Offset Public Report

Project LIFT

Gold Coast Airport Pty Ltd

APPROVALS

Rev	Date	Description
0	3 October 2019	Final report issued
1	15 October 2019	Final report addressing client feedback
2	24 October 2019	Final report addressing client feedback
3	13 July 2022	Updated timeframes and minor edits from client and DCCEEW

	Name	Position	Date
ORIGINATORS	Tara D'Arcy-Evans Dr Jarrad Cousin	Consultant Senior Ecologist	8 November 2021
APPROVER	Dr Jarrad Cousin	Head of Ecosystem Markets and Innovation	13 July 2022

EXECUTIVE SUMMARY

Background

The Gold Coast Airport Southern Development Area Expansion (Project LIFT) was approved under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth; EPBC Act; EPBC 2014/7266) on 24 December 2015. As a condition of approval Gold Coast Airport Pty Ltd (GCAL) is required to provide environmental offsets under the EPBC Act to compensate for residual impacts on the protected matters summarised in Table ES 1.

To identify appropriate offset sites for the environmental values in Table ES 1, desktop spatial assessment and field survey were undertaken, considering the following:

- requirements of the EPBC Act Environmental Offsets Policy
- proximity to Gold Coast Airport
- proximity to Vegetation Communities[1] (VC's)
- habitat and records for the offset values
- capacity of a property to acquit Project offset requirements
- availability of the property to be used as an offset site
- field-based verification and assessment of VC's and floristic and fauna features of the site, including assessment of the relevant water chemistry properties for each frog species listed in Table ES 1.

This assessment identified 36 properties as potentially suitable offset sites within the coastal half of the Northern Rivers Catchment Management Authority, NSW. This included six potentially suitable properties within the Tweed Shire; however, none of these properties were ultimately viable as environmental offset sites.

Landholder engagement identified seven landholders who were interested in progressing offsets. Following field assessments and further landholder engagement two properties in northern NSW were identified and put forward in the Project LIFT Offset Proposal in 2016. Together these two properties acquit 100% of the Project's offset requirements in accordance with the EPBC Act Environmental Offsets Policy and the associated offsets assessment guide. The Offset Proposal was approved by a delegate of the Minister for the Department of Environment and Energy, now the Department of Climate Change, Energy, the Environment and Water (DCCEEW), on 13 December 2016 and the two offset properties secured.

This Public Offset Report has been prepared to address condition 12 of EPBC 2014/7266 and details the requirements of two offset area management plans (OAMPs) that guide the ongoing management and monitoring for the Project LIFT offset areas in accordance with the specific criteria under condition 4 of EPBC 2014/7266.

[1] As defined under the NSW Vegetation Information System database

Table ES 1: Project LIFT impacts under EPBC 2014/7266 and offset areas secured for each environmental value

Environmental value	Status#			Project LIFT impact (ha)	Offset area to be secured (ha)	
	EPBC Act	NC Act	BC Act		Property 1	Property 2
Listed threatened species and ecological communities						
Wallum sedge frog (*Litoria olongburensis*)	V	V	V	3.80	11.29	-
Whole of the environment (from actions on Commonwealth land)						
Wallum froglet (*Crinia tinnula*)	-	V	V	26.43	11.29	66.93
Common planigale (*Planigale maculata*)	-	-	V	30.19	25.94	93.54
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community	-	-	E	16.41	7.48	42.48

 # Environment Protection and Biodiversity Conservation Act 1999 (Cwlth; EPBC Act), *Nature Conservation Act 1992* (Qld; NC Act), *Biodiversity Conservation Act 2016* (NSW; BCC Act); Vulnerable (V), Endangered (E).

Offset property 1

The property 1 offset area is approximately 50 km south of Gold Coast Airport (GCA), and comprises three VC's containing suitable habitat for offset values wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll forest Endangered Ecological Community (EEC), specifically:

- Scribbly gum woodland – Coastal mallee of the NSW North Coast bioregion (VC1)
- *Leptospermum* shrubland – Wet heathland and shrubland of coastal lowlands of the NSW North Coast bioregion (VC2)
- *Melaleuca* swamp forest – Paperbark swamp forest of the coastal lowlands of the NSW North Coast bioregion and Sydney Basin bioregion (VC3).

Offset property 2

The property 2 offset area is approximately 120 km south of GCA and comprises four VC's containing suitable habitat for offset values wallum froglet, common planigale and swamp sclerophyll forest EEC, specifically:

- *Melaleuca* swamp forest - Paperbark swamp forest of the coastal lowlands of the NSW North Coast bioregion and Sydney Basin bioregion (VC 1)
- Scribbly gum woodland - *Angophora paludosa* shrubby forest and woodland on sandstone or sands of the NSW North Coast bioregion (VC2)
- Eucalypt forest - Blackbutt bloodwood dry heathy open forest on quaternary sands of the Northern NSW North Coast bioregion (VC3)
- Heath - Wet heathland and shrubland of coastal lowlands of the NSW North Coast bioregion (VC4).

Table ES 2 summarises the extent of the offset areas for each value and the contributing VC's. The offset areas for each value identified in Table ES 2 are collocated where the contributing VC is suitable for multiple values.

Table ES 2: Summary of the Project LIFT offset areas to be secured

Offset value	Project LIFT offset area (ha)				
	VC1	VC2	VC3	VC4	Total
Property 1					
Wallum sedge frog	-	3.82	7.48	-	11.29
Wallum froglet	-	3.82	7.48	-	11.29
Common planigale	14.64	3.82	7.48	-	25.94
Swamp sclerophyll forest EEC	-	-	7.48	-	7.48
Total Property 1 offset area to be secured					**25.94**
Property 2					
Wallum sedge frog	-	-	-	-	-
Wallum froglet	42.48	-	-	24.45	66.93
Common planigale	42.48	11.71	14.90	24.45	93.54
Swamp sclerophyll forest EEC	42.48	-	-	-	42.48
Total Property 2 offset area to be secured					**93.54**

Purpose of the OAMPs

The aim of the OAMPs is to meet the EPBC Act offset obligations for Project LIFT. This will be achieved by protecting and improving the condition of habitat for wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll forest EEC within the offset areas and attaining and maintaining the completion criteria set out in this report. The offset areas will be managed and monitored in accordance with the OAMPs until 1 July 2037 (end of the approval) to meet the requirements of EPBC 2014/7266 condition 4.

Offset area management will follow the principles of adaptive management, to detect changes in the condition of the offset values, inform decisions on corrective actions, and ensure the completion criteria are achieved and maintained for the balance of the approval period. The management measures and monitoring program have been developed based on detailed field surveys of the offset areas and considering the key threats and recommended priority actions for each species and community as listed in recovery plans, threat abatement plans and conservation advices.

Management and monitoring

The management measures and monitoring events to be undertaken throughout the management period are summarised as follows:

- implementation of offset area restrictions including limited access and vegetation clearing, and weed hygiene protocols
- establishment and maintenance of:
  - access tracks for management purposes
  - fencing to restrict access by unauthorised personnel and livestock
- implementation of:
  - pest animal management to improve the condition of offset values and reduce the risk of direct predation, and associated pest animal monitoring
  - weed management to improve the condition of the offset values

  - fire management activities including the establishment and maintenance of firebreaks and controlling fuel loads to reduce the risk of an unplanned fire entering the offset area
- general offset area monitoring
- monitoring of:
  - fuel loads
  - water quality
  - weeds
- habitat condition assessments and photo monitoring
- targeted fauna surveys for wallum sedge frog, wallum froglet and common planigale.

The GCAL Environment Manager, or their nominated representative, is responsible for overseeing and managing the implementation of the OAMPs. Management and monitoring activities will be implemented and reported on by suitably qualified and experienced personnel, in accordance with the implementation schedule detailed herein.

APPROVAL HOLDER DECLARATION

I declare that:

1. To the best of my knowledge, all the information contained in, or accompanying this Project LIFT Public Offset Report Version 3 is complete, current and correct.

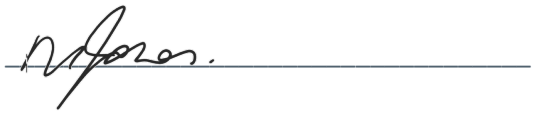
2. I am duly authorised to sign this declaration on behalf of the approval holder.

3. I am aware that:

   a. Section 490 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) makes it an offence for an approval holder to provide information in response to an approval condition where the person is reckless as to whether the information is false or misleading.

   b. Section 491 of the EPBC Act makes it an offence for a person to provide information or documents to specified persons who are known by the person to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cwlth) where the person knows the information or document is false or misleading.

   c. The above offences are punishable on conviction by imprisonment, a fine or both.

Signed: 

Full name: Matthew Jones

Organisation: Queensland Airports Limited

Date: 4/4/2022

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GLOSSARY

Adaptive management trigger: represented by:

- a completion criteria that has not been attained and/or maintained, or
- an identified, measurable event or parameter that if (or once) confirmed, is likely to prejudice attainment and/or maintenance of the completion criteria. This includes those incidentally detected and confirmed outside of monitoring activities (e.g. unplanned fire in offset area), as well as events or parameters with the potential to directly or indirectly impact on an offset value (e.g. a damaged fence likely to permit cattle to enter).

Approval holder: the person to whom the approval is granted, or any person acting on their behalf or to whom the approval is transferred under section 145B of the EPBC Act.

Baseline monitoring: the measurement of environmental parameters prior to implementation of offsets for the purpose of establishing reference points against which changes can be measured.

Completion criteria: time-bound values, specified for measurable parameters that, if attained and maintained, ensure the plan's environmental outcomes have been achieved.

Corrective action: a feasible and effective action that is undertaken where an adaptive management trigger is identified, a completion criteria not attained or, once attained, are not maintained. In concert with implementing corrective actions, ongoing reviews of the efficacy of management actions will be undertaken to ensure adaptive management triggers can be avoided, and completion criteria can be attained and maintained. In accordance with adaptive management principles, this may include additional management actions to that prescribed in the OAMP.

Environmental outcomes: the overall outcome sought by the plan. It is achieved by an environmental offset for a prescribed activity for a prescribed environmental matter if the offset is selected, designed and managed to maintain the viability of the matter.

EPBC Act Offsets Policy: the document *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Department of Sustainability, Environment, Water, Population and Communities, October 2012 (or any later revised version).

EPBC Act: the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Framework for biodiversity assessment: is the document *Framework for Biodiversity Assessment*. State of NSW and Office of Environment and Heritage (September 2014) (or any later revised version), or another document approved in writing by the Minister.

Interim performance targets: time-bound short/medium term targets, used to monitor, evaluate, review and improve the effectiveness of management actions to achieve the completion criteria.

Legally binding mechanism: a covenant or similar legal agreement in relation to a site, to provide enduring protection for the site against developments incompatible with conservation.

Management actions: management aimed at addressing management objectives, achieved by meeting interim performance targets and ultimately, attaining and maintaining completion criteria.

Management objectives: statements identifying achievable objectives contributing to achieving the environmental outcome/s of the plan. Management objectives are achieved by implementation of management actions.

Minister: the Australian Government Minister administering the EPBC Act and includes a delegate of the Minister.

Monitoring: qualitative and quantitative methodologies that produce measurable parameters to confirm whether or not management actions are meeting interim performance targets and/or attaining and maintaining completion criteria.

National recovery plan for the wallum sedge frog and other wallum-dependent frog species: is the document *National recovery plan for the wallum sedge frog and other wallum- dependent frog species* (2006) authored by Meyer, E., Hero, J-M., Shoo, L., and Lewis, B. A report to Department of the Environment and Water Resources, Canberra. Queensland Parks and Wildlife Service, Brisbane (or any later revised version).

New or increased impact: a new or increased impact on any matter protected by the controlling provisions for the action, when compared to the plan that has been approved by the Minister.

New South Wales identification guidelines for the Swamp sclerophyll forest on coastal floodplains endangered ecological community: is the document *Swamp sclerophyll forest on coastal plains- Identification guidelines for Endangered Ecological Communities* (2007). Department of Environment and Climate Change NSW (or any later revised version).

Offset values: environmental values considered whole of environment and listed threatened species and ecological communities under the EPBC Act in which significant residual impacts were identified to occur.

Performance criteria: short term management targets that if attained and maintained ensure the success of the management actions in achieving the management objectives.

Site condition: means the condition of a site in relation to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.

Suitably qualified person: a person who has professional qualifications, training, skills and/or experience related to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature.

1 INTRODUCTION

1.1 BACKGROUND

The Gold Coast Airport Southern Development Area Expansion (Project LIFT) was approved by the Minister for the Department of Infrastructure and Regional Development (now the Department of Infrastructure, Transport, Regional Development and Communications) under the *Airports Act 1996* (Cwlth) on 10 February 2016 and the Department of the Environment and Energy, now the Department of Climate Change, Energy, the Environment and Water (DCCEEW), under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth; EPBC Act; EPBC 2014/7266) on 24 December 2015.

As a condition of Project approval under EPBC 2014/7266, Gold Coast Airport Pty Ltd (GCAL) is to provide environmental offsets to compensate for residual impacts on the whole of environment and listed threatened species and ecological communities under the EPBC Act as presented in Table 1.

Environmental offsets to acquit the project's offset requirements will be secured on two properties in northern NSW that together acquit 100% of the project's offset requirements in accordance with the EPBC Act Environmental Offsets Policy (DSEWPaC 2012) and the offsets assessment guide previously approved by a delegate of the Minister for the Environment and Energy (now DCCEEW) on 13 December 2016 as part of the Project LIFT Offset Proposal (CO2 Australia 2016).

Table 1: Project LIFT impacts under EPBC 2014/7266 and offset areas to be secured for each environmental value

Environmental value	Status[#]			Project LIFT impact (ha)	Offset area to be secured (ha)	
	EPBC Act	NC Act	BC Act		Property 1	Property 2
Listed threatened species and ecological communities						
Wallum sedge frog (*Litoria olongburensis*)	V	V	V	3.80	11.29	-
Whole of the environment (from actions on Commonwealth land)						
Wallum froglet (*Crinia tinnula*)	-	V	V	26.43	11.29	66.93
Common planigale (*Planigale maculata*)	-	-	V	30.19	25.94	93.54
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community	-	-	E	16.41	7.48	42.48

 # Environment Protection and Biodiversity Conservation Act 1999 (Cwlth; EPBC Act), *Nature Conservation Act 1992* (Qld; NC Act), *Biodiversity Conservation Act 2016* (NSW; BC Act); Vulnerable (V), Endangered (E).

1.2 PURPOSE AND SCOPE

The purpose of this Public Offset Report is to summarise the management and monitoring activities for the offset areas. The aim of the OAMPs is to meet the EPBC Act offset obligations for Project LIFT. This will be achieved by protecting and improving the condition of habitat for wallum froglet, common planigale and swamp sclerophyll forest EEC within the offset area and attaining and maintaining the completion criteria set out in this plan. The offset area will be managed and monitored in accordance with this plan until 1 July 2037 (end of the approval) to meet the requirements of EPBC 2014/7266 condition 4, as presented in Table 2.

This report includes:

- a summary of the Project LIFT offset area offset areas
- details of the proposed legally binding mechanism
- a description of the offset areas and baseline condition of the offset values
- a description of the approach to offset management
- completion criteria and interim performance targets for each offset value
- the management objectives, performance criteria, adaptive management triggers and corrective actions
- the management actions to be implemented to achieve the management objectives, performance targets and completion criteria, including baseline surveys to inform pest animal management and weed management
- the monitoring and reporting requirements to be undertaken to assess the progress towards achieving the completion criteria.
- implementation schedules for management and monitoring of the offset area.

Table 2: Relevant sections of OAMP addressing EPBC 2014/7266 condition 4 criteria

EPBC 2014/7266 Condition 4 criteria	Relevant section
a. Management actions to achieve the following outcomes for the protected matters listed in Table 1: ▶ for the life of the approval, there must be no net loss to the extent (in hectares) of habitat relative to baseline monitoring; and ▶ for the life of the approval, there must be no net loss to the site condition relative to baseline monitoring; and ▶ before expiry of the approval, site condition must be improved relative to baseline monitoring	The environmental outcome sought will be to protect and improve the condition of habitat for wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll EEC within the offset area by achieving the completion criteria set out in section 6.1 The management actions outlined in this report have been developed to improve the condition of vegetation and offset values from the baseline habitat quality (section 4.3) in order to achieve the completion criteria by the fourth anniversary of the approval the OAMPs and maintained for the life of the approval (i.e. until 1 July 2037). Management actions for the offset area are detailed in section 7 and include: ▶ implementation of offset area restrictions including restricted access, limited vegetation clearing and weed hygiene ▶ establishment and maintenance of access tracks ▶ establishment and maintenance of fencing to restrict access by unauthorised personnel and livestock ▶ pest animal management to improve the condition of offset values and reduce the risk of direct predation ▶ weed management to improve the condition of the offset values ▶ fire management activities including the establishment and maintenance of firebreaks and controlling fuel loads in order to reduce the risk of an unplanned fire within the offset area The offset areas are proposed to be protected through a Conservation Agreement under the EPBC Act in order to protect the offset area from future development and ensure there is no net loss in extent of the offset area and values.
b. Performance criteria and completion criteria for evaluating the management of the environmental offset area and criteria for triggering corrective actions (if necessary)	Completion criteria for each offset value have been developed to align with the future habitat quality score in the approved offsets assessment guides for the offset area. Completion criteria for each of the offset values, if attained and maintained, will demonstrate the success of OAMPs management and acquit the project approval's offset obligations. The completion criteria are presented in section 6.1. Performance criteria and adaptive management triggers are specified to measure the success of the management actions in achieving the management objectives

EPBC 2014/7266 Condition 4 criteria	Relevant section
	and contributing towards attaining and maintaining the completion criteria. These are presented in section 6.1. Corrective actions have been identified should the management actions be unsuccessful and the adaptive management criteria are triggered. These are presented in section 6.1.
c. Timing of when management actions will be implemented and details of the proposed legally binding mechanism for securing the offset	The OAMPs must be implemented following approval by the Minister for the Environment or delegate. The offset area is proposed to be secured through an EPBC Act Conservation Agreement as outlined in section 2.3.
d. A monitoring program for the life of the approval (which includes baseline monitoring) at the offset area/s required under condition 1. The results of the monitoring program must be adequate to inform adaptive management and demonstrate whether the outcomes described in condition 4a are being met. Monitoring must be undertaken by a suitably qualified person and must take into consideration the framework for biodiversity assessment. Performance indicators which must be monitored include: ▶ For Wallum sedge frog habitat: ecosystem functionality and site condition; and the presence of known threats as identified in the national recovery plan for the wallum sedge frog and other wallum-dependent frog species ▶ For Wallum froglet habitat: ecosystem functionality and site condition; and the presence of known threats as identified in the national recovery plan for the wallum sedge frog and other wallum-dependent frog species ▶ For Common planigale habitat: ecosystem functionality and site condition; and the presence of predators, including but not limited to: feral cats, european red foxes, and cane toads ▶ For Swamp sclerophyll forest on coastal floodplains of the NSW north coast, Sydney basin and south east corner bioregions endangered ecological community: ecosystem functionality and site condition; and cover of plant species that are known to make up the ecological community as defined in the New South Wales identification guidelines for the Swamp sclerophyll	A monitoring program for the offset areas will assess the success of the management actions and monitor progress in achieving and maintaining the completion criteria. Details of the monitoring program are provided in section 8 and include the following: ▶ general offset area monitoring ▶ water quality monitoring ▶ fuel load monitoring ▶ weed monitoring ▶ pest animal monitoring ▶ habitat condition assessments ▶ photo monitoring. ▶ targeted fauna surveys for wallum sedge frog, wallum froglet and common planigale.
e. A process and timing to report to the Minister that includes the progress of adaptive management activities undertaken in the offset area/s and	Reports will be provided to DCCEEW within two months of the third anniversary of the approval of the OAMPs annually to 2031 and every two years until the end of the approval (1 July 2037). In accordance with condition 7 of the EPBC Act approval this

EPBC 2014/7266 Condition 4 criteria	Relevant section
outcomes of these activities, results of the monitoring program, progress towards meeting the outcomes described in condition 4a.	report will also address compliance with the approval conditions as per the information requirements of the Department's Annual Compliance Report Guidelines. Further detail is provided in section 9.

2 OFFSET SUMMARY

2.1 OFFSET AREAS

The offset areas are located on two properties in northern NSW within 120 km of Gold Coast Airport (Figure 1). GCAL has secured a legal interest in each property through an offset agreement with the landholder of the property. The purpose of the offset agreement is to:

- ensure that the offset areas are not adversely impacted through activities undertaken by the landholder on the property
- authorise GCAL to manage and monitor the offset area in accordance with the approved OAMP
- facilitate protection of the offset area through a legally binding mechanism.

The location of the offsets was informed by detailed field survey conducted by a suitably qualified ecologist in May and July 2016 generally in accordance with the Framework for Biodiversity Assessment (OEH 2014a) and the BioBanking Assessment Methodology 2014 (BBAM; OEH 2014b). The detailed field survey included an assessment of the baseline condition of the vegetation which was used to inform the assessment under the EPBC Act offsets assessment guide, which was in turn approved by a delegate of the Minister for the Environment and Energy on 13 December 2016 as part of the Project LIFT Offset Proposal (CO2 Australia 2016).

2.1.1 Property 1 offset area

The property 1 offset area comprises three vegetation communities, defined under the NSW Vegetation Information System database, containing suitable habitat for offset values wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll forest EEC, specifically:

- Scribbly gum woodland - Coastal mallee of the NSW North Coast bioregion (VC1).
- Leptospermum shrubland - Wet heathland and shrubland of coastal lowlands of the NSW North Coast bioregion (VC2).
- Melaleuca swamp forest - Paperbark swamp forest of the coastal lowlands of the NSW North Coast bioregion and Sydney Basin bioregion (VC3).

Table 3 summarises the extent of the offset values on the offset area and the contributing vegetation communities. The total offset area to be secured is 25.94 ha and is a combination of areas comprising VC1, VC2 and VC3. Note that the areas for each offset value identified in Table 3 are collocated where the contributing VC is suitable for multiple offset values. The whole offset area (25.94 ha) is suitable habitat for common planigale, therefore is equal to the total offset area to be secured.

Section 3 provides a detailed description of the vegetation communities and the offset values.

Table 3: Summary of the offset areas to be secured on property 1

Offset value	Project LIFT offset area (ha)			
	VC1	VC2	VC3	Total
Wallum sedge frog	-	3.82	7.48	11.29
Wallum froglet	-	3.82	7.48	11.29
Common planigale	14.64	3.82	7.48	25.94
Swamp sclerophyll forest EEC	-	-	7.48	7.48
Total offset area to be secured				**93.54**

2.1.2 Property 2 offset area

The property 2 offset area comprises four vegetation communities, defined under the NSW Vegetation Information System database, containing suitable habitat for offset values wallum froglet, common planigale and swamp sclerophyll forest EEC, specifically:

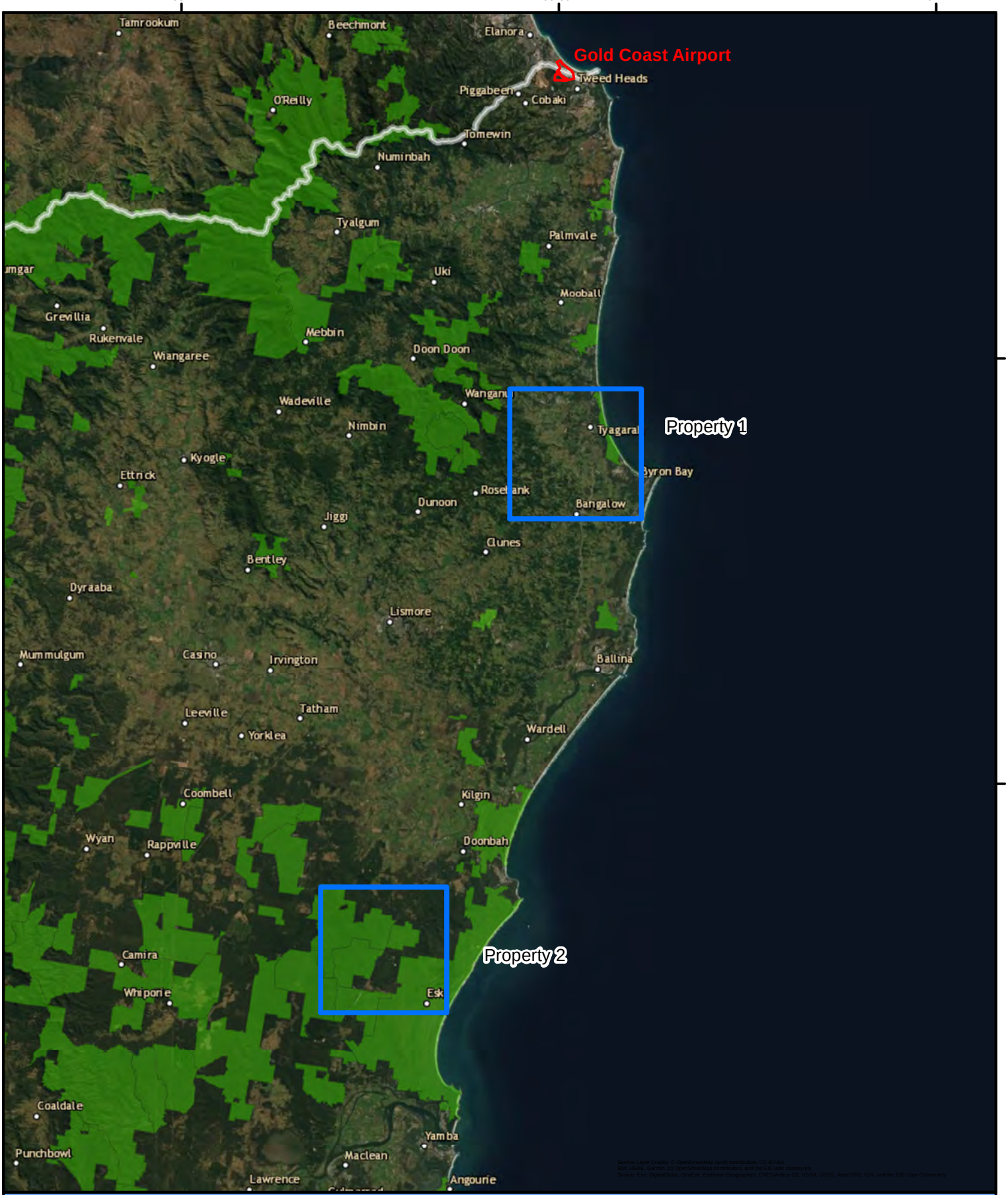
- Melaleuca swamp forest - Paperbark swamp forest of the coastal lowlands of the NSW North Coast bioregion and Sydney Basin bioregion (VC 1).
- Scribbly gum woodland - *Angophora paludosa* shrubby forest and woodland on sandstone or sands of the NSW North Coast bioregion (VC2).
- Eucalypt forest - Blackbutt bloodwood dry heathy open forest on quaternary sands of the Northern NSW North Coast bioregion (VC3).
- Heath - Wet heathland and shrubland of coastal lowlands of the NSW North Coast bioregion (VC4).

Table 4 summarises the extent of the offset values on the offset area and the contributing vegetation communities. The total Project LIFT offset area to be secured is 93.54 ha. The offset areas for each value identified in Table 4 are collocated where the contributing VC is suitable for multiple values.

Section 4 provides a detailed description of the vegetation communities and the offset values.

Table 4: Summary of the offset areas to be secured and managed on property 2

Offset value	Project LIFT offset area (ha)				
	VC1	VC2	VC3	VC4	Total
Wallum sedge frog	-	-	-	-	-
Wallum froglet	42.48	-	-	24.45	**66.93**
Common planigale	42.48	11.71	14.90	24.45	**93.54**
Swamp sclerophyll forest EEC	42.48	-	-	-	**42.48**
Total offset area to be secured					**93.54**



Gold Coast Airport - Project LIFT

Location diagram

Figure 1: Project LIFT
Offset properties

- general offset property location
- Gold Coast Airport Boundary
- Nature Conservation Reserve

0 10 20 30
Kilometres

N

CO2 Australia

DATA SOURCE:
The following datasets are © State of NSW:
- Cadastre

Date: 10/2/2019 Coordinate System: GDA 1994 MGA Zone 56 Projection: Transverse Mercator Datum: GDA 1994 Scale: 1:650,496 @A4

Path: \\co2lnels01.corp.co2australia.com.au\co2-gis\GIS Data\Projects\Gold_Coast_Airport\180301 - GCAPL offset presentation\191001_Context_map.mxd

2.2 DEPARTMENTAL REFERENCE DETAILS

The departmental reference details for the offset area are outlined in Table 5.

Table 5: Departmental reference details for application and offset trigger

Commonwealth Offset Trigger	
Relevant legislation	EPBC Act
EPBC Act approval	2014/7266
Impacts required to be offset	• Listed threatened species and ecological communities • The environment, where actions proposed are on, or will affect Commonwealth land and the environment

2.3 PROTECTION MECHANISM FOR OFFSETS

Under condition 5 of the EPBC Act approval, the offset areas are to be secured by a legally binding mechanism within six months of approval of the OAMP. The offset area will be secured through a Conservation Agreement under the EPBC Act. The Conservation Agreement will likely comprise a joint agreement between the landholder, GCAL and the Commonwealth Government Environment Minister for the protection and conservation of the offset area and the biodiversity values within it. The Conservation Agreement will remain in place until the Minister for the Environment agrees to revoke the conservation agreement.

Impacts associated with bushfires at the Property 1 offset area in November 2019 along with border closures and lockdowns associated with the COVID-19 pandemic presented significant challenges to the implementation of the OAMPs at Property 1 and 2 within the required timeframes and resulted in unavoidable delays.

Due to the above impacts and resultant delays to the implementation of the OAMP, a twelve-month extension was sought and granted by the Department of Agriculture, Water and the Environment (DAWE; now DCCEEW) on 18 July 2020 with regard to:

- Provision to the Department of the first implementation report for the OAMP
- Commencement of site management works
- Achievement of all interim performance targets under the OAMP, and
- Achievement of the final completion criteria for the OAMP.

Ongoing border restrictions and lockdowns following the extension being granted continued to impact the implementation of the OAMP. In consultation with DAWE (October 2021; now DCCEEW), timeframes for the above aspects were revised within the OAMP to provide an additional twelve months for implementation pursuant to condition 11 of the EPBC approval (EPBC 2014/7266).

3 DESCRIPTION OF PROPERTY 1 OFFSET AREA

The following sections describe the vegetation communities (section 3.1) and the offset values (section 3.2) present within the property 1 offset area. Section 3.3 presents the baseline condition of the vegetation communities and offset values.

3.1 VEGETATION COMMUNITIES

SCRIBBLY GUM WOODLAND - COASTAL MALLEE OF THE NSW NORTH COAST BIOREGION (VC 1).

This VC is located in upland parts of the offset site associated with parallel dune systems. These areas are characterised by deep white sands with a canopy dominated by *Eucalyptus signata* (to 15 m). Other species in the canopy layer and subcanopy layer (to 6 m) include *Banksia* spp., *Leptospermum* spp., *Eucalyptus robusta*, *Allocasuarina littoralis*, *Glochidion* spp., *Ficus coronata*, *Elaeocarpus reticulatus*, *Cupaniopsis anacardioides*, *Alphitonia excelsa* with some exotic *Cinnamomum camphora*. Shrub vegetation (2 – 6 m) is relatively open in parts, although included *Banksia* spp., *Acacia* spp., *Dodonaea triquetra*, *Leucopogon* spp., *Strangea linearis* and Xanthorrhoea spp. Understorey vegetation (< 2 m) varies in density and composition across the VC, with areas of bare white sand, and areas of dense Banksia leaf litter. Species include *Caustis recurva, Boronia spp., Pteridium esculentum, Dianella caerulea, Hibbertia scandens, Smilax australis, Smilax glyciphylla, Austromyrtus dulcis, Gahnia spp., Drosera spp*. and *Caleana major*. This vegetation community is generally consistent with NR153 under the NSW Vegetation Information System Classification (v2.1) database, identified as coastal mallee of the NSW North Coast Bioregion.

LEPTOSPERMUM SHRUBLAND - WET HEATHLAND AND SHRUBLAND OF COASTAL LOWLANDS OF THE NSW NORTH COAST BIOREGION (VC2)

This VC is located in downslope areas to the very east of the offset site characterised by a shrub canopy of *Leptospermum* spp. and *Melaleuca quinquenervia* (to 4 m). The whole area is perennially inundated or otherwise saturated, with numerous open wetland/sedgeland areas comprising emergent sedges and rushes. Understorey vegetation (<2 m) is dense, and comprised a diverse mix of wetland-dependent and ephemeral species including *Baloskion tetraphyllum, Gahnia clarkei, Baumea articulata, Lepironia articulata, Blechnum indicum, Boronia spp., Leptospermum spp., Hibbertia scandens, Gleichenia rupestris* and *Cassytha sp.* This vegetation community is generally consistent with NR278 under the NSW Vegetation Information System Classification (v2.1) database, identified as wet heathland and shrubland of coastal lowlands of the NSW North Coast Bioregion.

MELALEUCA SWAMP FOREST - PAPERBARK SWAMP FOREST OF THE COASTAL LOWLANDS OF THE NSW NORTH COAST BIOREGION AND SYDNEY BASIN BIOREGION (VC3)

This VC occurs in downslope areas to the west of VC1, as well as in a narrow swale within VC1 characterised by a canopy dominated by *Melaleuca quinquenervia* (to 25 m). Much of the area is perennially inundated or otherwise saturated, with small areas (or channels) of perennial wetland areas comprising emergent sedges and rushes. Other species in the canopy include *Eucalyptus robusta*, *Lophostemon confertus*, *Corymbia intermedia*, *Endiandra sieberi, Casuarina glauca* and *Eucalyptus siderophloia*. The sub-canopy (to 15 m) is characterised by a mix of swamp sclerophyll and adjacent sub-tropical rainforest species, including canopy recruits as well as *Alphitonia excelsa, Ficus coronata, Archontophoenix cunninghamiana* and *Syzygium* spp. Shrub vegetation (2 – 3 m) was relatively open, comprising a mix of canopy recruits, as well as *Gahnia clarkei, Elaeocarpus reticulatus, Ficus coronata, Cordyline congesta*, and patches of climbing *Hibbertia scandens*, *Parsonsia straminea, Smilax australis, Geitonoplesium cymosum* and *Stephania japonica*.

Understorey vegetation (< 2 m) comprises a mix of perennial wetland-dependent species and ephemeral species including *Dianella caerulea, Lomandra longifolia, Blechnum indicum, Hypolepis muelleri, Pteridium esculentum, Gleichenia rupestris, Viola hederacea, Ottochloa gracillima, Oplismenus aemulus, Centella asiatica, Sphagnum cuspidatum, Passiflora* sp. and *Commelina cyanea*. This vegetation community is generally consistent with NR217 under the NSW Vegetation Information System Classification (v2.1) database, identified as paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.

3.2 OFFSET VALUES

3.2.1 Wallum sedge frog and wallum froglet

Habitat attributes and vegetation species associated with VC2 and VC3 are generally consistent with those appropriate for wallum sedge frog and wallum froglet. These vegetation communities (NR278 and NR217) are recognised by the Atlas of NSW Wildlife (BioNet) as two of 12 vegetation communities known to support wallum froglet and two of six vegetation communities known to support wallum sedge frog in the Northern Rivers. The *Leptospermum* shrubland (VC2) is considered ideal breeding habitat for both species, with large areas of perennially-inundated areas with preferred emergent rushes and sedges, with wallum froglets heard while surveying vegetation within VC2. The presence of inundated *Melaleuca* swamp habitat (VC3), including areas of open water with emergent sedges and other perennial wetland vegetation is also consistent with breeding habitat required by both species. Confirmed records of wallum sedge frog and wallum froglet are known within 2 km of the property, with no fewer than 10 confirmed records of wallum sedge frogs and 74 confirmed records of wallum froglet. The result of the water chemistry analysis of the site is shown in Table 6. From the five water samples analysed across the site, analysis indicates that the pH of water is mildly acidic (pH 3.5 – 4), with low electrical conductivity (average 140 µS/cm), indicative of an absence of tidal influence or other dissolved salts on the water on the property. The water chemistry at the offset area is consistent with water quality required to support wallum sedge frog and wallum froglet typically associated with acidic, freshwater wetlands.

Table 6: Water chemistry results for property 1

Water chemistry measure	Avg (range)
pH	3.8 (3.5-4)
conductivity (µS/cm)	140 (90-230)
total dissolved solids (ppm)	108 (73-172)

3.2.2 Common planigale

All vegetation communities on property 1 are considered generally consistent with habitat for common planigale. These vegetation communities (NR153, NR217 and NR278) are recognised by the Atlas of NSW Wildlife (BioNet) as three of 113 vegetation communities known to support common planigale in the Northern Rivers. This species is known to occupy a diverse range of habitats including habitat consistent with scribbly gum woodland, *Leptospermum* shrubland and *Melaleuca* swamp vegetation communities on the property. In addition to the presence of these habitat types, all parts of the property are in close proximity to water; considered an important requirement for this species. Confirmed records of common planigale are known within 500 m of the property, with no fewer than six records within 2 km.

3.2.3 Swamp sclerophyll forest EEC

VC3 is considered consistent with swamp sclerophyll forest EEC, with at least eight of the 16 key indicator species (e.g. Melaleuca quinquenervia, Livistona australis, Glochidion ferdinandi, Dianella caerulea, Gahnia clarkei, Gahnia sieberiana, Imperata cylindrica, Pteridium esculentum) and many of the other characteristic species (DECC 2007) present within the extent of mapped swamp sclerophyll forest EEC (e.g. Allocasuarina littoralis, Eucalyptus resinifera, Lophostemon suaveolens, Melaleuca styphelioides).

3.3 BASELINE HABITAT QUALITY

In accordance with the offsets assessment guide calculations approved as part of the Project LIFT Offset Proposal, the start habitat quality score is required to be improved for each of the offset values within the first two years of management and maintained for the life of the approval (i.e. until 1 July 2037). This obligation also satisfies condition 4 (a) ii and iii of the EPBC Act approval that requires there is no net loss to the site condition relative to the baseline monitoring and the site condition of the offset area be improved relative to baseline monitoring. For the purposes of scoring habitat value to provide for a value of 'start quality' for use in the offsets assessment guide, three factors were considered, consistent with the EPBC Act Offset Guidelines:

- site condition
- site context
- species stocking rate (for species offset values only).

Site condition and site context were calculated generally in accordance with the Framework for Biodiversity Assessment (OEH 2014a) and the BBAM (OEH 2014b) as part of detailed field surveys conducted in May 2016. The BBAM has been developed by the NSW Office of Environment and Heritage to provide a process to assess the condition of the biodiversity values of a site. The BBAM also provides guidance on the number and location of assessment plots required to adequately assess the condition of a vegetation community.

The species stocking rate component was calculated in accordance with a set of weighted scores to questions reflecting the known or likely presence, density and importance of any species populations. Appendix A provides further detail on the method used to assess the baseline habitat quality of the offset values which will also be used to assess the proposed improvement in condition to attain the completion criteria as part of ongoing monitoring events in accordance with the OAMPs.

Table 9 provides a summary of the baseline habitat quality score for each of the offset values to be used as the baseline for improvement in accordance with the completion criteria in section 6.1.

Table 7: Summary of the baseline habitat quality score for property 1

Offset value	Site condition score	Site context score	Species stocking rate score	Baseline habitat quality score*
Wallum sedge frog	6.83	9.21	6.50	7.24
Wallum froglet	6.83	9.21	8.50	7.64
Common planigale	6.88	9.21	7.50	7.47
Swamp sclerophyll forest EEC	6.82	9.21	NA	7.30

* Quality scores for wallum sedge frog, wallum froglet and common planigale comprises site condition (60%), site context (20%) and species stocking rate (20%), whereas for swamp sclerophyll forest EEC it comprises site condition (80%) and site context (20%) only.

4 DESCRIPTION OF PROPERTY 2 OFFSET AREA

The following sections describe the vegetation communities (section 4.1) and the offset values (section 4.2) present within the offset area. Section 4.3 presents the baseline condition of the vegetation communities and offset values.

4.1 VEGETATION COMMUNITIES

MELALEUCA SWAMP FOREST - PAPERBARK SWAMP FOREST OF THE COASTAL LOWLANDS OF THE NSW NORTH COAST BIOREGION AND SYDNEY BASIN BIOREGION (VC 1).

This VC occurs in downslope areas throughout much of the site, characterised by a canopy of varying density, dominated by *Melaleuca quinquenervia* (to 25 m), but with some areas co-dominant with *Eucalyptus tereticornis, Eucalyptus resinifera* and/or *Lophostemon suaveolens*. Much of the area is subject to ephemeral inundation, with large areas under water following moderate rainfall, receding to small isolated pockets of muddy water outside of the rain season. The lowest lying areas support perennial wetland species. Weed species are largely restricted to the understorey strata, including patches of *Baccharis halimifolia, Urochloa mutica, Setaria* sp. and *Paspalum* sp. Other species in the canopy and sub-canopy layer (to 15 m) include *Angophora floribunda, Eucalyptus robusta, Melaleuca nodosa, Melaleuca styphelioides, Melaleuca sieberi, Livistona australis, Leptospermum spp., Allocasuarina littoralis* and *Glochidion ferdinandi* with *Dendrobium* sp. orchids in the canopy of some trees.

Shrub vegetation (to 6 m) is sparse and comprised a mix of canopy and sub-canopy species, as well as *Banksia integrifolia, Elaeocarpus reticulatus, Melaleuca sieberi, Melaleuca alternifolia, Melastoma affine* and *Hakea* sp. with *Parsonsia straminea* and *Cassytha filiformis* scrambling throughout.

Ground vegetation varies across VC1, including some species often dominating in patches such as *Hypolepis muelleri, Pteridium esculentum, Lomandra longifolia, Themeda australis, Imperata cylindrica, Entolasia stricta, Ottochloa gracillima, Setaria* spp. and *Cynodon dactylon*. Wetter areas are characterised by species such as *Baloskion tetraphyllus, Blechnum indicum, Gahnia clarkei, Gahnia sieberiana, Urochloa mutica, Sphagnum cuspidatum, Ranunculus sp., Liparophyllum exaltatum, Cryptostylis subulata, Philydrum lanuginosum, Cyperus exaltatus, Baumea spp., Juncus spp. Chorizandra cymbaria* and *Persicaria decipiens*. This vegetation community is generally consistent with NR217 under the NSW Vegetation Information System Classification (v2.1) database, identified as paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.

SCRIBBLY GUM WOODLAND - ANGOPHORA PALUDOSA SHRUBBY FOREST AND WOODLAND ON SANDSTONE OR SANDS OF THE NSW NORTH COAST BIOREGION (VC2)

This VC is located in a narrow band of sandy soils between VC1 and VC3 characterised by an open canopy (to ~12 m) of *Eucalyptus signata* with *E. tereticornis, E. pilularis, E. gummifera, E. resinifera*, *E. intermedia* and *Melaleuca quinquenervia.* The sub-canopy layer is largely absent, with a sparse tall shrub layer (8 m) comprising species similar in composition to adjacent VC1 and VC3, including *Lophostemon suaveolens, Banksia* spp., *Callistemon* sp., *Glochidion ferdinandi*, *Persoonia* sp., *Grevillea* sp., *Allocasuarina littoralis, A. torulosa, Acacia* spp. and *Elaeocarpus reticulatus*. Ground vegetation (<2 m) is similarly characterised by species such as *Dianella caerulea*, *Lomandra longifolia*, *Themeda triandra, Cymbopogon refractus, Entolasia stricta*, *Pratia purpurascens*, *Leptospermum* spp., *Leucopogon lanceolatus*, *Leptocarpus tenax*, *Adiantum atroviride, Xanthorrhoea* spp. and *Haemodorum* sp. with *Blechnum indicum, Gahnia clarkei* and *Gahnia sieberiana* present in wetter areas at the based on the ridges, adjacent VC1. This vegetation community is

generally consistent with NR101 under the NSW Vegetation Information System Classification (v2.1) database, identified as *Angophora paludosa* shrubby forest and woodland on sandstone or sands of the NSW North Coast Bioregion.

EUCALYPT FOREST - BLACKBUTT BLOODWOOD DRY HEATHY OPEN FOREST ON QUATERNARY SANDS OF THE NORTHERN NSW NORTH COAST BIOREGION (VC3)

This VC is characterised by eucalypt-dominated vegetation communities overlying sandy/clay loam soils on elevated ridges. Canopy vegetation (to 25 m) is characterised by a mix of eucalypts including *Eucalyptus resinifera*, *E. signata, E. pilularis, Corymbia intermedia* and *Angophora floribunda.* Other species in the canopy and sub-canopy layer (to 15 m) include *Melaleuca quinquenervia*, *Melaleuca sieberi*, *Alphitonia excelsa*, *Allocasuarina torulosa* and *Allocasuarina littoralis,* with the latter species often found in small, dense patches.

Shrub vegetation (2 – 6 m) is relatively open in parts and includes species such as *Banksia integrifolia*, *Persoonia* sp., *Grevillea* sp., *Glochidion ferdinandi, Leptomeria acida, Pultenaea* sp., *Notelaea ovata, Acacia ulicifolia*, *Elaeocarpus reticulatus*, *Melastoma affine* and *Melaleuca styphelioides*. Understorey vegetation (<2 m) comprises a mix of native species including *Dianella caerulea*, *Lomandra longifolia*, *Blechnum indicum*, *Entolasia stricta*, *Ottochloa gracillima*, *Leptospermum* spp., *Themeda triandra, Cymbopogon refractus, Ptilothrix deusta, Hibbertia vestita, Pimelea linifolia, Urochloa* sp.*, Lindsaea linearis, Xanthorrhoea* spp*. Goodenia rotundifolia, Caladenia catenata, Cassytha filiformis, Cryptostylis subulata* and *Hibbertia* sp. This vegetation community is generally consistent with NR114 under the NSW Vegetation Information System Classification (v2.1) database, identified as blackbutt - bloodwood dry heathy open forest on Quaternary sands of the northern NSW North Coast Bioregion.

HEATH - WET HEATHLAND AND SHRUBLAND OF COASTAL LOWLANDS OF THE NSW NORTH COAST BIOREGION (VC4)

This VC occurs in three patches, characterised by dense heath vegetation downslope of VC1. Areas of VC4 show evidence of ephemeral inundation, with some areas of moisture-laden sands and clay loam soils. The canopy layer (to 5 m) is very sparse, and is characterised by scattered *Melaleuca quinquenervia* and *Melaleuca sieberi* with some *Eucalyptus tereticornis* and *Lophostemon suaveolens.* Shrub and ground vegetation (to 2 m) is dense and comprised species such as *Callistemon pachyphyllus, Banksia integrifolia, Banksia oblongifolia, Melaleuca thymifolia, Grevillea sp., Leptospermum spp., Hakea laevipes, Petrophile sp., Xanthorrhoea fulva, Persoonia sp., Pultenaea robusta, Epacris sp., Cassytha filiformis, Baumea teretifolia, Chorizandra cymbaria, Philydrum lanuginosum, Trachymene anisocarpa, Entolasia stricta, Themeda triandra* and *Lepidosperma* sp. This vegetation community is generally consistent with NR278 under the NSW Vegetation Information System Classification (v2.1) database, identified as wet heathland and shrubland of coastal lowlands of the NSW North Coast Bioregion.

4.2 OFFSET VALUES

4.2.1 Wallum froglet

Habitat attributes and vegetation species associated with VC1 and VC4 provide suitable habitat for wallum froglet. Not only were multiple wallum froglets heard during field assessments, calling from swampy *Melaleuca* forest and heath vegetation communities (corresponding to VC1 and VC4, respectively), but these vegetation communities (NR217 and NR278) are recognised by the Atlas of NSW Wildlife (BioNet) as two of

12 vegetation communities known to support wallum froglet. In addition, confirmed records of wallum froglet are known within 1.6 km of the site.

Baseline water chemistry across the offset area was identified to be mildly acidic (pH 4.5 – 5.6), with low electrical conductivity (average 126 µS/cm), indicative of an absence of tidal influence or other dissolved salts on the water on the property (Table 8). The water chemistry at the offset area is consistent with water quality required to support wallum froglet typically associated with acidic, freshwater wetlands.

Table 8: Water chemistry results for property 2

Water chemistry measure	Avg (range)
pH	5.0 (4.5-5.6)
conductivity (µS/cm)	126 (0-420)
total dissolved solids (ppm)	97 (7-305)

4.2.2 Common planigale

All vegetation communities on property 2 are considered generally consistent with habitat for common planigale. These vegetation communities (NR217, NR101, NR114 and NR278) are recognised by the Atlas of NSW Wildlife (BioNet) as four of 113 vegetation communities known to support common planigale in the Northern Rivers. This species is known to occupy a diverse range of habitats including habitat consistent with Melaleuca swamp forest, scribbly gum woodland, eucalypt forest and heath vegetation communities on the property. In addition to the presence of these habitat types, all parts of the property are in close proximity to water; considered an important requirement for this species. Confirmed records of common planigale are known 4 km to the north and west of the property.

4.2.3 Swamp sclerophyll forest EEC

VC1 is considered consistent with swamp sclerophyll forest EEC, with at least eight of the 16 key indicator species (e.g. *Melaleuca quinquenervia, Livistona australis, Glochidion ferdinandi*, *Dianella caerulea, Gahnia clarkei, Gahnia sieberiana, Imperata cylindrica, Pteridium esculentum*) and many of the other characteristic species (Department of Environment and Climate Change 2007) present within the extent of mapped swamp sclerophyll forest EEC (e.g. *Allocasuarina littoralis, Eucalyptus resinifera, Lophostemon suaveolens, Melaleuca styphelioides*).

4.3 BASELINE HABITAT QUALITY

In accordance with the offsets assessment guide calculations approved as part of the Project LIFT Offset Proposal, the start habitat quality score is required to be improved for each of the offset values within the first two years of management and maintained for the life of the approval (i.e. until 1 July 2037). This obligation also satisfies condition 4 (a) ii and iii of the EPBC Act approval that requires there is no net loss to the site condition relative to the baseline monitoring and the site condition of the offset area be improved relative to baseline monitoring. For the purposes of scoring habitat value to provide for a value of 'start quality' for use in the offsets assessment guide, three factors were considered, consistent with the EPBC Act Offset Guidelines:

- site condition
- site context

- species stocking rate (for species offset values only).

Site condition and site context were calculated generally in accordance with the Framework for Biodiversity Assessment (OEH 2014a) and the BBAM (OEH 2014b) as part of detailed field surveys conducted in May 2016 (property 1) and July 2016 (property 2). The BBAM has been developed by the NSW Office of Environment and Heritage to provide a process to assess the condition of the biodiversity values of a site. The BBAM also provides guidance on the number and location of assessment plots required to adequately assess the condition of a vegetation community.

The species stocking rate component was calculated in accordance with a set of weighted scores to questions reflecting the known or likely presence, density and importance of any species populations. Appendix A provides further detail on the method used to assess the baseline habitat quality of the offset values which will also be used to assess the proposed improvement in condition to attain the completion criteria as part of ongoing monitoring events in accordance with the OAMPs.

Table 9 provides a summary of the baseline habitat quality score for each of the offset values to be used as the baseline for improvement in accordance with the completion criteria in Table 10.

Table 9: Summary of the baseline habitat quality score for property 2

Offset value	Site condition score	Site context score	Species stocking rate score	Baseline habitat quality score*
Wallum froglet	8.31	10.00	8.50	**8.69**
Common planigale	8.54	10.00	6.75	**8.47**
Swamp sclerophyll forest EEC	8.85	10.00	NA	**9.08**

* Quality input scores for wallum froglet and common planigale comprises site condition (60%), site context (20%) and species stocking rate (20%), whereas for swamp sclerophyll forest EEC it comprises site condition (80%) and site context (20%) only. The site condition score and final start quality input score is calculated from the sum of the Project LIFT offset area and advanced offsets area.

5 APPROACH TO MANAGEMENT

5.1 ADAPTIVE MANAGEMENT

The OAMPs are based on an adaptive management approach which involves 'flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood' (National Research Council 2004). Adaptive management includes two key phases. The first phase involves the establishment of the key components of a management framework including engaging stakeholders, developing clear and measurable objectives and performance criteria, identification and selection of potential management actions and the development of monitoring protocols which enable the evaluation of progress towards achieving objectives and which will effectively contribute to the adaptive decision making process. The second phase is an iterative learning phase which involves utilisation of the management framework to learn about the natural resource system and iteratively adapt management strategies and approaches based on what is learned (Williams 2011).

Implementation of the OAMPs will use the adaptive management framework , as outlined in Figure 2, in order to detect changes in the condition of the offset values, incorporate learnings from other similar management activities/conservation advice and inform decisions on corrective actions to ensure completion criteria are attained by the fourth anniversary of the approval of the OAMPs and maintained for the life of the approval.

The offset area for Project LIFT and the advanced offset area will be managed and monitored as a single area to ensure the environmental outcome and completion criteria are achieved across both areas.

The management measures and monitoring program have been developed based on detailed field surveys of the offset area and in accordance with the key threats and recommended priority actions for each species and community as listed in recovery plans, threat abatement plans and conservation advices (Appendix B)

Section 5 details the overall environmental outcome of the OAMPs, interim performance targets and completion criteria for each offset value, and management objectives to be achieved. Attainment and maintenance of the completion criteria will be assessed based on the results of ongoing management and monitoring events and will be presented as part of compliance reporting commitments to DCCEEW (section 9).

In the event that an interim performance target has not been achieved, or a completion criteria (once attained) has not been maintained, or an adaptive management trigger is identified, corrective actions will be implemented. Where there is uncertainty as to the cause of the management trigger (e.g. failure to

achieve the interim performance target), the event or circumstance triggering corrective action will be reviewed, and management actions in the OAMPs may be revised accordingly.

The offset site will be managed and monitored, as a minimum, for the life of the approval (until 1 July 2037) and until the completion criteria have been achieved in accordance with condition 4 of the EPBC Act approval. It is anticipated that the completion criteria will be achieved by the fourth anniversary of the approval of the OAMPs and maintained over the life of the approval through adaptively implementing the OAMPs.

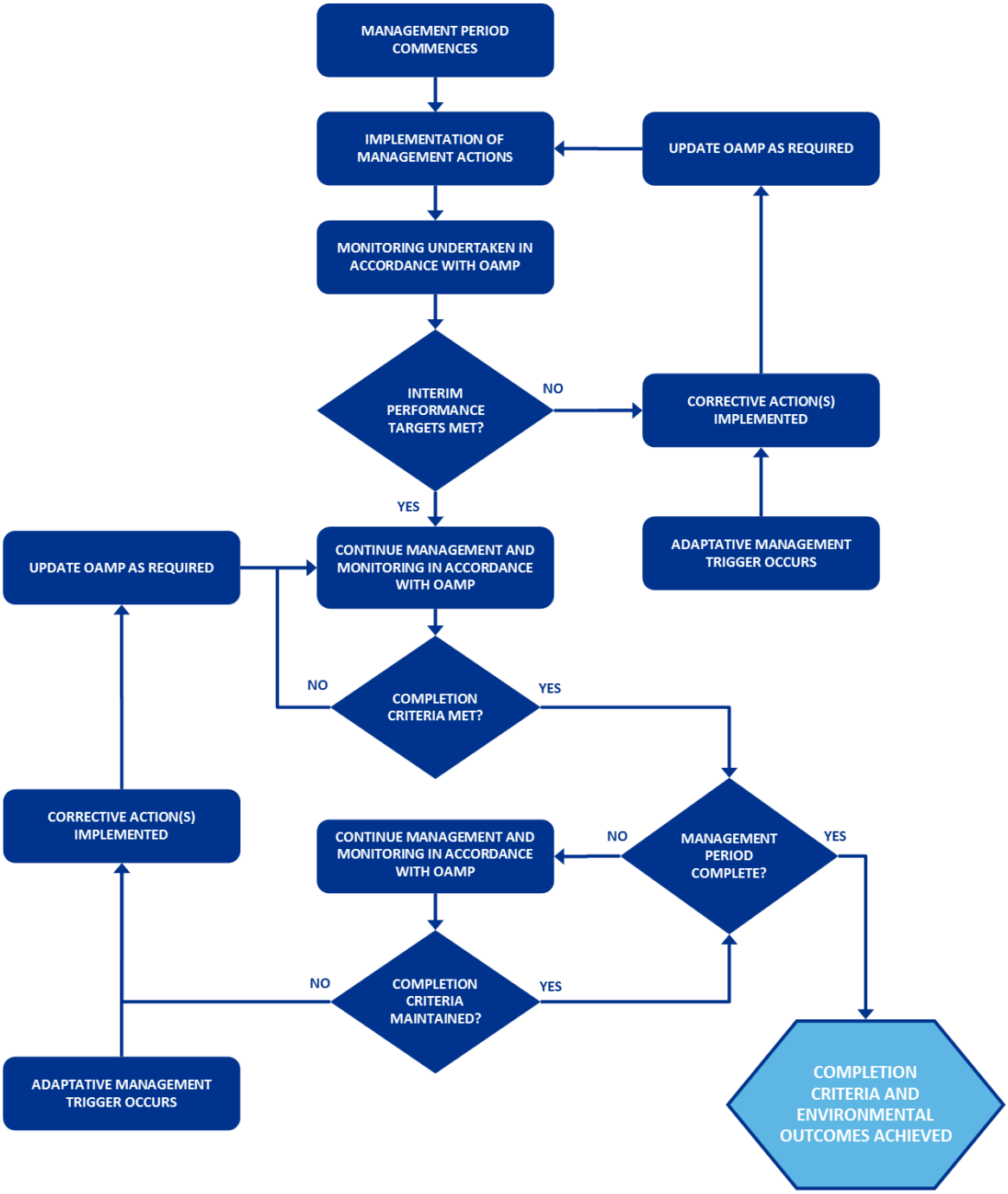


Figure 2: Adaptive management process for implementation of the OAMPs

5.2 MANAGING UNCERTAINTY

An adaptive management approach has been adopted in the development of the OAMPs to manage the uncertainty associated with natural resource systems in order to attain and maintain the completion criteria of the OAMPs.

Williams (2011) and Williams and Brown (2016) identify four kinds of uncertainty; environmental variation, partial observability, partial controllability and structural or process uncertainty. These uncertainties and how they have been managed through the development of the OAMPs are detailed below.

5.2.1 Environmental variation

Environmental variation is the most prevalent source of uncertainty, often has the most dominant influence on natural systems and is largely uncontrollable (Williams and Brown 2016). Environmental variation is caused by external factors that act upon natural systems which are not influenced by the resource conditions and dynamics, for example variation in precipitation patterns and temperature regimes as well as extremes in these conditions (Williams and Brown 2016).

The following key risks associated with environmental variation have the potential to influence the condition and viability of the offset values and the ability to attain and maintain the completion criteria. These risks are addressed as part of the risk assessment in Appendix C.

- Increase in presence of pest animals within the offset area due to more favourable climate conditions (i.e. increased rainfall, increase in food availability).
- Increase in weed abundance within the offset area due to more favourable climate conditions (i.e. increased rainfall).
- Increase in risk of unplanned fire within the offset area due to extreme drought and/or lightning strike.

Environmental variation is largely outside of the control of the manager (Williams 2011), however, its influence will be considered in the analysis of the effectiveness of the management framework based on the results of ongoing monitoring events (section 8), informing management decisions, and in the analysis of the ability to achieve and maintain the completion criteria.

Environmental variation will also be taken into consideration when determining the need for corrective actions or amendments to management strategies. For example, a review will be undertaken to understand if the cause of the trigger for corrective action is attributable to prior management activities or to environmental variation, prior to making a decision regarding the appropriate action to be taken.

5.2.2 Partial observability

Partial observability incudes potential uncertainty that arises from variation in the collection of monitoring data and the inability to completely observe the natural system that is being managed (Williams 2011; Williams and Brown 2016). This has the potential to result in incorrect assumptions regarding the status of the area and therefore ineffective management decisions affecting the ability to attain and maintain the completion criteria. Uncertainty arising from partial observability has been managed through the development of the monitoring program outlined in section 8 based on published, approved and scientifically tested guidelines developed by suitably qualified professionals and/or Government bodies. All

ongoing monitoring events will be undertaken in accordance with the OAMPs by suitably qualified persons (see section 10.1).

5.2.3 Partial controllability

Partial controllability refers to the difference between the effect of the management actions that is intended to be implemented as part of the OAMPs and the effect of their actual implementation on the ground (Williams and Brown 2016).

This uncertainty is dealt with through adherence to an adaptive management approach as outlined in section 5.1. Adaptive management includes iterative learning which involves utilisation of the management framework to learn about the natural resource system and iteratively adapt management strategies and approaches based on what is learned. This will involve regular monitoring, review and amendments to the OAMPs to incorporate learnings identified through management activities, and reporting to ensure that management actions are being effectively implemented on the ground to ensure the completion criteria are attained and maintained.

5.2.4 Structural or process uncertainty

Structural or process uncertainty concerns a lack of knowledge regarding biological and ecological processes and relationships, and differing views regarding how natural systems respond to management (Williams and Brown 2016). In contrast to environmental variation, structural or process uncertainty can be reduced largely through an adaptive management approach which incorporates an iterative learning process (Williams and Brown 2016).

The OAMPs has been developed based on published scientific literature, conservation advice and detailed baseline field data. Following the results of ongoing management, monitoring and reporting the OAMPs will be reviewed and updated as required to incorporate learnings from ongoing management activities. Furthermore, as updated conservation advice and best practice management techniques become available the OAMPs will be updated to assist in attaining and maintaining the completion criteria.

6 MANAGEMENT OUTCOMES

The environmental outcome sought by the OAMPs will be to protect and improve the condition of habitat for wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll EEC within the offset area and achieve the completion criteria set out in Table 10.

6.1 COMPLETION CRITERIA

Table 10 details completion criteria for each offset value to demonstrate the success of the OAMPs in achieving the overall environmental outcome.

The completion criteria align with the future habitat quality score included in the approved offsets assessment guides. Through the implementation of management and monitoring activities outlined in this report, the condition of the vegetation and offset values within the offset area will be improved from the baseline habitat quality (section 4.3) in order to achieve the completion criteria by the fourth anniversary of the approval of the OAMPs and be maintained for the life of the approval (i.e. until 1 July 2037).

As described in sections 3.3, 4.3 and Appendix A, the habitat quality score comprises three individual scores for site condition, site context and species stocking rate. Table 10 details the minimum site condition score

required to achieve the future habitat quality score, assuming that site context and species stocking rate scores do not change from the baseline in section 4.3. However, should the scores for site context and species stocking rate reduce or increase following assessment as part of habitat condition assessments (section 8.6), the scores will be used to calculate the habitat quality score in combination with the site condition score at the time.

In addition to completion criteria, Table 10 identifies interim performance targets to be achieved by the third anniversary of the approval of the OAMPs which is based on the site condition score for each offset value. The purpose of this interim target is to evaluate, review and (where required) improve the effectiveness of management actions to ensure the completion criteria can be attained and maintained by the fourth anniversary of the approval of the OAMPs.

Appendix A presents the method to be used to assess and calculate the site condition, site context, species stocking rate and habitat quality score as part of site condition assessment (section 8.6).

Appendix A also includes an indication of the ecological attributes for each vegetation community in which the scores against the relevant benchmark to be improved as a result of the management actions in order to achieve the future site condition score for each offset value.

Should the interim performance targets and completion criteria not be achieved within the required timeframes the management actions will be reviewed and revised in accordance with the corrective actions outlined in Table 11 and Table 12

Table 10: Offset value completion criteria

Offset value	Baseline site condition score	Completion criteria				
		Interim performance target[A]	Final site condition score after year 2 (minimum)[B]	Site context score	Species stocking rate score	Future habitat quality score[C]
Property 1						
Wallum sedge frog	6.83	8.00	9.00	9.21	6.50	9.00
Wallum froglet	6.83	7.75	8.50	9.21	8.50	9.00
Common planigale	6.88	7.50	8.00	9.21	7.50	8.00
Swamp sclerophyll forest EEC	6.82	7.50	8.00	9.21	NA	8.00
Property 2						
Wallum froglet	8.31	8.31	8.31	10.00	8.50	**9.00**
Common planigale	8.54	8.75	9.00	10.00	6.75	**9.00**
Swamp sclerophyll forest EEC	8.85	8.85	8.85	10.00	-	**9.00**

[A] Site condition score by the third anniversary of the approval of this OAMP
[B] Final site condition score (minimum) by the fourth anniversary of the approval of this OAMP

[C] Quality input scores for wallum froglet and common planigale comprises site condition (60%), site context (20%) and species stocking rate (20%), whereas for swamp sclerophyll forest EEC it comprises site condition (80%) and site context (20%) only

6.2 MANAGEMENT OBJECTIVES

Table 11, Table 12 and section 7 outline the management actions to be implemented across the offset areas. The management actions are appropriate to attain and maintain the completion criteria and also to address threats and recovery actions specific to each offset value, as identified in Commonwealth and State listing and conservation advice, recovery plans and other documentation prepared with the aim of encouraging the conservation of the relevant offset values. Implementation of the management actions will realise the following management objectives in order to achieve the overall environmental outcome and completion criteria:

- reduce predation risk by wild dogs, foxes and feral cats to wallum sedge frog, wallum froglet and common planigale
- reduce poisoning risk by cane toads to common planigale
- reduce predation risk of wallum sedge frog, wallum froglet eggs by mosquito fish
- reduce habitat degradation caused by pigs within the offset area to reduce impacts on habitat for wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll EEC
- prevent weed species' incursions and reduce existing weed species infestations to reduce impacts on habitat for wallum sedge frog, wallum froglet, common planigale and swamp sclerophyll EEC
- prevent livestock grazing within the offset area
- prevent unplanned fire within the offset area through management of fuel loads.

Performance criteria for each of the management objectives have been identified in Table 11 and Table 12 also identify adaptive management triggers that in the event these triggers are detected, a review of the cause will be undertaken and suitable corrective actions will be implemented as per the adaptive management approach.

Specific details of the management actions to be implemented are described in section 7. Ongoing monitoring will be undertaken throughout the life of the approval to inform the success of the management actions in achieving and maintaining the completion criteria, as outlined in section 8.

6.3 RISK ASSESSMENT

Appendix C presents a risk assessment completed for the offset area to identify and analyse any real or potential risks associated with achieving the management objectives, and any corrective actions to be undertaken if the risks occur. The risk of the management objectives failing is ranked low to medium.

Table 11: Property 1 management objectives and performance criteria for offset values, outlining management actions, and triggers for corrective action.

Management objective	Management action	Performance criteria	Adaptive management trigger	Contingency response and corrective action/s	Monitoring activity
Reduce predation risk by wild dogs, foxes and feral cats to wallum sedge frog, wallum froglet and common planigale.	Pest animal management will be undertaken across the offset area in accordance with section 7.5. Baseline assessments of pest animals in the offset area will be undertaken by the third anniversary of the approval of the OAMP, consisting of a survey to identify the presence of pest animals and inform species-specific control measures, location and timing of pest control actions.	The presence of wild dogs, foxes and feral cats and/or impacts from wild dogs, foxes and feral cats is less than wild dogs, foxes and feral cats /impacts detected during baseline surveys.	▶ evidence of foxes, feral cats, dogs within the offset area, or ▶ an increase in Catling Index from baseline and/or previous monitoring event (refer to section 8.5), or ▶ an observed increase in the abundance or signs of predator pest species in the offset area as part of pest animal monitoring in section 8.5, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained.	▶ Further review and evaluation of monitoring results to confirm the pest animal issue and inform any additional habitat assessment, pest animal and/or targeted fauna surveys within the offset area needed to identify the extent of the fox, feral cat, dog and/or pig problem. ▶ Following detection, implement pest animal control in accordance with section 7.5 for foxes, feral cats, dogs, pigs, cane toads and mosquito fish. ▶ Where there is an increase in Catling Index or mean abundance, review and revise fox, feral cat, dog and/or pig control in accordance with industry best practice and increase the frequency of control activities until monitoring demonstrates fox, feral cat, dog and/or pig abundance is eliminated and/or less than baseline levels. ▶ For mosquito fish and/or cane toads, implement control measures to reduce their extent and/or abundance to the greatest extent possible.	Pest animal monitoring (section 8.5) General offset area monitoring (section 8.1) Water quality monitoring (section 8.3)
Reduce poisoning risk by cane toads to common planigale		No mosquito fish and/or cane toads are confirmed within the offset area.	▶ evidence of mosquito fish or cane toads within the offset area, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained.		
Reduce predation risk of wallum sedge frog and wallum froglet eggs by mosquito fish					
Reduce habitat degradation caused by pigs within the offset area.		The presence of pigs and/or impacts from pigs is less than pigs/impacts detected during baseline surveys.	▶ an increase in mean pig abundance score from baseline and/or previous monitoring event, or ▶ an observed increase in the presence of (or signs of) pigs in the offset area as part of pest animal monitoring in section 8.5, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained, or ▶ decrease in the site condition of habitat assessed as part of habitat condition assessment (section 8.6), or ▶ decrease in the water quality favourable to wallum sedge frog and wallum froglet based on the monitoring and parameters in section 8.3.		
Prevent weed species' incursions and reduce existing weed species infestations	Weed control and weed hygiene restrictions will be implemented across the offset site to reduce the extent of *Passiflora* sp, camphor laurel, blue billy goat weed and pigeon grass, paspalum sp. and para grass, as well as preventing and controlling the potential introduction of other exotic weed species. Weed management will be undertaken in accordance with section 7.6 and weed hygiene restrictions will be implemented in	The extent of existing weed infestations across the offset area are reduced to less than the baseline survey. Additional weed species incursions into the offset area are prevented as much as reasonably practicable.	▶ an increase in the mean richness and/or abundance score of weed species from baseline and preceding monitoring event, (refer to section 8.4), or ▶ an increase in weed cover and density from baseline and preceding monitoring event as derived from photo monitoring results, or ▶ incursions of additional weed species, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained.	▶ Further review and evaluation of monitoring results to confirm the weed management issue and inform any additional habitat assessment and weed surveys within the offset area needed to confirm the extent of the infestation. ▶ Review adherence to weed hygiene procedures outlined in section 7.6 until the weed abundance/richness is identified to decrease in subsequent monitoring events to achieve the performance criterion. ▶ Investigate weed control actions for new outbreaks of weed species and implement to achieve the performance criteria. ▶ Investigate alternative weed management control actions and implement selected actions to achieve the performance criterion.	Weed monitoring (section 8.4) General offset area monitoring (section 8.1)

Management objective	Management action	Performance criteria	Adaptive management trigger	Contingency response and corrective action/s	Monitoring activity
	accordance with section 7.2.				
Prevent livestock grazing within the offset area	The offset area will be fenced to prevent livestock entering the offset area. See section 7.4.	Stock excluded from the offset area	Livestock (or evidence of livestock) identified within the offset area.	▶ Remove stock found in the offset area and consult with landholder to determine the cause of livestock entry. ▶ Inspect and evaluate boundary fencing and identify cause of livestock within the offset area. ▶ Repair boundary fencing. ▶ Construct additional boundary fencing should the current fencing be considered insufficient to exclude livestock.	General offset area monitoring (section 8.1) including monitoring of: ▶ condition of fencing ▶ exclusion of livestock from offset area and any signs of land degradation
Prevent unplanned fire within the offset area.	Fire management across the offset area will be undertaken in accordance with section 7.7 so as to manage fuel loads and reduce the risk of unplanned fire within the offset area.	No unplanned fire in the offset area	▶ an unplanned fire in the offset area ▶ fuel hazard rating greater than extreme	▶ Investigate potential sources of unplanned fire (e.g. incendiary sources, elevated fuel loads) ▶ Consult with the landholder and adjacent landholders regarding fuel load management of surrounding properties. ▶ Establish additional firebreaks outside the offset area. ▶ Increase frequency of weed control of relatively flammable weed species within and adjacent to the offset area. ▶ If increased weed control efforts are ineffective, consult with NSW NPWS to determine the feasibility, timing and implementation of controlled fuel reduction burns.	Weed monitoring (section 8.4) General offset area monitoring (section 8.1) Fuel load assessment (section 8.2)

Table 12: Property 2 management objectives and performance criteria for offset values, outlining management measures, and triggers for corrective action.

Management objective	Management action	Performance criteria	Adaptive management trigger	Contingency response and corrective action/s	Monitoring activity
Reduce predation risk by wild dogs, foxes and feral cats to wallum froglet and common planigale.	Pest animal management will be undertaken across the offset area in accordance with section 7.5. Baseline assessments of pest animals in the offset area will be undertaken by the third anniversary of the approval of the OAMP, consisting of a survey to identify the presence of pest animals and inform species-specific control measures, location and timing of pest control actions.	The presence of wild dogs, foxes and feral cats and/or impacts from wild dogs, foxes and feral cats is less than wild dogs, foxes and feral cats /impacts detected during baseline surveys.	▶ evidence of foxes, feral cats, dogs within the offset area, or ▶ an increase in Catling Index from baseline and/or previous monitoring event (refer to section 8.5, or ▶ an observed increase in the abundance or signs of predator pest species in the offset area as part of pest animal monitoring in section 8.5, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained.	▶ Further review and evaluation of monitoring results to confirm the pest animal issue and inform any additional habitat assessment, pest animal and/or targeted fauna surveys within the offset area needed to identify the extent of the fox, feral cat, dog and/or pig problem. ▶ Following detection, implement pest animal control in accordance with section 7.5 for foxes, feral cats, dogs, pigs, cane toads and/or mosquito fish. ▶ Where there is an increase in Catling Index or mean abundance, review and revise fox, feral cat, dog and/or pig control in accordance with industry best practice and increase the frequency of control activities until monitoring demonstrates fox, feral cat, dog and/or pig abundance is eliminated and/or less than baseline levels. ▶ For mosquito fish and/or cane toads, implement control measures to reduce the extent and/or abundance to the greater extent possible.	Pest animal monitoring (section 8.5) General offset area monitoring (section 8.1) Water quality monitoring (section 8.3)
Reduce poisoning risk by cane toads to common planigale		No mosquito fish and/or cane toads are confirmed within the offset area.	▶ evidence of mosquito fish or cane toads within the offset area, or ▶ interim performance target not attained or completion criteria are not attained within 2 years and/or once attained, are not maintained.		
Reduce predation risk of wallum froglet eggs by mosquito fish					
Reduce habitat degradation caused by pigs within the offset area.		The presence of pigs and/or impacts from pigs is less than pigs/impacts detected during baseline surveys.	▶ an increase in mean pig abundance score from baseline and/or previous monitoring event, or ▶ an observed increase in the presence of (or signs of) pigs in the offset area as part of pest animal monitoring in section 8.5, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained, or ▶ decrease in the site condition of habitat assessed as part of habitat condition assessment (section 8.6), or ▶ decrease in the water quality favourable to wallum froglet based on the monitoring and parameters in section 8.3		
Prevent weed species' incursions and reduce existing weed species infestations	Weed control and weed hygiene restrictions will be implemented across the offset site to reduce the extent of groundsel bush and pigeon grass, paspalum sp. and para grass, as well as preventing and controlling the potential introduction of other exotic weed species. Weed management will be undertaken in accordance with section 7.6 and weed hygiene restrictions will be implemented in accordance with section 7.2.	The extent of existing weed infestations across the offset area are reduced to less than the baseline survey. Additional weed species incursions into the offset area are prevented as much as reasonably practicable.	▶ an increase in the mean richness and/or abundance score of weed species from baseline and preceding monitoring event, (refer to section 8.4), or ▶ an increase in weed cover and density from baseline and preceding monitoring event as derived from photo monitoring results, or ▶ incursions of additional weed species, or ▶ interim performance target not attained or completion criteria are not attained by the fourth anniversary of the approval of the OAMP and/or once attained, are not maintained.	▶ Further review and evaluation of monitoring results to confirm the weed management issue and inform any additional habitat assessment and weed surveys within the offset area needed to confirm the extent of the infestation. ▶ Review adherence to weed hygiene procedures outlined in section 7.2 (general restrictions) to ensure compliance and update restrictions where required. ▶ Investigate increase in weed species richness and cover, including analysis of distribution of weeds within the offset site to identify likely and/or recurrent incursion sources. ▶ Increase the frequency of weed control efforts until the weed abundance/richness is identified to decrease in subsequent monitoring events to achieve the performance criterion. ▶ Investigate weed control actions for new outbreaks of weed species and implement to achieve the performance criteria. ▶ Investigate alternative weed management control actions and implement selected actions to achieve the performance criterion.	Weed monitoring (section 8.4) General offset area monitoring (section 8.1)

Management objective	Management action	Performance criteria	Adaptive management trigger	Contingency response and corrective action/s	Monitoring activity
Prevent livestock grazing within the offset area	The offset area will be fenced to prevent livestock entering the offset area. See section 7.4	Stock excluded from the offset area	Livestock (or evidence of livestock) identified within the offset area.	▶ Remove stock found in the offset area and consult with the landholder to determine the cause of livestock entry. ▶ Inspect and evaluate boundary fencing and identify cause of livestock within the offset area. ▶ Repair boundary fencing. ▶ Construct additional boundary fencing should the current fencing be considered insufficient to exclude livestock.	General offset area monitoring (section 8.1) including monitoring of: ▶ condition of fencing ▶ exclusion of livestock from offset area and any signs of land degradation
Prevent unplanned fire within the offset area.	Fire management across the offset area will be undertaken in accordance with section 7.7 so as to manage fuel loads and reduce the risk of unplanned fire within the offset area.	No unplanned fire in the offset area	▶ an unplanned fire in the offset area ▶ fuel hazard rating greater than extreme	▶ Investigate potential sources of unplanned fire (e.g. incendiary sources, elevated fuel loads) ▶ Consult with the landholder and adjacent landholders regarding fuel load management of surrounding properties. ▶ Establish additional firebreaks outside the offset area. ▶ Increase frequency of weed control of relatively flammable weed species within and adjacent to the offset area. ▶ If increased weed control efforts are ineffective, consult with NSW NPWS to determine the feasibility, timing and implementation of controlled fuel reduction burns.	Weed monitoring (section 8.4) General offset area monitoring (section 8.1) Fuel load assessment (section 8.2)

7 MANAGEMENT MEASURES

7.1 OVERVIEW

This section outlines the management actions that will be implemented within the offset area to achieve the completion criteria and management objectives detailed in section 6. Table 13 provides a summary of the management actions for each offset value within the offset area.

Table 13: Overview of management measures

Management measure	Wallum sedge frog	Wallum froglet	Common planigale	Swamp sclerophyll EEC
General restrictions	▶ Restricted access ▶ Vegetation clearing limited to new access tracks, fencing and emergency response ▶ Weed hygiene			
Fencing	Offset area will be fenced where required to exclude livestock and restrict unauthorised access			
Target pest animals for control	Pigs		Foxes, feral cats, and pigs	Pigs
Primary weed control method	Chemical, mechanical or biological			
Fire/fuel hazard	▶ Maintain existing firebreaks and access tracks ▶ Manage fuel loads through weed control ▶ Fuel reduction burns will only be considered where weed control of fuel loads is ineffective			
Exclusion of livestock	Any stock detected in the offset area will be removed			

7.2 GENERAL RESTRICTIONS

The general restrictions presented in Table 14 will be implemented to ensure the management objectives are achieved.

Table 14: Offset area restrictions

Restrictions	Details
Access	Access into the offset areas will be restricted to GCAL authorised personnel only and the landholder in accordance with the restrictions of the offset agreement. Existing and new fences will be used to restrict access into offset areas, with locks to be installed on gates. Signs will be installed in prominent locations advising that the areas are protected for conservation purposes and that access into these areas is restricted to authorised personnel only.
Vehicles	Vehicle movement will be limited to designated access tracks in the offset area and access will be restricted to authorised personnel only. Vehicles will travel to track conditions.
Vegetation clearing	No clearing of native vegetation will occur within the offset area, with the exception of clearing: ▶ that is required to realign, construct or maintain new access tracks, fencing and firebreaks up to 6 m wide and ▶ as directed by emergency management response personnel in the event of unplanned fire or other emergency procedure.

Restrictions	Details
Weed hygiene	Weed hygiene measures will be implemented to prevent the movement of weed material into the offset area. All persons entering the offset area will be required to ensure all vehicles and equipment are weed free (including removal of soil and seeds).

7.3 ACCESS TRACKS

Existing access tracks around the boundary and within the offset area will be utilised to facilitate necessary management, maintenance and monitoring activities. Existing tracks will be graded throughout the life of the OAMPs as required and maintained to be no wider than 6 m. Existing access tracks will also act as additional firebreaks for the offset area (see section 7.7).

Access tracks within the offset area will be monitored regularly as part of ongoing management and monitoring events and where suitable following a high rainfall event (>200 mm within a 24 hour period) when access is clear.

7.4 FENCING

The offset areas have previously been subject to grazing by livestock with evidence of grazing throughout the offset areas, with varying degrees of impact including browsing on shrubby vegetation, trampling, grazing on native grasses and weed infestations around grazing concentrated areas.

The offset areas will be fenced, where required, to prevent livestock entering the offset area.

Lockable gates will be installed at access points around the boundary of the offset area. Regular communication with the landholder will continue throughout the management period regarding the condition of fencing and livestock management, in addition to GCAL's monitoring commitments outlined in section 8.

7.5 PEST ANIMAL MANAGEMENT

The offset values and their habitat are known to be impacted by pest animals. Many of these animals are known or have the potential to be present within or in the immediate vicinity of the offset areas, with threats including:

- predation by wild dogs, foxes and cats (known)
- degradation of habitat by pigs (known)
- poisoning by ingestion of cane toads (potential)
- predation of eggs and larvae by introduced fish, namely *Gambusia holbrooki* (potential).

Pest animal management will be implemented to reduce the threat of predation on fauna offset values and minimise degradation of habitat.

Baseline assessments of pest animals in the offset area will be undertaken by the third anniversary of the approval of the OAMPs, consisting of a survey to identify the presence of pest animals and inform species-specific control measures, location and timing for pest control actions.

Species specific pest animal control will be undertaken within the offset area as required in accordance with the *Local Land Services Act 2013* (NSW). Table 15 provides examples of species-specific pest animal control measures recommended by the NSW Department of Primary Industries, including the Regional Pest

Management Strategy 2012–17: Northern Rivers Region (OEH 2012). The type of pest animal control, including the timing and frequency, will comprise of one or a combination of the control methods outlined in Table 15, based on the presence and density of pest animals within the offset area following the baseline assessment undertaken by the third anniversary of the approval of the OAMPs and subsequent management and monitoring activities. The nature, extent and effectiveness of pest animal control measures used will be described in compliance reporting to DCCEEW and periodically updated in the OAMPs.

It is important to note there are currently limited practical control measures and solutions to effectively eradiate and/or reduce the presence of cane toad and mosquito fish populations. Should these pest animals be identified as present within the offset area, control measures, outlined in Table 15, will be implemented to decrease the presence of the species within the offset area to the greatest extent possible

GCAL will make their best endeavour to engage and work with adjacent landholders in order to coordinate pest animal control activities in the offset area.

Table 15: Pest animal species and relevant control methods

Species	Control method
Fox (*Vulpes vulpes*)	Control methods for foxes include: ▶ ground baiting ▶ den fumigation ▶ cage trapping (OEH 2012). Fox control will be coordinated with NSW NPWS and among adjoining properties, as well as part of other pest management programs (i.e. dog and cat) to effectively reduce the impact of foxes.
Wild dog (*Canis familiaris*)	Control methods for wild dogs include: ▶ ground baiting ▶ trapping ▶ shooting ▶ fencing (OEH 2012) Wild dog control will be coordinated with NSW NPWS and among adjoining properties, as well as part of other pest management programs (i.e. fox and cat) to effectively reduce the impact of wild dogs.
Feral cat (*Felis catus*)	Control methods for feral cats include: ▶ shooting ▶ trapping ▶ baiting (OEH 2012). Feral cat control will be coordinated with NSW NPWS and among adjoining properties, as well as part of other pest management programs (i.e. fox and dog) to effectively reduce the impact of feral cats.
Feral pig (*Sus scrofa*)	Control methods for feral pigs include: ▶ trapping ▶ aerial and ground baiting ▶ shooting (OEH 2012). Pig control will be coordinated with NSW NPWS and among adjoining properties to effectively reduce the impact of pigs.
Cane toad (*Rhinella marina*)	There is currently no effective broad scale control method for cane toads. Within the offset area cane toads provide the biggest threat to common planigale and wallum froglet. Control strategies for cane toads will include, depending on the most suitable method for the conditions:

Species	Control method
	▶ manual removal of toads, tadpoles and their eggs using a sweep net (OEHDPC 2013) ▶ chemical trapping of tadpoles using toxins collected from adult cane toads (OEHDPC 2013) ▶ exclusion fencing around specific areas.
Mosquito fish (*Gambusia holbrooki*)	Well-established pest fish species are difficult to control and there are limited effective control techniques for mosquito fish that are practical for rivers, streams and wetlands. In the unlikely event that mosquito fish are detected in waterbodies on property 2 a combination of the following trapping methods will be used to reduce fish numbers to as low as possible: ▶ sweep net ▶ bait trap ▶ fyke net Pyke (2008) suggests that reducing any negative impacts of mosquito fish species on native species can be achieved by a reduction in their numbers, and by reducing the impacts per individual. Trapping will be undertaken at the end of the dry season during times of low water levels when mosquito fish generally have the greatest impact on native fauna (Macdonald and Tonkin 2008).

7.6 WEED MANAGEMENT

Weed management will be implemented within the offset area to limit the risk of new invasive weed incursions and reduce the extent and density of existing infestations. This will improve the condition of the offset values by minimising the impact of weed species, as well as reduce fuel loads to minimise the risk and/or impact of an unplanned fire.

Isolated occurrences of weed species, listed in Table 16, are present in the offset area. These occurrences are primarily located within close proximity to fences and tracks where there has been the greatest disturbance through access and grazing. In particular, weed infestations are concentrated along the south eastern boundary of the offset area near a water source accessed by livestock. Weed hygiene practices will be implemented to minimise likelihood of spreading weeds to other parts of the offset area.

Baseline surveys of the offset area will be undertaken by the third anniversary of the approval of the OAMPs to assess the distribution and abundance of weed infestations as well as inform species-specific control measures, location and timing for management activities.

Species specific weed control will be undertaken as required in accordance with the *Biosecurity Act 2015* (NSW) and the recommended weed control techniques by the NSW Department of Primary Industries (e.g. NSW Weed Wise[2]). Weed control measures are likely to include a combination of chemical, mechanical or biological removal. Chemical weed control in areas of habitat for wallum froglet in particular around areas with standing water will only use recommended herbicides which have been specifically developed for use in aquatic habitats with low toxicity to aquatic organisms. The type of weed control, including the timing and frequency, will comprise of one or a combination of the control methods outlined in Table 16 based on the presence and density of weed infestations within the offset area following the baseline assessment undertaken by the third anniversary of the approval of the OAMPs and will be adapted, as required, for subsequent control events. The nature, extent and effectiveness of weed control measures used will be described in compliance reporting to DCCEEW and periodically updated in the OAMPs.

[2] Department of Primary Industries NSW Weed Wise, available from http://weeds.dpi.nsw.gov.au/

Table 16 details the recommended effective control methods by the NSW Department of Primary Industries for those weed species currently present within the offset area.

Table 16: Weed species present in the offset area and recommended control methods

Species	Control method
Passiflora sp.	▶ Isolated vines will be hand pulled or grubbed out, including removal of the whole crown from the soil. Hand pull only when the soil is moist. ▶ Herbicide control.
Camphor laurel (*Cinnamomum camphora*)	▶ Effective chemical control of camphor laurel using either the cut stump, stem injection, basal bark or foliar spray application techniques. ▶ Mechanical removal of smaller trees (up to 10cm in diameter).
Blue billy goat weed (*Ageratum houstonianum*)	▶ Complete mechanical removal of plants. ▶ Chemical spray control with recommended herbicides.
Groundsel bush (*Baccharis halimifolia*)	Recommended control methods for groundsel bush include a combination of mechanical, biological and chemical control: ▶ Mechanical removal of plants, ensuring all roots are removed to prevent regrowth. ▶ Slashing to supress flowering and reduce the spread of seed. ▶ Biological control including gall forming fly, stem borers and rust fungus. ▶ Chemical control using recommended herbicides through cut stump, basal bark and foliar spraying applications.
Invasive perennial grasses species: ▶ Pigeon grass (*Setaria sp*) ▶ *Paspalum sp*. ▶ Para grass (*Urochloa mutica*)	▶ Recommended control methods include a combination of manual removal and chemical control, with follow up treatments, depending on the size of the infestation. ▶ Chemical treatment will be undertaken when the species are actively growing (late spring to early autumn). Weed control for invasive pasture grasses will aim to prevent seed set thereby reducing over time the density of invasive pasture grasses. ▶ Mechanical removal is likely to be more effective for smaller infestations, ensuring removal of all of the crown to prevent regrowth where plants are well established. ▶ Chemical control for dense infestation are best applied when plants develop inflorescences. ▶ Chemical control for infestations within or near surface water will only include recommended herbicides which have been specifically developed for use in aquatic habitats with low toxicity to aquatic organisms. Herbicides will be applied in accordance with the manufacturer's specifications and only by accredited operators who hold Chemcert certification.

7.7 FIRE MANAGEMENT

The aim of fire management is to minimise the risk and impacts of an unplanned fire within the offset area; recognised as a threat to all offset values. High intensity fires are often widespread and could have a severe impact on swamp sclerophyll forest EEC and impacts to habitat and microhabitat features (e.g. woody debris, fallen logs, and wetlands) known to support wallum froglet and common planigale.

Firebreaks will be established around the boundary of the offset area, no wider than 6 m. Existing firebreaks and access tracks along the boundaries of the offset area will be utilised and maintained through grading as required.

Firebreaks and fuel loads will be monitored and maintained at least annually at the end of the dry season and as part of regular management and monitoring site visits. Fuel loads will be maintained through a combination of:

- species-specific weed control actions – likely to comprise a combination of mechanical removal, biological and chemical control of infestations in order to reduce the biomass of fuel loads and reduce the extent of weed infestations (particular exotic pasture grasses). Weed infestations, contributing to areas of increased fuel loads, are generally localised to areas within proximity to fences and access tracks.
- controlled fuel-reduction burns – conducted only if required, in order to maintain fuel loads while ensuring species microhabitat requirements are retained and site condition is improved. For dry sclerophyll forest, the recommended fire regime interval is ~ 5-50 years (NPWS 2004). Controlled fuel-reduction burns will be excluded from habitat for wallum froglet, specifically from wetlands and areas of standing water, including vegetation buffers directly adjacent to these areas.

Fuel load management throughout the offset area will give priority to weed control methods and controlled fuel reduction burns will only be considered where weed control of fuel loads is ineffective (section 8.2). Local stakeholders will also be consulted when deciding the feasibility, timing and implementation of controlled fuel reduction burns in order to take into account the timing and location of previous and planned fire regimes in the adjacent properties.

8 MONITORING

8.1 GENERAL OFFSET AREA MONITORING

A site visit to inspect the offset area and assess the following matters will be undertaken twice a year, (approximately March and September):

- condition of fencing
- damage/degradation to offset values associated with weed infestations
- damage/degradation resulting from pest animal activity within the offset area
- incidental fauna observations and any additional risks to offset values
- exclusion of livestock from offset area and any signs of land degradation

8.2 FUEL LOADS ASSESSMENT

Fuel loads will be assessed in accordance with the Overall Fuel Hazard Assessment Guide (Hines *et al*. 2010; Appendix D) annually (approximately September). The purpose of the guide is to make a rapid, visual assessment of fuel loads and determine how this will affect the chances of controlling an unplanned fire.

The guide focuses on assessing the key structural layers of the fine fuels that burn in bushfires, specifically bark, elevated, near-surface and surface fuels. Each fuel layer is assessed in turn and given a hazard rating and are then combined to provide an overall fuel hazard rating of low, moderate, high, very high or extreme.

A baseline assessment of the fuel within the offset area will be undertaken by the third anniversary of the approval of the OAMPs (i.e. November 2022) to determine the overall fuel hazard rating. The fuel hazard rating of each of the vegetation communities will be monitored throughout the period of the OAMPs to

compare any changes from the baseline assessment due to implementing the OAMPs. Weed management within the offset area will be undertaken so as to maintain fuel hazard rating below extreme.

8.3 WATER QUALITY ASSESSMENT

In situ water chemistry assessments will be undertaken across the site annually (approximately March), with a baseline assessment undertaken by the third anniversary of the approval of the OAMPs, to assess for any changes in water quality unfavourable to the wallum sedge frog and wallum froglet. Assessment will be undertaken generally in accordance with the Department of the Environment and Heritage Protection's guideline for water quality sampling using in situ water quality instruments (DEHP, 2017a).

Details of the variables to be recorded and their relevance and significance to wallum sedge frog and wallum froglet are outlined in

. Should there be variation in the water quality of the offset area that is deemed unfavourable to wallum froglet (see Table 17), potential cause/s of the water quality impairment will be identified. Should current management of the offset area be resulting in the change in water quality, corrective actions relevant to the cause will be implemented. However, should it be a result of other activities outside of the offset area, the landholders will be consulted and resolution will be sought where possible. It should be noted that water chemistry may vary depending on season and rainfall. These natural influences as well as potential anthropogenic influences will be considered when interpreting any observed variations in water quality.

Water quality monitoring locations will be established at-inundated water bodies as part of the first monitoring event in year one of management. The water quality monitoring locations will be determined as part of the first monitoring event in year one of management and the locations and results will be presented as part of regular reporting to DCCEEW.

Table 17: Water chemistry variables

Variable	Details
pH	Generally, 'acid' frogs will occupy acidic wetlands and ephemeral swamps with a pH <6.0, with wallum sedge frogs adapted to occupy coastal sandplain wallum swamps with a pH as low as 2.8 (OEH 2018a). Preference for pH between 3.5 and 6.0 (DoE 2017)
Temperature	Temperature is a default variable recorded in portable meters, with temperature used to correct for measures that are, otherwise, temperature-dependent.
Electrical conductivity (EC)	EC is the electrical conductivity of a given solution as a consequence of dissolved salts, measured in microSiemens per centimetre (µS/cm), automatically corrected for temperature. Measures between 0 – 800 µS/cm are typical of freshwater rivers and waterbodies, with brackish water between 1,600 and 4,800 µS/cm, saline water >4,800 µS/cm and seawater ~51,500 µS/cm. The wallum sedge frog and wallum froglet prefer freshwater wetlands, therefore would require EC measures between 0 – 800 µS/cm.
Total dissolved solids (TDS)	TDS is a measure of the sum of all ions present in a sample of water and represents the total salt content of the sample, measured in parts per million (ppm). While inter-relate, TDS and EC are recorded and presented separately. A TDS of <500 ppm represents low salinity hazard, while 500 – 1,000 ppm represents medium salinity hazard, with a measure of >2,000 ppm representative of a very high salinity hazard. The wallum sedge frog and wallum froglet prefer freshwater wetlands, therefore would require TDS <500 ppm representing low salinity hazard.

8.4 WEED MONITORING

Weed monitoring will be used to assess the efficacy of weed control across the offset area and inform adaptive weed management targeting areas of high weed cover and risk of outbreaks/new infestations.

An initial baseline weed survey will be undertaken by the third anniversary of the approval of the OAMPs to assess the distribution and abundance of weed infestations within the offset area and inform species specific weed control actions with subsequent weed surveys completed every 5 years. Weed surveys will be undertaken in accordance with the NSW Guidelines for Monitoring Weed Control and recovery of native vegetation (Auld 2009).

Weed monitoring sites will be located in accordance with the following considerations:

- randomly stratified, permanent monitoring sites representative of particular offset values and incorporating natural variability such as aspect (e.g. a mix of north-, east-, south- and west-facing monitoring sites) and vegetation community type
- permanent weed monitoring sites at strategic trafficable areas (e.g. entry gates, creek crossings, access tracks) to monitor potential introduction and/or irruptions of prohibited and restricted weed species.

Permanent monitoring sites provide greater confidence in monitoring changes that have occurred over time, compared with random monitoring sites which are likely to just reflect natural variation at the site level (Auld 2009). Accordingly, weed monitoring sites will be established as part of the baseline surveys by the third anniversary of the approval of the OAMPs.

At each of the permanent weed monitoring sites, monitoring of weeds will be undertaken utilising two approaches:

- Plot-based weed transects – an assessment of weed species richness and relative abundance based on plot-based cover estimates along transects within 1 ha weed monitoring sites.
- Photo monitoring – time series analysis of changes in vegetation composition, structure and integrity over time. In areas where active management is being undertaken, photo monitoring offers a simple and effective visual means by which to capture the response of the vegetation to management actions.

In addition to permanent weed monitoring sites, incidental observations will be collated as part of general offset area monitoring, noting weed infestations away from permanent weed monitoring sites.

Details of the weed monitoring methodology are presented in Table 18.

Table 18: Weed monitoring methodology

Weed monitoring method	Methodology
Plot-based weed transects	An assessment of weed species richness and relative abundance, will be undertaken as follows: ▶ at randomly stratified, permanent 1 ha sites (100 m x 100 m) across the offset area in environments that are more regularly impacted by weeds (e.g. drainage lines, around wetlands etc.) and strategic trafficable areas ▶ at each site, mark out three 100 m transects (traversing in an east-west direction), keeping them parallel to one another, 50 m apart

Weed monitoring method	Methodology
	▶ at every 10 m interval along each of the transects, centre a 2 m x 2 m plot frame and record the presence, species and cover of weeds. Weed cover at each 2 m x 2 m survey site will be reported as one of five cover classes: 1 = 0%, 2 = 0-5%, 3 = 6-25%, 4 = 26-50% and 5 = 51-100% (Auld 2009) ▶ calculate an average cover score for each weed species for each 1 ha site. The average cover score is calculated as the average percentage from the plots surveyed from the three 100 m transects ▶ calculate the mean cover score across all weed monitoring sites in the offset site
Photo monitoring	A time-series photographic analysis providing an opportunity to visually assess changes in vegetation composition (namely, weeds), undertaken as follows: ▶ at each end of the plot-based weed transects, establish photo-monitoring points ▶ at each of the photo monitoring points, take five photos from 1.5 m height above ground level, namely photos facing north, east, south, west and one facing the ground. The ground shot should be chosen to give a representative indication of cover and species composition for the general area.
Incidental observations	As part of general offset site monitoring, outside of plot-based weed transects, record details (including location, species and extent) of notable weeds, species not previously encountered in the offset site, new weed outbreaks and areas of significant weed cover.

8.5 PEST ANIMAL MONITORING

An initial baseline pest animal survey will be undertaken by the third anniversary of the approval of the OAMPs to assess the presence of pest animals within the offset area and inform ongoing species specific control actions with subsequent pest animal surveys completed every 5 years.

In addition to surveys at permanent monitoring sites, pest animals will be opportunistically surveyed throughout the year outside of monitoring times. Any observed increase in the abundance or signs of predator pest species in the offset area will trigger corrective actions (refer to Table 12).

Pest animal monitoring sites will be established as part of the baseline surveys undertaken by the third anniversary of the approval of the OAMPs, comprising the following:

- fauna monitoring cameras (minimum of 3 nights)
- permanent 200 m x 200 m wild pig monitoring sites
- permanent 200 m x 200 m cane toad monitoring sites and additional monitoring within standing freshwater bodies with the potential to support cane toads
- monitoring within standing freshwater bodies with the potential to support mosquito fish.

For pest animals that are cryptic in their behaviour, it is usually impossible to take counts of individuals in order to determine their absolute abundance (Fleming *et al.* 1996). Instead, an assessment of abundance through signs and/or track counts is considered a reliable estimate of relative abundance for feral pigs (Hone 1988, Mitchell and Balogh 2007a), foxes, wild dogs (Mitchell and Balogh 2007b, c),and cats (Forsyth *et al.* 2005). Furthermore, targeting areas of known impacts/movements (e.g. along topographic features, including creeks, pads, paths, and roads for wild dogs; Harden, 1985) not only maximises success at encountering pest animals, but targets monitoring in environments that are more regularly impacted (e.g.

drainage lines, moist gullies and around swamps and wetlands favoured by feral pigs; Hone 1995). Estimates of relative abundance (through signs and/or track counts) are considered sufficient for an initial census of populations of pest animals, allowing for an evaluation of the success or otherwise of management programs (Saunders *et al.* 1995).

The purpose of monitoring methods detailed in Table 19 is to determine the presence/absence of the species and a measure of their relative abundance comparable between monitoring periods. The results of these pest animal surveys will be used to inform adaptive pest animal control, including targeting specific areas of pest animal outbreaks or impact.

Details of the pest animal monitoring methodology are presented in Table 19.

Table 19: Pest animal monitoring methodology

Pest animal	Methodology
Wild dog (*Canis familiaris, C. familiaris dingo, C. lupus familiaris, C. lupus dingo*) Fox (*Vulpes vulpes*) Feral cat (*Felis catus*)	An assessment of pest animal presence will be undertaken as follows: ▶ fauna monitoring cameras will be placed in offset area ▶ cameras will be placed along tracks, more than 500 m apart ▶ cameras will be left in place for a minimum of three consecutive nights ▶ convert to indices via the percentage of camera nights with animal captures (Catling index; Mitchell and Balogh 2007b, c), ensuring to account for cameras that have failed.
Feral pig (*Sus scrofa*)	An assessment of the presence or absence of feral pig signs[a] as a measure of feral pig activity in accordance with Mitchell and Balogh (2007a) and Hone (1988), will be undertaken as follows: ▶ randomly stratified, permanent 200 m x 200 m sites will be identified within the offset area ▶ at each site, the start location of two 200 m transects (100 m apart) will be selected running in an east-west direction, and the start locations will be recorded via GPS. ▶ a survey for the presence or absence of any feral pig signs will be undertaken 1 m either side of the transects in every 20 m section traversing in an east-west direction ▶ an abundance score for each sites' transects will be calculated as the percentage of 'present' feral pig signs from the 20 sections along the two 200 m transects ▶ the mean abundance score (and variance) across all transects in the offset site will be calculated. If the variance exceeds 20% of the mean, more sites/transects will be assessed. Repeat surveys will be undertaken from permanently established transects as part of each monitoring event. The average frequency of occurrence across the offset site will be used as an index of abundance and change over time. Furthermore, changes to scores for individual sites/transects will be used to point to areas to target for control activities. [a] Feral pig signs can include rooting, wallows, dung, footprints, travel pads, plant damage and tree rubs, as well as the physical presence of feral pigs
Cane toad (*Rhinella marina*)	An assessment of the presence/absence of cane toads within the offset area will be undertaken as follows based on survey methods outlined in OEHDPC (2013): ▶ randomly stratified, permanent 200 m x 200 m sites will be identified across the offset area, near areas of standing perennial freshwater water bodies ▶ at each site the start location of two 200 m transects (100 m apart) will be selected running in an east-west direction, and the start locations will be recorded via GPS. ▶ a survey for the presence or absence of any cane toads or signs of will be undertaken 1 m either side of the transects in every 20 m section traversing in an east-west direction. ▶ an abundance score for each sites' transects will be calculated as the percentage of 'present' cane toads from the 20 sections along the two 200 m transects. ▶ the mean abundance score (and variance) across all transects in the offset site will be calculated. If the variance exceeds 20% of the mean, more sites/transects will be assessed. In addition to the transect surveys above, a visual search for cane toads, tadpoles and eggs will be undertaken within standing freshwater water bodies with the potential to support cane toads. This will include scoop net sampling for cane toad eggs and tadpoles within standing freshwater bodies. Targeted searches for cane toads will be during warmer months (September to March) after dark when the species is most active, on a suitably warm and wet night. However, targeted searches of water bodies will also be undertaken during day light when tadpoles are most active and eggs can be easily identified.
Mosquito fish (*Gambusia* spp.)	There are currently no sampling techniques to survey pest fish species, however this monitoring method has been adapted from information collated on the biology of the species (e.g. Myers 1965; Pyke, 2008) as well as methodologies outlined in the Survey guidelines for Australia's threatened fish (DSEWPaC 2011a). Monitoring will be undertaken in order to determine the presence/absence of the species. Given the species does not occur in ephemeral aquatic environments (Myers 1965), surveying will be undertaken within any perennially inundated freshwater bodies in the offset area. Mosquito fish occur in perennial waterbodies, being most active in the top 15 cm of the water column, generally along the shallow edges, especially where they are well-vegetated. They breed during spring/summer (i.e. September to February) and peak number generally occur during autumn (Pyke 2008). Survey will be undertaken as follows: ▶ Surveys will be undertaken in autumn of the survey year. ▶ Systematic surveys will be undertaken across standing freshwater waterbodies in with the potential to support mosquito fish. ▶ Surveying will be undertaken using a fine mesh scoop net, sweeping the complete surface area (down to 15 cm depth), including vegetated edge habitat. Use of a scoop net is considered the most effective technique to cover a small area and sample around vegetation. ▶ Once all waterbodies have been surveyed, they will each be surveyed a second time. ▶ Total survey time for each waterbody to be recorded, as well as the presence and number of mosquito fish.

8.6 HABITAT CONDITION ASSESSMENTS

Habitat condition assessments will be undertaken annually including at the third anniversary of the approval of this OAMP, then by the fourth anniversary of the approval the OAMPs and then every two years until 2031, and then at 2035 and prior to the end of the approval (1 July 2037) at Property 1, or every five years from 2031 until the end of the approval at Property 2.

Habitat condition assessments will be undertaken to determine the site condition for the vegetation communities and overall condition of each offset value. Habitat condition assessments will be undertaken consistent with the baseline assessment methodology outlined in Appendix A.

Permanent habitat condition assessment plots have been established for baseline condition assessments (section 4.3) and will be monitored as part of ongoing habitat condition assessments during the period of the OAMPs.

The number and location of assessment plots were determined generally in accordance with the requirements set out in the Framework for Biodiversity Assessment and the BBAM. Assessment plots were randomly stratified within each of the vegetation communities across the offset area.

The results of ongoing habitat condition assessments will be compared against the completion criteria and the baseline condition scores for each offset value to assess the progress of the offset in achieving the completion criteria.

Habitat condition assessments will also assess and record:

- suitability of the habitat to support the fauna offset values in accordance with the national recovery plan for the wallum sedge frog and other wallum-dependent frog species and published conservation advice for common planigale (e.g. NSW BioNet) including:
  - presence of vegetation species recognised to support the species by the NSW BioNet
  - maintenance of water chemistry consistent with nutrient poor, acidic (pH 3.5 to 6.0) water, typically clear, still and tannin stained.
- ecosystem functionality and plant species components of swamp sclerophyll forest EEC as defined in the New South Wales identification guidelines for the Swamp sclerophyll forest on coastal floodplains endangered ecological community (DECC 2007) including:
  - presence of key indicator species (e.g. *Melaleuca quinquenervia, Livistona australis, Glochidion ferdinandi, Dianella caerulea, Gahnia clarkei, Gahnia sieberiana, Imperata cylindrica, Pteridium esculentum*) or other key indicator species or characteristic species of VC1 and swamp sclerophyll EEC in DECC (2007).
- evidence of threatening processes including weed infestations, grazing, high fuel loads, pest animals
- incidental observations of threatened fauna.

8.7 PHOTO MONITORING

Photo monitoring will be undertaken to enable visual assessment of habitat changes over time, and as part of habitat condition assessments. Permanent photo monitoring points will be established within the offset area at each of the habitat assessment plots. Photos at each photo monitoring point will be taken in a north,

east, south and westerly direction. A record of the photographs will be maintained, including GPS co-ordinates, date and time of each photograph and the direction in which the photograph was taken.

8.8 TARGETED FAUNA SURVEYS

Targeted fauna surveys will be undertaken for wallum froglet and common planigale within the offset area during the period of the OAMPs, commencing with a baseline survey by the third anniversary of the approval of the OAMPs, with follow up surveys every five years until the end of the approval (Property 1 and Property 2), including immediately prior to expiry of the EPBC Act approval (Property 1). The purpose of targeted fauna surveys will be to assess the presence of offset fauna species and changes in targeted fauna capture rates between sites and monitoring events. Survey design will be developed in accordance with the recommended fauna survey guidelines and/or previously published survey methods, at the beginning of management for baseline surveys and will be included as part of compliance reporting to DCCEEW. The survey guidelines for wallum froglet and common planigale listed in the sections below, include the recommended survey techniques and effort to establish whether the species is present, absent or in low abundance within the survey area.

Fauna surveys will be designed and conducted by suitably qualified and experienced personnel. It is proposed that the survey event will be conducted for the wallum froglet and common planigale during the period from January to March; however, the actual timing will be based on ideal weather conditions during this period. The timing for surveys will be based on when the species is most active and/or detectable. The wallum froglet is generally active anytime following heavy rainfall and breeds usually in autumn or early winter but has been recorded in all seasons following rainfall (DEHP 2017b). The common planigale breeds from October to January and has the ability to enter torpor in response to cold weather or food deprivation (OEH 2018b).

8.8.1 Wallum sedge frog and wallum froglet

Targeted surveys for wallum sedge frog and wallum froglet will be undertaken in accordance with species specific survey guidelines including:

- Targeted species survey guidelines Wallum froglet *Crinia tinnula* (Rowland 2012)
- National recovery plan for the wallum sedge frog and other wallum-dependent frog species (Myer *et al*. 2006)
- NSW Threatened species survey and assessment guidelines: field survey methods for fauna: Amphibians (DECC 2009)
- Survey guidelines for Australia's threatened frogs (DEWHA 2010)
- EPBC Act draft referral guidelines for the vulnerable wallum sedge frog, *Litoria olongburensis* (DSEWPaC 2011b).

The recommended survey technique is a combination of an aural census and visual survey focussing on waterbodies within suitable habitat. Surveys for this species can be undertaken at anytime of year shortly after heavy rainfall. Surveys will be conducted during periods of peak activity by suitably qualified personnel for a minimum of two nights. The presence of target threatened frog species, and an increase in the targeted fauna capture rates between monitoring events, is a strong indicator of management effectiveness.

8.8.2 Common planigale

Pit-fall trapping is designed to specifically target small sized ground-dwelling cryptic species and is considered the only reliable technique to capture planigale throughout their range (Lewis 2005; DSEWPaC 2004).

Sampling design and location of trapping sites will be set up for the first monitoring event. Survey effort for pitfall trapping common planigale will include the following features (DSEWPaC 2004):

- minimum of two sampling sites within representative habitat per 5 ha
- set traps for a minimum of four consecutive nights
- check traps early in the morning and cover during the day if targeting only mammal species
- provide a small amount of nesting material for shelter (shade or warmth) and if required a saturated sponge to provide high moisture levels or a dry sponge to act as a float in the event that water enters the trap.

9 REPORTING

Reports on the implementation of the OAMPs will be provided to DCCEEW within two months of the third anniversary of the approval of the OAMPs annually to 2031 and then every two years until the end of the approval (1 July 2037). The reports will detail the progress of the offset area towards achieving and/or maintaining the management objectives outlined section 6.2.

In accordance with condition 7 of the EPBC Act approval this report will also address compliance with the approval conditions as per the information requirements of the Department's Annual Compliance Report Guidelines.

The report will contain, but may not be limited to:

- EPBC approval number
- lot on plan property description
- a general description of climatic conditions for the management period
- activities undertaken within the management period
- results of monitoring activities conducted during the reporting period
- risks or potential threats that have become apparent since the development of the OAMP, and activities to be undertaken to avoid or mitigate these threats and risks
- progress towards achieving the management objectives/completion criteria and following attainment of completion criteria include an overview demonstrating maintenance of completion criteria
- if completion criteria have not been met after two years or have been prejudiced include contingency response and corrective actions proposed to return where required and the contingency responses and corrective actions that have been implemented
- recommendations for revising the OAMP, including changes to management and monitoring methodology

- condition compliance table in a similar format to that in Appendix A of the Department's Annual Compliance Report Guidelines noting if compliance or non-compliance with each EPBC Act approval condition has been achieved
- other information requirements of the Department's Annual Compliance Report Guidelines.

9.1 UPDATE OF OAMP

In accordance with the principles of adaptive management, the OAMPs will be reviewed annually and amended as required to incorporate changes identified through management activities, site visits and monitoring activities. This may include the revision of current management actions, identification of additional activities and responses to unexpected events or threats to the offset site (in accordance with the risk management and contingency responses described in section 6).

The OAMPs will be revised and implemented in accordance with condition 11 of the EPBC Act approval, whereby if the taking of the action in accordance with the revised plan would not be likely to have a new or increased impact the plan is not required to be submitted for approval (Appendix E). If the approval holder makes this choice they must:

- notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan;
- implement the revised plan from the date that the plan is submitted to the Department; and
- for the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan would not be likely to have a new or increased impact.

10 MANAGEMENT, MONITORING AND REPORTING SCHEDULE

10.1 ROLES AND RESPONSIBILITIES

GCAL is responsible for delivery of all elements of this plan and may engage contractors and other parties as relevant to assist with its implementation.

Persons implementing management and monitoring activities described in this management plan will be suitably qualified and experienced (Table 20).

Table 20: Minimum qualifications for management and monitoring activities

Management/monitoring event	Minimum qualifications
Threatened species surveys	Tertiary-qualified fauna ecologist operating under a NSW Scientific Purposes Permit and Animal Research Authority with greater than two years demonstrated experience surveying for amphibians and mammals.
Habitat condition assessments	Accredited biodiversity assessment method (BAM) assessor under the *Biodiversity Conservation Act 2016* (NSW) with demonstrated experience in the use of BAM and with greater than two years' demonstrated experience undertaking habitat condition assessments in northern NSW.
Weed control	Relevant qualification under the Pesticides Regulation 2017 (NSW), i.e. Australian Qualifications Framework Level 3 (AQF3) with demonstrated experience in undertaking weed control around waterbodies/wetland areas.

10.2 DATA HANDLING

The GCAL Environment Manager, or their nominated representative, is responsible for overseeing and managing the implementation of the OAMPs.

As outlined in section 10.1, suitably qualified personnel are required to undertake and report on various management and monitoring activities, which will include the engagement of external consultants who will be responsible for the analysis and interpretation of data as well as quality control.

Following the collection of data required as part of management and monitoring activities outlined in the OAMPs, the GCAL Environment Manager, or their nominated representative will be responsible for managing, storing and protecting all data within the company's database and environmental management system.

In accordance with condition 8 of the EPBC Act approval GCAL will maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to achieve the outcomes described in EPBC Act approval condition 4a. In addition, all data relevant to the EPBC Act approval and OAMPs will be made available to DCCEEW upon request for compliance and auditing purposes, as required in accordance with condition 8 of the EPBC Act approval. All relevant data collected within the management period will also be presented as part of ongoing reporting to DCCEEW as outlined in section 9.

10.3 IMPLEMENTATION SCHEDULE

Table 21: Implementation of management actions

Management action and description (relevant sections)		Timing	Related detection/monitoring activity/ies
General restrictions (section 7.2)	Install fencing and locked gates	By the third anniversary of the approval of the OAMPs	General offset area monitoring (section 8.1)
	Erect signs on access points		
	Control vehicle access/movement	At all times	
	Implement weed hygiene protocols		Weed monitoring (section 8.4)
Access tracks (section 7.3)	Maintain access tracks	At all times subject to constraints described in section 7.3	General offset area monitoring (section 8.1)
Fencing (section 7.4)	Install additional fencing and upgrade current fencing where required	By the third anniversary of the approval of the OAMPs	
	Maintain fencing	At all times	
Pest animal management (section 7.5)	Conduct baseline pest animal assessment	By the third anniversary of the approval of the OAMPs	Pest animal monitoring (section 8.5)
	Implement pest animal control as per section 7.5	Timing determined following results of baseline assessment and subject to constraints in section 7.5	
Weed management (section 7.6)	Conduct baseline pest animal assessment	By the third anniversary of the approval of the OAMPs	Weed monitoring (section 8.4)
	Implement weed control as per section 7.6	Timing determined following results of baseline assessment and subject to constraints in section 7.6	
Fire management (section 7.7)	Maintain firebreaks	Annually	General offset area monitoring (section 8.1) Fuel load assessments (section 8.2) Weed monitoring (section 8.4)
	Implement weed control to maintain fuel loads	Timing determined following results of baseline assessment and subject to constraints in section 7.7 and fuel load monitoring assessments (section 8.2)	

Table 22: OAMP monitoring events

Survey or monitoring objective (relevant sections)	Monitoring activity	Timing	Survey/monitoring guidelines
General offset area monitoring (section 8.1)	Monitoring within the offset area to assess the following matters: ▶ condition of fencing ▶ damage/degradation to offset values associated with weed infestations ▶ damage/degradation resulting from pest animal activity within the offset area ▶ incidental fauna observations and any additional risks to offset values ▶ exclusion of livestock from offset area and any signs of land degradation	Twice a year	N/A
Fuel load assessments (section 8.2)	Fuel load assessments to make a rapid, visual assessment of fuel arrangement and determine how this will affect the chances of controlling an unplanned fire.	Annually	Overall Fuel Hazard Assessment Guide (Hines *et al.* 2010; Appendix D)
Water quality assessments (section 8.3)	In situ water chemistry assessments will be undertaken across the site annually (approximately March) to assess for any changes in water quality unfavourable to the wallum froglet.	Annually	Water quality sampling using in situ water quality instruments (DEHP 2017a)
Weed monitoring (section 8.4)	Baseline weed survey to assess the distribution and abundance of weed infestations.	By the third anniversary of the approval of the OAMPs	NSW Guidelines for monitoring weed control and recovery of native vegetation (Auld 2009)

Survey or monitoring objective (relevant sections)	Monitoring activity	Timing	Survey/monitoring guidelines
	Ongoing weed surveys to assess the effectiveness of weed control.	Every five years for the life of the approval (i.e. until 1 July 2037), with the first monitoring event following baseline surveys conducted by the eighth anniversary of the approval of the OAMPs	
Pest animal monitoring (section 8.5)	Baseline pest animal survey to assess the presence of pest animals. Ongoing pest animal surveys to assess the effectiveness of pest animal control.	By the third anniversary of the approval of the OAMPs Every five years for the life of the approval (i.e. until 1 July 2037), with the first monitoring event following baseline surveys conducted by the eighth anniversary of the approval of the OAMPs	Monitoring method outlined in section 8.5
Habitat condition assessments (section 8.6)	Habitat condition assessments will be undertaken at permanent monitoring plots to determine the site condition for the vegetation communities and overall habitat quality of the offset values to assess progress towards attaining and maintaining the completion criteria.	The first event will occur by the third anniversary of the approval of the OAMPs, then by the fourth anniversary of the approval of the OAMPs and then every two years until 2031 and then at 2035 and prior to the end of the approval (1 July 2037) at Property 1, or every five years from 2031 until the end of the approval at Property 2	Assessment methodology outlined in Appendix A based on the Framework for Biodiversity Assessment and the BBAM.
Photo monitoring (section 8.7)	Visual assessment of habitat changes over time including habitat condition and weed infestations at habitat condition monitoring plots.	The first event will occur by the third anniversary of the approval of the OAMPs, then by the fourth anniversary of the approval of the OAMPs and then every two years until 2031 and then at 2035 and prior to the end of the approval (1 July 2037) at Property 1, or every five years from 2031 until the end of the approval at Property 2	Photos at each photo monitoring point will be taken in a north, east, south and westerly direction. A record of the photographs will be maintained, including GPS co-ordinates, date and time of each photograph and the direction in which the photograph was taken.
Targeted fauna surveys (section 8.8)	Targeted fauna surveys will be undertaken for wallum froglet and common planigale to assess the presence of offset fauna species and changes in targeted fauna capture rates between sites and monitoring events.	Baseline survey by the third anniversary of the approval of the OAMPs, then every five years until the end of the approval (Property 1 and Property 2), including immediately prior to expiry of the EPBC Act approval (Property 1)	▶ Targeted species survey guidelines Wallum froglet *Crinia tinnula* (Rowland 2012) ▶ National recovery plan for the wallum sedgefrog and other wallum-dependent frog species (Myer *et al*. 2006) ▶ NSW Threatened species survey and assessment guidelines: field survey methods for fauna: Amphibians (DECC 2009). ▶ Survey guidelines for Australia's threatened frogs (DEWHA 2010). ▶ Survey guidelines for Australia's threatened mammals (DSEWPaC 2004)

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APPENDIX A HABITAT ASSESSMENT METHOD AND BASELINE SITE CONDITION

For the purposes of scoring 'habitat quality' for use in the offsets assessment guide, three factors are applied, consistent with the EPBC Act Offset Guidelines:

- site condition
- site context
- species stocking rate (for species offset values only).

Site condition and site context are calculated generally in accordance with the BioBanking Assessment Methodology 2014 (BBAM; OEH 2014a), with species stocking rate calculated in accordance with a set of weighted scores to questions reflecting the known or likely presence, density and importance of any species populations. The following sections provide an overview of the methodology used to calculate each of these components contributing to the 'start quality' value.

Site condition

Site condition is calculated generally in accordance with Section 5 of the BBAM. This process initially involved stratification and identification of vegetation zones, identified as areas of native vegetation of the same plant community type (PCT[3]) with a similar broad condition state. This process was undertaken as part of preliminary field assessments of offset sites in order to identify whether observed PCT were associated with listed offset values, and to determine survey effort required to address BBAM assessment requirements.

Detailed field assessments were subsequently undertaken generally in accordance with the BBAM to assess vegetation condition within each of the vegetation zones identified from preliminary field assessments. Depending on the size of the vegetation zone, the number of assessment sites within each vegetation zone varied from one to five. At each of these assessment sites, 10 site attributes were assessed within a 50 m x 20 m plot including:

- native plant species richness within a 20 m x 20 m quadrat
- counts of trees with hollows and length of fallen logs within a 50 m x 20 m quadrat
- native over-storey, native mid-storey and native ground cover as well as exotic plant cover along a 50 m transect, and
- proportion of over-storey species occurring as regeneration throughout relevant vegetation zones.

An average score for each of the 10 site attributes was compared to benchmark values for the analogous PCT to generate a site condition assessment score contributing to the start quality score for the offsets assessment guide, in accordance with section 5.3.3 of BBAM.

Site context

Site context is calculated generally in accordance with Appendix 6 of the BBAM. This process calculates a score for the offset site based on a number of GIS-based analyses, including:

- strategic location of the offset site in relation to

[3] according to the NSW PCT classification as described in the Vegetation Information System (VIS) Classification Database

- distance from riparian buffers to watercourses of various stream orders
- distance from riparian buffers to important wetlands, local wetlands or estuarine areas, and/or
- proximity to state or regional biodiversity corridors

- percentage current (and future) extent of native vegetation within the immediate and broader landscape
- connectivity value of the offset site, based on current (and future) number, widths and condition of linkages
- patch size, including relevant significance of the size based on remaining vegetation within the corresponding Mitchell Landscape[4]

A single site context score was calculated for each offset site, with areas for all offset values on the site receiving the same score.

Species stocking rate

Species stocking rate (for species offset values only) is calculated based on a set of weighted scores to questions reflecting the known or likely presence and density of the species, as well as the role (known or otherwise) of the species in relation to the overall species population. Scoring for these questions is based on species records databases, relevant conservation advice documentation and results of detailed field assessments.

Table A-1 to Table A-7 present detailed results of the baseline biobanking field assessments for each vegetation community.

Table A-8 and Table A-9 summarise the baseline condition score of individual vegetation communities score for the offset values at each property.

Table A-10 and Table A-11 summarise the final condition score for the offset values at each property.

Table A-12 and Table A-13 summarise calculation of the site context and species stocking rate scores for each property.

Table A-14 and Table A-15 summarise calculation of species stocking rate scores for each property.

Table A-16 and Table A-17 provides a summary of the baseline habitat quality score for each offset value used as part of the offsets assessment guide for each property.

[4] Mitchell landscapes are areas of land, defined by OEH, with relatively homogenous geomorphology, soils and broad vegetation types

Table A-1: Property 1 Vegetation Community 1: Scribbly gum woodland

Vegetation type ID (BVTID)		NR153							
Vegetation Formation		Heathlands							
Vegetation Class		Coastal Headland Heaths							
Vegetation Type		Coastal mallee of the NSW North Coast Bioregion							
Scientific Name		*Angophora costata* (Sydney Red Gum), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus signata* (Scribbly Gum), *Lophostemon confertus* (Brush Box) / *Acacia* spp. (Wattle), *Banksia* spp., *Boronia* spp., *Bossiaea* spp.							
Attribute		**Benchmark**	**Plot 1**	**Plot 2**	**Plot 3**	**Avg**	**Weighting**	**Contribution**	**Future site condition**
A	Native species richness	25	20	29	22	23.67	25	50	Increase average native plant species richness to be equal to or greater than the benchmark
B	Native overstorey cover	0-5	39.50	30	31.50	33.67	10	0	Maintain current condition
C	Native mid-storey cover	0-50	42	48	58.50	49.50	10	30	Maintain current condition
D	Native ground cover (grasses)	5-75	0	0	0	0	2.50	0	Increase native grass cover to be within benchmark range
E	Native ground cover (shrubs)	5-80	50	28	30	36	2.50	7.50	Maintain current condition
F	Native ground cover (other)	1-40	32	12	16	20	2.50	7.50	Maintain current condition
G	Exotic plant cover	NA	0	0	0	0	5	15	Maintain exotic plant cover to be <5%
H	Number of trees with hollows	0	1	3	0	1.33	NA	0	-
I	Proportion of overstorey trees with regeneration	NA	100	100	100	100	12.50	37.50	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	0	8.50	30	4	14.17	NA	0	-
Total score (/210)[a]								147.50	
Multipliers assessing ecosystem function, structure and composition (/90) [b]									
5((A*G) +(C*((D+E+F)/3) =								60	
Vegetation community condition score (/10)								**6.92**	

[a] As the only benchmark value for attribute H and J is zero, then the attribute is not included in the calculation of site condition and the maximum total (where the relevant attributes are in benchmark condition) is scaled accordingly (i.e. out of 210 rather than 300)

[b] The multipliers for 'B × I' and 'H × J' are omitted from the calculation of site condition (and the maximum total is recalculated accordingly) for determining site condition as the PCT is from the 'freshwater wetlands' vegetation formation

Table A-2: Property 1 Vegetation Community 2: Leptospermum shrubland

Vegetation type ID (BVTID)		NR278				
Vegetation Formation		Freshwater Wetlands				
Vegetation Class		Coastal Heath Swamps				
Vegetation Type		Wet heathland and shrubland of coastal lowlands of the NSW North Coast Bioregion				
Scientific Name		*Baeckea frutescens*, *Baeckea linifolia* (Weeping Baeckea), *Banksia ericifolia subsp. macrantha*, *Banksia oblongifolia* (Fern-leaved Banksia) / *Eurychorda complanata, Pteridium esculentum* (Bracken), *Sprengelia sprengelioides*				
Attribute		**Benchmark**	**Plot 1**	**Relative weighting (%)**	**Contribution**	**Future site condition**
A	Native species richness	29	14	25	25	Increase native plant species richness to be equal to or greater than the benchmark
B	Native overstorey cover	0-50	2	10	30	Maintain current condition
C	Native mid-storey cover	0-80	0	10	30	Maintain current condition
D	Native ground cover (grasses)	0-30	0	2.50	7.50	Maintain current condition
E	Native ground cover (shrubs)	20-70	80	2.50	5	Maintain current condition
F	Native ground cover (other)	5-80	90	2.50	5	Maintain current condition
G	Exotic plant cover	NA	0	5	15	Maintain exotic plant cover to be <5%
H	Number of trees with hollows	0	0	NA	0	Maintain current condition
I	Proportion of overstorey trees with regeneration	NA	100	12.50	37.50	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	0	0	NA	0	Maintain current condition
Total score (/210)[a]					155	
Multipliers assessing ecosystem function, structure and composition (/90)[b]						
5((A*G) +(C*((D+E+F)/3) =					50	
Vegetation community condition score (/10)					**6.83**	

[a] As the only benchmark value for attribute H and J is zero, then the attribute is not included in the calculation of site condition and the maximum total (where the relevant attributes are in benchmark condition) is scaled accordingly (i.e. out of 210 rather than 300)

[b] The multipliers for 'B × I' and 'H × J' are omitted from the calculation of site condition (and the maximum total is recalculated accordingly) for determining site condition as the PCT is from the 'freshwater wetlands' vegetation formation

Table A-3: Property 1 Vegetation Community 3: Melaleuca swamp forest

Vegetation type ID (BVTID)		NR217						
Vegetation Formation		Forested Wetlands						
Vegetation Class		Coastal Swamp Forests						
Vegetation Type		Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion						
Scientific Name		*Melaleuca quinquenervia* (Broad-leaved Paperbark), *Melaleuca linariifolia* (Flax-leaved Paperbark), *Melaleuca sieberi, Melaleuca alternifolia / Leptospermum* spp. (Tea-tree), *Melastoma affine* (Blue Tongue), *Parsonsia straminea* (Common Silkpod) / *Blechnum indicum* (Swamp Water Fern), *Gahnia* spp., *Hypolepis muelleri* (Harsh Ground Fern)						
Attribute		**Benchmark**	**Plot 1**	**Plot 2**	**Plot 3**	**Avg**	**Weighting**	**Contribution**	**Future site condition**
A	Native species richness	24	27	32	27	28.67	25	75	Maintain current condition
B	Native overstorey cover	10-70	53	42	55	50	10	30	Maintain current condition
C	Native mid-storey cover	10-60	27.50	53	53.50	44.67	10	30	Maintain current condition
D	Native ground cover (grasses)	2-80	0	34	14	16	2.50	7.50	Increase native grass cover at plot 1 to be within benchmark range
E	Native ground cover (shrubs)	0-70	0	0	2	0.67	2.50	7.50	Maintain current condition
F	Native ground cover (other)	0-90	100	68	54	74	2.50	7.50	Maintain current condition
G	Exotic plant cover	NA	0	4	14	6	5	10	Decrease exotic plant cover to be <5% at all plots
H	Number of trees with hollows	0.1	0	0	0	0	20	0	Increase number of trees with hollows to be equal to or greater than the benchmark
I	Proportion of overstorey trees with regeneration	NA	100	67	100	89	12.50	25	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	5	38	40	26	34.67	10	30	Maintain current condition
Total score (/300)								222.50	
Multipliers assessing ecosystem function, structure and composition (/180)									
5((A*G)+(B*I)+(H*J)+(C*((D+E+F)/3) =								105	
Vegetation community condition score (/10)								**6.82**	

Table A-4: Property 2 Vegetation Community 1: Melaleuca swamp forest

Vegetation type ID (BVTID)	**NR217**
Vegetation Formation	Forested Wetlands
Vegetation Class	Coastal Swamp Forests
Vegetation Type	Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion
Scientific Name	*Melaleuca quinquenervia* (Broad-leaved Paperbark), *Melaleuca linariifolia* (Flax-leaved Paperbark), *Melaleuca sieberi*, *Melaleuca alternifolia* / *Leptospermum spp*. (Tea-tree), *Melastoma affine* (Blue Tongue), *Parsonsia straminea* (Common Silkpod) / *Blechnum indicum* (Swamp Water Fern), *Gahnia spp., Hypolepis muelleri* (Harsh Ground Fern)

Attribute		**Benchmark**	**Plot 1**	**Plot 2**	**Plot 3**	**Plot 4**	**Plot 5**	**Avg**	**Weighting**	**Contribution**	**Future site condition**
A	Native species richness	24	15	16	14	18	15	15.60	25	50	Increase average native plant species richness to be equal to or greater than the benchmark
B	Native overstorey cover	10-70	43.50	60	48.50	18.50	40.50	42.20	10	30	Maintain current condition
C	Native mid-storey cover	10-60	20	26.50	22	11	16	19.10	10	30	Maintain current condition
D	Native ground cover (grasses)	2-80	76	90	66	68	28	65.60	2.50	7.50	Maintain current condition
E	Native ground cover (shrubs)	0-70	0	4	0	12	0	3.20	2.50	7.50	Maintain current condition
F	Native ground cover (other)	0-90	100	40	100	96	76	82.40	2.50	7.50	Maintain current condition
G	Exotic plant cover	NA	0	14	0	0	20	6.80	5	10	Decrease exotic plant cover to be <5% at all plots
H	Number of trees with hollows	0.1	1	0	6	4	4	3	20	60	Maintain current condition
I	Proportion of overstorey trees with regeneration	NA	100	100	100	100	100	100	12.50	37.50	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	5	7	8	6	7	42	14	10	30	Maintain current condition
Total score (/300)										270	
Multipliers assessing ecosystem function, structure and composition (/180)											
5((A*G)+(B*I)+(H*J)+(C*((D+E+F)/3) =										155	
Vegetation community condition score (/10)										**8.85**	

Table A-5: Property 2 Vegetation Community 2: Scribbly gum woodland

Vegetation type ID (BVTID)		NR101						
Vegetation Formation		Dry Sclerophyll Forests (Shrubby sub-formation)						
Vegetation Class		North Coast Dry Sclerophyll Forests						
Vegetation Type		*Angophora paludosa* shrubby forest and woodland on sandstone or sands of the NSW North Coast Bioregion						
Scientific Name		*Corymbia intermedia* (Pink Bloodwood), *Eucalyptus signata* (Scribbly Gum), *Eucalyptus resinifera subsp. hemilampra, Eucalyptus tereticornis* (Forest Red Gum) / *Acacia spp*. (Wattle), *Allocasuarina littoralis* (Black She-Oak), *Allocasuarina torulosa* (Forest Oak), *Banksia spp. / Aristida vagans* (Threeawn Speargrass), *Digitaria parviflora* (Small-flowered Finger Grass), *Lomandra longifolia* (Spiny-headed Mat-rush), *Pteridium esculentum* (Bracken)						
Attribute		**Benchmark**	**Plot 1**	**Plot 2**	**Avg**	**Weighting**	**Contribution**	**Future site condition**
A	Native species richness	35	30	20	25	25	50	Increase average native plant species richness to be equal to or greater than the benchmark
B	Native overstorey cover	15-50	29.50	36	32.75	10	30	Maintain current condition
C	Native mid-storey cover	5-70	38	44.50	41.25	10	30	Maintain current condition
D	Native ground cover (grasses)	5-70	90	64	77	2.50	5	Maintain current condition
E	Native ground cover (shrubs)	5-60	26	24	25	2.50	7.50	Maintain current condition
F	Native ground cover (other)	5-80	48	10	29	2.50	7.50	Maintain current condition
G	Exotic plant cover	NA	0	0	0	5	15	Maintain exotic plant cover to be <5%
H	Number of trees with hollows	1.5	3	3	3	20	60	Maintain current condition
I	Proportion of overstorey trees with regeneration	NA	100	100	100	12.50	37.50	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	10	45	34	39.50	10	30	Maintain current condition
Total score (/300)							272.50	
Multipliers assessing ecosystem function, structure and composition (/180)								
5((A*G)+(B*I)+(H*J)+(C*((D+E+F)/3) =							160	
Vegetation community condition score (/10)							**9.01**	

Table A-6: Property 2 Vegetation Community 3: Eucalypt forest

Vegetation type ID (BVTID)		NR114								
Vegetation Formation		Dry Sclerophyll Forests (Shrubby sub-formation)								
Vegetation Class		North Coast Dry Sclerophyll Forests								
Vegetation Type		Blackbutt - bloodwood dry heathy open forest on Quaternary sands of the northern NSW North Coast Bioregion								
Scientific Name		*Eucalyptus pilularis* (Blackbutt), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus resinifera subsp. hemilampra / Acacia ulicifolia* (Prickly Moses), *Allocasuarina littoralis* (Black She-Oak), *Banksia spp., Gompholobium pinnatum* (Pinnate Wedge Pea) / *Baloskion tetraphyllum, Dianella caerulea* (Blue Flax-lily), *Entolasia stricta* (Wiry Panic), *Glycine clandestina* (Twining glycine)								
Attribute		**Benchmark**	**Plot 1**	**Plot 2**	**Plot 3**	**Plot 4**	**Avg**	**Weighting**	**Contribution**	**Future site condition**
A	Native species richness	35	20	22	29	19	22.50	25	50	Increase average native plant species richness to be equal to or greater than the benchmark
B	Native overstorey cover	15-50	16.50	38	18	49	30.38	10	30	Maintain current condition
C	Native mid-storey cover	5-70	6.20	32	14.50	49.50	25.55	10	30	Maintain current condition
D	Native ground cover (grasses)	5-70	100	90	78	44	78	2.50	5	Maintain current condition
E	Native ground cover (shrubs)	5-60	14	30	8	12	16	2.50	7.50	Maintain current condition
F	Native ground cover (other)	5-80	70	52	78	14	53.50	2.50	7.50	Maintain current condition
G	Exotic plant cover	NA	0	0	8	0	2	5	15	Decrease exotic plant cover to be <5% at all plots
H	Number of trees with hollows	1.5	0	3	2	4	2.25	20	60	Maintain current condition
I	Proportion of overstorey trees with regeneration	NA	100	100	100	100	100	12.50	37.50	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	10	17	14.50	36	63	32.63	10	30	Maintain current condition
Total score (/300)									272.50	
Multipliers assessing ecosystem function, structure and composition (/180)										
5((A*G)+(B*I)+(H*J)+(C*((D+E+F)/3) =									160	
Vegetation community condition score (/10)									**9.01**	

Table A-7: Property 2 Vegetation Community 4: Heath

Vegetation type ID (BVTID)		**NR278**							
Vegetation Formation		Freshwater Wetlands							
Vegetation Class		Coastal Heath Swamps							
Vegetation Type		Wet heathland and shrubland of coastal lowlands of the NSW North Coast Bioregion							
Scientific Name		*Baeckea frutescens, Baeckea linifolia* (Weeping Baeckea), *Banksia ericifolia subsp. macrantha, Banksia oblongifolia* (Fern-leaved Banksia) / *Eurychorda complanata, Pteridium esculentum* (Bracken), *Sprengelia sprengelioides*							
Attribute		**Benchmark**	**Plot 1**	**Plot 2**	**Plot 3**	**Avg**	**Relative weighting (%)**	**Contribution**	**Future site condition**
A	Native species richness	29	11	8	18	12.33	25	25	Increase average native plant species richness to be equal to or greater than the benchmark
B	Native overstorey cover	0-50	2.50	0.50	19.50	7.50	10	30	Maintain current condition
C	Native mid-storey cover	0-80	0	0	0	0	10	30	Maintain current condition
D	Native ground cover (grasses)	0-30	68	0	20	29.33	2.50	7.50	Maintain current condition
E	Native ground cover (shrubs)	20-70	90	100	70	86.67	2.50	5	Maintain current condition
F	Native ground cover (other)	5-80	100	100	100	100	2.50	5	Maintain current condition
G	Exotic plant cover	NA	0	0	0	0	5	15	Maintain exotic plant cover to be <5%
H	Number of trees with hollows	0	0	0	0	0	NA	0	Maintain current condition
I	Proportion of overstorey trees with regeneration	NA	100	100	100	100	12.50	37.50	Maintain at 100% of overstorey trees occurring as regeneration
J	Total length of fallen logs	0	0	0	0	0	NA	0	Maintain current condition
Total score (/210)[a]								155	
Multipliers assessing ecosystem function, structure and composition (/90) [b]									
5((A*G) +(C*((D+E+F)/3)[b] =								50	
Vegetation community condition score (/10)								**6.83**	

a As the only benchmark value for attribute H and J is zero, then the attribute is not included in the calculation of site condition and the maximum total (where the relevant attributes are in benchmark condition) is scaled accordingly (i.e. out of 210 rather than 300)

b The multipliers for 'B × I' and 'H × J' are omitted from the calculation of site condition (and the maximum total is recalculated accordingly) for determining site condition as the PCT is from the 'freshwater wetlands' vegetation formation

Table A-8: Property 1 site condition – Details and condition score for individual vegetation communities

Vegetation communities		Compliant NSW PCT	Area (ha)	Vegetation community condition score (/10)
VC1	Scribbly gum woodland	NR153	14.64	6.92
VC2	Leptospermum shrubland	NR278	3.82	6.83
VC3	Melaleuca swamp forest	NR217	7.48	6.82
		Total	25.94	

Table A-9: Property 1 site condition – Calculation of final condition score

Offset value	Contributing VC	Area of available habitat (ha)	Final site condition score (/10)
Wallum sedge frog	2,3	11.29	6.83
Wallum froglet	2,3	11.29	6.83
Common planigale	1,2,3	25.94	6.88
Swamp sclerophyll forest	3	7.48	6.82

Table A-10: Property 2 site condition – Details and condition score for individual vegetation communities

Vegetation communities		Compliant NSW PCT	Area (ha)[a]	Vegetation community condition score (/10)
VC1	Melaleuca swamp forest	NR217	81.10	8.85
VC2	Scribbly gum woodland	NR101	12.58	9.01
VC3	Eucalypt forest	NR114	40.60	9.01
VC4	Heath	NR278	29.68	6.83
		Total	163.96	

[a] Represents sum of Project LIFT offset area and advanced offsets area

Table A-11: Property 2 site condition – Calculation of final condition score

Offset values	Contributing VC	Area of available habitat (ha)[a]	Final site condition score (/10)
Wallum froglet	1,4	110.78	8.31
Common planigale	1,2,3,4	163.96	8.54
Swamp sclerophyll forest	1	81.10	8.85

[a] Represents sum of Project LIFT offset area and advanced offsets area

Table A-12: Property 1 calculation of site context score

Landscape attribute	Details	Score	Max score	Relative weighting	Weighted score contribution
Percent native vegetation cover within an outer assessment circle (minimum of 1000 ha)	Area of outer assessment circle required to enclose the offset area is 1000 ha. Area of native vegetation cover in 1000 ha outer assessment circle is 477.1 ha, equivalent to 47.7%	11.3	16	0.625	7.06
Percent native vegetation cover within an inner assessment circle (minimum of 100 ha)	Area of inner assessment circle is 100 ha. Area of native vegetation cover in 100 ha inner assessment circle is 78.7 ha, equivalent to 78.7%	9	10	1	9
Connectivity value[a]	Not applicable as the offset site is within a strategic location (see below)	NA	NA	NA	0

Total patch size	The majority of the offset site is located within the *Byron-Tweed Alluvial Plains* Mitchell Landscape, in which 81% of native vegetation has been cleared. The size of the total patch size is larger than 100 ha; the maximum consideration for Mitchell Landscapes with % native vegetation clearing 70-90%	12	12	1	12
Strategic location of an offset site[a]	The site of the offset contains a mapped important wetland, namely a SEPP 14 coastal wetland	18	18[a]	1	18[a]
Total (/50) **Final site context score (/10)**					**46.06** **9.21**

[a] Where an offset site is within a strategic location, a connectivity value is no longer calculated, and the maximum score for the connectivity value score shifts to the strategic location value, which increases from 9 to 18.

Table A-13: Property 2 calculation of site context score

Landscape attribute	Details	Score	Max score	Relative weighting	Weighted score contribution
Percent native vegetation cover within an outer assessment circle (minimum of 1000 ha)	Area of outer assessment circle required to enclose the offset area is 1000 ha. Area of native vegetation cover in 1000 ha outer assessment circle is 971.5 ha, equivalent to 97.2%	16	16	0.625	10
Percent native vegetation cover within an inner assessment circle (minimum of 100 ha)	Area of inner assessment circle is 100 ha. Area of native vegetation cover in 100 ha inner assessment circle is 97.4 ha, equivalent to 97.4%	10	10	1	10
Connectivity value[a]	Not applicable as the offset site is within a strategic location (see below)	NA	NA	NA	0
Total patch size	The majority of the offset site is located within the *Clarence - Richmond Barriers and Beaches* Mitchell Landscape, in which 32% of native vegetation has been cleared. The size of the total patch size is larger than 200 ha; the maximum consideration for Mitchell Landscapes with % native vegetation clearing 30-70%	12	12	1	12
Strategic location of an offset site[a]	The site of the offset is within the riparian buffer area of an important wetland, namely a SEPP 14 coastal wetland	18	18[a]	1	18[a]
Total (/50)					**50**
Final site context score (/10)					**10**

[a] Where an offset site is within a strategic location, a connectivity value is no longer calculated, and the maximum score for the connectivity value score shifts to the strategic location value, which increases from 9 to 18.

Table A-14: Property 1 calculation of species stocking rate score

Criteria	Relative weighting (%)	Options		Score (/4) Wallum sedge frog	Wallum froglet	Common planigale
What is the presence of the species on the site considered?	40%	Confirmed - species observed or recorded from the site	4	2	4	3
		Likely - site contains known or potential habitat for the species and species recorded in similar habitat in locality of the site	3			
		Possible - site contains known or potential habitat for the species, however the species has not been recorded from locality of the site, or vice versa	2			
		Unlikely - site does not contain known or potential habitat for the species and/or species not recorded from locality of the site	1			
What is the actual or likely density of species utilising the site?	30%	Density of species on the site known, and consistent or greater than density known for the species from the literature/anecdotal evidence	4	3	3	3
		Density of species inferred from confirmed presence of appropriate habitat, with evidence to suggest it is likely to support density consistent with literature/anecdotal evidence	3			
		Density of the species likely to be very sparse, with the likelihood that the site is suboptimal	2			
		Species not confirmed on site, with evidence to suggest the site supports only very limited appropriate habitat	1			
What is the role of the site's population in regards to the overall species' population?	30%	Site known or likely to support a key source species population for breeding and/or dispersal at the state to national scale, necessary for maintaining genetic diversity and/or the population is outside or near the geographical limit of the species	4	3	3	3
		Site known or likely to support an important species population for breeding or dispersal that is a contiguous or functional link between known, important or key source species populations at the landscape to regional scale	3			
		Site known or likely to support a species population that is not contiguous with an important or key source population of the species	2			
		Site known or likely to support only a small species population, not an important or key source population, and not near the geographical limit of the species' range	1			
Final species stocking rate score (/10)				**6.5**	**8.5**	**7.5**

Table A-15: Property 2 calculation of species stocking rate score

Criteria	Relative weighting (%)	Options		Score (/4)	
				Wallum froglet	Common planigale
What is the presence of the species on the site considered?	40%	Confirmed - species observed or recorded from the site	4	**4**	**3**
		Likely - site contains known or potential habitat for the species and species recorded in similar habitat in locality of the site	3		
		Possible - site contains known or potential habitat for the species, however the species has not been recorded from locality of the site, or vice versa	2		
		Unlikely - site does not contain known or potential habitat for the species and/or species not recorded from locality of the site	1		
What is the actual or likely density of species utilising the site?	30%	Density of species on the site known, and consistent or greater than density known for the species from the literature/anecdotal evidence	4	**3**	**3**
		Density of species inferred from confirmed presence of appropriate habitat, with evidence to suggest it is likely to support density consistent with literature/anecdotal evidence	3		
		Density of the species likely to be very sparse, with the likelihood that the site is suboptimal	2		
		Species not confirmed on site, with evidence to suggest the site supports only very limited appropriate habitat	1		
What is the role of the site's population in regards to the overall species' population?	30%	Site known or likely to support a key source species population for breeding and/or dispersal at the state to national scale, necessary for maintaining genetic diversity and/or the population is outside or near the geographical limit of the species	4	**3**	**2**
		Site known or likely to support an important species population for breeding or dispersal that is a contiguous or functional link between known, important or key source species populations at the landscape to regional scale	3		
		Site known or likely to support a species population that is not contiguous with an important or key source population of the species	2		
		Site known or likely to support only a small species population, not an important or key source population, and not near the geographical limit of the species' range	1		
Final species stocking rate score (/10)				**8.5**	**6.75**

Table A-16: Property 1 summary of start quality input score

Offset value	Site condition score	Site context score	Species stocking rate score	START QUALITY INPUT SCORE*
Wallum sedge frog	6.83	9.21	6.50	7.24
Wallum froglet	6.83	9.21	8.50	7.64
Common planigale	6.88	9.21	7.50	7.47
Swamp sclerophyll forest EEC	6.82	9.21	NA	7.30

* Quality input scores for wallum sedge frog, wallum froglet and common planigale comprises site condition (60%), site context (20%) and species stocking rate (20%), whereas for swamp sclerophyll forest EEC it comprises site condition (80%) and site context (20%) only

Table A-17: Property 2 summary of start quality input score

Offset values	Site condition score	Site context score	Species stocking rate score	Start quality input score*
Wallum froglet	8.31	10	8.50	**8.69**
Common planigale	8.54	10	6.75	**8.47**
Swamp sclerophyll forest EEC	8.85	10	NA	**9.08**

* Quality input scores for wallum froglet and common planigale comprises site condition (60%), site context (20%) and species stocking rate (20%), whereas for swamp sclerophyll forest EEC it comprises site condition (80%) and site context (20%) only. The site condition score and final start quality input score is calculated from the sum of the Project LIFT offset area and advanced offsets area.

APPENDIX B THREATS AND RECOVERY ACTIONS IDENTIFIED IN RELEVANT MATTER SPECIFIC DOCUMENTS

The threats and recovery actions presented in this table have been taken from relevant documentation including Commonwealth listing and conservation advice, recovery plans and other documentation prepared with the aim of encouraging the conservation of relevant protected matters.

Table B-1: Identified threats and recovery actions

Offset value	Identified threats	Recovery action
Wallum froglet	The wallum froglet and its habitat are subject to a number of threats identified as part of the national recovery plan for the wallum sedge frog and other wallum-dependent frog species (Meyer *et al*, 2006), NSW BioNet and other conservation advices: ▶ habitat loss through vegetation clearing ▶ habitat degradation through; – human trampling of reed beds – changes in hydrology – habitat eutrophication and pollution ▶ habitat fragmentation as a result of land clearing ▶ inappropriate fire regimes ▶ predation by introduced mosquito fish ▶ use of biocides in weed and mosquito control ▶ pig damage ▶ exotic disease ▶ vehicular traffic	The national recovery plan for the wallum sedge frog and other wallum-dependent frog species (Meyer *et al*, 2006) identifies a number of recovery actions relating to identified threats, including the following: ▶ minimising soil disturbance that may adversely affect soil hydrology and water quality at breeding sites ▶ retention of natural vegetation surrounding water bodies. At a minimum vegetation within 50m of breeding sites should be left intact. ▶ preventing nutrient enrichment ▶ adaptive fire management ▶ limiting use of biocides in wallum frog habitat ▶ managing recreational use of coastal lakes ▶ managing impact of feral animals including trampling by livestock and pigs, exclusion where possible of mosquito fish. ▶ road construction around or over habitat ▶ monitoring if habitat condition and frog numbers.
Common planigale	The common planigale is subject to a number of threats as identified on the NSW BioNet and other published conservation advice, including: ▶ predation by foxes and feral cats, ▶ predation and poisoning by cane toads ▶ loss and fragmentation of habitat through vegetation clearing for agriculture and development in coastal areas ▶ frequent burning that reduces ground cover such as hollow logs and bark ▶ overgrazing that reduces ground cover ▶ disturbance of vegetation surrounding water bodies.	The following activities are recommended by OEH to assist in managing the species and its habitat (NSW BioNet): ▶ control foxes, feral cats and cane toads. ▶ reduce the impact of burning to retain diverse understorey species and cover, such as hollow logs and bark. ▶ maintain adequate ground cover, especially near water. ▶ control cattle access to reduce grazing and trampling of waterside vegetation. ▶ protect areas of habitat from clearing and development.
Swamp sclerophyll forest EEC	Key threats to swamp sclerophyll forest EEC based on NSW BioNet and other published conservation advice for the vegetation community include: ▶ further clearing for urban and rural development, and the subsequent impacts from fragmentation ▶ flood mitigation and drainage works ▶ management of water and tidal flows ▶ landfilling and earthworks associated with urban and industrial development ▶ grazing and trampling by stock and feral animals (particularly pigs) ▶ changes in water quality, particularly increased nutrients and sedimentation ▶ weed invasion ▶ climate change ▶ activation of acid sulfate soils ▶ removal of dead wood ▶ rubbish dumping ▶ frequent burning which reduces the diversity of woody plant species	The following activities are recommended by OEH to assist in managing the ecological community (NSW BioNet): ▶ instigate pig, deer and goat control programs ▶ ensure that the fire sensitivity of the community is considered when planning hazard reduction and asset management burning. ▶ protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process. ▶ promote regeneration by avoiding prolonged or heavy grazing. ▶ undertake restoration including bush regeneration, revegetation and weed control

APPENDIX C RISK ASSESSMENT

This risk assessment presents the residual risk level of an event occurring that has the potential to prevent the offset from achieving the management objectives set out in the OAMP. The likelihood of the events/circumstances occurring are based on effective implementation of the management actions outlined in the OAMP. This risk assessment also identifies specific events that trigger the proposed contingency measures

Table C-1: Risk framework

		Consequence				
Likelihood		Minor	Moderate	High	Major	Critical
	Highly Likely	Medium	High	High	Severe	Severe
	Likely	Low	Medium	High	High	Severe
	Possible	Low	Medium	Medium	High	Severe
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Low	Medium	High

Table C-2: Likelihood and consequence

Qualitative measure of likelihood (how likely is it that this event/circumstances will occur after management actions have been put in place/are being implemented)	
Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances
Qualitative measure of consequences (what will be the consequence/result if the issue does occur)	
Minor	Minor incident of environmental damage that can be reversed
Moderate	Isolated but substantial instances of environmental damage that could be reversed with intensive efforts
High	Substantial instances of environmental damage that could be reversed with intensive efforts
Major	Major loss of environmental amenity and real danger of continuing
Critical	Severe widespread loss of environmental amenity and irrecoverable environmental damage

Table C-3: Risk assessment

Management objective	Risk related event or circumstance	Likelihood[5] and justification	Consequence and justification	Residual risk level
Reduce predation risk by wild dogs, foxes and feral cats to wallum sedge frog, wallum froglet and common planigale.	Detection or evidence of foxes, feral cats, dogs within the offset area predating on offset values	Possible Most pests are highly mobile and can readily replace those that are killed in control programs. Although pest animal control for wild dogs, foxes and feral cats are generally well documented and tested, an effective control should be carefully planned and coordinated across a broad area. GCAL will endeavour to work with surrounding land managers in order to implement a coordinated pest animal control approach; however, GCAL are ultimately unable to control the frequency and intensity of pest animal control within adjacent areas. Environmental variation resulting in favourable climate conditions (i.e. increased rainfall leading to increased food availability) also has the potential to influence the presence of pest animals within the offset area.	Moderate An increase in the number of wild dogs, foxes and feral cats within the offset area leading to predation of the offset values, may result in short term delays to attaining and maintaining the completion criteria. In order to successfully reduce presence and subsequently the impact of pest animals within the offset area, pest animal control methods will be revised and the frequency of control activities will be increased.	Medium
Prevent poisoning risk by cane toads to common planigale	Detection or evidence of cane toads within the offset area poisoning common planigale	Possible Due to the large extent of the cane toad infestation and the absence of a broad-scale biological solution, eradication (except locally) is not practicable. A control program for cane toads, if required, will focus on decreasing the impacts of cane toads and containing their spread within the offset area. GCAL will endeavour to work with surrounding land managers in order to implement a coordinated pest animal control approach; however, GCAL are ultimately unable to control the frequency and intensity of pest animal control within adjacent areas. Environmental variation resulting in favourable climate conditions (i.e. increased rainfall leading to a greater extent of inundated areas) also has the potential to influence the presence of cane toads within the offset area.	High There are currently no known effective broad scale control methods for cane toads available. Should cane toads occur within the offset area, potentially resulting in poisoning of common planigale, a control program will be implemented. Control strategies for cane toads can include manual removal of toads and their eggs and/or exclusion -fencing around specific areas. These methods are generally labour intensive and expensive; however, has the potential be successful depending on the density of cane toad infestations within the offset and surrounding areas.	Medium
Prevent predation risk of wallum sedge frog and wallum froglet eggs by mosquito fish	Detection or evidence of mosquito fish within the offset area predating on wallum froglet eggs	Possible Well-established pest fish species are difficult to control with limited effective control techniques for mosquito fish that are practical for rivers, streams and wetlands. A control program for mosquito fish, if required, will focus on decreasing the impacts of mosquito fish and containing their spread within the offset area. Environmental variation resulting in favourable climatic conditions (i.e. greater extent of potential freshwater habitat due to increased rainfall) also has the potential to influence the presence of mosquito fish within the offset area.	High Should mosquito fish be identified in the offset area a control program will be implemented. An effective control program suitable for the wetland offset areas, is likely to labour intensive and expensive; however, has the potential to be successful depending on the density of mosquito fish infestations within the offset and surrounding areas.	Medium
Reduce habitat degradation caused by pigs within the offset area.	Evidence of pig activity in the offset area directly decreases habitat condition, or indirectly decreases habitat condition through a decrease in the water quality favourable to wallum sedge frog and wallum froglet.	Possible Feral pigs can be difficult to control for a number of reasons including their ability to adapt, their intelligence, their reproduction potential, preference for a range of food sources and large home ranges. Therefore control programs must be highly effective and based on a combination of control techniques. GCAL will endeavour to work with surrounding land managers in order to implement a coordinated pest animal control approach; however, GCAL are ultimately unable to control the frequency and intensity of pest animal control within adjacent areas. Environmental variation resulting in favourable climatic conditions (i.e. increased rainfall leading to increased food availability) also has the potential to influence the presence of feral pigs within the offset area.	Moderate An increase in the number of feral pigs is likely to decrease the habitat quality scores for the offset values as a result of habitat degradation and may result in short term delays to attaining and maintaining the completion criteria. In order to successfully reduce presence and subsequently the impact of feral pigs within the offset area, pest animal control methods will be revised and the frequency of control activities will be increased.	Medium

[5] Likelihood and consequence ratings assume effective implementation of proposed management actions.

Management objective	Risk related event or circumstance	Likelihood[5] and justification	Consequence and justification	Residual risk level
Prevent weed species' incursions and reduce existing weed species infestations	New outbreaks of weed species, or existing weed species' richness and/or abundance is not reduced.	Possible Introduction of new weed species is only possible through overland flow due to flooding. There is the possibility for new outbreaks of weed species or an increase in the abundance of existing weeds to occur due to environmental variation resulting in favourable weather conditions for weed growth (i.e. increased rainfall).	Moderate An increase in the presence of weed outbreaks within the offset will decrease the habitat quality scores for the offset values and may result in short term delays to attaining and maintaining the completion criteria. In order to successfully reduce the abundance/richness of weed outbreaks within the offset area, weed control methods will be revised and the frequency of control activities will be increased.	Medium
Prevent livestock grazing within the offset area	Livestock are present in the offset area.	Unlikely The presence of livestock in the offset area may occur as a result of damaged fencing due to an unforseen weather event or if stock are able to access the offset via the creek.	Moderate Depending on the degradation caused by livestock to vegetation communities there may be in short term delays to attaining and maintaining the completion criteria. GCAL will be in regular contact with the landholder regarding the condition of the fencing and livestock management and any livestock in the offset area will be removed as soon as possible.	Low
Prevent un planned fire within the offset area.	There is an unplanned fire within the offset area of a scale and intensity that prejudices attainment of the plan's completion criteria.	Unlikely An unplanned fire in the offset area may occur as a result of environmental variation (extreme drought, lightning strike) or out of control fire in adjacent properties in which offset area firebreaks are unable to mitigate.	High An unplanned fire in the offset area is likely to result in medium-long term delays to attaining and maintaining the completion criteria. A high intensity fire is likely to result in degradation of sensitive vegetation communities and habitat features and a potential reduction in threatened fauna populations.	Medium

APPENDIX D OVERALL FUEL HAZARD ASSESSMENT GUIDE

Department of
Sustainability and
Environment

Overall fuel hazard assessment guide

4th edition July 2010

Fire and adaptive management

report no. 82

State Government
Victoria

Overall fuel hazard assessment guide

4th edition July 2010

Fire and adaptive management, report no. 82

By Francis Hines, Kevin G Tolhurst, Andrew AG Wilson and Gregory J McCarthy

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Cover image: Elaine – Atchison Rd Fire, Victoria, January 2008. Bark Hazard – Extreme, Elevated Fuel Hazard – Moderate, Near-surface Fuel Hazard – Low, Surface Fuel Hazard – Very High. Overall Fuel Hazard – Extreme. Fire burning under FFDI 17 – High.

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Contents

1. About this guide

1.1 Purpose

The main purpose of this guide is to allow people to:

- make a rapid, visual assessment of fuel arrangement, and
- gain an understanding of how this will affect the chances of controlling a bushfire.

1.2 Audience

This guide has been principally designed to provide information on fuel arrangement to be used by:

- firefighters to assess the difficulty of controlling a bushfire.

Information on fuel arrangement may also be used by:

- asset owners and managers to assess potential bushfire risks to assets
- land and fire managers to provide a measurable objective and trigger for fuel management in fire management plans
- personnel to identify which key attributes and fuel layers are contributing the most to the hazard
- personnel to plan and conduct planned burns
- personnel to assess the effectiveness of planned burning or mechanical hazard reduction
- fire behaviour analysts to produce fire-spread predictions and community warnings.

Those who use the guide for these other purposes need to be mindful of its limitations and how the results are applied and interpreted.

1.3 What fuel is assessed

This guide is for assessing fine fuels that burn in bushfires. Fine fuels are the fuels that burn in the continuous flaming zone at the fire's edge. They contribute the most to the fire's rate of spread and flame height. Typically, they are dead plant material, such as leaves, grass, bark and twigs thinner than 6mm thick, and live plant material thinner than 3mm thick. Once ignited, these fine fuels generally burn out within two minutes.

This guide focuses on assessing the key structural layers of the fine fuel complex, in particular those of bark, elevated, near-surface and surface fuels.

1.4 How the fuel is assessed

Each fuel layer is assessed simply and visually. Assessing the fuel takes only a few minutes and is based on the premise that the eye is better able to integrate local variations in fuel than systematic measurement. Each fuel layer is assessed in turn and given a hazard rating. Particular emphasis is placed on how the fuel is arranged within each of these layers. The hazard ratings are then combined to produce an Overall Fuel Hazard Rating that ranges from Low to Extreme.

1.5 Why fuel arrangement is more important than fuel load

The image below highlights the effect that changing the arrangement of the fuel can have on fire behaviour. Both fires were ignited at the same time in the same way. Both fires are burning in the same fuel load, approximately two broadsheets of newspaper over a 20cm diameter area. The fuel on the right was laid flat and has little vertical orientation. The fuel on the left was crumpled up, which gave it more vertical orientation and exposed more of the surface to the air. As a result, the fire on the left shows significantly greater flame height and the fuel is consumed much faster.

The simple difference in the arrangement of the fuel significantly affects the resulting fire behaviour. The effect would not be discerned if the fuel assessment was based purely on fuel load. An assessment of fuel hazard takes into account the fuel arrangement. It gives a better indication of potential fire behaviour and suppression difficulty.

1.6 Suppression difficulty is not just about fire behaviour

This guide has been mainly developed to allow people to assess the impact of fuel arrangement on suppression difficulty. An assessment of suppression difficulty (how hard it is to control a bushfire) is not based solely on the anticipated fire behaviour. Many other factors affect the chances of a firefighting operation succeeding, including resources, fire size and terrain.

In order to consider the impact of fuels, the other factors need to be treated as if they are constant. The factors that have been held constant are referred to as the Reference Extended First Attack Conditions. Further detail on these conditions is contained in Appendix 1.

1.7 Basis of the Overall Fuel Hazard classification

A comprehensive explanation of this guide is contained in DSE's *Overall fuel hazard assessment guide: a rationale report – fire and adaptive management report no. 83* (in prep.).

This assessment guide updates and builds on work previously published by Wilson (1992a, 1992b, 1993), McCarthy *et al*. (1998a, 1998b, 1998c, 1999, 2001), the Department of Environment and Heritage (2006) and Gould *et al*. (2007a, 2007b).

Classifying Overall Fuel Hazard is complex, with few available measurements. Therefore, we have relied on the perceptions of experienced fire personnel (e.g. fire behaviour specialists, fire managers and firefighters). The collective experience of these personnel is vast, with a broad geographic base across Australia.

1.8 Need for continual learning and development

Although our knowledge about fuels has many gaps, this guide is based on the best available information and experience. The authors acknowledge that this guide will need to change and improve as more information is obtained.

Observers of firefighting operations can improve future editions of this guide by carefully recording what they see. Observations, comments and feedback can be emailed to fire.monitoring@dse.vic.gov.au.

2. How to use the guide

This guide has been kept concise and should not be considered as a standalone document. To produce reliable and consistent results requires extra knowledge which may be gained through local hands-on training in fuel assessment.

2.1 Application

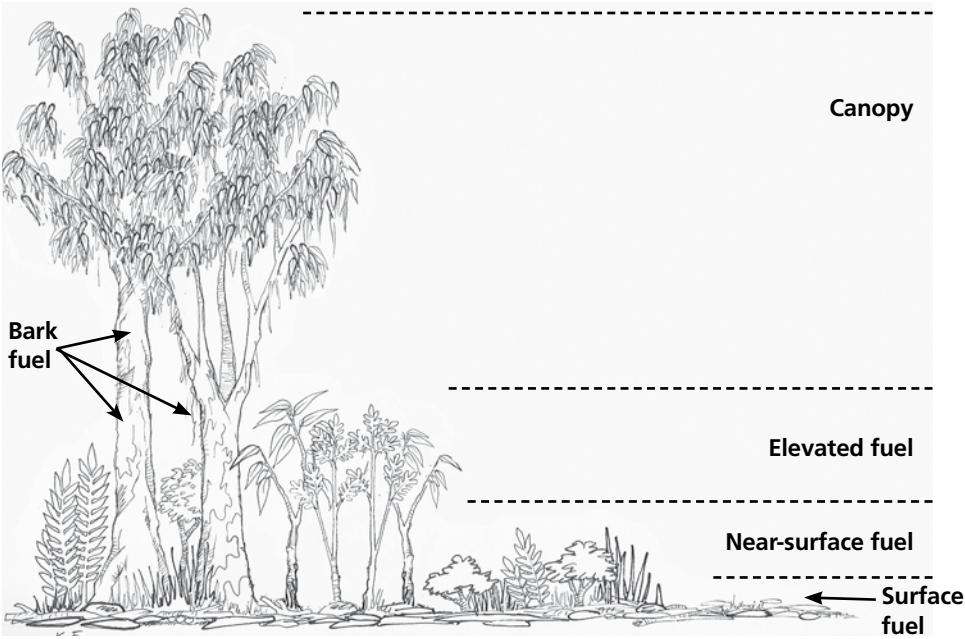
This guide is a tool for rapidly assessing fuel arrangement and its effect on the chances of controlling a bushfire. It may also be used for a range of other fire management purposes, as shown in the table below. Users of this guide should understand the underlying assumptions and limitations before applying it, particularly if applying it for purposes other than the assessment of suppression difficulty.

Application	Methodology
Assess suppression difficulty	Assess the fuels in which the fire may occur or is actually occurring.
Assess fuels for predicting potential risk to assets	Assess the fuels immediately adjacent to the asset as part of an assessment of possible radiant heat loads and defendable space. Assess the fuels further away from the asset; paying particular attention to areas that may generate spotting, such as ridges. Assessments should be focused, particularly in the direction of likely fire attack.
Assess the need for, or success of, fuel management activities	Assess the average fuels across the nominated area by sampling within major vegetation types, slopes and aspects.
Plan and conduct planned burns	Assess the variability in fuels across the nominated area by sampling within major vegetation types, slopes and aspects. Pay particular attention to areas where the burn may escape, such as the tops of gullies, ridge tops and areas adjacent to planned burn boundaries.
Assess fuels for predicting fire behaviour	Assess the fuel values needed as inputs for the appropriate fire behaviour model.

2.2 Fuel layers

Fuel in forests, woodlands and shrublands can be divided into four layers, each based on its position in the vegetation profile (Fig 2.1). This guide focuses on assessing the key structural layers of the fine fuel complex, those of bark, elevated, near-surface and surface fuels.

Figure 2.1 Fuel layers and bark



Use the following descriptions to determine how to separate vegetation into fuel layers.

Layer	Description	Contribution to suppression difficulty
Canopy	• Crowns of the tallest layer of trees. • Under some conditions canopy fuels can play a significant role in fire behaviour and suppression difficulty. Currently, however, these fuels are not assessed as part of Overall Fuel Hazard.	
Bark fuel	• Bark on tree trunks and branches, from ground level to canopy.	Spotting
Elevated fuel	• Fuels are mainly upright in orientation. • Generally most of the plant material is closer to the top of this fuel layer. • Sometimes contains suspended leaves, bark or twigs. • Fuels that have a clear gap between them and the surface fuels. • Can be highly variable in ground coverage. • Low-intensity fire (flame height of less than 0.5m) may pass beneath this layer without consuming much, if any, of it.	Influences the flame height and rate of spread of a fire.
Near-surface fuel	• Live and dead fuels, effectively in touch with the ground, but not lying on it. • Fuel has a mixture of vertical and horizontal orientation. • Bulk of the fuels are closer to the ground than to the top of this layer, or are distributed fairly evenly from the ground up. • Sometimes contains suspended leaves, bark or twigs. • Coverage may range from continuous to having gaps many times the size of the fuel patch. • Low-intensity fire (flame height of less than 0.5m) will consume most or all of this fuel. • Fuel in this layer will always burn when the surface fuel layer burns.	Influences the rate of spread and flame height of a fire.
Surface fuel (litter)	• Leaves, twigs, bark and other fine fuel lying on the ground. • Predominantly horizontal in orientation.	Influences the rate of spread of a fire.

This guide is for assessing fine fuels only. Coarse fuels including logs are not considered. See Section 1.3 for further details.

The descriptions of the fuel layers exclude references to species' names or common vegetation forms, such as shrubs. During a plant's life it may transition back and forth between different layers. For example, juvenile bracken fern can be classified as near-surface fuel before becoming elevated fuel as it matures. Once it dies and collapses it may become near-surface fuel again.

2.3 Assessment based on key attributes of fuel hazard

A fuel hazard rating of Low, Moderate, High, Very High or Extreme is assigned to each fuel layer by assessing it against the key attributes listed below.

Key attribute	
Horizontal continuity of the layer	Determines how readily a piece of burning fuel may ignite the fuel beside it. Identifies which of surface, near-surface or elevated fuels will determine the average flame height.
Vertical continuity of the layer	Determines how readily a piece of burning fuel may ignite the fuel above it.
Amount of dead material in the layer	Determines how much dead material is present to burn and thus help with igniting the live (green) fuels.
Thickness of the fuel pieces	Determines whether the fuel pieces will burn in the flaming front of the fire.
Total weight of fine fuel	Determines the weight of fine fuel contributing to the flaming front of the fire.

The descriptions in the hazard assessment tables do not cover all possible combinations of the key attributes. Users will need to exercise judgement and make an assessment using all key attributes when actual conditions fit between the descriptions.

2.4 Using the descriptions and photographs

This is **not** a photographic guide for assessing fuels. The **descriptions** for each of the key attributes should be used as the basis for determining the fuel hazard rating. Photographs cannot adequately show all of the key attributes that are important in determining fuel hazard. The photographs are provided to illustrate **some** of the key attributes for each fuel hazard rating. They do not represent all possible variations of that particular hazard rating.

2.5 Area of assessment

Within an area of interest fuels are assessed in small patches or plots. The size and number of plots depends on the reason for assessing the fuels. Some applications (such as for input into fire behaviour models) may require a more rigorous and systematic approach to sampling. Other applications (such as assessing fuel hazard during firefighting operations) will necessitate a more rapid informal approach. For whatever purpose the guide is being used it is recommended that the following principles be applied:

- Any assessment of fuels should try to assess the variability in fuels across an area by assessing the fuels at multiple plots.
- The size and number of plots should reflect the level of reliability required of the results.
- For surface, near-surface and elevated fuel layers the result of assessing the plot should reflect the average state of that fuel layer.
- For bark hazard the result of assessing the plot should be based on the trees with the highest rating.
- Always record with the result the name and the version of the guide used.

2.6 Tips for assessing fuel hazard

The process of assessing fuel hazard using this guide is largely subjective. Implementing the following techniques will help to improve accuracy and reliability:

- Identify and agree on examples of the highest rating of fuel hazard for each layer that occur locally. These examples should be used as benchmarks.
- Conduct assessments in pairs of observers and regularly change assessment pairs.
- Assessors should be no more than one hazard rating apart when assessing each layer (e.g. Low or Medium, not Low or High).
- Use different assessors to re-assess completed work and provide feedback.

2.7 Vesta fire behaviour predictions

In dry eucalypt forest with a litter and shrub understorey the *Field guide – fuel assessment and fire behaviour prediction in dry eucalypt forest* (Gould *et al.* 2007b) provides a systematic method for assessing fuel and predicting fire behaviour (rate of spread, flame height, and spotting). The Project Vesta fuel hazard scoring system is similar to the Victorian system developed by Wilson (1992a, 1992b, 1993) and revised by McCarthy *et al*. (1999). The scale that underlies the Vesta fuel hazard scores is directly related to fire behaviour. These scores, along with height measurements of various fuel layers, are needed as inputs into the fire behaviour prediction tables in Gould *et al*. (2007b). Section 9.3 contains a table for translating the fuel hazard rating for each fuel layer into Vesta fuel hazard scores.

2.8 Effect on fire behaviour

Each table for assessing fuel hazard contains information on the effect that the fuel arrangement is likely to have on fire behaviour. This effect is for weather conditions equivalent to a Forest Fire Danger Index (FFDI) of 25 (McArthur 1973). An FFDI of 25 can be achieved in many ways. For the purposes of this guide the specific conditions required to achieve this are:

Temperature: 33°C	Relative Humidity: 25%	Wind Speed: 20km/h
Drought Factor: 10	Slope: 0°	

If weather conditions vary from those listed above the effect on fire behaviour will also vary.

2.9 Fuel assessment data sheet

Appendix 2 contains a sample field data sheet that can be used when assessing fuels.

3. Bark fine fuel

3.1 Identification

Bark fuel is the bark on tree trunks and branches. Bark lying on or near the ground or draped over understorey plants is considered to be surface, near-surface or elevated fuel.

3.2 Identifying bark types

The key attributes for assessing the effect of bark on suppression difficulty are shown below:

Key attribute	Determines	How it is assessed
Ease of ignition	• How readily the bark will ignite. • Whether the fire will burn up the trunk and into the branches of the tree.	Thickness, size and shape of bark pieces.
How bark is attached	• How likely the bark is to break off the tree.	How easily the bark breaks off the tree.
Quantity of combustible bark	• Volume of potential embers that a fire may generate.	Relative quantity of combustible bark.
Size-to-weight ratio of the bark pieces	• How far the wind is likely to carry bark pieces once they break off the tree.	Thickness, size and shape of bark pieces.
Burn out time	• Length of time a piece of bark will stay ignited once it breaks off the tree.	Thickness, size and shape of bark pieces.

Descriptions of trees have been separated into three broad bark types using three of these key attributes – ease of ignition, burn out time and size-to-weight ratio:

1. Fine fibrous barks, including stringybarks
2. Ribbon or candle barks
3. Other bark types, including smooth, platy, papery and coarsely fibrous. The reason for describing these types in some detail is to help observers distinguish them from the above two types.

3.3 Identifying Stringybark and other fine fibrous bark types

Contribution to suppression difficulty	• Bark types that can produce massive quantities of embers and short distance spotting.
Physical description	• Bark is fine fibrous material with easily visible fibres less than 1mm thick covering the whole trunk. • Bark fibres resemble the fine fibres that are twisted together to form natural string. • Old bark is retained on the trunk of the tree for decades, forming a relatively spongy fibrous mass with deep vertical fissures. • Outer bark may weather to a greyish colour, while underlying bark retains its original colour. • Bark may form large strands when peeled off. • Fine, hairlike pieces also break off from the tree when it is rubbed.
Ease of ignition	• Bark is very flammable (can be easily lit with a match when dry). • Fires will readily climb the tree and branches.
How bark is attached	• Young or new bark is held tightly to the trunk. • As bark ages it becomes less tightly held. • Old, long-unburnt bark is held very loosely.
Quantity of combustible bark	• Bark on old, long-unburnt stringybarks can be more than 10cm in depth. During fires it can produce massive quantities of embers.
Size-to-weight ratio	Burning pieces of bark tend to be either: • Very fine lightweight fibres that will be carried for less than 100m. • Small lightweight wads (about the size of a thumb) that will be carried for less than 300m. • Very large wads (bigger than a fist) that fall close to the tree.
Burn out time	• Very fine fibres of bark that will burn out within one minute. • Small wads of bark that will burn out within 2–3 minutes. • Very large wads of bark that will burn for up to 10 minutes.
Hazard accumulation	• Bark hazard can reach Extreme. • Bark hazard increases over time as the thickness and looseness of the old bark increases. • Repeated low intensity fires (<0.5m flame height) may produce a 'black sock' effect on the base of the trunk, but this may have limited effect in reducing the overall quantity of bark and the hazard.

Examples

Table 3.1 Assessing the hazard of fine fibrous bark types including stringybarks

Only use this table if at least 10% of the trees in a forest have fine fibrous bark. To achieve a given hazard rating a best fit of both key attributes should be sought. Choices for the hazard rating of fuels that fit across several descriptions may be informed by the effect that different levels of key attributes have on fire behaviour.

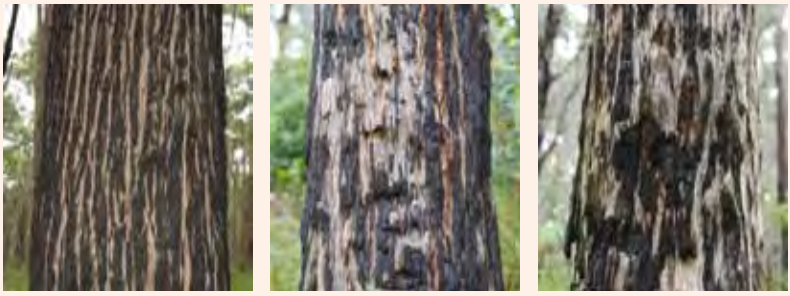
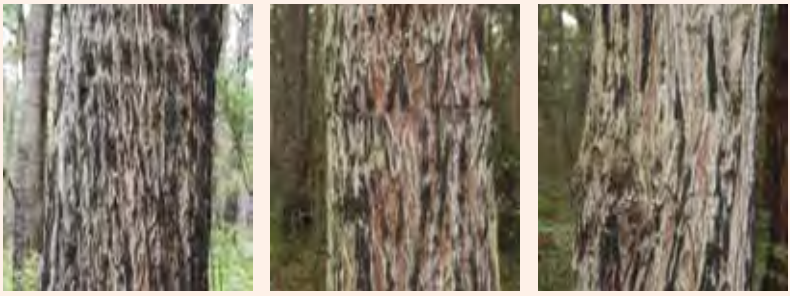
Key attributes		Hazard rating	Effect on fire behaviour (at FFDI 25)[1]
How bark is attached	**Quantity of combustible bark**		
This hazard rating cannot occur when only this bark type is present.		Low	
Bark tightly held. Requires substantial effort to break off bark by hand.	Very little combustible bark. Entire trunk almost completely black or charred.	Moderate	Spotting generally does not hinder fire control. Fires will not climb these trees.
Bark is mostly tightly held with a few pieces loosely attached.	Limited amount of combustible bark. 50–90% of trunk charred. Most of the bark is charred, especially on the lower part of the trunk.	High	Infrequent spotting. Fires will climb some of these trees.
Many pieces of bark loosely held. Deep fissures present in bark.	Large amounts of combustible bark. 10–50% of trunk charred. Upper parts of the tree may not be charred at all.	Very High	Substantial spotting. Fires will climb most of these trees.
Outer bark on trees is weakly attached. Light hand pressure will break off large wads of bark. Deep fissures present in bark.	Huge amounts of combustible bark. <10% of trunk charred. Minimal evidence of charring.	Extreme	Quantity of spotting generated makes fire control very difficult or impossible. Fires will climb virtually all these trees.

Assess bark hazard over a plot 20m in radius. Assessing multiple plots will give better results. Trunk is defined as being the part of the tree between the ground and the branches.

See Section 9.3 for application of bark hazard ratings for the Vesta fire behaviour tables.

1 FFDI 25 is a Forest Fire Danger Index of 25 (McArthur 1973). Refer to Section 2.8 for the specific weather conditions used to achieve this FFDI.

Table 3.2 Examples of Stringybarks and other fine fibrous bark hazard

Low	This hazard rating cannot occur when only this bark type is present.
Moderate	
High	
Very High	
Extreme	

The photos above show some of the variation possible within each bark hazard rating.

3

3.4 Identifying ribbon or candle bark types

Effect on suppression difficulty	• Bark types that can produce substantial quantities of spotting at distances greater than 2km. Will also produce short distance spotting.
Physical description	• Trees characterised by the annual shedding of old bark layers, exposing the smooth new bark underneath. • Bark is shed in the form of long strips or ribbons of bark. • Long strips of bark curl tightly inwards to form a candle-like shape (see image lower right). • Bark strips 50cm or more in length fall off and often drape around the trunk and over branches and surrounding shrubs. • Strips of bark are usually less than 2mm thick. • Bark is shed at various times of the year so that the trunk may have a mottled appearance.
Ease of ignition	• Bark is moderately flammable (can be lit with a cigarette lighter when dry). • Fires will climb up ribbons of bark.
How bark is attached	• Bark strips may drape over, or be weakly attached to, the trunk and branches.
Quantity of combustible bark	• Large quantities of bark can be retained in upper trunk and head of the tree.
Size-to-weight ratio	• Bark pieces are relatively light for their large size. • Easily transported by strong updrafts – may travel up to 30km downwind.
Burn out time	• Bark can burn and smoulder within the curled up ribbons for longer than 10 minutes.
Hazard accumulation	• Bark hazard never exceeds Very High. • Bark hazard tends to increase over the long term as ribbons accumulate on the tree. • A low intensity fire (flame height of less than 0.5m) may not reduce the hazard in this bark type.

Example

Note: Loose ribbon or candle-like bark that is retained on the trunk near ground level is not included in the assessment of ribbon or candle bark types. It is usually:
- firmly attached to the trunk of the tree
- consumed in place by a surface fire.

This bark is considered in 'Other bark types' and can also be considered as near-surface fuel.

Smooth-bark trees also shed bark as slabs or flakes. These bark types are considered in 'Other bark types'.

Table 3.3 Assessing the hazard of ribbon or candle bark types

If more than 10% of the trees in a forest are fine fibrous bark trees use Table 3.1 (Assessing the hazard of fine fibrous bark types) to determine the bark hazard for a site.

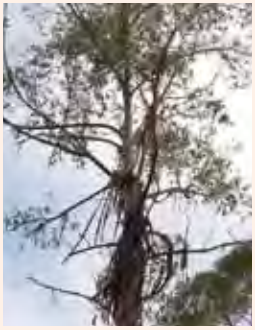
Key attribute Amount of combustible bark	Hazard rating	Effect on fire behaviour (at FFDI 25)[2]
This hazard rating cannot occur when only this bark type is present.	Low	
No long ribbons of bark present. Trunk and branches of trees almost entirely smooth.	Moderate	Spotting generally does not hinder fire control. Fires will not climb these trees.
Long ribbons of bark present on upper trunk (>4m above ground) and in head of trees. Lower trunk mainly smooth.	High	Infrequent spotting. Fires will climb some of these trees.
Long ribbons of bark in the head and upper trunk with: • ribbons hanging down to ground level or, • flammable bark covers trunk.	Very High	Substantial spotting. Fires will climb most of these trees.
This hazard rating cannot occur when only this bark type is present.	Extreme	

Assess bark hazard over a plot 20m in radius. Assessing multiple plots will give better results. Trunk is defined as the part of the tree between the ground and the branches.

See Section 9.3 for application of bark hazard ratings for the Vesta fire behaviour tables.

2 Refer to Section 2.8 for the specific weather conditions used to achieve this FFDI.

Table 3.4 Examples of ribbon or candle bark hazard

Low	This hazard rating cannot occur when only this bark type is present.		
Moderate			
High			
Very High			
Extreme	This hazard rating cannot occur when only this bark type is present.		

3.5 Identifying other bark types

This bark type includes all other bark types not included in the previous two types. As a result, many different tree species are grouped together. This grouping is based on the ease of ignition, burn out time and size-to-weight ratio of the bark, rather than on botanical values. These other bark types can produce limited quantities of short distance spotting.

This bark type group has been divided into several subgroups. These subgroups are described in some detail to help observers distinguish them from the other two main bark types.

3.5.1 Ironbarks and Platy barks

Physical description	• Trees characterised by layers of old, coarse bark retained on the trunk and branches. • Bark becomes rough, compacted and furrowed with age • Bark feels very abrasive when rubbed by hand. • Bark pieces tend to be more than 2mm thick when they break off. • There may be little or no evidence of charring on the bark following planned burns.
Hazard accumulation	• Bark hazard never exceeds Moderate.

Example

3.5.2 Coarsely fibrous barks

Physical description	• Trees characterised by short strand fibrous bark. • Layers of old dead bark are retained on the trunk and branches. • Unlike stringybark trees, the bark on these trees forms only short strands or chunks when peeled off. • Evidence of charring on the bark may last for up to 10 years.
Hazard accumulation	• Bark hazard never exceeds High. • Bark hazard increases over the long term as the thickness and looseness of the old bark increases.

Example

3.5.3 Papery barks

Physical description

- Shrubs and trees growing from 2m to 30m tall, often with flaky shedding bark.
- Old bark is retained on the trunk and branches and builds up into a thick spongy mass.
- Bark layers tend to split allowing sheets of bark to become loose and eventually peel off.
- Evidence of charring on the bark may last for up to 10 years.

Hazard accumulation

- Bark hazard never exceeds High.
- Bark hazard increases over the long term as the thickness and looseness of the old bark increases.

Example

3.5.4 Slab bark, smooth bark and small flakes

Physical description

- Trees characterised by the annual shedding of old bark layers, exposing the smooth living bark underneath.
- Bark shed is often seasonal and often annual.
- Species where the old bark tends to peel into large slabs (<50cm in length) or small flakes when shed.
- Most of the bark falls off the tree soon after it is shed.
- Some small amounts of bark may be retained on the stem or branches for several months before falling off, leading to a mottled effect.
- The mottled effect leads to discontinuous bark fuel up the tree.

Hazard accumulation

- Bark hazard never exceeds Moderate.
- Bark hazard tends to be seasonal.

Example

Table 3.5 Assessing the hazard of other bark types

If more than 10% of the trees in a forest are fine fibrous bark trees use Table 3.1 (Assessing the hazard of fine fibrous bark types) to determine the bark hazard for a site. To achieve a given hazard rating a best fit of both key attributes should be sought. Choices for the hazard rating of fuels that fit across several descriptions may be informed by the effect that different levels of key attributes have on fire behaviour.

Key attributes		Hazard rating	Effect on fire behaviour (at FFDI 25)[3]
How bark is attached	**Quantity of combustible bark**		
No trees present. or Trunk and branches of tree entirely smooth or free from loose bark.		Low	No bark present that could contribute to fire behaviour.
Bark rubs off by hand with firm pressure.	Limited amount of combustible bark.	Moderate	Spotting generally does not hinder fire control. Fires will climb some of these trees.
Light hand pressure will break bark off.	Large amounts of combustible bark.	High	Infrequent spotting. Fires will climb most of these trees.
This hazard rating cannot occur when only this bark type is present.		Very High	
This hazard rating cannot occur when only this bark type is present.		Extreme	

Assess bark hazard over a plot 20m in radius. Assessing multiple plots will give better results. Trunk is defined as the part of the tree between the ground and the branches.

See Section 9.3 for application of bark hazard ratings for the Vesta fire behaviour tables.

3 Refer to Section 2.8 for the specific weather conditions used to achieve this FFDI.

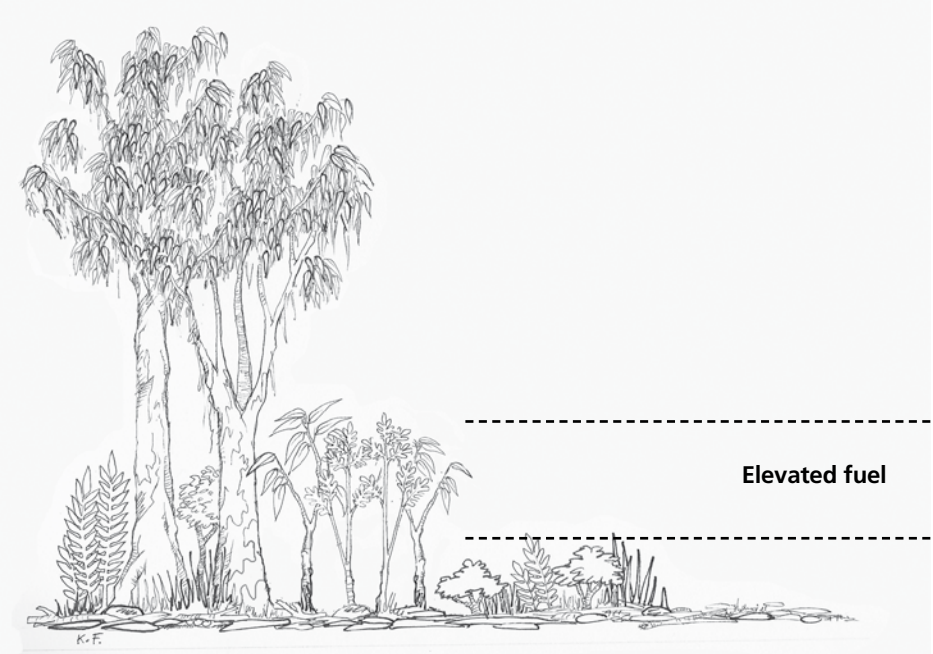
Table 3.6 Examples of other bark types

Low	No trees present. or Trunk and branches of tree entirely smooth or free from loose bark.			
Moderate				
High				
Very High	Does not occur when this is the only bark type present on a site.			
Extreme	Does not occur when this is the only bark type present on a site.			

4. Elevated fine fuel

4.1 Identification

- Fuels are mainly upright in orientation
- Generally most of the plant material is closer to the top of this layer
- Sometimes contains suspended leaves, bark or twigs
- Fuels that have a clear gap between them and the surface fuels
- Elevated fuel can be highly variable in ground coverage
- A low intensity fire (flame height of less than 0.5m) may pass beneath this layer without consuming much, if any, of it.



4.2 Assessment

The elevated fuel hazard is highest when the:

- foliage, twigs and other fuel particles are very fine (maximum thickness 1–2mm)
- proportion of dead material is high
- fuels are arranged with a high level of density and/or horizontal and vertical continuity that promotes the spread of flames
- live foliage has low fuel moisture content.

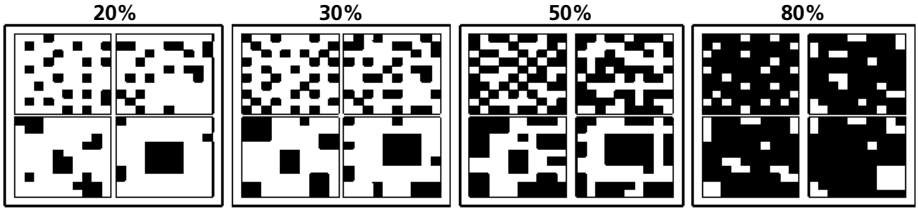
Table 4.1 Assessing elevated fine fuel hazard

To achieve a given hazard rating a best fit of all key attributes should be sought. Choices for the hazard rating of fuels that fit across several descriptions may be informed by the effect that different levels of key attributes have on fire behaviour.

Key attributes					Fuel hazard rating	Effect on fire behaviour (at FFDI 25)[4]
Plant Cover	% dead	Vertical continuity	Vegetation density	Thickness of fuel pieces		
<20% or low flammability species	<20%		Easy to walk in any direction without needing to choose a path between shrubs.		Low	Little or no effect.
20–30%	<20%	Most of the fine fuel is at the top of the layer.	Easy to choose a path through but brush against vegetation occasionally.		Moderate	Does not sustain flames readily.
30–50%	<20%	Most of the fine fuel is at the top of the layer.	Moderately easy to choose a path through, but brush against vegetation most of the time.		High	Causes some patchy increases in the flame height and/or rate of spread of a fire.
50–80%	20–30%	Continuous fine fuel from the bottom to the top of the layer.	Need to carefully select path through.	Mostly less than 1–2mm thick.	Very High	Elevated fuels mostly dictate flame height and rate of spread of a fire.
>70%	>30%	Continuous fine fuel from the bottom to the top of the layer.	Very difficult to select a path through. Need to push through vegetation.	Large amounts of fuel <2mm thick.	Extreme	Elevated fuels almost entirely determine the flame height and rate of spread of a fire.

Assessing plant cover

For the purpose of this guide, plant cover is defined as the amount of ground blocked out by that fuel layer if viewed while looking straight down from above. Each plant is considered opaque – any ground within the perimeter of the plant cannot be seen. The following visual guide can be used to assist in assessing plant cover. Each quarter of any one square has the same percent cover.



4 Refer to Section 2.8 for the specific weather conditions used to achieve this FFDI.

Table 4.2 Examples of elevated fine fuel hazard

Low	Elevated fuel absent or virtually absent	
Moderate		
High		
Very High		
Extreme		

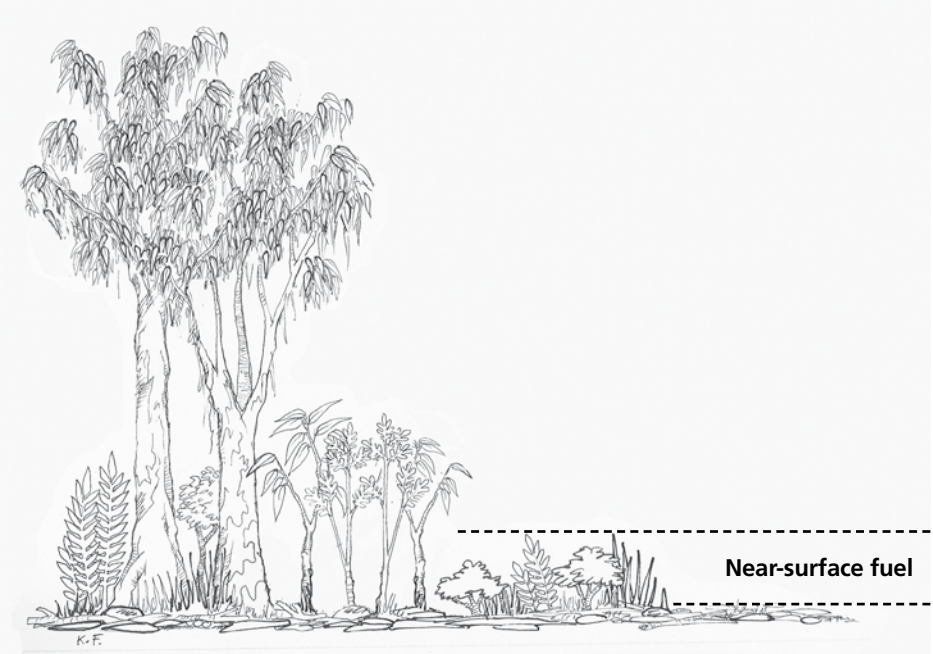
Assess elevated hazard over a plot 10m in radius. Assessing multiple plots will give better results.

See Section 9.3 for application of elevated fuel hazard ratings for the Vesta fire behaviour tables. For the Vesta fire behaviour tables the elevated fuel height (m) should be the average of 10 measurements taken along a 300m walk-through. Measure the typical height from ground level.

5. Near-surface fine fuel

5.1 Identification

- Live and dead fuels effectively in touch with the ground but not lying on it
- Fuel has a mixture of vertical and horizontal orientation
- Either the bulk of the fuels is closer to the ground than the top of this layer, or is distributed fairly evenly from the ground up
- Sometimes contains suspended leaves, bark or twigs
- Coverage may range from continuous to having gaps many times the size of the fuel patch
- A low intensity fire (flame height of less than 0.5m) will consume most or all of this fuel
- Fuel in this layer will always burn when the surface fuel layer burns.



5.2 Assessment

The near-surface fuel hazard is highest when the:

- foliage, twigs and other fine fuel particles are very fine (maximum thickness 1–2mm)
- proportion of dead material is high
- fuels are arranged with a high level of density and /or horizontal and vertical continuity, that promotes the spread of flames
- live foliage has low fuel-moisture content.

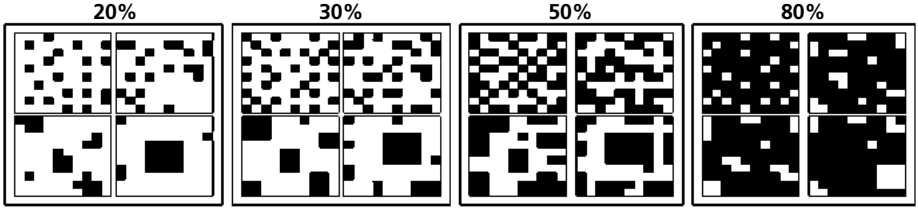
Table 5.1 Assessing near-surface fine fuel hazard

To achieve a given hazard rating a best fit of all key attributes should be sought. Choices for the hazard rating of fuels that fit across several descriptions may be informed by the effect that different levels of key attributes have on fire behaviour.

Key attributes			Fuel hazard rating	Effect on fire behaviour (at FFDI 25)[5]
Plant cover	% dead	Horizontal connectivity		
<10%	<10%	Near-surface fuel is absent or virtually absent.	Low	Little or no effect.
10–20%	<20%	Gaps many times the size of fuel patches.	Moderate	Occasionally increases flame height.
20–40%	>20%	Gaps between fuel patches are greater than the size of fuel patches. Starting to obscure logs and rocks.	High	Contributes to surface fire spread and causes patchy increase to flame height.
40–60%	>30%	Fuel patches are equal to or larger than the gaps between the fuel patches.	Very High	Contributes significantly to fire spread and flame height. A fire will spread readily in this layer without having to consume the surface layer.
>60%	>50%	Very small gaps between fuel patches. Logs and rocks obscured.	Extreme	Contributes significantly to fire spread and flame height. A fire will spread readily in this layer without having to consume the surface layer.

Assessing plant cover

For the purpose of this guide, plant cover is defined as the amount of ground blocked out by that fuel layer if viewed while looking straight down from above. Each plant is considered opaque – any ground within the perimeter of the plant cannot be seen. The following visual guide can be used to assist in assessing plant cover. Each quarter of any one square has the same percent cover.



5 Refer to Section 2.8 for the specific weather conditions used to achieve this FFDI.

Table 5.2 Examples of near-surface fine fuel hazard

Low	Near-surface fuel is absent or virtually absent	
Moderate		
High		
Very High		
Extreme		

Assess near-surface hazard over a plot 10m in radius. Assessing multiple plots will give better results.

See Section 9.3 for application of near-surface fuel hazard ratings for the Vesta fire behaviour tables. For the Vesta fire behaviour tables the near-surface fuel height (cm) should be the average of 10 measurements taken over a 300m walk through. Measure the typical height from ground level.

6. Surface fine fuel

6.1 Identification

- Leaves, twigs, bark and other fine fuel lying on the ground
- Predominantly horizontal in orientation
- Usually contributes the most to fuel load or quantity
- Includes the partly decomposed fuel (duff) on the soil surface.

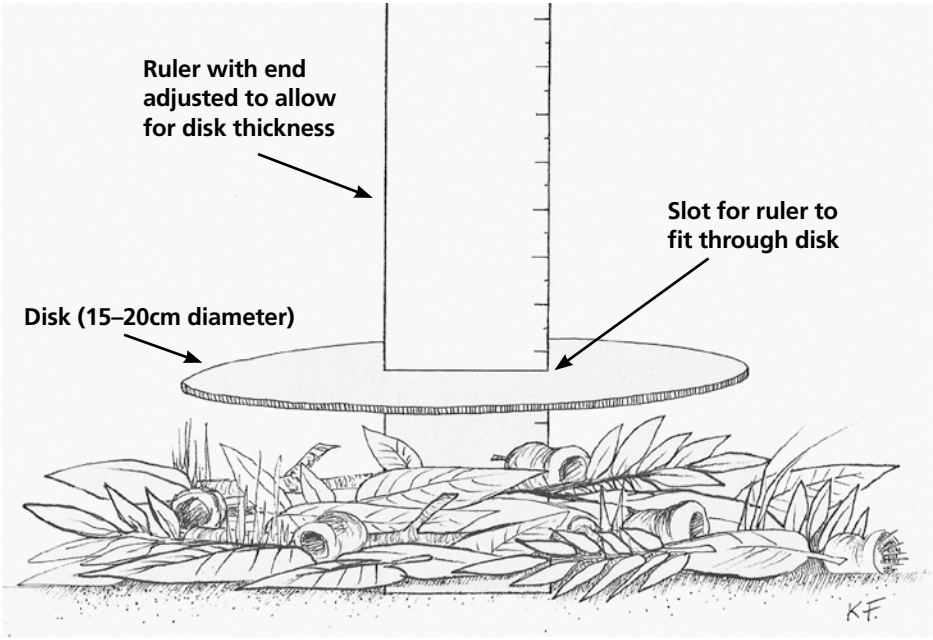
6.2 Assessment

The surface fine fuel hazard is highest when the:

- litter pieces are well connected
- surface litter cover is high, with minimal interruption from rocks, logs or patches of bare soil
- surface litter has substantial depth (greater than 30mm).

6.3 Measurement

Surface litter-bed depth should be measured using a simple depth gauge, as pictured below. This follows the methodology described in McCarthy (2004) and McCarthy *et al*. (1999).



Litter depth should be measured in areas where near-surface fuels do not obscure the litter. Fuel depth is measured using a 15cm circular disk with a ruler through a slot in its centre. To use this gauge, a small gap is made in the litter bed down to mineral soil, then the end of the ruler is placed resting on the mineral soil surface. The disk is pushed down with light pressure until its whole perimeter is in contact with the fuel. Light pressure can be described as 'enough pressure to hold a tennis ball under water'. The ruler is read off level with the top of the disk. Note that the end of the ruler needs to be adjusted to match the thickness of the disk.

Five measurements of litter bed depth should be made at each site. The average of these measurements is one of the attributes that can be used to determine the surface fine fuel hazard.

Table 6.1 Assessing surface fine fuel hazard

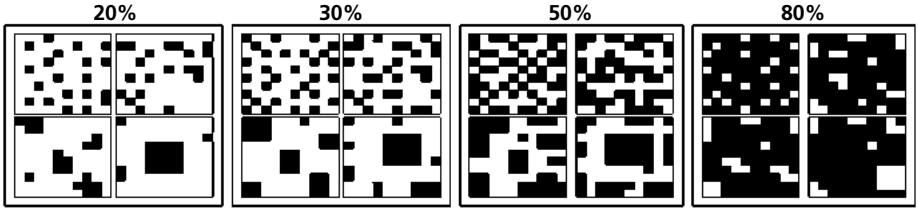
To achieve a given hazard rating a best fit of all key attributes should be sought. Choices for the hazard rating of fuels that fit across several descriptions may be informed by the effect that different levels of key attributes have on fire behaviour.

Key attributes			Fuel hazard rating	Effect on fire behaviour (at FFDI 25)[6]
Horizontal connectivity	Surface litter cover	Litter-bed depth		
Litter poorly interconnected. Large areas of bare soil or rock. More soil than litter. Soil surface readily visible through litter bed.	<60%	Very thin litter layer <10mm	Low	Surface fires will not spread.
Litter well connected. Some areas of bare soil or rock. Soil surface occasionally visible through litter bed.	60–80%	Thin litter layer 10–25mm	Moderate	Litter connected well enough to allow fire spread to overcome bare patches.
Litter well connected. Little bare soil.	80–90%	Established litter with layers of leaves ranging from freshly fallen to decomposing. 20–30mm	High	Surface fires spread easily with a continuous fire edge.
Litter completely connected.	>90%	Thick litter layer 25–45mm	Very High	Surface fires spread easily. Increasing flame depth and residence time.
Litter completely connected.	>95%	Very thick layer of litter >35mm	Extreme	Surface fires spread easily. Increasing flame depth and residence time.

Assess surface hazard over a plot 10m in radius. Assessing multiple plots will give better results. For each plot litter bed depth should be an average of five measurements (McCarthy 2004) or more.

See Section 9.3 for application of surface fuel hazard ratings for the Vesta fire behaviour tables.

The following visual guide can be used to assist in assessing surface litter cover. Each quarter of any one square has the same percent cover.



6 Refer to Section 2.8 for the specific weather conditions used to achieve this FFDI.

Table 6.2 Examples of surface fine fuel hazard

Low		
Moderate		
High		
Very High		
Extreme		

7. Determining the combined surface and near-surface fine fuel hazard rating

Assessments of surface and near-surface fuels must be combined together before an Overall Fuel Hazard rating can be determined. The near-surface fuel rating is used to adjust the surface fine fuel hazard rating, according to Table 7.1.

To determine the effect of near-surface fine fuel hazard:

1. Select the **surface fuel hazard rating** from column ❶
2. Select the **near-surface fuel hazard rating** from column ❷
3. Select the resulting **combined rating** value ❸
4. Use this value to determine the Overall Fuel Hazard rating using the Table 8.1.

Table 7.1 Determining the combined surface and near-surface fine fuel hazard rating

❶ Surface fine fuel hazard rating	❷ Near-surface fine fuel hazard rating				
	Low	Moderate	High	Very High	Extreme
	❸ Combined surface and near-surface fine fuel hazard rating				
Low	L	L	M	H	VH
Moderate	M	M	H	VH	E
High	H	VH	VH	VH	E
Very High	VH	VH	E	E	E
Extreme	E	E	E	E	E

8. Determining Overall Fuel Hazard

Overall Fuel Hazard = (sum of the influences of) Bark Hazard + Elevated Fine Fuel Hazard + Combined Surface and Near-surface Fine Fuel Hazard.

The following table is used to combine the assessed levels of Bark, Elevated and Combined Surface and Near-surface Fuel Hazard to give an Overall Fuel Hazard rating.

To determine the Overall Fuel Hazard rating:

1. Select the row that corresponds to the **Bark Hazard** ❶
2. Select the row that corresponds to the **Elevated Fine Fuel Hazard** ❷
3. Select the column that corresponds to the assessed level of **Combined Surface and Near-surface Fine Fuel Hazard** ❸
4. Identify where these two intersect and this will provide you with the corresponding Overall Fuel Hazard rating.

Table 8.1 Determining the Overall Fuel Hazard rating

❶ Bark Hazard	❷ Elevated Fine Fuel Hazard	❸ Combined Surface and Near-surface Fine Fuel Hazard *				
		L	M	H	VH	E
Low or Moderate	L	L	M	M	H	H
	M	L	M	M	H	H
	H	L	M	H	VH	VH
	VH	VH	VH	VH	VH	VH
	E	E	E	E	E	E
High	L	L	M	H	H	H
	M	L	M	H	H	H
	H	L	H	H	VH	VH
	VH	VH	VH	VH	VH	E
	E	E	E	E	E	E
Very High or Extreme	L	L	VH	VH	VH	E
	M	M	VH	VH	E	E
	H	M	VH	E	E	E
	VH	E	E	E	E	E
	E	E	E	E	E	E

* Combined Surface and Near-surface Fine Fuel Hazard is a measure of the Surface Fine Fuel Hazard adjusted to account for the level of near-surface fine fuel (see Table 7.1).

9. Interpreting and applying Overall Fuel Hazard

9.1 Chances of extended first attack success

The chances of extended first attack being successful[1] for a fire ignited in these fuels under the reference extended first attack conditions (Appendix 1) is approximately as follows:

Table 9.1 Chances of extended first attack success

GFDI[2]	FFDI[3]	Overall Fuel Hazard rating[4]				
		Low	Moderate	High	Very High	Extreme
0–2	0–5					
3–7	6–11					
8–20	12–24					
20–49	25–49					
50–74	50–74					
75–99	75–99					
100+	100+					

Chance of extended first attack success is greater than 95% (almost always succeeds)

Chance of extended first attack success is between 95% and 50% (succeeds most of the time)

Chance of extended first attack success is between 49% and 10% (fails most of the time)

Chance of extended first attack success is less than 10% (almost always fails)

Notes:

1. Extended first attack is deemed successful when a fire is controlled by 0800hrs the day after ignition and at less than 400 hectares.
2. GFDI is the Grass Fire Danger Index at the time of ignition and is assumed to be the highest GFDI expected before 0800hrs the next day.
3. FFDI is the Forest Fire Danger Index at the time of ignition and is assumed to be the highest FFDI expected before 0800hrs the next day.
4. Chance of success is for a fire ignited in fuels with this Overall Fuel Hazard rating.
5. Predicted outcomes will differ if the conditions vary from those listed in the reference extended first attack conditions.
6. Predicted outcomes based on expert opinion and informed by work carried out by Wilson (1992b, 1993), McCarthy *et al*. (1998a, 2001) and Plucinski *et al*. (2007).

9.2 Indicative fuel loads (t/ha)

In the absence of local data obtained by sampling fuel loads destructively the following table of indicative fuel load data from Project Vesta and Victorian studies may be useful. These tonnes per hectare figures may be applied to the Forest Fire Danger Meter Mark V (McArthur 1973) for predicting forward rate of spread and flame height for forest fires.

Table 9.2 Indicative fuel loads (t/ha)

Fuel	Fuel hazard rating				
	Low	Moderate	High	Very High	Extreme
Bark	0	1	2	5	7
Elevated	0–1	1–2	2–3	3–5	5–8
Near-surface	1–2	2–3	3–4	4–6	6–8
Surface	2–4	4–10	8–14	12–20	16–20+

9.3 Determining Vesta fuel hazard scores

The following table translates fuel hazard ratings for each fuel layer into Project Vesta fuel hazard scores. These scores can be used with the fire behaviour prediction tables in publications such as Gould *et al*. (2007b).

To determine the Vesta fuel hazard score:

1. Select the row that corresponds to the fuel hazard rating for required fuel layer (1)
2. Select the Vesta fuel hazard score column that corresponds to the same layer (2)
3. Identify where these two intersect and this will provide you with the corresponding Vesta fuel hazard score.

Table 9.3 Determining Vesta fuel hazard scores

	Vesta fuel hazard score (2)			
Fuel hazard rating (1)	**Surface**	**Near-surface**	**Elevated**	**Bark**
Low	1	1	1	0
Moderate	2	2	2	1
High	3	3	3	2
Very High	3.5	3.5	3.5	3
Extreme	4	4	4	4

Notes:

- Surface and near-surface hazard score and near-surface height (cm) is required for fire spread prediction.
- Rate of spread and elevated fuel height (m) is required for flame height prediction.
- Rate of spread, surface and bark fuel hazard scores are required for prediction of spotting distance.

Acknowledgements

This Fuel Hazard Assessment Guide updates and continues to develop work previously conducted by a number of authors. Andrew Wilson laid the foundations for this guide, with the conceptual framework presented in Research Report No. 31; and the visual guides for assessing the influence of bark and elevated fuels on suppression difficulty in the *Eucalypt Bark Hazard Guide and Elevated Fuel Guide* (Reports 32 and 35, respectively). Greg McCarthy (2004) detailed a method for rapidly assessing surface fine fuels in Research Report No. 44.

These three techniques were brought together in the first three editions of the *Overall Fuel Hazard Guide* (McCarthy, Tolhurst and Chatto, 1998b, 1998c, 1999). A subsequent unpublished edition of the guide, produced by Kevin Tolhurst (2005), provided greater detail on the assessment of near-surface fuels. In 2006, Mike Wouters adapted the guide for South Australian conditions, and incorporated the preliminary results from Project Vesta (CSIRO and Department of Conservation and Environment, Western Australia). Further information and results from the final Project Vesta report (Gould *et al.* 2007a) have also been incorporated.

Thanks to Lachie McCaw (Department of Environment and Conservation, Western Australia), Mike Wouters (Department of Environment and Heritage, South Australia), Jim Gould and Miguel Cruz (CSIRO) for their advice and comments during the production of this guide. Thanks must also go to the many other people across Australia who have provided comments and feedback during the production of the guide.

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Appendix 1. Reference extended first attack conditions

This guide assesses the impact of fuels in suppressing a fire during extended first attack, using local resources. Several factors affect the success of an extended first attack. Therefore, to consider the impact of fuels alone, the other factors must be treated as if they were constant. Table A1 below adapted from Wilson (1993) summarises reference extended first attack conditions for four fuel types.

Table A1. Revised reference extended first attack conditions

Fuel type	Forest fuels	Grass fuels	Mallee and scrub fuels	Heath fuels
Examples of typical resources (on scene within the designated arrival time)	Small dozer (D4) 1 to 2 small 4WD tankers (400l) 6 firefighters	5 x 4WD heavy tankers (4000l) each with 5 firefighters	Small dozer (D4) or tractor with scrub roller 1 to 2 small 4WD tankers (400l) 6 firefighters	Small dozer (D4) 1 to 2 small 4WD tankers (400l) 6 firefighters
Extended attack resources	Potential additional resources deployed to the fire during extended first attack may include heavy tankers, large plant (dozers, graders or tractors) and fire bombing aircraft.			
Arrival time	Within 60 minutes of detection			
Suppression workload	A single fire			
Topography and terrain	Burning on level ground with good access			
Fuel availability[1]	MDF is 10 or AFF is 1.0	100% grass curing	MDF is 10 or AFF is 1.0	
Wind speed[2]	20km/h	30km/h		20km/h
Fire danger rating system[3]	McArthur FFDI	McArthur GFDI	McArthur FFDI	

Notes:

1. MDF (McArthur Drought Factor) is calculated using the Forest Fire Danger Meter (McArthur 1973) and is a measure of the short-term availability of forest fuels. AFF (Available Fuel Factor) is used in Western Australia to define the proportion of litter fuel available for burning (Sneeuwjagt & Peet 1998).
2. Wind speed is measured at 10m height in the open above ground level.
3. FFDI is the McArthur Forest Fire Danger Index, GFDI is the McArthur Grass Fire Danger Index.

The rationale for the reference first attack conditions is documented in DSE's *Overall fuel hazard assessment guide: a rationale report – fire and adaptive management report no. 83* (in prep).

Appendix 2. Sample fuel assessment field work form v3

Date Assessed:	Assessors:
Sampling Location:	Veg Type:

Plot Information			
Plot No.			
Zone:			
Easting (GDA94 MGA UTM):			
Northing (GDA94 MGA UTM):			

Canopy height (Assess over a 20m radius)			
Average Height to Top of Canopy:	m	m	m
Average Height to Base of Canopy:	m	m	m

Bark fuel (Assess over a 20m radius)															
Stringybark Fuel Hazard:	NP	M	H	VH	E	NP	M	H	VH	E	NP	M	H	VH	E
Ribbon Bark Fuel Hazard:	NP	M	H	VH		NP	M	H	VH		NP	M	H	VH	
Other Bark Fuel Hazard:	L	M	H			L	M	H			L	M	H		

Select the Bark Hazard rating from above that will be used to determine Overall Fuel Hazard. (Only use the Stringybark hazard rating if more than 10% of the trees are Stringybark **AND** it has the highest rating. Otherwise use the bark with next highest rating.)

Bark Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Elevated fuel layer (Assess over a 10m radius)															
Elevated % Cover:	%					%					%				
Elevated % Dead	%					%					%				
Elevated Fuel Ave Height (m)	m					m					m				
Elevated Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Near-surface fuel layer (Assess over a 10m radius)															
Near-surface % Cover:	%					%					%				
Near-surface % Dead	%					%					%				
NS Average Height (cm):	cm					cm					cm				
NS Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

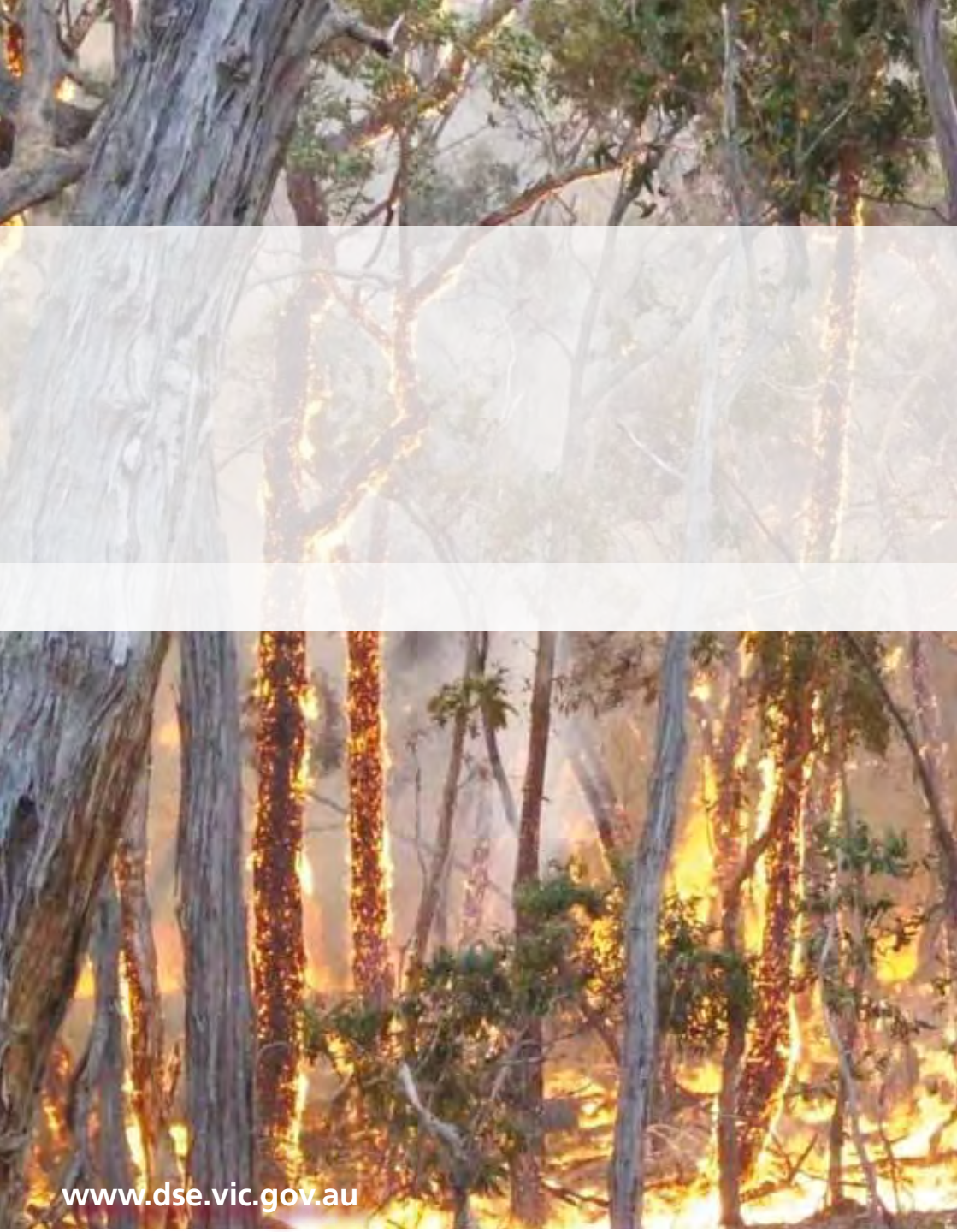
Surface fuel layer (Assess over a 10m radius)															
Surface Litter % Cover:	%					%					%				
Average Litter Depth (mm):	mm					mm					mm				
Surface Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Combined Surface and Near-surface Fine Fuel Hazard calculation (refer Section 7)															
Combined Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Overall Fuel Hazard calculation (refer Section 8)															
Overall Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Are the plots representative of the average fuels across the sampling location?	Yes	No

If no, explain any significant difference between plots. For example, wet gully runs through the sampling area, no plots were located in this gully.



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Appendix 2. Sample fuel assessment field work form V3

Date Assessed:	Assessors:
Sampling Location:	Veg Type:

Plot Information			
Plot No.			
Zone:			
Easting (GDA94 MGA UTM):			
Northing (GDA94 MGA UTM):			

Canopy Height (Assess over a 20m radius)			
Ave Hgt to Top of Canopy:	m	m	m
Ave Hgt to Base of Canopy:	m	m	m

Bark fuel (Assess over a 20m radius.) (Note: NP is bark type not present.)															
Stringybark Fuel Hazard:	NP	M	H	VH	E	NP	M	H	VH	E	NP	M	H	VH	E
Ribbon Bark Fuel Hazard:	NP	M	H	VH		NP	M	H	VH		NP	M	H	VH	
Other Bark Fuel Hazard:	L	M	H			L	M	H			L	M	H		

Select the Bark Hazard rating from above that will be used to determine Overall Fuel Hazard. (Only use the Stringybark hazard rating if more than 10% of the trees are Stringybark **AND** it has the highest rating. Otherwise use the bark with next highest rating.)

Bark Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Elevated fuel layer (Assess over a 10m radius)															
Elevated % Cover:	%					%					%				
Elevated % Dead	%					%					%				
Elevated Fuel Ave Height (m)	m					m					m				
Elevated Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Near-surface fuel layer (Assess over a 10m radius)															
Near-surface % Cover:	%					%					%				
Near-surface % Dead	%					%					%				
NS Average Height (cm):	cm					cm					cm				
NS Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Surface fuel layer (Assess over a 10m radius)															
Surface Litter % Cover:	%					%					%				
Average Litter Depth (mm):	mm					mm					mm				
Surface Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Combined Surface and Near-surface Fine Fuel Hazard calculation (refer Section 7)															
Combined Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Overall Fuel Hazard calculation (refer Section 8)															
Overall Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Are the plots representative of the average fuels across the sampling location?	Yes	No

If no, explain any significant difference between plots. For example, wet gully runs through the sampling area, no plots were located in this gully.

APPENDIX E DEE GUIDANCE ON NEW OR INCREASED IMPACT

Australian Government
Department of the Environment and Energy

Guidance on 'new or increased impact' relating to changes to approved management plans under EPBC Act environmental approvals

Introduction

Environmental approvals under Part 9 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) may contain an approval condition which uses the reference 'new or increased impact' in relation to revisions to approved management plans. This condition, referred to in this document as the Revised Management Plan condition, allows revised plans to be implemented without approval by the Minister, provided that the proposed changes are unlikely to have a new or increased impact on matters protected under the approval.

The aim of this guidance is to assist approval holders and officers of the Department of the Environment and Energy in determining whether or not a change is likely to have a 'new or increased impact' on a protected matter.

Background

Many EPBC Act Part 9 approvals include conditions for management plans, strategies or programs to be implemented, and usually these documents must be submitted for approval by the Minister prior to implementation. For the purposes of this guidance, such documents are referred to collectively as 'plans'.

From late 2015, the Revised Management Plan condition was included in new approvals where appropriate. The Revised Management Plan condition has also been retrospectively added to many projects with an existing EPBC Act approval through formal variations to conditions.

Comparing plans

In considering whether a revised plan is likely to have a 'new or increased impact', a comparison is made between the requirements of the revised plan and the last plan that was formally approved by the Minister. In other words, all deviations (including incremental or cumulative changes) from the last plan formally approved by the Minister must be considered when making a decision on whether there is a new or increased impact. It is the approval holder's responsibility to implement effective version control for plans.

New or increased impact

A 'new or increased impact' includes any direct or indirect increase in the impacts of an action, an increase to the risk of an impact occurring, a reduction to the monitoring or mitigation measures for a protected matter, or a change to the nature or management of an environmental offset.

Photo: A semi-arid landscape in South Australia. Photo copyright Nick Rains.

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What is a new impact?

A 'new impact' may be caused by a change to an activity or a change to circumstances surrounding the activity, and can include:

- new activities that may impact on protected matters
- any change to an activity that creates a new potential impact to a protected matter
- an impact to a protected matter that was not previously foreseen.

It should be noted that in some cases, a new activity may also require a formal variation to approval conditions (under section 143 of the EPBC Act); or may be beyond the scope of an approved action and therefore require separate EPBC Act approval.

What is an increased impact?

A change to a plan may result in an increase to an existing impact, and can include:

- an increase in the scale, intensity or duration of impacts
- an increase in the likelihood or consequences of an impact occurring
- a change to a measure designed to avoid, mitigate or offset an impact
- a reduced capacity to identify or measure an impact
- any other change that increases the risks or uncertainty associated with an impact.

Examples of a new or increased impact

The following changes to a plan would be **likely** to result in a new or increased impact:

- changing a plan to address different project stages
- increasing the amount of habitat for a listed threatened species that will be cleared
- a change in a measure designed to mitigate the impacts of an action on a RAMSAR wetland
- a delay to the start of an environmental offset
- a change in the timing of construction to when a listed migratory species is more likely to be present
- a reduction in the frequency of monitoring.

What is unlikely to be a new or increased impact?

Changes unlikely to be a new or increased impact include:

- changes to the structure or layout of a plan or other administrative changes that are unrelated to environmental impacts or risks
- a change to a plan which does not affect EPBC Act protected matters
- a clear improvement that avoids, mitigates or offsets environmental impacts.

Who decides whether a revised plan is likely to have a 'new or increased impact'?

The approval holder decides if a revision to a plan is likely to result in a new or increased impact.

If, after considering this guidance, approval holders are unsure whether a proposed revision to a plan is likely to result in a new or increased impact, they may request advice from the Department.

If the Minister disagrees with the approval holder's assessment that the revised plan is unlikely to result in a new or increased impact, the Minister may require implementation of the previously approved plan. In order to reduce the likelihood of the Minister making this decision, the approval holder should contact the Department for advice if they have any doubt about whether a change is likely to result in a new or increased impact.

How does an approval holder submit a revised plan to the Department?

All revised plans under the Revised Management Plan condition should be submitted to the Department. When submitting a revised plan, the approval holder should include a document clearly explaining the revisions (including a 'tracked changes' version of the plan and/or a table detailing the changes) and the reasons why they believe that the revisions will not have a new or increased impact. Approval holders should be mindful of their obligations under the conditions of the project in terms of whether they are also required to publish the revised version of the plan.

Option to submit a revised plan to the Minister for approval

Nothing in the Revised Management Plan condition prevents an approval holder from submitting a revised management plan to the Minister for formal approval under section 143A of the EPBC Act at any time.

Advice and further Information

Approval holders may request advice relating to the matters described in this document by emailing: post.approvals@environment.gov.au.