metres
0 50 100 200 300 400 500
N

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DRAWN BY: gjoyce
DATA SOURCE:
LPI - 2016
Nearmap - 2016

Rehabilitation Progression Plan Year 1

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
9

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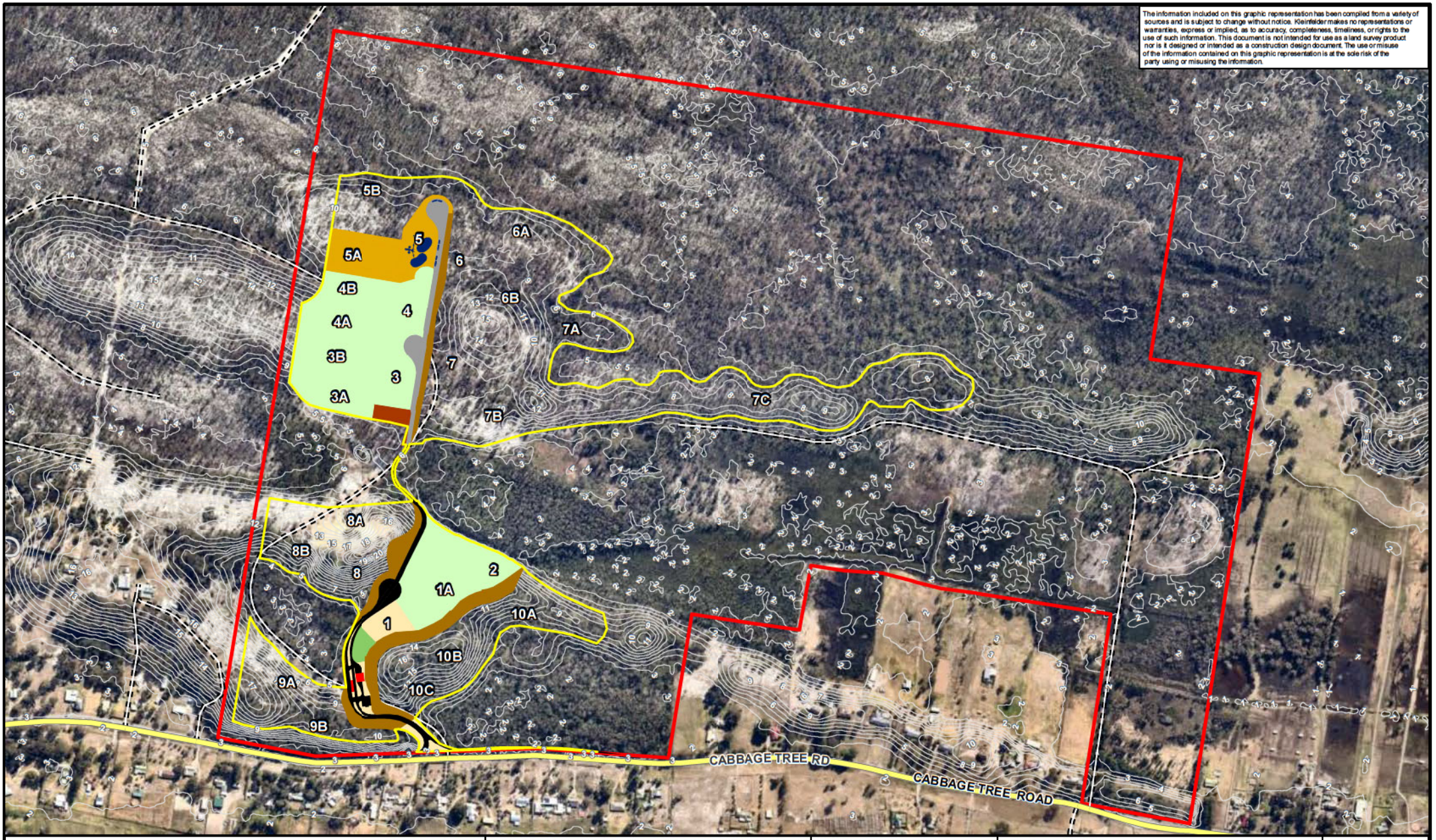

Legend

- Subject Land
- Development Area Boundary
- Arterial Road
- Local Road
- Track
- Contours (1m)

Year 3 Quarry Progress

- Extracted
- Batter
- Stockpile
- <2 Year-old Rehab
- <4 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - gravel
- Road - sealed
- Processing Plant

Metres
0 50 100 200 300 400 500
N

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DATA SOURCE:
LPI - 2016
Nearmap - 2016

Rehabilitation Progression Plan Year 3

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
10

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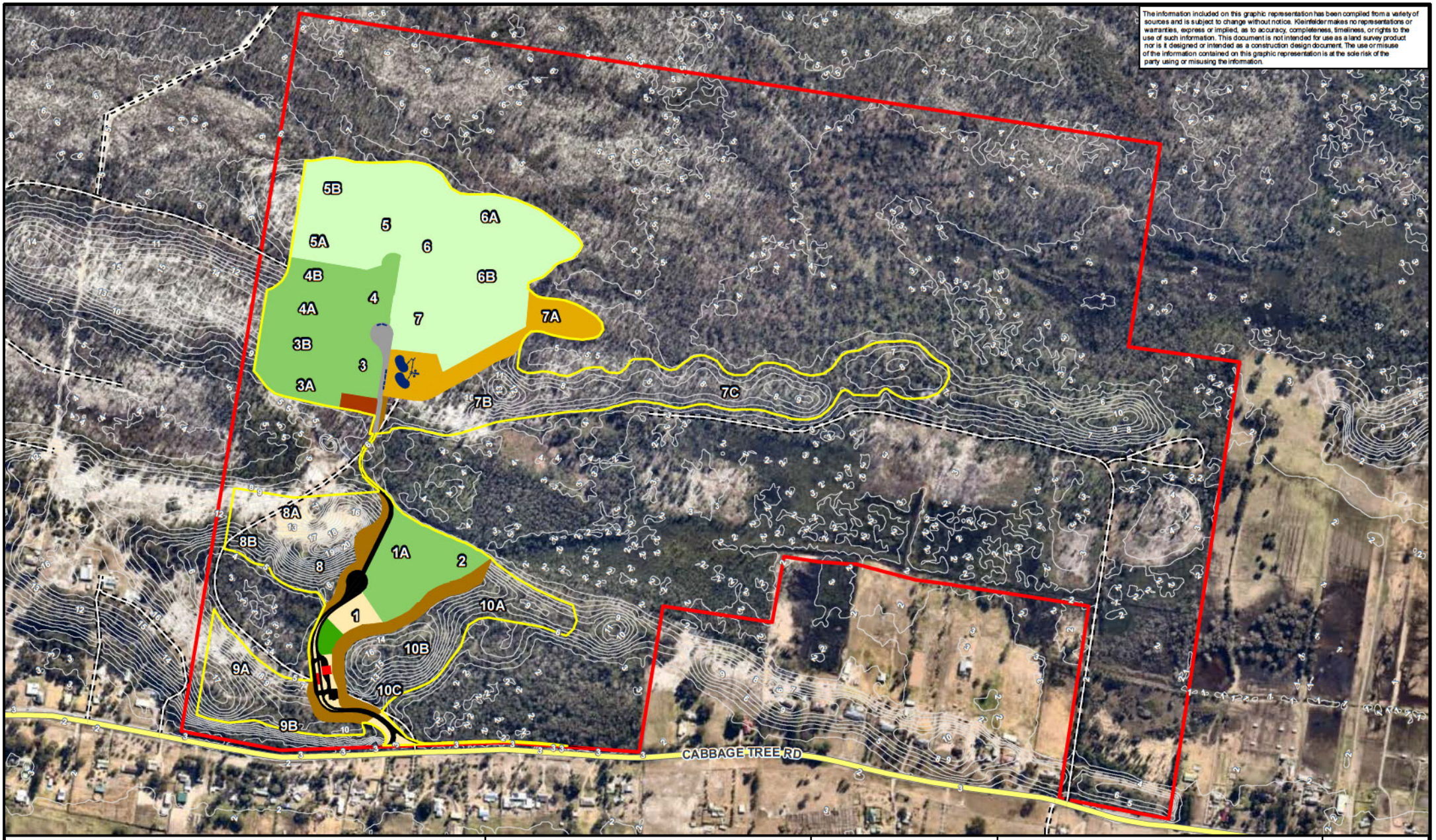

Legend

- Subject Land
- Development Area Boundary
- Arterial Road
- Track
- Contours (1m)

Year 5 Quarry Progress

- Extracted
- Batter
- Stockpile
- <2 Year-old Rehab
- <4 Year-old Rehab
- <6 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - gravel
- Road - sealed
- Processing Plant

Metres
0 50 100 200 300 400 500
N

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Rehabilitation Progression Plan Year 5

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
11

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Legend

- Subject Land
- Development Area Boundary
- Arterial Road
- Local Road
- Track
- Contours (1m)

Year 7 Quarry Progress

- Extracted
- Batter
- <2 Year-old Rehab
- <4 Year-old Rehab
- <6 Year-old Rehab
- <9 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - sealed
- Processing Plant

Metres
0 50 100 200 300 400 500
N

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Nearmap - 2016

Rehabilitation Progression Plan Year 7

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
12

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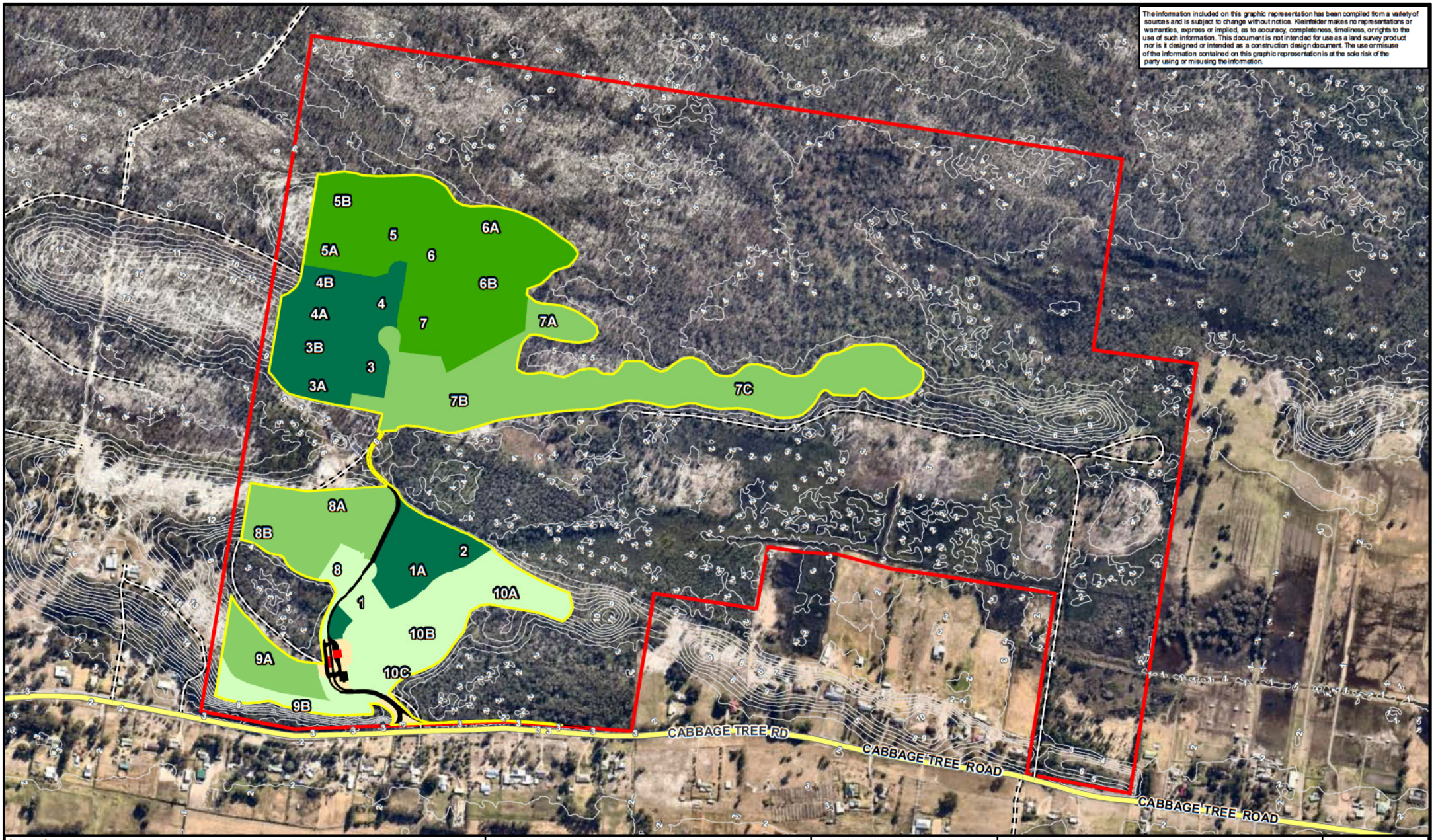

Legend

- Subject Land
- Development Area Boundary
- Arterial Road
- Local Road
- Track
- Contours (1m)

Year 9 Quarry Progress

- <2 Year-old Rehab
- <4 Year-old Rehab
- <6 Year-old Rehab
- <9 Year-old Rehab
- Building
- Landscaping
- Road - sealed

Metres
0 50 100 200 300 400 500
N

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DRAWN BY: gjoyce
DATA SOURCE:
LPI - 2016
Nearmap - 2016

Rehabilitation Progression Plan Year 9

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:
13

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5.3 FINAL LANDFORM AND VEGETATION

At the conclusion of quarry operations and rehabilitation, WSS propose to decommission the quarry and establish an ecosystem consistent with surrounding vegetation communities. Disturbed areas within the site that are unsuitable for establishment of native vegetation will be rehabilitated to a safe and stable landform. The final landform will be integrated into the surrounding landform through rehabilitation methods discussed in **Section 7** and management controls in **Section 6**. At present, subject to the approval of the land owner (PSC) and the secretary, the facilities area and access road is proposed to be retained (beneficial reuse of infrastructure) for a land use consistent with the land zoning.

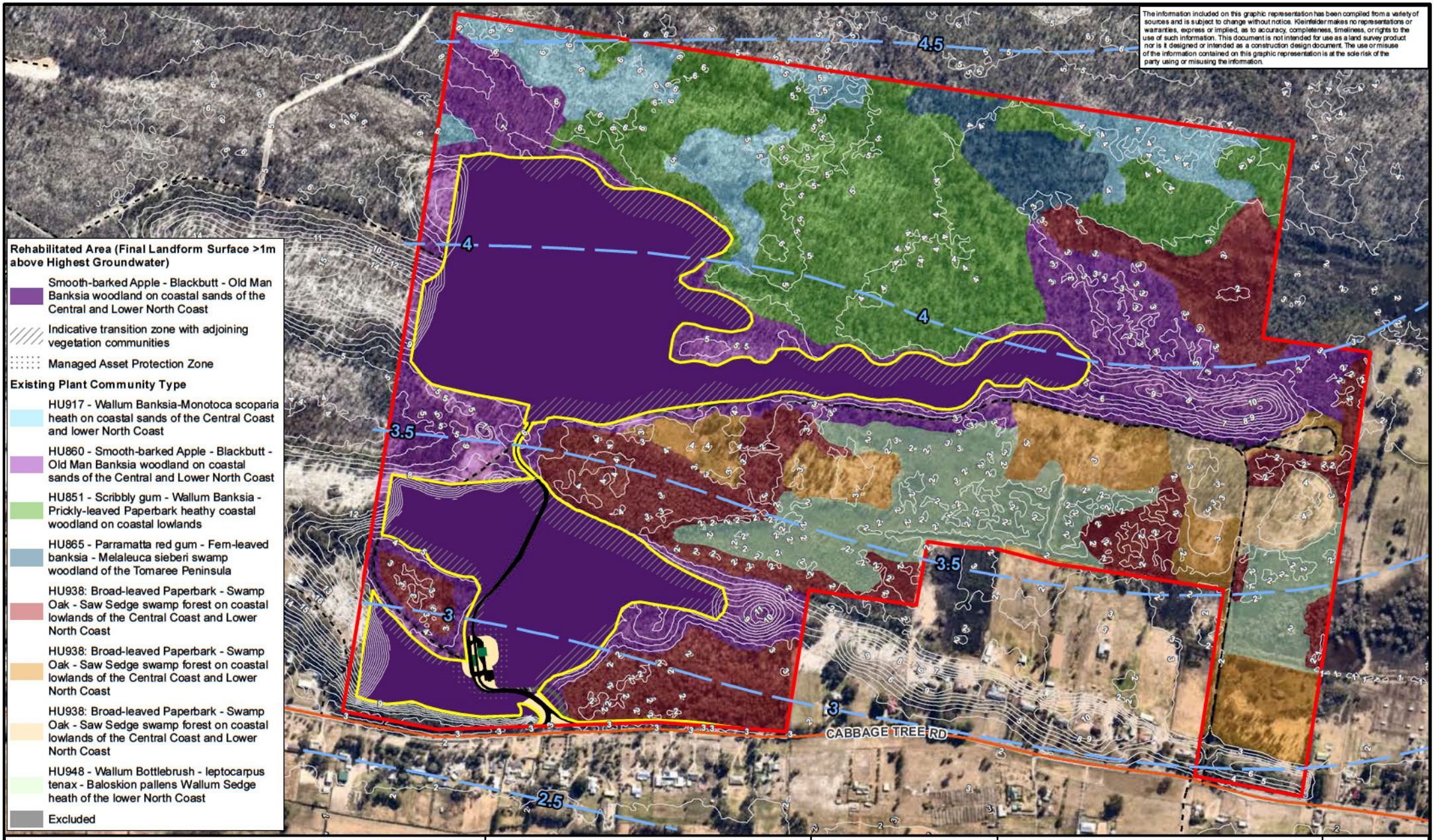
Rehabilitation will aim to achieve the species composition and structure of the following communities:

- HU860: Smooth-barked Apple – Blackbutt – Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Smooth-barked Apple – Blackbutt Forest), the dominant community across the extraction area;
- HU851: Scribbly Gum - Wallum Banksia - Prickly-leaved Paperbark heathy coastal woodland on coastal lowlands (Coastal Sand Wallum Woodland-Heath);
- Canopy species of the adjoining HU938: Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (Swamp Mahogany – Paperbark Swamp Forest) will supplement rehabilitation in areas where this community adjoins the rehabilitation area.

Landscaping Areas will include species composition and structure that will aim to establish native ground cover and shrub species that are consistent with requirements for fuel loads within Asset Protection Zones (e.g. maintained, minimal wood debris, discontinuous patches of the shrub layer, no canopy species within 10 m of building and where present do not have connected canopy with adjoining vegetation).

Temporary batters will be established within future resource areas during construction. These batters represent a relatively narrow band (approximately 20 m width) located between existing vegetation and rehabilitated areas. It is proposed to provide temporary stabilisation of the batters using tube stock, mulching, geotextile or similar. The temporary stabilisation efforts will reduce wind exposure and limit dust generation.

The final land form plan and indicative vegetation community distribution is provided in **Figure 14**. Proposed decommissioning activities and management measures will be confirmed within a Quarry Closure Plan developed 3 years prior to closure.



Legend

- Subject Land
- Project Area
- Arterial Road
- Track
- Local Road
- Contours (1m)
- Highest Predicted Groundwater Level (metres AHD)
- Infrastructure Pads/Buildings
- Road - sealed
- Landscaping

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:
LPI - 2016
Nearmap - 2016

Final Landform and Rehabilitation

Cabbage Tree Road Sand Quarry
Biodiversity and Rehabilitation Management Plan
Cabbage Tree Road, Williamtown, NSW

FIGURE:

14

L:\GIS FOLDER\00 CLIENT FILES\126863_TrusteeForWSS_UnitTrust\20170448_Williamtown\Mapping\20190803_BRMP_Fig14_FinalLandform.mxd

6. MANAGEMENT CONTROLS

Table 7 provides a summary of the anticipated implementation of the management controls of the life of the quarry, spanning, construction, operations and after completion for an anticipated period of up to eight (8) years post quarrying depending on rehabilitation success (i.e. demonstration of rehabilitation success may allow completion earlier). As the quarry will be progressively rehabilitated, some management measures may be implemented continuously throughout quarry operations as each extraction area is quarried and rehabilitated.

Table 7: Management measure implementation

Measure	Section addressed	Timing of Implementation		
		Construction First 6 Months	Operations (Years 1-8)	Post Operations (9+ years)
General	6.1	✓	✓	
Design	6.2	✓	✓	
Identification of approved limits	6.3	✓	✓	
Frog exclusion fence	6.4	✓	✓	
Koala fence	6.5	✓	✓	
Seed Collection	6.6	✓	✓	
Pre-clearance survey	0	✓	✓	
Koala protocol	0	✓	✓	
Vegetation clearing	6.7	✓	✓	
Retained vegetation management	6.8	✓	✓	✓
Fauna displacement protocol	0	✓	✓	
Habitat tree removal	0	✓	✓	
Topsoil stripping	6.9	✓	✓	
Operational levels and final landform	6.10	✓	✓	
Nest box installation	6.11	✓	✓	
Placement of vegetation, timber and brush matting	6.13		✓	
Direct seeding	6.14		✓	
Propagation and replanting	6.15	✓	✓	
Transplanting	6.16	✓	✓	
Species composition	6.17		✓	✓
Weed and disease control	6.18	✓	✓	✓
Pest control	6.19	✓	✓	✓

Measure	Section addressed	Timing of Implementation		
		Construction First 6 Months	Operations (Years 1-8)	Post Operations (9+ years)
Bushfire Management	6.20	✓	✓	✓
Erosion and Sediment Control	6.21	✓	✓	✓
Monitoring	6.22		✓	✓

Table 8 documents the management measures for biodiversity and rehabilitation over the next three years of quarry operation. These will be reviewed and updated over each 3-year period following initial approval of this plan by DPHI or in the event of an environmental incident or project non-compliance.

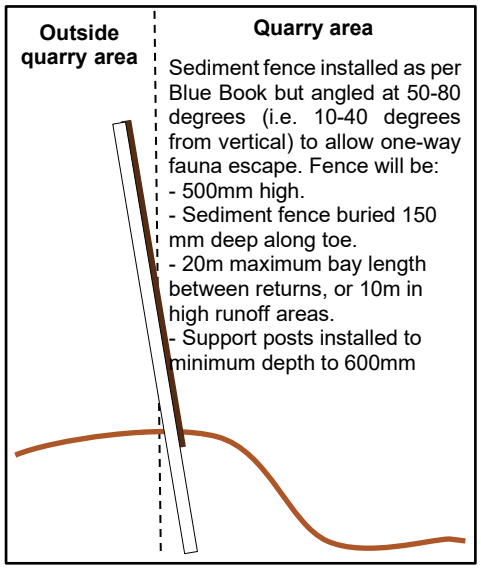
Table 8: Biodiversity and Rehabilitation Management Measures

Item	Action	Trigger/Timing	Responsibility	Reporting
6.1 GENERAL				
A	• Ground disturbing activities will not commence until this Biodiversity and Rehabilitation Management Plan is approved by DPHI, unless otherwise agreed with the Secretary.	Prior to commencement of construction	Quarry Manager	Approval of this plan by DPHI
B	• Site inductions to include awareness for all site personnel on the presence of the sensitive nature of the environment, with the following key items: ○ Requirement to stay within designated areas with no access to areas outside core access roads unless otherwise approved by the Quarry Manager. ○ Need for all vehicles entering site to be free of loose dirt, mud and organic material. ○ Need for clothing, boots and PPE to be free of mud or organic matter that may contain pathogens from another property. ○ Hygiene protocols relative to the contractors scope of works.	Ongoing	Quarry Manager	Induction
6.2 DESIGN				
A	• The boundary of the Sector 9B extraction area will be set 20m from Cabbage Tree Road.	During construction and extraction of Section 9B	Quarry Manager	Nil
B	• The intersection design will include vegetated and landscaped batters to minimise the visibility of the sand quarry operations from Cabbage Tree Road.	During construction	Quarry Manager	Nil
C	• The quarry extraction area will be limited to the extent required to meet operational demand, with extracted areas to be progressively rehabilitated in conjunction with the advancing quarry extraction face.	During operations	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
6.3 IDENTIFICATION OF APPROVED LIMITS				

A	• As per Schedule 2, Condition 19, engage a registered surveyor to mark out the boundaries of the approved limits of extraction within the site. Pegs are to be steel of installed to a minimum 1.5 m height and painted in white or brightly coloured paint and installed at spacing that ensures the previous and next peg are within visible range.
	• Using the pegged survey boundary as the outer limit, clear using suitable mulching machinery the minimum width path achievable to clearly define the pegged boundary. The mulched path will be installed against the following requirements:
	  ○ Mulch vegetation only within the boundary of the resource area.
	  ○ Avoid trees with diameter at breast height of more than 100 mm.
	  ○ Avoid trees containing habitat hollows.
	• Using these pegs, a rope barricade with hi-vis bunting will be erected to delineate the resource boundary. This will be continuous for the entire perimeter of the boundary of the active resource area and on-site biodiversity offset area.
		One month prior to commencing quarrying operations, unless otherwise agreed with the Secretary	Quarry Manager	Resource survey plan of the boundary

B	• While quarrying operations are being carried out, ensure the boundary remains clearly marked at all times, in a manner that allows operating staff to clearly identify the approved limits of extraction.	As required, minimum maintenance frequency of 12 months.	Quarry Manager	AEMR summary of work completed.
C	• Install signage at regular intervals on the boundary of the disturbance area and offset area. Signage should note words to the effect “Biodiversity Offset Area, no unauthorised entry”	Prior to quarrying in adjacent areas.	Quarry Manager	Nil
D	• In addition to the above, a Frog Exclusion / sediment fence provides a clear delineated boundary of the resource and development boundary assisting operators and contractors of the edge of disturbance.	See below.	Quarry Manager	Nil
E	• Where access tracks continue from the Disturbance Area into the surrounding Offset Area suitable gates are to be installed across the tracks with suitable signage installed on the gate. Ability to go around the gate should be considered and where necessary install log barrels or fencing to keep vehicles to the track.	Where active quarrying intersects the access road.	Quarry Manager	Nil
F	• Install fauna signage at main entrance and either side of corridor, reminding drivers of the presence of wildlife and to adhere to site speed limits.	Ongoing	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
	• Install signage on perimeter of Project Area on adjoining access roads advising the presence of the offset area.			
G	• Install speed limit signage on quarry access roads.	Ongoing	Quarry Manager	Nil
6.4	**FROG EXCLUSION FENCE**			
A	• Sediment fence will be installed along the boundary of native vegetation areas for the purpose of excluding frogs from the active extraction areas that are stripped of vegetation and topsoil. Fencing may be relocated between each extraction area, where not required for erosion control. • The intent of the fence is to provide a barrier to discourage movement between the wetter ponded areas offsite and the quarry area. It is not intended to be perimeter fence.  *Example of frog exclusion fence*	**Construction -** install fence prior to or immediately following vegetation clearing. **Year 1 onwards** – install fence during December for the next 12 months of expected clearing.	Quarry Manager	Nil
B	• Remove frog exclusion fencing where not required for sediment control on completion of extraction activities to enable access to rehabilitated areas.	On completion of extraction where not needed for sediment control.	Quarry Manager	Nil
C	**<u>Frog Monitoring</u>** • Suitably qualified ecologist to undertake monitoring as necessary to report on the following:	Two discrete monitoring events per year following rainfall in peak breeding	Quarry Manager	Summary of findings presented in AEMR.

Item	Action	Trigger/Timing	Responsibility	Reporting
	○ Adequacy of frog exclusion fence in restricting frogs from accessing open active extraction areas. ○ Presence of *U. mahonyi* (and *C. tinnula*) within the Subject Land in at least two previously observed locations within the Subject Land.	(Spring to Autumn) season.		
6.5	**KOALA FENCE**			
A	**Koala fence** • Construct a Koala fence on the Subject Land boundary adjoining Cabbage Tree Road for Lot 1 DP 224587 to limit movement of Koalas from the site onto Cabbage Tree Road. • Construct a Koala fence from the site entry to the weigh bridge (where speed limit is 40 km/h). • The fence is to be comprised of '1500 -1800 mm x 50 mm x 50 mm galvanised mesh supported above ground by 60 mm galvanised pipe uprights at 3m intervals (BEC, 2019) • Two-way koala bridges will be required at approximately 200 m intervals (two total), with locations maximised around areas of preferred koala habitat (BEC, 2019). Two-way movement by koalas both into and out of areas such as those protected for preferred koala habitat. • Refer to **Appendix 4** for diagrams of the Koala bridge and correspondence with DPHI during construction.	During construction	Quarry Manager	Nil
B	**Koala fence monitoring** • Four infra-red cameras will be used to monitor the Koala fence and the one-way and two-way koala bridges during the breeding season (September to February) when Koalas are most active, for two years post-fence-construction. This will help inform future design of similar structures and demonstrate if the structures are effective, both for Koalas and other locally occurring fauna species.	Minimum of 60 days per breeding season for two years post construction of the fence.	Quarry Manager	Summary of findings presented in AEMR.
6.6	**SEED COLLECTION**			
A	• Seed will be collected by appropriately qualified contractor in advance of clearing activities for species determined likely to require direct seeding or propagation and	Prior to vegetation clearing / Annually, during appropriate	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
	determined to be required for direct seeding and propagation based on monitoring results.	season for target species		
B	• Seed will be stored under appropriate conditions.	At all times	Quarry Manager	Nil
6.7	**VEGETATION CLEARING**			
A	**Pre-clearance Survey** Confirmation and delineation of resource boundaries and extent of clearing. • Undertaken by suitably qualified contractor. • Habitat trees (containing hollows or nests) within the clearing area will be clearly marked using flagging tape or spray paint. Habitat trees are to be felled using the procedure outlined in **Section 6.7 G**. • Habitat trees (containing hollows or nests) within 3 m of the resource boundary will be marked for avoidance (where feasible), including the delineation of the tree drip line to limit compaction and excavation that may affect the tree. • Areas of noxious weeds or environmental weeds will be marked to avoid mixing of weed containing road with weed-free topsoil (see **Section 6.9**). • The following surveys will be conducted within the area proposed for removal within a one day period: o Nocturnal surveys will be conducted the night before clearing; and o Diurnal surveys will be conducted the morning of clearing, prior to commencement; and o The procedure for when a Koala is identified within the clearing area is outlined below. • Any occupied trees will be clearly marked and will be left during clearing (**Section 6.7 E**). Where a Koala is identified in a tree, the procedure outlined below will be followed.	Prior to clearing each sector	Quarry Manager	Nil
B	**Koala Protocol** The following procedure will be used if a Koala is identified as occupying a tree within the proposed clearing area. The aim of this capture and relocation procedure is to ensure that no Koalas are harmed during the vegetation clearing activities within the extraction area:	During clearing, if a Koala is identified	Quarry Manager	AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting

	• The Koala will be left to self-relocate, and clearing temporarily suspended in the immediate vicinity surrounding the individual.
	• Upon re-commencement of clearing in the area of the Koala sighting, a pre-clearance will be done to ensure that the Koala has moved on.
	• In the event that the Koala has not self-relocated and that clearing must commence:
	  ○ The individual will be captured by a suitably qualified contractor prior to the commencement of clearing.
	  ○ The individual will be given a veterinary check for any disease or illness.
	  ○ Any Koalas captured will be relocated into an area of retained vegetation adjacent to where it was originally located.
	  ○ All individuals will be monitored for a three-month period post relocation.
	• Where any Koalas are identified and captured for re-location, the following will be reported on:
	  ○ Location identified within the disturbance area, and location of relocation;
	  ○ Movement of the Koala will be mapped for the three-month period;
	  ○ Any instances where the Koala enters areas proposed for future clearing will be identified, and the need for further monitoring/action determined. If there is the potential for the individual to occur within areas of future vegetation clearing, a plan to ensure the individual is not impacted will be developed; and
	• The health of the individual will be checked at the end of the three-month period and any impacts (i.e. dog attacks, vehicle strikes, bushfire impacts, or disease) will be identified.			

C	• Koala fencing will be installed along the frontage of Cabbage Tree Road to limit vehicle strikes and be extended into the quarry along the access road to the weighbridge. Fauna bridges will be installed along the fence in the event Koalas (or other fauna) are trapped on the road side of the fence.	Fence installed prior to operations and maintained for project duration.	Quarry Manager	Incident Notification in event of vehicle strike
D	**<u>Clearing</u>** • All clearing (defined as removal of vegetation with a diameter at breast height exceeding 75mm, i.e. excludes slashing and trimming of tree branches for maintenance of perimeters or access tracks) will be supervised by a suitably qualified and licenced ecologist. and encourage movement of any displaced animals into adjoining vegetation.	During clearing	Quarry Manager	Summary of species relocated, including records of death or injury due to clearing in AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting

E	• Clearing will be undertaken predominantly by bulldozer (with exception to the Southern Resource Area – Sectors 9B, 10A, 10B, and 10C) and may be conducted in conjunction with topsoil removal.
	• Vegetation should be cleared in a way that maintains habitat linkages and allows fauna living in or near the clearing site to move safely from the site to adjacent areas:
	  ○ Clearing should occur towards connecting vegetation.
	  ○ The direction of clearing should also ensure that fauna are directed away from Cabbage Tree Road and the quarry spine road.
	  ○ Sequential clearing should not create an 'island' of habitat that is isolated from adjoining habitat by roads or cleared and disturbed areas.
	• Habitat trees will be left to stand for a period of **two nights** (see **Section 0**) and "soft-felled" under supervision of a suitably experienced fauna ecologist.
	• No clearing should occur during the early evening or at night (when fauna species are most likely to be on the move and are more vulnerable to injury).
	• Plants that are suitable for brush matting (and may be vulnerable to dropping seed during clearing) will be cut ahead of the quarry face and stockpiled on weed-matting or similar to ensure seed is not "lost" during clearing and can then be spread over topsoiled areas.
	• Large organic debris, and where possible, other vegetation cleared from the operational area will be stockpiled and spread on rehabilitated areas immediately after re-distribution of topsoil.
	• Vegetation stockpiling should maintain a minimum 10 m cleared asset protection zone around the stockpile to minimise fire risk in adjoining vegetation.
		During clearing	Quarry Manager	Area cleared reported in AEMR

F	**Fauna Displacement Protocol** Displacement of fauna may occur as part of the clearing process. All clearing will be supervised by a suitable qualified, experienced and licenced ecologist, the following protocol should be followed in case of an injured animal: • If possible, any fauna fleeing the clearing area should be captured and relocated or directed to a safe area outside the extraction zone during the tree removal process. • All fauna are to be handled in such a way as to prevent injury to the animal or the handler.	During clearing	Quarry Manager	Summary of species relocated, including records of death or injury due to clearing in AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting
	• Once the animal is safely handled it should be relocated or caged in a hessian bag or box and released at an appropriate time of day. • Any microbats or other nocturnal species captured during the tree removal process should be held in cotton or hessian bags and released at dusk on the same day as capture if possible. • If any animal is injured during the construction process, a veterinarian should be contacted immediately for professional advice on the best course of action. • If any native animal is injured during other operational/ construction processes while an ecologist, environmental representative or animal handler is not present, they must be contacted immediately.			

G	**<u>Habitat Tree Removal</u>**
	Habitat trees will be removed according to the following protocol:
	• Hollow bearing trees will be left standing for two nights after the surrounding vegetation has been cleared to encourage any native fauna species utilising the habitat hollows to self-relocate. The actual felling of any habitat trees will be attended by a suitably experienced fauna ecologist in order to ensure the safety of any fauna found to be in the hollows.
	• On all occasions, trees having potential habitat hollows will be 'soft felled' by an experienced machine operator. The recommended soft felling procedure is as follows:
	  ○ The hollow-bearing tree is given several moderate nudges with an excavator to give a warning to any occupying native fauna.
	  ○ The hollow-bearing tree is then surveyed, and native fauna given an opportunity to self-relocate before the tree is actually felled.
	  ○ The hollow-bearing tree is soft felled with the rate of the tree's fall controlled by the machinery operator to minimise impact.
	  ○ All hollows will be inspected for fauna and if any are found, the animal should be relocated at an appropriate time of day (i.e. dusk for nocturnal species). If the animal is injured, it will be taken to a local veterinarian.
	  ○ Suitable medium and large hollows should be cut from the tree at least one metre beyond the deepest point of the hollow and then stored in a dry safe place in size related categories for replacement in rehabilitated areas.
	The number and size of hollows within each habitat tree will be recorded after each habitat is felled. This information will inform the nest box installation works that will occur post extraction (**Section 6.11**).
		During clearing of habitat trees	Quarry Manager	Summary of species relocated, including records of death or injury due to clearing in AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting
6.8 RETAINED VEGETATION				
A	• The majority of vegetation outside the disturbance area is part of the onsite biodiversity stewardship agreement and will therefore be managed and maintained as part of the Biodiversity Offset Strategy (refer Kleinfelder 2016) and associated agreements with the BCT. • Vegetation to be retained within the Subject Land (shown under hatch in **Figure 2**), but outside the offset area (e.g. 20m corridor along Cabbage Tree Road west of the intersection) will be managed generally consistent with the Offset area including weed management and restriction of access.	Ongoing	Quarry Manager	Offset Reporting as required by BCT Vegetation management summarised in AEMR
6.9 TOPSOIL STRIPPING AND PLACEMENT				
A	Areas of 'weed contaminated' topsoil: • Refer to Section 6.18	Before and during topsoil removal and topsoil respreading	Quarry Manager	AEMR
B	Areas of 'clean' topsoil: • Soil (and vegetation) excavated during the initial block construction will be stockpiled within an area adjacent to the processing plant. The initial area of cleared vegetation and topsoil will be used to supplement other extraction areas over the life of the project that are deficient in organic matter. • Topsoil is to be transferred and respread directly over the previously quarried area as soon as it is extracted and no longer required for access (exhausted area). • Once an area is exhausted and becomes available for rehabilitation the floor of the mined area will be ripped, if it is hard, prior to redistribution of topsoil. • Direct topsoil transfer from an area ahead of the quarry face, to the recently exhausted area, will be utilised to facilitate the natural regeneration of plant species and limit the degradation of soil microbes.	During topsoil removal and topsoil respreading	Quarry Manager	Records of rehabilitation progress will be reported in AEMR
C	• Strip topsoil to 100 mm minimum depth (having regard to final landform floor levels of the quarried area needing to meet the required 1 m above groundwater – i.e. if operational floor is 0.7m above groundwater, 300mm of topsoil would be required to meet final landform requirements).	During topsoil removal and topsoil respreading	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
D	• Minimising stripping depths to avoid seed burial and taking two strips where possible ensuring respreading is sequential. Where topsoil is stripped at more than 150 mm thickness, topsoil will be stripped in two paths and re-laid in the original order.			Depth and area of topsoil stripping reported in AEMR.
E	• Avoiding stockpiling topsoil, in preference for direct transfer to rehabilitation areas where feasible.			Nil
F	• If a hard or indurated layer is present on the floor of the quarried area, the floor will be ripped prior to topsoil respreading.	Prior to topsoil placement	Quarry Manager	Nil
G	• Respread topsoil to a minimum thickness of 100 mm, noting the need to achieve a final land form of 1 m above groundwater).	During topsoil placement	Quarry Manager	Nil
H	• Fines recovered from the wash plant will be integrated within the rehabilitation areas as an addition to the topsoil, or blended with sand to form a suitable sandy loam. The fines are a dark brown material containing organic material and silts. The material is initially heavily structured as a result of flocculant and coagulants (similar to those used in drinking water systems) in the wash process and requires blending with sand. This structured material breaks down (as the flocculant and coagulant break down) and is typically not visible within 6-12 months of application. Key controls in the application of this material are: o Avoid solid layers of fine material in rehabilitated areas, these are likely to reduce natural germination and increase rehabilitation costs. o Prior to offsite sale of the material, adequate characterisation of the material should be completed consistent with the relevant EPA guidelines. o Where PFAS monitoring (undertaken in the SWMP) identifies PFAS concentrations exceed trigger levels, a suitably qualified specialist will be engaged to review the following: ▪ Concentrations of PFAS in soils relative to applicable guidelines. ▪ Determine if additional testing if necessary. ▪ Consider the suitability of intended usage of fines (onsite or offsite) relative to the concentration and available criteria at that time. ▪ Consider if any remediation or management is beneficial in areas of existing fines usage.	During fines / topsoil placement or sale of fines	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
6.10 OPERATIONAL LEVELS AND FINAL LANDFORM *Also refer to the **Maximum Extraction Depth Report** for methodology on maintaining quarry floor levels.*				
A	• Quarry floor levels to be established on weekly basis.	Weekly	Quarry Manager	Nil
B	• Quarry floor levels to be reviewed on completion of quarrying to confirm required topsoil strip depth.	On completion of sector	Quarry Manager	AEMR
C	• Independent registered surveyor to undertake audit.	3 months	Quarry Manager	AEMR
D	• Operational floor of quarry to be no less than 0.7 m above highest predicted groundwater level.	At all times	Quarry Manager	AEMR
D	• Operational floor of quarry to be no less than 0.7 m above highest predicted groundwater level. Level relative to thickness of topsoil removal, i.e. if topsoil stripping is less than 0.3 m than the operational floor level must be increased accordingly such that replacement of topsoil achieves final landform requirement of 1 m above highest predicted groundwater level.	At all times	Quarry Manager	AEMR
E	• Final landform, including topsoil to be not less than 1 m above highest predicted groundwater level.	Upon completion of final landform shaping	Quarry Manager	AEMR
6.11 NEST BOX INSTALLATION				
A	**Survey** • Survey for hollow bearing trees proposed for removal in the following 12 months will be completed recording the number and size of hollows to be removed. Based on this survey, a 1:1 replacement of nest boxes will be installed along the outer fringe of the adjacent vegetated areas prior to clearing that vegetation. • The size, location, likely species use will be recorded for Rehabilitation Enhancement phase.	12 months prior to clearing where feasible.	Quarry Manager	AEMR
B	**Nest box and Hollow Installation - General** • Installed to a minimum three (3) m height above ground. • Installed so as to not directly face towards the quarry extraction areas. Hollows will ideally face towards the south, shielded from sunlight by the tree trunk. Small	All nest box installations	Quarry Manager	AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting

	hollow suitable for microbats may face in a westerly to north-westerly direction to allow for thermoregulation prior to bats exiting the hollow at dusk. Salvaged tree hollows will need also need to account for exposure to night-time light sources and the predominant aspects of severe storms.
	• Installed using the Habisure system (or equivalent).
	• The following information will be recorded during the installation of nestboxes and relocated hollow-bearing limbs:
	  ○ Nestbox Number.
	  ○ Nestbox Type (i.e. salvaged hollow, artificial).
	  ○ Target species.
	  ○ GPS location.
	  ○ Nestbox / Hollow height and orientation.
	  ○ If installed on existing tree – tree species and DBH.
	• Damaged hollows, deemed to retain some habitat value by the ecologist onsite during cleared, may be retained as ground habitat within the surrounding offset area.			

C	**<u>Pre-clearing installation – in surrounding vegetation</u>**
	• Nest box design will be selected to replace the natural size of removed hollows. The number and type of next boxes to be installed will be determined during surveys of hollow-bearing trees felled during clearing (approx. 99 hollows).
	• Where possible, hollows will be reinstated on trees within the onsite offset areas Subject to Stewardship Agreement), installed in accordance with the PSC *Technical Specification – Nestboxes* (2014). Hollows will not be installed on the following trees:
	  ○ The host tree is identified as a tree of cultural significance.
	  ○ The host tree is a preferred koala feed tree species.
	  ○ The host tree already contains hollows, a nest box or a salvaged hollow.
	  ○ The host tree is not located in suitable feeding habitat for target fauna species.
		6-12 months prior to clearing that sector where feasible.	Quarry Manager	AEMR

D	**<u>Rehabilitation Area Installation</u>** • At approximately Year 5 of rehabilitation, once vegetation has reached an estimated 3 m in height, any additional nest boxes (or salvaged hollows) will be installed within the rehabilitation areas.	After 5 years of rehabilitation growth within each Sector Rehabilitation (where	Quarry Manager	AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting
	• In the rehabilitation area nest boxes (or salvaged hollows) will be installed on wooden poles at an approximate height of 3 m within the rehabilitation area. • Hollows removed during clearing will be replaced with nest boxes (or salvaged hollows) at a ratio of 1:1 within the rehabilitation area, where possible the hollow distribution will match pre-existing distribution or be placed to improve hollow distribution. • Where feasible, hollows harvested from the site will be used in place of constructed boxes.	hollows were present).		

E	**Nest-box Monitoring and Replacement**
	• Complete nest box monitoring as per Section 8.1, including:
	  ○ 3 month post installation inspection to ensure installation is suitable.
	  ○ Annual inspection of nest box habitation and structural adequacy.
	  ○ On completion of quarrying, for an inspection for structural adequacy.
	• Where nest box is occupied by feral animal, remove where possible and seek suitably qualified person to humanely euthanise animal.
	• Where nest box is not structurally suitable, replace nest box with suitable alternative.
		As stated:
		• Three months post installation.
		• Annually.
		• At completion of quarrying.
			Quarry Manager	Summary within AEMR

6.12 TEMPORARY STABILISATION METHODS				

A	• Areas within the quarry that meet the assigned trigger, will have one or a combination of the following methods applied to minimise dust generation and erosion of exposed surfaces:
	  ○ Application of a polymer stabiliser approved by HWC for use in the Tomago Sand Beds – suitable for up to 6 months depending on product.
	  ○ Site won mulch, created during isolated campaigns with noise monitoring to verify suitable conditions for use – suitable for up to 6 months.
	  ○ Site won timber and brush matting of native species.
	  ○ Geofabric or Biodegradable matting – suitable for 6 to 24 months.
		Non-operational (i.e. for more than 20 days) exposed sand area with contiguous area above 1,000m^2.	Quarry Manager	AEMR

6.13 PLACEMENT OF VEGETATION, TIMBER AND BRUSH MATTING				
A	• Where possible, individual plant species (especially *Leptospermum*, *Melaleuca* and *Eucalyptus* species) will be harvested when they are bearing mature seed	Annually in autumn and late spring or as	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
	rather than immediately prior to clearing. Bradysporous (seed retaining) species are best harvested and spread in autumn whereas Geosporous (seed shedding) species are best harvested immediately prior to annual seed release in late spring. • Suitably Qualified Contractors to coordinate seed collection.	targeted species are suitable for collection		
B	• Distribution of all stockpiled vegetation will occur following the respreading of topsoil up to a maximum of 20% ground cover by woody debris (woody debris is considered greater than 10 cm diameter). The re-laid vegetation will comprise branches and timber of all sizes including leaves and stems of shrubs and grasses. • The placement of large timber should have regard to its orientation for the purpose of the capture of wind-blown sand and delay of runoff. Generally, this means an orientation along the north-east to south-west vectors, perpendicular to dominant onshore and off-shore winds. Some timber should also be positioned along the contour in sloping areas and partially below ground where branching can protrude above the ground. • Where timber is considered to be at a density that is likely to prohibit the achievement of required native cover, the timber should be stockpiled for use in other areas of rehabilitation where cover is lower; OR, • Where timber is considered to be at a density that is likely to prohibit the achievement of required native cover, a maximum of two wood piles per hectare can be installed to provide fauna habitat, piles should be no more than 2m – 6m in diameter and 2-4m tall (so as not to create unstable structures) and may or may not have a taller stem protruding to provide perching if this able to be firmly anchored. • Placement of timber must be consistent with requirements for fuel loads within Asset Protection Zones (see Section 6.17B), within landscaped areas around the office and workshop area.	During placement of woody debris and brush matting.	Quarry Manager	Nil
6.14 DIRECT SEEDING				
A	• Common pioneer species (i.e. *Acacia* species and *Actinotus helianthi*) and others will usually regenerate from topsoil or brush matting and direct seeding is not required. Where monitoring shows a deficiency in a particular species they will be introduced through direct seeding.	Where monitoring shows failure of species to regenerate	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
		by topsoil or brush matting.		
B	• Locally sourced seed will be used and will be sown in the soil rather than broadcast. Harvesting of mature seed and direct sowing into re-topsoiled areas at the most appropriate time of year (usually autumn or spring) will be undertaken for species that typically do not readily regenerate from the soil seedbank, such as *Eucalyptus*, *Angophora*, *Banksia* and *Xanthorrhoea*.	Annually in autumn and late spring as required.	Quarry Manager	Summary of seeding undertaken including timing, location and species sown reported in AEMR.
6.15 PROPAGATION AND REPLANTING				
A	The focus of propagation is to: • Introduce to the rehabilitation the dominant structural species that have difficulty establishing from topsoil, brush matting, or direct seeding or other recalcitrant species. • Provide advanced species that are desired for establishment in strategic locations or densities to achieve the revegetation objectives. • Propagation will be undertaken by a local wholesale nursery.	Where monitoring shows failure of species to regenerate by direct seeding or other means.	Quarry Manager	Summary of species provided to nursery for propagation reported in AEMR.
B	• Where targeted species do not regenerate through the topsoil seedbank or direct seeding, tubestock will be planted within the rehabilitation. Planted tubestock will be "watered in" to ensure initial establishment.	In autumn (for optimum success), as required	Quarry Manager	Summary of species planted and location reported in AEMR.
6.16 TRANSPLANTING				
A	• Transplanting will be a valuable method of revegetation for certain species (outlined in **Table 9**). • The plants will be excavated with a front-end loader, excavator (or similar) retaining as much soil around the roots as possible • The plant will then be moved to a prepared hole and watered in where possible. • For mature *Xanthorrhoea* species (Grass Trees), these will be burnt (where weather and conditions permit). Burning the shirt of dead leaves and some of the lower green leaves is important to stimulate new growth and flowering.	As required, during rehabilitation	Quarry Manager	Summary of species planted and location reported in AEMR.

Item	Action	Trigger/Timing	Responsibility	Reporting
6.17 SPECIES COMPOSITION AND STRUCTURE				

A	• Rehabilitation will aim to achieve the species composition and structure of the following communities:
	  ○ Smooth-barked Apple – Blackbutt Forest and Coastal Sand Wallum Woodland-Heath.
	  ○ Canopy species of the adjoining Swamp Mahogany – Paperbark Swamp Forest will supplement rehabilitation in areas where this community adjoins the rehabilitation area.
	• The composition of the rehabilitation will aim to meet the performance criteria in **Section 9.1** and ultimately the completion criteria in **Section 9.2**.
		When undertaking rehabilitation	Quarry Manager	Nil – rehabilitation monitoring will record composition.

B	• **Landscaping Areas** – will include species composition and structure that will aim to establish native ground cover and shrub species that are consistent with requirements for fuel loads within Asset Protection Zones (e.g. maintained, minimal wood debris, discontinuous patches of the shrub layer, no canopy species within 10 m of building and where present do not have connected canopy with adjoining vegetation).	For landscaped areas	Quarry Manager	Nil
6.18 WEED AND DISEASE CONTROL				
A	**Vehicle, machinery and personnel weed and disease hygiene** • All machinery introduced to the site (excluding road haulage trucks) will be cleaned of all soil and organic matter prior to entering the Site. • Road registered haulage vehicles are required to remain on the formed access roads and include induction for drivers on need for trucks to be cleaned of loose mud, dirt and organic matter prior to entering the site. Where visible mud or organic matter is present on road registered truck, Quarry Manager to remind driver of need for cleaning before entry. • Personnel or contractors entering the site will be reminded during inductions of need to enter the site with clothing, boots and PPE free of potential pathogens from other properties.	Ongoing	Quarry Manager	Induction records

Item	Action	Trigger/Timing	Responsibility	Reporting
B	**Access tracks and vectors for spread** • Personnel and contractors working onsite are not permitted to access areas outside the quarry disturbance area without authorisation. With the drainage and elevation of the quarry area this ensures limited access to swampy areas where pathogen spread is more likely. • Vehicle access to the rehabilitation will be restricted to authorised personnel only. • Once access tracks are no longer required they will be revegetated to minimise their potential as weed vectors.	Ongoing	Quarry Manager	Nil
C	**Inspections and monitoring** • During monitoring of the rehabilitation, surveys will include recording for the presence and type of weeds, including non-local native species within the site. Inspections will include focus on the outer perimeter of the current disturbance (i.e. interface with conservation areas) and the verges of internal access roads. • Surveys will include visual monitoring for potential plant diseases such as Myrtle Rust and evidence of declining plant health potentially due to *Phytophthora cinnamomi* (i.e. root rot fungus). If *Phytophthora cinnamomi* is suspected, testing will be undertaken to verify presence. • Fauna surveys will report any observations in fauna relating to disease, e.g. Amphibian Chrytrid Fungus.	During rehabilitation and/or frog monitoring	Quarry Manager	Key details included in AEMR

D	**When disease is identified**
	• The following management measures will be implemented as applicable when the relevant disease is identified onsite:
	  ○ All personnel will adhere to the 2015 Commonwealth Government Guidelines *Arrive Clean, Leave Clean, Guidelines to help prevent the spread of invasive plant diseases and weeds threatening our native plants, animals and ecosystems* (Arrive Clean, Leave Clean Guideline) to control potential site infestation by environmental pathogens such as *Phytophthora cinnamomi* and Myrtle Rust.
	  ○ All personnel will adhere to the NSW Office of Environment and Heritage (OEH – formerly NSW Department of Environment and Climate Change) guideline *Hygiene protocol for the control of diseases in frogs* (Frog Hygiene Guideline) to manage potential introduction and spread of *Batrachochytrium dendrobatidis* (Amphibian Chrytrid Fungus).
		Implemented as applicable when the relevant disease is identified onsite.	Quarry Manager	Incident Reporting / Key details included in AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting
E	**Weed-infested topsoil handling** Pre-clearing surveys: • Pre-clearance survey to record approximate cover and abundance of environmental weeds within each area to be cleared. • Where infestations of environmental weeds occur, they will be mapped and pegged as a "weed area" prior to clearing to allow for separate stockpiling and re-spreading. For practicality purposes during clearing and topsoil stripping, weed infestations greater than 100 m^2 (i.e. 10 m x 10 m) will be delineated and pegged.	Prior to clearing of each sector	Quarry Manager	Key details included in AEMR
F	• Topsoil containing environmental weeds (as delineated in pre-clearance) will stockpiled separately and will not be blended or stockpiled with "clean" (weed-free) topsoil. • Topsoil stockpiles containing environmental weeds will be respread within a mapped "weed area" similar to its pre-disturbance location to avoid weed spread across the site. • Weed containing topsoil will not be transported between the Southern and Northern Resource areas. • The extent of respread topsoil with environmental weeds will be delineated and recorded.	When clearing, stockpiling and respreading topsoil.	Quarry Manager	Key details included in AEMR
G	**Weed control** Weed management will be conducted by a suitably qualified contractor with a focus on the recommendations made as a result of rehabilitation monitoring and inspections. Control of weeds will predominantly be through manual removal to limit the use of chemicals. Chemical controls will only be utilised where there are significant outbreaks.	When required, as identified during monitoring events	Quarry Manager	Key details included in AEMR
6.19 PEST CONTROL				
A	All putrescible waste bins to be securely covered and removed from the site on a weekly basis to remove potential food source for vermin.	Ongoing	Quarry Manager	AEMR annual waste generation
B	Undertake monitoring for presence of pests through one of the following methods: • Conducting searches and spotlighting, and mapping evidence of pest species across Project Area (e.g. rabbit warrens, pig scratching, evidence of wild dogs).	Annually	Quarry Manager	Summary of results in AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting
	• Installing remote motion sensing camera traps at a minimum of five locations across the Project Area for a two-week period. The presence of domestic or wild cats and dogs within the central wildlife corridor (consistent with PSC lease conditions) will be included within the program.			
C	Recording of incidental observations for evidence of pests and where suspected to be domestic and (if considered safe to do so) are to be captured and reported to PSC and returned to the owner if known or animal shelter if unknown.	Opportunistically	Quarry Manager	Summary of results in AEMR
D	Where detected during monitoring, implement a pest control program to reduce vertebrate pest numbers where there is potential for impacts on native wildlife and rehabilitation. The program is to have regard for the presence of domestic animals and return these to the owners where captured. The vertebrate pest control program is to be conducted: • In consultation with the LLS and adjoining landholders. • In accordance with the 'EPBC Act Policy Statement 3.4 – Significant Impact Guidelines for the Endangered Spotted-tailed Quoll *Dasyurus maculatus maculatus* (Southeastern Mainland Population) and the use of 1080' and the 'Administrative Guidelines on Significance: Supplement for the Tiger Quoll (Southeastern Mainland Population) and the use of 1080'. • In accordance with Humane Pest Animal Control: Codes of Practice (DPI 2014). • By suitably qualified and experienced personnel. • Other control methods such as shooting or trapping can also be used if deemed necessary or appropriate with advice from BCD or the LLS. Given the proximity of residential properties baiting programs may not be appropriate.	Within three months of an observation with potential for impacts.	Quarry Manager	Summary of results in AEMR
6.20 BUSHFIRE MANAGEMENT				
A	The proposed final landform will provide improved access for emergency vehicles in the event of bushfire.	Ongoing	Quarry Manager	Nil

Item	Action	Trigger/Timing	Responsibility	Reporting
6.21 EROSION AND SEDIMENT CONTROL				
A	Erosion and sediment control measures will be implemented for the duration of quarry operations in line with the Soil and Water Management Plan for the project.	Ongoing	Quarry Manager	Refer to Soil and Water Management Plan
6.22 MONITORING AND COMPLIANCE				
A	Monthly Environmental Inspections for project to include review of Biodiversity and Rehabilitation Management measures in this section.	Monthly	Quarry Manager	Internal / Summary in AEMR
B	Frog monitoring as per 6.4 C above.	Two discrete monitoring events per year following rainfall in peak breeding (Spring to Autumn) season.	Quarry Manager	Summary in AEMR
C	Koala Fence monitoring as per 6.5 B above.	Minimum of 60 days per breeding season for two years post construction of the fence.	Quarry Manager	Summary in AEMR
D	Weed and disease monitoring as per Section 6.22 C above.	During rehabilitation monitoring and frog monitoring.	Quarry Manager	Summary in AEMR
E	Pest monitoring as per 6.23 B above.	Annually.	Quarry Manager	Summary in AEMR
F	Koala monitoring as per Section 6.8	In event Koala found onsite.	Quarry Manager	Summary in AEMR
G	Nest box and hollow monitoring as Per Section 6.15 E and Section 8.1.	As stated: • Three months post installation. • Annually.	Quarry Manager	Summary within AEMR

Item	Action	Trigger/Timing	Responsibility	Reporting
		At completion of quarrying.		
H	Six monthly (bi-annual) monitoring of rehabilitation for the first three years consistent with methodology in Section **8.1** and assessed against the performance criteria in **Section 9.1**.	Bi-annually for first three years post-rehabilitation of each sector.	Quarry Manager	AEMR
I	Post three years rehabilitation sectors will have three monitoring events; at years four or five and eight post-rehabilitation, consistent with methodology in **Section 8.4** and assessed against the performance criteria in **Section 9.1**. The Eight year monitoring event will also be compared against the completion criteria outlined in **Section 9.2**.	Annually, at years 4, 5 and 8 post-rehabilitation.	Quarry Manager	AEMR
J	Three-yearly Independent Environmental Audits as per Section 6.3 of the Project EMP.	Three-yearly	Quarry Manager	Audit Report
6.23 INCIDENT INVESTIGATION AND CORRECTIVE ACTIONS				
A	Where monitoring suggests the rehabilitation is not meeting performance criteria implement actions as defined in **Section 9.1.**	Failure to achieve performance criteria	Quarry Manager	Summary of corrective actions employed and results in AEMR
B	Where monitoring, landowner complaint, or observation suggest the project has failed to adhere to the controls in this plan, the following sequence of investigations and controls will be applied: • The nature of the complaint and non-compliance. • The impacts due to the non-compliance. • Review the details of non-compliance including the weather, operational activities at the time. • If due to failure of equipment or failure to follow controls, undertake corrective actions to prevent recurrence. • If non-compliance not as a result of failure, review and refine controls and procedures. • If a non-compliance has occurred, additional monitoring will be undertaken following implementation of relevant additional management controls listed above.	Complaint or observation of non-compliance with plan	Quarry Manager	Incident Investigation and Corrective Actions Report provided to DPHI within 7 days of event.

Item	Action	Trigger/Timing	Responsibility	Reporting
6.24 COMPLAINTS				
A	All complaints will be recorded within the Complaints Register.	Receipt of complaint	Quarry Manager	Complaints Register Summary in AEMR.
6.25 CONTINUOUS IMPROVEMENT				
A	All controls in this plan will be reviewed and if necessary, revised to confirm their applicability on an ongoing basis throughout the life of the Project and ensure continual improvement of management practices. In addition the following circumstances will require review of this plan: • Internal monthly compliance inspections. • Non-compliance with criteria. • Annual review. • Modifications of the Consent • Audit Report.	Annually at a minimum	Quarry Manager	Summary in AEMR

7. REHABILITATION METHODOLOGY

To aid in the re-establishment of native vegetation over the extraction area a combination of methods will be utilised. Initially topsoil will be distributed over the exhausted areas; a significant number of species will naturally regenerate from the topsoil seedbank. Where certain species are lacking (i.e. major structural species) or are known to not readily regenerate from the topsoil several different methods will be utilised to re-introduce these species. Baseline survey data will be collected prior to clearing that will define species and target plant densities for the key vegetation types adjusted as necessary from recommendations from subsequent monitoring events.

All rehabilitation activities during quarry operations and their management measures are outlined in **Section 6**. Where applicable, detailed rehabilitation methodology are presented below.

7.1 SPECIES SELECTION AND REVEGETATION METHOD

A large portion of the Project Area has been subject to past disturbance and rehabilitated with a broad range of species characteristic of vegetation in the adjoining Subject Land and the broader Tomago Sand Beds. Past rehabilitation in addition to respreading of 300 mm of the topsoil, included a combination of methods from direct seeding (with a composite seed mix from the local area), to more targeted planting of tube stock species that were likely to exist pre-disturbance. This history is the likely reason for the presence of *Eucalyptus signata, Eucalyptus parramattensis subsp. decadens* and *Eucalyptus camfieldii* within communities that would be more commonly dominated by *Angophora Costata*.

A list of indicative species that regularly occur across Coastal Sand Apple – Blackbutt Forest and Coastal Sand Wallum Woodland-Heath vegetation communities is provided in **Table 9**. This list is based on quadrat data collected by Kleinfelder (full species list in the Ecological Summary Report (Kleinfelder 2016)). Overstorey species of the Swamp-Mahogany-Broad-leaved Paperbark community will be included as an opportunity exists to broaden the existing ecotone from the interface with these communities. This ecotone is typically well defined where topography increases rapidly, however with the removal of the dunes an opportunity exists to broaden the ecotone of this important community, that is considered preferred koala habitat.

A number of key species for rehabilitation have been highlighted in **Table 9**. These 'key species' are indicative species of the targeted vegetation communities for the rehabilitation, and their presence will be specifically monitored (**Section 6**) to ensure the rehabilitation is achieving its performance indicators (**Section 9.1**) and completion criteria (**Section 9.2**).

The recommended choice of rehabilitation methods for particular plant species is summarised in **Table 9** (re-establishment mode provided in order or preference). This Table will be used as a guide to vegetation rehabilitation. Actual methods of rehabilitation may be modified or varied in response to the results of monitoring surveys as detailed in **Section 8**.

The rehabilitation method proposed through direct respreading of topsoil and transfer of cleared vegetation over the topsoil should improve the success of both the species that store seed in woody fruits/capsules on the branches or canopy of the parent plant (bradysporous species) and for the species that build up a seed bank within the topsoil (geosporous).

Methods of re-establishment are listed below and are abbreviated as follows:

- **R** Regenerates from topsoil
- **B** Brush matting
- **D** Direct Seeding
- **P** Propagation
- **O** Organic Screenings (from processing)
- **T** Transplanted specimens

Table 9: Typical species present within target vegetation communities

Stratum	Scientific Name	Common Name	Re-establishment Mode
# Indicative key target species for rehabilitation			
Note: this is not exhaustive or prescriptive (i.e. all species shown should not be present within all areas).			
Ground	#*Actinotus helianthi*	Flannel Flower	R
Ground	*Dianella caerulea*	Blue Flax-lily	T, R
Ground	*Entolasia stricta*	Wiry Panic	R
Ground	*Gonocarpus teucrioides*	Raspwort	R
Ground	*Hardenbergia violacea*	Purple Coral Pea	R, O, P
Ground	*Imperata cylindrica*	Blady Grass	R
Ground	*Leptocarpus tenax*	Slender Twine rush	R, T
Ground	#*Lomandra glauca*	Pale Mat-rush	T, R
Ground	#*Lomandra longifolia*	Spiny-headed Mat-rush	T, R
Ground	*Pandorea pandorana* subsp. *pandorana*	Wonga Wonga Vine	R, D, P
Ground	*Pomax umbellata*	-	R
Shrub	*Pteridium esculentum*	Common Bracken	R
Ground	*Ptilothrix deusta*	-	R
Ground	*Schoenus ericetorum*	Heath Bog-rush	R
Shrub	#*Acacia longifolia* subsp. *longifolia*	Sydney Golden Wattle	R, O
Shrub	*Acacia suaveolens*	Sweet Wattle	R, O
Shrub	*Acacia terminalis*	Sunshine Wattle	R, O
Shrub	#*Acacia ulicifolia*	Prickly Moses	R, O
Shrub	*Actinotus helianthi*	Flannel Flower	R
Shrub	*Amperea xiphoclada* var. *xiphoclada*	Broom Spurge	R

Stratum	Scientific Name	Common Name	Re-establishment Mode
[#] *Indicative key target species for rehabilitation*			
Note: this is not exhaustive or prescriptive (i.e. all species shown should not be present within all areas).			
Shrub	*Aotus ericoides*	Golden Pea	R, B
Shrub	*Astroloma pinifolium*	Pine Heath	R, P
Shrub	*Banksia oblongifolia*	-	B, D, P
Shrub	[#]*Bossiaea heterophylla*	Variable Bossiaea	R
Shrub	*Comesperma ericinum*	Pyramid Flower	R
Shrub	*Conospermum taxifolium*	Variable Smoke-bush	R
Shrub	[#]*Dillwynia retorta*	Small leaf Parrot pea	R, O
Shrub	[#]*Eriostemon australasius*	Pink Wax Flower	R, T
Shrub	*Gompholobium latifolium*	Golden Glory Pea	R, O
Shrub	*Haemodorum planifolium*	-	R
Shrub	*Hibbertia fasciculata*	-	R
Shrub	[#]*Hibbertia linearis*	Guinea Flower	R
Shrub	*Isopogon anemonifolius*	Broad- leaf Drumsticks	R
Shrub	*Lambertia formosa*	Mountain Devils	R, P
Shrub	[#]*Leucopogon ericoides*	Pink Beard-heath	R
Shrub	*Leucopogon esquamatus*		R
Shrub	*Leucopogon juniperinus*	Prickly Beard-heath	R
Shrub	*Leucopogon lanceolatus* var. *lanceolatus*	-	R
Shrub	*Macrozamia communis*	Burrawang	T, P, D
Shrub	*Marsdenia suaveolens*	Scented Marsdenia	R
Shrub	*Micromyrtus ciliata*	Heath- myrtle	R, P
Shrub	*Monotoca scoparia*	Prickly Broom heath	R
Shrub	*Pimelea linifolia* subsp. *linifolia*	Slender Rice-flower	R
Shrub	*Platysace ericoides*	-	R
Shrub	[#]*Ricinocarpos pinifolius*	Wedding Bush	R
Shrub	*Tetratheca thymifolia*	Thyme Pink-bells	R
Shrub	*Woollsia pungens*	Woollsia	R
Shrub	*Xanthorrhoea glauca*	Austral Grass Tree	T, P, D
Mid-Storey	[#]*Banksia aemula*	Wallum Banksia	P, D
Mid-Storey	[#]*Banksia serrata*	Old Man Banksia	P, D
Mid-Storey	*Leptospermum polygalifolium* subsp. *cismontanum*	Tantoon	B, P
Mid-Storey	[#]*Leptospermum trinervium*	Flaky-barked Tea-tree	B, P
Mid-Storey	*Melaleuca nodosa*	Prickly- leaved Paperbark	R, B, D, P
Mid-Storey	*Monotoca elliptica*	Tree Broom-heath	B, R, P

Stratum	Scientific Name	Common Name	Re-establishment Mode
# *Indicative key target species for rehabilitation*			
Note: this is not exhaustive or prescriptive (i.e. all species shown should not be present within all areas).			
Mid-Storey	*Persoonia lanceolata*	Lance Leaf Geebung	R
Mid-Storey	*Persoonia levis*	Broad-leaved Geebung	R
Over-storey	#*Angophora costata*	Smooth-barked Apple	B, D, P
Over-storey	#*Corymbia gummifera*	Red Bloodwood	B, D, P
Over-storey	#*Eucalyptus camfieldii*	Camfield's Stringybark	B, D, P
Over-storey	#*Eucalyptus parramattensis subsp. decadens*	Parramatta Red Gum	B, D, P
Over-storey	#*Eucalyptus piperita*	Sydney Peppermint	B, D, P
Over-storey	#*Eucalyptus signata*	Scribbly Gum	B, D, P
Over-storey	*Eucalyptus robusta*	Swamp Mahogany	B, D, P
Over-storey	*Melaleuca quinquenervia*	Broad-leaved Paperbark	B, D, P,

7.2 KOALA FEED TREES

A focus on the revegetation of species that are preferred Koala feed trees will occur where appropriate habitat for these species occurs in the final landform, with the whole rehabilitation area being returned to supplementary or preferred Koala habitat. This will aim to encourage Koalas into the post extraction landscape.

Table 10: Tree species important for Koalas proposed for rehabilitation

Scientific Name	Common Name	Source
Angophora costata	Smooth-barked Apple	Potentially important in LGA (CKPoM)
Corymbia gummifera	Red Bloodwood	Potentially important in LGA (CKPoM)
Eucalyptus piperita	Sydney Peppermint	Potentially important in LGA (CKPoM)
Eucalyptus robusta	Swamp Mahogany	Preferred feed tree in LGA (CKPoM) Primary feed tree on North Coast (Recovery Plan) Feed tree (SEPP 44)
Eucalyptus signata	Scribbly Gum	Feed tree (SEPP 44)
Melaleuca quinquenervia	Broad-leaved Paperbark	Potentially important in LGA (CKPoM)
Eucalyptus parramattensis subsp. decadens	Parramatta Red Gum	Preferred feed tree in LGA (CKPoM)
Eucalyptus camfieldii	Camfield's Stringybark / Heart-leaved Stringybark	Supplementary in 2013 Lower Hunter Koala Study.

7.3 REVEGETATION METHODS

7.3.1 Direct Seeding

Locally sourced seed will be used. Harvesting of mature seed and broadcast seeding into re-topsoiled areas at the most appropriate time of year (usually autumn or spring) will be undertaken for species that typically do not readily regenerate from the soil seedbank, such as *Eucalyptus*, *Angophora*, *Banksia* and *Xanthorrhoea*.

Common pioneer (i.e. *Acacia* species and *Actinotus helianthi*) will usually regenerate in abundance and direct seeding is not required. If for any reason they don't germinate within areas of the rehabilitation; they can be introduced in this way.

7.3.2 Brush Matting

Rehabilitation will be facilitated by spreading brush matting composed of plant material cut ahead of the quarry face and spread in a thick layer over the rehabilitation areas. Large branches and whole plants are preferred for matting because they will not move in the wind. Brush matting facilitates direct seeding, provides a protected microclimate for developing seedlings, and adds nutrients to the soil.

Where possible individual plant species (especially *Leptospermum*, *Melaleuca* and *Eucalyptus* species) will be harvested when they are bearing mature seed rather than immediately prior to clearing. Bradysporous (seed retaining) species are best harvested and spread in autumn whereas geosporous (seed shedding) species are best harvested immediately prior to annual seed release in late spring.

7.3.3 Propagation and Replanting

The focus of propagation is twofold:

- Dominant structural species that have difficulty establishing naturally or recalcitrant species, and
- Species that are desired for establishment in strategic locations or densities to achieve the revegetation objective.

Seed will be collected locally and supplied to a wholesale nursery for propagation, or alternatively, will be propagated at a local nursery. Planting programs will occur in autumn for optimum seedling establishment success.

7.3.4 Transplanting

Transplanting of will be a valuable method of revegetation for certain species (outlined in **Table 9**). The transplanting efforts will focus on mature *Xanthorrhoea* and *Macrozamia* species as they do not readily germinate from the topsoil seedbank. The methodology for transplanting the species is outlined in **Section 6.16**.

8. MONITORING

8.1 COMPENSATORY HABITAT MONITORING

The proposed monitoring of compensatory nestboxes has been developed with regard to the PSC *Technical Specification – Nestboxes* (2014) with adjustments developed commensurate with the approval proposed offset strategy.

Specifically the following monitoring will be completed:

- 3 month post-installation inspection to ensure installation is suitable.
- Annual inspection of nest box habitation and structural adequacy.
- On completion of quarrying, inspect for structural adequacy.

Monitoring will be undertaken by a suitably qualified person. Monitoring will be undertaken using a wireless GoPro™ camera mounted on an extension pole (or similar) capable of reaching heights of over 4 m. This will produce a live video feed that will be captured in the field but may be processed offsite. A handheld Global Positioning System (GPS) will be used to verify box identification. If a box is found to be occupied by native fauna, ecologists will further record potential signs of fauna use including the presence of hair, scats or nesting material.

Feral fauna utilising nest boxes will be captured (if possible) and euthanised by suitably qualified person.

Where nest boxes are damaged, unstable or deemed unsuitable for habitation by native fauna the box will be removed and replaced by a nest box (or hollow) of similar size in the same location.

Monitoring results and nest box replacement will be recorded and summarised within the AEMR.

8.2 MONTHLY INSPECTIONS

Monthly Environmental Inspections will be undertaken for the project to confirm compliance with management plans, including this Biodiversity and Rehabilitation Plan.

Inspections will be conducted by the Quarry Manager or delegate and will assess implementation of management measures in **Section 6.**

8.3 BI-ANNUAL MONITORING

The following monitoring methodology will be conducted every six months (bi-annually) across each sector post rehabilitation for a period of three years.

8.3.1 Plot monitoring

Each sector will have points overlaid in a grid fashion at approximately 15 m intervals using a GIS program; these points represent a single sample plot, each 2 x 2 m (4 m^2). The plot points will be confirmed in the field during the first monitoring event, to ensure each point occurs within the extraction area. These confirmed points will be retained and used for following monitoring events until completion after 3 years.

The pre-confirmed 2 x 2 m quadrat locations will be uploaded on to hand held GPS unit and a qualified ecologist will visits each of these quadrat locations using the GPS. Once the point is located, four 2 m poles will be laid on the ground around the point to define the sample area and the data outlined in **Table 11** will be collected at each point.

Table 11: Details of data collected at each survey

Parameter	Details	Description
Species richness	The total number of different species of plant present.	A measure of biodiversity/ species composition
Abundance	The total number of each species present.	A measure of plant/ species density.
	The total number of Camfield's Stringybark individuals	A measure of the number of individuals per sector
Height	The average height of all plants in the plot.	An indicator of overall growth.
Percentage cover	An estimate of the total plot area having plant cover-percentage of area.	A measure of the total green cover for the rehabilitation area.

8.3.2 Inspection

During all monitoring events an inspection of each sector for weeds, signs of feral pests, erosion, die-off, and site access issues will occur. Any significant problems will be mapped.

8.3.3 Photo Monitoring

A minimum of four photo monitoring points will be established within each sector. Photographs will be taken at the same location and bearing at each monitoring event. A panoramic photograph will be taken at each survey to allow a visual assessment of the rehabilitation progression in future monitoring events.

8.3.4 Reporting

Data will be collected bi-annually and reported on annually. These data will be compared to any previous surveys events to assess the progression of the rehabilitation. Additionally, the

rehabilitation will be assessed against the performance indicators outlined in **Table 12**. If the rehabilitation sectors are not meeting these performance indicators, specific management measures (i.e. revegetation measures, weed and pest control and/ or measures for erosion control) will be outlined in the AEMR.

8.4 POST 3-YEAR MONITORING

The following monitoring methodology will be conducted annually at years four or five and year eight post-rehabilitation of an area. Subsequent monitoring post Year 8 to be determined pending rehabilitation success and evidence of a self-sustaining ecosystem.

8.4.1 Quadrat Monitoring

One permanent 20 m x 20 m quadrat will be established per hectare of rehabilitation. This quadrat will be used to give a broad scale indication of the rehabilitation structure and diversity. The quadrat location will be in an area that is representative of rehabilitation within the sector. The data collected from each quadrat will include:

- Total species richness.
- Average height.
- Percent foliage cover of each species: recorded from 1 – 5% and then to the nearest 5%.
- Abundance rating of each species, using the following intervals (numbers above 20 are estimates only): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1,000 or specify a number greater than 1,000 if required.
- Reproductive status and any evidence of second-generation plants (succession) will be recorded for each species; and
- General comments; including notes on litter deposition and structural formation.

8.4.2 Photo Monitoring

The photo monitoring points established during bi-annual monitoring will be continued during the post 3-year monitoring. Additionally, a permanent photographic monitoring point will be established in one corner of each quadrat. A panoramic photograph will be taken at each survey to allow a visual assessment of the rehabilitation progression in future monitoring events.

8.4.3 Inspection

During all monitoring events an inspection of each sector for weeds, signs of feral pests, erosion, die-off, and site access issues will occur. Any significant problems will be mapped.

8.4.4 Reporting

The survey data from the post 3-year monitoring will be compared against previous survey events and the performance indicators to assess the progression of the rehabilitation. Any recommendations for revegetation, weed and pest control and any mitigation measures for erosion issues will be outlined in the AEMR. In addition, the eight-year survey data will be assessed against the completion criteria (outlined in **Table 13**) to determine whether the rehabilitation sector can be released from further rehabilitation and monitoring.

9. PERFORMANCE AND COMPLETION CRITERIA

9.1 PERFORMANCE CRITERIA

At each stage of monitoring the rehabilitation will be compared to the performance criteria outlined in **Table 12** to measure compliance with rehabilitation aims and objectives. If the rehabilitation areas are not meeting these performance criteria, specific corrective actions will be developed to remedy the deficiencies.

For each year outlined below the effects of bushfire will vary, as will the required response, it is feasible that fire will be beneficial at some stages, but may also hinder development. The corrective actions stated for Years 1-7 equally apply to post-bushfire, the timing of monitoring following fire may necessitate adjustment to enable representative monitoring.

Table 12: Performance criteria for rehabilitation

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
1	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring structural components and dominant species of vegetation, comparable with pre-extraction vegetation at	• Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species). • Key species present, including tree species important for	• Early pioneer stage appearing: Small seedlings (< 5 cm) regenerating from topsoil, < 5% surface cover. • Brush-matting evident. • Woody debris (>10 cm diameter) does not exceed 20% of the ground surface cover. • Local seed has been collected and is stored appropriately for direct seeding or propagation	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species)

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark • Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, • Protection of onsite Offset Area.	Koalas and Camfield's Stringybark • No significant erosion problems. • Weed control program in place. • No damage or disturbance to Offset Area.		• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by suitably qualified contractor if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring
				• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel
2	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring	• Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species).	• Natural regeneration of pioneer species occurring. • Seedlings developing under brush-matting.	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species)

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark • Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, • Protection of onsite Offset Site	• Key species present, including tree species important for Koalas and Camfield's Stringybark • No significant erosion problems. • Weed control program in place. • No damage or disturbance to Offset Site	• Cover of 10 - 20% of ground surface. • Plant height and density in each strata increasing • Trees and shrubs not present but expected are planted (based on deficiencies identified in Year 1 monitoring), including tree species important for Koalas and Camfield's Stringybark. • No significant erosion problems. • Weed control program in place.	• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by qualified engineer if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring
				• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel
3	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring	• Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species).	• Mid and over-storey species are present. • Shrub layer and ground cover strata evident.	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species)

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark • Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, • Protection of onsite Offset Site	• Key species present, including tree species important for Koalas and Camfield's Stringybark • No significant erosion problems. • Weed control program in place. • No damage or disturbance to Offset Site	• Natural regeneration covering 30 - 50% of surface. • Key species present across sector, including tree species important for Koalas. and Camfield's Stringybark. • No significant erosion problems. • Weed control programme in place and weeds successfully controlled.	• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by qualified engineer if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring
				• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel
4	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring	• Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species).	• Key species present across each sector, including tree species important for Koalas. • Number of Camfield's Stringybark individuals	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species)

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark • Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, • Protection of onsite Offset Site	• Key species present, including tree species important for Koalas and Camfield's Stringybark • No significant erosion problems. • Weed control program in place. • No damage or disturbance to Offset Site	approaching the numbers removed from the extraction area • Mature pioneer stage evident; cover 50 – 70% • No significant erosion problems. • Weed control programme in place and weeds successfully controlled.	• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by qualified engineer if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring
				• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel
5-7	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring	• Topsoil stabilised by primary colonisers ((e.g. *Acacias* & pea species).	• Decline in pioneer community, coinciding with emergence in canopy species. • Canopy layer emerging above shrub layer.	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species)

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark • Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, • Protection of onsite Offset Site	• Key species present, including tree species important for Koalas and Camfield's Stringybark • No significant erosion problems. • Weed control program in place. • No damage or disturbance to Offset Site	• No significant erosion problems. • Weed control programme in place and weeds successfully controlled.	• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by qualified engineer if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring
				• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel
8	• Safe, stable, non-polluting and fit for the intended post-quarrying land use(s) • Final landform integrated with surrounding natural landforms as far as is reasonable and designed to minimise	• Key species present. • Species composition similar to pre-disturbance. • Landform is stable, no	• Overstorey and midstorey species increasing in height and percentage cover. • Overstorey and midstorey species density stable. • Key species present across each sector • Overstorey layer evident above shrub layer.	• Bushfire	• Review bushfire management procedures and asset protection zones, update where appropriate • Development of a supplemental monitoring plan to occur following a

C	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	visual impacts when viewed from surrounding land • Landform rehabilitated to 1.0 metres above the predicted maximum groundwater level • Decommissioned and removed, unless otherwise agreed by the Secretary • No final void	evidence of erosion • Bushfire Management Plan in place • Revegetation density maintains visual amenity • All structures decommissioned and removed in accordance with Quarry Closure Plan • Suitable koala feed trees to encourage presence of koalas within rehabilitated areas	• Number of Camfield's Stringybark individuals present at, or above, numbers removed from extraction area. • No remaining structures onsite following decommissioning • Preferred Koala feed trees at suitable density across rehabilitation area to support Koala population. • Landform blends in within surrounding landscape		bushfire event. Response actions will be determined by factors, including age of rehabilitation impacted, but may include additional seeding or planting in impacted areas.
				• Preferred Koala feed trees occupy less than 15% of the canopy.	• Increase number of Koala Feed species • Koala population monitoring
				• Waste, litter or structures left onsite • Landholder complaints • Bond withheld	• Increase species composition, particularly mature species where visual amenity is not maintained
				• Final landform with visible void	• Review of rehabilitation procedures

9.2 COMPLETION CRITERIA

At the end of the Project life the rehabilitation will be assessed against the completion criteria set out in **Table 13**. Each rehabilitation sector will be assessed against these completion criteria to determine eligibility of operational areas for release from further rehabilitation or monitoring, and if the rehabilitation bond can be released.

The Completion Criteria will be independently audited to assess whether the adopted criteria are reasonable performance indicators for the rehabilitation, relative to its age. Monitoring of the rehabilitation post quarrying should be conducted until such time that these completion criteria are met or there is a high degree of confidence that based on monitoring undertaken the rehabilitation is on the correct trajectory to meeting those levels.

Table 13: Completion criteria for rehabilitation

Completion Indicator	Completion Criteria
Topsoil coverage across the rehabilitation area.	100% topsoil cover.
Similar species composition to pre-extraction at similar topographic levels.	Species composition of the rehabilitation similar to Coastal Sand Apple – Blackbutt Forest and/ or Coastal Sand Wallum Woodland-Heath (determined through comparison of quadrat data in **Table 9** and **Section 8**).
Canopy average height.	Canopy 3 m tall within sectors 1A, 2, 3, 3A, 3B, 4, 4A, 4B, 5, 5A, 5B, 6, 6A, 6B, 7B, 7A, 7C, 7, 8A, 8B, 9A and >1 m tall within sectors 1, 8, 9B, 10A, 10B, 10C.
Midstorey average height.	Midstorey >1 m tall (average at 8 years).
Shrub layer average height.	Shrubs 90 cm tall (average at 8 years).
Vegetation cover	Vegetation cover present across 90% of each sector (assessed via inspection), with no bare areas >25 m^2 (i.e. 5 m x 5 m). Bare area defined as no foliage cover.
Key species	Key species present across the rehabilitation sector.
	Parramatta Red Gum present at, or above, numbers removed from sector.
	Camfield's Stringybark present at, or above, numbers removed from sector.
Litter development.	Early litter development evident.
Woody debris	Woody debris (>10 cm diameter) does not exceed 20% of the ground surface cover.
Koala habitat	Tree species important for Koalas present across the rehabilitation sector at pre-disturbance densities.

9.3 WEED AND PEST PERFORMANCE AND COMPLETION CRITERIA

Table 14 outlines the performance and completion criteria applicable to weed and pest control.

Table 14: Weed and pest control performance and completion criteria

Action	Performance Criteria					Completion Criteria
	Years 0 – 2	Years 3 – 4	Years 5 – 6	Years 7 - 8	Closure	
Rehabilitated land monitoring for weeds (Sectors 1 – 7)	Annual weed monitoring completed including a review of the effectiveness of the weed control activity, reporting to include map of occurrences and recommendations for management.				Meets completion criteria	On closure, rehabilitated land to have less than 5% cover of environmental weeds on average across Sectors 1 – 7, with no noxious weeds.
Rehabilitated land monitoring for weeds (Sectors 8 and 9)						The cover of environmental weeds is less than that prior to extraction.
Where previously unrecorded weeds to the site are identified during monitoring, identify likely vector and control actions required.	Within 2 months of monitoring, vectors for unrecorded weeds are identified. Weed controls are updated and implemented as required.				Nil	Weed controls updated and implemented as required
Weed control activity.	Weed control undertaken consistent with survey recommendations by suitably qualified contractor/personnel.				Nil	Weed controls undertaken are recorded
All machinery working within the extraction area, free of soil and organic matter prior to entering work area. All haulage trucks keep to formed roads.	Conducted throughout life of project.				Nil	Only machinery free of soil and organic matter entered the extraction area and all haulage trucks remained on formed tracks.
Pest management controls implemented as required.	Actions completed				Nil	Nil

Action	Performance Criteria					Completion Criteria
	Years 0 – 2	Years 3 – 4	Years 5 – 6	Years 7 - 8	Closure	
Pest monitoring undertaken.	Annual monitoring survey completed.				Nil	Annual surveys completed, survey to include map of occurrences and recommendations for management.
Pest control program undertaken as per management.	Pest control undertaken consistent with survey recommendations by suitably qualified and experienced contractor.				Nil	Pest controls undertaken are recorded.

10. REPORTING

Table 15 provides a summary of reporting requirements under this plan.

Table 15: Reporting Requirements

Item	Report	Trigger	Responsibility	Reporting Authority
A	Resource Survey Plan prepared by registered surveyor	One month prior to commencing quarrying operations, unless otherwise agreed.	Quarry Manager	DPHI
B	Monthly Environmental Inspection Report	Following monthly internal environmental inspections	Quarry Manager	Internal
C	Compensatory Habitat Monitoring	Following monitoring event	Quarry Manager	Internal
D	Bi-Annual Monitoring Results	Following monitoring event	Quarry Manager	DPHI
E	Post-3 year Monitoring Results	Following monitoring event	Quarry Manager	DPHI
F	Non-Compliance and Corrective Action Report	Following identification of a non-compliance	Quarry Manager	DPHI
G	Three-yearly Independent Environmental Audits	Following three-yearly independent audit	Quarry Manager	DPHI
H	Annual Environmental Management Report (AEMR). AEMR to include: • Summary of all monitoring results and management actions undertaken in the 12-month period; • Summary of work completed in maintaining the boundary delineation. • Summary of any non-compliances recorded in the 12-month period; • Summary of any complaints recorded in the 12-month period; • Summary of corrective actions and improvements to reduce biodiversity impacts or improve rehabilitation.	Annually at time agreed with DPHI	Quarry Manager	DPHI

Item	Report	Trigger	Responsibility	Reporting Authority
	AEMR will be uploaded to Project website within two weeks of report being issued.			

REFERENCES

Biolink Ecological Consultants, (2019) Email to Kleinfelder, 18th December.

Port Stephens Council (2014). *Technical Specification – Nest Boxes*, Port Stephens Council, Raymond Terrace NSW 2324

Commonwealth of Australia (2015). *Arrive Clean, Leave Clean* – Australian Government: Department of the Environment, Canberra, ACTNSW Department of Environment and Climate Change (2008). *Hygiene protocol for the control of disease in frogs.* NSW Government, South Sydney NSW

APPENDIX 1: AUTHOR QUALIFICATIONS

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Jonathan Berry

Senior Advisor | Environmental Management and Approvals

Jonathan has over 15 years' experience in environmental assessment, project management and environmental approvals. Jonathan's passion in environmental consulting is working with the client to design and develop their projects to optimize future operations and reduce environmental impacts, ultimately simplifying the approvals process. With good communication and technical skills, he is well placed to discuss projects with clients, community and regulators and assess or direct specialists to assess potential environmental and social constraints.

A large portion of Jonathan's experience has been in developing and gaining project approvals and project modifications for state significant coal mining and extractive industry projects. Managing a team of specialists has required an excellent understanding of a range of disciplines including air quality, noise, water, ecology and subsidence. Jonathan has also worked in contaminated land remediation projects, baseline and environmental compliance monitoring and reporting, development of environmental management strategies and plans, exploration approvals for coal, metalliferous and gas projects and residential development and subdivision approvals.

Project Experience

The following is a representative selection of Jonathan Berry's project experience:

- **Environmental assessment reports and advice for State Significant Development** – Eagleton Rock Syndicate, Williamtown Sand Syndicate, Ashton Coal Operations Limited, Felix Resources Ltd and Hunter Enviro-Mining Pty Ltd – various assessments for open cut and underground coal mining, sand and hard rock quarries, gas management, a Chitter and Tailings Rehabilitation Project. Environmental Manager, specialist advice and report writing.
- **Environmental assessment reports and advice for local and regional infrastructure projects** – including the Newcastle Muslim Association's Mosque at Buchanan, upgrades to Merimbula Airport, a Solar Farm in the Hunter Valley, various applications supporting residential rezoning and subdivisions.

Education

B App Sc. (Hons)
(major in Engineering and Environmental Geochemistry).

Training and Certifications

Senior First Aid

Class C Driver's Licence

White Card – General Induction for Construction Work in NSW (CGI00400067SEQ1)

Basic 4wd and Vehicle Recovery,

Environmental Management Systems Lead Auditor (ISO 14001:2015)

IA19 Radiation User License to use portable x-ray fluorescence XRF radiation apparatus for analysis.

Expertise

Project scoping, design and management

Environmental Assessment

Environmental Management Plans

Community and Stakeholder Consultation

GIS mapping and graphics

- **Environmental Management Systems and Plans** including air quality, noise, waste, lighting, water, rehabilitation, biodiversity offset and visual management plans for the Black Hill Quarry, Hunter Enviro-Mining Pty Ltd, Ashton Coal Project and the Moolarben Coal Project. This has included preparation of management plans, the management of specialists preparing plans and development of environmental management systems.
- **Assessment of Legacy Petroleum Wells** – Under contract to the NSW Department of Planning & Environment through InGauge Energy Pty Ltd. The aim of the project is to audit the database records of legacy petroleum wells. The project included the development of a risk assessment methodology for the desktop and field assessment of potential legacy exploration wells across NSW including preparation of environmental assessments for well decommissioning.
- **Review of Environmental Factors (REF)** under Part 5 of the NSW EP&A Act for several clients for gas, metaliferous and coal exploration projects within NSW. These REFs were pursuant to the ESG2: Environmental Impact Assessment Guidelines.
- **Review of Environmental Factors (REF)** under Part 5 of the NSW EP&A Act for local Councils and Utility Service providers on bridge and road upgrades, stormwater and drainage works, sewer lead-in and water main amplifications. These REFs followed the relevant authorities templates, the RMS Major Works template for environmental assessment or custom templates addressing the Clause 228 factors.
- **Community consultation** for various projects including the Williamtown Sand Quarry, Eagleton Rock Quarry, Newcastle Mosque, Moolarben Coal Project, Mt Penny Coal Project, Ashton Coal Mine and Hebburn No.3, that has included chairing community meetings, door knocking, one on one discussions, preparation of plans and presentations for static displays at open days.
- **Contaminated land and hazardous material assessments** for Department of Planning & Environment – Derelict Mines Program, private land holders, Mobil, Singleton Shire Council, Muswellbrook Shire Council, Department of Commerce, including hazardous materials assessments, Preliminary and Detailed Site Investigations, UST removals and validation, remediation and sampling and Remedial Action Plans.
- **Management and treatment of water** including reports for Metgasco, Nabalco, Euralumina, and the NSW Environmental Trust. Including decommissioning options and related risk for coal seam gas produced water dams, use of bauxite refinery residues for water treatment, geochemistry and remediation of coal tailings and leachate at Aberdare East.
- **Mapping and geographic information systems** including management of GIS databases for coal mines and industrial developments, creation of graphics and plans for numerous reports and presentations. Using ESRI, Manifold, Maptek Vulcan and Surfer software.

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Dr Nigel Fisher

Soil Microecologist

Nigel is a Soil Microecologist with a strong research background including molecular identification of soil micro-organisms. Nigel's primary areas of expertise are in the fields of rhizobia-legume interactions, general soil microecology, plant nutrition and mine site rehabilitation. Nigel has broad ecological knowledge and experience in flora and fauna surveys, monitoring, reporting and project management which has been greatly expanded since joining Kleinfelder in 2011.

Prior to joining Kleinfelder, Nigel worked at The Centre for Sustainable Ecosystem Restoration, The University of Newcastle as a Research Assistant where his duties included vegetation surveys, soil sampling, student supervision associated with research projects undertaken by the CSER at field sites located in the Hunter Valley of New South Wales. Further duties included the collection, analysis, identification of rhizobia bacteria and establishment and evaluation of a collection of nitrogen-fixing bacteria for the revegetation of disturbed lands.

Since joining Kleinfelder, Nigel has been promoting the use of soil microbial inoculation as a means of improving the success of rehabilitation projects, especially in areas where revegetation is required in degraded soils.

Soil microecology is often recognised as a vital component of rehabilitation, but apart from "Managing Topsoil" not many rehabilitation programs provide pro-active strategies to improve the nutrient cycling that soil microbes provide. Nigel has the expertise and through his appointment as a Conjoint Fellow at the University of Newcastle access to state of the art equipment that allows for the capture, culture and reintroduction of soil microbes for any project in Australia.

Qualifications / Licenses

Bachelor of Biological Sciences Discipline of Biology,

Honours (Class 2.1),
Anatomical Response of Selected Native Plant Taxa to Differing Levels of Phosphorus

PhD,
Sustainable Reintroduction of the Nitrogen Cycle Post Coal Mining Utilizing the Legume –Rhizobia Symbiosis.
The University of Newcastle

Class C Driver's Licence,
NSW

4WD Training,
Statement of Attainment

Work Safely at Heights,
RIIOHS204A

Snake Safety and Handling Course, SSSafe
Statement of Attainment

Senior First Aid.
Statement of Attainment

BAM Assessor
Completed training, currently awaiting accreditation (August 2018)

Project Experience

Mine Rehabilitation, Completion and Monitoring

Peabody Coal Australia. Completion Criteria for the Moorvale and Coppabella Open Cut Coal Mines – Central Queensland. Mine closure requires the design of criteria that are attainable and readily measured. Nigel contributed to the design of closure criteria for these two mines focusing on his specialty of soil management and soil microecology.
Liddell and Munmorah Power Station Ash Dams Revegetation Management Plans. Two different clients required strategies enhance the ecological value of the revegetation on the ash dams taking into account the particular aspects of ash dams – shallow capping topsoils with potentially undesirable materials underneath – that required different yet cost-effective approaches.
Mount Penny Open Cut Coal Mine, Bylong NSW. Nigel designed the progressive rehabilitation strategy for this development including milestone and completion criteria.
Ashton Coal (Yancoal) – Design and implementation of the rehabilitation monitoring requirements for the Bowmans Creek diversion. Ashton Coal diverted two sections of a tributary of the Hunter River to gain access to underground coal seams. Nigel designed the monitoring program and is currently running this program and providing ecological advice to ensure that the consent conditions are being adhered to and indeed exceeded in terms of successful revegetation for five years. Annual Flora Monitoring Program and Reporting – Nigel has conducted and managed this program for five years.
Tanilba Dunes North Sand Mining Project – (Sibelco Australia). Kleinfelder designed and implemented the rehabilitation flora monitoring program for this project and has been conducting the monitoring for the past 15 years. Nigel has been running the flora monitoring program for the last four years. Nigel designed and implemented the flora monitoring program for the next stage of the sand extraction project and has been conducting the monitoring and associated reporting used to guide further revegetation efforts.
Annual Flora Monitoring Program – Stratford and Duralie Coal Mines (Yancoal). Nigel has been running and conducting the Annual Flora Monitoring program at these mines for the past three years. This monitoring includes a large component of Landscape Functional Analysis. Biodiversity Offsets Revegetation Program – Nigel has project managed the revegetation of 360 ha of formal grazing lands back to native woodland and forest. The program has utilised several techniques to ascertain efficacy and cost effectiveness. These have included microbial inoculation of seeds and tube stock, burning, slashing and intensive grazing to reduce ground cover prior to planting and seeding, broad acre seeding and hand seeding on steeper slopes.
Landscape Functional Analysis – LFA is monitoring protocol designed by the CSIRO that measures biophysical processes (as opposed to flora species) to measure the functionality of a landscape. Nigel is an experienced practitioner of the methodology and has delivered training in the implementation and interpretation of LFA to mining environmental officers and Local Land Services personnel.
Closure Criteria – Swan Bay Kaolin Mine (Sibelco Australia). After conducting baseline vegetation surveys, ascertaining the on-site vegetation communities Nigel then designed the closure criteria for the successful revegetation of this site to the approval of the regulators which were incorporated directly into the MOP. Nigel is now project managing the

revegetation of the site with the stated goal of relinquishment by the end of 2020. Nigel will also be conducting the rehabilitation monitoring and reporting required to meet consent conditions.

Soil Microecology

Internal Soil Microecology Trial – Kleinfelder. Nigel designed and implemented a pot trial testing the efficacy of two commercially available inocula – native rhizobia and native mycorrhiza – regarding their ability to promote the growth of a selected range of native shrubs and trees. The results were positive, and Nigel presented the results at the Seventh International Conference on Mine Closure in Brisbane, September 2012.
Ellendale Diamond Mine, Kimberley Diamonds – West Kimberley, Western Australia. KDC is required to rehabilitate their excavation sites and spoil dumps to native vegetation while being surrounded by highly degraded native and exotic pastures, resulting in high weed infestation of rehabilitated sites. Nigel has designed and implemented a field trial on site whereby microbial inoculation of native seeds precludes the use of fertiliser, giving the native plants a competitive advantage over the exotics.
Glencore Coal Australia – As part of an expansion project for a Hunter Valley Open Cut Mine Nigel was involved in the design and implementation of soil microbial sampling program in conjunction with nearby landholders to provide data on the possible effects of the expansion.
Yancoal – Inoculation of tube stock and seeds with both mycorrhizal fungi and native rhizobia bacteria as a component of the Biodiversity Offsets Revegetation Program (as outlined above).
Mackay City Council – designed and implemented an inoculation trial to determine the effectiveness of inoculation to improving foredune rehabilitation. Trial still underway (August 2018).

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Daniel O'Brien

Ecologist (Herpetologist)

Daniel is a fauna ecologist (specialist herpetologist) with almost 10 years experience. Daniel attained first class honours researching the evolution of life-history strategies in unpredictable environments for the brown brood frog Pseudophryne bibronii under the supervision of Michael Mahony, and is currently undertaking his PhD investigating the behavioural ecology of terrestrial toadlets. Daniel has undertaken numerous successful surveys for U. mahonyi across the species range including the type locality at five known localities and has detected the species at an additional thirty-one sites within the Tomago Sandbeds.

Conferences, Publications and Exhibitions

2019 O'Brien, D. M., Keogh, J.S., Silla, A.J. & Byrne, P.G. Females prefer to mate with more related males in wild red-backed toadlets. *Journal of Behavioural Ecology – in press.*

2018 O'Brien, D. M., Keogh, J.S., Silla, A.J. & Byrne, P.G. The unexpected genetic mating system of the red-backed toadlet (*Pseudophryne coriacea*). *43rd Annual Meeting of Australian Society of Herpetologists*. Presented at Kindilan, Redland Bay, Queensland.

2018 O'Brien, D. M., Keogh, J.S., Silla, A.J. & Byrne, P.G. The unexpected genetic mating system of the red-backed toadlet (*Pseudophryne coriacea*); a species with prolonged terrestrial breeding and cryptic reproductive behaviour. *Journal of Molecular Ecology*.

2017 & 2015 O'Brien, D. M., Keogh, J.S., Silla, A.J. & Byrne, P.G. The genetic mating system of a cryptic,

Qualifications / Licenses

Environmental Science and Management – PhD candidate
The reproductive ecology of terrestrial toadlets from the genus: Pseudophryne School of Earth, Atmospheric and Life Sciences.

The University of Wollongong, NSW

Environmental Science and Management – Honours (1st Class)
Evolution of life-history strategies in the brown brood frog Pseudophryne bibronii: optimising reproductive success in the face of environmental unpredictability

School of Environmental and Life Sciences. The University of Newcastle, NSW

Bachelor of Environmental Science and Management (Biology)
School of Environmental and Life Sciences. The University of Newcastle, NSW

Trained in Specialised Snake Safety & Management

Awarded Australian Postgraduate Award, 2014, University of Wollongong, NSW

Awarded Newcastle Flora and Fauna Protection Award 2010, University of Newcastle, NSW

Senior First Aid, Statement of

	prolonged breeding anuran: female monogamy and male nest-takeover. *School of Biology Annual Post-Graduate Conference*. Presented at Kioloa, New South Wales.	Attainment
2011	O'Brien, D. M., Clulow, S., Pickett, E. J., Clulow, J. & Mahony, M. J. Evolution of life history strategies in the brown brood frog *Pseudophryne bibronii*: Optimising reproductive success in the face of environmental unpredictability. *36th Annual Meeting of Australian Society of Herpetologists*. Paluma, Queensland.	**WorkCover NSW OHS General Induction** for Construction Work in NSW
2011	**Australian Geographic Magazine (AG103) article and photo** Daniel O'Brien's Smirking Frog – 'An ecologist looks through his lens at a frog freshly emerged from the sand'	**4WD Driver training** - Statement of Attainment
2009 – present	**Illustrator, Photographer and Author** - Australian Museum, Australian Geographic, Macmillian Education Australia, ARKive, State Governments and Local Councils. Contributed to educational posters, textbooks, field guides, websites, brochures, magazines, museum exhibitions, calendars, honours theses and PhD papers.	

Written Reports

The following is a representative selection of Daniel O'Brien's project experience.

- Whyte, G & O'Brien, D. (2019) West Wyalong Solar Project – Biodiversity Development Assessment Report, West Wyalong, NSW. Report prepared for Lightsource Development Services Australia Pty Ltd.
- Whyte, G & O'Brien, D. (2018) Yarrabee Solar Project – Biodiversity Development Assessment Report, Narrandera, NSW. Report prepared for Reach Solar Energy.
- O'Brien, D & Whyte, G. (2019) Ecological Assessment – proposed NBN tower and access, Cooranbong, NSW. Report prepared for Aurecon Australasia Pty Ltd.
- O'Brien, D & Whyte, G. (2018) Addendum Ecological Assessment – proposed NBN tower and access, Wyee, NSW. Report prepared for Aurecon Australasia Pty Ltd.
- Whyte, G & O'Brien, D. (2018) Flora and Fauna Assessment to support REF – Charles Sturt University, Port Macquarie Campus, Port Macquarie, NSW. Report prepared for BVN Architects.
- O'Brien, L., O'Brien, D., Peters, K., Fagan, P., & Dean, M. (2017) Winter Fauna Monitoring Report, Donaldson Open Cut Mine, Beresfield, NSW. Report prepared for Yancoal Australis Pty Ltd.
- Schulz, S., Fagan, P., O'Brien, D., O'Brien, L. Williams, S., & Joyce, G. (2017) Ecological Due Diligence, Sugarloaf State Conservation Area, NSW. Report prepared for Oceanic Coal Australia Pty Ltd.
- Fagan, P., O'Brien, D., Mark, J., O'Brien, L., Joyce, G., & Peters, K. (2017) Subtropical Rainforest Monitoring, Abel Underground Coal Mine, Blackhill, NSW. Report prepared for Yancoal Australia Pty

Ltd.

- Forrest, C., O'Brien, D., Fagan, P., O'Brien, L., Peters, K., Marshall, A., Joyce, G. & Deane, B. (2017) Pambalong Nature Reserve Annual Monitoring Report, Abel Underground Coal Mine, Beresfield, NSW. Report prepared for Yancoal Australia Pty Ltd.

- O'Brien, D. (2016) Assessment of suitable habitat for Red-crowned Toadlet at Galston Gorge for the purpose of a Biobanking Assessment. Independent expert judgement.

- O'Brien, D. & Paull, D. (2011) Fauna Assessment, Goyder River (East Arnhem Land), Northern Territory. Report prepared for Aurecon Australia Pty Ltd.

- O'Brien, D., Peters, K. (2012) Nest Box Insulation Experiment - Donaldson Open-cut Coal Mine, Beresfield, New South Wales. Report prepared for Gloucestor Coal Ltd.

- O'Brien, D., Peters, K. (2012) Fauna Survey and Monitoring – Bulga Coal Underground Operations, Broke, New South Wales. Report prepared for Xstrata.

- O'Brien, D., Capararo, S., & Peters, K. (2012) Fauna Survey and Monitoring - Tarong Coal Project - Meandu Mine, Bulga, New South Wales. Report prepared for Aurecon Australia Pty Ltd on behalf of Theiss Pty Ltd.

- O'Brien, D., Paull, D. (2012) Revision of Environmental Impacts – Tea Gardens Water Treatment Plant, Tea Gardens, New South Wales. Report prepared for MidCoast Water.

- O'Brien, D., Mulcahy, A., Peters, K. & Leonard, G. (2012) Fauna, Flora and Threatened Species Assessment - Werrington Arterial Road widening from M4 Motorway to Great Western Highway, Penrith, New South Wales. Report prepared for Aurecon Australia Pty Ltd on behalf of the Roads and Maritime Services.

- O'Brien, D., Peters, K. (2011) Biannual Fauna Monitoring Report -

Donaldson Open-cut Coal Mine, Beresfield, New South Wales – Report prepared for Gloucestor Coal Ltd.

Professional Associations

- Evolution & Assisted Reproduction Laboratory Wollongong.
- Birdlife Australia.
- Ecological Society of Australia.
- Hunter Bird Observers Club.
- Australian Society of Herpetologists.

APPENDIX 2: AGENCY CORRESPONDENCE

Table 16: Summary of agency correspondence and issue resolution

Correspondence	Comment	Response
Letter sent to OEH 1 February 2019	• Acknowledged of receipt of plan though weren't able to comment at that time.	• Nil required.
Letter sent to Port Stephens Council 1 February 2019	**Section 5.2 – Stages of Rehabilitation** • The figure for 'Rehabilitation Progression Plan Year 8' is missing.	• No Year 8 Plan is considered necessary. Quarrying finishes in Year 8, as such the Year 9 plan is shown and the Final Landform Plan in effect provides that information.
	General The following recommendations should be considered: • Inductions should also inform personnel of any hygiene protocols that are to be followed.	• Adopted (See Section 6.1).
	6.7 Pre clearance survey The following recommendations should be considered: • Pre-clearance protocols for threatened amphibians. This should include specific measures for an ecologist to walk ahead of slashing equipment and any frogs found should be captured and relocated. • Pre-clearance surveys for frogs should occur during slashing for the site boundary, with frog exclusion fencing installed immediately after boundary slashing. • All vegetation slashing after the installation of frog exclusion fencing should also be supervised by an ecologist and any frogs found be relocated to behind the frog exclusion fencing.	• During the day, terrestrial toadlets typically burrow several centimetres into the soil/sand or take refuge at the base of thick vegetation cover. • As such, pre-clearance surveys during the day are unlikely to detect toadlets on the surface. Furthermore, slashing is unlikely to substantially disturb these refuge habitats to the point at which toadlets would become exposed. • Supervision of vegetation clearing should be prioritised as toadlets are more likely to be disturbed and become exposed on the surface. Toadlets should be relocated to adjacent habitats outside of the extraction footprint.
	6.22 – Weed and disease control The following recommendations should be considered: • Hygiene protocols (include those for Phytophthora, Myrtle Rust and Chytrid Fungus) should be implemented at all times during vegetation clearing works to prevent the introduction of pathogens to the site - not just if the disease is identified.	• Section changed (See Section 6.22). • Application of these guidelines at all times is not considered practical or necessary. The quarry is located outside of core areas likely to maintain these pathogens (i.e. wet areas), and implementing the degree of hygiene protocols suggested within an operational quarry is not feasible. Hygiene protocols are adopted for all new equipment, clothing, boots and PPE coming onto site to minimise risks. However, no disinfection protocols are
	• The trigger of "If the disease is identified" is considered suitable for operational activities once the site is cleared of vegetation.	

Correspondence	Comment	Response
	• Hygiene protocols for Chytrid fungus be implemented on site in accordance with 'Hygiene Protocol for the Control of Disease in Frogs' (Department of Environment & Climate Change 2008).	proposed for day to day quarrying activities. Contractors working outside the quarry footprint, or directly handling fauna must be familiar with the protocols. • In event disease identified onsite, management practices to follow guidelines.
	6.15 – Nest box installation There are some potential issues with the nest box installation measure including: • The suitability of nest box and salvaged hollow installation on wooden poles with a barren rehabilitation landscape (installed prior to planting). • The distribution of uninstalled salvaged hollows on the ground.	• Nest box installation timing, location and monitoring included within document, refer to Section 6.15 and Section 8.1.
	The following recommendations should be considered: • Where poles are to be used for the installation of nest boxes, vegetation should be rehabilitated to at least 3m in height before nest boxes/salvaged hollows are installed OR if installation is to occur in the absence of vegetation establishment nest boxes should be replaced after 10 years. Establishing vegetation cover prior to installation is considered important in providing adequate shade and cover for fauna species utilisation, and also for ensuring that the limited life span (approx. 10 years) of nest boxes is maximised for use. It should be noted that it is considered suitable for poles to be installed prior to planting in preparation for nest box installation. • It should be considered whether it is suitable to position a proportion of nest boxes/salvaged hollows within surrounding vegetation that is to be retained. This would provide a refuge resource to any potentially displaced fauna. • Salvaged hollows that are not able to be installed on poles should be preferentially installed within trees in the surrounding offset areas, and only placed as ground hollows as a last resort. • Where nest boxes or salvaged hollows are to be placed in surrounding vegetation, they should not be placed in preferred koala feed trees.	

Correspondence	Comment	Response
	• Provisions for nest box maintenance and monitoring including the management of feral species found utilising nest boxes • Consideration to Port Stephens Council's Technical Specification for Nest Boxes (2014) (http://www.portstephens.nsw.gov.au/trim/other?RecordNumber=PSC2015-03638%2F011). • It may be worth Including a detailed section of nest boxes/salvaged hollows within section 7 – Rehabilitation methodology	
	Section 9.2 - Table 12: Completion criteria for rehabilitation It is recommended that the completion criteria for canopy height be revised. The canopy should reach 3 metres in height prior to installing nest boxes on poles at 3 m high, as it is considered important for vegetation cover to be established prior to the installation of nest boxes. Recommended completion criteria for canopy height is: • Canopy rehabilitated to maturity (average 3m tall) within sectors 1A, 2, 3, 3A, 3B, 4, 4A, 4B, 5, 5A, 5B, 6, 6A, 6B, 7B, 7A, 7C, 7, 8A, 8B, 9A • Canopy >1 m within Sectors 1, 8, 9B, 10A, 10B, 10C	• Adopted.
	Threatened amphibians Considering the close proximity of sand mining operations to threatened frog habitat, stronger provisions for the prevention and mitigation of impacts should be implemented as discussed below. The following are excerpts from the Scientific Determination for Mahony's Toadlet: *"Vegetation communities in which U. mahonyi has been found include wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland* *Outside of the breeding period, adults of U. mahonyi are terrestrial. During non-breeding periods the species has been recorded up to 400 m from standing water within intact native vegetation, indicative of a need for large vegetation buffers around breeding sites to ensure persistence of this species"*	Frog exclusion fence included, see Section 6.4, based on advice from D.O'Brien, discussion provided below: • The installation of frog exclusion fencing should be used with caution as fencing may impede the movement of frogs from inside the site boundary to adjacent habitats. This is particularly important when considering the movement patterns of terrestrial toadlets throughout the year. Migratory behaviour from non-breeding vegetated areas (including extraction zones) towards breeding habitats (outside the extraction footprint) is likely to take place in Spring. Installation of fencing during this period should be avoided as individuals may be excluded from breeding habitats, becoming trapped within the extraction areas. Metamorphosis for U. mahonyi has been recorded in December (summer) and March (autumn) (Anstis, 2018) where post-metamorphic dispersal from the natal breeding sites occurs. Similarly, adults may attempt to

Correspondence	Comment	Response
	It should be considered that there is a high potential for clearing activities associated with the establishment of each sector to impact on Mahony's Toadlet, particularly as they are known to forage up to 400 m from breeding habitat within woodland vegetation i.e. there is the potential for Mahony's Toadlet to occur across the majority of the site. This information should be considered when installing frog exclusion fencing. It may be most appropriate to install frog exclusion fencing during the breeding period for Mahony's toadlet in an attempt to contain a heightened quantity of toadlets within the eastern portion of the site. It is recommended that expert advice should be sought from Professor Mahony (Newcastle University) on the most appropriate timing for the installation of frog fences and also the extent of frog fencing required to ensure adequate containment.	take refuge in vegetated areas within the extraction footprint following breeding (late summer). • It is recommended that prior to vegetation clearing (within 12 months), frog exclusion fencing be installed around extraction areas in December when toadlets are likely to be concentrated within breeding habitats (outside of extraction footprint). Installation of fencing during this time will avoid individuals becoming trapped inside the extraction zone and will prevent frogs entering the extraction zone following the breeding period. However, given that extraction zone 1 includes a small area of breeding habitat, it is recommended that frog exclusion fencing be installed following vegetation clearing, as to not disturb breeding behaviour. • Given the toadlets are terrestrial frogs, which lack toe-pads, individuals are unlikely to be able to climb steep fencing (no need for loose overhanging lip). Frog exclusion fencing (sediment fencing) should be installed on an angle (50-80 degrees) pointing away from extraction areas. This will allow passage of toadlets from within the extraction area over the fence but will block individuals attempting to move into the extraction footprint.

DPE Comments on Version 4.0

The table below provides responses and updates where items identified in the DPE review were partially or not adequate.

#	Condition	Biodiversity and Rehabilitation Management Plan	Sufficient	Document reference and comment	Action Required	AMENDED
1	37 Schedule 3	managing bushfire risk	Partial	Section 6.20	It is recommended that Table 12 is updated to include corrective actions to address any impacts to biodiversity and rehabilitation from bushfires	Table 12 updated Bushfire may be beneficial depending on timing and intensity. Existing actions remain suitable for Years 1-7. Year 8 adjusted to include supplemental monitoring after fire to determine response.
2	**Written Direction of the Planning Secretary dated 14/03/23** Newcastle Sand must install perimeter fencing delineating the active resource area and on-site offset area by 30 April 2023. The fencing must:	a. be constructed from star pickets and either rope barricade or equivalent (such as plain two or three strand wire). A frog fence, silt fence, or similar does not satisfy this requirement.	No	The plan is not consistent with the written direction provided.	Update the plan to include detail of fencing delineating the active resource area and on-site offset area including the type / materials used.	Table 8: 6.3A
3		b. be continuous for the entire perimeter of the boundary of the active resource area and on-site biodiversity offset area.	No	The plan is not consistent with the written direction provided.	Update the plan to include detail of the requirement for continuous delineation fencing and how it has been met.	Table 8: 6.3A

#	Condition	Biodiversity and Rehabilitation Management Plan	Sufficient	Document reference and comment	Action Required	AMENDED
4	SOC 8.3.3 Access, Fencing, Gates and Signage	f) Progressively delineate the perimeter of the active resource area that will prevent incidental access into Offset Lands and not impede the movement of, or be a danger to, native fauna (e.g., rope barricade, or equivalent).	Partial	6.3 A	Provide detail in accordance with required actions above for Written Direction of the Planning Secretary dated 14/03/23	Table 8: 6.3A
5		i) Install fauna signage at main entrance and either side of corridor reminding drivers of the presence of wildlife and to adhere to site speed limits.	Partial	Table 8	Update Table 8 to align with these requirements	Table 8: 6.3F
6		j) Install signage on perimeter of Project Area on adjoining access roads advising the presence of the offset area.	Partial	Table 8	Update Table 8 to align with these requirements	Table 8: 6.3F
7		l) Install speed limit signage on quarry access roads.	No	Not addressed	Please include detail of speed limit signage	Table 8: 6.3G
8	SOC 8.3.18 Ecology and Rehabilitation Management	c) Pre-clearing surveys (see table for more detail)	Partial	Section 6.7 A Nocturnal survey requirement has been removed.	Reinstate nocturnal surveys.	Table 8: 6.7A
9		r) Quarry floor levels to be reviewed on completion of	No	Was removed	Please reinstate review of quarry floor	Table 8: 6.10B

#	Condition	Biodiversity and Rehabilitation Management Plan	Sufficient	Document reference and comment	Action Required	AMENDED
		quarrying to confirm required topsoil strip depth.			levels on completion of quarrying	This is reinstated but is practically redundant as floor level heights are an essential aspect of the quarry captured in numerous locations.
10		x) • Distribution of all stockpiled vegetation will occur following the respreading of topsoil up to a maximum of 20% ground cover by woody debris (greater than 10 cm diameter). The re-laid vegetation will comprise branches and timber of all sizes including leaves and stems of shrubs and grasses. • The placement of large timber should have regard to its orientation for the purpose of the capture of wind-blown sand and delay of runoff. Generally, this means an orientation along the north-east to south-west vectors, perpendicular to dominant onshore and off-shore winds.	Partial	Section 6.13 Propose max 2 piles per hectare 2-6m diameter, 2-4m tall with possible taller stem protruding.	Demonstrate that this measure would not compromise other commitments regarding the placement of woody debris.	The establishment of the wood piles provides measures to help minimise high density timber cover in some areas, whilst creating additional habitat. There is no commitment to a minimum cover of woody debris. The proposed measure therefore does not compromise the woody debris commitments.

#	Condition	Biodiversity and Rehabilitation Management Plan	Sufficient	Document reference and comment	Action Required	AMENDED
11	General Comments	In the Site inspection Follow Up Letter dated 16 December 2022. Direction to avoid the application of silt (wash plant fines) on the site, until further direction is provided by the Secretary was given with options for reuse on site or disposal to be provided for consideration and approval, in the form of an update to the BRMP.	Partial	6.9 (H) describes spread of silt fines	Please confirm testing and management of potential PFAS-containing or contaminated water and sediments in accordance with conditions 15 (d) (ii) and (iii) in Schedule 3.	The SWMP provides frequency and criteria for testing of PFAS in sediments and water. PFAS where detected around the wash plant has only been found at levels just above detection, any reapplication of sediments as proposed will most likely result in levels being below detection. Table 8: 6.9H, includes comment on PFAS.
12		Table 3 of BRMP	Partial	References in Table 3 are incorrect	Please update cross references	Table 3 updated.
	General Comments	In the Site inspection Follow Up Letter dated 16 December 2022. Direction to avoid the application of silt (wash plant fines) on the site, until further direction is provided by the Secretary was given with options for	Partial	6.9 (H) describes spread of silt fines	Please confirm testing and management of potential PFAS-containing or contaminated water and sediments in accordance with	Table 8: 6.9H, includes comment on PFAS management.

#	Condition	Biodiversity and Rehabilitation Management Plan	Sufficient	Document reference and comment	Action Required	AMENDED
		reuse on site or disposal to be provided for consideration and approval, in the form of an update to the BRMP.			conditions 15 (d) (ii) and (iii) in Schedule 3. RFI Response The SWMP provides frequency and criteria for testing of PFAS in sediments and water. PFAS where detected around the wash plant has only been found at levels just above detection, any reapplication of sediments as proposed will most likely result in levels being below detection. Table 8: 6.9H, includes comment on PFAS **DPE Response V4.1** Table 8, 6.9H Does not refer to PFAS. Please update the plan with a detailed process for the management of PFAS in silt fines.	

APPENDIX 3: BIODIVERSITY AND REHABILITATION BOND CALCULATIONS

This appendix provides for the calculation of the anticipated biodiversity and rehabilitation bond as required by Schedule 3, Condition 38 of the Development Consent. Pursuant to the Condition, within 6 months of the approval of the Biodiversity and Rehabilitation Management Plan the applicant must lodge the relevant bond. The sum of the bond is to be determined by:

(a) calculating the cost of implementing the measures contained in the Biodiversity and Rehabilitation Management Plan;

(b) calculating the cost of rehabilitating all disturbed areas of the site, taking into account the likely surface disturbance over the next 3 years of quarrying operations; and

(c) employing a suitably qualified quantity surveyor or other expert to verify the calculated costs, to the satisfaction of the Secretary.

Refer to attached Quantity Surveyors estimate.

APPENDIX 4: GUIDELINES

Australian Government
Department of the Environment

Arrive Clean, Leave Clean

Guidelines to help prevent the spread of invasive plant diseases and weeds threatening our native plants, animals and ecosystems

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

Images
(front cover) John Baker and the Department of the Environment
(back cover) Nick Rains

Arrive Clean, Leave Clean

Help prevent the spread of invasive plant diseases and weeds threatening our native plants, animals and ecosystems

When working in the bush, it's important to remember:

- Any activity in the bush has the potential to spread invasive species, including environmental restoration activities such as weeding and revegetation.
- Revegetation carries a particularly high risk as it involves the introduction of plants and soil. This risk increases through the use of dirty tools and equipment or plants and materials that are not certified to be free of pathogens and weeds.
- Clothing, hats, footwear, tools, equipment, machinery and vehicles can transport invasive species like *Phytophthora cinnamomi*, myrtle rust (*Puccinia psidii*), insects and weeds into our bushland.
- Even your skin and hair, as well as glasses, phones, watches, wallets and other pocket items can carry myrtle rust spores.
- Once these pathogens and weeds invade our bushland, eradication is often impossible. Follow these guidelines to help prevent their spread.

Photos: (left) Wildflowers on Mondurup Peak, Stirling Range before Phytophthora dieback (Robert Olver), (right) Mondurup Peak, Stirling Range after Phytophthora dieback (Department of Parks and Wildlife WA)

Phytophthora cinnamomi

What is *Phytophthora cinnamomi*?

Phytophthora cinnamomi is a soil-borne plant pathogen that attacks the roots of susceptible plants—destroying the root system and reducing the ability of the plant to absorb water and nutrients. This causes symptoms referred to as 'dieback' which can lead to plant death.

Under favourable conditions *Phytophthora* spp. can spread easily and quickly, destroying plants and plant communities. These guidelines to help minimise the risk of spreading *Phytophthora cinnamomi* also apply to other species of *Phytophthora* present in Australia, as the management of those species is similar.

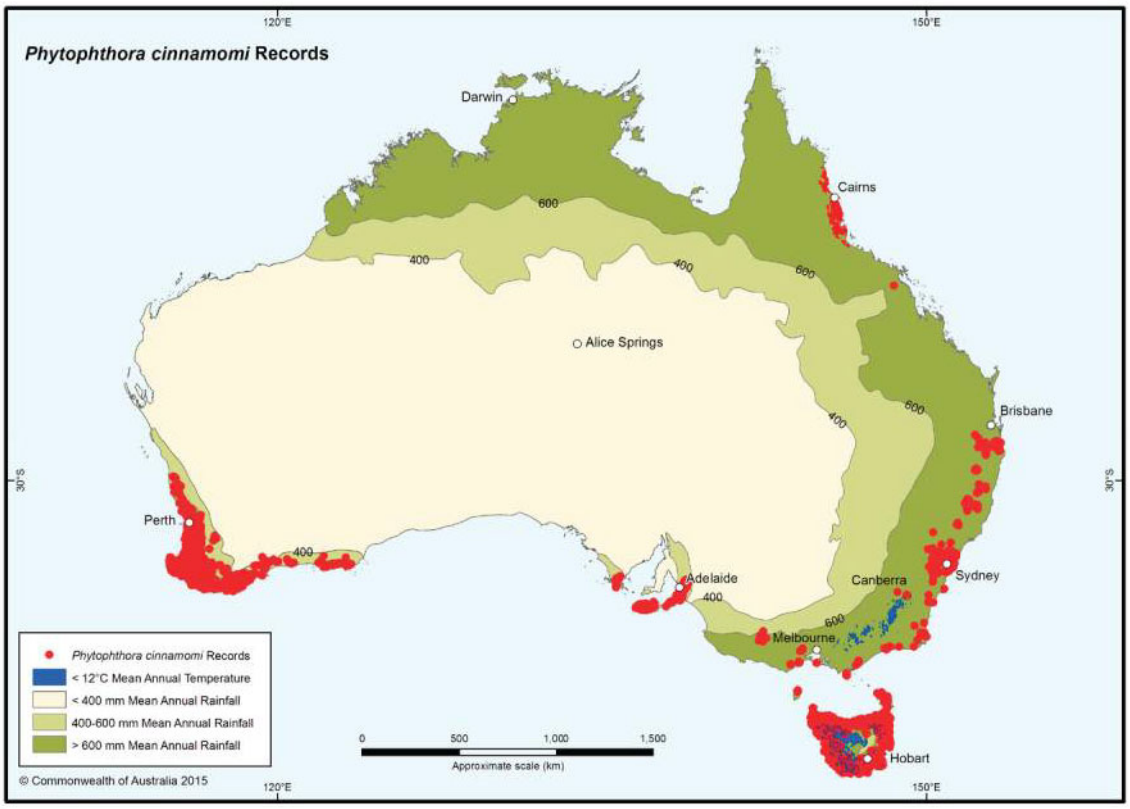
Photo: Impact of *Phytophthora cinnamomi* at Dwellingup, WA (Department of Parks and Wildlife WA)

What does *Phytophthora cinnamomi* threaten?

Thousands of Australian native plant species are susceptible to *Phytophthora cinnamomi*, and several of those species may be at risk of extinction due to its impacts. The dramatic impact of *Phytophthora* spp. infestations on plant communities may also lead to major declines in some insect, bird and animal species due to the loss of shelter, nesting sites and food sources.

Where is *Phytophthora cinnamomi* found?

Phytophthora cinnamomi thrives in warm, moist conditions with temperatures between 15°C and 30°C, and with rainfall greater than 400 millimetres a year. Its impact is greatest in Western Australia, Victoria, Tasmania and South Australia. The Northern Territory remains the only jurisdiction unaffected, as its environmental conditions are generally unfavourable to the pathogen.



Map: *P. cinnamomi* isolations, records of impact and broad climatic envelope of *P. cinnamomi* susceptibility in Australia.

This map was published in the *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi* in 2014. It does not represent the precise distribution of the pathogen in Australia and is for general information only.

How does *Phytophthora cinnamomi* spread?

Phytophthora cinnamomi spreads through soil, water and organic matter. It can remain dormant for long periods during dry weather and is impossible in most situations to eradicate from infested areas, which means limiting further spread is critical. Any activity that moves soil, water or plant material can spread the disease. This includes soil on tools, footwear and vehicles.

To help to prevent the spread of this plant disease:

- arrive clean, leave clean: ensure all clothing, hats, footwear, tools, equipment, machinery and vehicles are free of mud, soil and organic matter before entering and exiting bushland
- ensure any soil, plants or other materials entering the site are certified free of weeds and pathogens. You can do this by purchasing from Nursery Industry Accreditation Scheme Australia (NIASA) accredited businesses, and by ensuring that materials conform to Australian Standards—for example, *AS3743–2003 Potting mixes* or *AS4454–2012 Composts, soil conditioners and mulches*.

Myrtle rust

What is myrtle rust?

Myrtle rust is a disease caused by the fungus *Puccinia psidii*, initially identified as *Uredo rangelii*. It affects trees and shrubs in the Myrtaceae plant family—attacking young, soft, actively-growing leaves, shoot tips and young stems, as well as fruits and flower parts.

The first signs of rust infection are tiny raised spots or pustules on infected leaves. After a few days, the pustules erupt into distinctive bright yellow spore masses. Left untreated, the disease can cause deformed leaves, heavy defoliation of branches, dieback, stunted growth and plant death.

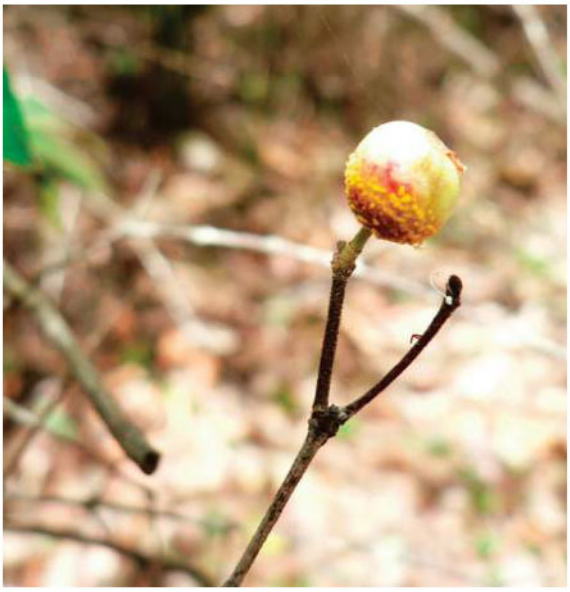


Photo: Myrtle rust pustules on scrub turpentine (*Rhodamnia rubescens*) fruit (R.O. Makinson)

What does myrtle rust threaten?

Plants susceptible to myrtle rust are those in the Myrtaceae family, which includes bottle brush (*Callistemon* spp.), tea tree (*Melaleuca* spp. and *Leptospermum* spp.), lilly pillies (*Syzygium* spp.) and eucalypts (*Eucalyptus* spp., *Angophora* spp. and *Corymbia* spp.). The Myrtaceae family in Australia is ecologically important, accounting for about 10% of Australia's native flora, with many Australian plant communities dominated by myrtaceous species.

Knowledge of the impacts of myrtle rust on Australian biodiversity is still limited. Myrtle rust infection may cause significant mortality among younger plants and therefore reduce the number of plants capable of maturing and reproducing. This may contribute to the decline of species, including threatened species, leading to potential impacts on the structure and function of ecosystems dependent on Myrtaceae. At the time of writing, nearly 350 native species are known to be susceptible to myrtle rust infection, some severely. The host list (see **References and resources** below) is expected to grow. However, all Myrtaceae are potentially susceptible and potential hosts for the disease.

Photo: Myrtle rust pustules on scrub turpentine (*Rhodamnia rubescens*) leaves (R.O. Makinson)

Where is myrtle rust found?

Myrtle rust was first detected in Australia in 2010 on the New South Wales central coast. It is now established along the east coast of Australia from southern New South Wales to far north Queensland, mostly east of the Great Escarpment. It is also present in Victoria, mainly at production nurseries and wholesale outlets in and around metropolitan Melbourne. The first detection of myrtle rust in Tasmania was in February 2015 at a property near Burnie on the north-west coast. At the time of writing, myrtle rust has not been detected in the Australian Capital Territory, the Northern Territory, South Australia, Western Australia or on Lord Howe Island or Christmas Island, but moister regions and vegetation types in all these jurisdictions are at risk of myrtle rust establishment. Domestic import restrictions apply for non-infested jurisdictions.

How does myrtle rust spread?

Myrtle rust spores can spread easily via contaminated clothing, hats, footwear, equipment or vehicles. It can also be spread by infected plant material, insects and other animals, or the wind. Even your skin and hair, as well as watches, wallets and other pocket items can carry myrtle rust spores. It is impossible to eradicate myrtle rust from infested bushland, so limiting further spread is critical.

To help to prevent the spread of myrtle rust:

- arrive clean, leave clean:
  - Wash all clothing, hats and gloves between site visits—using warm or hot machine wash with detergent.
  - Ensure all clothing, hats, footwear, tools, equipment, machinery and vehicles are free of mud, soil and organic matter before entering and exiting bushland.
  - Use a solution of 70% ethanol or methylated spirits in 30% water to disinfect items that may be contaminated (including hats, footwear, tools, equipment, machinery, vehicles, walking sticks, tent pegs, phones, glasses, watches, wallets and other personal items).
- ensure any soil, plants or other materials entering the site are certified free of weeds and pathogens. You can do this by purchasing from Nursery Industry Accreditation Scheme Australia (NIASA) accredited businesses, and by ensuring that materials conform to Australian Standards—for example, *AS3743–2003 Potting mixes* or *AS4454–2012 Composts, soil conditioners and mulches*.
- monitor plants carefully as nurseries and plant maintenance facilities may provide ideal conditions for myrtle rust (see Australian Nursery Industry myrtle rust management plan 2012 in **References and resources** below).

Photo: Myrtle rust spores on clothing after chance contact with an infected shrub (R.O. Makinson)

Weeds

What is a weed?

A weed is any plant that has a negative impact on our economy, environment, health and surroundings. Weeds are generally species which are not native to Australia. However, some native species growing outside of their native range can also become invasive. Many weeds are species which have escaped cultivation and become naturalised—that is, they have begun reproducing without human assistance.

What do weeds threaten?

Many weed species are able to invade natural areas and cause disturbance to bushland ecosystems. They can alter plant and animal community composition, cause changes to nutrient cycles, change natural fire regimes, outcompete native species for resources, impact threatened species and threaten biodiversity.

Where are weeds found?

The diversity of weed species recorded in Australia means that most terrestrial and aquatic ecosystems are vulnerable to weed invasion. Weeds have characteristics that help them grow well in many environments—from our towns and cities through to our coasts, deserts and alpine areas.

How do weeds spread?

Weeds typically spread easily by producing large numbers of seeds or reproducing vegetatively. They are often excellent at surviving and reproducing in disturbed environments and are commonly the first species to colonise and dominate in these conditions. Seeds and other plant material can spread into natural and disturbed environments via wind, animals, waterways and people (including contaminated clothing, hats, footwear, tools, equipment, machinery and vehicles).

To help to prevent the spread of weeds:

- arrive clean, leave clean: ensure all clothing, hats, footwear, tools, equipment, machinery and vehicles are free of weed seeds, mud, soil and organic matter before entering and exiting bushland.
- ensure any soil, plants or other materials entering the site are certified free of weeds and pathogens. You can do this by purchasing from Nursery Industry Accreditation Scheme Australia (NIASA) accredited businesses, and by ensuring that materials conform to Australian Standards—for example, *AS3743–2003 Potting mixes* or *AS4454–2012 Composts, soil conditioners and mulches*.
- if revegetating, select indigenous plants that occur naturally in your local area. Undertake weed control work well in advance to minimise the weed seed bank before you start planting. At the very least, slash the flower heads of weed species before they go to seed.

Before beginning a project

Undertake a risk assessment:

- Identify any planned activities with the potential to spread pathogens and weeds. This includes movement of people, equipment, vehicles and materials to/from/through infected or potentially infected areas.
- Determine the project site's pathogen and weed risks through liaison with land managers (for example government agencies, traditional owners, Indigenous Protected Area managers etc.).
- Consult sources of advice and expertise for contingent risks (for example state/territory departments of primary industry, pathology/weed identification services at botanic gardens).

Develop a hygiene management plan:

- Use your risk assessment to determine which hygiene procedures are necessary to prevent the spread of pathogens and weeds, and how and where to apply them.
- Ensure all materials taken onto the site—such as seedlings, mulch, soil, gravel, rock and sand—are certified free of weeds and pathogens. You can do this by purchasing from Nursery Industry Accreditation Scheme Australia (NIASA) accredited businesses, and ensuring materials conform to Australian Standards—for example, *AS3743–2003 Potting mixes* or *AS4454–2012 Composts, soil conditioners and mulches*.
- Create a checklist of hygiene procedures for project managers and participants to use.

Consider the following during project planning:

- Limit the number of sites you visit to one per day. If this is not possible, visit clean sites before infested sites.
- Provide training or briefing to all participants on the risks of spreading pathogens and weeds and risk mitigation strategies. If available, provide maps to participants with the location of infested and clean areas and wash-down points.
- Ensure that rigorous inspections and quality checks are built into the management of the entire supply chain for materials and plant material when carrying out revegetation or translocation activities where pathogens are a potential concern (see Australian Nursery Industry myrtle rust management plan 2012 in **References and resources** below). This is particularly important when working in areas where threatened species and threatened ecological communities are found.
- Where there is the risk of Phytophthora dieback (a plant disease caused by the pathogen *Phytophthora cinnamomi*), schedule activities for the dry season as it spreads more easily in wet and muddy conditions. If necessary, postpone activities and reschedule for a day when the soil is dry and doesn't stick to footwear, equipment and tools.
- If working in a weedy area, try to schedule activities for when the weed species are not in seed.
- Avoid taking vehicles into bushland. If a vehicle is necessary, ensure it is clean and dry on entry and exit, and restrict movement to hard, dry surfaces, formed roads and designated parking areas—avoid driving through puddles and mud. Where myrtle rust is a risk, avoid parking near myrtaceous plants—for example bottle brushes, tea trees, lilly pillies and eucalypts—and thoroughly clean vehicles inside and out between site visits.
- Avoid polystyrene boxes and tools with wooden or cracked handles. Use equipment that can be cleaned easily and thoroughly.
- Minimise the number of personal items you carry. Where myrtle rust is a risk, clean all items—such as GPS devices, glasses, phones, watches, wallets and other items kept in your pockets—with alcohol wipes before entering and leaving sites.

One site per day

Before entering or leaving a site

- Be aware of what plants look like when infected with myrtle rust and Phytophthora dieback (see images above).
- Remove all weed seeds, mud, soil and organic matter from clothing, footwear, tools, equipment, machinery, vehicles, boxes, backpacks, walking sticks, tent pegs and anything else that touches plants or the ground. Stay as clean as possible while in the bush.
- If you are entering clean bushland or have come from an area that is infested with *Phytophthora* spp. or myrtle rust, ensure everything with you is cleaned and disinfected with a solution of 70% ethanol or methylated spirits in 30% water. This includes footwear, tools, equipment, machinery, vehicles, backpacks, walking sticks, tent pegs and personal items.

Disinfecting clothing, footwear, equipment and other personal items

i. Carry a hard brush and a spray bottle of disinfectant—made up of a solution of 70% ethanol or methylated spirits in 30% water. If you are able to carry more, assemble a simple hygiene kit—see Appendix A.

ii. Set up a wash-down area for participants to wash and dry their face and hands and clean their footwear before entering and exiting the site.

iii. To clean footwear, first use a hard brush or stick to remove as much mud, soil and organic matter as possible before disinfecting with a solution of 70% ethanol or methylated spirits in 30% water—applied through a spray bottle or a footbath.

iv. Seal all personal rubbish in a bag and spray the outside of the bag with a solution of 70% ethanol or methylated spirits in 30% water before responsible disposal offsite.

v. Collect all removed mud, soil and organic matter in a bag or bucket, and keep it out of clean bushland.

Disinfecting vehicles and machinery

i. Use a wash-down facility for vehicles and machinery if available, or wash-down on a hard, well-drained surface, for example a road, and on ramps if possible. See **References and resources** below for links to online wash-down guidelines.

ii. Pay particular attention to cleaning mud flaps and tyres.

iii. Dispose of wash-down water so that it drains back into a low area of the infested zone away from waterways. If this is not possible, empty it into a waste container for responsible disposal offsite.

iv. Don't allow wash-down water to drain into clean bushland.

v. Don't drive through wash-down water.

Photo: Wash-down point (Department of Parks and Wildlife WA)

Photo: Truck undercarriage wash-down (South Coast Natural Resource Management, WA)

Additional considerations where myrtle rust is present

- Disposable overalls and caps may be worn over clothing upon entering a site, and removed when leaving the site. However, in high-risk cases, also shower and change into clean clothes (including hats, gloves and footwear).
- Wash all clothing, hats and gloves between site visits using warm or hot machine wash with detergent.
- Do **NOT** remove any plant material from sites infested with myrtle rust. Dispose of plant waste by burial on site. If this is not possible, seal the waste in a plastic bag, seal the bag in a second bag and spray the outside of the bag with a solution of 70% ethanol or methylated spirits in 30% water before responsible disposal offsite.

Revegetation

Where weeds and other disturbances are controlled, natural regeneration can assist the bushland to revegetate over time. Where revegetation activities are necessary, the following steps will help stop the spread of invasive species:

- Arrive clean, leave clean—ensure all clothing, hats, footwear, tools, equipment, machinery and vehicles are free of weed seeds, mud, soil and organic matter before entering and exiting bushland.
- Liaise with land managers and relevant plant specialist stakeholders (for example Australian Network for Plant Conservation, Greening Australia, Landcare groups, botanic gardens, seed banks etc.) to collaborate on the revegetation strategy.
- Select indigenous plants that occur naturally in your local area wherever possible.
- Avoid species with the potential to become weeds of the environment or agriculture.
- If the site is infested with *Phytophthora* spp. or myrtle rust, select species resistant to the disease, or seed from more tolerant individuals of susceptible plant species.
- Consult the Australian Network for Plant Conservation translocation guidelines 2004 (see **References and resources** below). These focus on threatened species but many of the techniques and considerations also apply to non-threatened species.
- Consider a combination of revegetation techniques such as seed production areas, direct sowing and enhancement of natural sites to assist natural regeneration. Many of these will be lower risk than the use of seedlings.
- If using seedlings, purchase them from a supplier that can guarantee high standards of hygiene—such as NIASA-accredited businesses. For added certainty, ensure the supplier allows testing of a random sample of seedlings and soil for *Phytophthora* spp. 3–6 weeks before acceptance of the seedlings. If the pathogen is present, the batch must be rejected.
- Check plants on receipt and at intervals during any holding period. Seek specialist advice if any suspect symptoms appear (for example coloured pustules, leaf necrosis).
- If propagating, maintain high standards of hygiene—see the section on propagation below.
- Plant when the soil is moist but not wet.
- Use mains or disinfected water to irrigate plants.
- If you are aware of a plant pathogen infestation, begin revegetation in the clean part of the bushland before moving to the infested area. Ensure all clothing, hats, footwear, tools, equipment, machinery and vehicles are clean before leaving the infested area.

Weed management

When conducting weed management activities, the following steps will help stop the spread of invasive species:

- Arrive clean, leave clean—ensure all clothing, hats, footwear, tools, equipment, machinery and vehicles are free of weed seeds, mud, soil and organic matter before entering and exiting bushland.
- Schedule weeding for dry soil conditions where possible.
- Use techniques that minimise soil disturbance. For example, mow or slash or use an appropriate herbicide in preference to digging or grading.
- Ensure transport and disposal of plant material does not introduce weeds to new areas. In sites free of myrtle rust, place weeds into a bag or container immediately for removal. Always cover trailers when transporting plant material to prevent anything from falling off. Some weeds can reproduce vegetatively—from leaves, bulbs or other plant material—while others use seeds, and some may require heat or cold treatment before composting, mulching or disposal.
- If a site is infested with myrtle rust, do **NOT** remove any plant material. Dispose of plant waste by burial on site. If this is not possible, seal the waste in a plastic bag, seal the bag in a second bag and spray the outside of the bag with a solution of 70% ethanol or methylated spirits in 30% water before responsible disposal offsite.
- If you are aware of a plant pathogen infestation, begin weeding in the clean part of the bushland before moving to the infested area. Clean all clothing, hats, footwear, tools, equipment, machinery and vehicles before leaving the infested area.

Propagation

The following steps will help stop the spread of invasive species during propagation activities:

- Ensure all benches, equipment, pots and containers are clean and disinfected.
- While using implements such as cutting knives or secateurs, wash them regularly with a solution of 70% ethanol or methylated spirits in 30% water.
- Steam-air pasteurise soil mixes for 30 minutes at 60°C, or select materials that conform to Australian Standard *AS3743–2003 Potting mixes* or *AS4454–2012 Composts, soil conditioners and mulches*. These standards require the materials to be free from plant pathogens, pests, harmful chemicals and weeds.
- Avoid bringing soil on boots and equipment into the nursery areas.
- If possible, keep pots on raised wire-mesh benches at least 30 centimetres off the ground. Otherwise, keep them on free-draining blue metal.
- Keep the whole nursery area clean and free of dead plant material and rubbish.

References and resources—general

Guidelines for the translocation of threatened plants in Australia—Second edition	2004	Vallee L, Hogbin T, Monks L, Makinson B, Matthes M and Rossetto M; Australian Network for Plant Conservation, Canberra	https://www.anbg.gov.au/anpc/publications/translocation.html
Leave no trace Australia		Web resources	www.lnt.org.au/resources/biosecurity/bio-security.html www.lnt.org.au/resources/skills-ethics-series.html

References and resources—wash-down procedures

Vehicle and machinery checklists—clean-down procedures	2014	Biosecurity Queensland, Department of Agriculture, Fisheries and Forestry; State of Queensland	https://www.daff.qld.gov.au/__data/assets/pdf_file/0011/58178/IPA-Cleandown-Procedures.pdf
Weed out the seeds—How to clean down your vehicle and machinery to help prevent the spread of weed seeds	2011	Biosecurity Queensland, Department of Agriculture, Fisheries and Forestry; State of Queensland	https://www.youtube.com/watch?v=dTNDecjTVfI
A guide for machinery hygiene for civil construction	2011	Civil Contractors Federation, State of Victoria, Department of Primary Industries, Department of Sustainability and Environment, VicRoads and the Association of Land Development Engineers	www.civilcontractors.com/Uploads/files/LR%20CCF%20Machinery%20Hygiene%20Bklt%2040pp.pdf
Keeping it clean: A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens	2010	NRM South, Tasmania	dpipwe.tas.gov.au/Documents/15130802_52keepingitcleanspreadswe.pdf
Biosecurity videos		NRM South, Tasmania	www.nrmsouth.org.au/biosecurity/
Field hygiene kits for landholders or community groups in Tasmania—available for purchase		NRM South, Tasmania	Landholders www.nrmsouth.org.au/wp-content/uploads/2014/08/Biosecurity-kits-sales-flyer-2015-Landholders.pdf Community groups www.nrmsouth.org.au/wp-content/uploads/2014/08/Biosecurity-kits-sales-flyer-2015-community.pdf

References and resources—seed production areas

Sowing seeds: bridging the gap between ex situ collections and reintroduction	2012	Guja L, North T, Taylor D and McAuliffe J; Australasian Plant Conservation 21(3)	www.anbg.gov.au/anpc/apc/21-3_guja.html
Developing seed production areas for native plants—Corangamite region guidelines	2008	Heyes S, Butler M, Gartlan C and Ovington A; Corangamite Seed Supply and Revegetation Project	www.florabank.org.au/files/documents/seedproductionareas/Corangamite%20Seed%20Production%20Area%20Guidelines08%20P1.pdf
Introducing seed production areas: an answer to native seed shortages	2008	Vanzella B; Greening Australia	www.florabank.org.au/files/newsattachments/SPA%20handout_%20master%20GACR%20Bindi%20Vanzella%20March08.pdf

References and resources—*Phytophthora cinnamomi*

Managing Phytophthora dieback—Guidelines for local government	2000	Dieback Working Group	https://www.dwg.org.au/images/dieback_publications/Managing_Phytophthora_Dieback_guidelines.pdf
Managing Phytophthora dieback in bushland—A guide for landholders and community conservation groups	2008	Dieback Working Group	https://www.dwg.org.au/images/dieback_publications/Managing_Phytophthora_Dieback_in_Bushland.pdf
Resistant native plant species—A list of resistant native plant species from Western Australia from the Centre of Phytophthora Science and Management at Murdoch University		Dieback Working Group	https://www.dwg.org.au/images/dieback_publications/Western_Australian_Natives_Resistant.pdf
Susceptible native plant species—A list of susceptible native plants species from Western Australia from the Centre of Phytophthora Science and Management at Murdoch University		Dieback Working Group	https://www.dwg.org.au/images/dieback_publications/Western_Australian_natives_susceptible.pdf

Management of *Phytophthora cinnamomi* for biodiversity conservation in Australia: Part 1—A review of current management.	2005	O'Gara E, Howard K, Wilson B and Hardy GEStJ—a report by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia funded by the Australian Government Department of the Environment and Heritage	www.environment.gov.au/biodiversity/invasive-species/publications/management-phytophthora-cinnamomi-biodiversity-conservation
Management of *Phytophthora cinnamomi* for biodiversity conservation in Australia: Part 2—National best practice guidelines. Appendix 1—*Phytophthora cinnamomi* Appendix 2—The rationale of current management options Appendix 3—Areas vulnerable to disesase caused by *Phytophthora cinnamomi* Appendix 4—The responses of native Australian plant species to *Phytophthora cinnamomi*	2005	O'Gara E, Howard K, Wilson B and Hardy GEStJ—a report by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia funded by the Australian Government Department of the Environment and Heritage	www.environment.gov.au/biodiversity/invasive-species/publications/management-phytophthora-cinnamomi-biodiversity-conservation
Management of *Phytophthora cinnamomi* for biodiversity conservation in Australia: Part 3—Risk assessment for threats to ecosystems, species and communities: A review	2005	Wilson B, Howard K, O'Gara E and Hardy GEStJ—a report by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia funded by the Australian Government Department of the Environment and Heritage	www.environment.gov.au/biodiversity/invasive-species/publications/management-phytophthora-cinnamomi-biodiversity-conservation
Management of *Phytophthora cinnamomi* for biodiversity conservation in Australia: Part 4—Risk assessment models for species, ecological communities and areas.	2005	Centre for Phytophthora Science and Management—a report by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia funded by the Australian Government Department of the Environment and Heritage	www.environment.gov.au/biodiversity/invasive-species/publications/management-phytophthora-cinnamomi-biodiversity-conservation

Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*	2014	Australian Government Department of the Environment	www.environment.gov.au/resource/threat-abatement-plan-disease-natural-ecosystems-caused-Phytophthora-cinnamomi
Background: Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*	2014	Australian Government Department of the Environment	www.environment.gov.au/resource/threat-abatement-plan-disease-natural-ecosystems-caused-Phytophthora-cinnamomi
Response of selected South Australian native plant species to *Phytophthora cinnamomi*	2012	Kueh KH, McKay SF, Facelli E, Facelli JM, Velzeboer RMA, Able AJ, Scott ES	onlinelibrary.wiley.com/doi/10.1111/j.1365-3059.2012.02593.x/full
Infection of native plants by *Phytophthora cinnamomi*—key threatening process listing	2002	New South Wales Government Office of Environment and Heritage	www.environment.nsw.gov.au/determinations/PhytophthoraKTPListing.htm
Stamp out the spread of Phytophthora dieback		Royal Botanic Gardens Sydney	www.rbgsyd.nsw.gov.au/__data/assets/pdf_file/0008/106937/Phytophthora_brochure.pdf
Are you a carrier? Phytophthora dieback is a silent plant killer		Royal Botanic Gardens Sydney	www.rbgsyd.nsw.gov.au/__data/assets/pdf_file/0007/106936/Phytophthora_flyer.pdf
Management of *Phytophthora cinnamomi* in production forests	2009	Tasmanian Government Forest Practices Authority	www.fpa.tas.gov.au/__data/assets/pdf_file/0004/58054/Flora_technical_note_8_Phytophthora.pdf
Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects Guide 7: Pathogen management	2011	NSW Roads and Maritime Services	www.rms.nsw.gov.au/documents/about/environment/biodiversity_guidelines.pdf

References and resources—myrtle rust

Look out for myrtle rust	2010	New South Wales Department of Primary Industries	www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/364870/myrtle-rust-brochure.pdf
Identification of myrtle rust	2010	New South Wales Department of Primary Industries	www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/337374/identification-myrtle-rust.pdf
Preventing spread of myrtle rust in bushland	2010	New South Wales Department of Primary Industries	www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/362096/preventing-spread-Myrtle-Rust-bushland.pdf
New South Wales Department of Primary Industries myrtle rust resources page		New South Wales Department of Primary Industries	www.dpi.nsw.gov.au/biosecurity/plant/myrtle-rust/resources
Australian Nursery Industry myrtle rust management plan	2012	Nursery and Garden Industry Australia	www.ngia.com.au/Folder?Action=View%20File&Folder_id=135&File=Myrtle%20Rust%20Management%20Plan%202012%20Final%20V2.pdf
Myrtle rust—current information including national and international host lists; bibliography.	2014	The Australian Network for Plant Conservation	https://www.anbg.gov.au/anpc/resources/Myrtle_Rust.html
Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects Guide 7: Pathogen management	2011	NSW Roads and Maritime Services	www.rms.nsw.gov.au/documents/about/environment/biodiversity_guidelines.pdf
Current Biosecurity Threats		Biosecurity Tasmania, Department of Primary Industries, Parks, Water and Environment	dpipwe.tas.gov.au/biosecurity/current-biosecurity-threats

References and resources—weeds

Australian Weeds Strategy—A national strategy for weed management in Australia	2006	Natural Resource Management Ministerial Council, Australian Government Department of the Environment and Water Resources	www.environment.gov.au/biodiversity/invasive/weeds/publications/strategies/pubs/weed-strategy.pdf
Weeds in Australia web pages		Australian Government Department of the Environment	www.weeds.gov.au
Weeds of National Significance (WoNS) web pages		Australian Weeds Committee	www.weeds.org.au
Vehicle and machinery checklists—clean-down procedures	2014	Biosecurity Queensland, Department of Agriculture, Fisheries and Forestry; State of Queensland	https://www.daff.qld.gov.au/__data/assets/pdf_file/0011/58178/IPA-Cleandown-Procedures.pdf
Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects Guide 6: Weed management	2011	NSW Roads and Maritime Services	www.rms.nsw.gov.au/documents/about/environment/biodiversity_guidelines.pdf

Appendix A

Example checklists

Risk assessment checklist

Determine all risks associated with the potential transfer of pathogens or weeds to/from/through the project site (consider all participants handling plant material and equipment, from collection to site through to on-site works and clean-up).

Liaise with the project site's land managers to determine the presence of:

☐ *Phytophthora* spp.

☐ Myrtle rust

☐ Weeds

Liaise with the project site's land managers to determine the presence of:

☐ Vulnerable native plant communities

☐ Species susceptible to *Phytophthora* spp. or myrtle rust

☐ Threatened species or communities listed under Commonwealth or state/territory legislation

Identify any planned activities with the potential to introduce or spread pathogens or weeds:

☐ Introduction of plant material to a site (seedlings, seeds, mulch etc.)

☐ Introduction of other materials to a site (soil, gravel, rock, sand etc.)

☐ Vehicle or machinery access to a site

☐ Any potential soil disturbance

Hygiene management plan checklist

To prevent the risks having an impact:

☐ Plan to visit only one site per day

☐ Schedule activities for the right conditions

☐ Use equipment that can be cleaned easily and thoroughly

☐ Minimise personal items that can carry pathogens

☐ Include training sessions so participants are aware of why hygiene is necessary, how to arrive clean, stay clean and leave clean

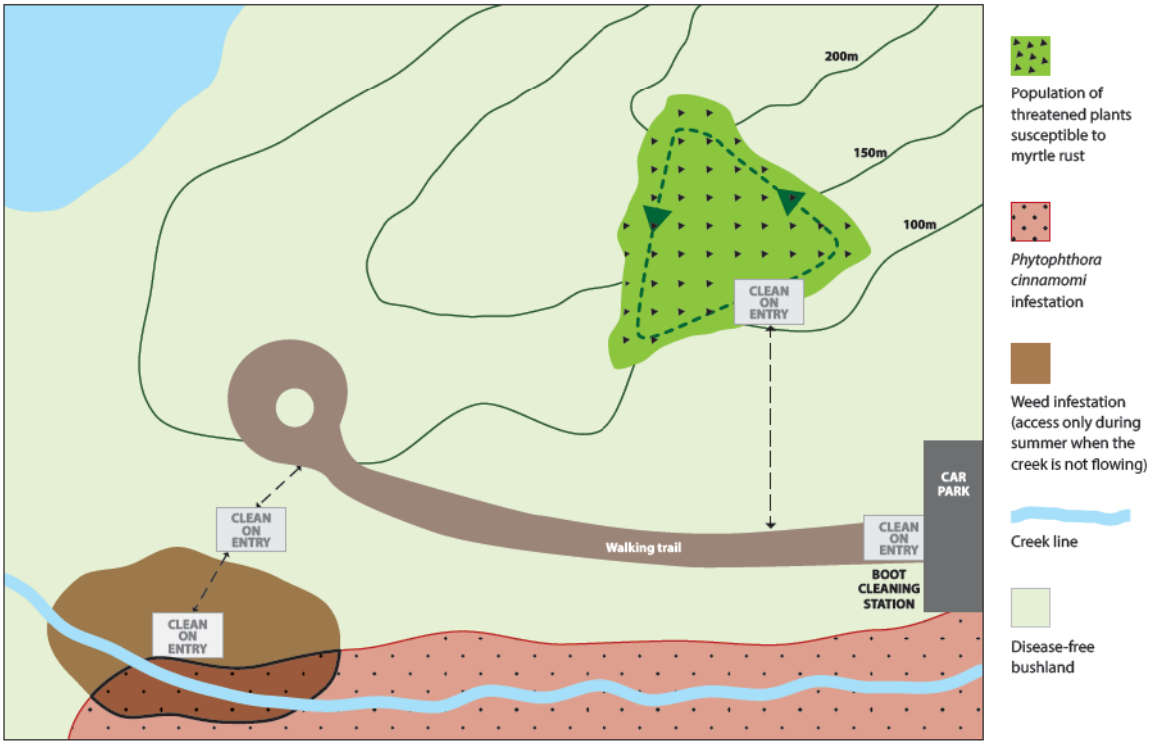
☐ Establish access controls including routes of access and timing on a management map

☐ Establish hygiene controls including hygiene procedures, hygiene infrastructure, clean on entry locations and wash-down points on a management map

☐ Maintain wash-down facilities and hygiene infrastructure

☐ Record and monitor site for any accidental spread of pathogens or weeds

Example hygiene management map



A large area within the project site is disease-free bushland, including a population of threatened plants susceptible to myrtle rust. This population must be monitored regularly during and after the project for any indications of disease.

There is an infestation of the weed arum lily (*Zantedeschia aethiopica*) limited to a small area on either side of the creek. Part of this area is also infested with *Phytophthora cinnamomi* which is present along much of the creek line. To avoid the spread of *Phytophthora cinnamomi*, all weed control activities should be scheduled during the dry season when the creek is not flowing.

'Clean on entry' access to the site is via a boot cleaning station at the car park entrance. From the walking trail there is one pathway of access to the population of threatened plants and another to the arum lily population. At both of these 'clean on entry' points there will be hygiene kits containing hard brushes, spray bottles of disinfectant and alcohol wipes.

Biosecurity hygiene kit: assemble a simple kit with the following items:

☐ Plastic tub with a lid (to carry items and to use as a footbath)

☐ Stiff brush

☐ Newspaper to cover the footwell of a vehicle (replace with clean newspaper regularly)

☐ Dustpan and brush; possibly also a long-handled broom

☐ Plastic bag for sweepings and dirty newspaper

☐ Drum of water and some disinfectant, for example a solution of 70% ethanol or methylated spirits in 30% water; or 20% household bleach (with 5% active ingredient) in 80% water; or quaternary ammonium disinfectant diluted according to manufacturer's directions.

☐ Spray bottle with a solution of 70% ethanol or methylated spirits in 30% water

☐ Alcohol wipes or gel for hands and personal items

Photo: Biosecurity hygiene kit (Department of Parks and Wildlife WA)

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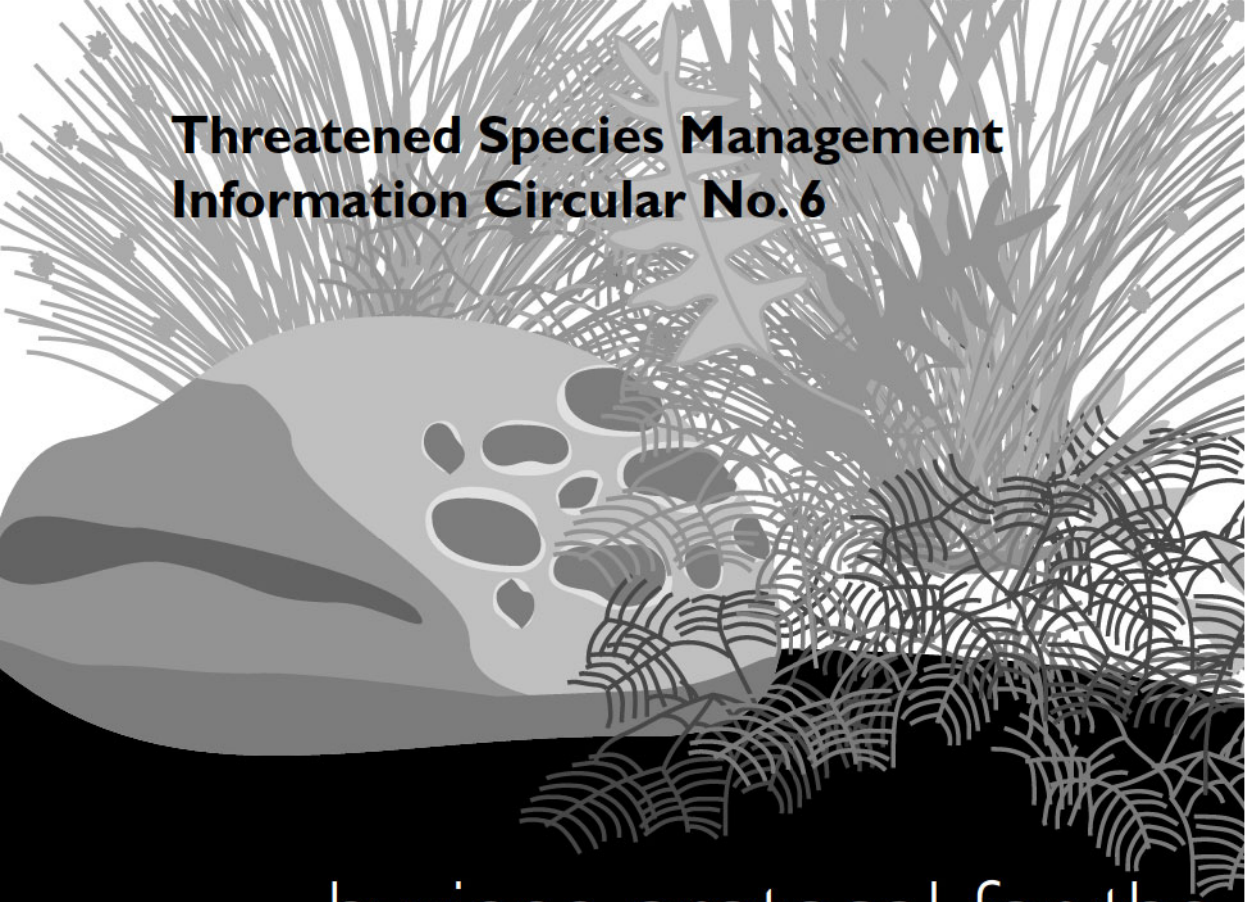
Threatened Species Management Information Circular No. 6



hygiene protocol for the control of disease in frogs

April 2008

Department of **Environment & Climate Change** NSW

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This hygiene protocol is an adaptation of the Declining Amphibian Population Task Force (DAPTF) Fieldwork Code of Practice and the recommendations of Speare et al. (1999) and has drawn on recommendations from earlier guidelines prepared by Environment ACT.

Foundation for National Parks and Wildlife funded the printing of this protocol.

hygiene protocol for the control of disease in frogs

1 introduction

This information circular outlines measures to:

- Prevent or reduce disease causing pathogens being transferred within and between wild populations of frogs.
- Ensure captive frogs are not infected prior to release.
- Deal safely with unintentionally transported frogs.
- Assist with the proper identification and management of sick and dead frogs in the wild.

1.1 Who should read this document?

This protocol is intended for use by all researchers, wildlife consultants, fauna surveyors and students undertaking frog field-work. In addition, the protocol should be read by Department of Environment and Climate Change (DECC) personnel, frog keepers, wildlife rescue and carer organisations, herpetological/frog interest groups/ societies, fauna park/zoo operators/workers and other individuals who regularly deal with or are likely to encounter frogs.

This protocol outlines the expectations of the DECC regarding precautionary procedures to be employed when working with frog populations. The intention is to promote implementation of hygiene procedures by all individuals working with frogs. New licences and licence renewals will be conditional upon incorporation of the protocol. The DECC recognises that some variation from the protocol may be appropriate for particular research and frog handling activities. Such variation proposals should accompany any licence application or renewal to the DECC.

1.2 Background

1.2.1 Amphibian Chytrid Fungus

The apparent decline of frogs, including extinctions of species and local populations, has attracted increased international and national concern. Many potential causes for frog declines have been proposed (eg see Pechmann et al., 1991; Ferrero and Bergin, 1993; Pechmann and Wilbur, 1994; Pounds and Crump, 1994; Pounds et al., 1997). However, the patterns of decline at many locations suggest that epidemic disease maybe the cause (Richards et al., 1993; Laurance et al., 1996; Alford and Richards, 1997). Recent research has implicated a water-borne fungal pathogen *Batrachochytrium dendrobatidis* as the likely specific causative agent in many of these declines both in Australia and elsewhere (Berger et al., 1998; 1999). This agent is commonly known as the amphibian or frog chytrid fungus and is responsible for the disease Chytridiomycosis (Berger et al., 1999).

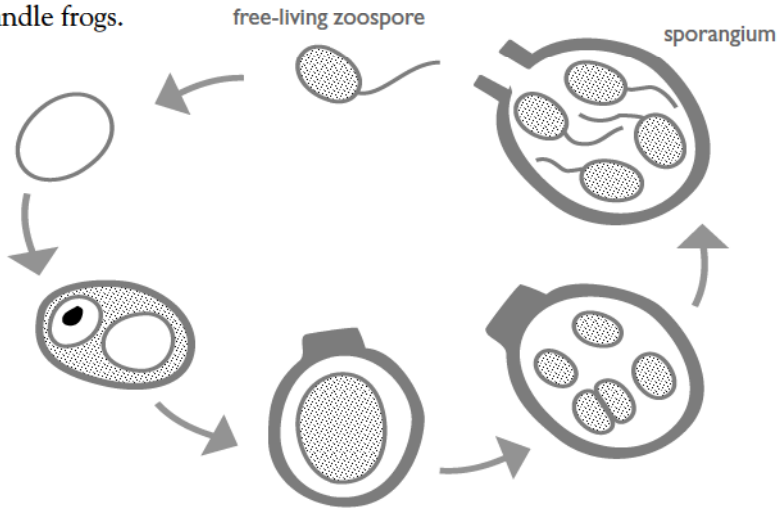
B. dendrobatidis is a form of fungus belonging to the phylum Chytridiomycota. Most species within this phylum occur as free-living saprophytic fungi in water and soil and have been found in almost every type of environment including deserts, artic tundra and rainforest and are considered important primary biodegraders (Powell 1993). *B. dendrobatidis* is a unique parasitic form of Chytridiomycete fungi, in that it invades the skin of amphibians, including tadpoles, often causing sporadic deaths with up to 100% mortality in some populations. Chytridiomycosis has been detected in over 40 species of native amphibian in Australia (Mahony and Workman 2000). However, it is not currently known whether the fungus is endemic or exotic to Australia.

The infective stage of *B. dendrobatidis* is the zoospore and transmission requires water (Berger et al.,1999). Zoospores released from an infected amphibian can potentially infect other amphibians in the same water. More research is needed on the dynamics of infection in the wild. *B. dendrobatidis* is known to be susceptible to seasonal temperature changes, dehydration, salinity, water pH, light, nutrition and dissolved oxygen (Berger et al., 1999).

1.3 Objectives

The objectives of the hygiene protocol are to:

- Recommend best-practice procedures for DECC personnel, researchers, consultants and other frog enthusiasts or individuals who handle frogs.
- Suggest workable strategies for those regularly working in the field with frogs or conducting fieldwork activities in wetlands and other aquatic environments where there is the potential for spreading pathogens such as the frog chytrid fungus.
- Provide background information and guidance to people who provide advice or supervise frog related activities.
- Provide standard licence conditions for workers engaged in frog related activities.
- Inform Animal Care and Ethics Committees (ACEC) for their consideration when granting research approvals.



Life cycle of frog chytrid fungus from infective free-living zoospore stage to sporangium (adapted from L. Berger).

2 site hygiene management

A checklist of risk management procedures and recommended standard hygiene kit is provided in Appendix 1. Please note Footnote 1 on page 4.

Individuals studying frogs often travel and collect samples of frogs from multiple sites. Some frog populations can be particularly sensitive to the introduction of infectious pathogens such as the frog chytrid fungus. Also, the arrangement of populations in the landscape may make frogs particularly vulnerable to transmission of infectious pathogens. Therefore, it is important that frog workers recognise the boundaries between sites and undertake measures which reduce the likelihood of spreading infection.

Where critically endangered species or populations of particular risk are known to occur, this protocol should be applied over very short distances ie a single site may need to be subdivided and treated as separate sites.

When planning to survey multiple sites, always start at a site where frog chytrid fungus is not known to be present before entering other infected areas.

2.1 Defining a site

Defining the boundary of a site maybe problematic. In some places, the boundary between sites will be obvious but in others, less so. Undertaking work at a number of sites or conducting routine monitoring at a series of sites within walking distance creates obvious difficulties with boundary definitions. It is likely that defining the boundary between sites will differ among localities. It may be that a natural or constructed feature forms a logical indicator of a site boundary eg a road/track, a large body of water such as a river or the sea, a marked habitat change or a catchment boundary.

As a guiding principle, each individual waterbody should be considered a separate site.

When working along a river or stream or around a wetland or a series of interconnecting ponds it is reasonable, in most instances, to treat such examples as a single site for the purposes of this protocol. Such a case would occur in areas where frogs are known to have free interchange between ponds.

Where a stream consists of a series of distinctive tributaries or sub-catchments or where there is an obvious break or division then they should be treated as separate sites, particularly if there is no known interchange of frogs between sites.

2.2 On-site hygiene

When travelling from site to site it is recommended that the following hygiene precautions be undertaken to minimise the transfer of disease from footwear, equipment and/or vehicles.

Footwear

Footwear must be thoroughly cleaned and disinfected at the commencement of fieldwork and between each sampling site.

This can be achieved by initially scraping boots clear of mud and standing the soles in a disinfecting solution. The remainder of the boot should be rinsed or sprayed with a disinfecting solution that contains *benzalkonium chloride* as the active ingredient. Disinfecting solutions should be prevented from entering any water bodies.

Rubber boots such as 'gum boots' or 'Wellingtons' are recommended because of the ease with which they can be cleaned and disinfected.

Several changes of footwear bagged between sites might be a practical alternative to cleaning.

Equipment

Equipment such as nets, balances, callipers, bags, scalpels, headlamps, torches, wetsuits and waders etc that are used at one site must be cleaned and disinfected before re-use at another site.

Disposable items should be used where possible. Non-disposable equipment should be used only once during a particular field exercise and disinfected later or disinfected at the site between uses using procedures outlined in 2.4 below.

Vehicles

Where necessary, vehicle tyres should be sprayed/flushed with a disinfecting solution in high-risk areas.

Transmission of disease from vehicles is unlikely to be a problem. However, if a vehicle is used to traverse a known frog site, which could result in mud and water being transferred to other bodies of water or frog sites, then wheels and tyres should undergo cleaning and disinfection. This should be carried out at a safe distance from water bodies, so that the disinfecting solution can infiltrate soil rather than run-off into a nearby water body.

Spraying with 'toilet duck' (active ingredient *benzalkonium chloride*) is recommended to disinfect car wheels and tyres.

Cleaning of footwear before getting back into the car will prevent the transfer of pathogens from/to vehicle floor and control pedals.

2.3 Handling of frogs in the field

The spread of pathogenic organisms, such as the frog chytrid fungus, may occur as a result of handling frogs.

Frogs should only be handled when necessary.

Where handling of frogs is necessary the risk of pathogen transfer should be minimised as follows:

- Hands should be either cleaned and disinfected between samples or a new pair of disposable gloves used for each sample[1]. This may be achieved by commencing with a work area that has a dish containing a disinfecting solution and paper towels.
- A 'one bag – one frog' approach to frog handling should be used especially where several people are working together with one person processing frogs and others doing the collecting. Bags should not be reused.
- A 'one bag – one sample' approach to tadpole sampling should be used. Bags should not be reused.

Researchers who use toe clipping or Passive Integrated Transponder (PIT) tagging are likely to increase the risk of transmitting disease between frogs due to the possibility of directly introducing pathogens into the frogs' system. This can be minimised by using:

- Disposable sterile instruments
- Instruments disinfected previously and used once
- Instruments disinfected in between each frog

Disinfecting solutions containing *benzalkonium chloride* are readily available from local supermarkets. Some brands include Toilet Duck, Sanpic, New Clenz and Pine Clean.

[1] As a principle, this protocol assumes that not all frogs in an infected pond will be contaminated by the frog chytrid fungus. The infective load of a body of water may not be high enough to cause cross contamination of individual frogs in the same pond. Therefore care should be taken to use separate gloves and bags and clean hands for each sample, to avoid transmission of high infective loads between individuals.

Open wounds from toe clipping and PIT tagging should be sealed with a cyanoacrylate compound such as *Vetbond*© to reduce the likelihood of entry of pathogens. The DECC ACEC further recommends the application of topical anaesthetic *Xylocaine*© cream and *Betadine*© disinfectant (1% solution) before and after any surgical procedure. This should then be followed by the wound sealant.

All used disinfecting solutions, gloves and other disposable items should be stored in a sharps or other waste container and disposed or sterilised appropriately at the completion of fieldwork. Disinfecting solutions must not come into contact with frogs or be permitted to contaminate any water bodies

2.4 Disinfection Methods

Disinfecting agents for hands and equipment must be effective against bacteria and both the vegetative and spore stages of fungi. The following agents are recommended:

- Chloramine and Chlorhexidine based products such as *Halamid*©, *Halasept*© or *Hexifoam*© are effective against both bacteria and fungi. These products are suitable for use on hands, footwear, instruments and other equipment. The manufacturers instructions should be followed when preparing these solutions.
- Bleach and alcohol (ethanol or methanol), diluted to appropriate concentrations can be effective against bacteria and fungi. However, these substances may be less practical because of their corrosive and hazardous nature.

  When using methanol either:

  - immerse in 70% methanol for 30 minutes or
  - dip in 100% methanol then flame for 10 seconds or boil in water for 10 minutes

Fresh bleach (5% concentration) may be also effective against other frog pathogens such as Rana Virus.

Some equipment not easily disinfected in these ways can be effectively cleaned using medical standard 70% isopropyl alcohol wipes – *Isowipes*©.

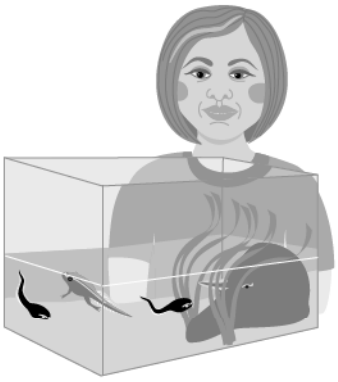
3 captive frog hygiene management

3.1 Housing frogs and tadpoles

Frogs and tadpoles should only be removed from a site when absolutely necessary.

When it is necessary for frogs or tadpoles to be collected and held for a period of time, the following measures should be undertaken:

- Animals obtained at different sites should be kept isolated from each other and from other captive animals.
- Aquaria set up to hold frogs should not share water, equipment or any filtration system. Splashes of water from adjacent enclosures or drops of water on nets may transfer pathogens between enclosures.
- Prior to housing frogs or tadpoles, ensure that tanks, aquaria and any associated equipment are disinfected.
- Tanks and equipment should be cleaned, disinfected and dried immediately after frogs/tadpoles are removed.



Careful maintenance of your enclosures will ensure a safe and hygienic environment for captive frogs and tadpoles.

When contemplating a release of captive bred tadpoles for conservation purposes a Translocation Proposal should be submitted to the DECC and pathological screening for disease should be undertaken (see also DECC Translocation Policy). Tadpoles can be tested by randomly removing 10 individuals at 6 weeks and again at 2 weeks before anticipated release. Testing could be undertaken by the pathology section at Taronga Zoo, Newcastle University, CSIRO Australian Animal Health Laboratories at Geelong and James Cook University at Townsville. Such an arrangement would need to be negotiated by contacting one of these institutions well before the anticipated release date. (see Appendix 2 for contact details)

DECC have licenced NSW Schools to allow students and/or teachers to remove tadpoles for classroom life cycle studies. They are authorised to remove individuals from only one location, each school also requires endorsement from Department of Education and Training Animal Care and Ethics Committee and comply with this protocol.

Tadpoles collected for these purposes are to be obtained from the local area of the school and are not to be obtained from DECC Reserves. As soon as tadpoles have transformed, froglets must be returned to the exact point of capture. Tadpoles from different locations are not to be mixed.

Antifungal cleansing treatments to clear tadpoles of the frog chytrid fungus are currently being trialed. In the future, such a treatment may be an added procedure required prior to froglet releases.

Detailed information on safely maintaining frogs in captivity is provided in Voigt (2001).

3.2 Tadpole treatment

In most instances:

Release to the wild of tadpoles held or bred in captivity should be avoided.

3.3 Frog treatment

The rigour with which frogs must be treated to ensure pathogens are not introduced to native populations means that any proposal for the removal of adult frogs (particularly threatened species) from wild populations should be given careful consideration.

When it is essential for frogs to be removed from the wild, the following should apply.

Individuals to be released should be quarantined for a period of 2 months and monitored for any signs of illness or disease.

Frogs must not be released if any evidence of illness or infection is detected. If illness is suspected, further advice must be sought from a designated frog recipient (Appendix 2) as soon as possible to determine the nature of the problem. Chytridiomycosis can be diagnosed in live frogs by microscopical examination of preserved toe clips or from shedding skin samples. Research is still in progress on the development of a simple technique for the detection of Chytridiomycosis and a treatment for infected frogs.

Current methods which may be used include:

- A technique for the treatment of potentially infected frogs is to place the frogs individually in a 1mg/L benzalkonium chloride solution for 1 hour on days 1, 3, 5, 9, 11 and 13 of the treatment period. Frogs are then isolated/quarantined for two months. This and other possible treatments are documented in Berger and Speare (1998)
- *Betadine*© and *Bactone*© treatments have also been used on adult frogs with some success (M. Mahony, Newcastle University pers. comm.)
- *Itraconazole*© is an expensive drug which has been used successfully (Lee Berger CSIRO Australian Animal Health Laboratory pers. comm.). Information on this method is available on the Website http://www.jcu.edu.au/school/PHTM/frogs/adms/attach6.pdf.

Frogs undergoing treatment should be housed individually and kept separate from non-infected individuals.

3.4 Displaced frogs

Displaced frogs are those native frog species and introduced Cane Toads (Bufo marinus) which have been unintentionally transported around the country with fresh produce, transported produce and landscaping supplies. Procedures to be undertaken when encountering introduced/displaced native frog species (as well as Cane Toads) are as follows.

3.4.1 Banana box frogs

'Banana Box' frog is the term used to describe several native frog species (usually Litoria gracilenta, L. infrafrenata, L. bicolor and L. caerulea) commonly transported in fruit and vegetable shipments and landscaping supplies. In the past, well meaning individuals have attempted to return these frogs to their place of origin but this is usually impossible to do accurately. There is risk of spread of disease if these frogs are transferred from place to place.

It is strongly recommended that:

Displaced Banana Box frogs should be treated as if they are infected and should not to be freighted anywhere for release to the wild unless specifically approved by DECC.

When encountering a displaced frog:

- Contact a licensed wildlife carer organisation to collect the animal. The frog should then undergo a quarantine period of 2 months along with an approved disinfection treatment.
- Post-quarantine, the frog (if one of the species identified above) may be transferred to a licensed frog keeper. All other species require the permission from DECC Wildlife Licensing and Management Unit (WLMU) prior to transfer. Licensed carer groups are to record and receipt frogs obtained and disposed of in this way.
- Licensed Frog Keepers are to list these frogs in their annual licence returns to DECC.

Frogs held by licensed frog keepers are not to be released to the wild except with specific DECC approval.

Displaced frogs may be made available to recognised institutions for research projects, display purposes or perhaps offered to the Australian Museum as scientific specimens once approval has been provided by the DECC WLMU.

Frogs are often unintentionally transported with fresh produce and landscaping supplies. They are collectively known as 'banana box' or displaced frogs.

3.4.2 Cane toads

Cane toads are known carriers of the Frog chytrid fungus and should not be knowingly transported or released to the wild.

If a cane toad is discovered outside of its normal range, it should be humanely euthanased in accordance with the recommended NSW Animal Welfare Advisory Council procedure (see Appendix 3). Care should be taken to avoid euthanasia of native species due to mistaken identity.

3.4.3 Local frog species

Frogs encountered on roads, around dwellings and gardens or in swimming pools should not be considered as displaced frogs.

Frogs encountered in these situations should be assisted off roads, away from dwellings, or out of swimming pools preferably to the nearest area of vegetation or suitable habitat.

Incidences of frogs spawning or tadpoles appearing in swimming pools should be referred to a wildlife carer/rescue organisation for assistance (see Appendix 4).

Contact the Frogwatch Helpline if you are unsure whether a frog is a local species or displaced.

An NPWS information brochure titled 'Cane Toads in NSW' provides further information on cane toads and assistance with identification of some of the commonly misidentified native species. This information is also available on the DECC website.

4 sick or dead frogs

Unless an obvious cause of illness or death is evident (eg predation or road mortality): Sick or dead frogs encountered in the wild should be collected and disposed of in accordance with the procedures described in section 4.2 below.

4.1 Symptoms of sick and dying frogs

Sick and dying frogs exhibit a range of symptoms characteristic of chytrid infection. Symptoms may be expressed in the external appearance or behaviour of the animal. A summary of these symptoms are described below. More detailed information can be found in Berger et al., (1999) or at the James Cook University Amphibian Disease website at: http://www/jcu.edu.au/school/phtm/PHTM/frogs/ampdis.htm.

Appearance (one or more symptoms)

- darker or blotchy upper (dorsal) surface
- reddish/pink-tinged lower (ventral) surface and/or legs and/or webbing or toes
- swollen hind limbs
- very thin or emaciated
- skin lesions (sores, lumps)
- infected eyes
- obvious asymmetric appearance

Behaviour (one or more symptoms)

- lethargic limb movements, especially hind limbs
- abnormal behaviour (eg a nocturnal, burrowing or arboreal frog sitting in the open during the day and making no vigorous attempt to escape when approached)
- little or no movement when touched

Great barred frog (*Mixophyes fasciolatus*) with severe Chytrid infection — note lethargic attitude and sloughing skin. Photo: L. Berger

Diagnostic behaviour tests

Sick frogs will fail one or more of the following tests:

test	healthy	sick
Gently touch with finger	Frog will blink	Frog will not blink above the eye
Turn frog on its back	Frog will flip back over	Frog will remain on its back
Hold frog gently by its mouth	Frog will use its forelimbs to try to remove grip	No response from frog

4.2 What to do with sick or dead frogs

A procedure for the preparation and transport of a sick or dead frog is given below[2]. Adherence to this procedure will ensure the animal is maintained in a suitable condition for pathological examination and assist the DECC and researchers to determine the extent of the disease and the number of species affected.

- Disposable gloves should be worn when handling sick or dead frogs. Avoid handling food and touching your mouth or eyes as this could transfer pathogens and toxic skin secretions from some frog species.
- New gloves and a clean plastic bag should be used for each frog specimen to prevent cross-contamination. When gloves are unavailable, use an implement to transfer the frog to a container rather than using bare hands.
- If the frog is dead, keep the specimen cool and preserve as soon as possible (as frogs decompose quickly after death making examination difficult). Specimens can be fixed/preserved in 70% ethanol or 10% buffered formalin.

Cut open the belly and place the frog in about 10 times its own volume of preservative. Alternatively, specimens can be frozen (although this makes tissues unsuitable for some tests). If numerous frogs are collected, some should be preserved and some should be frozen. Portions of a dead frog can be sent for analysis eg a preserved foot, leg or a portion of abdominal skin.

- The container should be labelled showing at least the species, date and location. A standardised collection form is provided in Appendix 5.
- If the frog is alive but unlikely to survive transportation (death appears imminent), euthanase the frog (see Appendix 3) and place the specimen in a freezer. Once frozen, the specimen is ready for shipment to the address provided below.
- If the frog is alive and likely to survive transportation, place the frog into either a moistened cloth bag with some damp leaf litter or into a plastic bag with damp leaf litter and partially inflated before sealing. Remember to keep all frogs separated during transportation.
- Preserved samples can be sent in jars or wrapped in wet cloth, sealed in bags and placed inside a padded box.
- Send frozen samples in an esky with dry ice (available from BOC/CIG Gas outlets).
- Place live or frozen specimens into a small styrafoam esky (available from K-Mart/Big W for approximately $2.50).
- Seal esky with packaging tape and address to one of the laboratories listed in Appendix 4.
- Send the package by courier.

Further information on sick and dying frogs is available on the Amphibian Disease Home Page at http://www.jcu.edu.au/dept/PHTM/frogs/ampidis.htm — in particular refer to *'What to do with dead or ill frogs'*.

[2] The measures described below are standard procedures and may vary slightly depending on the distance and time required to reach the intended recipient. Contact the intended recipient of the sick or dead frog prior to sending to confirm the appropriate procedure.

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appendix 1

hygiene protocol checklist and field kit

The following checklist and field kit are designed to assist with minimising the risk of transferring pathogens between frogs.

Have you considered the following questions before handling frogs in the field:

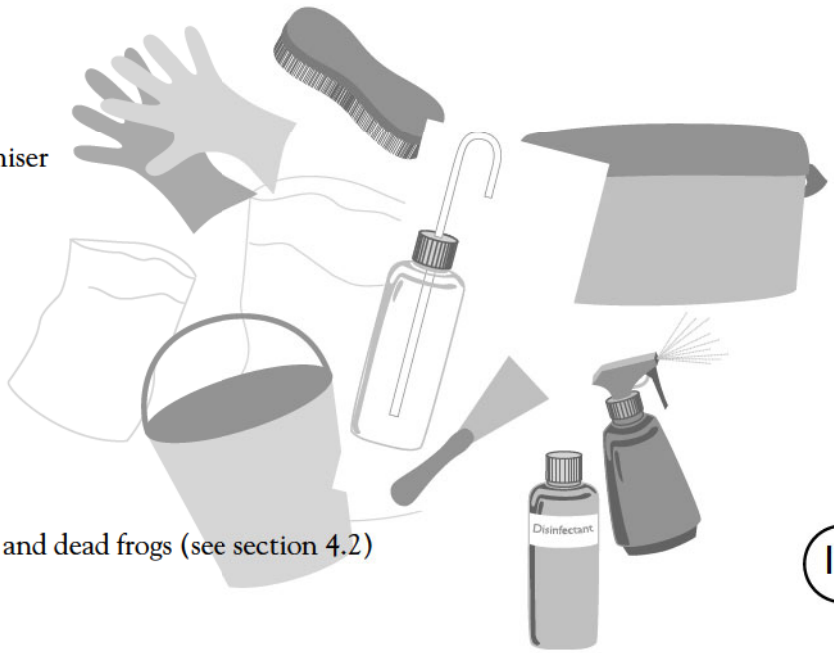
- Has your proposed field trip been sufficiently well planned to consider hygiene issues?
- Have you taken into account boundaries between sites (particularly where endangered species or populations at risk are known to occur)?
- Have footwear disinfection procedures been considered and a strategy adopted?
- Have you planned the equipment you will be using and developed a disinfection strategy?
- Are you are planning to visit sites where vehicle disinfection will be needed (consider both vehicle wheels/tyres and control pedals) and if so, do you have a plan to deal with vehicle disinfection?
- Have handling procedures been planned to minimise the risk of frog to frog pathogen transmission?
- Do you have a planned disinfection procedure to deal with equipment, apparel and direct contact with frogs?

If you answered NO to any of these questions please re-read the relevant section of the DECC Hygiene Protocol for the Control of Disease in Frogs and apply a suitable strategy.

Field hygiene kit

When planning to survey frogs in the field a portable field hygiene kit should be assembled to assist with implementing this protocol. Recommended contents of a field hygiene kit would include:

- Small styrofoam eski
- Disposable gloves
- Disinfectant spray bottle (atomiser spray) and/or wash bottle
- Disinfecting solutions
- Wash bottle
- Scraper or scrubbing brush
- Small bucket
- Plastic bags large and small
- Container for waste disposal
- Materials for dealing with sick and dead frogs (see section 4.2)



appendix 2

designated sick and dead frog recipients

Always contact the relevant specialist prior to sending a sick or dead frog. In some cases, only wild frogs will be assessed for disease. Analysis may also attract a small fee per sample.

Contact one of the following specialists to arrange receipt and analyse sick and dead frogs. Make contact prior to dispatching package:

Karrie Rose
Australian Registry if Wildlife Health
Taronga Conservation Society, Australia
PO Box 20
MOSMAN NSW 2088

Phone: 02 9978 4749
Fax: 02 9978 4516
Krose@zoo.nsw.gov.au

Diana Mendez or
Rick Speare
School of Public Health,
Tropical Medicine and
Rehabilitation Sciences
James Cook University
Douglas Campus
TOWNSVILLE QLD 4811

Phone: 07 4796 1735
Fax: 07 4796 1767
Diana.Mendez@jcu.edu.au
Richard.Speare@jcu.edu.au

Michael Mahony
School of Biological Sciences
University of Newcastle
CALLAGHAN NSW 2308

Phone: 02 4921 6014
Fax: 02 4921 6923
bimjm@cc.newcastle.edu.au

For information on frog keeping licences and approvals to move some species of displaced frog contact:

Co-ordinator, Wildlife Licensing
Wildlife Licensing and Management Unit
DECC
PO Box 1967
Hurstville NSW 1481
Ph 02 9585 6481
Fax 02 9585 6401
wildlife.licensing@environment.nsw.gov.au

For information on the possible identity of displaced frogs contact:

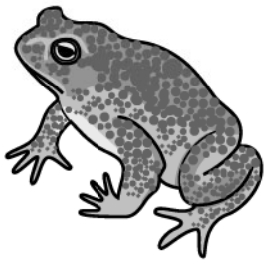
Frog and Tadpole Society (FATS)
Frogwatch Helpline

Ph: 0419 249 728

appendix 3

NSW Animal Welfare Advisory Council methodology

The NSW Animal Welfare Advisory Council procedure for humanely euthanasing cane toads or terminally ill frogs is stated as follows:



- Using gloves, or some other implement, place cane toad or terminally ill frog into a plastic bag.
- Cool in the refrigerator to 4°C.
- Crush cranium with a swift blow using a blunt instrument.

Note: Before killing any frog presumed to be a cane toad, ensure that it has been correctly identified and if outside the normal range for cane toads in NSW (north coast) that local DECC regional office is informed.

appendix 4

licensed wildlife carer and rescue organisations

Following is a list of wildlife rehabilitation groups licensed by Department of Environment and Climate Change (NSW):

Northern NSW

Australian Seabird Rescue
For Australian Wildlife Needing Aid (FAWNA)
Friends of the Koala
Friends of Waterways (Gunnedah)
Great Lakes Wildlife Rescue
Koala Preservation Society of NSW
Northern Rivers Wildlife Carers
Northern Tablelands Wildlife Carers
Tweed Valley Wildlife Carers
Seaworld Australia
WIRES branches in Northern NSW

Southern NSW

Looking After Our Kosciuszko Orphans (LAOKO)
Native Animal Network Association
Native Animal Rescue Group
Wildcare Queanbeyan
WIRES branches in Southern NSW

Sydney, Hunter and Illawarra

Hunter Koala Preservation Society
Ku-ring-gai Bat Colony Committee
Kangaroo Protection Co-operative
Native Animal Trust Fund
Organisation for the Rescue and Research of Cetaceans (ORRCA)
Sydney Metropolitan Wildlife Services
Wildlife Aid
Wildlife Animal Rescue and Care (Wildlife ARC)
Waterfall Springs Wildlife Park
Oceanworld
Wildlife Care Centre, John Moroney Correctional Centre
Koalas in Care
WIRES branches around Sydney, Hunter and Illawarra

Western NSW

Rescue and Rehabilitation of Australian Native Animals (RRANA)
RSPCA Australian Capital Territory Inc.
Wildlife Carers Network (Central West)
WIRES branches in Western NSW
Cudgegong Wildlife Carers

[4] Note: some of these organisations may not care for frogs.

appendix 5 — sick or dead frog collection form

Sender details:

name: address: postcode:

phone: (w) (h) fax: email:

Collector details: (where different to sender)

name: address: postcode:

phone: (w) (h) fax: email:

Specimen details:

record no: no. of specimens: species name: date collected:
day/month/year

time collected: sex: status at time of collection: date sent:
male/female healthy(H)/ sick(S)/ dead(D) day/month/year

location: map grid reference:
(easting) (northing)

reason for collection:

Batch details for multiple species collection:

species	no.	locality	(AMG)	date	sex	status (H/S/D)

habitat type: vegetation type: micro habitat:
eg creek, swamp, forest eg rainforest, sedgeland eg creek bank, under log, amongst emergent vegetation, on ground in the open

unusual behaviour of sick frogs:
eg lethargic, convulsions, sitting in the open during the day, showing little or no movement when touched.

dead frogs appearance:
eg thin, reddening of skin on belly and/or toes, red spots, sore, lumps or discolouration on skin

deformed frogs: dead/sick tadpoles:
eg limb(s) missing, abnormal shape or length eg numbers/behaviour

unusual appearance of egg masses: recent use of agricultural chemicals in area:
eg grey or white eggs eg pesticides, herbicides, fertilisers

other potential causes of sickness/mortality/comments/additional information:

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

General inquiries: PO Box A290 South Sydney 1232
Phone: 9995 5000 or 1300 361967
Fax: 02 9995 5999 **Web site:** www.environment.nsw.gov.au

Department of **Environment & Climate Change** NSW

From: Anthony Barnes
To: Jonathan Berry
Cc: Colin Phillips
Subject: RE: Williamtown Sand Quarry - Koala Fence
Date: Wednesday, 15 January 2020 9:50:57 AM

External Email.

Hi Jonathan,

I've received advice from BCD that the change in fencing in this instance is appropriate. I will draft an approval letter for my Director's signature.

Regards,

Anthony Barnes
Senior Environmental Assessment Officer
Energy and Resource Assessments
320 Pitt Street | GPO Box 39 | Sydney NSW 2001
T 02 8289 6709 E anthony.barnes@planning.nsw.gov.au

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From: Jonathan Berry <JBerry@kleinfelder.com>
Sent: Tuesday, 14 January 2020 8:47 AM
To: Anthony Barnes <Anthony.Barnes@planning.nsw.gov.au>
Subject: Williamtown Sand Quarry - Koala Fence

Hi Anthony,

Any luck talking with Mathew on the koala fence change?

Cheers

Jonathan Berry **BAppSc (Hons)**
Principal Advisor
Environmental Management, Approvals & Compliance

95 Mitchell Road,
Cardiff, NSW 2285
d|: +61 2 4949 5224
o|: +61 2 4949 5200
m|: 0421 440 139

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T 61 2 6679 5523
www.biolink.com.au

ABN: 27 090 572 099

Jonathan Berry (Senior Advisor)
Kleinfelder
E: jberry@kleinfelder.com

18th December 2019

Dear Jonathan

RE: Cabbage Tree Road Infrastructure Advice

This advice has been prepared in response to a request for infrastructure (fencing) recommendations along the boundary of a proposed sand quarry at Cabbage Tree Road, Williamtown in New South Wales.

The intent of the proposed infrastructure is to deter human access into the quarry, whilst also preventing access and reducing the potential for vehicle-strike to koalas along Cabbage Tree Road and higher speed sections of internal haul roads. In addition, given the presence of preferred koala habitat within the site, there is also a need to accommodate egress from such areas where koalas may maintain part or all of their respective home range areas.

This advice thus focuses on desirable infrastructure that we consider necessary to achieve the envisioned outcomes.

Fencing

A recent review of the efficacy of fencing (in terms of impeding koala movement) that we completed for NSW Roads and Maritime Services (Phillips and Fitzgerald 2014), provided strong *defacto* support for acceptance of a broader range of fence types being recognised as capable of influencing/impeding koala movement. This knowledge has allowed us to promote less expensive designs that are capable of achieving the same end result. By example, the fencing standard we have recommended for purposes of the Ocean Drive Road Corridor Koala Management Framework (Biolink 2014) comprises 1500 - 1800 mm x 50 mm x 50 mm galvanised mesh supported above ground by 60 mm galvanised pipe uprights at 3 m intervals.

For this project, and as per our email correspondence regarding fencing options, the use of a 1500 - 1800 mm chain mesh fencing design will work to deter humans from entering the sand quarry site, while also (in required locations along Cabbage Tree Road and internal haul roads) creating a barrier for koalas. Notwithstanding, fencing will also need to be permeable to koalas in areas containing preferred habitat within the site.

Koala bridges

Koala bridges are timber structures that enable koalas to traverse barriers such as fences that function form an obstacle to linear passage. On the site, one-way and two-way koala bridges will be required. The former to enable passive (one-way) egress from vegetated areas that are located within the quarry site (once fenced), the second to enable two-way movement by koalas both into and out of areas such as those protected for preferred koala habitat. The design in both instances is the same (**Appendix 1**), the one-way effect created by use of a galvanised metal sleeve 600 – 900 mm wide (upper edge located 1 m off the ground) on the lower end of the bridge on that side of the fence where a reverse crossing is not to be enabled.

Koala bridges should be located at ~ 200 m intervals along fenced areas, with locations maximised around areas of preferred koala habitat. To prevent human use of koala bridges, they can be designed with a weak-link in the middle that ensures anything over a certain weight (i.e. 12 kg) causes the bridge to break.

Koala grids

Koala-grids should be considered at any access point into areas that are protected as preferred koala habitat. The intent of the koala-grid is to enforce the exclusion concept of fencing at locations where vehicular crossings occur or where access is otherwise required for management purposes. They are especially useful in terms of restricting access by koalas into road corridors through driveways and/or intersections.

Originally designed for purposes of the Skyline Road upgrade undertaken by Lismore City Council in 2004, koala-grids proved 100% effective in restricting access by koalas over the course of a 5-year monitoring program (Biolink 2009). Koala-grids are constructed using 60 mm tubular steel pipe at 200 mm centres as a means of restricting access by koalas to an exclusion area (**Figure 1**).

Figure 1. Koala-grid / fence-end configurations. The grid on the far right reflects recent design modifications initiated by NSW RMS as part of retro-fitting modifications on the Gulgan Road interchanges that afford access to the Pacific Highway between Ewingsdale and Chinderah on the NSW north coast.

Please don't hesitate to contact the undersigned if you require any further information.

Yours Sincerely

Dr. Grant Brearley
Senior Ecologist

References

Biolink. (2009). Koala Monitoring Report No 6 – Skyline Road Upgrade, Lismore NSW. Report to Lismore City Council.

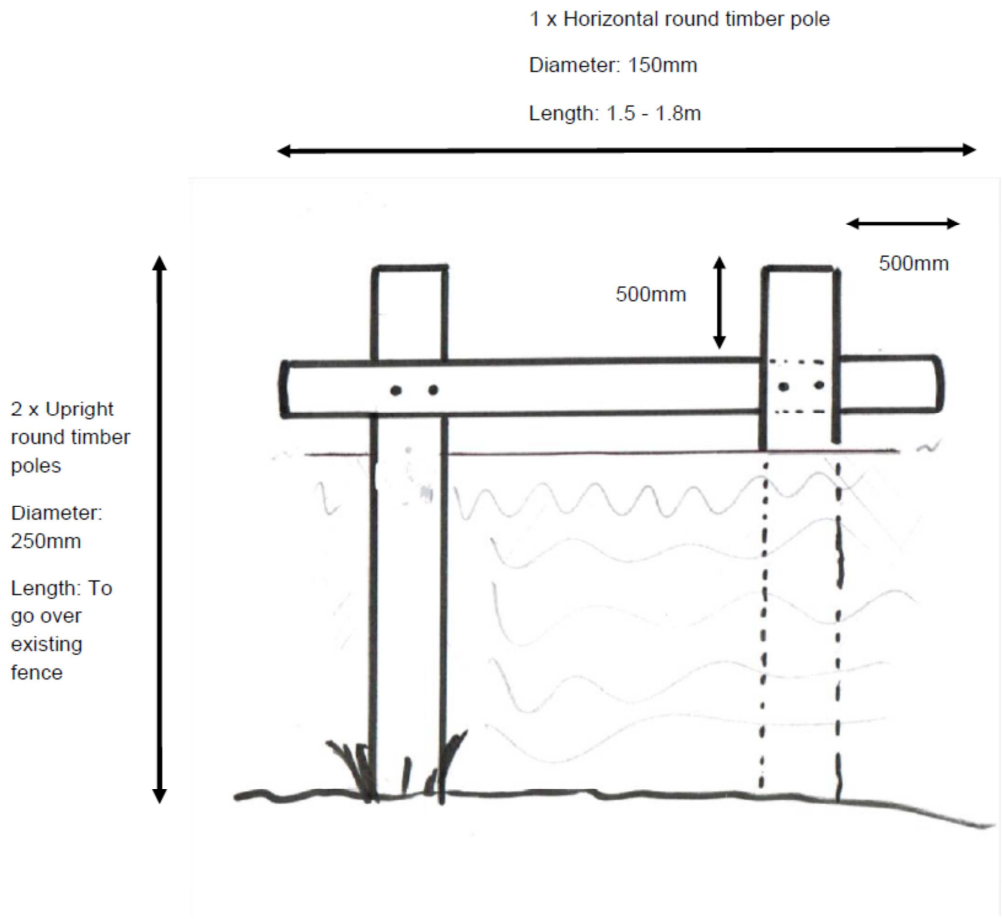
Biolink (2014). Ocean Drive Road Corridor: Koala Management Framework. Final Report to Port Macquarie Hastings Council.

Phillips, S., and Fitzgerald, M. (2014). Review of koala road-kill data and issues relating to underpass use by koalas: Pacific Highway upgrades from Clothier's Creek to Ewingsdale, NSW. Final Report to NSW Roads & Maritime Services. Biolink Ecological Consultants.

APPENDIX 1
Typical Koala Bridge

Not to scale

a) Koala bridge design concept



b) View of koala bridge design from above

Appendix B: Annual Rehabilitation Report (Wedgetail, 2025)

WEDGETAIL
PROJECT CONSULTING

Cabbage Tree Rd Sand Quarry

2024 Rehabilitation Monitoring Report

Williamtown, New South Wales

Rev 1
29 March 2025

Cabbage Tree Rd Sand Quarry
2024 Rehabilitation Monitoring Report

Williamtown, New South Wales

REPORT PREPARED FOR:

Newcastle Sand Pty Ltd

REPORT PREPARED BY:

WEDGETAIL PROJECT CONSULTING PTY LTD
PO Box 234
Cardiff, NSW 2285

ABN: 93 640 388 683

File Ref: NS_2024_Rehab_Mon_Report Final 2025.docx

Version Control

Rev. No.	Revision Date	Author / Position	Reviewer	Details
Rev 1	29 March 2025	Shea Brunt Ecologist	Jonathan Berry Principal Advisor	Final

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1. INTRODUCTION

Williamtown Sand Syndicate Pty Ltd (WSS), trading as Newcastle Sand currently operate a sand quarry on four lots of land located at 398 Cabbage Tree Road, Williamtown, approximately 30 km from the Newcastle central business district (**Figure 1**) The Quarry is approved to extract up to 530,000 tonnes per annum of sand products over a period of up to 15 years.

Development Consent (SSD-6125) was granted by the NSW Independent Planning Commission on 9 May 2018 for construction and operation of the quarry subject to a series of conditions. Condition 37 of Schedule 3 of the Development Consent requires the preparation and implementation of a Biodiversity and Rehabilitation Management Plan (BRMP). Condition 35 of Schedule 3 states that the site will be rehabilitated to the satisfaction of the Secretary and rehabilitation must be generally consistent with the rehabilitation strategy in the EIS and the conceptual rehabilitation plan as outlined in the BRMP. Condition 36 of Section 3 states the site must be rehabilited pregressively, that is as soon as reasonably practicable after disturbance to minimise the total area exposed for dust generation at any time.

2. SCOPE

Section 6.22 (H) of the BRMP sets out the monitoring requirements for the rehabilitated areas. Six monthly (bi-annual) monitoring will occur for the first three years consistent with the methodlogy set out below and the results compared to the performance criteria and reported in the Annual Environmental Monitoring Report (AEMR).

This report is written to satisfy the above requirement and reports on the progress of monitoring undertaken up to December 2024.

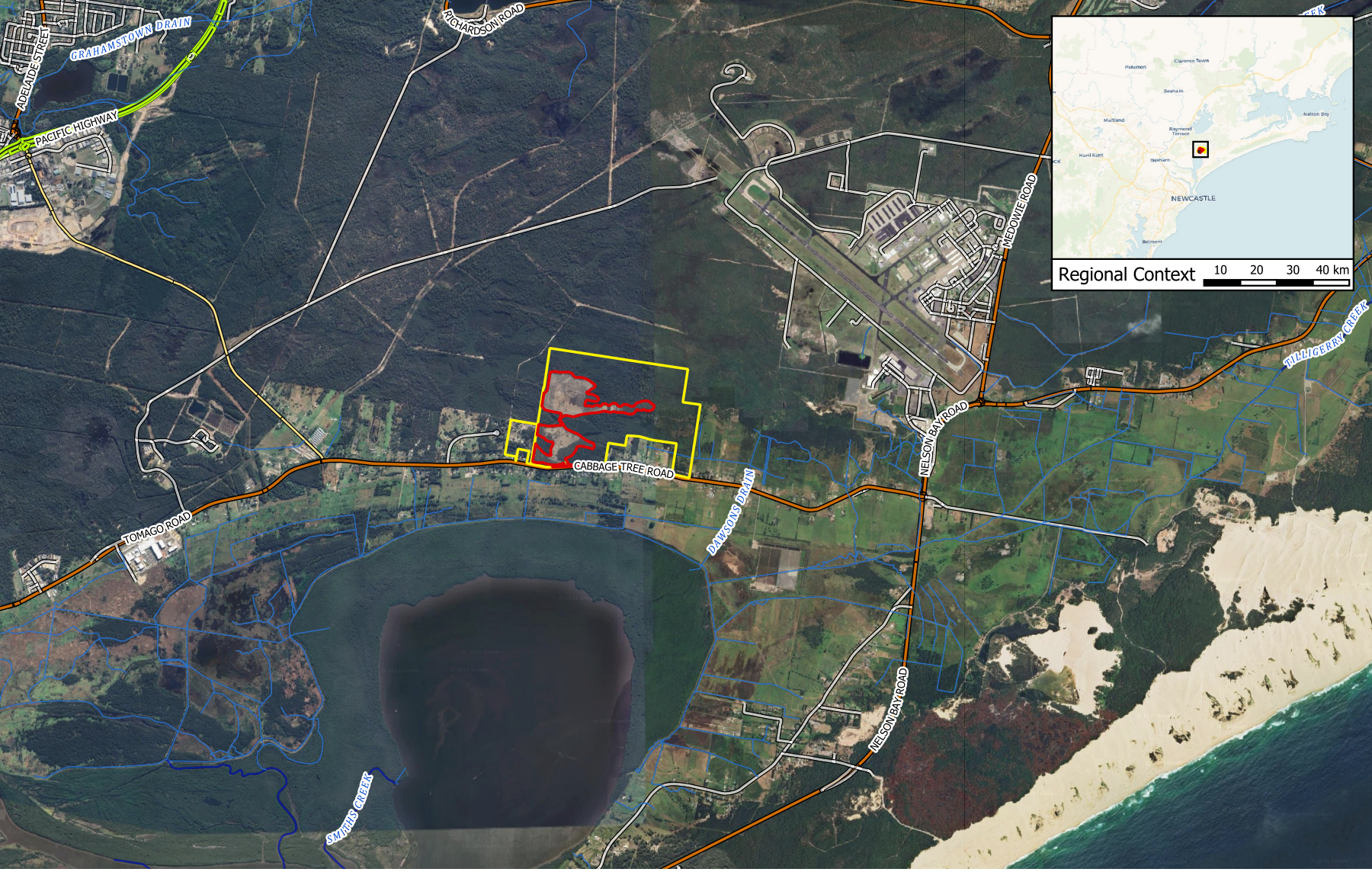
Rehabilitation monitoring was undertaken on May 20th to 25th 2024, and covered Blocks 3A, 3B, 4A, 4B, 5, 5A, 5B, 6, 6A, 6B, 7B and 7C (**Figure 2**). The December rehabilitation monitoring took place over several days, December 17th to 19th 2024 January 20th to 28th, February 11th, 2025, and covered Blocks 1A, 2, 3A, 3B, 4A, 4B, 5, 5A, 5B, 6, 6A, 6B, 7A, 7B and 7C.

Table 1, illustrates the distinction between blocks based on their rehabilitation stages and frequency of monitoring.

Table 1: Rehabilitation Stages of Blocks

Block No.	Rehabilitation Stage	Monitoring Events
1A	Year 1	Dec 24
2	Year 1	Dec 24
3A	Year 2	Nov 22, Mar 23, Aug 23, May 24, Dec 24
3B	Year 2	Mar 23, Aug 23, May 24, Dec 24
4A	Year 2	Aug 23, May 24, Dec 24
4B	Year 1	May 24, Dec 24
5	Year 1	May 24, Dec 24
5A	Year 1	May 24, Dec 24

Block No.	Rehabilitation Stage	Monitoring Events
5B	Year 1	May 24, Dec 24
6	Year 1	May 24, Dec 24
6A	Year 1	May 24, Dec 24
6B	Year 1	May 24, Dec 24
7A	Year 1	Dec 24
7B	Year 2	Nov 22, Mar 23, Aug 23, May 24, Dec 24
7C	Year 2	Mar 23, Aug 23, May 24, Dec 24



WEDGETAIL
PROJECT CONSULTING PTY LTD

Lease Boundary
Development Site

Primary Road
Arterial Road
Sub-Arterial Road
Local Road

Major watercourse
Minor watercourse

Figure 1

Regional Context

0.5 1 1.5 2 km

N

GDA94 / MGA zone 56
EPSG:28356

Map Produced: 12/02/2025
Produced By: Kane Blundell

Wedgetail Project Consulting\Arbus - Documents\24-010 Newcastle Sand - Compliance\Monitoring Data\Revegetation\@GIS\NS_RehabilitationMonitoringPoints_250210.qgz

Monitoring Plots (4mx4m)- Feb 2024

Lease Boundary

Quary Sectors

Track-Vehicular

Fig. 2. Monitoring Point location (Feb 2025)

25 50 75 100 125 150 m

Produced: 27/02/2025
By: Keryn Dowling
GDA94 / MGA zone 56
Project code: 24-010

WEDGETAIL PROJECT CONSULTING

Newcastle Sand
398 Cabbage Tree Rd, Williamtown NSW 2318

3. MONITORING METHODOLOGY

The following monitoring methodology is conducted every six months (bi-annually) across each sector post rehabilitation for a period of three years.

3.1 PLOT MONITORING

Each block has points overlaid in a grid fashion at approximately 15 m intervals using a GIS program; these points represent a single sample plot, each 2 x 2 m (4 m^2). The plot points will be confirmed in the field during the first monitoring event, to ensure each point occurs within the extraction area. These confirmed points will be retained and used for following monitoring events until completion after three years.

The pre-confirmed 2m x 2m quadrat locations will be uploaded on to handheld GPS units and a qualified ecologist will visit each of these quadrat locations using the GPS. Once the point is located, four 2 m poles will be laid on the ground around the point to define the sample area and the data outlined in **Table 2** will be collected at each point.

Table 2: Details of data collected at each survey.

Parameter	Details	Description
Species Richness	The total number of different species of plant present	A measure of the biodiversity/species composition
Abundance	The total number of each species present	A measure of plant/species density
	The total number of Camfield's Stringybark present	A measure of the number of individuals per sector
Height	The average height of all plants in the plot	An indicator of overall growth
Percentage Cover	An estimate of the total plot area having plant cover-percentage of area.	A measure of the total green cover for the rehabilitation area.

During all monitoring events an inspection of each sector for weeds, signs of feral pests, erosion, die-off, and site access issues occurs.

A minimum of four photographic monitoring points will be established within each block. Photographs will be taken at the same location and the same bearing at each monitoring event. A panoramic photograph will be taken at each survey to allow visual assessment of the rehabilitation progression in future monitoring events.

The results of the bi-annual monitoring is reported annually. Data will be compared to previous surveys events to assess the progression of the rehabilitation. Additionally, the rehabilitation will be assessed against the performance indicators outlined in **Table 3** below. If the rehabilitation sectors are not meeting these performance indicators, specific management measures (i.e. revegetation measures, weed and pest control and/ or measures for erosion control) will be outlined in the report.

Table 3: Performance criteria for the first and second year of rehabilitation.

Year of Rehabilitation	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
1	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark • Facilitate regional movement of Koalas and their occupation of the site and limit	• Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species). • Key species present, including tree species important for Koalas and Camfield's Stringybark • No significant erosion problems. • Weed control program in place. • No damage or disturbance to Offset Area.	• Early pioneer stage appearing: Small seedlings (< 5 cm) regenerating from topsoil, < 5% surface cover. • Brush-matting evident. • Woody debris (>10 cm diameter) does not exceed 20% of the ground surface cover. • Local seed has been collected and is stored appropriately for direct seeding or propagation	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species)
				• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by suitably qualified contractor if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring

Year of Rehabilitation	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	impacts to all native fauna, • Protection of onsite Offset Area.			• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel
2	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark	• Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species). • Key species present, including tree species important for Koalas and Camfield's Stringybark • No significant erosion problems.	• Natural regeneration of pioneer species occurring. • Seedlings developing under brush-matting. • Cover of 10 - 20% of ground surface. • Plant height and density in each strata increasing • Trees and shrubs not present but expected are planted (based on deficiencies identified in Year 1 monitoring), including tree species important for Koalas and Camfield's Stringybark. • No significant erosion problems.	• Lack of adequate species growth • Plant survival falls below 70%	• Replanting of tubestock or reseeding where appropriate • Monitoring of survival rates (new and existing species) • Stabilise surface to prevent significant erosion occurring • Stability assessment by qualified engineer if evidence of significant instability • Increase erosion and sediment controls where relevant

Year of Rehabilitation	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Performance Criteria	Trigger for Corrective Action(s)	Recommended Corrective Action(s)
	• Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, Protection of onsite Offset Site	• Weed control program in place. • No damage or disturbance to Offset Site	• Weed control program in place.		• Ongoing erosion monitoring
				• Erosion observed	• Stabilise surface to prevent significant erosion occurring • Stability assessment by qualified engineer if evidence of significant instability • Increase erosion and sediment controls where relevant • Ongoing erosion monitoring
				• Weed invasion observed within rehabilitated area or edge of native vegetation	• Manual and/or chemical weed control where appropriate • Ongoing weed monitoring
				• Damage to Offset Site from quarry activities	• Increase fencing/signage • Monitoring of personnel

3.2 WOODY DEBRIS COVER

Woody debris (timber with stem above 100mm) cover should not exceed 20%. Assessments of cover were undertaken during the previous period and determined cover was below the required threshold. All additional cover applied since has maintained similar or lower rates of cover.

3.3 EUCALYPTUS PARRAMATTENSIS REVEGETATION

Seeds of *Eucalyptus parramattensis decadens* were collected from mature local trees to ensure genetic compatibility. The collected seeds were carefully stored and later propagated by a local nursery. Once established, 280 seedlings were planted across the rehabilitation site in October 2024.

Three months after planting, a survey was conducted in January 2025 to assess the survival rate of the propagated trees. The results indicated that 157 or **56%** of the tubestock planted are alive and in good condition, while 5 or **1.7%** are alive but require maintenance, suggesting that survival rates are relatively low, but given the environment are surviving well.

Additional planting is recommended to meet the intended target of 239 individuals consistent with the number removed during clearing. To meet the intended target and account for the projected survival rate it is estimated that a further 147 tubestock should be planted once available.

4. MONITORING RESULTS

4.1 BLOCK 1A

This is the first monitoring event for this sector.

This was Block 1A's first monitoring event, and as such, the results are preliminary. *Conyza bonariensis* (Fleabane) is the dominant weed species present but does not pose a significant threat. Recent spraying of *Eragrostis curvula* in December 2024 has been effective in managing its spread.

Table 4: Rehabilitation parameters for the Block 1A.

Parameter	Target (at completion)	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	7
Ave Ht All Plants (cm)	**Nil**	23.63
Ave Ht Overstorey (cm)	**300**	20
Ave Ht Midstorey (cm)	**100**	0
Ave Ht Shrub (cm)	**90**	35
Ave. No. of plants (plants/4 m^2)	**Nil**	52.2
Ave. Species Richness (species/4 m^2)	**Nil**	2.2

Plate 1: Block 1A February 2025

Plate 2: Block 1A February 2025

4.2 BLOCK 2

This was the first monitoring event for Block 2 and as such results are indicative. Similarly to Block 1A, *Conyza bonariensis* is the dominant weed species present but does not pose a significant threat. Recent spraying of *Eragrostis curvula* (African Lovegrass) in December 2024 has been effective in managing its spread.

Table 5: Rehabilitation parameters for the Block 2

Parameter	Target (at completion)	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	20.35
Ave Ht All Plants (cm)	**Nil**	36.35
Ave Ht Overstorey (cm)	**300**	200
Ave Ht Midstorey (cm)	**100**	30
Ave Ht Shrub (cm)	**90**	51.11
Ave. No. of plants (plants/4 m^2)	**Nil**	46.4
Ave. Species Richness (species/4 m^2)	**Nil**	3

Plate 3: Block 2 February 2025

Plate 4: Block 2 February 2025

4.3 BLOCK 3A

Rehabilitation monitoring data (**Table 6**) shows significant improvements in vegetation cover, plant growth, and species richness. Average cover increased from 3.61% (November 2022) to 41.38% (May 2024), with a slight decline to 35.49% (December 2024), likely due to observer bias rather than actual vegetation loss. Overall, the trend indicates successful vegetation establishment.

The average plant height increased from 12.88 cm (Nov 2022) to 40.89 cm (Dec 2024), indicating steady growth. However, growth varied across vegetation layers. Overstorey height declined to 8.01 cm (May 2024) before recovering to 62 cm (Dec 2024), suggesting slow tree establishment requiring further monitoring. Midstorey height remained stagnant initially but rose sharply from 7.95 cm to 62 cm (May–Dec 2024), indicating delayed yet promising growth. Shrub height steadily increased to 43.53 cm (Dec 2024), progressing toward its 90 cm target.

The number of plants per 4m² and species richness have generally increased, indicating successful vegetation establishment, though species richness slightly declined after May 2024.This suggests strong plant recruitment, although minor fluctuations may be due to plant competition or mortality. Similarly, species richness, showed positive growth from 4.7 species/4m² in November 2022 to 10.3 species/4m² in May 2024, before slightly declining to 7.45 species/4m² in December 2024. This slight decrease could indicate a need for continued species diversity management.

Overall, the rehabilitation efforts appear to be on a positive trajectory, with substantial gains in vegetation cover, plant height, and species richness. However, challenges remain, particularly in achieving the overstorey height target and stabilizing species richness. Moving forward, monitoring efforts should focus on identifying limiting factors for tree growth and mitigating potential threats to biodiversity. Additional interventions, such as targeted planting of overstorey species and adaptive management strategies, may help sustain long-term rehabilitation success.

Table 6: Rehabilitation parameters for the Block 3A.

Parameter	Target (at completion)	Rehab status Nov 2022	Rehab status Mar 2023	Rehab status Aug 2023	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	3.61	11.62	18.71	41.38	35.49
Ave Ht All Plants (cm)	**Nil**	12.88	18.25	17.99	34.77	42.15
Ave Ht Overstorey (cm)	**300**	180	56.25	27.50	8.01	46.4
Ave Ht Midstorey (cm)	**100**	0.0	5.0	6.67	7.95	62
Ave Ht Shrub (cm)	**90**	8.79	16.85	20.72	41.45	46.23
Ave. No. of plants (plants/4 m^2)	**Nil**	8.88	14.52	12.18	21.02	21.23
Ave. Species Richness (species/4 m^2)	**Nil**	4.7	6.67	5.82	10.3	8.12

Plate 5: Block 3A November 2022

Plate 6: Block 3A March 2023

Plate 7: Block 3A August 2023

Plate 8: Block 3A May 2024

Plate 9: Block 3A January 2025

4.4 BLOCK 3B

Rehabilitation monitoring data **(Table 7)** shows overall improvement in vegetation cover, plant growth, and species richness, though progress varies across different parameters.

Vegetation cover has increased steadily from 1.11% in March 2023 to 27.95% in December 2024, reflecting successful plant establishment. Plant height trends indicate strong growth overall. The average height of all plants increased from 10.09 cm in March 2023 to 41.31 cm in December 2024, showing steady improvement. The overstorey height, has increased significantly, growing from 5 cm to 26 cm. The midstorey layer, initially absent, showed remarkable progress, reaching 75.83 cm in December 2024, suggesting a delayed but significant improvement. Similarly, shrub height increased from 8.97 cm to 45.74 cm, approaching its 90 cm target but still requiring further growth.

Plant density and biodiversity have also improved. The number of plants per 4m² rose from 4.00 in March 2023 to 20.03 in December 2024, reflecting successful recruitment. However, species richness, which peaked at 7.97 species/4m² in May 2024, slightly declined to 7.60 in December 2024, indicating a potential stabilisation or competition limiting species establishment.

Table 7: Rehabilitation parameters for the Block 3B.

Parameter	Target (at completion)	Rehab status Mar 2023	Rehab status Aug 2023	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	1.11	3.87	25.59	27.95
Ave Ht All Plants (cm)	**Nil**	10.09	7.59	30.91	41.31
Ave Ht Overstorey (cm)	**300**	5.00	5.00	25	26
Ave Ht Midstorey (cm)	**100**	0.0	0.0	8.5	75.83
Ave Ht Shrub (cm)	**90**	8.97	10.43	36.49	45.74
Ave. No. of plants (plants/4 m^2)	**Nil**	4.00	4.66	18.51	20.03
Ave. Species Richness (species/4 m^2)	**Nil**	2.61	2.54	7.97	7.60

Plate 10: Block 3B March 2023

Plate 11: Block 3B August 2023

Plate 12: Block 3B May 2024

Plate 13: Block 3B January 2025

4.5 BLOCK 4A

Rehabilitation monitoring data **(Table 8)** indicates steady improvements in vegetation cover, plant height, and species richness, though some parameters remain below target levels. Average vegetation cover increased from 4.92% (Aug 2023) to 24.86% (Dec 2024), showing progressive establishment. Overall plant height increased slightly, with the highest gains observed in shrubs (19.4 cm to 26.16 cm). The number of plants per 4m² declined over time (19.64 to 12.51), possibly due to natural thinning or competition. Species richness showed minor fluctuations, peaking at 6.23 (May 2024) before slightly decreasing to 5.29 (December 2024). While overall trends indicate positive rehabilitation progress, further monitoring and intervention may be required to meet long-term targets.

Table 8: Rehabilitation parameters for the Block 4A.

Parameter	Target (at completion)	Rehab status Aug 2023	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	4.92	16.7	24.86
Ave Ht All Plants (cm)	**Nil**	19.62	24.53	22.68
Ave Ht Overstorey (cm)	**300**	10.0	20	15
Ave Ht Midstorey (cm)	**100**	0	10	10
Ave Ht Shrub (cm)	**90**	19.4	29.75	26.16
Ave. No. of plants (plants/4 m^2)	**Nil**	19.64	14.2	12.51
Ave. Species Richness (species/4 m^2)	**Nil**	5.15	6.23	5.290

Plate 14: Block 4A 2023

Plate 15: Block 4A May 2024

Plate 16: Block 4A January 2025

4.6 BLOCK 4B

The rehabilitation data **(Table 9)** presents mixed outcomes. While plant numbers (11.33 to 13.78 per 4m²) and species richness (4.66 to 5.82 species per 4m²) increased, plant height declined across all categories. Overstorey height fell from 28.75 cm to 10 cm, midstorey from 19 cm to 10 cm, and shrub height from 27.5 cm to 14.73 cm, indicating setbacks in vegetation growth. Ground cover showed only a slight increase (10.79% to 11.68%). These declines suggest environmental stress or disturbance, and if improvements are not observed in the next assessment, targeted interventions may be necessary to stabilise plant growth and accelerate ground cover recovery.

Table 9: Rehabilitation parameters for the Block 4B.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	10.79	11.68
Ave Ht All Plants (cm)	**Nil**	23.26	13.67
Ave Ht Overstorey (cm)	**300**	28.75	10
Ave Ht Midstorey (cm)	**100**	19	10
Ave Ht Shrub (cm)	**90**	27.5	14.73
Ave. No. of plants (plants/4 m^2)	**Nil**	11.33	13.78
Ave. Species Richness (species/4 m^2)	**Nil**	4.66	5.82

Plate 17: Block 4B May 2024

Plate 18: Block 4B January 2025

4.7 BLOCK 5

Rehabilitation monitoring data **(Table 10)** showed that whilst overstorey and midstorey vegetation showed minor improvements, overall plant height, shrub height, and vegetation cover declined, indicating growth challenges and possible stress factors affecting rehabilitation. Plant density remained stable with a slight increase, but species richness showed little variation.

While the timing of flowering and proliferation of *Actinotus helianthi* may account for some of the variation, these declines may also suggest environmental stress or disturbance, and if improvements are not observed in the next assessment, targeted interventions may be necessary to stabilise plant growth and accelerate ground cover recovery.

Table 10: Rehabilitation parameters for the Block 5.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	10.83	9.40
Ave Ht All Plants (cm)	**Nil**	21.03	10.90
Ave Ht Overstorey (cm)	**300**	16.66	18.18
Ave Ht Midstorey (cm)	**100**	15.71	19
Ave Ht Shrub (cm)	**90**	22.52	11
Ave. No. of plants (plants/4 m^2)	**Nil**	12.91	14.08
Ave. Species Richness (species/4 m^2)	**Nil**	6.21	5.94

Plate 19: Block 5 May 2024

Plate 20: Block 5 January 2025

4.8 BLOCK 5A

Rehabilitation monitoring data **(Table 11)** indicates positive vegetation recovery between May and December 2024, with notable increases in vegetation cover, overall plant height, midstorey, and shrub height. However, the lack of overstorey height development suggests challenges in establishing taller vegetation. Plant density remained relatively stable, and species richness showed only a slight increase, indicating that while vegetation is expanding, diversification may be slower than structural growth. Overall, the findings suggest steady progress in rehabilitation, however, if no improvements are observed in the next monitoring event, further intervention may be required to promote overstorey establishment and species diversity.

Table 11: Rehabilitation parameters for the Block 5A.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	10.09	22.02
Ave Ht All Plants (cm)	**Nil**	19.33	27.35
Ave Ht Overstorey (cm)	**300**	0	0
Ave Ht Midstorey (cm)	**100**	11.25	22.14
Ave Ht Shrub (cm)	**90**	20.33	28.93
Ave. No. of plants (plants/4 m^2)	**Nil**	14.45	14.86
Ave. Species Richness (species/4 m^2)	**Nil**	6.59	7

Plate 21: Block 5A May 2024

Plate 22: Block 5A January 2025

4.9 BLOCK 5B

Rehabilitation monitoring data **(Table 12)** indicates, notable progress in vegetation rehabilitation between May and December 2024, with improvements in cover, plant height, density, and species richness. The increase in plant density and species richness suggests successful recruitment and biodiversity growth, but further intervention may need to be considered to enhance midstorey development and accelerate ground cover expansion for long-term rehabilitation success.

Table 12: Rehabilitation parameters for the Block 5B.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	13.67	19.06
Ave Ht All Plants (cm)	**Nil**	20.57	23.0
Ave Ht Overstorey (cm)	**300**	20.55	24.37
Ave Ht Midstorey (cm)	**100**	9.37	18.81
Ave Ht Shrub (cm)	**90**	21.96	24.18
Ave. No. of plants (plants/4 m^2)	**Nil**	28.14	24.80
Ave. Species Richness (species/4 m^2)	**Nil**	8.58	8.65

Plate 23: Block 5B May 2024

Plate 24: Block 5B January 2025

4.10 BLOCK 6

Rehabilitation monitoring data **(Table 13)** indicates rehabilitation progress shows strong gains in vegetation cover, plant height, and biodiversity, suggesting successful early-stage establishment. The midstorey should be closely monitored, and if no improvements are observed in the next monitoring event, further intervention may be required.

Table 13: Rehabilitation parameters for the Block 6.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	3	20.07
Ave Ht All Plants (cm)	**Nil**	18.34	26.73
Ave Ht Overstorey (cm)	**300**	18.57	29.37
Ave Ht Midstorey (cm)	**100**	0	0
Ave Ht Shrub (cm)	**90**	19.68	28.69
Ave. No. of plants (plants/4 m^2)	**Nil**	6.60	26.16
Ave. Species Richness (species/4 m^2)	**Nil**	3.95	7.6

Plate 25: Block 6, May 2024

Plate 26: Block 6, January 2025

4.11 BLOCK 6A

The data **(Table 14)** indicates notable improvements in vegetation establishment and diversity between May and December 2024. Vegetation cover more than doubled (9.83% to 21.59%), demonstrating early-stage recovery. Plant height increased across all structural layers, with overstorey, midstorey, and shrub heights showing steady growth, indicating progress in canopy development. Plant density nearly tripled (9.74 to 27.82 plants per 4m²), and species richness increased (5.53 to 7.70 species per 4m²), suggesting enhanced biodiversity and recruitment.

Overall, the data reflects positive trends in rehabilitation, with increasing vegetation cover, structural complexity, and species diversity.

Table 14: Rehabilitation parameters for the Block 6A.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	9.83	21.59
Ave Ht All Plants (cm)	**Nil**	23.95	25.66
Ave Ht Overstorey (cm)	**300**	23.12	32.35
Ave Ht Midstorey (cm)	**100**	30	35.89
Ave Ht Shrub (cm)	**90**	25.28	27.91
Ave. No. of plants (plants/4 m^2)	**Nil**	9.74	27.82
Ave. Species Richness (species/4 m^2)	**Nil**	5.53	7.70

Plate 27: Block 6A, May 2024

Plate 28: Block 6A, January 2025

4.12 BLOCK 6B

The rehabilitation monitoring data **(Table 15)** shows gradual vegetation establishment with increases in cover (5.23% to 9.26%), plant density (11.45 to 16.59 plants/4m²), and species richness (5.75 to 6.19 species/4m²). However, overall plant height declined (18.64 cm to 10.52 cm), with reductions in overstorey, midstorey, and shrub heights, indicating growth challenges. While biodiversity and density improvements are positive, declining plant height should be monitored, and intervention may be needed if growth setbacks persist.

Table 15: Rehabilitation parameters for the Block 6B.

Parameter	Target (at completion)	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	5.23	9.26
Ave Ht All Plants (cm)	**Nil**	18.64	10.52
Ave Ht Overstorey (cm)	**300**	11.66	9.68
Ave Ht Midstorey (cm)	**100**	10	3.66
Ave Ht Shrub (cm)	**90**	20.33	12.07
Ave. No. of plants (plants/4 m^2)	**Nil**	11.45	16.59
Ave. Species Richness (species/4 m^2)	**Nil**	5.75	6.19

Plate 29: Block 6B, May 2024

Plate 30: Block 6B, January 2025

4.13 BLOCK 7A

The December 2024 monitoring event was the first time Block 7A has been surveyed, and as such the growth parameters are indicative only **(Table 16)**. **Plate 31**and **Plate 32** show the very early stages of revegetation, with little vegetation visible at his stage.

Table 16: Rehabilitation parameters for the Block 7A.

Parameter	Target (at completion)	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	2.07
Ave Ht All Plants (cm)	**Nil**	7.47
Ave Ht Overstorey (cm)	**300**	14.5
Ave Ht Midstorey (cm)	**100**	2
Ave Ht Shrub (cm)	**90**	7.04
Ave. No. of plants (plants/4 m^2)	**Nil**	8.63
Ave. Species Richness (species/4 m^2)	**Nil**	4.5

Plate 31: Block 7A, January 2025

Plate 32: Block 7A, January 2025

4.14 BLOCK 7B

Rehabilitation monitoring data (**Table 17)** indicates significant vegetation recovery over time, with vegetation cover increasing from 4.34% (Nov 2022) to 55.76% (May 2024) before declining to 35% (Dec 2024). Overall plant height, overstorey, and midstorey heights steadily improved, reaching 39.76 cm, 70 cm, and 29.86 cm, respectively, indicating strong structural development. However, shrub height and plant density declined after peaking in May 2024, suggesting possible competition or environmental stress. Species richness increased overall but stabilized in recent months. While progress is evident, the recent declines highlight the need for continued monitoring and potential intervention to sustain long-term rehabilitation success.

Table 17: Rehabilitation parameters for the Block 7B.

Parameter	Target (at completion)	Rehab status Nov 2022	Rehab status Mar 2023	Rehab status Aug 2023	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	4.34	19.64	19.22	55.76	35
Ave Ht All Plants (cm)	**Nil**	14.68	17.53	20.50	47.03	39.76
Ave Ht Overstorey (cm)	**300**	12.5	22.50	35.00	60.71	70
Ave Ht Midstorey (cm)	**100**	10.0	5.0	6.14	19.64	29.86
Ave Ht Shrub (cm)	**90**	13.91	25.95	33.37	56.48	45.25
Ave. No. of plants (plants/4 m^2)	**Nil**	14.68	17.04	19.20	21.8	16.37
Ave. Species Richness (species/4 m^2)	**Nil**	5.53	6.77	6.64	8.1	7.97

Plate 33: Block 7B, November 2022

Plate 34: Block 7B, March 2023

Plate 35: Block 7B, August 2023

Plate 36: Block 7B, May 2024

Plate 37: Block 7B, December 2025

4.15 BLOCK 7C

Rehabilitation monitoring data **(Table 18)** showed substantial improvement. Average cover increased from 3.19% to nearly 37%, and overall plant height peaked at 43.74 cm in May 2024 before slightly declining to 36.63 cm by December. Overstorey height rose from 9.58 cm to 63.57 cm, while midstorey height, after an initial drop, stabilized around 19–20 cm. Shrub height reached a peak of 47.72 cm in May 2024, then fell to 37.70 cm. Additionally, plant density more than doubled, and species richness nearly tripled, indicating robust vegetation recovery and diversity enhancement.

Table 18: Rehabilitation parameters for the Block 7C.

Parameter	Target (at completion)	Rehab status Mar 2023	Rehab status Aug 2023	Rehab status May 2024	Rehab status Dec 2024
Ave Cover (%) (per 4m^2)	**90**	3.19	10.58	35.88	36.98
Ave Ht All Plants (cm)	**Nil**	9.29	16.01	43.74	36.63
Ave Ht Overstorey (cm)	**300**	9.58	13.33	53.14	63.57
Ave Ht Midstorey (cm)	**100**	35.00	5.00	20	18.33
Ave Ht Shrub (cm)	**90**	8.75	14.09	47.72	37.70
Ave. No. of plants (plants/4 m^2)	**Nil**	6.47	12.73	16.73	16.17
Ave. Species Richness (species/4 m^2)	**Nil**	2.75	4.27	7.11	6.60

Plate 38: Block 7C, August 2023

Plate 39: Block 7C, August 2023

Plate 40: Block 7C, May 2024

Plate 41: Block 7C, January 2025

Plate 42: Block 7C, January 2025

Plate 43: Block 7C, January 2025

5. RECOMMENDATIONS

5.1 WEED CONTROL

Multiple invasive species were recorded across the site, including common forbs such as *Conyza bonariensis* (Flea bane) and *Taraxacum officinale* (dandelion), along with the grass *Eragrostis curvula* (African Lovegrass). While these weeds do not currently impede rehabilitation efforts, *Acacia saligna* is notably more prevalent and requires immediate management.

Acacia saligna is a challenging weed due to its rapid growth, prolific seed production, and vigorous regeneration capacity. Effective control requires an integrated approach. Mechanical methods—such as cutting or uprooting—should be combined with chemical treatments; for example, applying a suitable herbicide like glyphosate or triclopyr directly to freshly cut stumps can help prevent regrowth. It's also essential to time treatments during periods of active growth and to follow up with repeated applications if necessary. Additionally, preventing seed dispersal through proper disposal of plant material and ongoing monitoring of the treated area are key to long-term control.

Plate 44: Image of *Acacia saligna* (Lucid Central. (n.d.). Acacia saligna [Image]. Retrieved 25/02/2025, from http://keyserver.lucidcentral.org/weeds/data/media/Html/acacia_saligna.htm)

5.2 SEED COLLECTION AND PLANTING - *EUCALYPTUS CAMFIELDII*

With a requirement to replace 227 *E. camfieldii,* a planting campaign should be conducted in 2025/26 with locally sourced seed used to propagate and grow the appropriate numbers. Once the seeds are

collected during their optimal fruiting period, they should be processed and propagated under controlled conditions to produce robust seedlings. These seedlings can then be planted strategically across the rehabilitation area. Seeds will need to be collected from confirmed *E.camfieldii* trees to ensure they are the correct species, owing to the significant similarities to *E. capitellata* (Brown Stringybark).

Using the success of *E.parramattensis decadens* as a guide, an estimated 405 tubestock should be planted to allow for expected loss.

5.3 SEED COLLECTION AND PLANTING - *EUCALYPTUS PARRAMATTENSIS DECADENS*

Further planting of an estimated 164 tubestock individuals of *E.parramattensis decadens* (accounting for a 56% survival rate) is required to meet the required replanting effort for this threatened species.

5.4 SUPPLIMENTRARY PLANTING

Recent monitoring indicates inadequate increases in midstorey species—specifically *Banksia spp*., *Leptospermum polygalifolium*, and *Leptospermum trinervium*. The midstorey should be closely monitored in the next assessment; if improvements remain minimal, targeted supplementary planting is warranted.

6. SUMMARY

The rehabilitation monitoring results show variable progress across different sectors, reflecting both the inherent variability of the site and variations in monitoring frequency and seasonal factors associated with rainfall and growth. Sectors monitored over multiple years generally exhibit more advanced vegetation development compared to those in their first monitoring year. For example, multi-year monitored sectors tend to show higher ground cover, greater overall plant height, and some improvement in overstorey and shrub development.

In sectors with only one year of monitoring, the data indicates early pioneer stage conditions—characterized by low cover and smaller plant sizes—which is expected. Conversely, sectors monitored more frequently have had additional time to develop, yet they still face challenges such as inconsistent midstorey establishment and limited species diversity. These discrepancies underscore the need for ongoing, targeted management strategies—including supplementary planting, enhanced weed control (especially for invasive species like *Acacia saligna*), and continued monitoring—to support further ecological recovery and bridge the gap toward achieving the set performance criteria.

7. DISCUSSION

Overall, rehabilitation at the Cabbage Tree Rd Sand Quarry is progressing well, with most performance criteria achieved or partially achieved (**Table 19**). While ground cover and overall plant height show positive trends, significant gaps remain in overstorey development and total vegetation cover. Inconsistent midstorey establishment and relatively low species richness underscore the need for targeted interventions—such as supplementary planting, enhanced weed control, and continuous monitoring—to promote structural complexity and biodiversity. Notably, blocks in their second year of monitoring did not record a sufficient increase in midstorey species such as Banksias, Leptospermum polygalifolium, and L. trinervium. As a result, the midstorey should be closely monitored in the next assessment, and if improvements remain minimal, targeted supplementary planting will be warranted.

Based on the monitoring data, all blocks would benefit from targeted supplementary planting focused on overstorey and midstorey species. While performance varies among blocks, many consistently fall short of the established rehabilitation targets for vertical structure and diversity. The introduction of additional overstorey and midstorey species is anticipated to enhance structural complexity, increase species richness, and ultimately contribute to the long-term ecological resilience of the rehabilitated areas.

Other non-vegetative parameters have been successfully met, with no erosion observed in the rehabilitation blocks—a result of strategic timber placement (maintained below 20% cover) and the predominantly flat terrain. Although common weed species like *Conyza bonariensis* (Flea bane), *Taraxacum officinale* (dandelion), and *Eragrostis curvula* (African Lovegrass) are present, they do not currently impede rehabilitation. However, the presence of *Acacia saligna*, a highly invasive species, necessitates immediate management to prevent further establishment and potential negative impacts on site recovery.

Table 19: Monitoring results compared against the performance criteria.

Year of Rehab	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Aims for Rehabilitation Achieved	Performance Criteria	Performance Criteria Achieved
Year 1 **Blocks** 1A, 2, 4B, 5, 5A, 5B, 6, 6A, 6B, 7A	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark. • Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna. • Protection of onsite Offset Area.	Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species)	✅ Achieved: Pioneer species recorded in all rehabilitation blocks	Early pioneer stage appearing: Small seedlings (< 5 cm) regenerating from topsoil, < 5% surface cover Brush-matting evident	✅ Achieved: Pioneer species recorded in all rehabilitation blocks ✅ Achieved: Brush matting observed in all rehabilitation blocks
		Key species present, including tree species important for Koalas and Camfield's Stringybark	⚠️ Partially Achieved: – a number Eucalypt species have been observed and identified in the rehabilitation blocks *E camfieldii* has been formally identified	Woody debris (>10 cm diameter) does not exceed 20% of the ground surface cover	✅ Achieved: woody debris as measured does not exceed 20%
		No significant erosion problems	✅ Achieved: no erosion observed in the rehabilitation area	Local seed has been collected and is stored appropriately for direct seeding or propagation	✅ Achieved: four seed collection events have been undertaken, seed is stored and tubestock has been propagated and installed from this locally sourced seed

Year of Rehab	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Aims for Rehabilitation Achieved	Performance Criteria	Performance Criteria Achieved
		Weed control program in place.	✅ Achieved: No significant weed infestations identified		
		No damage or disturbance to Offset Area	Not the subject of this report		
Year 2 **Blocks** 3A, 3B, 4A, 7B, 7C	• Progressive rehabilitation, revegetation with original vegetation community type, or similar, ensuring structural components and dominant species of vegetation, comparable with pre-extraction vegetation at similar elevations; free of significant weeds. • Ensure there is no net loss of koala habitat or Camfield's Stringybark	Topsoil stabilised by primary colonisers (e.g. *Acacias* & pea species)	✅ Achieved: Pioneer species recorded in all rehabilitation blocks	Natural regeneration of pioneer species occurring	✅ Achieved: Pioneer species recorded in all rehabilitation blocks

Year of Rehab	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Aims for Rehabilitation Achieved	Performance Criteria	Performance Criteria Achieved
	• Facilitate regional movement of Koalas and their occupation of the site and limit impacts to all native fauna, Protection of onsite Offset Site				
		Key species present, including tree species important for Koalas and Camfield's Stringybark	⚠️ Partially Achieved: – a number Eucalypt species have been observed and identified in the rehabilitation blocks *E camfieldii* has been formally identified	Seedlings developing under brush-matting	✅ Achieved: Seedlings developing under the brush matting
		No significant erosion problems	✅ Achieved: no erosion observed in the rehabilitation area	Cover of 10 - 20% of ground surface	✅ Achieved: All blocks have a cover greater than 20%

Year of Rehab	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Aims for Rehabilitation Achieved	Performance Criteria	Performance Criteria Achieved
		Weed control program in place	✅ Achieved: Weed control has been taking place and will continue	Plant height and density in each strata increasing	✅Achieved: The analysis of plant height and density trends across the rehabilitation blocks indicates overall positive growth, with some variations between strata. Overstorey height has generally increased in four of the five blocks (3B, 4A, 7B, and 7C), suggesting successful establishment and growth of taller vegetation. Block 3A is an exception, where overstorey height has not shown consistent growth, which may warrant further investigation. Midstorey height has increased in all blocks except 7C, indicating progressive growth of intermediate vegetation layers in most areas. Shrub height has shown consistent upward trends across all blocks, reflecting strong development in the lower vegetation strata. Plant density, measured as the average number of plants

Year of Rehab	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Aims for Rehabilitation Achieved	Performance Criteria	Performance Criteria Achieved
					per 4m², has increased in all blocks except 4A, where density appears to have declined slightly, potentially due to natural thinning processes or competitive exclusion as vegetation matures. Overall, the data suggests that the rehabilitation process is successfully fostering vegetation growth and structural complexity in most blocks, with minor deviations that may be expected as ecosystems develop.
		No damage or disturbance to Offset Area.	Not the subject of this report	Trees and shrubs not present but are expected to be planted (based on deficiencies identified in Year 1 monitoring), including tree species important for Koalas and Camfield's Stringybark	⚠ Partially Achieved: – *Eucalyptus paramatensis* seedlings were planted and had a 56% survival rate. Recommendation for further seed collection and planting of Eucalyptus *camfieldii and E.parramattensis* have been made.

Year of Rehab	Overall Rehabilitation Objectives	Aims for each Rehabilitation Year	Aims for Rehabilitation Achieved	Performance Criteria	Performance Criteria Achieved
				No significant erosion problems	✅ Achieved: no erosion observed in the rehabilitation area
				Weed control program in place	✅ Achieved: Weed control has been taking place and is planned to continue

APPENDIX A: FLORA SPECIES LIST

Table 20: Species list for the August 2023 Monitoring event by rehabilitation block

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Acacia falcata				✓													
Acacia irrorata				✓													
Acacia longifolia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Acacia saligna			✓	✓		✓			✓								
Acacia sp. (Long Leaf)			✓								✓		✓			✓	✓
Acacia suaveolens			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Acacia terminalis		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Acacia ulicifolia			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Acianthus fornicatus				✓													
Actinotus helianthi		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Allocasuarina spp.								✓					✓				
Amperea xiphoclada							✓	✓	✓	✓		✓	✓			✓	✓
Angophora costata				✓													
Aotus ericoides			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Astroloma pinilfolium			✓		✓	✓	✓	✓		✓	✓	✓	✓			✓	

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Axonopus fissifolius															✓		
Banksia aemula				✓				✓	✓			✓	✓				
Billardiera scandens										✓							
Bossiaea ensata				✓					✓	✓	✓	✓	✓				
Bossiaea heterophylla			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bossiaea rhombifolia			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Calytrix tetragona										✓		✓					
Cassytha glabella																✓	
Caustis recurvata										✓							
Chrysanthemoides monilifera								✓									
Comesperma ericinum				✓													
Conospermum taxifolium			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Conyza bonariensis	✓	✓		✓			✓		✓								
Conyza spp.			✓			✓											
Cynodon dactylon								✓								✓	

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Cyperus aggregatus															✓		
Cyperus brevifolius	✓	✓	✓	✓								✓		✓	✓		
Dianella sp.		✓	✓							✓		✓	✓	✓	✓		
Dichondra repens												✓					
Digitaria sanguinalis				✓									✓				
Dillwynia longifolia																✓	
Dillwynia retorta			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Drosera auriculata				✓													
Entolasia stricta								✓	✓	✓		✓					
Eragrostis brownii													✓	✓	✓	✓	
Eragrostis curvula													✓	✓		✓	
Eragrostis spp.		✓		✓	✓				✓		✓			✓	✓		
Euc spp.	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Eucalyptus signata				✓													
Euphorbia maculata																✓	
Euryomyrtus ramosissima																	✓

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Gahnia spp.			✓		✓		✓	✓	✓	✓		✓	✓		✓	✓	✓
Glycine microphylla														✓			
Gompholobium virgatum			✓	✓				✓		✓	✓	✓		✓	✓	✓	
Gonocarpus teucrioides		✓	✓										✓	✓	✓		
Haemodorum planifolium								✓									
Hakea teretifolia				✓													
Hardenbergia violacea		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Hibbertia fasciculata					✓	✓	✓	✓		✓	✓	✓	✓				
Hibbertia linearis			✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Hydrocotyle bonariensis													✓				
Imperata cylindrica														✓			
Juncus planifolius													✓				
Leptospermum polygalifolium				✓	✓	✓	✓	✓		✓		✓	✓			✓	✓
Leucopogon ericoides			✓		✓	✓	✓	✓	✓	✓		✓	✓			✓	✓

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Leucopogon juniperinus				✓													
Leucopogon rodwayi				✓													
Leucopogon virgatus				✓													
Lomandra glauca		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓				
Lomandra longifolia			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Macarthuria neocambrica				✓													
Macarthuria sp.					✓								✓				
Melaleuca sieberi				✓													
Melenis repens													✓				
Monotoca elliptica		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓
Monotoca scoparia			✓	✓			✓	✓	✓	✓		✓	✓		✓	✓	✓
Pandorea pandorana																✓	✓
Panicum diffusa													✓				
Paspildium distans						✓											
Persoonia laevis					✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Persoonia lanceolata			✓	✓		✓	✓		✓	✓							
Phytolacca octandra															✓	✓	
Pimelea linifolia				✓			✓		✓	✓		✓		✓	✓	✓	✓
Pinus elliottii						✓							✓	✓			
Platysace ericoides		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Poa labillardieri			✓	✓													
Pomax umbellata	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pteridium esculentum	✓	✓	✓							✓		✓		✓	✓		✓
Richardia brasiliensis				✓													
Ricinocarpos pinifolius				✓	✓		✓	✓	✓	✓	✓	✓	✓		✓		
Schoenus ericetorum				✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	
Schoenus turbinatus					✓					✓	✓	✓	✓			✓	
Selaginella uliginosa				✓													
Setaria parviflora													✓	✓			
Solanum nigrum													✓	✓			

Scientific Name	1A	02	03A	03B	04	04A	04B	05	05A	05B	06	06A	06B	07	07A	07B	07C
Taraxacum officinal		✅															
Themeda australis				✅													
Tricoryne elatior		✅	✅	✅		✅		✅					✅			✅	
Woollsia pungens			✅	✅	✅	✅	✅		✅	✅		✅				✅	✅
Xanthorrhoea glauca			✅														
Grand Total	**6**	**16**	**33**	**50**	**29**	**27**	**32**	**35**	**33**	**40**	**27**	**40**	**47**	**27**	**32**	**39**	**25**