COMPLIANCE REPORT

EPBC 2011/6228

Mount Emerald Wind Farm

April 2019

MEWF

RATCH-Australia Corporation

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DOCUMENT STATUS

Version	Purpose of Document	Author	Review	Date
1	EPBC - Annual Compliance Report	T Johannesen	R Kuypers	17-4-2019

APPROVAL FOR ISSUE

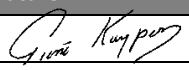
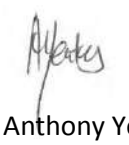
Name	Signature	Date
Rene Kuypers		17-4-2019

TABLE OF CONTENTS

ATTACHMENTS

1. DECLARATION OF ACCURACY

In making this declaration, I am aware that sections 490 and 491 of the Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this compliance report is true and correct in every particular. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed:	
Full name (please print):	Anthony Yeates
Position (please print):	Director
Organisation (please print including ABN/ACN if applicable):	Mount Emerald Wind Farm Pty Ltd ACN – 149 050 322 ABN – 19 149 050 322
Date:	24 April 2019

2. PROJECT DESCRIPTION

The Mount Emerald wind farm site is a large rural allotment (Lot 7 SP235224) comprising some 2,422ha. It is located approximately 3.5km south-west of Walkamin, off Springmount Road at Arriga on the Atherton Tablelands. Topographically, the site is situated at the northern most end of the Herberton Range (part of the Great Dividing Range) with the north-western section of the site being dominated by Walsh's Bluff.

The site is characterised by rugged terrain with elevations of between 540m up to 1089m ASL (above sea level). The town centre of Mareeba is situated approximately 18km to the north of the site, with the town of Atherton approximately 12km south-east of the site.

Other features of the site include a series of ephemeral drainage lines, including the headwaters of Granite Creek. An established 275kV transmission line (Powerlink: Chalumbin-Woree) and its associated easement traverses the site in an east-west direction, broadly bisecting it.

3. PROJECT ACTIVITY STATUS

The project involves a range of activities needed to be conducted through the construction, commissioning and operation phases.

The project commenced construction on the 7th February 2017.

At the anniversary of this date (2 years) the construction is predominantly complete with only minor works being undertaken to finalise civil works.

On the 22nd February 2019, a notice of Commencement of Operation was issued under the terms of the construction contract, as such the wind farm is now considered to be currently in the "Operation" phase.

Key activities and their status as at the anniversary of this date are shown in the Table below.

Activity	Description	Start Date	End Date	% Complete
Civil Works	Works necessary to construct; • main access road from site entry • access roads from main access road to the various infrastructure locations • the cleared work areas to allow installation, adjacent to each of the wind turbine locations • wind turbine foundations	7-02-2017	17-06-2019	95%
Electrical Works	Works necessary to construct; • Powerlink Substation • Wind Farm Substation including all foundations, cabling and infrastructure necessary for connection of the wind farm underground HV reticulation to the Powerlink Substation • Installation of underground electrical cabling which connects each wind turbine to the WF Substation	18-03-2017	29-09-2018	100%
Component Delivery	Delivery from Port to the wind farm site for the wind turbine components – tower	29-05-2017	13-09-2018	100%

Activity	Description	Start Date	End Date	% Complete
	sections, nacelle, blades, rotor, nose cone, transformer and controls			
WTG Installation	Installation and erection of the wind turbines on the foundation	24-10-2017	1-12-2018	100%
WTG Commissioning	Preparation and testing of each completed wind turbine to ensure it is mechanically and electrically sound and in full operational order	9-06-2018	18-12-2018	100%
Wind Farm Commissioning	Testing of full wind farm including control systems and interfaces with electricity grid network.	16-08-2018	18-12-2018	100%
Commencement of Operations	Wind Farm Operational	22-02-2019		

4. COMPLIANCE TABLE

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
General				
1	The action is limited to the construction of a maximum of 63 wind turbines and associated infrastructure on the wind farm site	Max. 63 WTG	COMPLIANT	For Construction layout comprises 53 WTG. As verified by TLDFP. (Attachment A)
2	To minimise impacts to EPBC Act listed threatened species, the approval holder must not disturb more than 78 ha of habitat for EPBC Act listed threatened species on the wind farm site	Max. 78ha of disturbed area	COMPLIANT	Ground Disturbance Tracking. (Attachment B)
3	Prior to commencement of the action, the approval holder must submit a Turbine Location and Development Footprint Plan identifying the final position of all proposed turbines, access roads and associated operational and maintenance infrastructure, for the written approval of the Minister	Turbine Location and Development Footprint Plan (TLDFP)	COMPLIANT	Approval received 18/1/17. (Previously supplied in 2018 Year 1 Compliance Report - Attachment C) TLDFP sent to DOEE 13/01/2017 TLDFP (Attachment A)
4	The Turbine Location and Development Footprint Plan must demonstrate how the approval holder has avoided and minimised disturbance to denning habitat for the Northern Quoll (Dasyurus hallucatus) and to *Grevillea glossadenia* and *Homoranthus porteri*.	Turbine Location and Development Footprint Plan (TLDFP)	COMPLIANT	Approval received 18/1/2017 (Previously supplied in 2018 Year 1 Compliance Report - Attachment C) Documents sent to DOEE 13/01/2017 TLDFP shows locations of plant species (Attachment A) Refer to Design Justification Report (Previously supplied in 2018 Year 1 Compliance Report - Attachment D)
5	The approval holder must not commence the action until the Turbine Location and Development Footprint Plan has been approved by the Minister in writing.	Minister Sign-off	COMPLIANT	Approval of TLDFP received 18/1/2017. (Previously supplied in 2018 Year 1 Compliance Report - Attachment C) Date of Commencement 7/2/2017.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
6	The Turbine Location and Development Footprint Plan must be implemented	Turbine Location and Development Footprint Plan (TLDFP)	COMPLIANT	Construction is occurring in-line with TLDFP
Northern Quoll Management				
7	For the protection of the Northern Quoll, the approval holder must maintain a viable population of Northern Quoll on the wind farm site.	Northern Quoll population ~50		Current estimate of population remains as per previous study.
8	The approval holder must prepare and submit an Outcomes Strategy for the Minister's written approval which describes a monitoring program to inform adaptive management and determine whether the outcome required under condition 7 is being or has been met. The Outcomes Strategy must: (a) be prepared by a suitably qualified expert; (b) identify and justify performance measures, which are capable of accurate and reliable measurement, and will be used to measure the outcome required under condition 7; (c) include a monitoring program, to detect changes in the performance measures. The monitoring must include baseline surveys, control sites and experimental design (to test the effectiveness of different management measures); and (d) describe how the baseline and monitoring data will be adequate to: inform adaptive management; enable an objective decision to be made on whether the outcome described in condition 7 has been met.	Northern Quoll Outcomes Strategy (NQOS)	COMPLIANT	Approval received 23/12/16. (Previously supplied in 2018 Year 1 Compliance Report - Attachment F) NQOS submitted 7/12/2016. (Previously supplied in 2018 Year 1 Compliance Report - Attachment E)
9	The approval holder must not commence construction until the Minister has approved the Outcomes Strategy in writing.	Minister Sign-off	COMPLIANT	Approval received 23/12/2016 (Previously supplied in 2018 Year 1 Compliance Report - Attachment F)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
10	The approved Outcomes Strategy must be implemented.		COMPLIANT	All Survey Results have been posted to Project WEBSITE. ***www.mtemeraldwindfarm.com.au/compliance/*** QOS Survey Results (Attachment C)
11	If the Minister is not satisfied that either the outcomes required under condition 7 are likely to be achieved, or there is insufficient evidence that the outcomes required under condition 7 are being achieved, the Minister may (in writing) require the approval holder to submit a plan for the Minister's approval to reduce, mitigate, remediate, or offset impacts to matters protected under the controlling provisions of this approval within a designated timeframe. The Minister may require the plan be prepared or reviewed by a suitably qualified person or another person specified or agreed to by the Minister. If the Minister approves the plan then the approved plan must be implemented.	Northern Quoll Mitigation Plan	NOT APPLICABLE	Not required at this time.
Bare-rumped Sheathtail Bat and Spectacled Flying-fox Management				
12	Prior to commissioning, the approval holder must evaluate the effectiveness of suitable measures, including changed cut-in speed, avian radar system and SCADA system, to avoid and mitigate the impacts of turbine collision to Spectacled Flying-fox (*Pteropus conspicillatus*) and Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) on the wind farm site.	Evaluation of Potential Measures to Reduce Turbine Collision	COMPLIANT	Email from DoEE confirming requirements met - 2/6/2017 (Previously supplied in 2018 Year 1 Compliance Report - Attachment G) Report provided to DoEE 5/5/2017. (Previously supplied in 2018 Year 1 Compliance Report - Attachment H)
13	Prior to commissioning, the approval holder must submit to the Minister for written approval, a Wind Farm Implementation Plan that is informed by the results of the evaluation required by condition 12. The Wind Farm Implementation Plan must include: (a) details of intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare-rumped Sheathtail	Wind Farm Implementation Plan (WFIP)	COMPLIANT	WFIP approved 4/05/2018 (Attachment D) Final WFIP submitted to DoEE 24/4/2018. (Attachment E)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
	Bat which are based on information contained in relevant guidance material including; - *Matters of National Environmental Significance: Significant Impact Guidelines 1.1 Environmental Protection and Biodiversity Conservation Act 1999 (2013);* - *EPBC Act Policy Statement 2.3 Wind Farm Industry (2009); and* - *Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (2015).* (aa) a program to implement a *Low Windspeed Curtailment Study*; (b) a program to monitor the effectiveness of progress against performance criteria; and (c) contingency measures and corrective actions that will be implemented if performance criteria are not being or are not likely to be met.			
14	The Wind Farm Implementation Plan must be reviewed by a suitably qualified expert prior to submission to the Minister for approval. The Wind Farm Implementation Plan must include the findings of the review undertaken by the suitably qualified expert and details of how any recommendations made by the suitably qualified expert have been addressed.	Wind Farm Implementation Plan Review (WFIP)	COMPLIANT	WFIP approved 4/5/2018 (Attachment D)
15	The approval holder must not commission the wind farm until the Wind Farm Implementation Plan has been approved by the Minister in writing.	Minister Sign-off	COMPLIANT	WFIP approved 4/5/2018 (Attachment D)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
16	The approved Wind Farm Implementation Plan must be implemented.		IN PROGRESS	Environmental consultant engaged to undertake the activities as per WFIP
17	Upon the direction of the Minister, the approval holder must cease to operate any specified wind turbine generator/s if the Minister considers that, based on compliance reporting required by condition 26, they are having an impact on Bare-rumped Sheathtail Bat and Spectacled Flying-fox greater than the performance criteria required by condition 13(a) that cannot be mitigated or compensated.	Operational Strategy		
Offsets				
18	To compensate for residual significant impacts to EPBC Act listed threatened species, the approval holder must provide environmental offsets that comply with the principles of the EPBC Act Environmental Offsets Policy.	Offset Area Management Plan (OAMP)	COMPLIANT	Approval of OAMP provided 20/12/2016 (Previously supplied in 2018 Year 1 Compliance Report - Attachment K) Response and final OAMP submitted 16/12/2016. (Previously supplied in 2018 Year 1 Compliance Report - Attachment J)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
19	The approval holder must prepare and submit an Offset Management Plan to the Minister for approval in writing . The Offset Management Plan must include: (a) details of the minimum offset areas proposed to compensate for the loss of habitat for EPBC Act listed threatened species from the wind farm site, (b) information about how the offset area/s provide connectivity with other relevant habitats and biodiversity corridors, including a map depicting the offset areas in relation to other habitats and biodiversity corridors; (c) a description of the management measures that will be implemented on the offset site for the protection and management of habitat for EPBC Act listed threatened species, including a discussion of how measures proposed are consistent with the measures in conservation advice, recovery plans and relevant threat abatement plans; (d) performance and completion criteria for evaluating the management of the offset area/s, and criteria for triggering remedial action (if necessary); (e) a program, including timelines to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria; (f) a description of potential risks to the successful implementation of the plan, and a description of the contingency measures that would be implemented to mitigate against these risks; (g) the proposed legal mechanism and timelines for securing the offset/s; and (h) a textual description and map to clearly define the location and boundaries of the offset area. This must be accompanied with the offset attributes and a shapefile.	Offset Area Management Plan (OAMP)	COMPLIANT	Approval of OAMP provided 20/12/2016 (Previously supplied in 2018 Year 1 Compliance Report - Attachment K) Response and final OAMP submitted 16/12/2016. (Previously supplied in 2018 Year 1 Compliance Report - Attachment J)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
20	The approval holder must not commence construction until the Offset Management Plan has been approved by the Minister in writing.	Minister Sign-off	COMPLIANT	Approval of OAMP provided 20/12/2016 (Previously supplied in 2018 Year 1 Compliance Report - Attachment K)
21	The approved Offset Management Plan must be implemented		COMPLIANT	2017 Monitoring Report submitted 17/04/2018 (Attachment F) 2018 Monitoring Report submitted 6/12/2018 (Attachment G)
Administrative Conditions				
22	To avoid duplication, the approval holder may provide the Minister with plans and strategies prepared for the State and/or an Authority provided the plans, and/or strategies meets the conditions specified in this approval. The plans and/or strategies must include a cross reference table that clearly identifies: (a) the condition specified in the approval for which the plan or strategy is being provided; and (b) the relevant folder, chapter, section number and page number in the plan or strategy where the condition has been addressed.		NOT APPLICABLE	Plans and Strategies have been provided to directly address conditions of this approval.
23	Within 10 business days after the commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement.	Notification of Commencement of Construction	COMPLIANT	Date of Commencement 7 February 2017. Notice provided 13/2/2017 (Previously supplied in 2018 Year 1 Compliance Report - Attachment L) and acknowledged. (Previously supplied in 2018 Year 1 Compliance Report - Attachment M)

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
24	The approval holder must maintain a dedicated webpage on compliance with these conditions that is publically available on the approval holder's website for the life of the approval. The webpage must include: • a copy of the approval conditions (and any subsequent variations or other formal changes to the approval); • all monitoring results and • documentation required under these conditions and any other relevant information as directed by the Minister in writing. Unless otherwise agreed to in writing by the Minister, the approval holder must provide a copy of documents required to be published on the dedicated webpage to members of the public upon request, within a reasonable time of the request.	Website	COMPLIANT	EPBC Decision Notice and Conditions placed on website. **www.mtemeraldwindfarm.com.au/compliance/**
25	The approval holder must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement any plans and strategies required by this approval and measures taken to achieve the outcomes specified in conditions 7 and 13 and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.	File management		

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
26	Within three months of every 12 month anniversary of the commencement of the action, the approval holder must publish a report on the webpage required in condition 24 addressing compliance with each of the conditions of this approval, including implementation of any plans and strategies as specified in these conditions and whether the outcome required by conditions 7 and 13 have been or are track to being met. The compliance report must consider the Department's Annual Compliance Report Guidelines. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published.	EIS Compliance Report	COMPLIANT	Date of Commencement 7 February 2017. 2018 Year 1 Compliance Report – issued 13 April 2018.
27	The approval holder must report any contravention of the conditions of this approval to the Department within 2 business days of the approval holder becoming aware of the contravention.	Notification of Contravention	COMPLIANT	No contravention identified.
28	Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The audit must not commence until the Minister has approved the independent auditor and audit criteria. The audit report must address the criteria to the satisfaction of the Minister.	Independent Audit	NOT APPLICABLE	No direction from Minister at this time.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
29	The approval holder may choose to revise a plan or strategy approved by the Minister under conditions 3, 8, 13 and 19 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan or strategy would not be likely to have a new or increased impact. If the approval holder makes this choice they must: (a) notify the Department in writing that the approved plan or strategy has been revised and provide the Department with an electronic copy of the revised plan or strategy; (b) implement the revised plan or strategy from the date that the plan or strategy is submitted to the Department; and (c) 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 or strategy would not be likely to have a new or increased impact.	Revised Plans: #3 - Turbine Location and Development Footprint Plan #8 - Northern Quoll Outcomes Strategy #13 - Wind Farm Implementation Plan #19 - Offset Area Management Plan	NOT APPLICABLE	TLDFP submitted 13/1/2017; approved 18/1/2017 TLDFP as-built (Attachment A) NQOS submitted 7/12/2016; approved 23/12/2016 WFIP submitted 24/4/2018; approved 4/5/2018 OAMP submitted 16/12/2016; approved 20/12/2016
30	The approval holder may revoke its choice under condition 29 at any time by notice to the Department. If the approval holder revokes the choice to implement a revised plan without approval under section 143A of the Act, the approval holder must implement the version of the plan most recently approved by the Minister.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
31	Condition 29 does not apply if the revisions to the approved plan or strategy include changes to environmental offsets provided under the plan or strategy in relation to a matter protected by a controlling provision for the action, unless otherwise agreed in writing by the Minister. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan or strategy would, or would not, be likely to have new or increased impacts.	Revised Plans	NOT APPLICABLE	No revisions made at this time.

No.	CONDITION	DELIVERABLE	DESIGNATION	CURRENT STATUS
32	If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then: (a) condition 29 does not apply, or ceases to apply, in relation to the revised plan; and (b) the approval holder must implement the version of the plan most recently approved by the Minister. To avoid any doubt, this condition does not affect any operation of conditions 29 and 30 in the period before the day after the notice is given.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
33	At the time of giving a notice under condition 32, the Minister may also notify that for a specified period of time condition 29 does not apply for one or more specified plans required under the approval.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
34	Conditions 29, 30, 31 and 32 are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised plan to the Minister for approval.	Revised Plans	NOT APPLICABLE	No revisions made at this time.
35	If, at any time after five years from the date of this approval, the approval holder has not substantially commenced the action, then the approval holder must not commence the action without the written agreement of the Minister.	Drop Dead Date - 26 November 2020	COMPLIANT	Refer to Condition 23.

A. TURBINE LOCATION AND DEVELOPMENT FOOTPRINT PLAN

LEGEND

- EXISTING 5m CONTOUR (DRONE SURVEY 06.12.16)
- T01 — PROPOSED TURBINE LOCATION - V117
  V117 HUB HEIGHT = 90m
  V117 ROTOR DIAMETER = 117m
  V117 TIP HEIGHT = 148.5m
- T42 — PROPOSED TURBINE LOCATION - V112
  V112 HUB HEIGHT = 84m
  V112 ROTOR DIAMETER = 112m
  V112 TIP HEIGHT = 140m
- PROPOSED WIND FARM ROAD
- EXISTING ROAD
- NEW STORMWATER CULVERT & HEADWALL (TYPICALLY ROUNDEL STILCOR 2mm U.N.O.)
- H1 — HEADWALL TYPE
  REFER DETAILS SHEET 0404
- EXISTING OVERHEAD ELECTRICAL
- DENOTES POWERLINK TOWER & 30m ZONE FROM CENTRE (COORDINATES RECEIVED 25.11.16)
- ORIGINAL UXO BOUNDARY (SUBSTANTIAL)
- ORIGINAL UXO BOUNDARY (SLIGHT)
- WORKS BOUNDARY
- EXCLUDED ZONE BOUNDARY
- INDICATIVE WATERCOURSE
- UPDATED UXO BOUNDARY (RECEIVED CATCON 18.07.2017)
- UNDERGROUND AS BUILT U/G CABLES - 20180808
- MET MASTS - REFER TABLE
- MEWF SUBSTATION
- POWERLINK SUBSTATION
- AREA TO BE AVOIDED (FUTURE SUBSTATION)
- CONSTRUCTION COMPOUNDS
- OPERATIONS AND MAINTENANCE BUILDING

SIGNIFICANT PLANTS

- GREVILLEA GLOSSADENIA
- HOMORANTHUS PORTERI
- PLECTRANTHUS AMOENUS
- MELALEUCA UXORUM
- PROSTANTHERA CLOTTENIANA
- ACACIA PURPUREOPETALA

NOTE: SIGNIFICANT PLANT SURVEY COORDINATES RECEIVED 25.11.2016

NOTES:

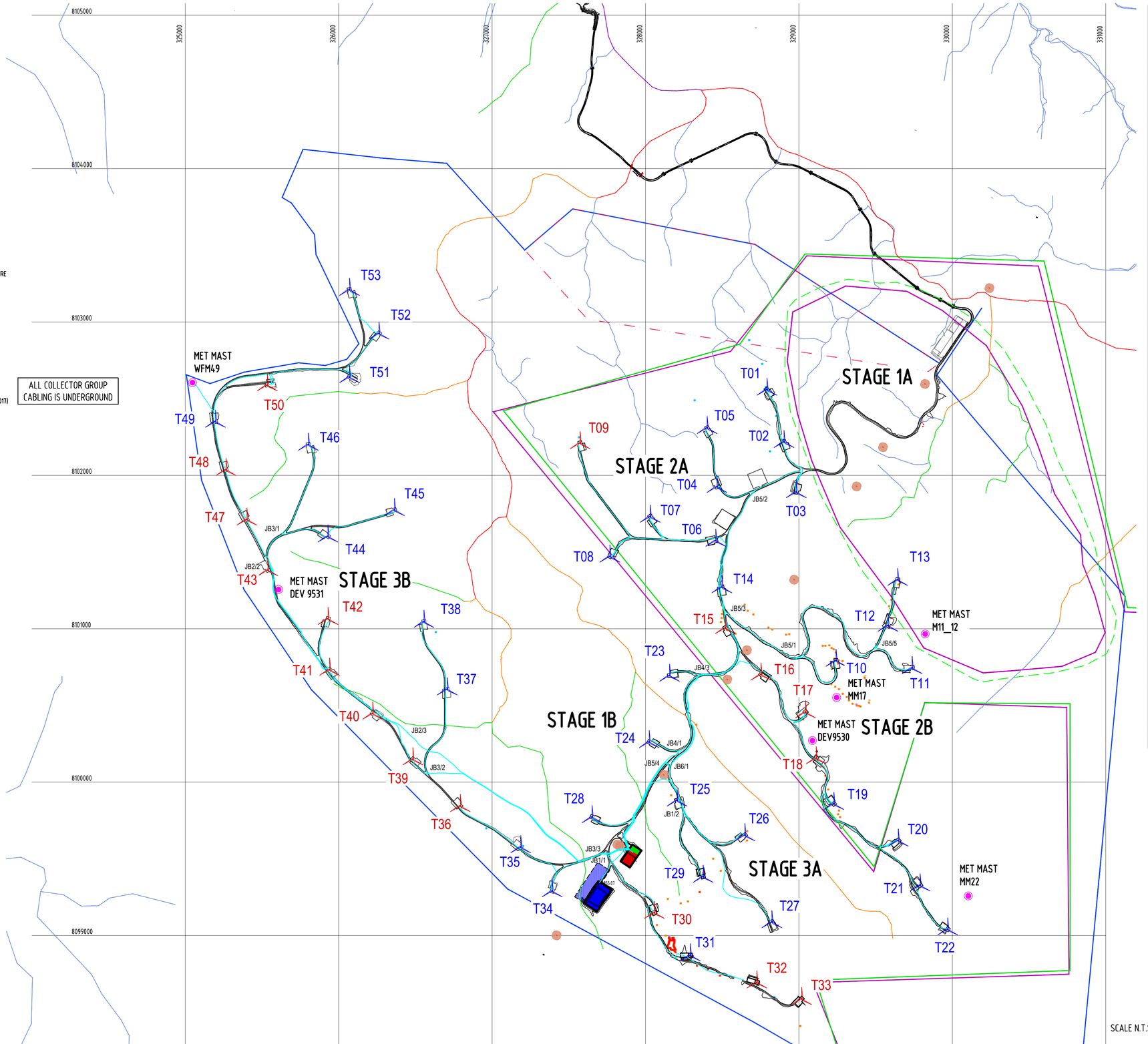
1. DRAWING HORIZONTAL DATUM IS GDA94, MGA ZONE 55.
2. ALL LEVELS ARE TO AHD (m).

RPEQ Certification:

WALLBRIDGE GILBERT AZTEC
MR DAMIEN BYRNE
RPEQ 19028
08 8223 7433

Signature: .....

Date: 14 / 08 / 2018



MEWF TURBINE CO-ORDINATES - AS CONSTRUCTED

TURBINE ID	EASTING	NORTHING	RL. (m)	HUB HEIGHT (m)	BLADE DIAMETER (m)	BLADE TIP RL. (m)
T01	328791.918	8102559.956	819.538	90	117	968.038
T02	328903.02	8102218.99	810.97	90	117	959.47
T03	328982.94	8101892	803.23	90	117	951.73
T04	328466	8101925.98	821.05	90	117	969.55
T05	328402.06	8102310.2	807.45	90	117	955.95
T06	328458	8101575	834.14	90	117	982.64
T07	328030.99	8101732	832.99	90	117	981.49
T08	327768	8101472	808.59	90	117	957.09
T09	327574.03	8102210.99	841.3	84	112	981.3
T10	329242.03	8100793.01	856.63	90	117	1005.13
T11	329739.526	8100745.116	839.592	90	117	988.092
T12	329581.612	8101020.402	806.575	90	117	955.075
T13	329643.489	8101320.753	808.758	90	117	957.258
T14	328498.13	8101272.17	843.86	90	117	992.36
T15	328520.64	8101005.69	869.68	84	112	1009.68
T16	328752.63	8100703.01	879.18	84	112	1019.18
T17	329043.55	8100459.46	927.54	84	112	1067.54
T18	329114.864	8100157.452	911.2	84	112	1051.2
T19	329228.402	8099858.861	891.904	90	117	1040.404
T20	329646.856	8099620.572	879.38	90	117	1027.88
T21	329775.511	8099321.975	907.447	90	117	1055.947
T22	329970.19	8099040.832	881.258	90	117	1029.758
T23	328157.03	8100695	809.98	90	117	958.48
T24	328024.27	8100261.99	818.73	90	117	967.23
T25	328206.01	8099881.01	848.49	90	117	996.99
T26	328648	8099654.94	849.16	90	117	997.66
T27	328823.794	8099088.239	910.989	90	117	1059.489
T28	327652	8099773.03	853.7	90	117	1002.2
T29	328376.791	8099384.729	900.43	90	117	1048.93
T30	328056.328	8099148.829	925.236	84	112	1065.236
T31	328216.616	8098849.896	971.475	90	117	1119.975
T32	328646.934	8098717.192	1003.157	90	117	1151.657
T33	329017.99	8098586.999	1037.91	84	112	1177.91
T34	327391.98	8099290.05	858.62	90	117	1007.12
T35	327186.96	8099577.02	868.71	90	117	1017.21
T36	326792.98	8099844.98	845.63	84	112	985.63
T37	326707.95	8100605.99	831.64	90	117	980.14
T38	326556	8101045.99	822.71	90	117	971.21
T39	326484.02	8100149.97	844.77	84	112	984.77
T40	326222.01	8100448	849.69	84	112	989.69
T41	325941.03	8100734.01	869.25	84	112	1009.25
T42	325931.253	8101065.024	889.487	84	112	1029.487
T43	325538.97	8101383.06	858.39	84	112	998.39
T44	325929.98	8101603.01	853.46	90	117	1001.96
T45	326363.99	8101774.97	850.76	90	117	999.26
T46	325803	8102201.03	818.53	90	117	967.03
T47	325402.06	8101713.01	844.41	84	112	984.41
T48	325265.98	8102037.02	841.38	84	112	981.38
T49	325187.002	8102349.553	826.854	90	117	975.354
T50	325535.368	8102587.252	804	84	112	944
T51	326072.142	8102642.225	785.052	90	117	933.552
T52	326263.451	8102926.372	794.678	90	117	943.178
T53	326070.987	8103211.006	801.75	90	117	950.25

MEWF MET MAST LOCATIONS

MAST ID	EASTING	NORTHING
WFM49	325047	8102605
MM11_12	329828	8100964.696
MM17	329246	8100552
MM22	330111.0001	8099256.357
DEV9530	329088	8100271
DEV9531	325608	8101256

INFORMATION ISSUE
NOT FOR CONSTRUCTION

SCALE N.T.S.

REV	DETAIL OF REVISION	RVD	CHKD	APP'D	CLIENT	DATE
A	INFORMATION ISSUE	TSM	DB			14.08.18

REFERENCE DRAWING | DRAWING No.

WALLBRIDGE & GILBERT Consulting Engineers | MEWF | catcon civil & allied technical construction | Vestas | CONSOLIDATED POWER PROJECTS

DRAWN	TSM	DATE	09.08.18
CHECKED	DB	DATE	14.08.18
APPROVED	RPEQ No. 19028	DATE	14.08.18
CONTRACTOR PROJ. No.	WAD141161		

PROJECT: MT EMERALD WIND FARM
TITLE: CIVIL WORKS
MEWF AS-BUILT WIND FARM LAYOUT
SCALE: AS SHOWN | A1 | DRAWING No.: MEWF-CI-DR | SHT: 0003 | REV: A

DO NOT SCALE DRAWINGS FOR WORKING DIMENSIONS

B. DISTURBANCE AREA TRACKING

LOCATION/SECTION	AREA (ha)
WTG 53	4,494.5
AR 52-53	6,678.0
WTG 52	3,848.2
WTG 51 + AR 51-52	15,000.0
AR 50-51	7,825.0
WTG 50	6,078.0
WTG 37, 38, 39, 40, 41, 42, 43, 44, 46, 47, 48, 49 + Access roads	143,925.8
AR 44-45	7,270.0
AR 40-41	5,307.0
WTG 45	3,266.0
WTG 35, 36 + AR 35-39	29,285.0
AR 28-34-35	13,378.0
WTG 34	3,974.0
AR F-28, WTG 14, 15, 23, 24, 28	80,066.0
WTG 6 + AR 6-7-8	16,485.0
WTG 7	3,392.0
WTG 8	3,751.0
AR 8-9	10,421.8
WTG 9	3,122.0
WTG 5 + AR 4-5	5,457.0
WTG 4	3,720.0
AR 4 - MSR	3,954.0
MSR E-100X100	3,920.0
WTG 3 + AR 3	4,855.0
WTG 1, 2 and AR 1-2	15,222.0
WTG 16	5,130.0
AR H-16	3,409.0
WTG 17 + AR 17	7,313.0
WTG 18, 19 + AR 18-19	21,765.0
WTG 20	7,616.0
WTG 21 + AR 20-21	12,210.0
WTG 22	4,850.0
WTG 10	4,122.0
WTG 11	4,668.0
WTG 12, 13 + AR 12-13	12,012.0
WTG 25	3,188.0
WTG 26 + AR 26	7,560.0
AR I-25-26-29	14,804.0
WTG 27	5,240.0
WTG 29	3,073.0
WTG 31	4,731.0
WTG 32	4,565.0
WTG 33 + AR 32-33	11,141.0
PLQ Access road	3,361.0
PLQ substation bench	25,525.0
Cable route WTG41 - WTG 34	19,562.0
MEWF Substation bench	27,612.0
AR K-30	5,842.0
AR 30-31	6,342.0
AR 31-32	6,408.0
AR 26-27	13,323.3
AR 21-22	4,393.0
AR 19-20	4,854.0
AR 17-18	2,745.0
AR 16-17	4,783.0
AR H-10-11-12-13	40,482.0
MSR F-100X100 + batching plant	13,043.0
100X100	9,822.0
Entry road (Washbay - E)	39,035.0
AR50 (initial design)	4,371.0
Total Disturbance Area (Ha)	**77.4**

C. NORTHERN QUOLL OUTCOMES STRATEGY – SURVEY RESULTS

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS

MONITORING PERIOD: Late 2016 (September/October/November)

Monitoring Grid (refer to Fig. 1)	No. survey points monitored	Survey Period	No. individual quolls detected	Quoll population estimate*	Quoll occupancy#	Quoll detection probability[1]
Mt Emerald Site 1	36	Sept - Oct 2016	10	20	0.52	0.04
Mt Emerald Site 2	36	Sept - Oct 2016	13	25	0.79	0.05
Davies Ck Site, Davies Ck NP	36	Oct 2016	11	18	0.79	0.1
Tinaroo Ck Site, Dinden NP	36	Oct 2016	12	20	0.95	0.04
Upper Walsh River Site	36	Oct - Nov 2016	8	18	0.77	0.05
Biboorah Site	36	Sept - Oct 2016	2	NA	NA	NA

NOTES

*population estimated using spatially explicit capture-recapture modelling.

Occupancy is the proportion of sites (in this case the 36 trail camera monitoring points within each monitoring grid), at which quolls are estimated to occur, given the modelled uncertainty in detecting quolls when they occur at a point. Modelled using Presence software.

[1] Detection probability is the modelled probability of detecting a quoll on each detection opportunity when it is present at a site. Modelled using Presence software.

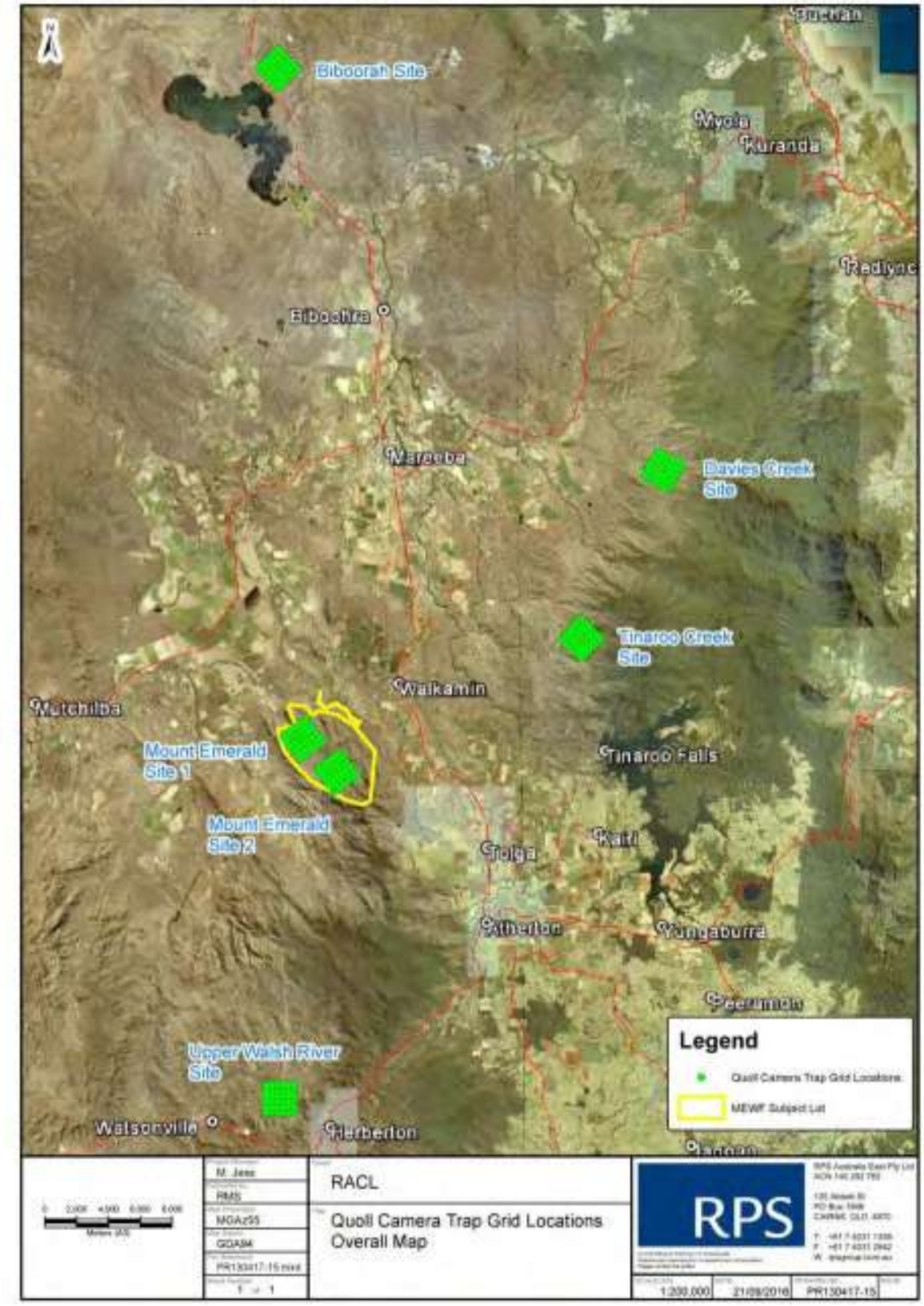


Figure 1 - Indicative locations of the six monitoring grids used to monitor Northern Quoll populations in the northern Atherton Tablelands

NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS

Program Summary

A condition of the Mt Emerald Windfarm approval is that the impacts of the project on populations of the northern quoll *Dasyurus hallucatus* are documented and managed. To this end, a quoll population and habitat monitoring program was established in late 2016.

This monitoring program consists of six camera trapping grids (Fig. 1) located across the northern Atherton Tablelands in North Queensland.

Each monitoring grid consists of a 6 x 6 grid with an approximate spacing of 350m, for a total area of 306ha. This provides a total of 36 trail camera survey points which are monitored continuously for 14 days and nights during each monitoring period.

Quoll habitat monitoring (using the Qld Government's BioCondition Assessment method) is undertaken at a subset of the 36 points on each monitoring grid.

Quoll Identification

Quolls are well suited to population monitoring using trail cameras because every quoll has its own unique spot pattern. By orientating cameras vertically, we always get the same image of each quoll which makes identification of individuals from spots that much easier.

See the photos below for an example of some of the individuals detected during the late 2016 quoll monitoring.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: JULY 2017

Monitoring Grid (refer to Fig. 1)	No. survey points	Survey Occasion	No. individual quolls detected	Quoll population estimate (se)[1]	Quoll occupancy (se)[2]	Quoll detection probability (se)[3]
Mt Emerald Site 1	35	July 2017	9	32.6 (17.9)	0.7319 (0.2628)	0.0523 (0.0215)
Mt Emerald Site 2	36	July 2017	8	Insufficient spatial recapture data	0.4841 (0.1591)	0.0739 (0.0269)
Davies Ck Site, Davies Ck NP	36	July 2017	22	Insufficient spatial recapture data	0.8164 (0.2212)	0.0619 (0.0199)
Tinaroo Ck Site, Dinden NP	36	July 2017	26	62 (18.06)	0.6295 (0.0992)	0.1418 (0.0235)
Upper Walsh River Site	36	July 2017	1	Insufficient spatial recapture data	Naïve occupancy 0.02* Insufficient detections for modelling	Insufficient detections for modelling
Brooklyn Sanctuary[4]	36	July 2017	17	60.5 (25.02)	0.4625 (0.1304)	0.0903 (0.0278)

Table 1. Three metrics of quoll abundance and detection probability values for six quoll monitoring sites monitored during July 2017.

NOTES

[1]population estimated using spatially explicit capture-recapture modelling (Efford 2016);

[2] Occupancy is the proportion of sites (in this case the 36 trail camera monitoring points within each monitoring grid), at which quolls are estimated to occur, given the modelled uncertainty in detecting quolls when they occur at a point. Modelled using Presence software (Hines 2006);

[3] Detection probability is the modelled probability of detecting a quoll on each detection opportunity when it is present at a site. Modelled using Presence software (Hines 2006);

[4] The Brooklyn site replaced the Biboorah site from July 2017 onwards;

* Naïve occupancy used in this case as insufficient detections were made.

NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: JULY 2017

Trail cameras were used to collect capture-recapture and site occupancy data on six populations of northern quoll *Dasyurus hallucatus* (Map 1) during July 2017. Eighty-three individual quolls were detected (Table 1) during approximately 3000 camera trap days. Population estimates were able to be generated at half of the sites due to low numbers of spatial recaptures from the other half of sites. Occupancy estimates were able to be generated at all but one site.

Figure 1 - Indicative locations of the six monitoring grids (red diamonds) used to monitor Northern Quoll populations in the northern Atherton Tablelands from July 2017 onwards. Monitoring site names in white text. Local place names in black text. *Basemap: GoogleEarth Pro 9 December 2017*.

The number of quoll individuals detected on each of our 3km^2 sites ranged from 1 to 26. The numbers from the Mt Emerald sites are at the lower end of this range (Table 1). Of the three sites for which population sized could be estimated, the Mt Emerald 1 site had the lowest population size. The occupancy of the Mt Emerald sites is within the range of values at the three control sites for which occupancy could be modelled (Table 1).

References

Efford, M. G. (2016) secr: Spatially explicit capture-recapture models. R package version 2.10.4. http://CRAN.R-project.org/package=secr.

Hines, J. E. (2006). PRESENCE- Software to estimate patch occupancy and related parameters. USGS-PWRC. <http://www.mbr-pwrc.usgs.gov/software/presence.html>.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: OCTOBER 2017

Monitoring Grid (refer to Fig. 1)	No. individual quolls detected (naïve occupancy)[1]		Quoll population estimate (se)[2]		Quoll occupancy (se)[3]		Quoll detection probability (se)[4]		Overall trend in Quoll population between sampling occasions
	Oct 2016	Oct 2017	Oct 2016	Oct 2017	Oct 2016	Oct 2017	Oct 2016	Oct 2017	
Mt Emerald Site 1	10 (0.3889)	6 (0.1944)	20 (6.96)	12.64 (6.56)	0.52 (0.11)	0.4474 (0.271)	0.047 (0.02)	0.039 (0.0265)	All abundance metrics downwards
Mt Emerald Site 2	13 (0.5278)	8 (0.25)	25 (7.57)	Insufficient recaptures	0.79 (0.16)	Insufficient data	0.052 (0.018)	0.0179 (0.0059)	All abundance metrics downwards
Davies Ck Site, Davies Ck NP	11 (0.72)	13 (0.42)	17.44 (5.71)	24.3 (7.217)	0.79 (0.08)	0.5144 (0.1125)	0.102 (0.023)	0.11 (0.026)	Abundance upwards, occupancy downwards
Tinaroo Ck Site, Dinden NP	12 (0.6667)	19 (0.6389)	19.16 (5.72)	39.06 (9.79)	0.95 (0.08)	0.98 (0.1867)	0.044 (0.014)	0.073 (0.018)	All abundance metrics upwards or stable
Upper Walsh River Site	8 (0.4848)	0 (0.00)	17.99 (10.57)	No quoll captures	0.77 (0.16)	Insufficient data	0.046 (0.015)	Insufficient data	All abundance metrics downwards
Brooklyn Sanctuary[5]	NA	8 (0.25)	NA	22.93 (10.96)	NA	0.434 (0.1798)	NA	0.059 (0.027)	NA

Table 1. Four metrics of quoll abundance and detection probability values for six quoll monitoring sites, on two comparable occasions, Oct 2016 and Oct 2017.

NOTES

[1] Naïve occupancy is the proportion of sites at which quolls were detected

[2] Population estimated using spatially explicit capture-recapture modelling (Efford 2016);

[3] Occupancy is the proportion of sites (in this case the 36 trail camera monitoring points within each monitoring grid), at which quolls are estimated to occur, given the modelled uncertainty in detecting quolls when they occur at a point. Modelled using Presence software (Hines 2006);

[4] Detection probability is the modelled probability of detecting a quoll on each detection opportunity when it is present at a site. Modelled using Presence software (Hines 2006);

[5] The Brooklyn site replaced the Biboorah site from July 2017 onwards;

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: OCTOBER 2017

Trail cameras were used to collect capture-recapture and site occupancy data on six populations of northern quoll *Dasyurus hallucatus* (Map 1) during October-November 2017. Fifty-four individual quolls were detected (Table 1) during approximately 3000 camera trap days. Population estimates were able to be generated at two thirds (4/6) of the sites due to low numbers of spatial recaptures at 2 two of the sites. Occupancy estimates were also only able to be generated at two thirds of the sites due to very low detection rates there.

Figure 1 - Indicative locations of the six monitoring grids (red diamonds) used to monitor Northern Quoll populations in the northern Atherton Tablelands from July 2017 onwards. Monitoring site names in white text. Local place names in black text. *Basemap: GoogleEarth Pro 9 December 2017*.

The number of quoll individuals detected on each of our 3km^2 sites ranged from 1 to 19. The numbers from the Mt Emerald sites are at the lower end of this range (Table 1). Of the four sites for which population sized could be estimated, the Mt Emerald 1 site had the lowest population size of any site that could be modelled. Occupancy could only be calculated for one of the Mt Emerald sites (Mt Emerald 1) and was at the lower end of occupancy ranges of any of the six sites (Table 1).

Changes in populations between October 2016 and October 2017

The October 2017 monitoring session marks the first time during this project we have repeat monitoring data from the same season in different years. This is important as quoll abundance, activity and detection probability are likely to vary with seasonal life history stages. Comparative data reveal all indices of northern quoll abundance (no. individuals, proportion of sites detected, modelled population size, and occupancy) have decreased on the two Mt Emerald sites between October 2016 and October 2017 (Table 1, Fig 2).

Interpretation of this with respect to the role of construction activity on quoll populations is ambiguous, as one of the control sites (Walsh) has demonstrated an even more extreme decline in

quoll abundance during the same period (Table 1), effectively disappearing from this site despite no obvious changes in land management there. Metrics of quoll abundance at the other two control sites for which we have comparable data have increased or remained stable during the same period (Table 1).

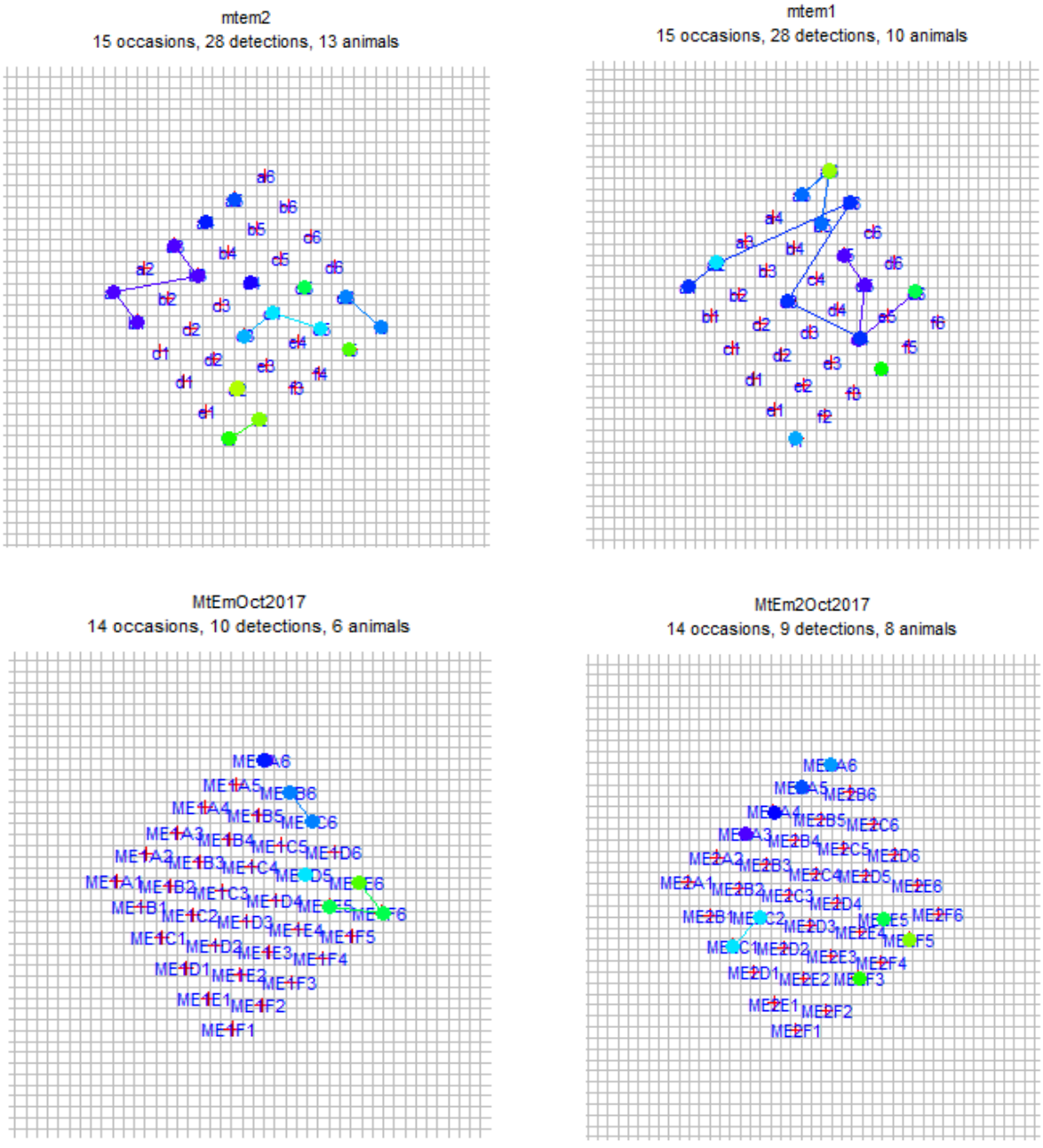


Fig 2. Comparison of detections of northern quolls at Mt Emerald 1 site between October 2016 (top left) and October 2017 (top right), and at Mt Emerald 2 site between October 2016 (bottom left) and October 2017 (bottom right). Labelled red crosses indicate camera trap locations, coloured dots are quoll detections, and coloured lines show movements by individuals between detectors.

References

Efford, M. G. (2016) secr: Spatially explicit capture-recapture models. R package version 2.10.4. http://CRAN.R-project.org/package=secr.

Hines, J. E. (2006). PRESENCE- Software to estimate patch occupancy and related parameters. USGS-PWRC. <http://www.mbr-pwrc.usgs.gov/software/presence.html>.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: FEBRUARY 2018

Monitoring Grid (refer to Map. 1)	No. survey points	Survey Occasion	No. individual quolls detected	Quoll population estimate (se)[1]	Quoll occupancy (se)[2]	Quoll detection probability (se)[3]
Mt Emerald Site 1	35	February 2018	21	45.5(11.4)	1(0.001)	0.0853(0.013)
Mt Emerald Site 2	36	February 2018	18	67.9(29.1)	Naïve occupancy 0.53*	0.05(0.01)
Davies Ck Site, Davies Ck NP	36	February 2018	20	38.7(10.8)	0.6396(0.1231)	0.1047(0.0231)
Tinaroo Ck Site, Dinden NP	NA	February 2018	NA	NA	NA	NA
Upper Walsh River Site	36	February 2018	1	Insufficient spatial recapture data	Naïve occupancy 0.06*	Insufficient detections for modelling
Brooklyn Sanctuary[4]	36	February 2018	14	Insufficient spatial recapture data	0.3839(0.1248)	0.0781(0.026)
TOTAL	179		74			

Table 1. Three metrics of quoll abundance and detection probability values for six quoll monitoring sites monitored during February 2018.

NOTES

[1]population estimated using spatially explicit capture-recapture modelling (Efford 2016); [2] Occupancy is the proportion of sites (in this case the 36 trail camera monitoring points within each monitoring grid), at which quolls are estimated to occur, given the modelled uncertainty in detecting quolls when they occur at a point. Modelled using Presence software (Hines 2006); [3] Detection probability is the modelled probability of detecting a quoll on each detection opportunity when it is present at a site. Modelled using Presence software (Hines 2006); [4] The Brooklyn site replaced the Biboorah site from July 2017 onwards; * Naïve occupancy used in this case as insufficient detections were made.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: FEBRUARY 2018

Trail cameras were used to collect capture-recapture and site occupancy data on five populations of northern quoll *Dasyurus hallucatus* (Map 1) during February 2018. Access to one site "Tinaroo" was denied due to changes to Queensland government permitting which provides for veto of permit applications by Native Title holders. We therefore only surveyed five of the six sites intended for long-term monitoring.

Seventy-four individual quolls were detected (Table 1) during approximately 3000 camera trap days. Population estimates were able to be generated at three of the sites due to low numbers of spatial recaptures from two of sites. Occupancy estimates were able to be generated at three of the five sites (Table 1), also due to the low numbers of captures.

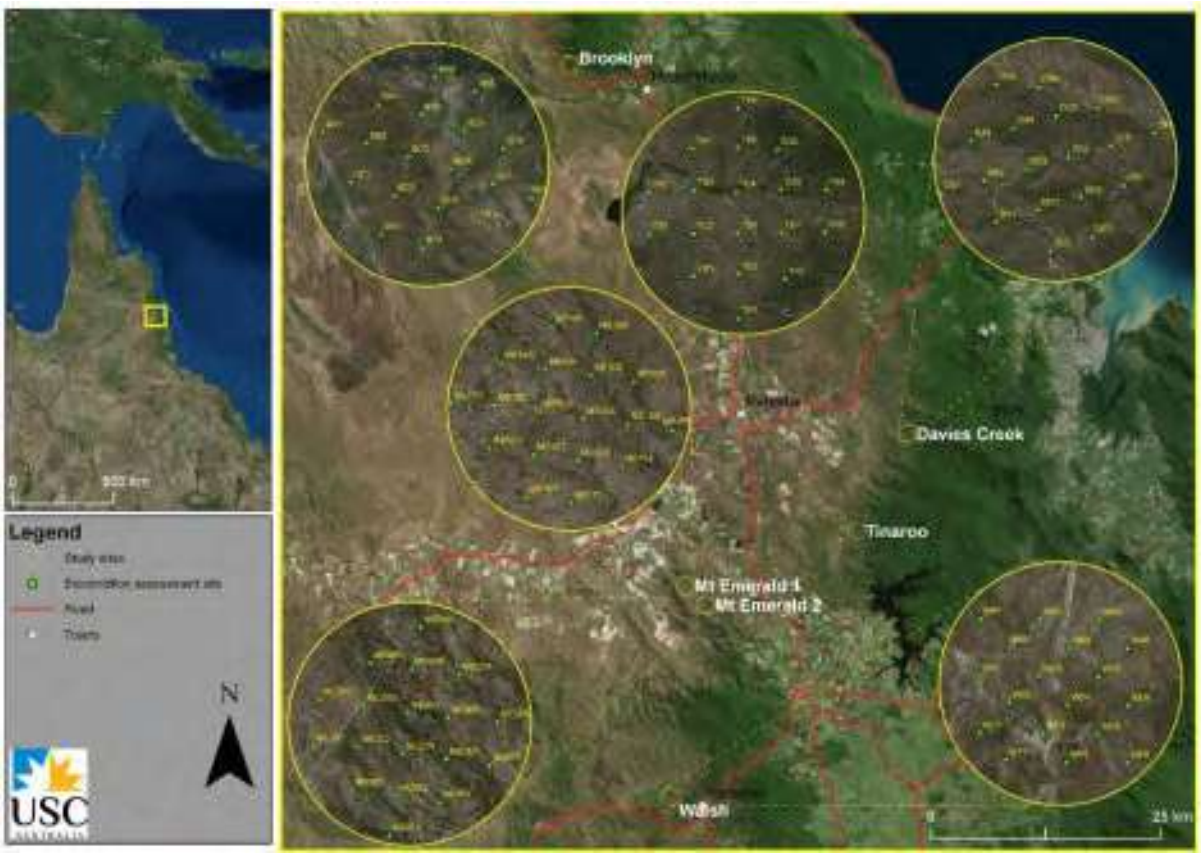


Figure 1 - Indicative locations of the six monitoring grids (red diamonds) used to monitor Northern Quoll populations in the northern Atherton Tablelands from July 2017 onwards. Monitoring site names in white text. Local place names in black text. Note that Site Tinaroo was not utilised during February 2018 due to permits being denied for this area. Basemap: GoogleEarth Pro 9 December 2017.

The number of quoll individuals detected on each of our 3km^2 sites ranged from 1 to 21 (Appendix A). The numbers from the Mt Emerald sites are at the higher end of this range (Table 1). Of the three sites for which population sized could be estimated, the Davies Creek site had the lowest population size. The occupancy of the Mt Emerald sites was within the range of values, but at the higher end of those value at the two control sites (Table 1).

APPENDIX A. The distribution and abundance of northern quolls from each of the five quoll monitoring sites used in this project.

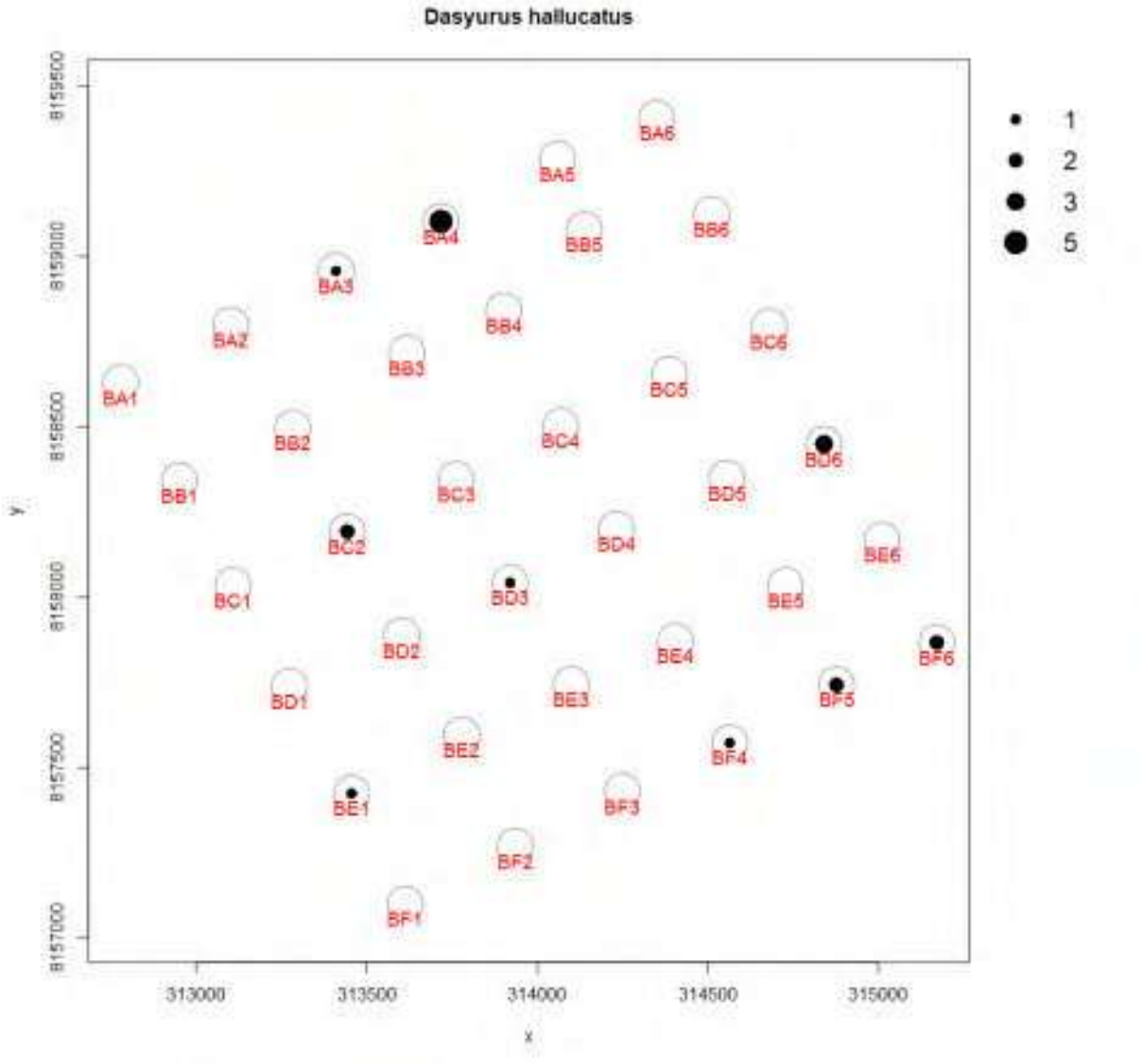


Fig. A1. The distribution of quolls, and the number of individuals detected at each camera trap station during February 2018 monitoring at Site "Brooklyn Reserve". The number of individuals per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Site locations are illustrated in Map 1.

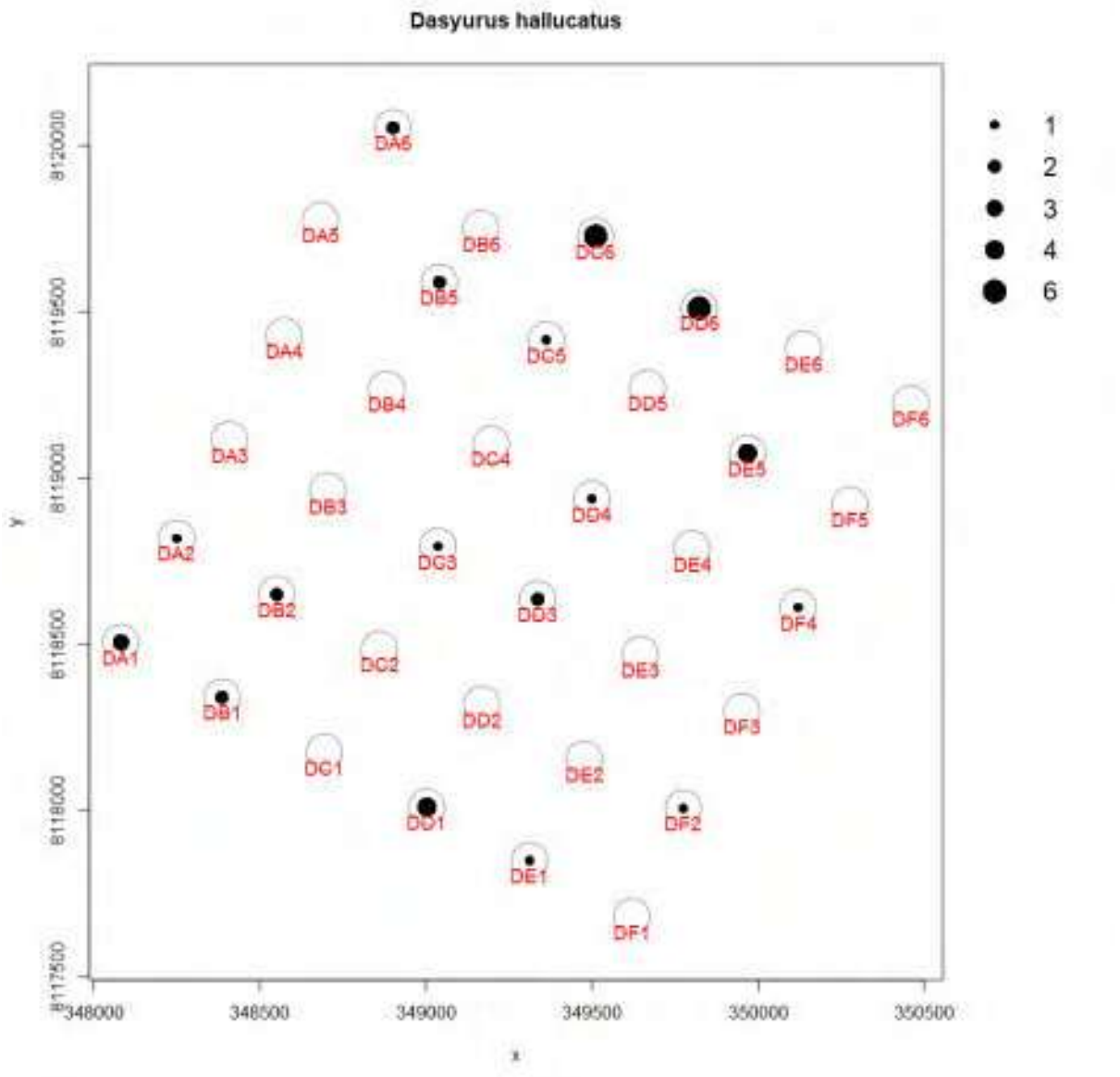


Fig. A2. The distribution of quolls, and the number of individuals detected at each camera trap station during February 2018 monitoring at Site "Davies Creek". The number of individuals per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Site locations are illustrated in Map 1.

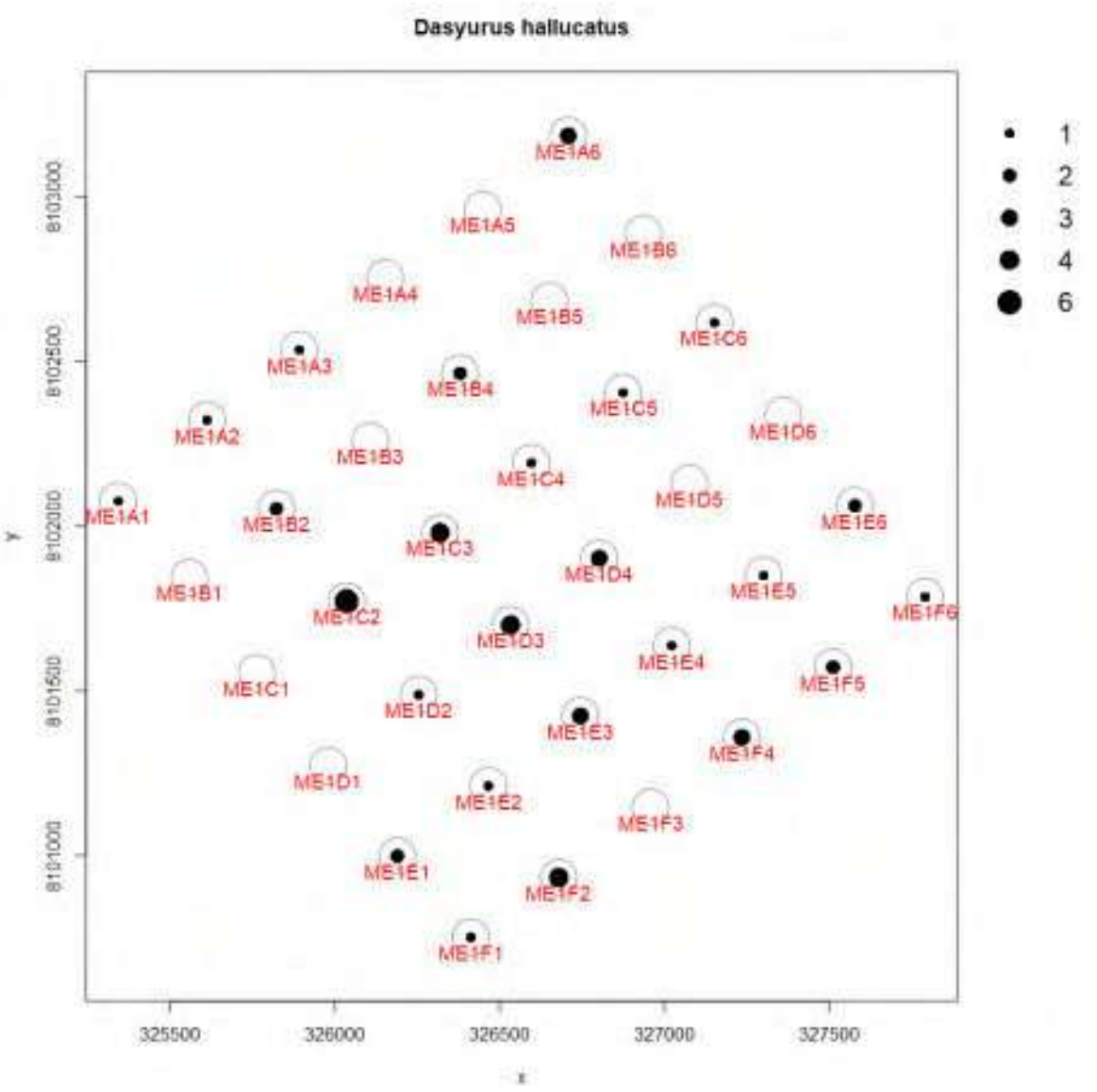


Fig. A3. The distribution of quolls, and the number of individuals detected at each camera trap station during February 2018 monitoring at Site "Mt Emerald 1". The number of individuals per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Site locations are illustrated in Map 1.

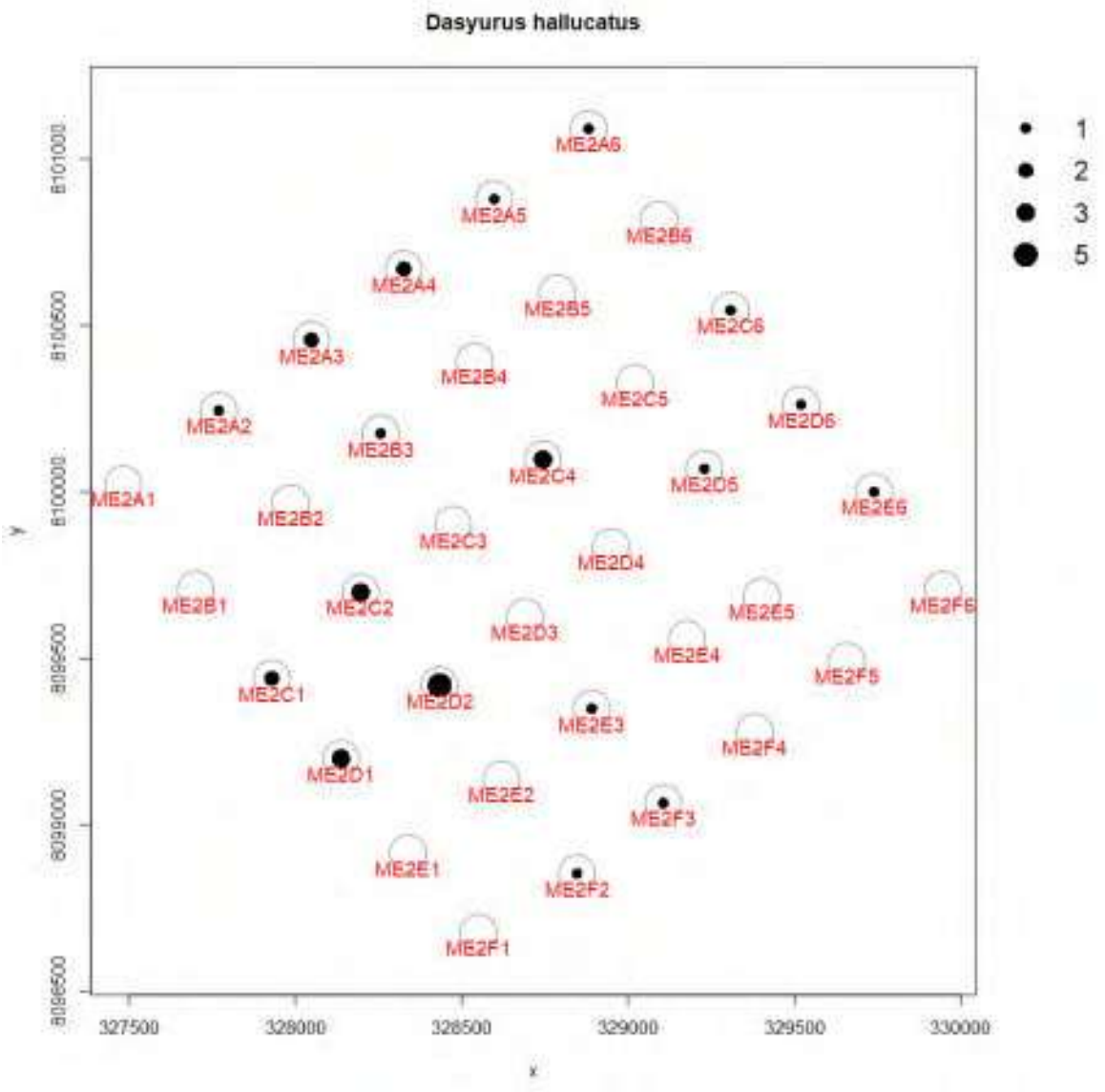


Fig. A1. The distribution of quolls, and the number of individuals detected at each camera trap station during February 2018 monitoring at Site "Mt Emerald 2". The number of individuals per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Site locations are illustrated in Map 1.

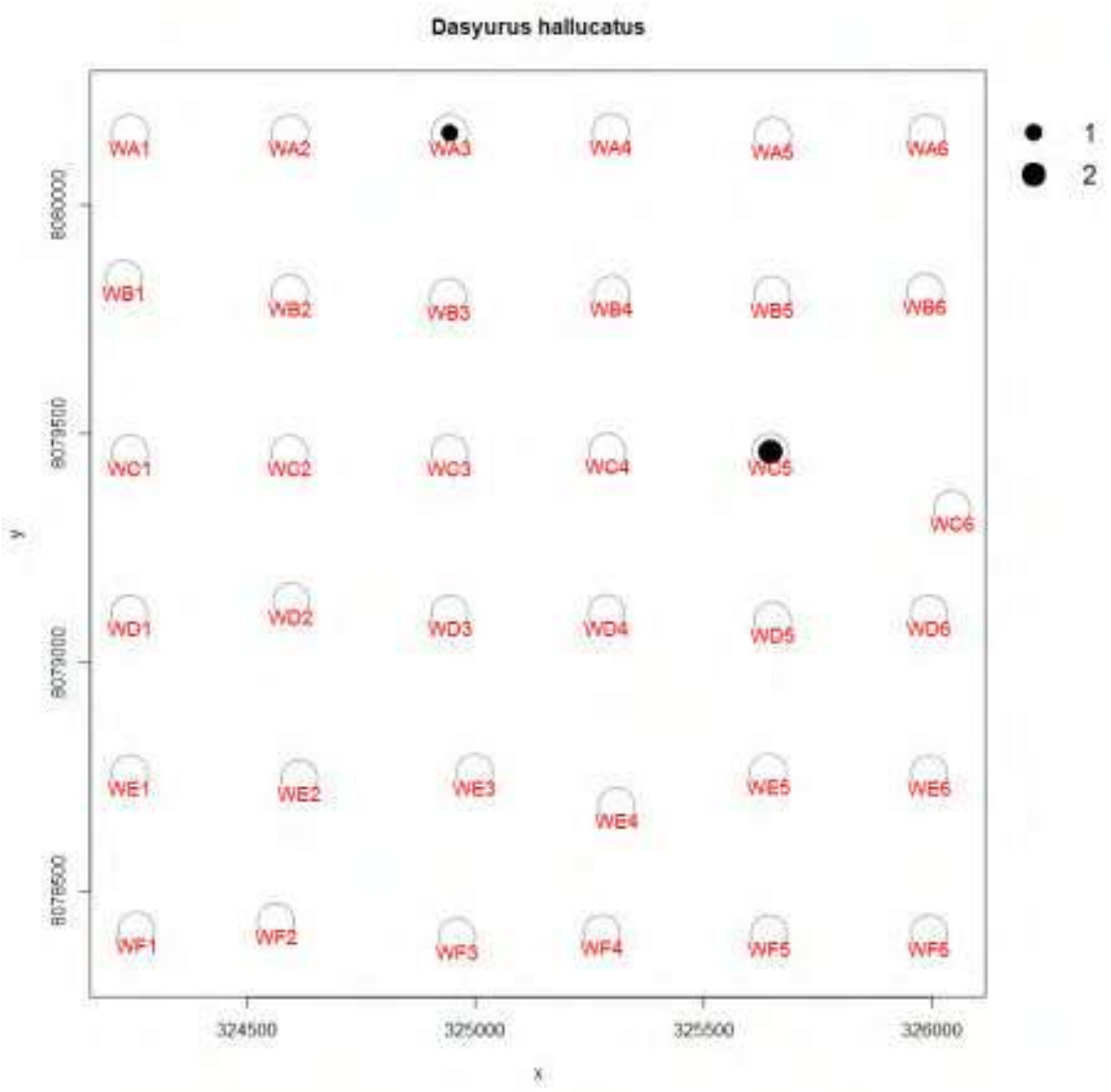


Fig. A5. The distribution of quolls, and the number of individuals detected at each camera trap station during February 2018 monitoring at Site "Walsh River". The number of individuals per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Site locations are illustrated in Map 1.

References

Efford, M. G. (2016) secr: Spatially explicit capture-recapture models. R package version 2.10.4. http://CRAN.R-project.org/package=secr.

Hines, J. E. (2006). PRESENCE- Software to estimate patch occupancy and related parameters. USGS-PWRC. <http://www.mbr-pwrc.usgs.gov/software/presence.html>.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: JULY 2018

Site	No. individual quolls detected (naïve occupancy)[1]		Quoll population estimate (se)[2]		Modelled occupancy (se)[3]		Modelled detection probability (se)[4]		Overall trend in quoll population between sampling occasions
	July 2017	July 2018	July 2017	July 2018	July 2017	July 2018	July 2017	July 2018	
Mt Emerald Site 1	9 (0.3824)	2 (0.0556)	32.6 (17.9)	Insufficient spatial recapture data	0.7319 (0.2628)	0.0556*	0.0523 (0.0215)	0.0046 (0.0032)	All abundance metrics downwards
Mt Emerald Site 2	8 (0.3056)	11 (0.4118)	Insufficient spatial recapture data	34.9 (14.7)	0.4841 (0.1591)	0.6407 (0.1763)	0.0739 (0.0269)	0.0735 (0.0233)	All abundance metrics upwards or no change
Davies Ck Site, Davies Ck NP	22 (0.4722)	30 (0.6286)	Insufficient spatial recapture data	85.2 (18.8)	0.8164 (0.2212)	0.7586 (0.1121)	0.0619 (0.0199)	0.1184 (0.0214)	All abundance metrics upwards or no change
Tinaroo Ck Site, Dinden NP	26 (0.5556)	NA	62 (18.06)	Not accessible for sampling	0.6295 (0.0992)	NA	0.1418 (0.0235)	NA	NA
Upper Walsh River Site	1 (0.0286)	2 (0.0556)	Insufficient spatial recapture data	Insufficient spatial recapture data	0.0286*	0.0556*	0.0021 (0.0021)	NA	No change
Brooklyn Sanctuary[5]	17 (0.3333)	26 (0.7714)	60.5 (25.02)	64.6 (14.4)	0.4625 (0.1304)	0.7714*	0.0903 (0.0278)	0.0898 (0.0129)	All metric upwards or unchanged

Table 1. Three metrics of quoll abundance and detection probability values for six quoll monitoring sites monitored during July 2018.

NOTES.[1] naive occupancy is proportion of sites at which quolls were detected, [2] population estimated using spatially explicit capture-recapture modelling (Efford 2016); [3] Occupancy is the proportion of sites (in this case the 36 trail camera monitoring points within each monitoring grid), at which quolls are estimated to occur, given the modelled uncertainty in detecting quolls when they occur at a point. Modelled using Presence software (Hines 2006); [4] Detection probability is the modelled probability of detecting a quoll on each detection opportunity when it is present at a site. Modelled using Presence software (Hines 2006); [5] The Brooklyn site replaced the Biboorah site from July 2017 onwards; * Naïve occupancy used in this case as insufficient detections were made for occupancy modelling.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: JULY 2018

Trail cameras were used to collect capture-recapture and site occupancy data on five populations of northern quoll *Dasyurus hallucatus* (Map 1) during July 2018. Access to one site "Tinaroo" continues to be denied since February 2018 due to changes to Queensland Government permitting which provides for veto of permit applications by Native Title holders. We therefore only surveyed five of the six sites intended for long-term monitoring.

Seventy-one individual quolls were detected (Table 1) during the approximately 3000 camera trap days of this survey occasion. Population estimates were able to be generated using spatial mark-recapture modelling (Efford 2016), at two of the sites due to low numbers of spatial recaptures from the remaining three sites. Occupancy estimates were able to be generated at four of the five sites (Table 1), also due to the low numbers of captures at one site (Walsh).

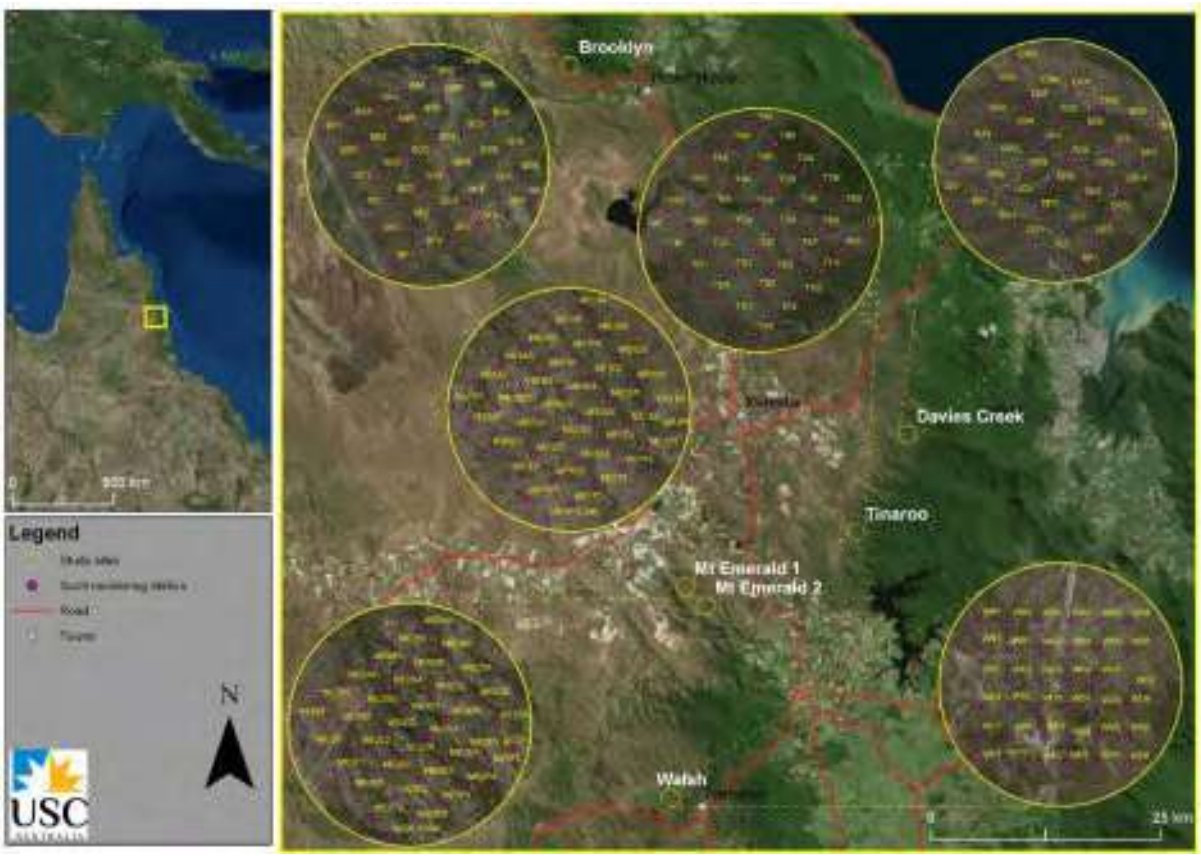


Fig. 1. Indicative locations of the six monitoring grids (purple circles) used to monitor Northern Quoll populations in the northern Atherton Tablelands from July 2017 onwards. Monitoring site names in white text. Local place names in black text. Note that Site Tinaroo was not utilised during July 2018 due to permits being denied for this area. Basemap: GoogleEarth Pro 9 December 2017.

The number of quoll individuals detected on each of our approximately 3km^2 sites ranged from 2 to 30 (Table 1, Appendix A). The numbers from the Mt Emerald sites are at the lower end of this range (Table 1). Of the three sites for which population sized could be estimated, the Mount Emerald 2 site had the lowest population size, although the absolute counts was lowest at the "Walsh" control site.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: JULY 2018

Changes in quoll populations between July 2017 and July 2018

The July 2018 monitoring session marks the second occasion during this project where we have comparable repeat monitoring data from the same season in different years (comparable with July 2017). This is important as quoll abundance, activity and detection probability are likely to vary with seasonal life history stages. Quoll populations increased or remained stable on all control sites and the Mt Emerald 2 site in July 2018 compared to July 2017. Quoll numbers were significantly decreased on "Mt Emerald 1" site in 2018 compared to July 2017.

Vegetation Monitoring

Partial Biocondition Monitoring was undertaken at all Biocondition plots (Map 2) during the July round of survey (summarised raw data included as a separate attachment to this document "Master Biocon_summary_to_July2018.xlsx"). In keeping with standard Biocondition monitoring protocols, if no obvious disturbance such as storm, fire or construction damage is observed at a site, then only ground, shrub and canopy cover measurements are redone. The incidence of large woody debris, trees counts are only repeated at a site when there is obvious cause to do so. Biocondition plots are situated at every second camera trapping station on each site. These habitat monitoring plots do not suggest any disproportionate change in key vegetation parameters at the Mt Emerald sites (although there are obviously localised impacts from construction of wind turbines and road infrastructure through the site)(Appendix B) although they do reveal a decline in ground cover from February to July 2018, in line with changes in this parameter at all other sites.

Summary of impacts of Mt Emerald windfarm on quoll populations

There continues to be no clear overall trend towards disproportionate declines in quoll numbers on the Mt Emerald windfarm site. Although quoll numbers on each of the two impact sites have fluctuated, these fluctuations are within the range of such changes experienced at the control sites. Quolls continue to be present on Mt Emerald windfarm monitoring sites 1 and 2. Our next report (on the October 2018 data) will provide a clearer picture on the long-term trends in quoll populations at these and our control sites.

MOUNT EMERALD WIND FARM – NORTHERN QUOLL MONITORING PROGRAM

SUMMARY OF RESULTS: JULY 2018

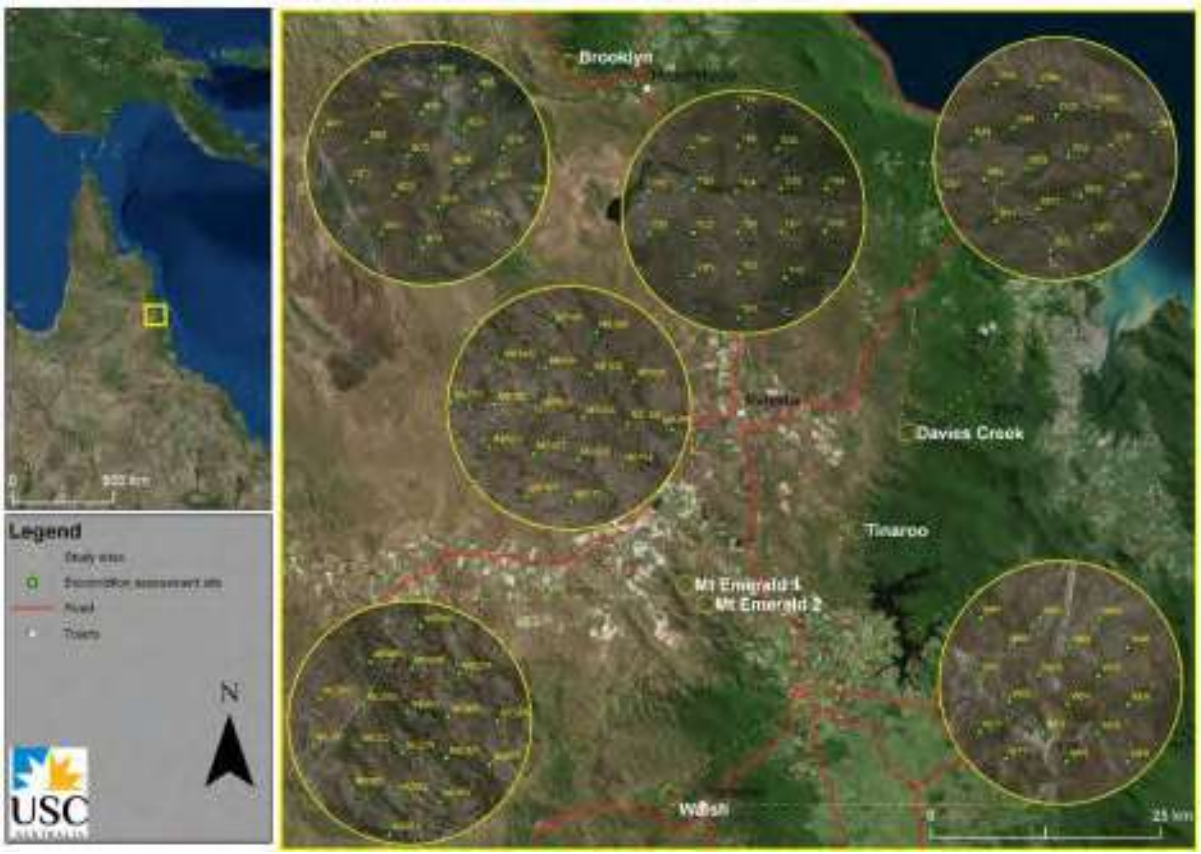


Fig. 1. Indicative locations of the six Biocondition monitoring grids (green circles) used to monitor habitat Biocondition in the northern Atherton Tablelands from July 2017 onwards. Monitoring site names in white text. Local place names in black text. Note that Site Tinaroo was not utilised during July 2018 due to permits being denied for this area. Basemap: GoogleEarth Pro 9 December 2017.

APPENDIX A. The distribution and abundance of northern quolls from each of the five quoll monitoring sites used in this project.

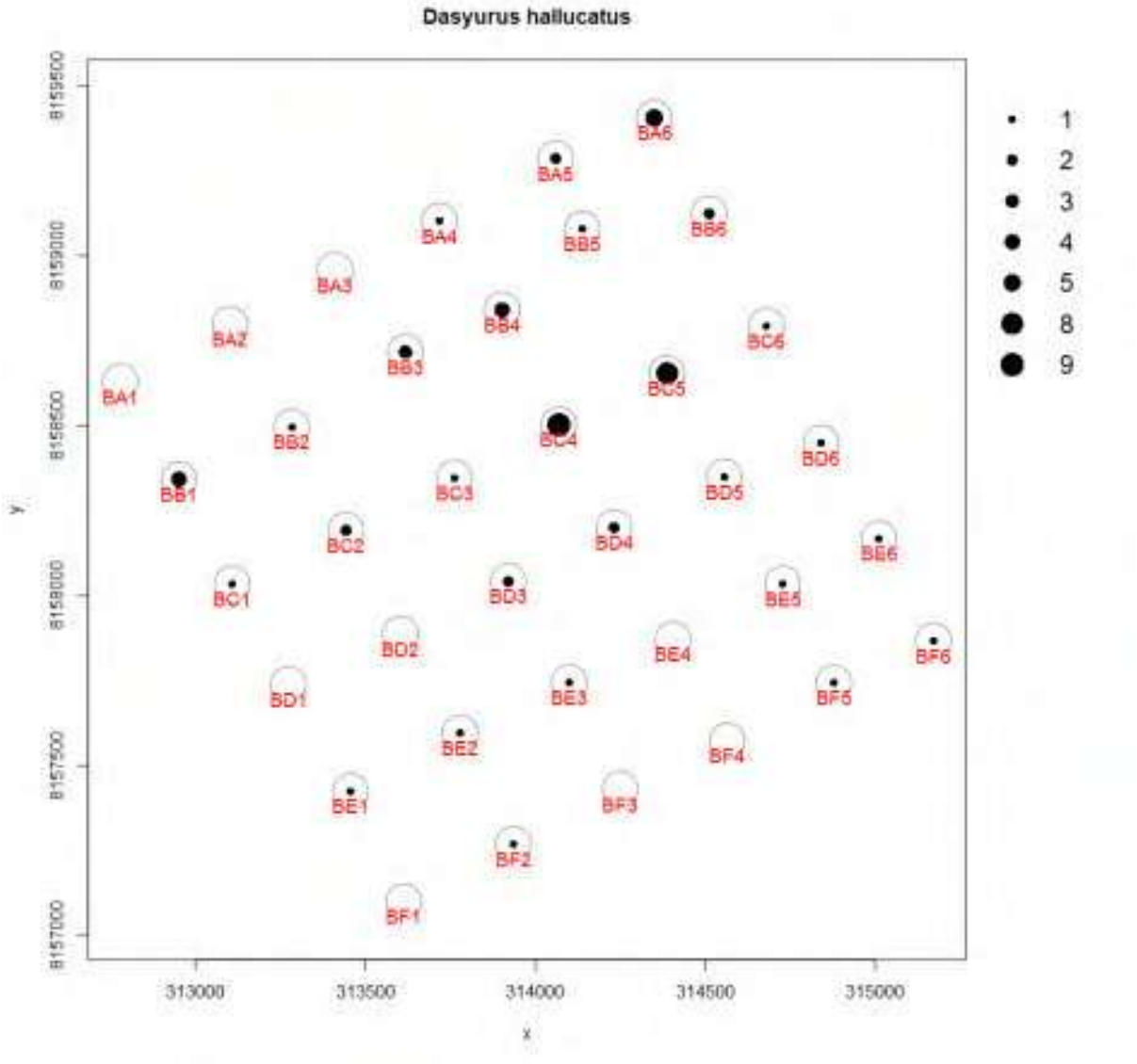


Fig. A1. The distribution of quolls, and the number of detections at each camera trap station during July 2018 monitoring at Site "Brooklyn". The number of detections per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Each camera station is approximately 350-m-apart and site locations are illustrated in Map 1.

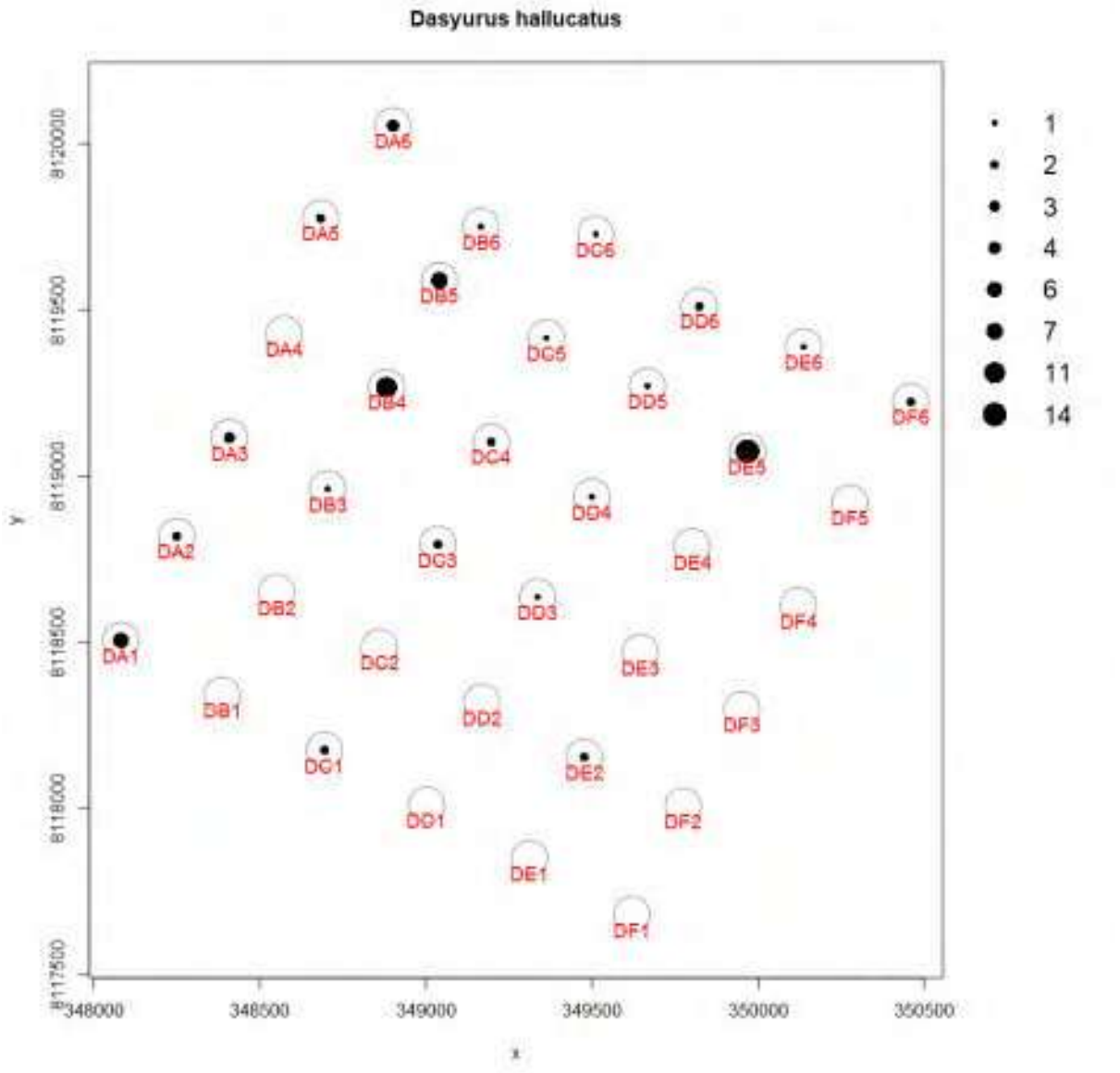


Fig. A2. The distribution of quolls, and the number of detections at each camera trap station during July 2018 monitoring at Site "Davies Creek". The number of detections per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Each camera station is approximately 350-m-apart and site locations are illustrated in Map 1.

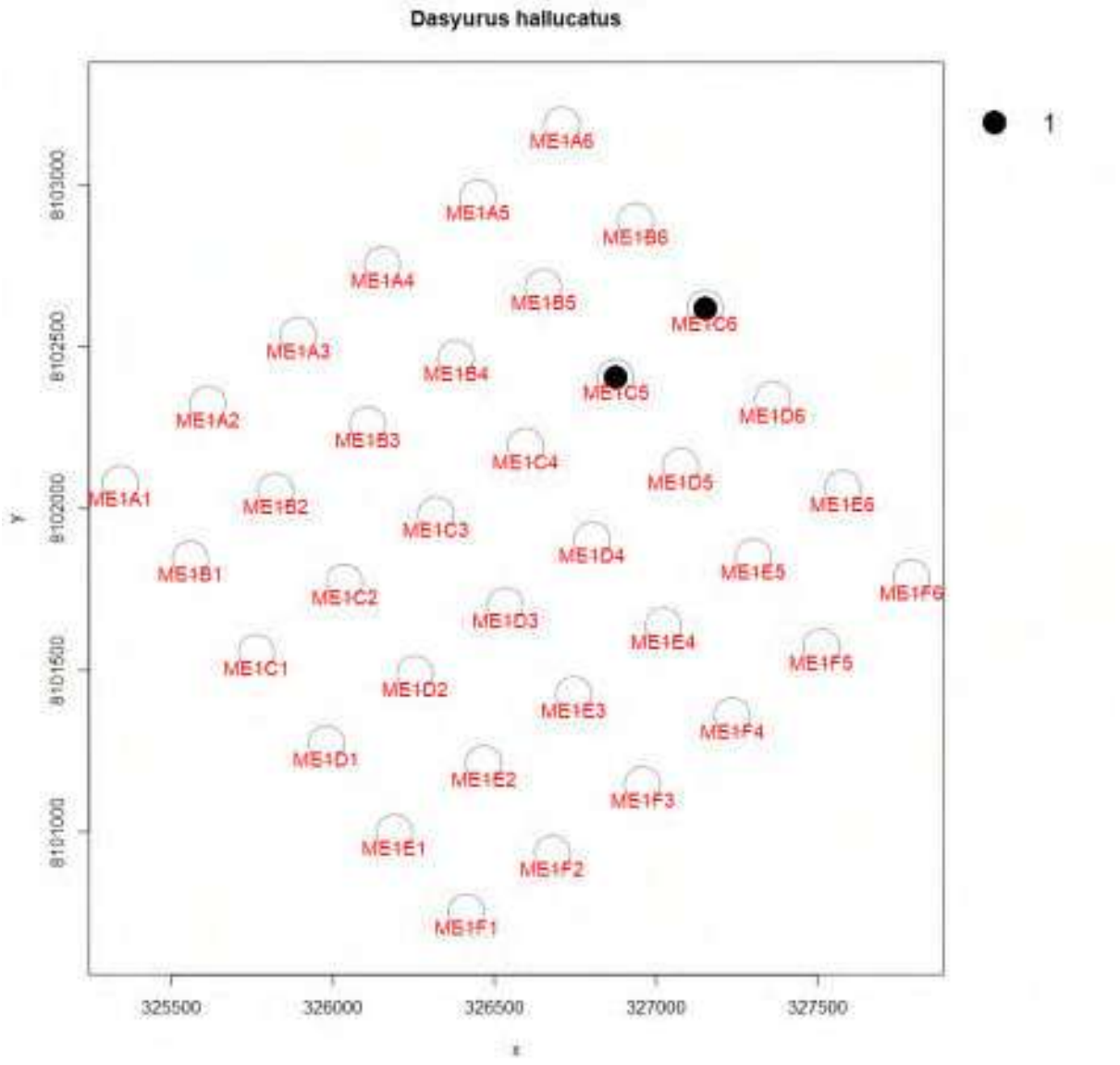


Fig. A3. The distribution of quolls, and the number of detections at each camera trap station during July 2018 monitoring at Site "Mt Emerald 1". The number of detections per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Each camera station is approximately 350-m-apart and site locations are illustrated in Map 1.

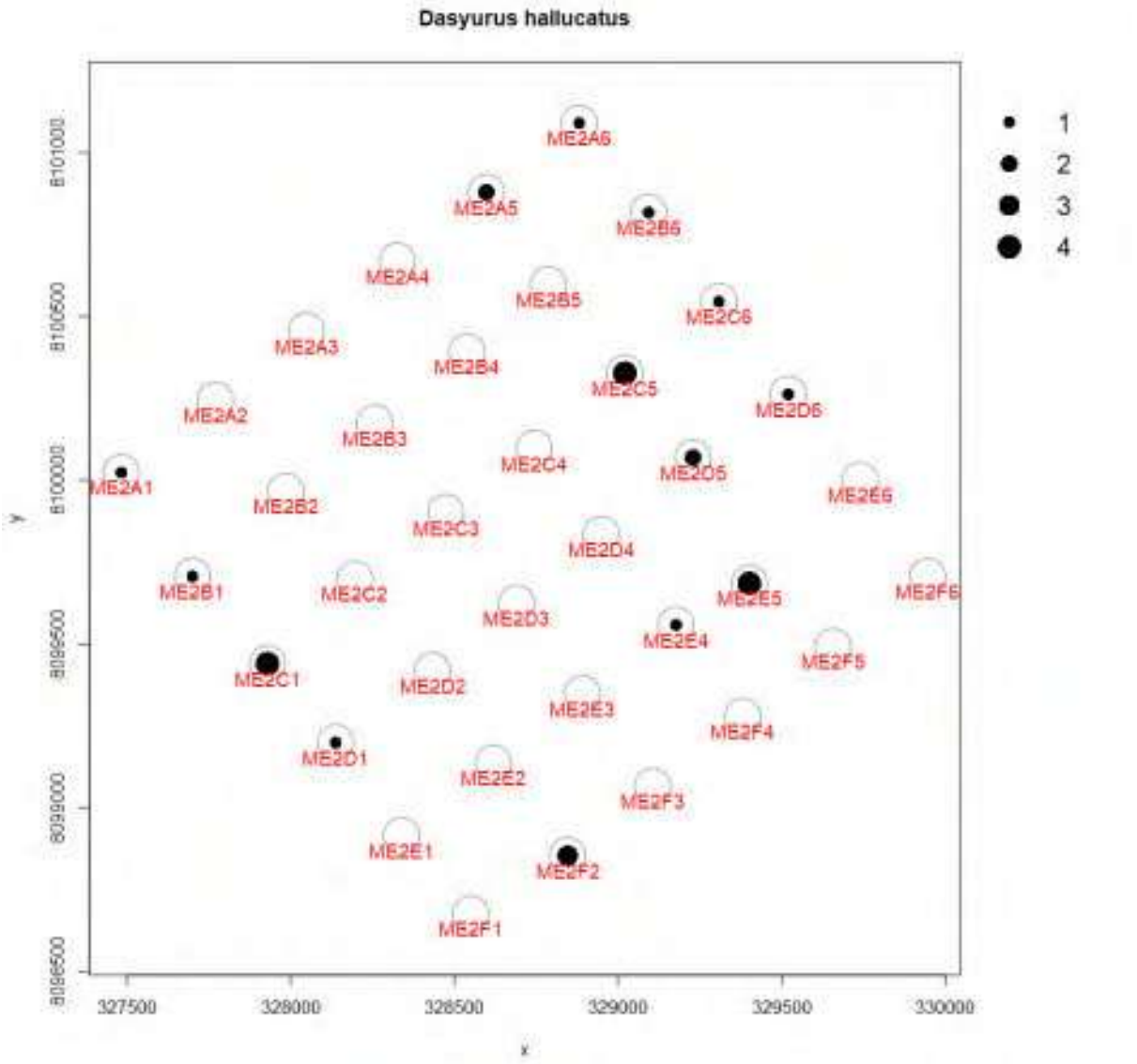


Fig. A4. The distribution of quolls, and the number of detections at each camera trap station during July 2018 monitoring at Site "Mt Emerald 2". The number of detections per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Each camera station is approximately 350-m-apart and site locations are illustrated in Map 1.

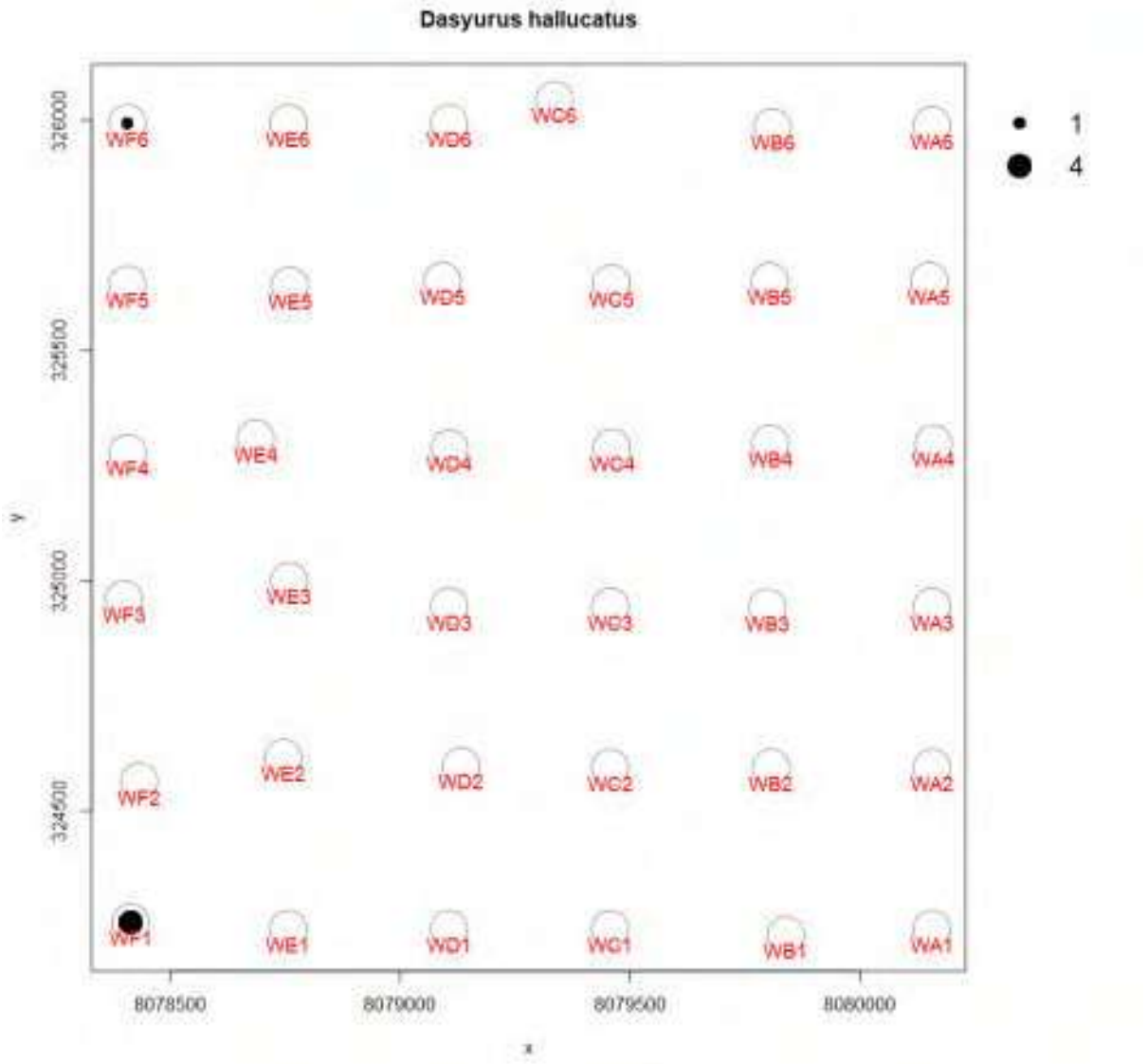


Fig. A5. The distribution of quolls, and the number of detections at each camera trap station during July 2018 monitoring at Site "Walsh River". The number of detections per station is reflected in the size of the black circle, as per the legend to the right of the plot. Plots were generated within R-package "camtrapR". Each camera station is approximately 350-m-apart and site locations are illustrated in Map 1.

Appendix B. Trends in canopy and shrub cover, incidence of fire and extent of course woody debris on each quoll monitoring site during this study.

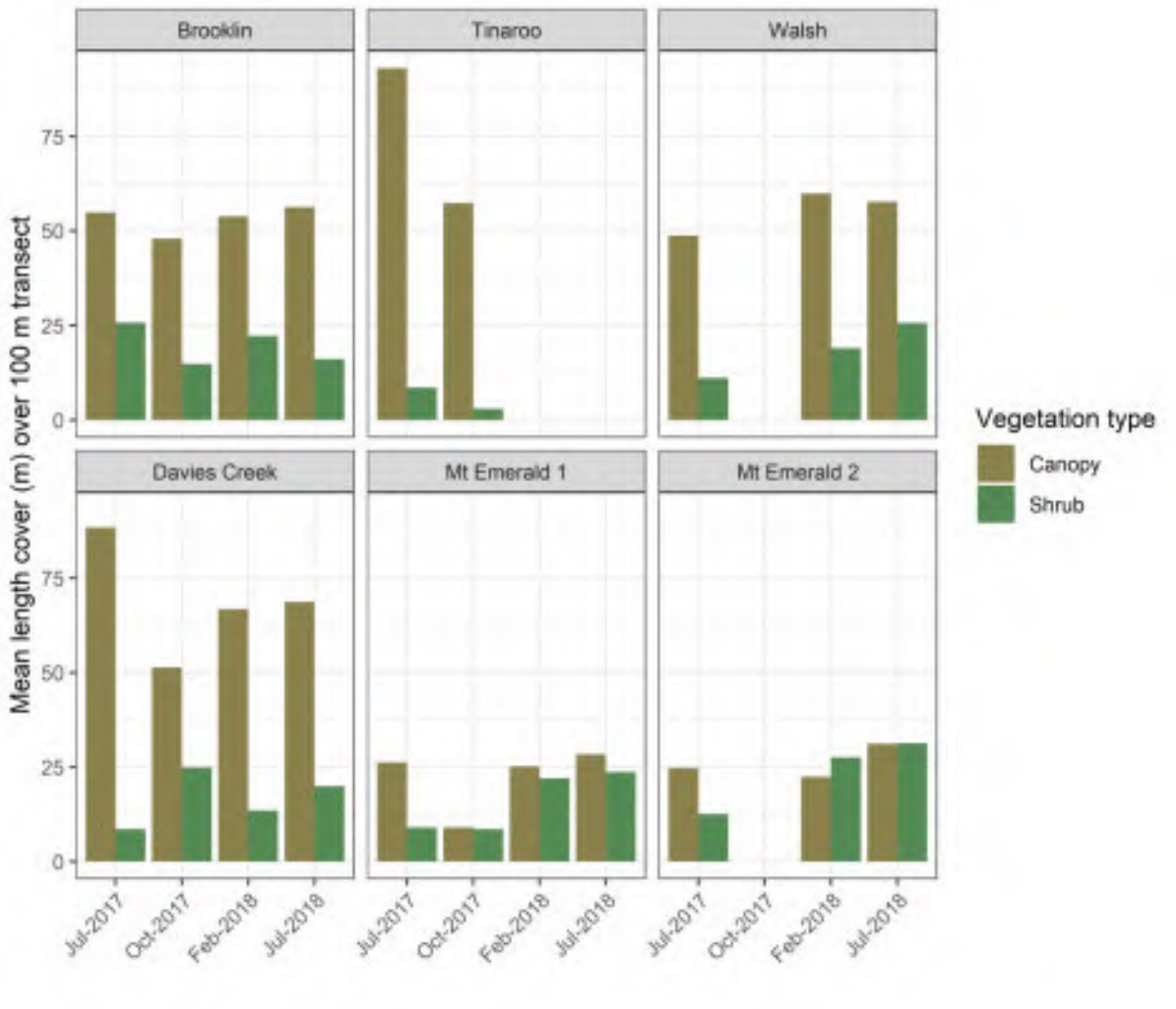


Fig. B1. Canopy and shrub cover on the 18 Biocondition plots at each of the six quoll monitoring sites surveyd between July 2017 and July 2018. Data was not collected from sites on some occasions due to site access or other logistic issues. Note that site @Tinaroo@ has been unavailable from February 2018.

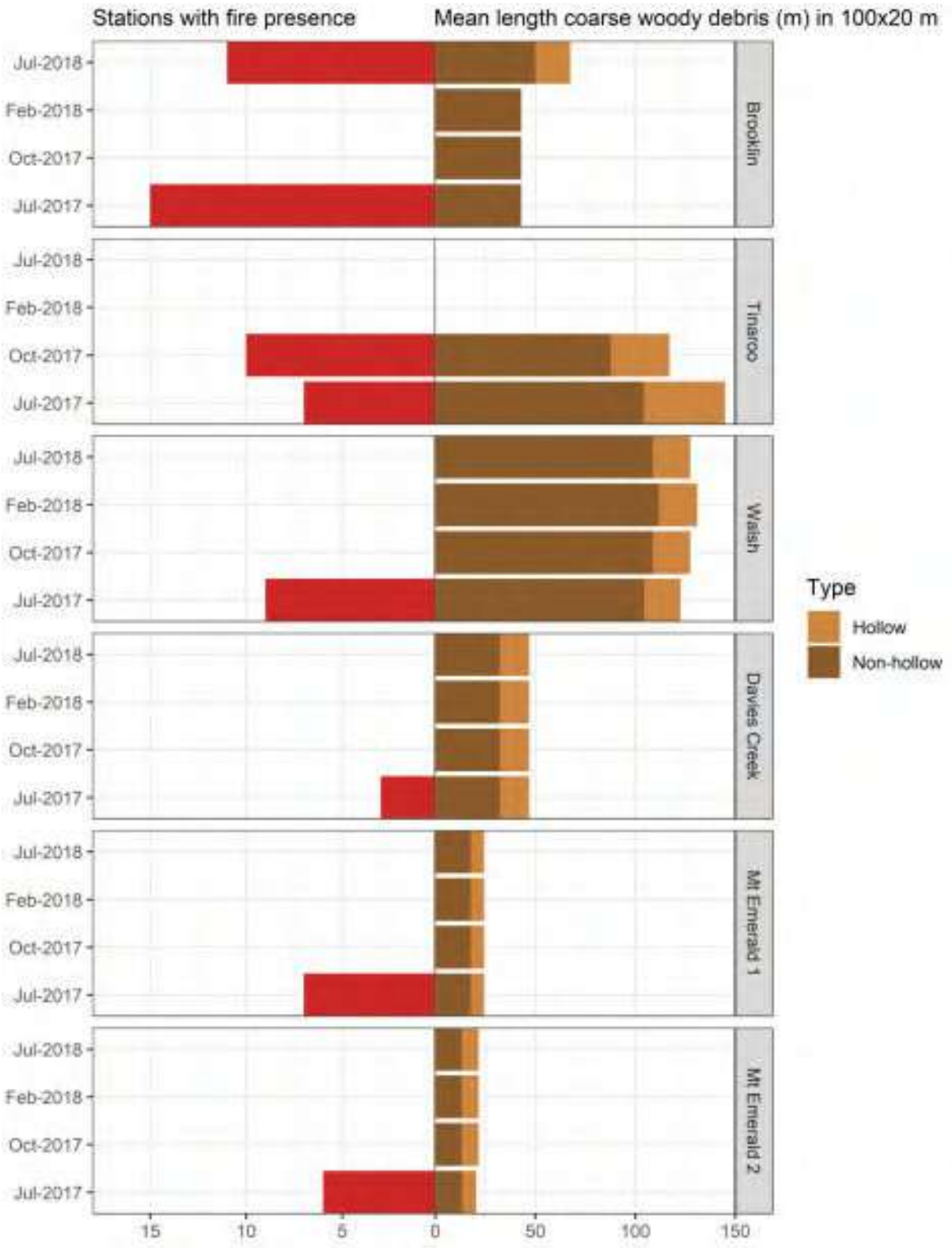


Fig. B2. Number of stations (out of 18 at each site) on which there was evidence of recent fire and mean length of hollow and non-hollow course woody debris at each site between July 2017 and July 2018. Note that site "Tinaroo" has been unavailable from February 2018.

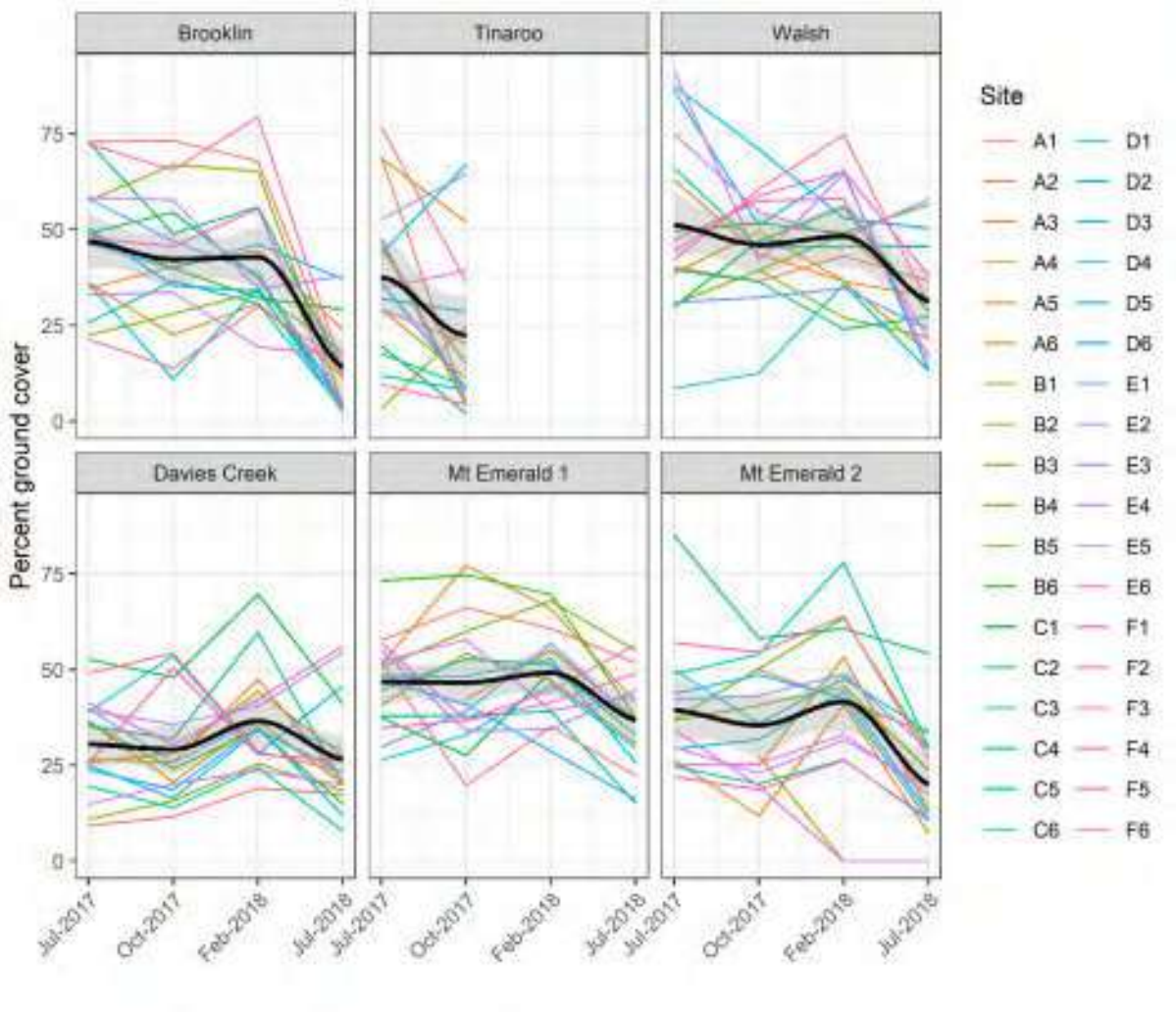


Fig. B3. The percentage of vegetative ground cover at each Biocondition station at each quoll monitoring site between July 2017 and July 2018. Individual plot measurements at each site are individually labelled for each site. Alphanumeric site numbers relate to the labelled stations in Fig 2. The thick black line represents an average value for each site, and the grey margin the standard error of that mean. Note that site "Tinaroo" has been unavailable from February 2018.

References

Efford, M. G. (2016) secr: Spatially explicit capture-recapture models. R package version 2.10.4. http://CRAN.R-project.org/package=secr.

Hines, J. E. (2006). PRESENCE- Software to estimate patch occupancy and related parameters. USGS-PWRC. <http://www.mbr-pwrc.usgs.gov/software/presence.html>.

D. WIND FARM IMPLEMENTATION PLAN APPROVAL

Australian Government
Department of the Environment and Energy

Our reference: 2011/6228

Mr Terry Johannesen
RATCH-Australia on behalf of Mount Emerald Wind Farm Pty Ltd
Suite F Level 1, 33 Queen Street
BRISBANE QLD 4000

Dear Mr Johannesen

Mount Emerald Wind Farm (EPBC 2011/6228)

Thank you for your email dated 24 April 2018 to the Department, seeking approval of the *Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland; 23 April 2018*, in accordance with condition 13 of the approval decision dated 26 November 2015.

Officers of this Department have considered the *Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland; 23 April 2018* and are satisfied that it meets the requirements of condition 13 of the approval for this project. On this basis, and as a delegate of the Minister for the Environment, I have decided to approve the *Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland; 23 April 2018*. This plan must now be implemented.

EPBC 2011/6228 condition 29 allows you (under certain circumstances) to implement revised plans without seeking the Minister's approval. If you require any advice on whether or not to submit a revised plan for approval, please contact the officer below. When submitting any revised plan to the Minister under condition 29, please provide a 'tracked changes' version of the plan. I also attach a fact sheet providing guidance on 'new or increased impact' relating to changes to approved management plans under EPBC Act environmental approvals.

Should you require any further information please contact Robin Nielsen, Project Officer, Post Approvals Section, on (02) 6274 1004 or email: post.approvals@environment.gov.au.

Yours sincerely

Chris Videroni
A/Assistant Secretary
Assessments (WA, SA, NT) & Post Approvals Branch
Environment Standards Division

4 May 2018

E. WIND FARM IMPLEMENTATION PLAN

Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland

Prepared for Ratch Australia

23 April 2018

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Document information

Report to: Mount Emerald Wind Farm Pty Ltd

Prepared by: Ian Smales

Biosis project no.:25362

File name: 25362.Mt.Emerald.Bat.Implementatio.Plan.FIN01.20180423

Citation: Biosis 2018. Implementation Plan for two species of bats at Mount Emerald Wind Farm, Queensland. Report for Mount Emerald Wind Farm Pty ltd. Author: I. Smales, Biosis Pty Ltd, Melbourne. Project no. 25362

Document control

Version	Internal reviewer	Date issued
Draft version 01	MV	16/08/2017
Draft version 02	MV	19/09/2017
Draft version 03	MV	08/12/2017
Draft version 03		15/02/2018
Final version 01	CH	23/04/2018

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in development of this plan:

- Terry Johannesen, Hugh Sangster: Ratch Australia
- Stuart Muir: Symbolix Pty Ltd
- Cindy Hull: Joule Logic Pty Ltd for peer-review

Contents

Executive Summary

This document is an Implementation Plan prepared to meet the requirements of Condition 13 of approval for Mount Emerald Wind Farm under provisions of the *Environment Protection and Biodiversity Conservation Act* 1999. Condition 13 is focussed on minimising potential effects on the EPBC Act threatened Spectacled Flying-fox and Bare-rumped Sheathtail Bat.

In summary, the plan sets out details of:

- intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare-rumped Sheathtail Bat;
- a study to evaluate the possible values to the two species of curtailed low wind-speed cut-in for wind turbines;
- monitoring of the wind farm's effectiveness against specified performance thresholds for the two species; and,
- contingency measures and potential corrective actions intended to ensure any effects on the two species do not exceed performance thresholds.

In addition to a detailed plan for implementation of specific items set out in Condition 13, explanatory background information and rationale underpinning the plan are provided.

1 Introduction

1.1 Background

Mount Emerald Wind Farm was approved, with conditions, under provisions of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) in 2011. The approval (number 2011/6228) allows for a maximum of 63 turbines at the wind farm site. Conditions 12 to 17 of the approval relate to the EPBC Act threatened Spectacled Flying-fox and Bare-rumped Sheathtail Bat. A variation to the approval of Condition 13 was granted on 31/07/2017 and is incorporated in the conditions reproduced below.

12. Prior to commissioning, the approval holder must evaluate the effectiveness of suitable measures, including changed cut-in speed, avian radar system and SCADA system, to avoid and mitigate the impacts of turbine collision to Spectacled Flying-fox (*Pteropus conspicullatus*)and Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) on the wind farm site.

13. Prior to commissioning, the approval holder must submit to the Minister for written approval, a Wind Farm Implementation Plan that is informed by the results of the evaluation required by condition 12. The Wind Farm Implementation Plan must include:

(a) details of intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare rumped Sheathtail Bat which are based on information contained in relevant guidance material including:

- *Matters of National Environmental Significance: Significant impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (2013);
- *EPBC Act Policy Statement 2.3 Wind Farm Industry* (2009); and
- *Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act* (2015).

(aa) a program to implement a Low Windspeed Curtailment Study;

(b) a program to monitor the effectiveness of progress against performance criteria; and

(c) contingency measures and corrective actions that will be implemented if performance criteria are not being or are not likely to be met.

14. The Wind Farm Implementation Plan must be reviewed by a suitably qualified expert prior to submission to the Minister for approval. The Wind Farm Implementation Plan must include the findings of the review undertaken by the suitably qualified expert and details of how any recommendations made by the suitably qualified expert have been addressed.

15. The approval holder must not commission the wind farm until the Wind Farm Implementation Plan has been approved by the Minister in writing.

16. The approved Wind Farm Implementation Plan must be implemented.

17. Upon the direction of the Minister, the approval holder must cease to operate any specified wind turbine generator/s if the Minister considers that, based on compliance reporting required by condition 26, they are having an impact on Bare-rumped Sheathtail Bat and Spectacled Flying-fox greater than the performance criteria required by condition 13(a) that cannot be mitigated or compensated.

In compliance with Condition 12 of the approval, Mount Emerald Wind Farm Pty Ltd commissioned Biosis Pty Ltd to undertake the evaluation of potential measures to avoid and mitigate the impacts of turbine collision. The evaluation is contained in Biosis (2017a) *Evaluation of potential mechanisms to reduce turbine collision risk for threatened bats at Mount Emerald Wind Farm, Queensland.*

Prior to the variation to the approval of Condition 13 granted on 31/07/2017, Condition 13 included a clause providing that the Wind Farm Implementation Plan should include details of intended outcomes and performance criteria based on the outcomes of population viability analysis and numerical collision risk modelling for the Spectacled Flying-fox and Bare-rumped Sheathtail Bat. Biosis provided Ratch Australia with a letter of advice (Biosis 2017b, dated 4th May 2017) about those aspects. In summary, it noted that neither numerical collision risk modelling nor population viability analysis was feasible for either species because there is no realistic capacity to obtain the numerical data required to undertake those processes for either species. This was accepted by the Commonwealth and the variation to Condition 13, worded as above, was granted.

The present document has been prepared as the Wind Farm Implementation Plan required by Condition 13 of the approval under the EPBC Act.

1.2 Mount Emerald Wind Farm

Mount Emerald Wind Farm is situated on a single rural property, formerly described as Lot 7 on Plan SP235244, and covering an area of approximately 2422 ha approximately midway between Mareeba and Atherton and 5 kilometres west of Walkamin in north Queensland (Figure 1).

The site is at the northern most end of the Herberton Range, which forms part of the Great Dividing Range. The site varies in altitude from 540 m ASL at the northern-most point along Kippen Drive to 1089 m ASL in the south-eastern most section closest to Mt Emerald. The north-western section of the site is dominated by Walsh's Bluff (907 m ASL).

The site is dominated by a series of three, approximately parallel high rhyolite ridges running in a south-east to north-west direction. There is a large area (~500 ha) of relatively flat country located in the western section. The site is dissected by a series of steep rocky ephemeral drainage lines and gorges, including the headwaters of a tributary of Granite Creek.

The site is intersected by Powerlink's Chalumbin to Woree 275 kV transmission line that roughly traverses the property. The site is not currently grazed by domestic stock and aside from the wind farm infrastructure, consists entirely of remnant vegetation. The site is located on the boundary of the Einasleigh Uplands and the Wet Tropics Bioregions, both of which are characterized by high levels of bioregional endemic flora and fauna species.

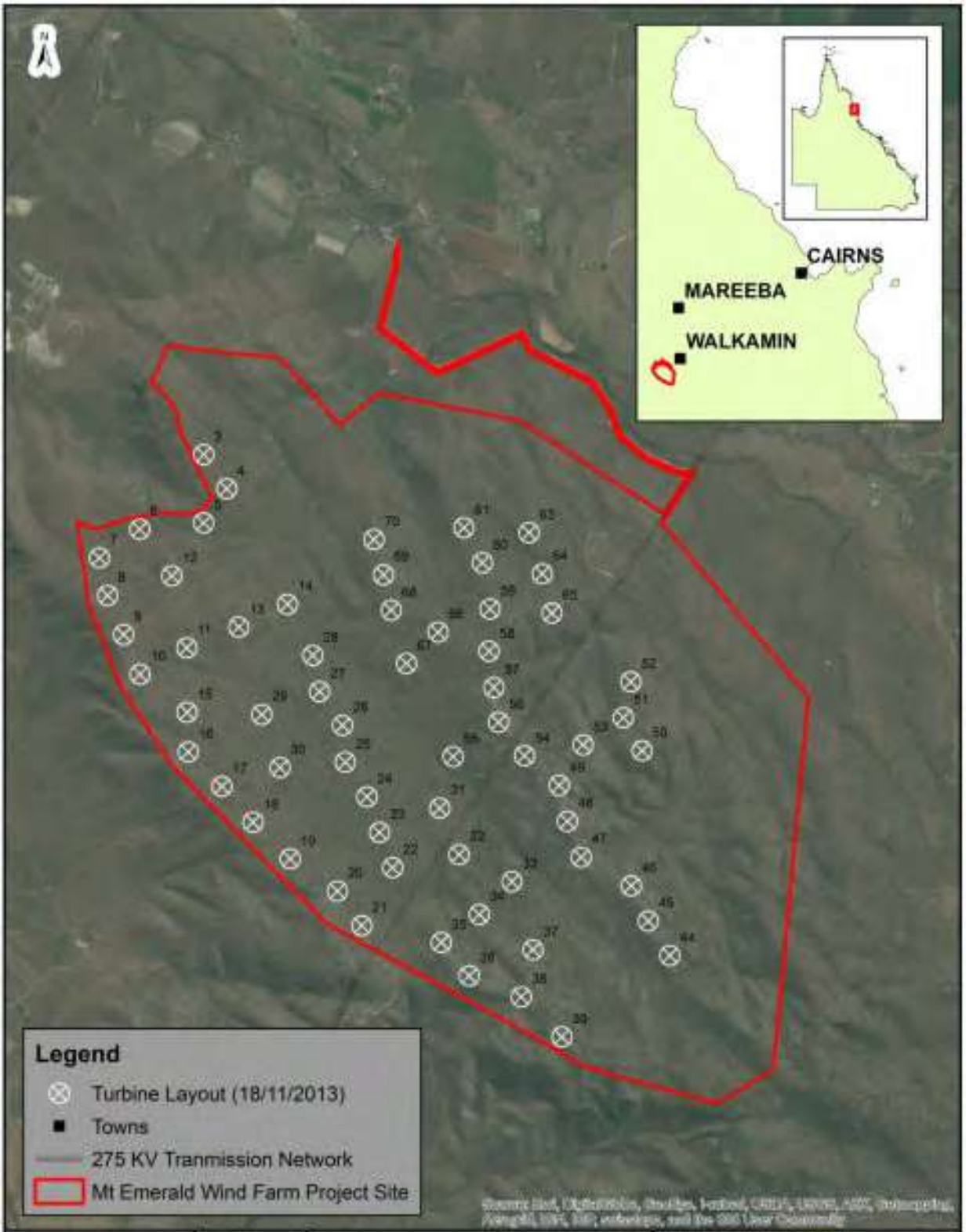
The constructed wind farm will consist of 53 wind turbines with an overall capacity of generating 180.5 MW. The complement of turbines is comprised of 37 x 3.45MW turbines with 117 meter diameter rotors on 90 metre towers and 16 x 3.3MW turbines with 112 metre diameter rotors on 84 metre towers. Associated infrastructure includes road access to all turbines, a hardstand under each turbine, a switchyard and staff facilities. The wind farm layout is shown in Figure 2.

The construction and operation of the facility has been subject to an environmental impact assessment process which identified a variety of potential effects on the biodiversity of the site. For the two species of bats that are the focus of the current plan, potential impacts include some permanent loss of habitat required for the wind farm infrastructure and the potential for collisions with turbines at are a risk for all volant fauna that may fly at rotor-swept height.

Condition 2 of the EPBC Act approval for the project says that,

> *"To minimise impacts to EPBC Act listed threatened species, the approval holder must not disturb more than 73 ha of habitat for EPBC Act listed threatened species on the wind farm site".*

Some of the vegetation removed may represent foraging habitat for the Spectacled Flying-fox and foraging and roosting habitat for Bare-rumped Sheathtail Bat. A detailed plan for habitat removal, including specifics of methods to avoid and minimise injury or mortality of bats during the construction phase has been provided by RPS (2010).



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Map Datum	GDA94
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Sheet Number	1 of 1

RACL

Mt Emerald Wind Farm
Project Location

RPS

RPS Australia East Pty Ltd
ACN 140 292 762
135 Abbott St
PO Box 1949
CAIRNS QLD 4870
T +61 7 4031 1336
F +61 7 4031 2942
W rpsgroup.com.au

Original Size	Date	Drawing No.	Issue
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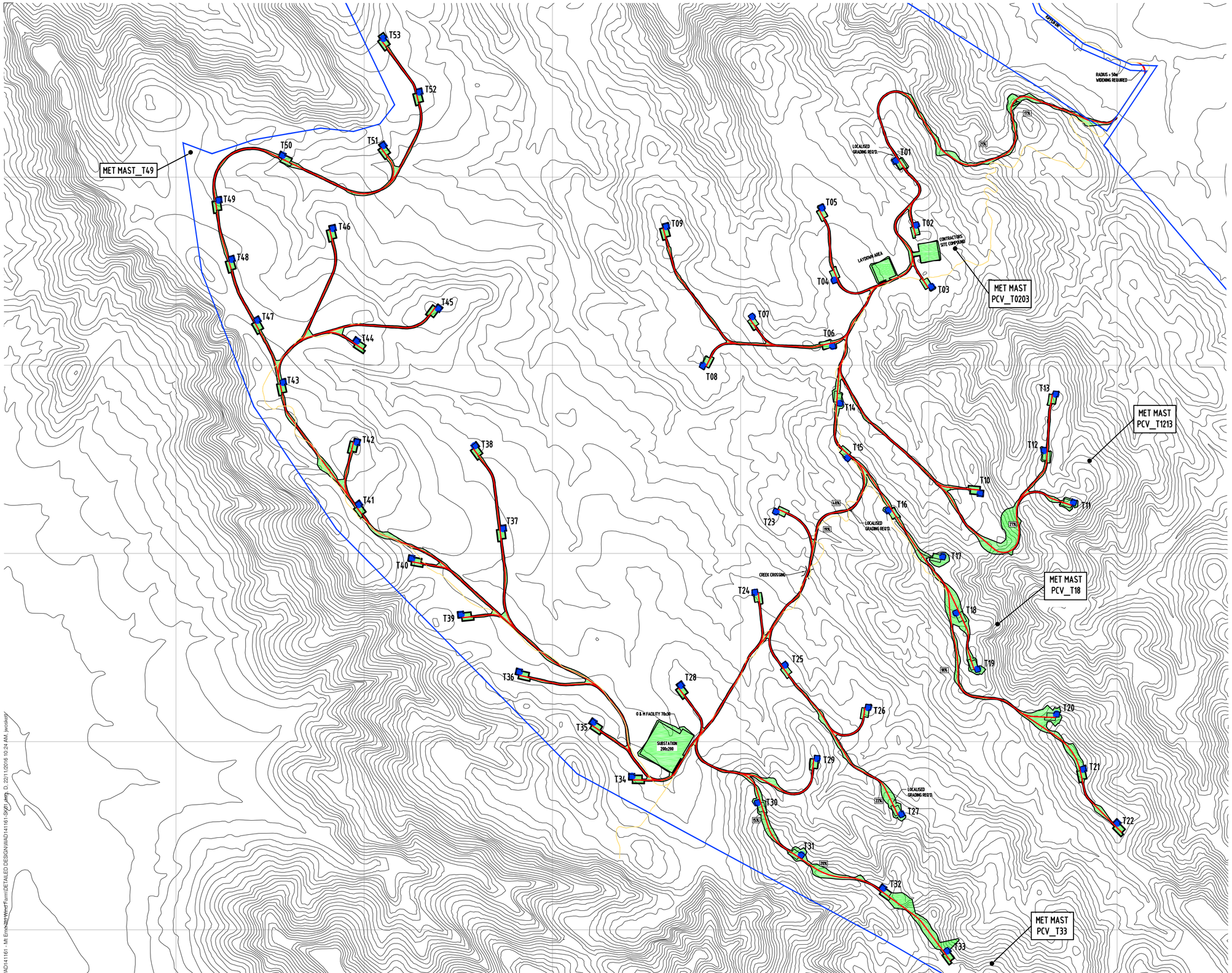

LEGEND

- T01 — PROPOSED TURBINE LOCATION
- PROPOSED WIND FARM ROAD
- 10m CONTOUR
- EXISTING ROADS
- PROPOSED BATTER EXTENTS (1 IN 2 BATTERS)

NOTE:

CONCEPT LAYOUT BASED ON 10m CONTOUR DATA ONLY
AREA OF PROPOSED BATTER EXTENTS = 71.8 HECTARES

TURBINE COORDINATES

T01	E. 328792	N. 8102560
T02	E. 328903	N. 8102219
T03	E. 328983	N. 8101892
T04	E. 328466	N. 8101926
T05	E. 328402	N. 8102310
T06	E. 328458	N. 8101575
T07	E. 328031	N. 8101732
T08	E. 327768	N. 8101472
T09	E. 327574	N. 8102211
T10	E. 329242	N. 8100793
T11	E. 329738	N. 8100745
T12	E. 329581	N. 8101021
T13	E. 329644	N. 8101320
T14	E. 328498	N. 8101272
T15	E. 328537	N. 8100981
T16	E. 328753	N. 8100703
T17	E. 329043	N. 8100457
T18	E. 329113	N. 8100157
T19	E. 329228	N. 8099859
T20	E. 329648	N. 8099620
T21	E. 329790	N. 8099328
T22	E. 329970	N. 8099041
T23	E. 328157	N. 8100695
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T38	E. 326556	N. 8101046
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T40	E. 326222	N. 8100448
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T44	E. 325930	N. 8101603
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T46	E. 325803	N. 8102201
T47	E. 325402	N. 8101713
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T49	E. 325197	N. 8102351
T50	E. 325535	N. 8102589
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T52	E. 326263	N. 8102926
T53	E. 326071	N. 8103211

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INFORMATION ISSUE
NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	06.10.16	CONCEPT INFORMATION ISSUE	BJH	RB	
B	17.11.16	TURBINES RENUMBERED	JJW	RB	
C	21.11.16	REVISED TURBINE NUMBERING AND MET MAST LOCATIONS	JJW	RB	
D	22.11.16	REVISED TURBINE NUMBERING	JJW	RB	

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MT EMERALD WIND FARM

TURBINE LOCATION AND DEVELOPMENT FOOTPRINT PLAN (TLDFP)

A1

DRAWING NUMBER
Job Number WAD141161 Sheet No. SK01 Rev. D

Design BJH Drawn BJH

2 Background information about Spectacled Flying-fox & Bare-rumped Sheathtail Bat for Mount Emerald Wind Farm

The Spectacled Flying-fox *Pteropus conspicillatus* and Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus* belong to different suborders of bats and differ from each other in many respects.

Investigations into the occurrence of both species that were undertaken specifically to inform statutory decisions for Mount Emerald Wind Farm are detailed in RPS (2013a). Both species were recorded at the site of Mount Emerald Wind Farm. Bare-rumped Sheathtail Bat was documented from a relatively small number of species-specific ultrasonic calls recorded there between 2010 and 2013. Spectacled Flying-foxes were also positively identified at the site during both late dry season and late wet season between 2010 and 2013. However, the majority of observations made during surveys for that species using night-vision goggles and thermal imaging were not able to consistently or reliably distinguish Spectacled Flying-fox from Little Red Flying-fox, although one or other, or both of those two species were documented from a broad range of locations across the site.

There is no empirical information from operating wind farms about turbine collision risk for either Spectacled Flying-fox or Bare-rumped Sheathtail Bat. As a consequence, while both species have been recorded at the site of Mount Emerald Wind Farm, the actual risk that turbines there may pose to either species is not known and there are numerous uncertainties entailed in consideration of this risk.

Uncertainties are not only due to the lack of experience with the two species at existing wind farms. They also are the result of very limited general understanding of behaviour and biology, especially in the case of the Bare-rumped Sheathtail Bat. Despite substantial survey effort for the two species at the site (RPS 2013a, b), there is still very little information about how either species uses the site.

We consider the following information, drawn from general knowledge of the two species, is relevant to the purposes of this plan which is aimed at improved understanding of potential turbine collision risks and at minimising such risk at Mount Emerald Wind Farm.

2.1 Spectacled Flying-fox

General information and biology

The Spectacled Flying-fox is a fruit and blossom feeder with a wingspan exceeding one metre and weight of more than 500 grams. Camps comprised of hundreds to thousands of individuals of these bats roost in trees in or close to rainforests during daylight. They fly out nightly to forage and return to the camp and may travel many kilometres in doing so (Churchill 2009).

Crepuscular and nocturnal flights by Spectacled Flying-foxes may cover several tens of kilometres but they are principally for the purpose of moving to and from sources of food (Churchill 2009). A Spectacled Flying-fox was recorded by RPS (2013b) feeding at blossom on the site and it is expected the species makes flights associated with foraging within the site when appropriate tree species are in flower.

If, or when no foraging opportunities are present on the site, Spectacled Flying-foxes may fly through or over the site to reach food sources beyond it. It is possible such commuting flights may be concentrated on particular periods of the night (possibly close to dusk and prior to dawn), but that has not been determined.

The heights at which Spectacled Flying-foxes routinely fly are not known and attempts to determine them using night vision equipment and thermal imaging at the site were not successful (RPS 2013b). Flights above

or below turbine rotor-swept height do not represent a collision risk. The risk of collision will be substantially influenced by the heights of the species flights at the site.

Similarly, it is not known how flight activity of Spectacled Flying-foxes is correlated with wind-speed, but they are large, powerful flyers and are not likely to be affected by relatively small changes in wind-speed to the extent some species of small bats are.

Flying-foxes use their excellent colour vision as their primary means for navigation in flight. They do not echolocate using ultrasonic calls. Consequently, it is likely their capacity to actively avoid collisions with turbines may be similar to that of crepuscular and nocturnally-flying birds and less like that of insectivorous bats that primarily use echolocation to navigate.

The species is known in Australia from major rainforest tracts in North East Queensland and Torres Strait. It also occurs in Papua New Guinea and the Solomon Islands (Churchill 2009).

Substantial census information for the Australian population of Spectacled Flying-fox is provided by CSIRO through the National Flying-fox Monitoring Programme which uses counts of flying-fox camps to census populations. A summary covering the period from 2005 to 2014 is contained in Westcott et al. (2015). The Australian Spectacled Flying-fox population counts declined from 214,750 in November 2005 to 92,880 in November 2014. The effects of two major cyclones on roost trees and food trees are considered to have been the primary causes of the observed decline, but human impacts are also believed to have involved. More recent information about individual roost camps is provided in reports of individual counts until August 2017 (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf).

Spectacled Flying-fox at Mount Emerald

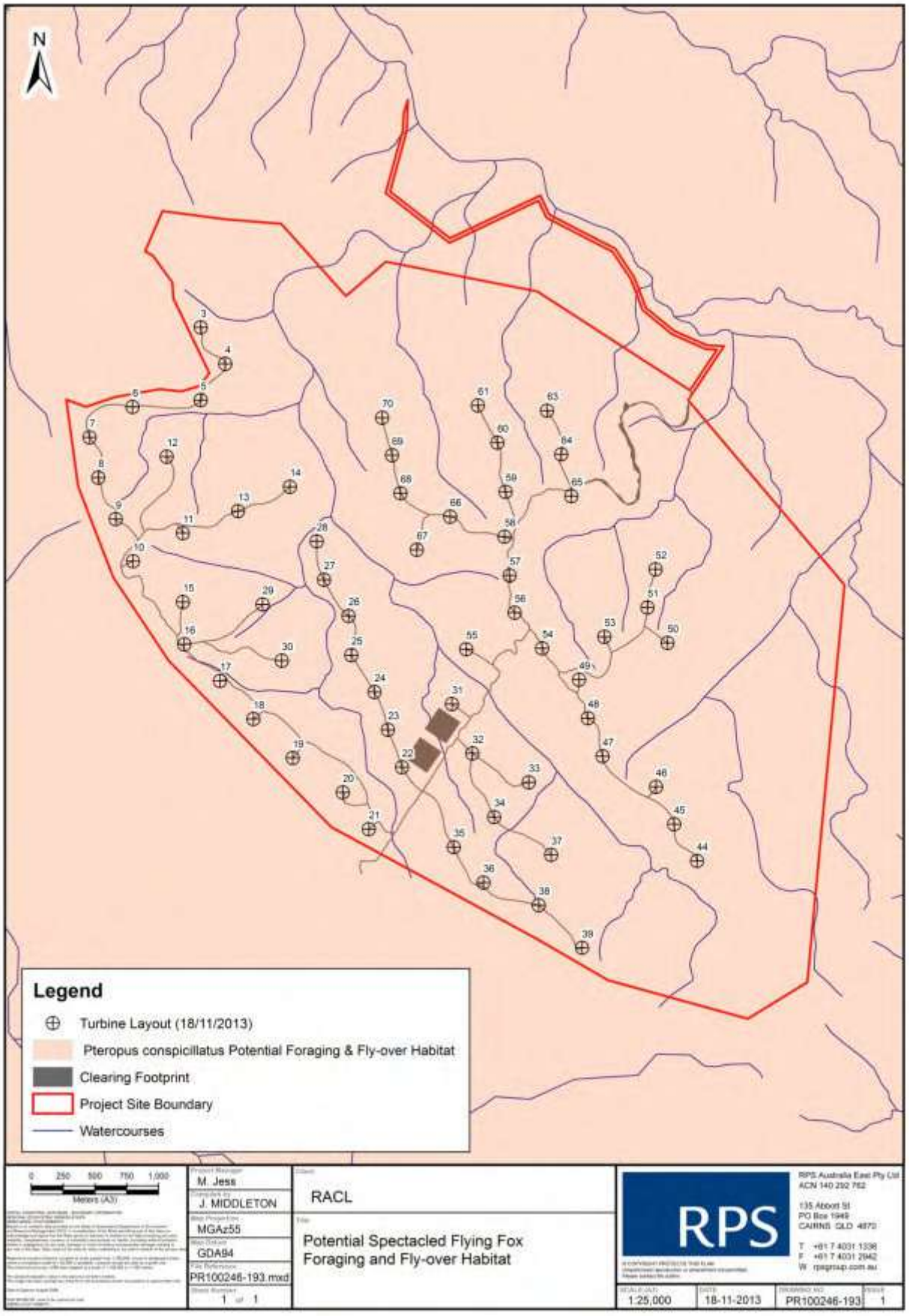
In regard to the suitability of the Mount Emerald Wind Farm site for Spectacled Flying-foxes RPS (2013b) said:

> *"The EPBC referral submitted for the project concluded that there was a low likelihood of* P. conspicillatus *occurring on the site due to the absence of closed rainforest roosting habitat (RPS, 2009). However,* P. conspicillatus *is now known to forage extensively in other vegetation communities such as eucalypt and Melaleuca e including the wet and dry sclerophyll habitats of the Herberton Range adjacent to the proposed High Road and [Mount Emerald] wind farms (D. Westcott, pers. comm.) and is also known to forage on the fruits of Wild Tobacco (*Solanum mauritianum*) (Eggert, 1994, Spencer et al., 1992), which is an abundant introduced plant occurring in disturbed habitats on the Atherton Tablelands."*

The *EIS Mount Emerald Wind Farm Volume 2* (RPS 2014) Figure 18.1 (reproduced below) shows foraging and fly-over habitat for Spectacled Flying-foxes across the entire wind farm site and surrounding local landscape.

Spectacled Flying-foxes frequently make flights during daylight in the immediate area in which they roost, however there is no rainforest suitable for daytime roost camps of the species on the site. Hence any risk of turbine collisions for this species will essentially be confined to the overnight period from dusk until dawn when animals may fly from nearby roost camps outside the site and either commute across the site or move into it to forage.

As noted in the *EIS Mount Emerald Wind Farm Volume 2* (RPS 2014), Spectacled Flying-foxes can have daily feeding ranges of over 50 kilometres from their roost sites. Figure 18.2 of that report shows potential for animals from known roost locations in the Wet Tropics to reach the Mount Emerald site.


N
Legend
Turbine Layout (18/11/2013)
Pteropus conspicillatus Potential Foraging & Fly-over Habitat
Clearing Footprint
Project Site Boundary
Watercourses
0 250 500 750 1,000
Meters (A3)
M. Jess
J. MIDDLETON
MGAz55
GDA94
PR100246-193.mxd
1 of 1
RACL
Potential Spectacled Flying Fox
Foraging and Fly-over Habitat
RPS
RPS Australia East Pty Ltd
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135 Abbott St
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18-11-2013
PR100246-193
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Given that there are active roost camps within a closer radius of the site, all documented flying-fox roost camps within 30 kilometres of Mount Emerald Wind Farm were identified from the National Flying-fox Monitoring Programme (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf accessed 09 February 2018). Information from all for these camps is summarized as follows. The closest active roost camps of Spectacled Flying-foxes are at Tolga Scrub, approximately 6 kilometres from the closest point of the wind farm; and four camps at Mareeba are approximately 15 kilometres from the closest point of the wind farm. Two other roost camps in the region (Mareeba, Leinster Park (866) and Nassers Fragment (838) at Atherton) have not been surveyed and are considered to be inactive. A site at New Powley Road (690), near Lake Tinnaroo has been surveyed but no flying-foxes found. The Lakeside (684) site near Yungaburra was estimated variously to have between 2,500 up to 49,999 in counts in 2012 and 2013 but no more recent information is available.

In targeted investigations of Spectacled Flying-foxes at the Mount Emerald Wind Farm site RPS (2013b) positively identified the species during late dry seasons and late wet seasons between 2010 and 2013. However, the majority of observations made during surveys for the species using night-vision goggles and thermal imaging were not able to consistently or reliably distinguish Spectacled Flying-fox from Little Red Flying-fox *Pteropus scapulatus*. *Pteropus* spp. individuals were recorded at 12 of 21 survey sites spread across the wind farm site, with individual flying-foxes observed in both the Wet Tropics Bioregion and the Einasleigh Uplands Bioregion portions of the site. A total of 67 individual observations were documented of *Pteropus* spp. during the surveys, of which only two individuals could be confidently identified as *P. conspicillatus*. As a result, although one or other of these flying-fox species was documented from a broad range of locations across the site, the actual utilisation of the site by Spectacled Flying-foxes remains poorly understood. It is possible Black Flying–fox *Pteropus alecto* may also occur at the site.

During incidental observations, RPS (2013b) observed a single Spectacled Flying-fox individual foraging in a flowering *Melaleuca viridiflora* tree approximately 3 metres above the ground. In evaluation of weeds at the site, RPS (2010) did not find Wild Tobacco.

Methods to detect Spectacled Flying-foxes tested by RPS (2013b) proved suitable for collection of presence/absence data on site, but detailed abundance and flight height data were not able to be obtained due to technical limitations of all techniques tested and difficulties of access and movement around the site due to the ruggedness of its terrain.

While it is known the Mount Emerald site does not contain suitable habitat for the species to use as roost camps, the limitations outlined above mean there is no empirical basis distinguishing or mapping any other resources or areas within the wind farm that may be more or less likely to be used by the species.

Information from the National Flying-fox Monitoring Programme shows the Australian population of Spectacled Flying-fox, which is confined to Queensland, is both relatively large and is subject to significant natural variation.

Table 1 shows information about the locations and census information for the species roost sites close to the Mount Emerald site obtained from the National Flying-fox Monitoring Programme (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf accessed 09 February 2018). Two other roost camps in the region (Mareeba, Leinster Park (866) and Nassers Fragment (838) at Atherton) have not been surveyed and are considered to be inactive.

The National Flying-fox Monitoring Programme provides numbers of animals counted at each census for each roost camp categorised as follows:

Flying-fox Numbers category
1 = 1-499
2 = 500-2,499
3 = 2,500-9,999
4 = 10,000-15,999
5 = 16,000-49,999
6 = >50000

Table 1 Spectacled Flying-fox census data for five roost camps closest to Mount Emerald Wind Farm

Numbers for census months as per National Flying-fox Monitoring Programme categories

Site name & number	Count month										Census range (min - max) over past three years
	May 2015	Aug 2015	Nov 2015	Feb 2016	May 2016	Aug 2016	Nov 2016	Feb 2017	May 2017	Aug 2017	
Tolga Scrub (698)	5	5	5	4	3	3	3		3	3	**2,500 - 49,999**
Mareeba (686)				2							**500 - 2,499**
Mareeba Hospital (687)	3	2									**500 - 9,999**
Mareeba, Swimming pool (937)									3		**2,500 - 9,999**
Mareeba, Stewart St (890)								3			**2,500 - 9,999**

Queensland Department of Environment and Heritage (EHP) mapping (2016) provides less detail but shows the closest known Spectacled Flying-fox roost sites to be at Mareeba Granite Creek, Mareeba Barron River and Tolga Scrub (https://www.ehp.qld.gov.au/wildlife/livingwith/flyingfoxes/pdf/roosts/map39.pdf accessed 08 February 2018). These roosts are not among those routinely monitored by EHP.

The National Flying-fox Monitoring Programme census data for given roost camps provide estimates of maximum and minimum numbers within a range of several hundred or thousand individuals. We understand this is due to the difficulty of counting the animals in rainforest environments and to allow for natural variation and exchange of animals between nearby camps. For the five roost sites the cumulative total census numbers for the past three years range from a minimum of 8,500 to a maximum of 82,495.

In summary, it is likely that Spectacled Flying-foxes from nearby roost camps will visit the Mount Emerald Wind Farm site when flowering trees such as *Eucalyptus*, *Corymbia*, and *Melaleuca* species are in blossom. It is also possible Spectacled Flying-foxes may fly across the site between roost camps and locations of food resources outside the site. Any such flights that are at the height swept by turbine rotors will have some associated risk of collisions.

2.2 Bare-rumped Sheathtail Bat

General information and biology

The Bare-rumped Sheathtail Bat weighs approximately 50 grams. Little is known of the species biology as it is rarely trapped or recorded during bat surveys (Armstrong et al. 2014; Churchill 2009) using the range of techniques routinely used to detect insectivorous bat species.

In Australia the species is known from two distinct populations, one in coastal Queensland from around Townsville to near Coen, and another in the top end of the Northern Territory. The species has a wide distribution from India through south-eastern Asia and New Guinea to the Solomon Islands (Churchill 2009).

The most up-to-date collation of information about the population of this species in Australia is contained in the 2016 EPBC Act Conservation Advice for the species (Threatened Species Scientific Committee 06/09/2016). It includes the following information:

- There is no robust estimate of population size. Population data are limited as only a small number of roost sites have been found in Australia.
- Although there is no robust estimate of population size, considering the subspecies' wide distribution, the number of mature individuals is very likely to be greater than 1000.
- Woinarski et al. (2014) and Armstrong (2016) suspect the number of mature individuals to be greater than 10 000, given that there is likely to be good roosting potential for the species in a significant proportion of the available habitats across its broad distribution.
- Given the limited data available, the number of roost sites and average number of individuals per roost site across the species distribution cannot be reliably estimated.

Small groups of Bare-rumped Sheathtail Bats roost in hollows in large eucalypts during daylight hours. The heights at which Bare-rumped Sheathtail Bats routinely fly are not known, although they are believed to forage for aerial insects mainly above tree canopy height (Churchill 2009). Bare-rumped Sheathtail Bats echolocate using ultrasonic calls as their primary means for navigation in flight.

Distinguishing sonograms of recorded calls of Bare-rumped Sheathtail Bat from other species of *Saccolaimus* and of Beccari's Freetail Bat *Mormopterus beccarii* has proven difficult and many calls cannot be ascribed to a particular species with complete certainty. Use of full spectrum detectors has somewhat improved this because they have capacity to provide more information on call harmonics that are useful in discriminating the species, than could generally be obtained from zero crossed based systems. However, capture of calls that have sufficient definition for this purpose is reliant on the bat flying close enough to the detector microphone for the relevant parts of the call signal to be recorded.

Other suggested methods to survey for the species include mist-netting using nets set high within or above the tree canopy and targeted searches for roost sites in trees with large hollows (Commonwealth of Australia 2010).

Bare-rumped Sheatail Bat at Mount Emerald

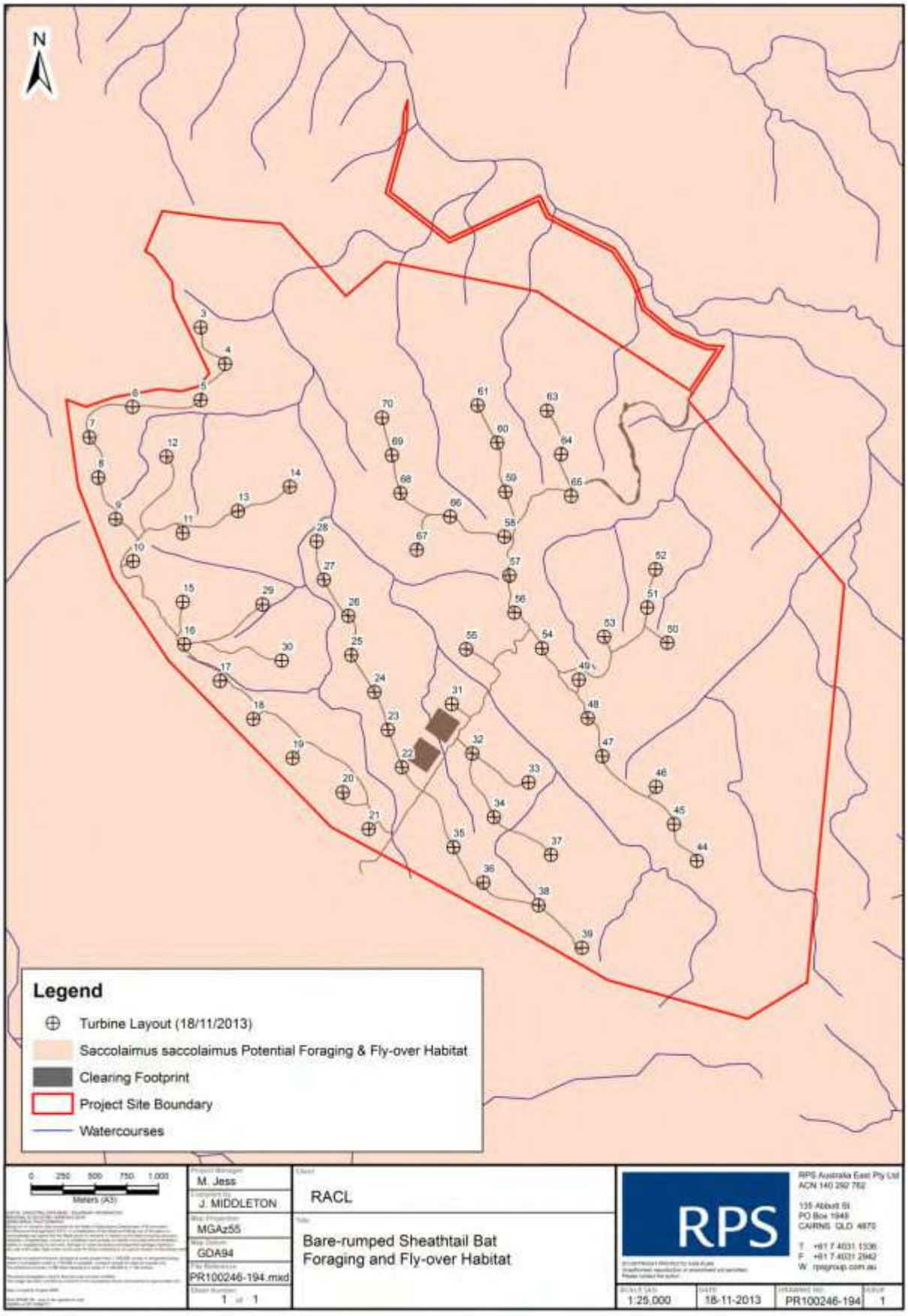
Bare-rumped Sheathtail Bat was recorded at the Mount Emerald Wind Farm site from a relatively small number of species-specific ultrasonic calls recorded there between 2010 and 2013, but they were from six locations spread widely across the site that sampled both the Wet Tropics Bioregion and the Einasleigh Uplands Bioregion portions of the site. A small number of additional calls detected may have been from this, or one of three other species (RPS 2013a).

Bare-rumped Sheathtail Bat was one of 17 microchiropteran bat species documented with a high degree of confidence at the site and a further three to six species were possibly recorded there (RPS 2013a). Calls of Bare-rumped Sheathtail Bats were not common when compared with those of some other small bat species encountered during surveys at the site (RPS 2013a). This agrees with a general low encounter rate despite the distribution of the species in Australia which extends along much of the coastal zone of northern Queensland.

Due to the high number of other small species of bats known to use the site, the capacity to distinguish the Bare-rumped Sheathtail Bat from other species is almost certainly limited to detection of bat-calls. Methods such as use of thermal imaging do not offer the capacity to discriminate between the various species present. Survey for the species using mist-nets set high within or above the tree canopy and targeted searches for roost sites in trees with large hollows would present significant challenges due to the difficult terrain and near complete cover of trees at Mount Emerald Wind Farm site and, while such surveys might provide further information about presence of the species there, neither would be likely to offer additional information about the risk of Bare-rumped Sheathtail Bat collisions with turbines.

Saccolaimus bats, including the Bare-rumped Sheathtail Bat, are thought to have capacity to travel substantial distances from roost locations to forage locations but it appears the Mount Emerald site offers habitat suitable for all the requirements of the species and it is likely to be resident there. It is thus possible the species may fly widely within the site on almost any night when weather conditions are suitable. The limitations outlined above mean there is no empirical basis distinguishing or mapping any particular resources or areas within the wind farm that may be more or less likely to be used by the species. The *EIS Mount Emerald Wind Farm Volume 2* Figure 17.2 (reproduced below) shows foraging and fly-over habitat for Bare-rumped Sheathtail Bats across the entire wind farm site and surrounding local landscape.

In summary, it appears a small number of Bare-rumped Sheathtail Bats are likely to use the Mount Emerald site. Any of their flights that are at the height swept by turbine rotors will have some associated risk of collisions.


N
Legend
Turbine Layout (18/11/2013)
Saccolaimus saccolaimus Potential Foraging & Fly-over Habitat
Clearing Footprint
Project Site Boundary
Watercourses
0 250 500 750 1,000
Meters (A3)
M. Jess
J. MIDDLETON
MGAz55
GDA94
PR100246-194.mxd
1 of 1
RACL
Bare-rumped Sheathtail Bat
Foraging and Fly-over Habitat
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3 Evaluation of potential measures to reduce or mitigate impacts on bats

Condition 12 of the approval of Mount Emerald Wind Farm under provisions of the EPBC Act required Mount Emerald Wind Farm Pty Ltd to undertake a review and evaluation of mechanisms that might assist in reduction of turbine collision risk for Spectacled Flying-foxes and Bare-rumped Sheathtailed Bats at the proposed wind farm. For the purposes of reducing impacts the term 'collision' is used to apply both to incidents in which a bat physically strikes, or is struck by the moving rotor of a turbine and to the potential for barotrauma. Barotrauma in bats has been described by Baerwald *et al.* (2008) as the fatal effect on an animal's respiratory tract due to its encountering a rapid change in air pressure close to a moving turbine blade. The effect has since been questioned as it has been shown to be difficult to diagnose and may have been confused with traumatic injury associated with direct collisions (Rollins *et al.* 2012). Nonetheless, it remains prudent to include the possibility of barotrauma in the present context.

Biosis (2017a) provided the required evaluation of a range of potential mechanisms and that report should be read in full for relevant details. Its findings and recommendations are summarized in Section 3.1. The review is specifically intended to assess the applicability of potential methods for the two species at the Mount Emerald Wind Farm.

3.1 Summary of potential mechanisms to reduce collision risk

The Biosis (2017) review found:

- Use of low wind speed turbine curtailment may be applicable although at present no information is available about response to wind speed by the two species of concern. An adaptive management approach for the use of this method was recommended. It would use initial controlled experiments in which a subset, or subsets, of turbines are programmed to cut-in at different defined wind speeds and the incidence of collisions by both species is documented to ascertain whether the incidence of collisions differs according to cut-in wind speed. On that basis a determination can then be made about whether low wind speed turbine curtailment would be of value to reducing collisions and if so, what wind speeds should be applied to turbine cut-in.
- Some methods intended to deter bats for approaching wind turbines have been tried overseas. Due to the entirely experimental nature of these possible deterrent techniques, they are not considered to be applicable for the two species of concern at Mount Emerald.
- Current information suggests that systems for turbine shut-down and re-start triggered by radar are not applicable to the specific and individual requirements for reduction of collision risk for the two bat species of concern at Mount Emerald.
- Systems for turbine shut-down and re-start triggered by ultrasonic bat calls are not applicable to Spectacled Flying-fox because the species does not use ultrasonic calls. Current limitations due to inability to obtain consistent, accurate identification of Bare-rumped Sheathtail Bat; call-detection distance relative to size of turbines; and time taken for turbine shut-down, indicate that such systems do not have capacity to achieve meaningful reduction of collision risk for the species.
- Systems using thermal imaging and acoustic sensors do not offer the capacity for automated shut-down and re-start of turbines and are not applicable to reduction of turbine collision risk.

On the basis of that evaluation, further consideration of low wind-speed curtailment is provided below.

3.2 Low wind-speed curtailment for bats

Background

A number of investigations overseas have demonstrated that flight activity of small species of bats is concentrated on periods when wind-speeds are relatively low (e.g. Arnett et al. 2009; Arnett 2017; Martin et al. 2017).

A wind turbine will not turn under zero wind conditions, but as the wind increases, the rotating speed of the turbine will also increase until it reaches a point where it is effective to generate electricity, this point is known as the 'cut-in' wind speed. The manufacturer's rated cut-in speed for both of two types of turbines planned to be used at Mount Emerald is 3.0 metres per second (m/s).

In recent years various studies have investigated whether a reduction in bat fatalities due to turbine collision can be achieved by the relatively simple measure of programming the turbines to alter their night-time operation so that their rotors do not turn during periods of specified low wind speed when many species of bats are most active (Arnett et al. 2009; Arnett 2017). This is termed 'low wind-speed turbine curtailment'.

There may be two phases to low wind-speed turbine curtailment. They are summarised as follows:

> **Phase 1**. The blades of some turbine models turn, at wind speeds between zero and the turbine's rated cut-in speed. In that situation a turbine 'freewheels' and has potential to kill bats even when no electricity is being generated. In this situation, the rotor blades can be feathered to prevent the rotor from turning until the rated cut-in wind speed is reached. This curtailment involves no loss of electricity generation.
>
> **Phase 2**. In this phase the turbine rotors are prevented from turning until a specific, pre-determined wind speed above the rated cut-in speed is reached. This curtailment involves loss of electricity generation for wind speeds between the rated cut-in speed and the pre-determined higher wind speed.

The majority of published studies of low wind-speed curtailment intended to protect bats have been undertaken in North America and the species primarily involved have been migratory, tree roosting bat species with relatively high incidences of collisions. They include Hoary Bat *Lasiurus cinereus*, Eastern Red Bat *Lasiurus borealis*, Silver-haired Bat *Lasionycteris noctivagans* and Big Brown Bat *Eptesicus fuscus*.

Low wind speed curtailment has been demonstrated to be an effective operational measure to reduce fatalities of these bats at a number wind farms in the U.S.A. and Canada. In some jurisdictions of the USA and Canada turbine cut-in speed has been mandated with a view to reducing collisions of migratory bats. All documented investigations of low wind speed curtailment have involved Phase 1 curtailment and the great majority have also involved Phase 2 curtailment up to a wind speed a little above the turbines' rated cut-in speed.

Arnett (2017) provides a review of current information which was set out in detail in Arnett et al. (2013). The latter provides a detailed synthesis of ten low wind speed curtailment studies. A number of variables between wind farms, turbines, study methods and species of bats were included among the ten studies, but all compared bat fatality rates at non-curtailed turbines with curtailed turbines. The great majority of the studies demonstrated at least a 50% reduction in bat fatalities when turbine cut-in speed was increased from manufacturers' rated cut-in speed by at least 1.5 m/s.

As an indication of the likely mechanism by which collision risk is influenced by cut-in wind speed, even at quite low wind speeds, Arnett et al. (2013) note that independent of blade length, most of the turbines under full operating conditions, had tip speeds at or above 160 km/h. Almost all turbines undergoing normal operations (i.e. when blades were not feathered) had tip speeds in excess of 80 km/h, even when wind

speeds were below the normal cut-in, which suggests that measures such as feathering blades below rated cut-in speed can be taken to reduce tip speeds and consequent hazard to bats, even without increasing turbine cut-in speeds above the manufacturers' set cut-in speed.

One study demonstrated equally beneficial reductions with a low-speed idling approach, while another discovered that feathering turbine blades at or below the manufacturer's cut-in speed resulted in up to 72% fewer bats killed when turbines produced no electricity into the power grid (Arnett 2017).

The investigations detailed in Arnett et al. (2013) were all timed to coincide with the peak migration season of relevant species (late summer – early autumn in the northern hemisphere) and for all but one of them, in which the study encompassed the relevant season in two years, the study of curtailed turbines covered a period of less three months or less.

More recently, Forcey et al. (2016) conducted a 2-year study at Raleigh Wind Energy Centre in south-western Ontario to compare bat mortality at wind turbines curtailed at 3.5 m/s vs 4.5 m/s (2014) and 4.0 m/s vs 4.5 m/s (2015). In 2014, bat mortality at turbines with a 3.5 m/s cut-in speed were significantly higher than turbines curtailed at 4.5 m/s across all species ($P = 0.001$). During 2015, bat mortality at turbines curtailed at 4.0 m/s was similar to mortality at turbines curtailed at 4.5 m/s ($P > 0.10$). As the 2015 study did not show significant differences in estimated bat mortality between 4.5 m/s and 4.0 m/s cut-in speeds, they suggest that implementing the 4.0 m/s cut-in speed compared to a 4.5 m/s cut-in speed would not increase estimated bat mortality, but would increase the electricity generated at the project through increased operational time, while keeping the mortality below a prescribed threshold.

At two wind farms in Hawaii, Snetsinger et al. (2016) compared bat mortality data from 2 – 3 years of uncurtailed turbines with 1 – 2 years of data for turbines curtailed to cut-in wind speeds of 5 m/s and 5.5 m/s. They found substantial between-year variance in bat mortality and that low wind-speed turbine curtailment did not always coincide with reduced mortality of Hoary Bats, but it did in some seasons and they recommended the application of low wind-speed curtailment.

Two recent investigations have considered refinements to the simple blanket measure of a low wind-speed turbine curtailment, particularly with a view to enacting curtailment in a fashion that is better tailored to periods of actual bat activity. Sutter et al. (2016) and Martin et al. (2017) investigated the relationship of bat activity and/or bat turbine collisions to a combination of wind speed and ambient temperature. The results of these studies showed promise of capacity to reduce the incidence of bat collisions while minimizing the loss of electricity generation in the North American situation for migratory bats.

Applicability to Mount Emerald Wind Farm

Low wind speed curtailment is not known to have been undertaken in Australia and its applicability as a method to reduce turbine collisions by any species of bat here is unknown.

The present plan sets out an investigation of low wind speed curtailment for Mount Emerald. Because there are multiple uncertainties about the utility of low wind speed curtailment as a mechanism to reduce risk to Bare-rumped Sheathtail Bat and Spectacled Flying-fox, the study set out here is designed as an experiment that has potential value to the species concerned, but also offers good opportunity to learn about the values of this mechanism in an Australian environment.

Relative to what has been demonstrated in North America, a variety of factors may influence the applicability and values of low wind speed curtailment for Bare-rumped Sheathtail Bat and Spectacled Flying-fox at Mount Emerald. Amongst them are the following:

- A factor common to substantial incidence of bat collisions in America is that it involves long-distance migratory species and occurs during relatively short periods of the year that coincide with large numbers of bats during their migration movements. In general, Australia does not have migratory

bats and the two species of bats of concern at Mount Emerald Wind Farm are not known to have seasonal and geographical concentrations of the types that occur in long-distance migratory species.

- The principal species of bats that have been benefitted by low wind speed curtailment in North America differ substantially in both morphology and behaviours from Bare-rumped Sheathtail Bat and Spectacled Flying-fox. The morphology and behaviours of Bare-rumped Sheathtail Bat and Spectacled Flying-fox are very different from each other and it seems likely the responses of the two species to wind turbines and to low wind speed curtailment may differ considerably.

4 Potential for significant impacts & defined performance criteria

While the most desirable outcome for Mount Emerald Wind Farm is that it will operate without any negative effect on the two species of bats, it is recognised some impact may occur.

The overarching objective will be that the wind farm does not have a significant impact on the viability of the population of either species.

It is important to define a level of effect on each of the Spectacled Flying-fox and Bare-rumped Sheathtail Bat which might constitute a 'significant impact' and to ascertain the likelihood of that occurring.

Secondarily, it is necessary to determine and set performance criteria and establish means to monitor the effectiveness of the wind farm in achieving performance goals.

4.1 Defining a significant impact

The following discussion outlines the approach to determine and define relevant criteria for measuring what would constitute a 'significant impact' on the two species of bats.

The Bare-rumped Sheathtail Bat and Spectacled Flying-fox are both listed as vulnerable under provisions of the EPBC Act. Australian Government policies for the EPBC Act provide a set of principles and criteria for determining what may constitute a 'significant impact' on a vulnerable species. We note the possibility of the wind farm resulting in a significant impact has been considered in the EIS process undertaken in the approvals process for the wind farm but at present there is no certainty about whether any impact may actually be significant as per the relevant criteria. The approach set out here uses the criteria and principles of EPBC Act policies to further consider the potential for the wind farm to result in a significant impact on either species.

The primary policy guidance and significant impact criteria relevant to Bare-rumped Sheathtail Bat and Spectacled Flying-fox are provided in:

- *Matters of National Environmental Significance: Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2013).

Guidance and relevant principles are also provided in:

- *EPBC Act Policy Statement 2.3 Wind Farm Industry* (Commonwealth of Australia 2009).
- *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (Commonwealth of Australia 2015a).

The EPBC Act Policy Statement *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (Commonwealth of Australia 2015b) is applicable to management actions within flying-fox camps. Mount Emerald Wind Farm site does not encompass any camps and the guideline is thus not applicable to the wind farm.

4.1.1 EPBC Act significant impact criteria

The criteria for what may constitute a significant impact on a vulnerable taxon are set out in *Matters of National Environmental Significance: Significant impact guidelines 1.1* (Commonwealth of Australia 2013) as follows:

> *"An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:*
>
> *• lead to a long-term decrease in the size of an important population of a species*
>
> *• reduce the area of occupancy of an important population*
>
> *• fragment an existing important population into two or more populations*
>
> *• adversely affect habitat critical to the survival of a species*
>
> *• disrupt the breeding cycle of an important population*
>
> *• modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
>
> *• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*
>
> *• introduce disease that may cause the species to decline, or*
>
> *• interfere substantially with the recovery of the species."*
>
> *An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*
>
> *• key source populations either for breeding or dispersal*
>
> *• populations that are necessary for maintaining genetic diversity, and/or*
>
> *• populations that are near the limit of the species range.*

Spectacled Flying-fox

The site of Mount Emerald Wind Farm is not used for breeding by Spectacled Flying-foxes and this species disperses widely across all types of habitat. The population of the species that uses the site thus does not represent a key source populations either for breeding or dispersal.

As the site is not used for breeding by Spectacled Flying-fox, it does not contribute to maintenance of the species genetic diversity.

The site is not near the limit of the Spectacled Flying-fox distributional range.

The populations of Spectacled Flying-foxes that may use the site thus do not meet the defined criteria for an 'important' population' as used in dot points 1, 2, 3 and 5 of the criteria.

Within the wide range and diversity of habitats used by Spectacled Flying-foxes the Mount Emerald Wind Farm site does not represent *habitat critical to the survival of a species.*

Effects on habitat for Spectacled Flying-foxes associated with development and operation of Mount Emerald Wind Farm are not *to the extent that the species is likely to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *result in invasive species that are harmful to the species becoming established in the species' habitat.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *introduce disease that may cause the species to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *interfere substantially with the recovery of the species.*

In summary, evaluation of the potential effects on the Spectacled Flying-fox indicate they do not constitute a significant impact on the species.

Bare-rumped Sheathtail Bat

Bare-rumped Sheathtail Bats may breed at Mount Emerald Wind Farm site but information about the species indicates that it breeds in tree hollows across a widely dispersed range in Queensland and the Northern Territory. There are thus, no known 'key' source breeding or dispersal populations that can be differentiated from any others.

There is no information to suggest any subpopulation of Bare-rumped Sheathtail Bats or any resource used by the species is more important than any other for maintaining genetic diversity.

The site is not near the limit of the Bare-rumped Sheathtail Bat distributional range.

The population of Bare-rumped Sheathtail Bats that may use the site thus does not meet the defined criteria for an 'important' population' as used in dot points 1, 2, 3 and 5 of the criteria.

The Queensland population of Bare-rumped Sheathtail Bats is known to extend in a zone extending from approximately Bowen to Cooktown. Within this range there is no basis for consideration that the Mount Emerald Wind Farm site represents *habitat critical to the survival of a species*, and effects on habitat for the species, associated with development and operation of Mount Emerald Wind Farm will not be *to the extent that the species is likely to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *result in invasive species that are harmful to the species becoming established in the species' habitat.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *introduce disease that may cause the species to decline.*

Development and operation of Mount Emerald Wind Farm has no known capacity to *interfere substantially with the recovery of the species.*

In summary, evaluation of the potential effects on the Bare-rumped Sheathtail Bat indicates they do not constitute a significant impact on the species.

4.1.2 Further guidance regarding significance of impacts

The *EPBC Act Policy Statement 2.3 Wind Farm Industry* (Commonwealth of Australia 2009) provides some additional explanation and examples relative to potential effects of the wind industry. The following excerpt is useful in its indication that the risk should be considered as proportional to the population size of particular species:

> *"An activity that affects, or is likely to affect, a small number of individuals usually would not be expected to have a significant impact on the species as a whole. However, when a species or community is in small numbers nationally, or its distribution or habitat is limited, or if the habitat has particular importance for the species, the activity could have a significant impact. In general, this would apply to species or communities that are most at risk of extinction and are, as such, listed as critically endangered or endangered.*
>
> *An action is likely to have a significant impact on a species listed as vulnerable where it significantly affects an important population of that species. An example might be where a wind farm is proposed on an*

island or headland, or near a wetland, that has a key breeding population of a bird species listed as vulnerable. The breeding frequency and success rate for that species would also be relevant considerations."

As noted above, populations of either Spectacled Flying-fox or Bare-rumped Sheathtail Bat that are likely to use the Mount Emerald Wind Farm site do not meet defined criteria for an 'important population'.

The Commonwealth guidance documents clearly indicate the level of impact that may be significant is based on the measure of change that may be experienced by the population of a vulnerable species. In principle this 'population' approach is ecologically meaningful as it responds appropriately to the population sizes of different species.

The concept of impact on an 'ecologically significant proportion' of a population has been elaborated in *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (Commonwealth of Australia 2015a). For an impact measured by mortalities of individual animals it defines a significant impact as one in which annual mortality rates meet or exceed 1% of the population. It also indicates a potential or real impact that may meet or exceed 0.1% of the population should be investigated further through more targeted surveys and be subject to mitigation.

4.2 Defining performance criteria

Numerical collision risk modelling is frequently used to determine an estimated range of the number of collisions that might occur at a proposed wind farm. It has been applicable almost entirely to diurnal birds because it is very difficult to obtain pre-requisite data about the rates and heights of flights by bats that might be at risk of colliding with turbines. Technologies that have capacity to detect and quantify flying bats, such as radar and thermal imaging, do not generally have capacity to distinguish between species of bats. Studies by RPS at Mount Emerald (RPS 2010; 2013a; b) experienced very low detection rates for the two species of interest and/or very limited capacity to identify them to species-level using routine and novel techniques. For these reasons, quantified collision risk modelling cannot be undertaken for either of the two species.

Numerical collision risk estimates would be required as a measure of mortality in order to place the potential effects of turbine collisions into a population viability framework. In addition, to undertake population modelling, it is necessary to have quite precise demographic details and numerical values for the population in question. Limitations on our understanding of the populations of both species have been discussed in Sections 2 and 4, above. In combination, these limitations mean population viability analysis also cannot be undertaken to evaluate the potential effects of the wind farm on the population of either Bare-rumped Sheathtail Bat or Spectacled Flying-fox.

Further details about collision risk modelling and population viability for the two species is provided in Biosis 2017b.

Published information about the numbers of bat fatalities that occur at Australian wind farms is very limited and is confined to insectivorous microbats. A search of the internet using the terms, 'flying, fox, fruit, bat, pteropus, wind, turbine' found no information about effects of operational wind farms on flying-foxes anywhere in the world. In large measure, this is considered to be because commercial-scale wind energy facilities are rare in parts of the world inhabited by flying-foxes, but also may reflect a lack of monitoring at such sites that do exist. Hull and Cawthen (2013) is the only peer-reviewed published investigation into turbine collision mortality of Australian microbats. It documented 54 fatalities of two species that were detected over an eight-year study at Bluff Point and Studland Bay Wind Farms in Tasmania. Other than Windy Hill Wind Farm (which has not been subject to detailed collision monitoring), there are no operational wind farms within the ranges of the Bare-rumped Sheathtail Bat or Spectacled Flying-fox. The Yellow-rumped Sheathtail Bat *Saccolaimus flaviventris* is closely related to Bare-rumped Sheathtail Bat and appears to have a

similar ecology to it. It has a widespread distribution that includes regions of south-eastern Australia where there are a number of operational wind farms that have been monitored for bird and bat collisions. To date, we are not aware of any information to suggest the population of Yellow-rumped Sheathtail Bats has been significantly impacted by wind energy facilities within its range.

While the currently available information is clearly limited, it does not indicate that Mount Emerald Wind Farm is likely to result in mortalities of either Bare-rumped Sheathtail Bat or Spectacled Flying-fox that will impact on the viability of the population of either species.

4.2.1 Significant impact & performance threshold measures for Bare-rumped Sheathtail Bat & Spectacled Flying-fox at Mount Emerald Wind Farm

It is recognized the situation at Mount Emerald Wind Farm does not involve migratory birds covered in the guidance of Commonwealth of Australia (2015a). However, since demographic information about both species of bats is limited to the extent that more sophisticated techniques, such as population modelling are simply not feasible, and given the principle set out in this guidance is responsive to the population size of any threatened species regardless of how large or small it is, the principles of the approach described in that guidance, and set out here can be applied to the two species of bats of concern at Mount Emerald.

Condition 13 of the EPBC Act approval requires that,

"*details of intended outcomes and measurable performance criteria for the Spectacled Flying-fox and Bare rumped Sheathtail Bat which are based on information contained in relevant guidance material...*".

The criteria contained in the referenced EPBC Act significant impact guidelines documents and the Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (Commonwealth of Australia 2015a) have provided the basis for performance measures set out here. As noted above, the latter document provides a numeric approach based on population size of particular taxa. In accordance with the principles set out in that guideline, a significant impact would entail mortalities equalling or exceeding 1% of the populations of the two species per annum and further investigation would be required if it equalled or exceeds 0.1% of the populations of the two species. Thus, it is suitable to set performance thresholds for Mount Emerald Wind Farm on the basis that a management response will be required if collisions by either species with turbines were to equal or exceeds 0.1% of their populations.

4.2.2 Quantified performance measures

Census data for Spectacled Flying-foxes, including for each roost camp close to Mount Emerald, is measured only to within an order of magnitude for several thousand individuals (see Section 2.1) and the data indicates the local roost-site populations have varied substantially over the past three years. In light of the large range of counts of the population that may use the Mount Emerald site, it is evident additional mortality that may occur at the wind farm will be completely masked by those pre-existing variables. There is no similar information to quantify the population of Bare-rumped Sheathtail Bats in the area of Mount Emerald.

In light of this lack of precise information about the local populations of either species, the principles discussed above for their entire Australian populations are used here. Thus a performance threshold, requiring further investigation and consideration of a management response will be required if collisions by either species with turbines were to equal or exceeds 0.1% of their populations

Recent expert population estimates for the Australian populations of the two species are:

- Greater than 10,000 for Bare-rumped Sheathtail Bat (Woinarski et al. 2014)
- Approximately 100,000 for Spectacled Flying-fox (CSIRO 2015, 2016).

Using these population estimates, annual performance thresholds will be to ensure total annual mortalities due to operation of the wind farm do not exceed 0.1% of these population sizes, which equates to 10 Bare-rumped Sheathtail Bats and 100 Spectacled Flying-foxes.

4.3 Monitoring of performance

Assessment against performance thresholds will require a program for monitoring collisions in a sample of years. This will entail a regime of searches for dead bats under turbines as detailed in full in Section 5 *Post-commissioning bat studies at Mount Emerald Wind Farm*.

It is important to note the number of fatalities detected by searches will almost certainly not represent the total number killed because searches rarely detect all carcasses and because some carcasses will be removed by scavengers before they can be found. These effects are well known and there is an existing science for determining estimates of total mortalities from numbers of mortalities detected during searches (e.g. Huso et al. 2017). Performance thresholds for Mount Emerald relate to the total number of the two species that may collide with turbines. For this reason, the factors that may influence determination of appropriate estimates (see Section 5) will be used as the basis for mathematics to estimate the total number of either species that may have been killed and for 95% confidence intervals for those values.

An evaluation of potential measures to reduce turbine collision risk for threatened bats at Mount Emerald Wind Farm was undertaken in compliance with condition 12 of the EPBC Act approval of the project. It is set out in Biosis (2017a). The evaluation is summarised in Section 3.1 of this plan. It indicated that low wind-speed turbine curtailment is likely to offer the best option to minimise collisions, particularly for Bare-rumped Sheathtail Bat.

4.3.1 Adaptive management framework

A low wind speed turbine curtailment study is set out below (Section 5.3). Its results will be used to inform subsequent decisions about requirement for any further or additional management actions aimed at further reduction of effects on either of the two bat species (see Section 6).

5 Post-commissioning bat studies at Mount Emerald Wind Farm

The studies described here are intended to meet the requirements of Condition 13 of the EPBC Act approval for Mount Emerald Wind Farm. The following important principles have guided their design:

- To the extent possible, they will be simple and minimise extraneous variables.
- In order to maximise their potential to meet stated objectives, they will obtain the largest sample sizes that are practicable.
- They are be able to be implemented without significantly compromising the routine operation and management of the wind farm.

Statistical design and aspects related to biometry for the studies outlined below have been determined in collaboration with Dr Stuart Muir of Symbolix Pty Ltd, and his advice is acknowledged.

No other wind energy facility of the size of Mount Emerald Wind Farm exists in tropical Australia, and the great majority of other wind farms in Australia are situated within agricultural land-use settings. By contrast, Mount Emerald is located in an environment where the great majority of pre-existing remnant vegetation and natural ecosystems are retained. For these reasons alone, the potential interactions of the two species of concern with the wind farm are currently uncertain. In order to improve general knowledge of the interactions of bats with wind turbines and to demonstrate the outcomes at Mount Emerald, the results of the investigations described here will be made publicly available in reports to be prepared by Mount Emerald Wind Farm, within six months of their completion and appropriate analyses of their results. The information will be provided on the Mount Emerald Wind Farm website and every effort will be made to publish the studies in the peer-reviewed technical literature.

5.1 Turbine operation

Subject to confirmation of technical requirements by the turbine manufacturer, it is planned for all turbines operated at Mount Emerald Wind Farm to be programmed so that rotor blades will remain feathered to prevent the rotors from turning at wind speeds between zero and 3.0 m/s. Hence, all turbines will permanently operate with Phase 1 curtailment.

The benefits in reducing collision risk for birds and bats will not be able to be quantified because that will be the routine operation of the turbines, however Phase 1 curtailment of all turbines at all times will, at the very least, reduce the time in which turbines represent a collision risk to fauna. On the assumption that small bat species preferentially fly during conditions of low wind speed, Phase 1 curtailment represents a likely substantial measure aimed at reducing collision risk for all species of small bats.

5.2 Investigating numbers of bat collisions relative to performance thresholds

Study objectives

Results of the study are intended to be used in calculating an annual estimate of total fatalities of the two species. This will be used to assess the wind farm's annual performance relative to prescribed thresholds for the two species of concern. Depending on the numbers of collisions detected, the study may also be able to provide information about variable usage of the site by the two species.

The investigation will also be integral to the low wind-speed curtailment study set out in Section 5.3, below, and will provide the data required for it.

5.2.1 Experimental design

Carcass searches will be used to detect individuals of the two bat species of concern that may have collided with turbines. The numbers detected will provide the basis for estimations of the total mortality rates for the wind farm and/or for individual turbines. Searches will collect data for all species of birds and bats that may collide with turbines but any implications of collisions relate only to Spectacled Flying-fox and Bare-rumped Sheathtail Bat. The results of searches will be used along with relevant correction factors (see *Analyses of results*, below) to provide estimates of total collision mortalities for the two species.

At the time of preparing this plan, information about the two species at the Mount Emerald Wind Farm site is very limited and there is no strong evidence for habitat preferences for either species there. The locations where any carcasses of the two species are found may provide information about their fine-scale usage of the site.

Carcass search method

Specially trained dogs have been shown to be highly efficient at detecting carcasses (Mathews et al. 2013) and have been used for this purpose at a number of wind farms in agricultural environments in Australia (Bennett 2015). During the construction of Mount Emerald Wind Farm, detection dogs have successfully been used to identify and clear areas of the endangered Northern Quoll prior to the commencement of works. However, there does remain some risk the use of dogs will not be practicable at the Mount Emerald site because of the high risk to dogs from snakes and ticks. The alternative is to use human observers who have been trained in identification of bats of the region. Whichever method is chosen, searches of all turbines will be undertaken.

Fall zone and estimation for unsearchable zones

Hull and Muir (2010) provide the sizes of likely fall zones for different turbines and sizes of birds and bats based on ballistics theory. They note that distance from the base of a turbine is an important factor in dispersion of carcasses and that with increased distance the density of carcasses decreases. They provide modelled fall zones and radii for percentages of expected distribution for two size classes of birds and one for small bats. Huso and Dalthorp (2014) compared five estimators for the relationship of carcass density to distance from modern wind turbines. For all five estimators tested they found that density approached zero at about 70 metres horizontal distance from the turbine base for the size of turbines at the wind farms used in their work.

The greatest capacity to detect carcasses is obtained from intensive searches of defined areas of the potential fall zones and the most valid estimates of mortality come from distance-based carcass-density models (Huso and Dalthorp 2014). Because the densities of carcasses diminish with horizontal distance from a turbine, searching of large areas including the outer extremities of potential fall zones were shown by those authors to add little to detection rates but to add very substantially and disproportionally to search effort. Hence, intensive searches of the portion of the fall zone in which the majority of carcasses will be found, as defined for the size of turbines at Mount Emerald Wind Farm, will be the most effective and appropriate. The turbines at Mount Emerald Wind Farm are larger than those considered by Huso and Dalthorp (2014), but, since the density of carcasses will diminish with distance from the turbine base and in light of practical considerations about capacity to effectively search for carcasses, a search zone defined by a 70-metre radius of the base of the turbine is considered to be reasonable and the mathematics outlined in Huso and Dalthorp (2014) will be applicable to quantify carcasses that land beyond that zone.

Due to the rocky, dissected nature of the ground at Mount Emerald along with natural cover of vegetation, it will not be practical to effectively search the entire 70 metre radius around the base of each turbine. This is common to many wind farms internationally and Huso and Dalthorp (2014) and Huso et al. (2017) provide sound methodology for extrapolation from searchable areas and those methods will be used at Mount Emerald. Within a 70 metre radius of the base of the tower each turbine will have a hardstand area and a portion of road on which visibility will to be high. The combined hardstand and road at each turbine covers an area approximately 60 metres long and 50 metres wide. In the great majority of cases the access road extends to, and beyond a 70 metre distance from the turbine tower. Carcass searches will be undertaken on all such areas within a 70 metre radius of the base of the tower where visibility is high under each turbine. Prevailing wind direction; wind strength; and, the physical location of the hardstand and road relative to each turbine may introduce a small degree of variability in where carcasses may fall, but that is a minor factor common to all wind farms.

Turbines to be searched

In order to maximise capacity to provide statistically meaningful sample sizes and because collisions with turbines are likely to be infrequent events for these species, and could occur at any turbine within the wind farm, carcass searching will be carried out under all turbines.

Search duration and frequency

The regime of carcass searching will run for two years and will commence when all turbines are commissioned and become operational at the wind farm.

It is likely (but uncertain at present) that carcasses of small bats will be scavenged quickly at Mount Emerald. Carcass persistence trials will be undertaken during the course of the study (see below), particularly to inform analyses required to extrapolate from numbers of carcasses detected to estimate total number of collisions. In order for the search regime to accommodate the likelihood of rapid scavenging a relatively short period between initial searches is important.

A primary consideration is to ascertain the frequency at which collisions occur. This is necessary for use in extrapolation to estimate total fatality rates. A 3-day interval between two searches at the beginning of the search cycle is designed to provide good capacity to determine frequency of collisions, because there is a high probability that a carcass found on day 4 must have collided in the preceding three days.

One search will be undertaken followed by a second search three days later, followed by an interval of 27 days. In other words, there will be a search on day one, a search on day four, and a search on day 28. The search on day 28 becomes day one of the second cycle and will be followed by a search three days later. That cycle will be repeated for the life of the study. It is vital that the survey intervals be consistent, and rigidly maintained and enforced. It is important for analyses that the longer period is exactly divisible by the shorter. Of greater import however, is the rigid and consistent maintenance of the scheduling.

Carcass persistence trials

Carcasses of bird and bats that collide with turbines may be removed by scavengers or will ultimately disappear due to decomposition. Carcass persistence affects the detection of dead bats that collide with turbines and consequently influences estimation of the total number of fatalities for each species.

Trials to determine persistence time of carcasses are required to derive correction factors necessary to estimate total fatalities from the results of the carcass searches. Two persistence trials will be undertaken annually, one in each of the dry and wet seasons.

Remote cameras will be used to record persistence of carcasses placed on-site for the purpose. Carcasses for the trials will be sourced from other species of common bats, of similar size to the two species of concern,

found at the site or from other local sources. Carcasses used for trials will be individually marked to ensure they are not confused with collision carcasses. Individual marking allows trial carcasses to be identified if they are simply moved by scavengers. Radio-frequency identification (RFID) microchips inserted into carcasses can provide individual identification. Cameras used for the purpose will be set to take a photograph every hour (day and night) and also when triggered by movement. This method has been demonstrated in Victoria to be highly efficient and substantially reduces potential influence on scavengers as may occur when human observers visit routinely to check carcasses. Cameras will be deployed and left to operate for the duration of the trial as this entails substantially less effort than having people check carcasses daily. Cameras have the additional advantage of recording the precise time of carcass removal and the species of scavenger that removes the carcass. As a result of the precise documentation of the time of carcass removal there is also no need to estimate the period of carcass persistence which is required when carcasses are checked only at an intervals of several days. Censored analysis must still be used, to account for those carcasses that persist beyond the trial period (Klein & Moschberger 2003).

It is possible that some scavengers at Mount Emerald, particularly mammalian scavengers, will move carcasses out of the field of view of cameras to den sites or other locations. In order to check for carcasses that have been moved out of camera view, each trial will commence approximately one week before the next routine search for carcasses. This will provide capacity to find any moved carcasses so that they are not lost from the trial.

Each trial will be run for up to one month, but cameras will be checked after two weeks to check on their operation and at that point the trial may either be terminated or a second carcass may be placed to increase the sample size of the trial.

The results of these trials will permit average carcass persistence times to be determined.

Searcher efficiency trials

Searchers do not routinely find all carcasses, so it is necessary to ascertain the efficiency of searches in order to determine and apply appropriate correction factors for carcasses missed to inform estimation of total collision mortality for each of the two species of concern.

The efficiency of each dog or person undertaking searches will be determined by the use of blind trials. Without the prior knowledge of searchers, a number of bat carcasses will be placed within search plots prior to routine searches. The number of carcasses placed in any given trial will not be known to the searcher, but over a number of routine searches at least ten carcasses of flying-foxes and ten of microbats will be placed at a minimum of ten different turbines and over sufficient time to permit the rate of carcass detection to be determined.

Two searcher efficiency trials will be undertaken for each searcher annually, one in each of the dry and wet seasons, over the entire search regime.

Carcasses for the trials will be sourced from other species of common bats, of similar size to the two species of concern, found at the site or from other local sources.

Data collection & management

During all searches, all species of birds and bats detected as carcasses will be recorded on a data pro forma designed for the purpose. All information, including metadata for each turbine search will also be recorded on the data sheet irrespective of whether a carcass is found during a given search. All data will be entered into a single database to be maintained by the Project Ecologist. The dataset will be updated following each search and a back-up copy of the database will be maintained by Mount Emerald Wind Farm Pty Ltd. Raw data will be available to DoEE (or successor) on request.

On finding a carcass, it will be photographed in situ and its location will be logged using a portable GPS device. If species identification of any specimen is uncertain it should be sent to the Queensland Museum for identification. Wherever possible the sex and age-class of each specimen will be recorded. All carcasses of threatened taxa, including the two bats species of concern, will be collected and frozen to permit any necessary investigations of cause of death. A freezer for this purpose will be available on-site. At the conclusion of the overall investigation, all specimens will be made available to the Queensland Museum.

Analyses of results

Estimates of the annual total number of collision mortalities for Spectacled Flying-fox and Bare-rumped Sheathtail Bat will be undertaken using current best-practice science to account for searched areas; carcass persistence times relative to search interval and searcher efficiency rates. Along with the estimates, 95% confidence intervals will also be determined as a measure of variance around the estimates. Current best practice (2017) for these analyses are provided by Huso et al. (2017) (see also Huso (2009, 2010), Huso and Dalthorp (2014) Dalthorp et al. (2017)). The analyses will be undertaken by a biometrician with a thorough understanding of the relevant science.

The locations where any carcasses of the two species are detected will be evaluated to assess whether they provide statistically valid indications of variable usage of the overall Mount Emerald site. Patterns of use by the two species may be related to the geographic distribution of habitats or in response to temporal seasonal changes.

5.3 Low wind-speed curtailment study

A study of low wind speed curtailment at Mount Emerald Wind Farm will involve an experiment designed to test the potential effects of Phase 2 curtailment as a means to reduce collisions by Spectacled Flying-fox and Bare-rumped Sheathtail Bat.

Study objectives

The purpose of the low wind-speed curtailment study at Mount Emerald Wind Farm is to demonstrate whether altered low wind-speed curtailment has a beneficial value to the two species of concern. It is intended to compare whether fatalities differ between turbines operated under Phase 1 and Phase 2 curtailed cut-in wind-speeds. It is intended that results of the study will be informative for on-going adaptive management of Mount Emerald Wind Farm, specifically in the event that performance thresholds for either of the two species is reached or exceeded.

The study will be the first of its kind in Australia and, due to the high diversity of bats species known from the site, it is expected it will offer important insights into minimisation of wind turbine effects on bats that will be of value widely within the wind energy sector. At completion of the study its results will be made publicly available on the Mount Emerald Wind Farm website and, if possible, in the peer-reviewed technical literature.

Ultimately the results of the study will be used to determine whether Phase 2 curtailment has an influence on collisions by the two species with turbines and thus whether or not it has utility as an on-going strategy for reducing impacts on them. If that is demonstrated, it will be implemented with a clearly defined cut-in speed and a set of other circumstances when that cut-in speed is not applicable.

5.3.1 Experimental design

The turbines proposed to be operated at Mount Emerald Wind Farm have a rated cut-in wind speed of 3.0 m/s and as outlined above, all turbines are proposed to be feathered to prevent their rotors from turning at wind speeds below 3.0 m/s (Phase 1 curtailment).

The study set out here will involve Phase 2 curtailment in which cut-in wind speed will be set at 4.5 m/s (i.e. 1.5 m/s above the rated cut-in speed of 3.0 m/s). For curtailed turbines the computer SCADA system will be programmed to cut-in at 4.5 m/s. This will require the blades of selected turbines to be programed to remain feathered to prevent them from turning until the increased cut-in speed is reached over an average number of minutes defined by the turbine SCADA operating system (usually 5–10 min), thus triggering the turbine blades to pitch back "into the wind" and begin to turn.

Wind data records collected from on-site monitoring (commenced in 2010), indicate the amount of time wind speeds are likely to be below 3m/s to be 5% of the year, with speeds below 4.5m/s likely to occur for 12% of the year.

The study will be undertaken as a controlled experiment using a Before-After-Control-Impact (BACI) design.

The BACI design will compare:

1. **Before**: baseline information about collisions at all turbines operating under Phase 1 curtailment
2. **After**: [Control] information about collisions at half of turbines operating under Phase 1 curtailment

   [Impact or treatment] information about collisions at half of turbines operating under Phase 2 curtailment.

Data about collisions by the two bat species will be collected in the course of the search regime set out in Section 5.2 *Investigating numbers of bat collisions relative to performance thresholds*, above.

'Before' component

The baseline information required for the 'before' component of the study will be obtained from all turbines operating under Phase 1 curtailment for 12 months.

'After' component

The 'after' component of the study will consist of simultaneous operation of one half of the complement of turbines operating under Phase 1 curtailment (control) and the other half of the complement of turbines (treatment) operating under Phase 2 curtailment with a cut-in wind-speed of 4.5 m/s. Running this portion of the study simultaneously using half of all the turbines in the subsets for both control and treatment will maximise statistical power of the study. It will also reduce the likelihood of variables other than cut-in wind-speed to influence collision risk. This 'after' portion of the study will run for 12 months.

As outlined above, information about the two species of concern at the Mount Emerald Wind Farm site is very limited and at present it is insufficient to indicate whether either might use parts of the site preferentially. Nonetheless, Mount Emerald Wind Farm site does support two basic vegetation types that occupy different portions of the site. Half of all turbines in each of the two vegetation types will operate under Phase 1 curtailment and half will operate under Phase 2 curtailment, but otherwise within each of the two vegetation communities the selection of which turbines will operate under each phase will be at random.

The rationale behind using a high cut-in wind-speed is to maximise capacity for the study to demonstrate whether wind-speed influences collision risk for either of the two species. In various American studies a cut-in wind-speed of 4.5 m/s has been shown to substantially reduce the rate of bat collisions compared to the rate

that occurred using a cut-in wind-speed of 3.0 m/s (details provided in Arnett *et al.* 2013 and reviewed Arnett 2017).

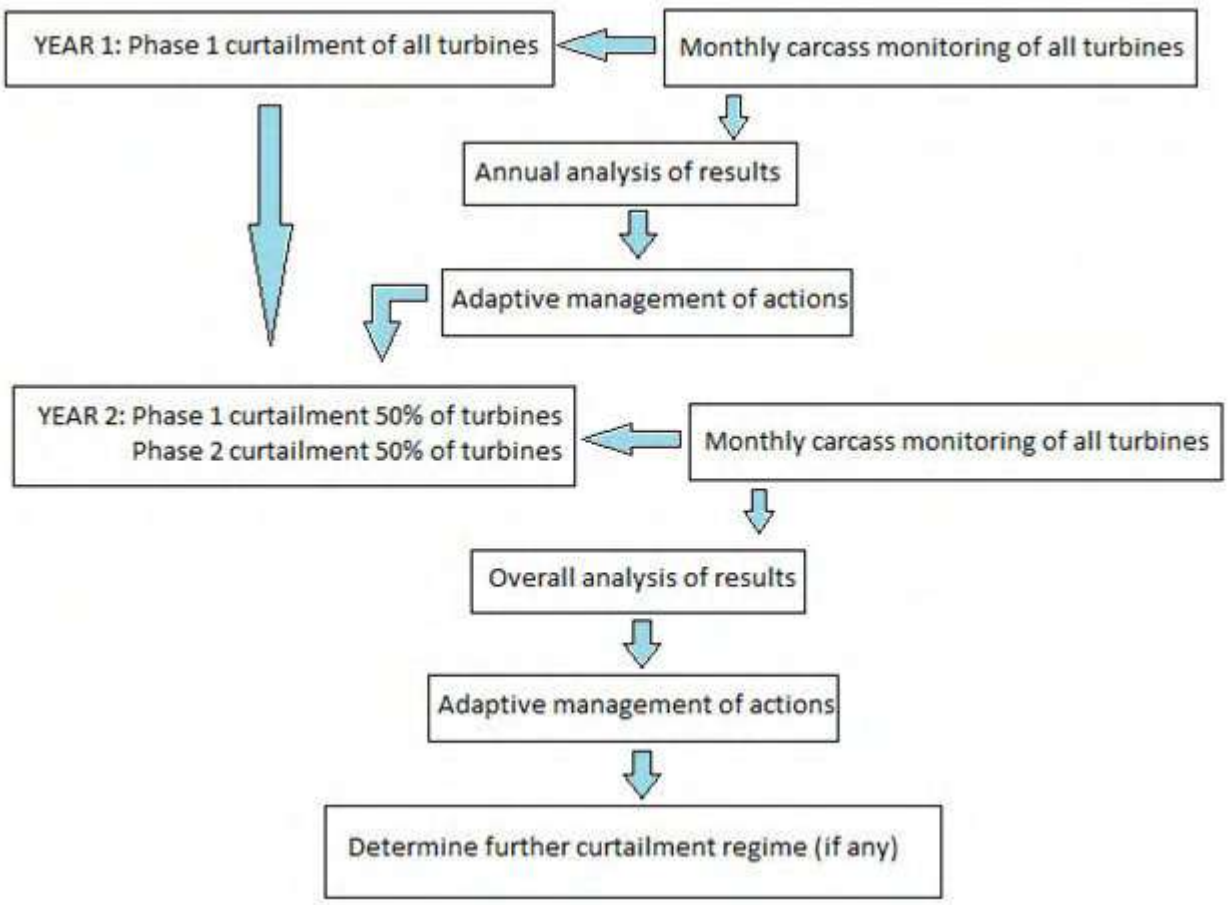
As bat flight activity is nocturnal, the study will entail simultaneous operation of the two subsets of turbines with different cut-in wind-speeds between sunset and sunrise (only).

Analyses

For the purposes of the low wind-speed curtailment study, the study design will compare numbers of the two species detected by searches, rather than derived estimates of total numbers of collisions.

5.4 Summary of study design

The schematic plan below provides a summary outline of the basic study design.



6 Potential contingency measures & corrective actions

As noted above, subject to confirmation of technical requirements by the turbine manufacturer, it is planned for all turbines operated at Mount Emerald Wind Farm to be programmed so that rotor blades will remain feathered to prevent the rotors from turning at wind speeds between zero and 3.0 m/s. Hence all turbines will permanently operate with this Phase 1 curtailment.

Implementation of additional long-term contingency measures and corrective actions will be necessary only if performance thresholds set out in Section 4.2, for impacts on either Spectacled Flying-fox or Bare-rumped Sheathtail Bat are exceeded.

6.1 Adaptive management measures

Assessment of performance will be undertaken in an adaptive management framework with annual reviews during the post-commissioning studies set out above.

At the time of preparing this plan, there are multiple uncertainties associated with its implementation. The likelihood of exceeding performance thresholds is unknown and the studies described here are intended to determine that and to improve general understanding about the possible interactions of the two species with wind turbines. In light of present uncertainties, a highly prescriptive approach is not considered to be appropriate. Rather, an approach that is responsive to the results of the studies is an important element of this plan.

For instance, if results of the curtailment experiment set out in this plan indicate that;

- it would be useful to test the relative effectiveness of turbine start-up wind speed(s) between 3 m/s and 4.5 m/s,
- individual turbines represent particular risk,
- or there may be some seasonality or other special conditions associated with collision risk for either species,

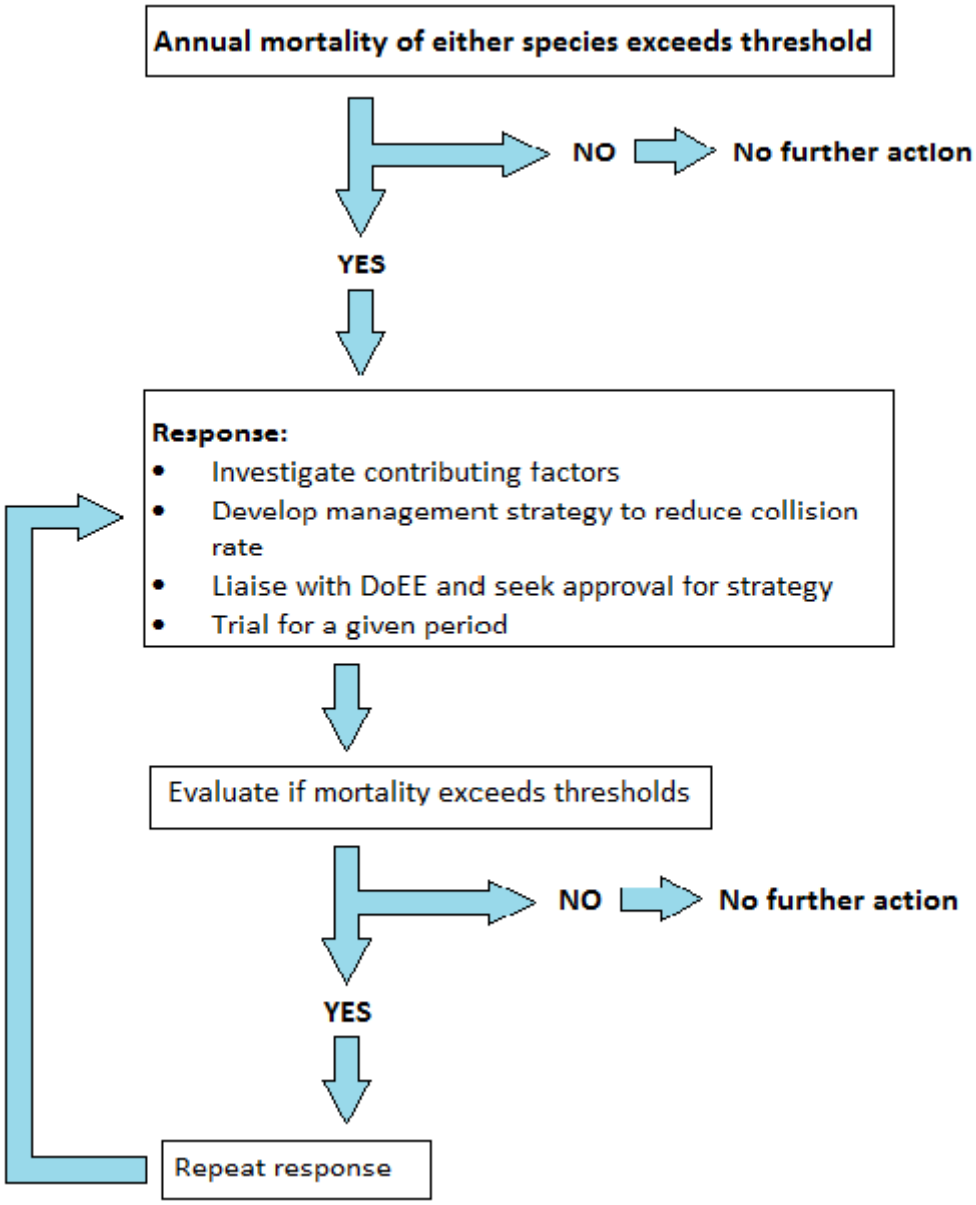
consideration will be given to further investigation or to management actions informed by data obtained from the study set out here.

In the event the annual estimated number of mortalities for either species reaches or exceeds the performance thresholds (i.e. equal to or greater than 100 Spectacled Flying-foxes or 10 Bare-rumped Sheathtail Bats in any 12 month period), as determined in accordance with Section 5.2 *Analyses of results*, then the results of the investigations detailed here will form the basis for consideration of potential corrective actions that may be taken.

Results of the low wind-speed curtailment study will be used to determine whether a higher turbine cut-in wind-speed represents a long-term method for reduction of collisions to a rate below prescribed performance thresholds for either or both of the key bat species. If so, and the relevant cut-in wind-speed is no higher than 4.5 metres per second, it will be implemented.

If necessary, results of the studies will be used to determine measures intended to reduce collisions to a level below prescribed performance thresholds. Such measures will be informed by results of the studies and depending on those results may take the form of implementing Phase 2 low wind-speed curtailment at specific turbines; during specified seasonal events; or under particular conditions.

The flow diagram below sets out the adaptive response process to be implemented in the event the annual mortality of either Spectacled Flying–fox or Bare-rumped Sheathtail Bat exceeds the defined threshold level.



6.2 Lifetime monitoring of the wind farm

The long-term operation of the wind farm will incorporate one or other low wind-speed curtailment regime which will be determined only after results of the two-year experiment set out in this plan are available.

Given the conditions may alter over the life of the wind farm monitoring of bat collisions will be undertaken at five year intervals throughout the full operational term. It is proposed for this regular monitoring to be conducted over a shorter period of three months, however this will be determined depending on results of previous studies.

If the initial two years of monitoring and experiment with low wind speed curtailment provide information that indicates collision risk for the two key bat species is associated with particular turbines, seasons, events or environmental conditions, that information will be used in tailoring future monitoring. Otherwise the search regime to be used will operate as set out in Section 5.2 *Investigating numbers of bat collisions relative to performance thresholds*.

7 Reporting

Conditions 24, 25, 26 and 27 of the EPBC Act approval for Mount Emerald Wind Farm specify requirements for reporting and provision of information relative to this plan. Mount Emerald Wind Farm Pty Ltd will do the following to ensure compliance with those conditions:

- Maintain a dedicated website about the project's compliance with the EPBC Act conditions of approval that is publicly available for the life of the approval. The webpage will include all monitoring results and documentation required under the conditions of approval and any other relevant information as directed by the Australian Government Minister for the Environment (or similar).
- Provide a copy of the documents published on the dedicated webpage to members of the public on request, within a reasonable timeframe.
- Maintain accurate records substantiating all activities associated with conditions of approval and this plan, including measures taken to implement the plan.
- Within three months of every 12 month anniversary of the commissioning of the wind farm publish a report on the webpage addressing compliance with each condition including implementation of this plan. The report will include information about whether the outcome required by condition 13 and this plan have been or are on track to being met.
- Provide a report to DoEE (or similar) within 2 business days of becoming aware of any contravention of conditions of approval under the EPBC Act that clearly specifies details of the contravention.

8 Roles & responsibilities

This section allocates responsibilities and details the roles necessary to ensure implementation of this plan.

Mount Emerald Wind Farm Pty Ltd is the approval holder under EPBC Act conditions of approval number 2011/6228 and is ultimately responsible to ensure this plan is fully enacted. Mount Emerald Wind Farm Pty Ltd will engage a qualified Project Ecologist who will have technical oversight of implementation of the plan.

8.1 Mount Emerald Wind Farm Pty Ltd

The key responsibilities of Mount Emerald Wind Farm Pty Ltd are to:

- Comply fully with all conditions of approval number 2011/6228 and any other relevant directions of the Australian Government Minister for the Environment (or similar).
- Engage, consult and collaborate with a suitably qualified Project Ecologist to ensure this plan is fully enacted.
- Ensure operations of the wind farm, including management of turbines and any other facilities or infrastructure, conform to requirements set out in this plan.
- Undertake all reasonable measures to ensure that any impacts on Spectacled Flying-foxes or Bare-rumped Sheathtail Bats remain below performance thresholds set out in this plan.
- In the event a performance threshold is reached or exceeded, consult and collaborate with DoEE and the Project Ecologist to ensure appropriate contingency measures, corrective actions or adaptive management measures are selected and are implemented.
- Ensure all requirements of conditions of approval numbers 24, 25, 26 and 27 related to reporting and provision of information are fully complied with.
- Liaise with the landowner and any other stakeholder/s, as necessary, to ensure this plan is implemented.

8.2 Project Ecologist

The key responsibilities of the Project Ecologist are to implement the technical and on-ground aspects of this plan. The Project Ecologist must have demonstrated experience in ecology. Ideally, the Project Ecologist will be a tertiary qualified zoologist with experience in the ecology of bats of tropical Australia.

The Project Ecologist must have a comprehensive understanding of the objectives, rationale and specifics of this plan. The key role of the Project Ecologist is to conduct and/or supervise all works set out in Section 5 *Post-commissioning bat studies at Mount Emerald Wind Farm.* Specific functions of the role are to:

- Conduct and/or oversee searches for bat carcasses.
- Undertake carcass persistence trials.
- Undertake searcher efficiency trials.

- Collect and manage all data required by the plan.
- Ensure Mount Emerald Wind Farm Pty Ltd is kept current with information about performance relative to mortality threshold set out in this plan for Spectacled Flying-fox and Bare-rumped Sheathtail Bat.
- In the event a performance threshold is reached or exceeded, consult and collaborate with DoEE and Mount Emerald Wind Farm Pty Ltd to ensure appropriate contingency measures, corrective actions or adaptive management measures are selected and are implemented.
- Undertake analyses of data, incorporating factors to account for searched areas; carcass persistence times relative to search interval and searcher efficiency rates to determine estimates of the annual total number (if any) of collision mortalities of Spectacled Flying-fox and Bare-rumped Sheathtail Bat, with 95% confidence intervals. As relevant, the analyses must provide comparative rates of collision by the two species for turbines with different low wind-speed curtailment regimes.
- Prepare reports on the monitoring and experiments, including information about methods, details of analytical methods used and results. The reports must be prepared in a timely manner and be submitted to Mount Emerald Wind Farm Pty Ltd with sufficient time for them to comply with conditions of approval numbers 24, 25, 26 and 27 related to reporting and provision of information.

9 Conclusion

This plan defines metrics against which to measure the performance of Mount Emerald Wind Farm relative to populations of Spectacled Flying-fox and Bare-rumped Sheathtail Bat. The performance is measured as numbers of collisions per annum with turbines at the facility.

The plan also details science-based studies designed to both assess whether performance thresholds are being met and to determine the effect of low wind-speed curtailment of turbines as a potential management measure to reduce collisions.

At the time of preparing this plan there are considerable uncertainties, including the extent to which either species utilises the site and whether possible collisions will have any measurable effect on their populations. Hence, a substantial outcome of enacting this plan will be to improve knowledge, and this has been built in as a responsive component to the plan.

The overarching intention of this plan is to minimise impacts of Mount Emerald Wind Farm on Spectacled Flying-fox and Bare-rumped Sheathtail Bat and to ensure any collisions that may occur will not have significant impacts on the viability of the population of either species.

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F. OFFSET AREA MANAGEMENT PLAN REPORT 2017

Offset Monitoring Program – Mount Emerald Wind Farm

RATCH Australia Corporation Limited

4 Elements Consulting Pty Ltd

Offset Monitoring Program – Mount Emerald Wind Farm

RATCH Australia Corporation Limited

4 Elements Consulting Pty Ltd

Revision History

Version	Purpose	Issued by	Date	Reviewer	Date
0.1	Draft	Mellissa Jess	01.12.2017	Kristin Keane	03.12.2017
1.0	Final	Mellissa Jess	22.12.2017	Kristin Keane	22.12.2017

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Contents

Appendices

Tables

Figures

Plates

1.0 Introduction

1.1 Background

The Mount Emerald Wind Farm (MEWF) Offset Site (the site) is located within land described as Lot 22 SP210202, which comprises approximately 434.9 ha (**Figure 1**). It is located immediately to the south west of the MEWF site at Mutchilba within the Mareeba Shire Council Area at the end of Lemontree Drive. The lot tenure is freehold and the primary land use is vacant. The area fringes the Baldy Mountain Forest Reserve and the Herberton Range National Park, via the Herberton Range (Queensland Government 2016).

On 26 November 2016, approval under the provisions of the Environmental Protection and Biodiversity Conservation (EPBC) Act, was granted to RATCH Australia Corporation Limited (RACL). As a requirement of the EPBC Act approval 2011/6228, as issued by the Federal Department of the Environment and Energy (DoEE), a Biodiversity Offset Area was developed to compensate for the clearing of 73 ha of habitat on the MEWF Project Site.

This site has been protected as a Nature Reserve through a statutory process through consultation with the Queensland Department of Environment and Heritage.

The offset site lies completely within the wet tropics bioregion. The site is mountainous with narrow ridges and rocky terrain that are steeply dissected along three dominant ridge lines falling towards Lemontree Drive at the entrance to the site. The offsets site lies adjacent to the MEWF project site.

The majority of the site consists of remnant vegetation with approximately 192.89 ha consisting of Least Concern vegetation and the remaining 242 ha listed as Of Concern vegetation.

4 Elements Consulting was commissioned by RACL to conduct the annual ecological monitoring surveys on the MEWF Offsets Site and this report has been prepared to comply with the requirements outlined in the Mount Emerald Wind Farm Offset Area Management Plan (RPS, 2016), which details monitoring management actions. The data collected in 2016 provided baseline data for future monitoring to be compared against and enables targeted and adaptive management procedures to be implemented to ensure the biological integrity of the biodiversity area is maintained or improved and conserved into the future.

The actions required include:

- Targeted survey of threatened fauna species to determine changes to species diversity on site over time;
- Pest species presence/absence assessment;
- Photo-monitoring points to determine variation over time.
- Targeted weed surveys.

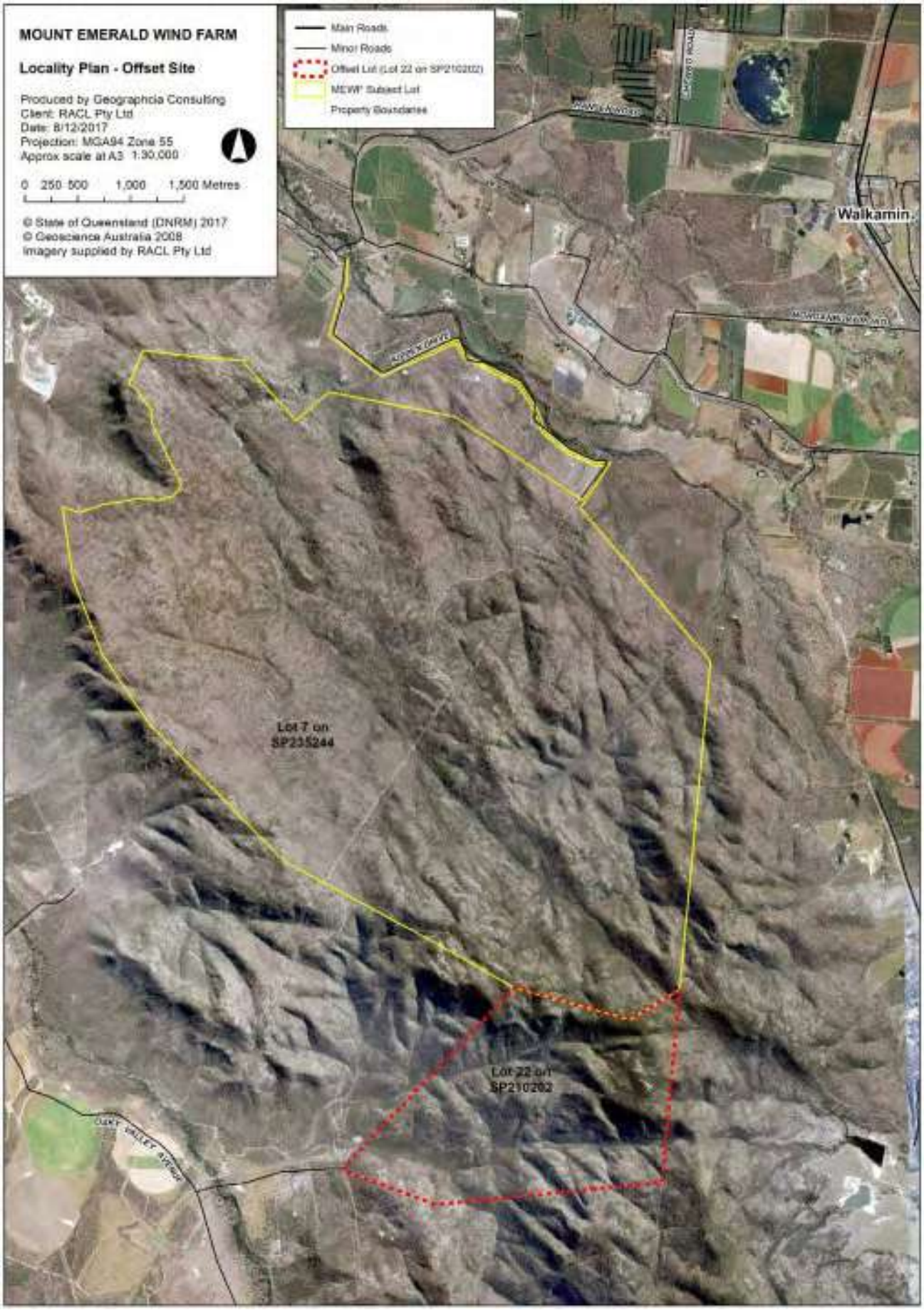

Figure 1 Project Location

1.2 Objectives and Outcomes

As identified in the Offset Area Management Plan (RPS, 2016), the offset area provides for the long-term protection of habitat for seven threatened species and through the implementation of adaptive management practices the quality of the habitat will be improved and maintained over time. The offset area is to be protected in perpetuity as a Nature Refuge. The management plan objectives and outcomes are to:

- Protect all vegetation within the offset area from future clearing;
- Protect all fauna within the offset area from introduced weeds and pests;
- Protect the site vegetation and fauna from un-prescribed burn and wildfire;
- Maintain the ecological condition of remnant of-concern and least concern vegetation within the Offset area where the BioCondition Class of 1 for each assessment unit does not change;
- Implement a translocation plan based on the criteria and guidelines detailed in the Guidelines for the translocation of threatened plants in Australia (Vallee et al, 2004) should be developed to identify MNES plant species appropriate for relocation as well as target and recipient sites.

This ecological monitoring report presents the methods and results of the 2017 ecological monitoring program at the MEWF Biodiversity Offset Area, including a discussion of the findings and comparisons with the results of the baseline data conducted in 2016. Management recommendations that relate to the current monitoring phase are documented in **Section 4.0**.

1.2.1 Regional Ecosystems:

The RE's mapped for the offset site are described in **Table 1** and shown on the mapping in **Figure 2**. Baseline surveys in 2016 identified that RE mapping was consistent with ground-truthed vegetation assessments.

Table 1 Regional Ecosystems Present Within the Proposed Offset Site

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.3.26a	*Casuarina cunninghamiana* (river oak) woodland to open forest on alluvium fringing streams. Occurs on channel benches, levees and terraces on deep loamy sands or sandy clay loams (often with loose surface gravel). (BVG1M: 16a). Vegetation communities in this regional ecosystem include: 7.3.26a: Riverine wetland or fringing riverine wetland. *Casuarina cunninghamiana*, *Eucalyptus tereticornis*, *Lophostemon suaveolens*, *Melaleuca leucadendra*, *M. fluviatilis*, *Buckinghamia celsissima*, *Mallotus philippensis* woodland and forest with an understorey of *Melaleuca viminalis* and *Bursaria tenuifolia*. Fringing forests of larger streams. (BVG1M: 16a)□.	OC	E	2.63
7.12.7c	Simple to complex microphyll to notophyll vine forest, often with *Agathis robusta* (kauri pine) or *A. microstachya* (bull kauri). Granites and rhyolites of foothills and uplands, of the moist rainfall zone. (BVG1M: 5c). Vegetation communities in this regional ecosystem include: □7.12.7c: Simple notophyll semi-evergreen vine forest. Uplands of the dry rainfall zone. Rhyolite. (BVG1M: 5c)□.	LC	NCP	1.24
7.12.9	*Acacia celsa* (brown salwood) open forest to closed forest. Foothills, uplands and highlands on granites and rhyolites, of the very wet and wet rainfall zone. (BVG1M: 5d).	OC	OC	1.16
7.12.16a	Simple to complex notophyll vine forest, including small areas of *Araucaria bidwillii* (Bunya pine). Uplands and highlands on granites and rhyolites, of the cloudy wet to moist rainfall zones. (BVG1M: 6b). Vegetation communities in this regional ecosystem include: □7.12.16a: Simple notophyll vine forest (often with *Agathis microstachya*). Uplands of the cloudy wet to moist rainfall zones. Granite and rhyolite. (BVG1M: 6b)□.	LC	NCP	9.34

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.26a	*Syncarpia glomulifera* (turpentine) +/- *Corymbia intermedia* (pink bloodwood) +/- *Allocasuarina* spp. (sheoaks) closed-forest to woodland, or *Lophostemon suaveolens* (swamp mahogany), *Allocasuarina littoralis* (black sheoak), *C. intermedia* shrubland, (or vine forest with these species as emergents). Exposed ridgelines or steep rocky slopes, on granite and rhyolite.□ 7.12.26a: *Syncarpia glomulifera*, *Allocasuarina torulosa* and/or *A. littoralis* open-forest and woodland. Uplands and highlands, often on steep slopes, of the wet rainfall zone. Granite and rhyolite. (BVG1M: 28e)□.	LC	NCP	4.41
7.12.26e	*Syncarpia glomulifera* (turpentine) +/- *Corymbia intermedia* (pink bloodwood) +/- *Allocasuarina* spp. (sheoaks) closed forest to woodland, or *Lophostemon suaveolens* (swamp mahogany), *Allocasuarina littoralis (bla*ck sheoak), *C. intermedia* shrubland, (or vine forest with these species as emergents). Exposed ridgelines or steep rocky slopes, on granite and rhyolite. (BVG1M: 9d).□Vegetation communities in this regional ecosystem include: □7.12.26e: *Syncarpia glomulifera* low open forest and low woodland. Uplands on steep rocky slopes, of the moist and dry rainfall zone. Granite and rhyolite. (BVG1M: 28e)□.	LC	NCP	8.99
7.12.29a	*Corymbia intermedia* (pink bloodwood) and/or *Lophostemon suaveolens* (swamp mahogany) open forest to woodland +/- areas of *Allocasuarina littoralis* (black sheoak) and *A. torulosa* (forest sheoak). Uplands, on granite and rhyolite. (BVG1M: 9c). Vegetation communities in this regional ecosystem include: □7.12.29a: *Corymbia intermedia*, *Eucalyptus tereticornis*, *E. drepanophylla* open forest to low open forest and woodland with *Allocasuarina torulosa*, *A. littoralis*, *Lophostemon suaveolens*, *Acacia cincinnata*, *A. flavescens*, *Banksia aquilonia* and *Xanthorrhoea johnsonii*. Uplands, on granite and rhyolite. (BVG1M: 9c)□.	LC	NCP	4.60
7.12.30d	*Corymbia citriodora* (lemon-scented gum) +/- *Eucalyptus portuensis* (white mahogany) woodland to open forest. Granite and rhyolite (often coarse-grained red earths and lithosols with much surface rock). (BVG1M: 10b). Vegetation communities in this regional ecosystem include: 7.12.30d: Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *C. citriodora*, *E. portuensis*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. reducta*, *C. intermedia* and *E. shirleyi*. There is often a very sparse to mid-dense secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens*, *Persoonia falcata*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina inophloia*, *Petalostigma pubescens* and *Grevillea glauca*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Xanthorrhoea johnsonii* and *Grevillea glossadenia*. The ground layer may be dominated by species such as *Themeda triandra*, *Heteropogon triticeus*, *Mnesithea rottboellioides*, *Arundinella setosa*, *Cleistochloa subjuncea*, *Eriachne pallescens* var. *pallescens*, *Lepidosperma laterale* and *Xanthorrhoea johnsonii*. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	LC	NCP	133.42
7.12.34	*Eucalyptus portuensis* (white mahogany) and/or *E. drepanophylla* (ironbark), +/- *C. intermedia* (pink bloodwood) +/- *C. citriodora* (lemon-scented gum), +/- *E. granitica* (granite ironbark) open woodland to open forest. Uplands on granite, of the dry rainfall zone. (BVG1M: 9d).	LC	NCP	23.76
7.12.57a	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57a: Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis* and *Xanthorrhoea johnsonii*. Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d).	OC	OC	58.60

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.57c	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57c: Shrubland/low woodland (1.5-9 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana*, *E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *Callitris intratropica*, *E. atrata*, *E. pachycalyx*, *E. shirleyi*, *E. drepanophylla* and *Homoranthus porteri*, on rhyolite and granite. There is occasionally a very sparse to sparse secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Persoonia falcata*, *Exocarpos cupressiformis* and *Melaleuca viridiflora* var. *viridiflora*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Coelospermum reticulatum*, *Xanthorrhoea johnsonii*, *Acacia humifusa*, *Dodonaea lanceolata* var. *subsessilifolia*, *Grevillea dryandri* subsp. *dryandri*, *Grevillea glossadenia*, *Acacia umbellata* and Ericaceae spp. The ground layer may be dominated by species such as *Themeda triandra*, *Xanthorrhoea johnsonii*, *Eriachne pallescens* var. *pallescens*, *Cleistochloa subjuncea*, *Borya septentrionalis*, and *Eriachne* spp. Includes open rocky dominated by herbs and grasses. This RE includes areas of 7.12.65k (rocky areas with shrubby/herbaceous cover) which are too small to map. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	OC	OC	107.32
7.12.58	*Eucalyptus reducta* woodland to open forest (6-18m tall). Common associated species include *E. granitica*, *Corymbia dimorpha*, *C. citriodora*, *E. cloeziana* and occasionally *C. intermedia*. There is often a sparse secondary tree layer of *C. abergiana* and/or *E. lockyeri*. There may be a very sparse tall shrub layer of species such as *Acacia flavescens*, *Persoonia falcata*, *Allocasuarina littoralis* and *Acacia simsii*, and a very sparse to dense lower shrub layer of *Acacia calyculata*, *Pultenaea millarii*, *Jacksonia thesioides*, *Grevillea glossadenia*, *Grevillea dryandri* subsp. *dryandri*, *Homoranthus porteri* and *Dodonaea lanceolata* var. *subsessilifolia*. The ground layer is often dominated by species such as *Themeda triandra*, *Eriachne* spp., *Cleistochloa subjuncea*, *Lomandra longifolia*, *Mnesithea rottboellioides*, *Xanthorrhoea johnsonii*, *Heteropogon triticeus* and *Coronidium newcastlianum*. Granite and rhyolite. (BVG1M: 9d).	OC	OC	72.45
7.12.65k	Rock pavements or areas of skeletal soil, on granite and rhyolite, mostly of dry western or southern areas, often with shrublands to closed forests of *Acacia* spp. (wattles) and/or *Lophostemon suaveolens* (swamp mahogany) and/or *Allocasuarina littoralis* (black sheoak) and/or *Eucalyptus lockyeri* subsp. *exuta*. (BVG1M: 28e). 7.12.65k: Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon* spp. and/or *Allocasuarina* spp. In the Mount Emerald area, shrubs may include *Acacia umbellata*, *Melaleuca borealis*, *Homoranthus porteri*, *Leptospermum neglectum*, *Melaleuca recurva*, *Melaleuca uxorum*, *Grevillea glossadenia*, *Corymbia abergiana*, *Eucalyptus lockyeri*, *Sannantha angusta*, *Pseudanthus ligulatus* subsp. *ligulatus*, *Acacia aulacocarpa*, *Leptospermum amboinense*, *Xanthorrhoea johnsonii* and *Jacksonia thesioides*. Ground-cover species may include *Borya septentrionalis*, *Lepidosperma laterale*, *Eriachne* spp., *Cleistochloa subjuncea*, *Boronia occidentalis*, *Cheilanthes* spp., *Coronidium newcastlianum*, *Schizachyrium* spp., *Tripogon loliiformis*, *Gonocarpus acanthocarpus* and *Eragrostis* spp. Dry western areas. Granite and rhyolite. (BVG1M: 29b).	LC	OC	7.03
9.5.8	Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) and/or *E. leptophleba* (Molloy red box) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). *Eucalyptus tardecidens* (box) may also occur as a subdominant in northern extent of this regional ecosystem. A sparse shrub layer includes *Petalostigma* spp., *Melaleuca* spp., *Grevillea* spp., *Alphitonia pomaderroides* and *Maytenus cunninghamii* (yellowberry bush). The sparse to dense ground layer is dominated by *Heteropogon contortus* (black speargrass) and *Sarga plumosum* (plume sorghum). Occurs on undulating plains in valleys in ranges on Tertiary/Quaternary soils overlying granite and metamorphic geologies. (BVG1M: 13a)	LC	NCP	0.01

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
9.5.9a	Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) and/or *Eucalyptus leptophleba* (Molloy red box) and/or *E. platyphylla*. A sparse to mid-dense shrub layer including *Melaleuca* spp., *Grevillea* spp., and *Planchonia careya* (cocky apple) can occur. The ground layer is dominated by *Themeda triandra* (kangaroo grass) and *Heteropogon* spp. Occurs on plains, undulating plains and outwash deposits and Tertiary to Quaternary locally consolidated high-level alluvium and colluvium. Major vegetation communities include: 9.5.9a: Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) +/- *Eucalyptus platyphylla* (poplar gum) +/- *E. leptophleba* (Molloy red box) +/- *C. tessellaris* (Moreton Bay ash) with a distinct to sparse sub-canopy layer often including *Melaleuca viridiflora* (broad-leaved paperbark), *Grevillea glauca* (bushman's clothes peg), *Petalostigma pubescens* (quinine) and *Alphitonia pomaderroides* (soapbush). An open to sparse shrub layer includes *Melaleuca* spp., *Persoonia falcata*, *Grevillea* spp. and *Petalostigma pubescens (*quinine). The sparse to mid-dense ground layer is dominated by *Themeda triandra* (kangaroo grass), *Aristida* spp., *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), and *Sarga plumosum* (plume sorghum). Occurs on undulating plains. (BVG1M: 9e).	LC	NCP	
9.12.7a	Woodland to low open-woodland of Eucalyptus cullenii (Cullen's ironbark) +/- Erythrophleum chlorostachys (Cooktown ironwood) +/- C. leichhardtii (yellowjacket) +/- Corymbia erythrophloia (red bloodwood). The mid-layer is generally absent but a subcanopy and/or shrub layer can occur. The ground layer is sparse to dense and dominated by Heteropogon contortus (black speargrass) and Themeda triandra (kangaroo grass). Occurs on predominantly felsic volcanic rocks, on rolling to steep hills. Major vegetation communities include: 9.12.7a: Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood) +/- *C. dallachiana* (Dallachy's gum). An open to mid-dense subcanopy can occur and includes a variety of species. The shrub layer is absent to open and dominated by *Maytenus cunninghamii* (yellowberry bush), *Alphitonia pomaderroides* (soapbush), *Petalostigma* spp., and *Acacia* spp. The ground layer is sparse to dense and dominated by *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), *Themeda triandra* (kangaroo grass) and *Sarga plumosum* (plume sorghum) with a *Xanthorrhoea* sp. (grasstree) occurring in some areas. Occurs on rhyolite hills. (BVG1M: 13a).	LC	NCP	0.01
9.12.40	Low open-woodland to low woodland of *Melaleuca citrolens* (scrub teatree) +/- *Terminalia platyptera* (yellow-wood) +/- *Corymbia dallachiana* (Dallachy's gum) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). The sparse shrub layer consists of *Petalostigma banksii* (smooth-leaved quinine), *M. citrolens* and *Gardenia vilhelmii* (breadfruit). The ground layer is frequently bare, with patches of short grasses including *Eriachne* spp., *Aristida* spp. and *Schizachyrium* spp. (firegrass). This community also occurs as short open-tussock grassland wooded with low trees and shrubs of *Melaleuca citrolens* +/- *Terminalia* spp. Occurs on gentle slopes, footslopes, rolling hills and colluvial low slopes. (BVG1M: 21b).	LC	NCP	
Non-rem	Non-remnant: modified land, roads, clearings and tracks.			0.08

[1] Status under Vegetation Management Act 1999: OC - Of Concern; LC - Least Concern.

[2] Biodiversity management status: E - Endangered; OC - Of Concern, NCP - No Concern at Present.

[3] Area - total area in hectares of RE type within offset site.

Conservation status of EVNT species: *Acacia purpureopetala* (CE - EPBC Act, V - NCA); *Grevillea glossadenia* (V- EPBC Act, V - NCA); *Homoranthus porteri* (V - EPBC Act, V - NCA); *Melaleuca uxorum* (E - NCA); *Plectranthus amoenus* (V - NCA); *Prostanthera albohirta* (CE - EBC Act, E - NCA); *Prostanthera clotteniana* (CE - EBC Act, E - NCA).

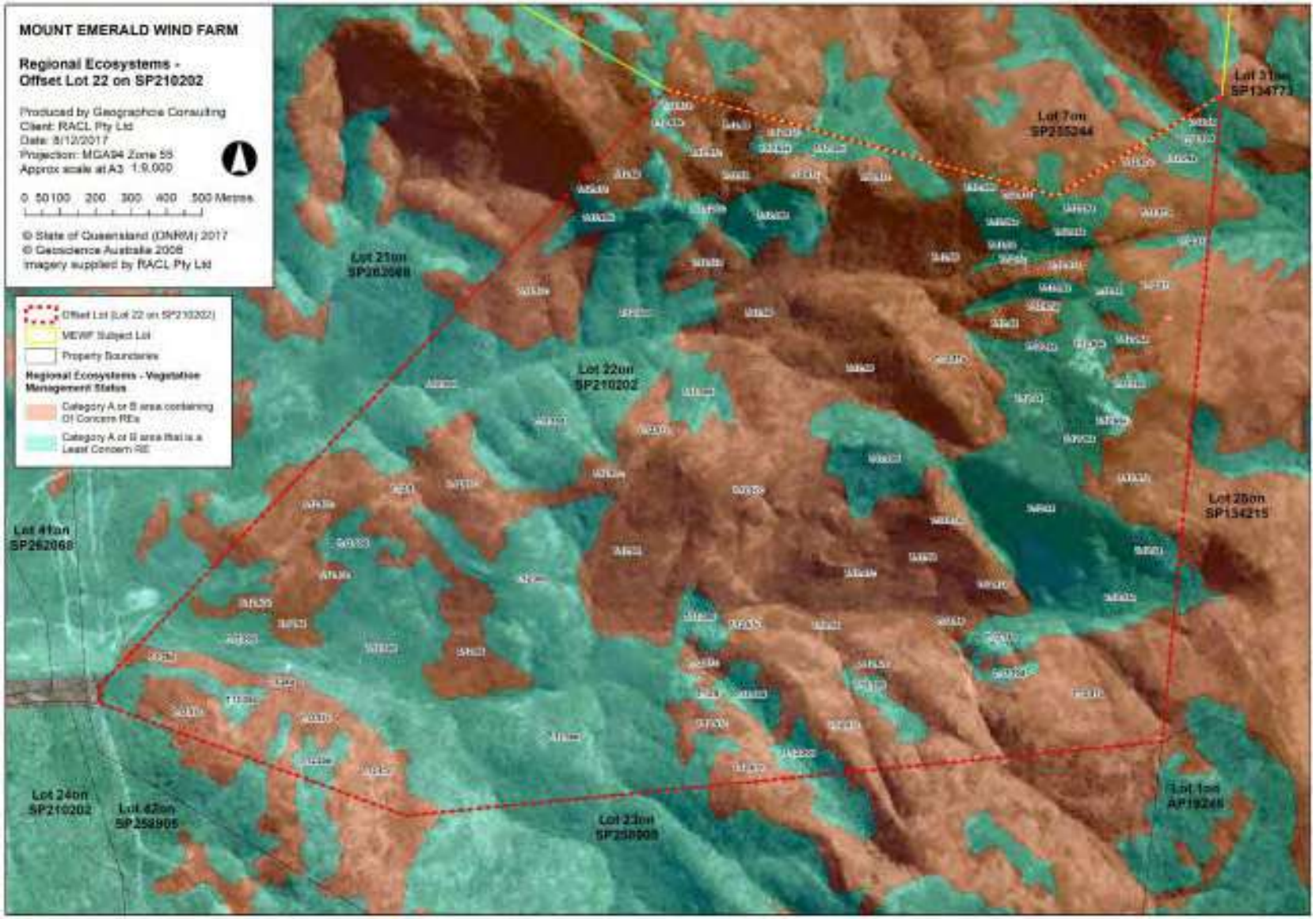

Figure 2 MEWF Regional Ecosystems on Offset Lot

2.0 Methods

The following sections detail the methods employed for the 2017 ecological offset area monitoring program. The methods employed as part of this monitoring program are consistent with those outlined in the MEWF Offset Area Management Plan (RPS, 2016).

Field surveys were conducted on site between 24 October -10 November 2017.

Total rainfall across the Mount Emerald range was recorded as 58 mm over that period. Minimum temperatures were 11 °C and maximum temperatures were 35 °C with average nightly temperature falling to 17 °C. Daily temperatures averaged 29.2 °C. Winds were calm until day 10 when speeds increased to 19 knots ESE for the final four days of survey.

2.1 Targeted Fauna Surveys for Conservation Significant Fauna

2.1.1 Northern Quoll (*Dasyurus hallucatus*)

2.1.1.1 Methods

Camera Traps

The most suitable method for determining the presence of Northern Quoll is by undertaking a Camera Trapping Survey. This method follows that of Eyre *et al* (2014). Survey sites replicated those of the 2016 surveys conducted by RPS (2016) and shown in **Figure 3**.

A total of 18 camera traps (Reconyx visible flash units) were used for the camera trapping survey. At each survey site a single camera trap was attached horizontally to the trunk of a tree with a 'dbh' (diameter at breast height) of at least 15 cm with a metal angle bracket, at ~1 m above the ground so the camera faced the ground. Directly beneath the camera, a bait holder, consisting of a Rain Harvesting ™ PVC toilet vent pipe cap with a 50 mm PVC pipe insert, baited with two chicken necks, was affixed to the ground with a 30 cm, 5 mm diameter tent peg.

Each camera was set at the medium-level trigger sensitivity. All loose vegetation (e.g. grass stalks, forbs and shrub branches) within the field of view of each camera were removed to minimize false triggers. Camera traps were active for a period of 14 days.

Habitat Assessments

Habitat assessments were conducted at each site.

Measurements of habitat will also be made. Parameters monitored:

- Evidence of fire;
- Nature and extent of erosion;
- Extent of weed species;
- Presence of feral animals;
- Type of groundcover;
- Structure and floristics of vegetation cover; and
- Number of habitat trees.

2.1.2 Spectacled Flying Fox (*Pteropus conspicillatus*)

2.1.2.1 Methods

Diurnal searches for roosts and feeding signs were undertaken over a large proportion of the project site per Eyre *et al* (2014). Surveys followed meandering transects while completing camera trapping, and targets surveys concentrated on regional ecosystems with a high likelihood of flowering myrtaceous

species. A botanical assessment of the presence of feed trees and the percentage currently flowering (during this survey) across the site was undertaken by a qualified botanist.

As with previous surveys the terrain on the site is extremely rugged and hazardous with large cliff overhangs. The total number of spot-lighting transects as recommended by DoEE (2014b) were unachievable (i.e. 5 hours per 50 ha/night = a total of 365 hrs of spotlighting) under these conditions. Observers conducted a total of 39 hours spotlighting.

2.1.3 Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*)

2.1.3.1 Methods

Five ultrasonic bat call detectors (Wildlife Acoustics SM2+BAT fitted with a SM-UX microphone) were placed across the site (**Figure 3**), to determine presence and species composition of bats within the Offset Site. The bat call detectors were programmed to turn on automatically at 6 pm each evening and record for a 12 hour period.

All call analysis was conducted by Kelly Matthews from Green Tape Solutions, Brisbane. Ms Matthews is a recognised expert on bat call analysis and has an extensive library of reference calls from the FNQ Bioregion. Survey limitations identified bat detectors failures preventing recording across the full site during the full fortnight duration. Functioning bat detectors identified large numbers of bat calls.

2.2 Targeted Weed Surveys

The weed assessmen of the offset site concentrated on the access track from Lemontree Drive to the small clearing adjacent to a tributary of Oaky Creek. The entire length of the track was traversed on foot. Additional spot observations of weed presence in remnant, undisturbed vegetation were undertaken in 2016 and during the 2017 survey. The full survey results including site recommendations are detailed in **Appendix A**.

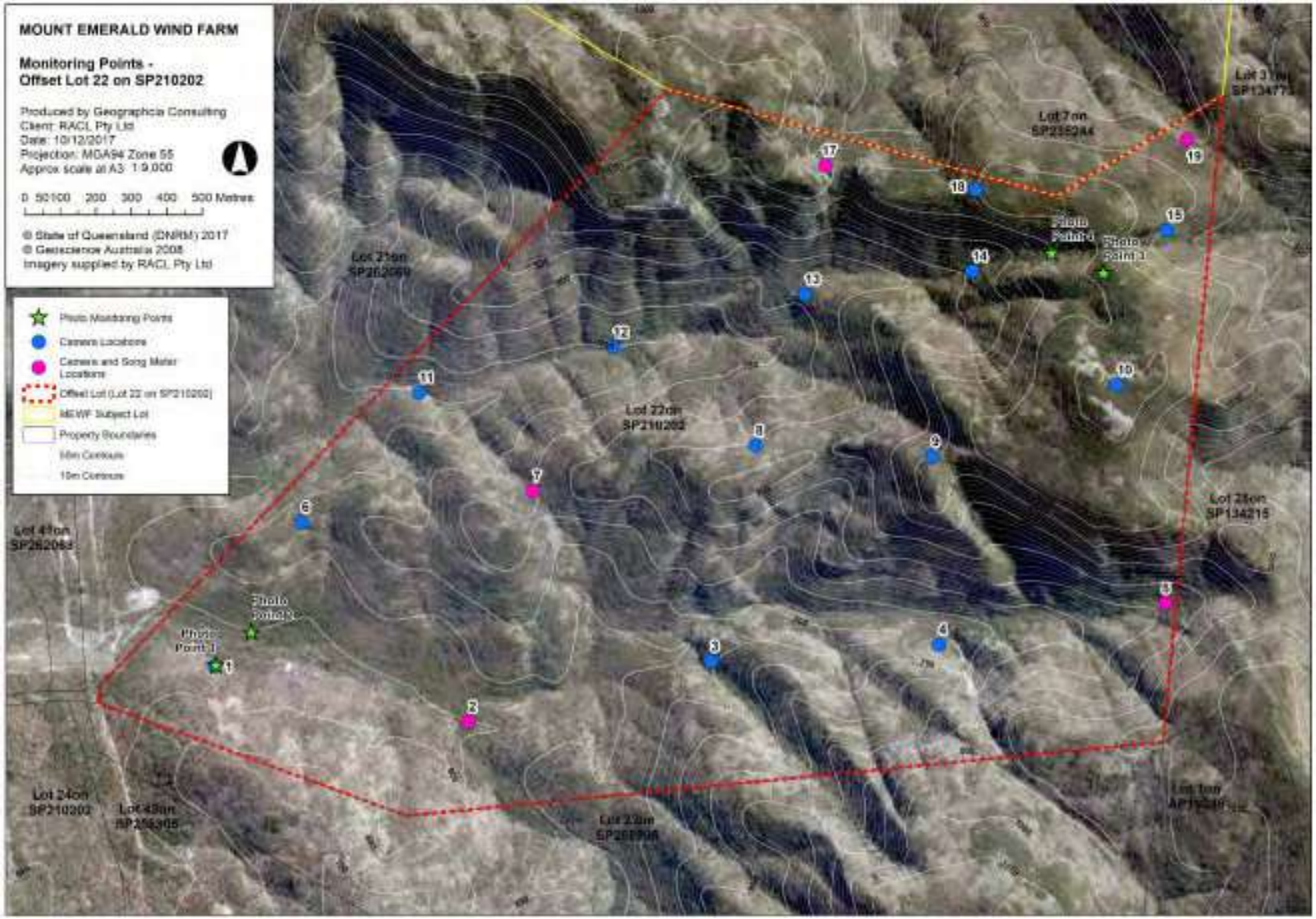

Figure 3 Monitoring Points on Offset Lot

2.3 Opportunistic Assessment

Fauna were monitored at 18 sites. Parameters monitored:

- Diurnal bird, herpetofauna, terrestrial mammal; and
- Threatened species presence.

2.4 Photo-monitoring points

Four photo monitoring points were established within the offset area to enable a visual assessment of changes over time (**Figure 3**). Each point was:

- Marked with flagging tape and the GPS points recorded;
- Annual photographs in north, south east and west directions.

Maintain a record of the photographs, including GPS co-ordinates, date and time of each photograph, the direction in which the photograph was taken; and the height above the ground at which the photograph was taken.

2.5 Pest Vertebrate Assessment

2.5.1 Camera trap Locations

Secondary monitoring data was achieved from camera traps set at 18 Quoll monitoring traps (refer to **Section 2.1**). Pigs, feral dogs and cats are all known to be attracted to this bait.

Data collection included:

Species identification (feral pigs and other animals);

- Number of each species;
- Age class of feral pigs;
- Sex of feral pigs.

2.5.2 Spotlight Monitoring for Feral Cat and Dog

Spotlighting was completed on four nights across the offset site at a total of 36 hours. Spot lighting commenced approximately 30 minutes after sunset. Transects were walked across the site, and where possible roads were traversed at speeds of 10 km/hr. The observer held the spotlight at eye level searching into the vegetation surrounding the site. When an animal was sighted the team stopped and recorded the species and number of each species.

Further visual assessments were conducted of pest species from, scats, tracks, evidence of damage and incidentals sightings across the site.

2.6 Results and Discussion

2.6.1 Northern Quoll

A total of 252 camera trap nights were conducted on the offsets site and all of the units captured images. Ten Northern Quolls were recorded during the camera trapping survey and many of the quolls revisited the same site on multiple nights. Eight of 10 animals were in good condition however there were two animals with severe hair loss at sites 5 and 17. From experience at the MEWF site these are most likely to be persistent males at the end of their breeding season. Three animals were located at multiple monitoring locations, identified from the spot marking on their back.

Site 11 recorded the highest number of species of the sites surveyed. This was at high altitude with a large number of hollows and available habitat.

Thirteen Northern Quolls were detected across the Offset site during baselines surveys in 2016 (RPS, 2016). This monitoring survey was conducted several months after the baselines surveys therefore it is expected there will be fewer animals due to male die off following breeding (Burnett *et al*, 2013). Numbers are still comparative to 2016. The distribution of the population across the offset site is similar to 2016, with the majority of monitoring sites recording quoll activity in both sampling years regardless of vegetation composition.

Plate 1 Northern Quoll

The Offset Site has maintained its integrity and the habitat was observed to be high quality with large refugial areas of rock outcrops, tree hollows and fallen logs for Northern Quoll. The seasonal creeks from the Mt Emerald massif contained a large number of rocky pools this dry season with abundant fish and insect fauna. Quoll scats were evident from adults and juveniles at a number of these locations (7).

2.6.2 Spectacled Flying-fox

Three Spectacled Flying-fox (SFF) and an unidentified (Little Red or Black Flying Fox sp.) were identified foraging on site. SFF were located on the northern ridge line as identified in **Figure 4**, whereas the unidentified species foraged in the creek line.

Targeted search for the SFF concentrated search effort in areas where vegetation was either in fruit or flower. The creek lines were considered the most likely location as they contained flowering Pink Poplar (*Euroschinus falcatus*) and fruiting Burdekin Plum (*Peigynium timorense*). The SFF is difficult to locate however, where the noted plant species were found individuals were often recorded during survey.

Single locations of flowering Eucalypt trees were also recorded during other survey work. The ridgelines did contain some flowering Northern Ironbark (*Eucalyptus crebra*). These individual trees were used as locations to sit and wait for any Flying Fox activity.

Approximately 15% of available foraging trees were flowering or commencing flowering across the site due to recent rainfall and were of high quality. As identified the OAMP (RPS, 2016) foraging habitat is available across the offset site and is considered in moderate to high quality. It is highly likely each species will utilise the site widely when available vegetation is flowering.

Baselines surveys in 2016 identified the presence of habitat trees however, no SFF or similar species were sighted due to lack of flowering. The timing of these surveys was better suited for spotting SFF however, the species would be best identified later in the wet season.

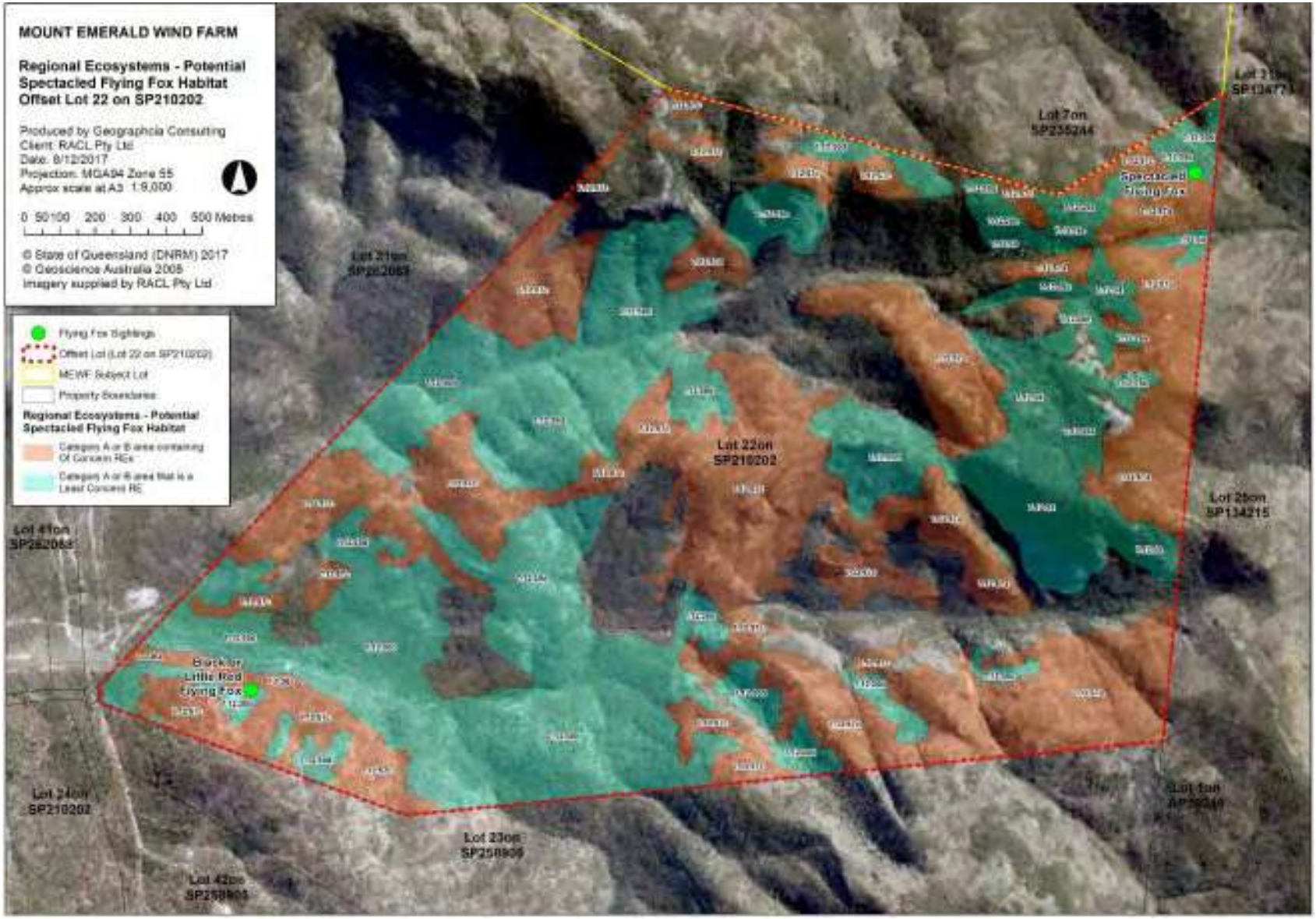

Figure 4 **Potential Spectacled Flying Fox Habitat on Offset Lot**

2.6.3 Bare-rumped Sheathtail Bat (*S. saccolaimus*)

A total of 35 detector nights of microchiropteran bat call surveys were conducted within the project site between late October and Early November.

A total of 10 microbat species were detected occurring within the site. A total of seven (7) microbat species were potentially/probably recorded on site (**Table 2**).

The presence of Bare-rumped Sheathtail Bat (BRSB), listed as Endangered under NC Act, and listed as Vulnerable under EPBC Act, was analysed. This species could not be definitely confirmed due the similarity in call with sympatric species and overlap in their distribution. This species also presents a number of call variations which makes it difficult to confirm its presence using only echolocation techniques. However, a number of calls presented harmonics that could highly likely be attributed to BRSB and therefore, we would consider BRSB is highly likely to occur within the surveyed area (**Appendix B**).

Characteristic call attributes of BRSB include:

- A dominant harmonic with characteristic frequency around 22-25 kHz;
- At least 3 and up to five distinct harmonics at approximately 13 kHz intervals (1 below and up to 3 above the dominant harmonic); and
- Call pulses sometimes in “triplet” sets with pulse intervals of approximately 10-20 ms between first and second pulses and 20-40 ms between second and third pulses and an inter-triplet interval of about 80-100 ms (**Appendix B**).

In both 2016 and 2017, calls were recorded at Site 19 which is the high altitude *Corymbia citriodora* (lemon-scented gum) +/- *Eucalyptus portuensis* (white mahogany) woodland to open forest aspect of the site.

All bats identified on the site were expected to be present within the region. Bat activity levels at the site are considered to be similar compared to other surveys within similar areas in the surrounding region. Six further species were identified during this monitoring season than during the baselines surveys in 2016, each with strong call signatures. Weather conditions were with low wind, good insect availability due to recent rain were good for collecting bat data survey during this survey period.

Table 2 summarises the Call Analysis.

Table 2 Summary of Call Analysis

Species	Status EPBC	Status NCA	Confidence
Austronomus australis	Least Concern	NOC	Definite
Chaerophon jobensis	Least Concern	NOC	Definite
Chalinobus picatus	Least Concern	NOC	Definite
Chalinobus nigrogiseus	Least Concern	NOC	Definite
Miniopterus australis	Least Concern	NOC	Definite
Miniopterus orianae oceanensis	Least Concern	NOC	Definite
Mormopterus lumsdenae	Least Concern	NOC	Definite
Mormopterus ridei	Least Concern	NOC	Definite
Nyctophilus geoffroyi	Least Concern	NOC	Possible
Nyctophilus gouldi	Least Concern	NOC	Possible
Nyctophilus bifax	Least Concern	NOC	Possible
Rhinolophus megaphyllus	Least Concern	NOC	Definite
Saccolaimus flaviventris	Least Concern	NOC	Possible
Saccolaimus saccolaimus	Vulnerable	Endangered	Possible
Scotorepens orion	Least Concern	Least Concern	Possible
Taphozous troughtoni	Least Concern	Least Concern	Possible
Vespadelus pumilus	Least Concern	Least Concern	Definite

2.7 General Fauna

From a combination of spotlighting, diurnal, camera trap and opportunistic sightings a total of 54 species were able to be positively identified with three of these species listed under the EPBC and NC Act as those targeted: Northern Quoll, Spectacled Flying Fox and the Bare-rumped Sheathtail Bat. No other threatened species were identified. This consisted of 28 birds 15 mammals, 6 reptiles and 5 frogs (**Appendix C**). A total of 71 species were identified on site.

The birds included species such as the Pheasant Coucal (*Centropus phasianinus*) and Noisy Friarbird (*Philemon corniculatus*) Red-backed Buttonquail (*Turnix maculosus*) Australian golden whistler (*Pachycephala pectoralis).* Noctural Surveys located Boobook Owl (*Ninox boobook*) and the Tawny Frogmouth (*Podargus strigoides*).

The cryptic Mareeba Rock-wallaby (*Petrogale mareeba*) was identified on the lower mountain slopes at site 11 at a similar location to 2016 therefore a den location must be in close proximity. The Echidna *Tachyglossus aculeatus* and Melomys (*Melomys burtoni)* were distributed in multiple locations across the site.

A total of five lizards were identified in camera traps:

- 2 monitors (Varanus tristis and V. varius),
- 1 gecko (Gehyra dubia,
- 1 Rainbow Skink (Liburnascincus mundivensis) and
- 2 Lined Dragon (Diporiphora bilinieata).

An Eastern brown snake (*Pseudonaja textilis*) was also located.

With the exception of the Cane Toad (*Rhinella marina*), all frogs identified in the creek during spotlighting surveys were *Litoria* species. (*L. rubella; L.inermis; L. atopalmata; L. wilcoxii*). No amphibians were located in 2016 due the lack of rainfall during the dry season.

A complete list of fauna species is provided in **Appendix C**.

3.0 Pest Vertebrate Monitoring

The availability of freshwater pools throughout the site appears to have influenced the presence of large feral animals in the 2017 monitoring season. Evidence of pig (*Sus scrofa*) activity was found at the entry to the site off Lemontree Drive along the creek bed where these water pools remained.

Feral pig observations are provided in **Table 3** below.

Table 3 Evidence of Feral Pigs on Offset Site

Survey	Location	Species	Number
Spotlighting	Nil detected	0	0
Camera Trapping	18	Pig	1
Scats	Site 5, 7, 16, 18	Pig	4
Visual Observation	Site 18, front gate, creek and gully tree roots and dugouts located.	Pig	7

Feral cat and dog observations are reported in **Table 4** below. The only evidence of these species on site were single observations at a camera trap (cat) and scat (dog). The dog scat is most likely to be from a neighbouring yard as they have been known to utilise the creek for swimming. This scat showed signs of being from a domestic animal due to its content.

Table 4 Evidence of Feral Cat and Dogs on Offset Site

Survey	Location	Species	Number
Spotlighting	-	-	0
Camera Trapping	# 13	Cat	1
Scats	# 2 (may not be feral as close to houses)	Dog	1
Visual Observation	-	-	0

3.1 Photo-monitoring Points

A visual assessment was undertaken at four photo monitoring points. These locations were selected based on habitat quality, Regional Ecosystem attribute and location. **Table 5** below summarises the characteristics of these sites where photographs are oriented towards the North, South-east and West facing directions. Whilst the photo will aid in the broad comparisons over time, they are best used in combination with floristic data (Gleed, 2017) as they are unlikely to show fine scale changes on their own.

Table 5 Photo Monitoring Points

Site ID	Description	Photograph from North, South east, West
Photo Point 1 Location :0327999, 8096486	Mapped as RE 7.3.26a Site only partially conforms to mapped RE absence of *Allocasuarina cunninghammii* in community however some key associates were present in canopy and shrub layer. Alluvial sandy loam on riverine wetland. Canopy of *Eucalyptus tereticornis*, *Corymbia Leichardtii* with a sparse shrub layer containing *Lophostemon grandiflorus*, *Bursaria tenuifolia*, *Exocarpus cupressiformis, Callitris intratropica, Acacia spp.* with a ground layer containing *Heteropogon triticeus*, *Sarga spp.* and *Themada triandra*. Weeds present *Stylo guianensis*	  

Site ID	Description	Photograph from North, South east, West
Photo Point 2 Location: 0328099, 8096579	Mapped 7.12.30d Site conforms to RE containing dominant canopy and key lower level associates. Rocky slopes on granite and rhyolite. Canopy *Eucalyptus cloeziana*, *Corymbia leichardtii* and Eucalyptus *crebra* with a very sparse shrub layer containing *Petalostigma pubescens*, *Coelospermun reticulatum, Persoonia falcata, Grevillea parrallela* and a ground layer containing *Heteropogon triticeus*, *Sarga spp.* and *Themada triandra*. Weeds present *Melenis repens*	  

Site ID	Description	Photograph from North, South east, West
Photo Point 3 Location 0330501, 8097591	Site conforms to RE containing low open woodland to shrubland containing key canopy and lower level associates. High uplands slopes on granite and rhyolite. Tall shrub/ low tree layer *Syncarpia glomulifera, Corymbia abergiana, Eucalyptus portuensis, Eucalyptus crebra, Allocasuarina littoralis. Banksia aquilonia. Ground layer Xanthorrea johnsoni, Themeda triandra, Imperata cylindrical, Pteridium esculentum,*	  

Site ID	Description	Photograph from North, South east, West
Photo Point 4 Location: 0330355, 8097647	Mapped as RE 7.12.7a Site conforms to mapped RE containing simple to complex notophyll vine forest with emergent *Agathis microstachya* on granite and rhyolite in the uplands of the moist rainfall zone. Closed vine forest with emergent *Agathis microstachya* lower level associates include *Alectryon semicinereus*, *Guioa acutifolia, Mallotus phillipensis, Wilkea pubescens, Polyscias elegans, Phsychotria lonciceroides, Pipturus argenteus, Smilax australis, Ground layer Dicranopteris linearis, Adiantum diaphanum*	  

4.0 Management Actions

4.1 Comparison to Baseline Monitoring

Since the baseline monitoring collection in 2016 the conditions of the site have changed very little. The absence of fire has improved the condition of some habitat on the site in combination with availability of freshwater pools has increased the availability of resources and mobility for some species. Fauna distribution and population of target species is very similar and although no statistical analysis could be undertaken, there was no indication of a population decline in Northern Quoll, Spectacled Flying-fox, or Bare-rumped Sheathtail Bat due to habitat impacts on the offset site.

4.2 Biodiversity management issues

Several minor biodiversity management issues were identified during monitoring. These include the state of the access track, and signs of feral fauna within the Biodiversity Offset Area.

4.2.1 Access Track

Since the baseline monitoring data was collected in 2016, the conditions of access tracks within the Biodiversity Offset Site are to be improved through the securing perimeter fencing. The tracks were showing signs of rill erosion, as well as disturbance by unauthorised vehicular access (primarily motorbikes). Unauthorised access by vehicles should stop with fencing however, these tracks will continue to be scoured by water runoff, resulting in rill erosion. The track may require remediation to prevent excess sediment loading of the nearby ephemeral drainage line if tracks continue to be utilised to the 50x50 m pad.

4.2.2 Pest Species

The biodiversity offset area is considered to contain a low density of pest fauna species, predominately pigs. This is based on the observations of tracks and scats sightings starting within the creek at Lemontree Drive. Aerial baiting and the MEWF pest management plan should target this offset site in the next round of pest management activities.

Camera traps should be selectively used to record feral pig activity across the site. This will give an indication of the proportion of pigs which are impacting the habitat. The employment of bait stations will assist in obtaining more accurate records of feral pig visitation rates.

4.2.3 Timing

It is recommended further monitoring surveys be conducted in April at the end of the wet season to encompass full flowering of plants to ensure feeds trees are available and fauna are most mobile throughout their range.

5.0 Summary

Th ecological surveys undertaken in the MEWF offset site during 2017 provide the first round of annual monitoring data that can be directly compared with the baseline data collected in 2016. The ecological monitoring surveys include information that will be used with weed survey information to fulfil obligations to include in the annual reporting required for the conservation agreement with DoEE and DEH.

A total of three threatened species were recorded in the MEWF Offset site in 2017:

- Northern Quoll (*Dasyurus hallucatus*)
- Spectacled Flying Fox (*Pteropus conspiculatus*)
- Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus*).

Fauna habitat resources remain abundant within the MEWF offset site and the habitat is of high quality.

The site has a high density of the large hollows that several nocturnal birds of prey, bat and large mammal species require for breeding. In addition, small mammals (terrestrial and arboreal), which are the respective prey of a number of predatory species, were identified throughout the site. Canopy tree species and understorey shrubs within the site provide abundant foraging resources such as foliage, seeds, pollen, nectar and invertebrates for variety of species on a seasonal basis and may potentially influence the occurrence and abundance of arboreal mammal species and birds.

Groundcover has improved since baselines surveys due to increased rainfall and rehabilitation since a fire event therefore small reptiles and amphibians have increasingly utilised a wider distribution of the offsets site.

Feral pigs, dogs and cats are evident on the site however only pigs are at a stage that management actions require appropriate measures.

Weed surveys described that although there are currently no priority listed weed species on site, vigilance will be require along the access track and road entry to ensure there are no access points for these threats. Management measures to remove weeds from tracks and external site boundaries will reduce the risks significantly.

The ecological condition of the MEWF Offset site has been maintained since baselines surveys were conducted in 2016.

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Appendix A Offset Site Weed Survey

Mt Emerald Wind Farm Offset Site Weed Survey 2017

Report prepared for 4 Elements Consulting for the Mt Emerald Wind Farm

S. Gleed, January 2018

Mt Emerald Wind Farm Offset Site Weed Survey 2017

Mt Emerald Wind Farm

Simon Gleed

18th January 2018

Report prepared for 4 Elements Consulting for the Mt Emerald Wind Farm

Disclaimer

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Photo credits in this report: Simon Gleed

This document is confidential and its contents or parts thereof cannot be disclosed to any third party without the written approval of the author.

Simon Gleed undertook the fieldwork and preparation of this document in accordance with specific instructions from 4 Elements Consulting, to whom this document is addressed. This report has been prepared using information and data supplied by the Mt Emerald Wind Farm, 4 Elements Consulting and other information sourced by the author.

The conclusions and recommendations contained in this document reflect the professional opinion of the author based on the data and information supplied and available at the time of the work. The author has used reasonable care and professional judgment in the interpretation and analysis of the data. The conclusions and recommendations must be considered within the agreed scope of work, and the methodology used to perform the work, both of which are outlined in this report.

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Simon Gleed	1 (electronic)	S. Gleed

CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

The Mt Emerald Wind Farm offset site is located on land described as Lot 22 on SP210202 and by road is accessed via Lemontree Drive. The offset site has an area of 434.9 ha and is entirely covered by remnant vegetation in near-pristine condition (see **Figure 1**).

A survey was undertaken in the offset site of the areas where invasive or problematic weeds are likely to occur. Additional information regarding species of weeds and their distribution in remnant vegetation in remote areas of the property was derived from previous investigations of the site undertaken in 2016.

The primary area of weed infestation is from the entry into the property on Lemontree Drive and along an informal track which was constructed some years ago (date unknown), which provides access to a small clearing in remnant vegetation adjacent to a tributary of Oaky Creek

The survey of the track section of the property was completed in December 2017 approximately two weeks after rain had fallen. The recent rainfall had triggered growth in many weed species, which allowed for easy identification. It is expected the results of this survey of weeds are indicative of the main weed component of the offset site.

Figure 1. Regional location of the Mt Emerald Wind Farm offset site (within yellow line), showing the site's mountainous setting and remnant vegetation cover.

2.0 AIMS and METHODS

The aim of the survey was to assess and describe the current status of weeds on the offset site through ground-based surveys; and to inform the Mt Emerald Wind Farm management interests of the priority weed species requiring control and management.

A brief assessment of weeds adjacent to the roads leading to the offset site was completed whilst driving, and is therefore not inclusive or detailed. The weed assessment of the offset site concentrated on the access track from Lemontree Drive to the small clearing adjacent to a tributary of Oaky Creek. The entire length of the track was traversed on foot. Additional spot observations of weed presence in remnant, undisturbed vegetation were undertaken in 2016 and during the 2017 survey.

3.0 RESULTS OF WEED SURVEY

3.1 Regional Setting and Road Access

The offset site is located at the end of Lemontree Drive and is positioned among contiguous tracts of sclerophyll woodlands occurring on steep rocky and dissected hills of rhyolite rock with soils of low fertility. Oaky valley (e.g. the roads Oaky Valley Avenue and Lemontree Drive) has flatter topography and soils with higher fertility – hence its agricultural and farming setting. The valley harbours a higher proportion of weeds, which primarily occupy property boundaries and the verges of roads and tracks.

From the township of Walkamin, access to the offset site is via the following sealed roads: Hansen Road, Springmount Road, Oaky Valley Avenue and ultimately Lemontree Drive, where the entrance to the offset site is located. These roads, although sealed, are lined in places by invasive weeds – mostly grasses. A brief overview of the weed status along these roads is given in **Table 1**. Weeds not listed in the table is not an indication a particular species is absent from the section of road.

Table 1. Weeds of concern found along the main roads leading to the site.

Road section	Problematic weeds (inclusive survey not undertaken of roads)
Hansen Road	Japanese Sunflower (*Tithonia diversifolia*), Grader Grass (*Themeda quadrivalvis*), Thatch Grass (*Hyparrhenia rufa*), Stinking Passion Flower (*Passiflora foetida*), Guinea Grass (*Megathyrsus maximus*), Rhodes Grass (*Chloris gayana*), Signal Grass (*Urochloa decumbens*), Red Natal Grass (*Melinis repens*).
Springmount Road	Grader Grass, Rubber Vine (*Cryptostegia grandiflora*), Light Blue Snakeweed (*Stachytarpheta jamaicensis*), Stinking Passion Flower, Guinea Grass, Signal Grass, Red Natal Grass.
Oaky Valley Avenue	Red Natal Grass, Signal Grass.
Lemontree Drive	Red Natal Grass, Rhodes Grass, Signal Grass.

3.2 Current Condition and Weed Status of Offset Site

The condition of the offset site is very high in terms of remnant vegetation cover, its structure and plant species integrity. Previous surveys in 2016 recorded significant levels of natural integrity and very low weed presence. Where weeds were encountered (during the 2016 and December 2017 surveys), they were invariably associated with vehicle tracks and associated small areas of vegetation clearing.

Elsewhere on the site, weeds are limited to isolated occurrences of Praxelis (*Praxelis clematidea*), which has a tendency to favour rocky habitats; Molasses Grass (*Melinis minutiflora*), where small swards are typically found in more sheltered woodlands; and Red Natal Grass (*M. repens*), which has a similar diffuse distribution pattern as Praxelis, and can also favour rocky habitats. None of these species were observed to be problematic on the offset site where they occur in natural, undisturbed remnant vegetation.

At the entrance gate into the property on Lemontree Drive (**Figure 2**), common weeds of roadsides are present, which include Wynn Cassia (*Chamaecrista rotundifolia*), Praxelis, Stylo (*Stylosanthes scabra*), Red Natal Grass, Hyptis (*Hyptis suaveolens*), Signal Grass (*Urochloa decumbens*), Flannel Weed (*Sida cordifolia*) and Common Sida (*S. rhombifolia*).

Figure 2. The entrance to the offset site through the gate and to the right of picture. The bitumen provides a useful barrier to weed growth, rendering the access to the property relatively easily managed in terms of weed control.

The largest area of weed concentration is along both sides of the access track to the tributary of Oaky Creek (**Figures 3 & 4**). Here, the main weeds are Stylo, Praxelis, Red Natal Grass and small patches of Molasses Grass. They are all associated with prior disturbance and have most likely been introduced into the area on vehicles and machinery used to grade the track.

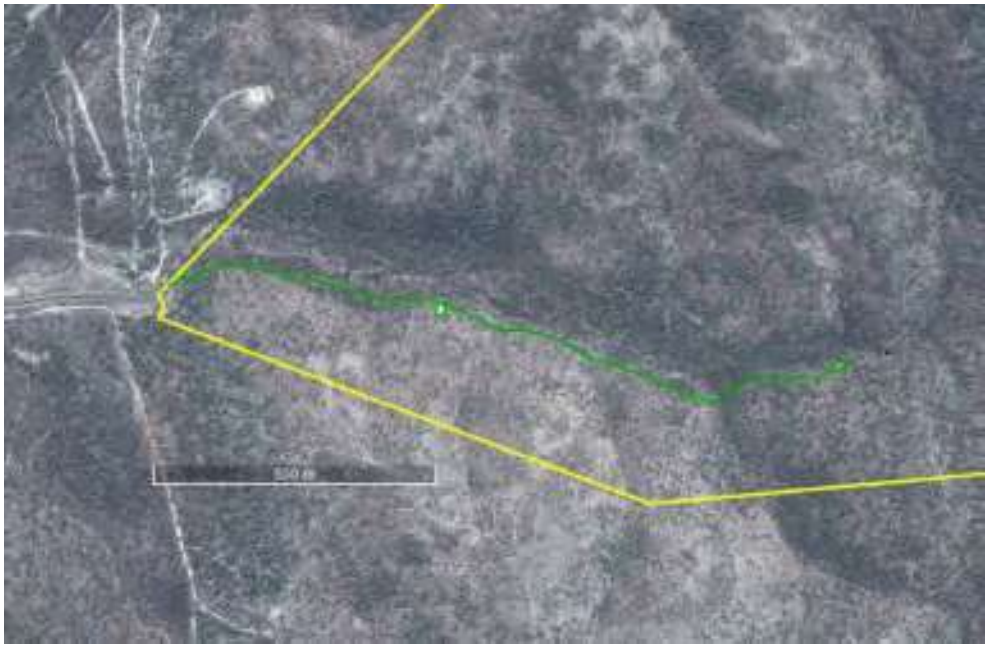

Figure 3. The track (green line) from Lemontree Drive is 1.3 km long and terminates at a circular clearing near a tributary of Oaky Creek. Weeds are concentrated along the track, becoming more diffuse away from the track.

An area of dense weed infestation is found at the cleared area presently used for turning vehicles around at the end of the track described above (**Figure 5**). Invasive grasses, most notably Rhodes Grass (*Chloris gayana*) have established and co-occur with native grasses such as Black Speargrass (*Heteropogon contortus*). Other weeds in this area include Stylo, Wynn Cassia, Signal Grass, Molasses Grass, Hyptis and Beggar's Ticks (*Bidens bipinnata*).

Figure 4. The track from Lemontree Drive passing through remnant vegetation. Stylo is one of the commonest weeds along the edges of the track.

Figure 5. Clearing at the end of the track. The tall invasive Rhodes Grass (*Chloris gayana*) has established here, and the clearing also harbours several other weeds in rocky soil.

3.3 Distribution and Characteristics of Weed Species

Stylo (*Stylosanthes scabra*) is the commonest weed along the edges of the track from Lemontree Drive. Along some sections of the track, dense stands have established on disturbed rocky soil, but the species becomes less common in neighbouring woodlands. It is found at the property entrance and almost continuously along the track and into the clearing at the end of the track.

The herbaceous to semi-woody Praxelis (*Praxelis clematidea*) is scattered throughout the offset site. It is more common on disturbed rocky soils. It can be locally problematic if allowed to regenerate without intervention.

Red Natal Grass (*Melinis repens*) and the related Molasses Grass (*M. minutiflora*) have similar weed characteristics to Praxelis, and can form dense stands on disturbed sites becoming problematic if not controlled. Red Natal Grass is found along the road verge of Lemontree Drive, and as small populations and isolated incidences near the track. The species is often found as individual plants in remnant woodland. Molasses Grass is uncommon in the offset site and is found as isolated patches in more sheltered woodlands on slopes; a small patch near a creek crossing along the track; and in the circular clearing at the end of the track.

Rhodes Grass (*Chloris gayana*) is restricted to near the entrance into the property, along Lemontree Drive, and at the circular clearing at the end of the track, where it forms a dense stand. This tall grass can be very problematic when established in large areas.

Wynn Cassia (*Chamaecrista rotundifolia*), although appearing to be an inconspicuous ground creeper, is difficult to eradicate once established. The weed sets large quantities of seed with a hard coating, which remain viable in the soil seed bank for many years. Successive germination of the species retards native species succession and displaces important native grasses. Wynn Cassia is found at the property entrance and at the circular clearing at the end of the track.

Signal Grass (*Urochloa decumbens*) is a weedy grass that will establish in dense swards under woodland cover, particularly marginally wetter woodlands and zones where water runoff increases longer-term soil-moisture availability. The grass effectively displaces native species and carries a hot fire, which can have serious impacts. Signal Grass is found along the verges of Lemontree Drive and at the offset site property entrance. An established stand of Signal Grass is also found at the circular clearing at the end the track leading to the tributary of Oaky Creek. Another interesting location of this grass is at the vehicle track end which provides access to the walking track to the Mt Emerald summit. Although this vehicle track section is not on the offset site, the walking track heads into the offset site, and therefore, there is potential for Signal Grass to be carried into the high elevation aspects of the property, where it would be very difficult to control.

Hyptis (*Hyptis suaveolens*) is found as a few plants near the gate on the property boundary at Lemontree Drive, and at the circular clearing at the end of the track. This is serious shrubby weed, which can significantly alter natural fire ecology. It is highly invasive if not controlled early. The seeds will adhere to clothing, the fur of animals, and on vehicles and machinery.

Beggar's Tick's (*Bidens bipinnata*) occurs in disturbed rocky soil at the clearing at the end of the track. It is a semi-herbaceous daisy which will germinate in large numbers. The species could be locally problematic and should be controlled early before it becomes an issue.

Less conspicuous weeds are found at the property entrance, and include Flannel Weed (*Sida cordifolia*) and Common Sida (*S. rhombifolia*). These weeds are scattered and do not form dense infestations.

4.0 WEED IDENTIFICATION GUIDE

Unless stated, the weeds shown here were recorded from the Mt Emerald Wind Farm offset site (Lot 22 on SP210202) at the gate entrance on Lemontree Drive or along and at the end of the track leading to the tributary of Oaky Creek.

Although not found on the offset site, Grader Grass, Light Blue Snakeweed, Rubber Vine, Stinking Passion Flower and Thatch Grass are included as these species occur along the primary access roads leading to the property and are known to be deleterious to natural processes.

Beggar's Ticks
(*Bidens bipinnata*)

Common Sida - juvenile
(*Sida rhombifolia*)

Flannel Weed
(*Sida cordifolia*)

Grader Grass - **NOT ON SITE**
(*Themeda quadrivalvis*)

Hyptis
(*Hyptis suaveolens*)

Light Blue Snakeweed – **NOT ON SITE**
(*Stachytarpheta jamaicensis*)

Molasses Grass
(*Melinis minutiflora*)

Praxelis
(*Praxelis clematidea*)

Red Natal Grass
(*Melinis repens*)

Rhodes Grass
(*Chloris gayana*)

Rubber Vine - **NOT ON SITE**
(*Cryptostegia grandiflora*)

Signal Grass
(*Urochloa decumbens*)

Stinking Passion Flower – **NOT ON SITE**
(*Passiflora foetida*)

Stylo
(*Stylosanthes scabra*)

Thatch Grass - **NOT ON SITE**
(*Hyparrhenia rufa*)

Wynn Cassia
(*Chamaecrista rotundifolia*)

5.0 RECOMMENDATIONS

The following recommendations are intended as a guide, as this document is not a weed management plan. The principles and methods of weed control should be relevant to the weed species, the population size and be in accordance with the label instructions of the registered chemical herbicide (if used). Records of weed sightings, new species, control measures and outbreaks should be maintained at all times.

5.1 Dedicated Weed Management and Control

The offset site is in near-pristine natural condition and weeds have the potential to detract from these values. A commitment should be made to continuous weed detection, management and control in order to preserve the long-term integrity and condition of the site.

5.2 Weed Surveillance and Vigilance

The early detection and ability to prioritise weed control is critical for effective weed management. Invasive grasses and shrubs should be detected and controlled as a priority. Follow-up control must be applied until weed populations are either eradicated or adequately controlled.

Field surveys and monitoring for weeds should be undertaken every month during the wet season when conditions and weed growth are likely to be optimal. One survey during the driest period of the year is also recommended. Specific timing of the weed surveillance surveys will be dictated by the prevailing weather conditions and patterns.

5.3 Priority Weed Species

Surveillance for weeds and timely control should target the most invasive and potentially harmful species. Priority weeds include, but are not limited to the species outlined in **Table 2**.

Table 2. Priority weeds.

Weed	Location	Comment
Rhodes Grass (*Chloris gayana*)	Gate and cleared area at end of track.	**PRIORITY**. Grub out plants at gate. Control with herbicide at clearing. Surveillance and control of future outbreaks.
Hyptis (*Hyptis suaveolens*)	Gate and cleared area at end of track.	**PRIORITY**. Grub out plants and spot spray seedlings with herbicide. Surveillance and control of future outbreaks.
Signal Grass (*Urochloa decumbens*)	Cleared area at end of track.	**PRIORITY**. Control with herbicide at clearing. Surveillance and control of future outbreaks.
Stylo (*Stylosanthes scabra*)	At gate, along and at end of track. Isolated occurrences elsewhere.	Herbicide control along track, particularly dense patches. Herbicide control at clearing.
Molasses Grass (*Melinis minutiflora*)	On watercourse crossing and at end of track. Isolated occurrences elsewhere.	Spot control with herbicide patches near vehicle access. Hand remove smaller plants in isolated sections of site if possible.
Red Natal Grass (*Melinis repens*)	At gate, along and at end of track. Isolated occurrences elsewhere.	Spot control with herbicide larger patches. Hand remove isolated specimens detected in new areas.
Grader Grass (*Themeda quadrivalvis*)	**NOT ON OFFSET SITE**	**PRIORITY** for continued surveillance and early detection. If detected control immediately.
Thatch Grass (*Hyparrhenia rufa*)	**NOT ON OFFSET SITE**	**PRIORITY** for continued surveillance and early detection. If detected control immediately.
Stinking Passion Flower (*Passiflora foetida*)	**NOT ON OFFSET SITE**	**PRIORITY** for continued surveillance and early detection. If detected control immediately.
Rat's Tail Grasses (*Sporobolus* spp.)	**NOT ON OFFSET SITE**	**PRIORITY** for continued surveillance and early detection. If detected control immediately.
Other weeds*	Lantana, Gambia Pea, Senna spp., Snakeweeds, Fountain Grasses, *Chloris* spp., *Pennisetum* spp., *Cenchrus* spp., Mother-of-Millions, etc.	**PRIORITY** for continued surveillance, early detection and control of any new weed species which become problematic. Any existing weeds which are currently relatively benign but may become problematic should be controlled.
* This list is not inclusive and surveillance and early detection should treat all introduced species as potentially harmful, and therefore should be controlled immediately upon detection.		

Appendix B Bat Fauna MEWF Offsets Site Report

Green Tape Solutions

Quality, Integrity, Experience

Bat Call Analysis Report

Mt Emerald Wind Farm

Prepared for Four Elements Consulting Pty Ltd

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Document Records - Quality

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FILED AS	PR17247_BA_Ver2

Revision	Date	Prepared by (name/title)	Reviewed by (name/ title)	Approved by (name/title)
Version A	27/11/2017	Kelly Matthews, Director / Principal Ecologist	Kelly Matthews, Director / Principal Ecologist	Melissa Jess from Four Element
Version B	5/12/2017	Kelly Matthews, Director / Principal Ecologist	Kelly Matthews, Director / Principal Ecologist	Melissa Jess from Four Element
Version C	8/12/2017	Kelly Matthews, Director / Principal Ecologist	Kelly Matthews, Director / Principal Ecologist	Melissa Jess from Four Element

Table of Content

TABLES

FIGURES

1.0 Introduction

1.1 Background

An assessment on the likelihood of the presence of microbat species using four echolocation detectors (Songmeters SM2BAT) was conducted during an ecological survey at Mt Emerald Wind Farm. The site is located in Mutchilba, Mareeba Shire in Queensland.

1.2 Scope of Works

The specific scope of works for this report includes the following:

- Outline the methodology used to survey microbat species within the subject site;
- Analyse and provide an assessment of the likelihood of occurrence of threatened microbat species listed under State and Commonwealth legislation; and,
- Identify of local statutory considerations relevant to ecological aspects (relevant to bats) of the site.

2.0 Methodology

2.1 Capture

Data was collected over seven nights from 24 October 2017 using Songmeters SM2BAT. The original call files display Australian Eastern Standard Time. The majority of calls were considered to be of medium to good quality calls.

Data was received via an electronic transfer (Dropbox) on the 23rd November 2017 and was analysed using Kaleidoscope Pro. In total, 1,424 call sequence files were marked as containing recognisable bat calls.

2.2 Call Identification

Call identification for this dataset was based on call keys and descriptions published for Queensland (Reinhold, 2001) and Northern Territory (PWCNT, 2002) with reference to descriptions for New South Wales (Pennay et al., 2004).

Species' identification was further refined using the probability of occurrence of each species based on their geographic distribution (Churchill, 2008, Van Dyck and Strahan, 2008). Species nomenclature used in this report follows Churchill (2008).

The reliability of identification is as follows:

- **Definite** - one or more calls where there is no doubt about the identification of the species;
- **Probable** - most likely to be the species named, low probability of confusion with species that use similar calls; and,
- **Possible -** call is comparable with the named species, with a moderate to high probability of confusion with species of similar calls.

2.3 Survey Limitations

The ability to detect call and accurately identify them to species level can vary greatly with the surrounding environment and the location of the echolocation device. The survey undertaken as part of this assessment only represents a ‘snapshot’ in time and therefore, may not provide a true indication of species presence at the site. Hence, this survey should not be regarded as conclusive evidence that certain protected microbats species do not occur at the site.

2.4 National Standard

The format and content of this report complies with the nationally accepted standards for the interpretation and reporting of Anabats and Songmeters data (Reardon, 2003), which is currently available from the Australasian Bat Society at www.ausbats.org.au.

3.0 Results

3.1 Total of Species Recorded

A total of 1,424 sequence files were marked as recognised bat calls.

A total of 10 microbat species were definitely identified being present on site and an additional seven (7) species were potentially recorded on site.

One threatened species, *Saccolaimus saccolaimus,* listed under the *Nature Conservation Act 1992* as Endangered and under the *Environmental Protection and Biodiversity Act 1999* as Vulnerable was highly likely recorded on site. This species cannot be definitely confirmed due the similarity in call with sympatric species and overlap in their distribution. This species also presents a number of call variation, even on reference calls, which makes it difficult to confirm its presence using only echolocation techniques. Only direct capture of this species is likely to definitely confirm the presence of this species on site.

However, we note that the full spectrum of number of recorded calls were clustered closely with those of *S. saccolaimus* and harmonics would likely be attributed to *S. saccolaimus*. As this species was also recorded 500m away from the site, it is considered highly likely that the calls can be attributed to this species. A detailed assessment of the call recorded is provided in **Section 3.2.**

A summary of the species present on site is provided in **Table 1**.

Table 1: Summary of bat calls

Species	NC Act	EPBC Act	Site 12						Site 19		
			24/10	25/10	26/10	27/10	28/10	29/10	25/10	26/10	27/10
Austronomus australis	LC	NOC	Definite	Definite	Definite	Definite	Definite		Definite	Definite	Definite
Chaerephon jobensis	LC	NOC		Definite		Possible	Possible		Definite		
Chalinolobus picatus	LC	NOC				Definite	Definite				
Chalinolobus nigrogriseus	LC	NOC	Definite	Definite	Definite					Definite	Definite
Miniopterus australis	LC	NOC	Possible		Definite	Definite	Definite	Definite	Possible		Definite
Miniopterus orianae oceanensis	LC	NOC	Definite	Definite	Definite	Definite			Definite	Definite	Definite
Mormopterus lumsdenae	LC	NOC		Definite	Definite	Definite		Definite	Definite		Definite
Mormopterus ridei	LC	NOC	Definite	Definite			Definite	Definite		Definite	Definite
Nyctophilus geoffroyi,	LC	NOC	Possible		Possible	Possible			Possible	Possible	
Nyctophilus gouldi	LC	NOC	Possible		Possible	Possible			Possible	Possible	
Nyctophilus bifax	LC	NOC	Possible		Possible	Possible			Possible	Possible	
Rhinolophus megaphyllus	LC	NOC		Definite	Definite				Definite		Definite
Saccolaimus flaviventris	LC	NOC	Possible	Possible				Possible	Possible		Possible
Saccolaimus saccolaimus	Endangered	Vulnerable	Probable	Probable		Probable	Probable	Possible	Possible		Possible
Scotorepens orion	LC	NOC		Probable	Probable	Probable				Probable	
Taphozous troughtoni	LC	NOC	Possible	Possible		Possible	Possible	Possible	Possible		Possible
Vespadelus pumilus	LC	NOC	Possible	Definite	Definite				Possible	Possible	

LC: Least Concern /NOC: Not Of Concern / NR: Not Recorded

3.2 Analysis of the presence of *Saccolaimus saccolaimus*

The purpose of the bat survey was to identify the presence of *S. saccolaimus* on site. Characteristic call attributes of *S. saccolaimus* (PWCNT, 2002) include:

- A dominant harmonic with characteristic frequency around 22-25 kHz;
- At least 3 and up to five distinct harmonics at approximately 13 kHz intervals (1 below and up to 3 above the dominant harmonic); and
- Call pulses sometimes in “triplet” sets with pulse intervals of approximately 10-20ms between first and second pulses and 20-40ms between second and third pulses and an inter-triplet interval of about 80-100ms.

A number of sequence files were recorded that may be representative of *S. saccolaimus* and this call show all the harmonic characteristics. While it is not possible to reliably separate this species from several sympatric species with similar call attributes (i.e. *T. troughtoni*), *S. saccolaimus* was previously recorded within the site and it is considered that *S. saccolaimus* is highly likely to occur on site.

3.3 Samples of Calls / Sequences Files

Samples of call extracted from the dataset for each species identified is provided in the following figures.

Figure 1: Probable *Austronomus australis*

This species is one of the few bat species with calls audible to human ears. This species exhibits a characteristic frequency ranging from 10.5 to 15 kHz (Pennay *et al,* 2004).

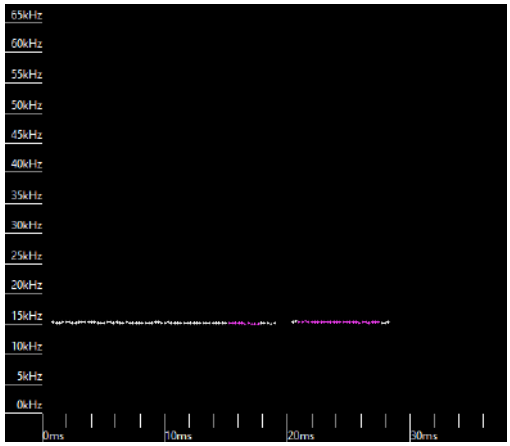


Figure 2: : Definite *Chaerephon jobensis*

Their characteristic frequency average 19.8 kHz (range 16.12-23.6kHz). *C. jobensis* often flies in pairs and therefore produce paired call pulses at alternating frequencies with intermittent, “excited”, linear pulses. This pattern is probably the result of bats interacting with each other. The calls of an individual *C. jobensis* are therefore likely to be difficult to identify from *S. flaviventris* or *M. lumsdenae.*

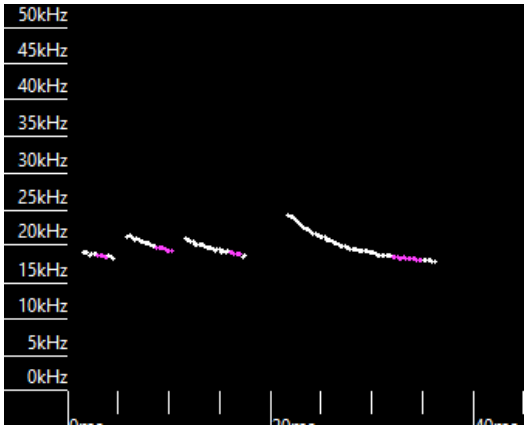
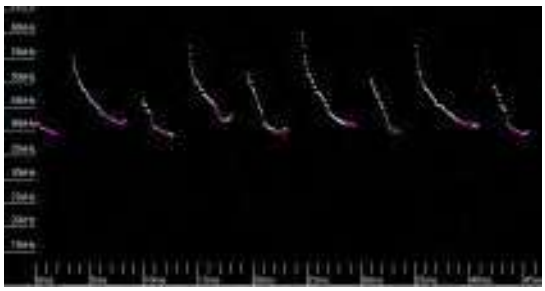


Figure 3: Definite *Chalinolobus nigrogriseus*

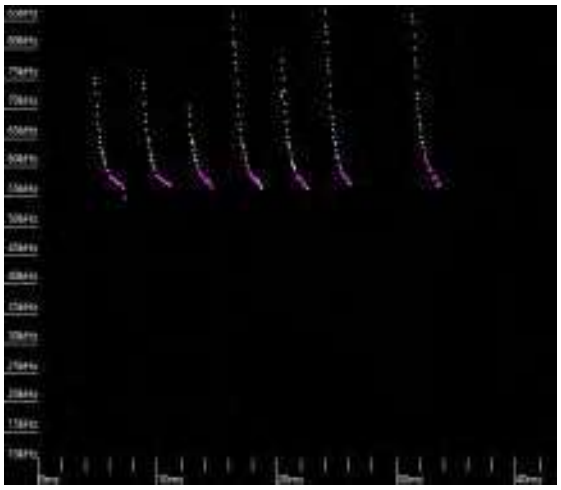
Curved shape with characteristic frequency 37 to 40kHz (Reinhold *et al,* 2001). Usually has no tail. Characteristic section and tail takes up at least 2/3 if the time of the pulse when in search phase.

Figure 4: Definitely *Chalinolobus picatus*



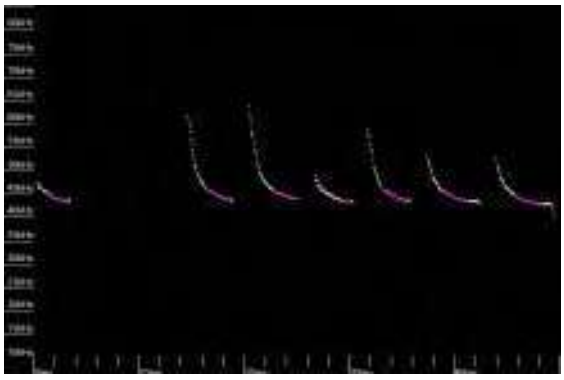
Usually no tail with a characteristic frequency 38 to 42kHz with distinctive pulses alternate in frequency every second pulse is stepped-up by about 2kHz. Cannot be confused with any other species. While this species is rare in the location of the survey, it has been recorded around Cairns.

Figure 5: Definitely *Miniopterus australis*



This species displays a characteristic frequency between 54.5 – 64.5 kHz with a curved, usually down-sweeping tail (Pennay et al 2004). It overlaps in frequency with *Vespadelus pumilus* between 57 – 58 kHz but the latter exhibits curved up-sweeping tail.

Figure 6: Definite *Miniopterus orianae oceanensis*



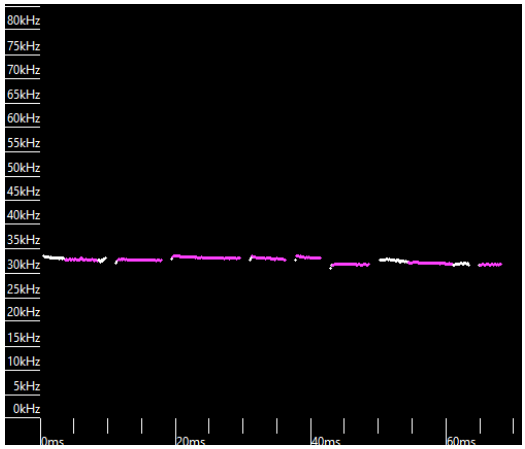
The species call is characterised by its relatively long curved pulse with a small down-sweeping tail and its frequency 43-47kHz (Reinhold, 2001).

Pulse shape and time between calls usually variable within a sequence.

Figure 7: : Definite *Mormopterus lumsdenae*

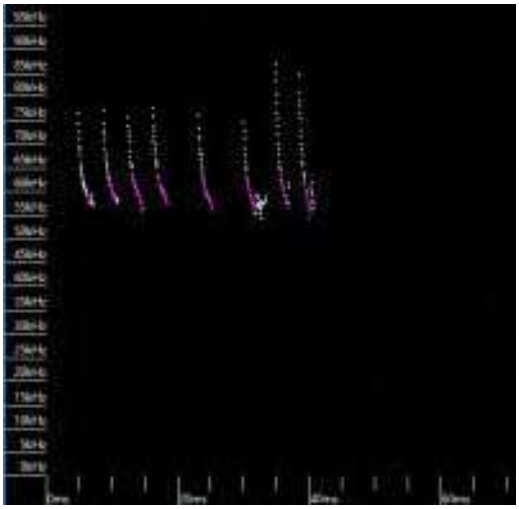
Characteristic frequency higher than 22 and lower than 24kHz. *Mormopterus lumsdenae* pulse can be confused with *S. flaviventris* However, the latest rarely have calls above 22kHz. *M. lumsdenae* reference calls have pulse rising in frequency and can get up to 27kHz as shown here. *S. flaviventris* change more rapidly from search phase to buzz phase which is distinctive.

Figure 8: Definite *Mormopterus ridei*



Characteristic frequency 30 to 36 kHz. May be flat but sometime with short initial and down-sweeping tail (Reinhold *et al,* 2001).

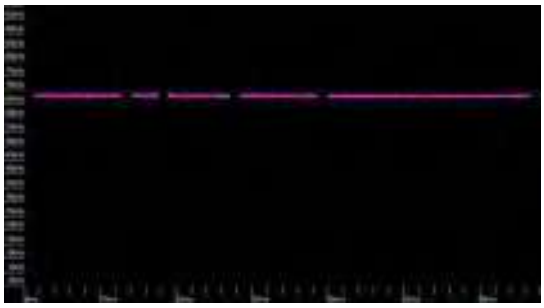
Figure 9: Possible *Nyctophilus sp.*



This species displays a near-vertical pulse, characteristic frequency between 80 and 35KHz (Pennay *et al*, 2004). The call of these species cannot be distinguished from each other.

There are three species of *Nyctophilus spp* occurring within the site area. *N. geoffroyi, N. gouldi* and *N. bifax*.

Figure 10: Definite *Rhinolophus megaphyllus*

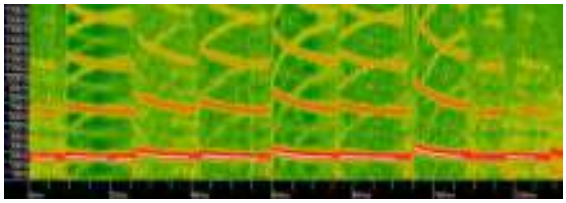


The species call cannot be misidentified with any other species. Pulses have an up-sweeping initial section a perfectly flat, relatively long characteristic section and a down sweeping tail (Reinhold, 2001). Characteristic frequency ranges from 66 to 72 kHz.

Figure 11: Probable *Saccolaimus saccolaimus*

Few sequence files were recorded on site that may be representative of *Saccolaimus saccolaimus*. Distinguishing this species acoustically is not straightforward, despite some recent literature and conference presentations that have pointed to subtle but diagnostically useful characters and sequence patterns.

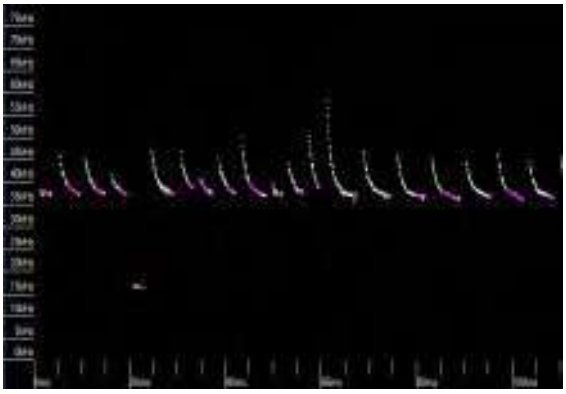
Harmonics



Echolocation calls for *S. saccolaimus* have peak energy in the range 23-25kHz, similar to the frequency band of other large sheathtail bats in Australia. *S. flaviventris* pulses rarely go above 22kHz and have one harmonic at about 30kHz which we cannot see here.

T. troughtoni also produces a flat type call pulse at the same frequency as *S. saccolaimus*. It is typically long and straight or slightly curved and almost horizontal, similar to *S. saccolaimus.*

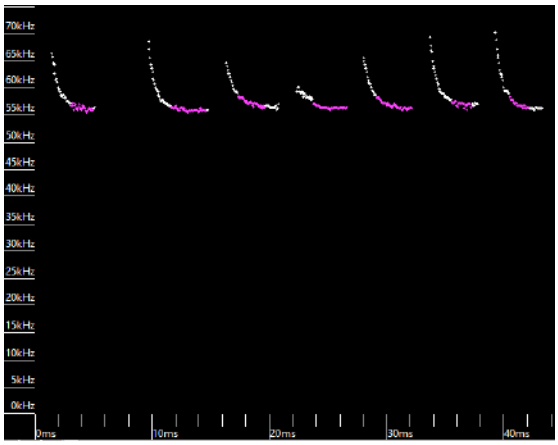
Figure 12: Probable *Scotorepens orion*



Characteristic frequency between 34.5 and 37.5 kHz with curved, absent tail sometime down-sweeping tail (Reinhold et al, 2001). Knee of the pulse is usually lower than 38 kHz.

Can be confused with *Scoteanax rueppelli* but has a longer pre-characteristic section (can be up to 70kHz) which differentiate it from other species.

Figure 13: Definite *Vespadelus pumilus*



This species displays a characteristic frequency between 50 – 58 kHz and has a prominent up-sweeping tail (Pennay *et al*, 2004).

Calls of this species may be easily confused with *V. troughtoni,* unless the end frequency is higher than 54 kHz, which is representative of *V. pumilus*, as illustrated in the **Figure 4**.

4.0 Conclusion

A total of 10 microbat species were detected occurring within the site. A total of seven (7) microbat species were were potentially/probably recorded on site.

The presence of *S. saccolaimus,* listed as Endangered under NC Act, and listed as Vulnerable under EPBC Act, was analysed. This species could not be definitely confirmed due the similarity in call with sympatric species and overlap in their distribution. This species also presents a number of call variation which makes it difficult to confirm its presence using only echolocation techniques. However, a number of call presented harmonics that could highly likely be attributed to S. *Saccolaimus* and therefore, we would consider that *S. saccolaimus* is highly likely to occur within the surveyed area.

All bats identified on the site were expected to be present within the region. Bat activity levels at the site are considered to be similar compared to other surveys within similar areas in the surrounding region.

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Appendix C Fauna List

A summary of species identified during survey on the MEWF Offset Site.

Species	Common Name
Bird	
Centropus phasianinus	Pheasant Coucal
Strepera graculina	Pied Currawong
Turnix maculosus	Red-backed Buttonquail
Alectura lathami	Australian Brush-turkey
Podargus strigoides	Tawny frogmouth
Ninox boobook	Boobook Owl
Coracina tenuirostris	Common cicadabird
Lichmera indistincta	Brown honeyeater
Todiramphus macleayii	Forest kingfisher
Pachycephala pectoralis	Australian golden whistler
Colluricincla harmonica	Grey shrikethrush
Dacelo novaeguineae	Laughing kookaburra
Meliphaga lewinii	Lewin's honeyeater
Myiagra rubecula	Leaden flycatcher
Hieraaetus morphnoide	Little eagle
Philemon corniculatus	Noisy friarbird
Manorina melanocephala	Noisy miner
Platycercus adscitus	Pale-headed rosella
Merops ornatus	Rainbow Bee-eater
Malurus melanocephalus	Red-backed fairywren
Neochmia temporalis	Red-browed finch
Rhipidura rufifrons	Rufous fantail
Dicrurus bracteatu	Spangled drongo
Ninox boobook	Southern boobook
Lalage leucomela	Varied triller
Aquila audax	Wedge-tailed eagle
Haliastur sphenurus	Whistling kite
Melithreptus albogulari	White-throated honeyeater
Mammal	
Dasyurus hallucatus	Northern Quoll
Felis catus	Cat
Isoodon macrourus	Northern brown bandicoot
Canis Lupus	Dog

Species	Common Name
Melomys burtoni	Melomys
Petrogale mareeba	Mareeba Rock Wallaby
Rattus fuscipes	Bush rat
Sus scrofa	Pig
Tachyglossus aculeatus	Short-beaked echidna
Trichosurus vulpecula	Brush Tailed Possum
Uromys caudimaculatus	Giant white-tailed rat
Wallabia bicolor	Agile Wallaby
Pteropus conspicillatus	Spectacled Flying fox
Pteropus alecto	Black Flying Fox
Pteropus scapulatus	Little Red Flying Fox
Austronomus australis	White-striped free-tailed bat
Chaerophon jobensis	Northern freetail bat
Chalinobus picatus	Little Pied Bat
Chalinobus nigrogiseus	Hoary Wattled Bat
Miniopterus australis	Little bent-wing bat
Miniopterus orianae oceanensis	Eastern Bent-wing Bat
Mormopterus lumsdenae	Northern Free-tailed Bat
Mormopterus ridei	Ride's Free-tailed Bat
Nyctophilus geoffroyi	Lesser long-eared bat
Nyctophilus gouldi	Gould's long-eared bat
Nyctophilus bifax	Eastern long-eared bat
Rhinolophus megaphyllus	Smaller horseshoe bat
Saccolaimus flaviventris	Yellow-bellied sheath-tailed bat
Saccolaimus saccolaimus	Bare-rumped Sheathtail Bat
Scotorepens orion	Eastern broad-nosed bat
Taphozous troughtoni	Troughton's sheath-tailed bat
Vespadelus pumilus	Taphozous troughtoni
Reptile	
Diporiphora bilinieata	Two Lined Dragon
Pseudonaja textilis	Eastern brown snake
Varanus tristis	Black-headed monitor
Varanus varius	Lace monitor
Liburnascincus mundivensis	Outcrop Rainbow-skink
Gehyra dubia	Gecko

Species	Common Name
Amphibian	
Rhinella marina	Cane Toad
Litoria rubella	Desert tree frog
Litoria inermis	Bumpy rocket frog
Litoria latopalmata	Broad-palmed Frog
Litoria wilcoxii	Eastern stony creek frog

G. OFFSET AREA MANAGEMENT PLAN REPORT 2018

Offset Monitoring Program – Mount Emerald Wind Farm

RATCH Australia Corporation Limited

4 Elements Consulting (Qld) Pty Ltd

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Revision History

Version	Purpose	Issued by	Date	Reviewer	Date
1	Draft	R Hughes	30/08/2018	M Jess	16/10/2018

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Contents

Tables

Figures

Plates

Appendices

1.0 Introduction

1.1 Background

The Mount Emerald Wind Farm (MEWF) Offset Site (the site) is located within land described as Lot 22 SP210202, which comprises approximately 434.9 ha (**Figure 1**). It is located immediately to the south west of the MEWF site at Mutchilba within the Mareeba Shire Council Area at the end of Lemontree Drive. The lot tenure is freehold and the primary land use is vacant. The area fringes the Baldy Mountain Forest Reserve and the Herberton Range National Park, via the Herberton Range (Queensland Government 2016).

On 26 November 2016, approval under the provisions of the Environmental Protection and Biodiversity Conservation (EPBC) Act, was granted to RATCH Australia Corporation Limited (RACL). As a requirement of the EPBC Act approval 2011/6228, as issued by the Federal Department of the Environment and Energy (DEE), a Biodiversity Offset Area was developed to compensate for the clearing of 73 ha of habitat on the MEWF Project Site.

This site has been protected as a Nature Reserve through a statutory process through consultation with the Queensland Department of Environment and Science.

The offset site lies completely within the wet tropics bioregion. The site is mountainous with narrow ridges and rocky terrain that are steeply dissected along three dominant ridge lines falling towards Lemontree Drive at the entrance to the site. The offsets site lies adjacent to the MEWF project site.

The majority of the site consists of remnant vegetation with approximately 192.89 ha consisting of Least Concern vegetation and the remaining 242 ha listed as Of Concern vegetation.

4 Elements Consulting was commissioned by RACL to conduct the annual ecological monitoring surveys on the MEWF Offsets Site and this report has been prepared to comply with the requirements outlined in the Mount Emerald Wind Farm Offset Area Management Plan (RPS, 2016), which details monitoring management actions. The data collected in 2016 provided baseline data for future monitoring to be compared against and enables targeted and adaptive management procedures to be implemented to ensure the biological integrity of the biodiversity area is maintained or improved and conserved into the future.

The actions required include:

- Targeted survey of threatened fauna species to determine changes to species diversity on site over time;
- Pest species presence/absence assessment;
- Photo-monitoring points to determine variation over time; and
- Targeted weed surveys.

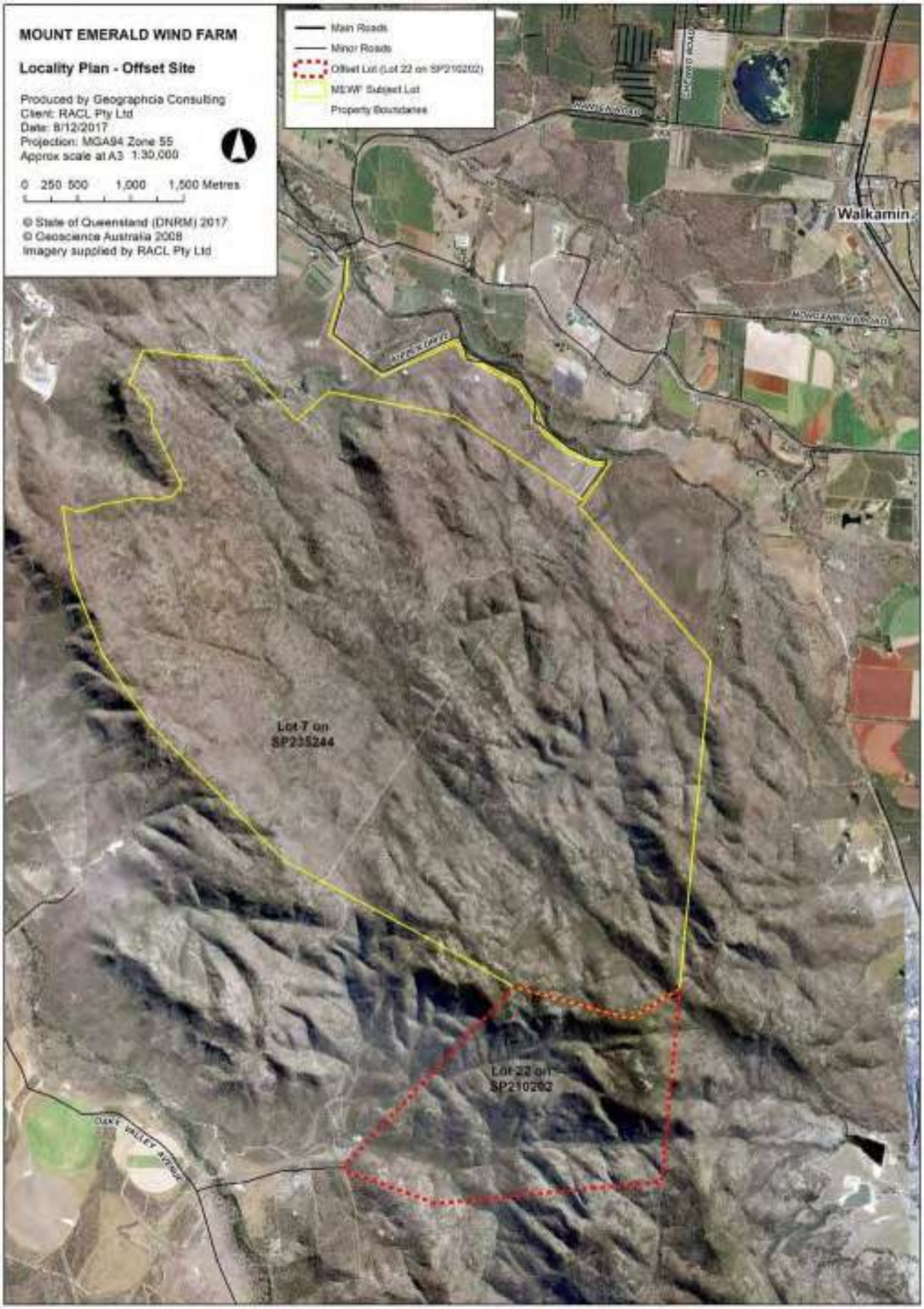

Figure 1 Project Location

1.2 Objectives and Outcomes

As identified in the Offset Area Management Plan (RPS, 2016), the offset area provides for the long-term protection of habitat for seven threatened species and through the implementation of adaptive management practices the quality of the habitat will be improved and maintained over time. The offset area is to be protected in perpetuity as a Nature Refuge. The management plan objectives and outcomes are to:

- Protect all vegetation within the offset area from future clearing;
- Protect all fauna within the offset area from introduced weeds and pests;
- Protect the site vegetation and fauna from un-prescribed burn and wildfire;
- Maintain the ecological condition of remnant of-concern and least concern vegetation within the Offset area where the BioCondition Class is of 1 for each assessment unit does not change;
- Implement a translocation plan based on the criteria and guidelines detailed in the Guidelines for the translocation of threatened plants in Australia (Vallee et al, 2004) should be developed to identify MNES plant species appropriate for relocation as well as target and recipient sites.

This ecological monitoring report presents the methods and results of the 2018 ecological monitoring program at the MEWF Biodiversity Offset Area, including a discussion of the findings and comparisons with the results of the baseline data conducted in 2016. Management recommendations that relate to the current monitoring phase are documented in **Section 4.0**.

1.2.1 Regional Ecosystems:

The RE's mapped for the offset site are described in **Table 1** and shown on the mapping in **Figure 2**. Baseline surveys in 2016 identified that RE mapping was consistent with ground-truthed vegetation assessments.

Table 1 Regional Ecosystems Present Within the Proposed Offset Site

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.3.26a	*Casuarina cunninghamiana* (river oak) woodland to open forest on alluvium fringing streams. Occurs on channel benches, levees and terraces on deep loamy sands or sandy clay loams (often with loose surface gravel). (BVG1M: 16a). Vegetation communities in this regional ecosystem include: 7.3.26a: Riverine wetland or fringing riverine wetland. *Casuarina cunninghamiana*, *Eucalyptus tereticornis*, *Lophostemon suaveolens*, *Melaleuca leucadendra*, *M. fluviatilis*, *Buckinghamia celsissima*, *Mallotus philippensis* woodland and forest with an understorey of *Melaleuca viminalis* and *Bursaria tenuifolia*. Fringing forests of larger streams. (BVG1M: 16a).	OC	E	2.63
7.12.7c	Simple to complex microphyll to notophyll vine forest, often with *Agathis robusta* (kauri pine) or *A. microstachya* (bull kauri). Granites and rhyolites of foothills and uplands, of the moist rainfall zone. (BVG1M: 5c). Vegetation communities in this regional ecosystem include: 7.12.7c: Simple notophyll semi-evergreen vine forest. Uplands of the dry rainfall zone. Rhyolite. (BVG1M: 5c).	LC	NCP	1.24
7.12.9	*Acacia celsa* (brown salwood) open forest to closed forest. Foothills, uplands and highlands on granites and rhyolites, of the very wet and wet rainfall zone. (BVG1M: 5d).	OC	OC	1.16
7.12.16a	Simple to complex notophyll vine forest, including small areas of *Araucaria bidwillii* (Bunya pine). Uplands and highlands on granites and rhyolites, of the cloudy wet to moist rainfall zones. (BVG1M: 6b).	LC	NCP	9.34

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.26a	*Syncarpia glomulifera* (turpentine) +/- *Corymbia intermedia* (pink bloodwood) +/- *Allocasuarina* spp. (sheoaks) closed-forest to woodland, or *Lophostemon suaveolens* (swamp mahogany), *Allocasuarina littoralis* (black sheoak), *C. intermedia* shrubland, (or vine forest with these species as emergents). Exposed ridgelines or steep rocky slopes, on granite and rhyolite. 7.12.26a: *Syncarpia glomulifera*, *Allocasuarina torulosa* and/or *A. littoralis* open-forest and woodland. Uplands and highlands, often on steep slopes, of the wet rainfall zone. Granite and rhyolite. (BVG1M: 28e).	LC	NCP	4.41
7.12.26e	*Syncarpia glomulifera* (turpentine) +/- *Corymbia intermedia* (pink bloodwood) +/- *Allocasuarina* spp. (sheoaks) closed forest to woodland, or *Lophostemon suaveolens* (swamp mahogany), *Allocasuarina littoralis (bla*ck sheoak), *C. intermedia* shrubland, (or vine forest with these species as emergents). Exposed ridgelines or steep rocky slopes, on granite and rhyolite. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.26e: *Syncarpia glomulifera* low open forest and low woodland. Uplands on steep rocky slopes, of the moist and dry rainfall zone. Granite and rhyolite. (BVG1M: 28e).	LC	NCP	8.99
7.12.29a	*Corymbia intermedia* (pink bloodwood) and/or *Lophostemon suaveolens* (swamp mahogany) open forest to woodland +/- areas of *Allocasuarina littoralis* (black sheoak) and *A. torulosa* (forest sheoak). Uplands, on granite and rhyolite. (BVG1M: 9c). Vegetation communities in this regional ecosystem include: 7.12.29a: *Corymbia intermedia*, *Eucalyptus tereticornis*, *E. drepanophylla* open forest to low open forest and woodland with *Allocasuarina torulosa*, *A. littoralis*, *Lophostemon suaveolens*, *Acacia cincinnata*, *A. flavescens*, *Banksia aquilonia* and *Xanthorrhoea johnsonii*. Uplands, on granite and rhyolite. (BVG1M: 9c).	LC	NCP	4.60
7.12.30d	*Corymbia citriodora* (lemon-scented gum) +/- *Eucalyptus portuensis* (white mahogany) woodland to open forest. Granite and rhyolite (often coarse-grained red earths and lithosols with much surface rock). (BVG1M: 10b). Vegetation communities in this regional ecosystem include: 7.12.30d: Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *C. citriodora*, *E. portuensis*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. reducta*, *C. intermedia* and *E. shirleyi*. There is often a very sparse to mid-dense secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens*, *Persoonia falcata*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina inophloia*, *Petalostigma pubescens* and *Grevillea glauca*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Xanthorrhoea johnsonii* and *Grevillea glossadenia*. The ground layer may be dominated by species such as *Themeda triandra*, *Heteropogon triticeus*, *Mnesithea rottboellioides*, *Arundinella setosa*, *Cleistochloa subjuncea*, *Eriachne pallescens* var. *pallescens*, *Lepidosperma laterale* and *Xanthorrhoea johnsonii*. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	LC	NCP	133.42
7.12.34	*Eucalyptus portuensis* (white mahogany) and/or *E. drepanophylla* (ironbark), +/- *C. intermedia* (pink bloodwood) +/- *C. citriodora* (lemon-scented gum), +/- *E. granitica* (granite ironbark) open woodland to open forest. Uplands on granite, of the dry rainfall zone. (BVG1M: 9d).	LC	NCP	23.76
7.12.57a	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57a: Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis* and *Xanthorrhoea johnsonii*. Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d).	OC	OC	58.60

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
7.12.57c	Shrubland and low woodland mosaic with *Syncarpia glomulifera* (turpentine), *Corymbia abergiana* (range bloodwood), *Eucalyptus portuensis* (white mahogany), *Allocasuarina littoralis* (black sheoak) and *Xanthorrhoea johnsonii* (grasstree). Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d). Vegetation communities in this regional ecosystem include: 7.12.57c: Shrubland/low woodland (1.5-9 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana*, *E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *Callitris intratropica*, *E. atrata*, *E. pachycalyx*, *E. shirleyi*, *E. drepanophylla* and *Homoranthus porteri*, on rhyolite and granite. There is occasionally a very sparse to sparse secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Persoonia falcata*, *Exocarpos cupressiformis* and *Melaleuca viridiflora* var. *viridiflora*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Coelospermum reticulatum*, *Xanthorrhoea johnsonii*, *Acacia humifusa*, *Dodonaea lanceolata* var. *subsessilifolia*, *Grevillea dryandri* subsp. *dryandri*, *Grevillea glossadenia*, *Acacia umbellata* and Ericaceae spp. The ground layer may be dominated by species such as *Themeda triandra*, *Xanthorrhoea johnsonii*, *Eriachne pallescens* var. *pallescens*, *Cleistochloa subjuncea*, *Borya septentrionalis*, and *Eriachne* spp. Includes open rocky dominated by herbs and grasses. This RE includes areas of 7.12.65k (rocky areas with shrubby/herbaceous cover) which are too small to map. Rocky slopes on granite and rhyolite. (BVG1M: 9d).	OC	OC	107.32
7.12.58	*Eucalyptus reducta* woodland to open forest (6-18m tall). Common associated species include *E. granitica*, *Corymbia dimorpha*, *C. citriodora*, *E. cloeziana* and occasionally *C. intermedia*. There is often a sparse secondary tree layer of *C. abergiana* and/or *E. lockyeri*. There may be a very sparse tall shrub layer of species such as *Acacia flavescens*, *Persoonia falcata*, *Allocasuarina littoralis* and *Acacia simsii*, and a very sparse to dense lower shrub layer of *Acacia calyculata*, *Pultenaea millarii*, *Jacksonia thesioides*, *Grevillea glossadenia*, *Grevillea dryandri* subsp. *dryandri*, *Homoranthus porteri* and *Dodonaea lanceolata* var. *subsessilifolia*. The ground layer is often dominated by species such as *Themeda triandra*, *Eriachne* spp., *Cleistochloa subjuncea*, *Lomandra longifolia*, *Mnesithea rottboellioides*, *Xanthorrhoea johnsonii*, *Heteropogon triticeus* and *Coronidium newcastlianum*. Granite and rhyolite. (BVG1M: 9d).	OC	OC	72.45
7.12.65k	Rock pavements or areas of skeletal soil, on granite and rhyolite, mostly of dry western or southern areas, often with shrublands to closed forests of *Acacia* spp. (wattles) and/or *Lophostemon suaveolens* (swamp mahogany) and/or *Allocasuarina littoralis* (black sheoak) and/or *Eucalyptus lockyeri* subsp. *exuta*. (BVG1M: 28e). 7.12.65k: Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon* spp. and/or *Allocasuarina* spp. In the Mount Emerald area, shrubs may include *Acacia umbellata*, *Melaleuca borealis*, *Homoranthus porteri*, *Leptospermum neglectum*, *Melaleuca recurva*, *Melaleuca uxorum*, *Grevillea glossadenia*, *Corymbia abergiana*, *Eucalyptus lockyeri*, *Sannantha angusta*, *Pseudanthus ligulatus* subsp. *ligulatus*, *Acacia aulacocarpa*, *Leptospermum amboinense*, *Xanthorrhoea johnsonii* and *Jacksonia thesioides*. Ground-cover species may include *Borya septentrionalis*, *Lepidosperma laterale*, *Eriachne* spp., *Cleistochloa subjuncea*, *Boronia occidentalis*, *Cheilanthes* spp., *Coronidium newcastlianum*, *Schizachyrium* spp., *Tripogon loliiformis*, *Gonocarpus acanthocarpus* and *Eragrostis* spp. Dry western areas. Granite and rhyolite. (BVG1M: 29b).	LC	OC	7.03
9.5.8	Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) and/or *E. leptophleba* (Molloy red box) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). *Eucalyptus tardecidens* (box) may also occur as a subdominant in northern extent of this regional ecosystem. A sparse shrub layer includes *Petalostigma* spp., *Melaleuca* spp., *Grevillea* spp., *Alphitonia pomaderroides* and *Maytenus cunninghamii* (yellowberry bush). The sparse to dense ground layer is dominated by *Heteropogon contortus* (black speargrass) and *Sarga plumosum* (plume sorghum). Occurs on undulating plains in valleys in ranges on Tertiary/Quaternary soils overlying granite and metamorphic geologies. (BVG1M: 13a)	LC	NCP	0.01

RE	RE Description	VMA[1]	Bio.[2]	Area[3]
9.5.9a	Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) and/or *Eucalyptus leptophleba* (Molloy red box) and/or *E. platyphylla*. A sparse to mid-dense shrub layer including *Melaleuca* spp., *Grevillea* spp., and *Planchonia careya* (cocky apple) can occur. The ground layer is dominated by *Themeda triandra* (kangaroo grass) and *Heteropogon* spp. Occurs on plains, undulating plains and outwash deposits and Tertiary to Quaternary locally consolidated high-level alluvium and colluvium. Major vegetation communities include: 9.5.9a: Woodland to open-woodland of *Corymbia clarksoniana* (Clarkson's bloodwood) +/- *Eucalyptus platyphylla* (poplar gum) +/- *E. leptophleba* (Molloy red box) +/- *C. tessellaris* (Moreton Bay ash) with a distinct to sparse sub-canopy layer often including *Melaleuca viridiflora* (broad-leaved paperbark), *Grevillea glauca* (bushman's clothes peg), *Petalostigma pubescens* (quinine) and *Alphitonia pomaderroides* (soapbush). An open to sparse shrub layer includes *Melaleuca* spp., *Persoonia falcata*, *Grevillea* spp. and *Petalostigma pubescens (*quinine). The sparse to mid-dense ground layer is dominated by *Themeda triandra* (kangaroo grass), *Aristida* spp., *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), and *Sarga plumosum* (plume sorghum). Occurs on undulating plains. (BVG1M: 9e) .	LC	NCP	
9.12.7a	Woodland to low open-woodland of Eucalyptus cullenii (Cullen's ironbark) +/- Erythrophleum chlorostachys (Cooktown ironwood) +/- C. leichhardtii (yellowjacket) +/- Corymbia erythrophloia (red bloodwood). The mid-layer is generally absent but a subcanopy and/or shrub layer can occur. The ground layer is sparse to dense and dominated by Heteropogon contortus (black speargrass) and Themeda triandra (kangaroo grass). Occurs on predominantly felsic volcanic rocks, on rolling to steep hills. Major vegetation communities include: 9.12.7a: Woodland to open-woodland of *Eucalyptus cullenii* (Cullen's ironbark) +/- *Corymbia erythrophloia* (red bloodwood) +/- *Erythrophleum chlorostachys* (Cooktown ironwood) +/- *C. dallachiana* (Dallachy's gum). An open to mid-dense subcanopy can occur and includes a variety of species. The shrub layer is absent to open and dominated by *Maytenus cunninghamii* (yellowberry bush), *Alphitonia pomaderroides* (soapbush), *Petalostigma* spp., and *Acacia* spp. The ground layer is sparse to dense and dominated by *Heteropogon contortus* (black speargrass), *H. triticeus* (giant speargrass), *Themeda triandra* (kangaroo grass) and *Sarga plumosum* (plume sorghum) with a *Xanthorrhoea* sp. (grasstree) occurring in some areas. Occurs on rhyolite hills. (BVG1M: 13a) .	LC	NCP	0.01
9.12.40	Low open-woodland to low woodland of *Melaleuca citrolens* (scrub teatree) +/- *Terminalia platyptera* (yellow-wood) +/- *Corymbia dallachiana* (Dallachy's gum) +/- *Erythrophleum chlorostachys* (Cooktown ironwood). The sparse shrub layer consists of *Petalostigma banksii* (smooth-leaved quinine), *M. citrolens* and *Gardenia vilhelmii* (breadfruit). The ground layer is frequently bare, with patches of short grasses including *Eriachne* spp., *Aristida* spp. and *Schizachyrium* spp. (firegrass). This community also occurs as short open-tussock grassland wooded with low trees and shrubs of *Melaleuca citrolens* +/- *Terminalia* spp. Occurs on gentle slopes, footslopes, rolling hills and colluvial low slopes. (BVG1M: 21b).	LC	NCP	
Non-rem	Non-remnant: modified land, roads, clearings and tracks.			0.08

[1] Status under Vegetation Management Act 1999: OC - Of Concern; LC - Least Concern.

[2] Biodiversity management status: E - Endangered; OC - Of Concern, NCP - No Concern at Present.

[3] Area - total area in hectares of RE type within offset site.

Conservation status of EVNT species: *Acacia purpureopetala* (CE - EPBC Act, V - NCA); *Grevillea glossadenia* (V- EPBC Act,
V - NCA); *Homoranthus porteri* (V - EPBC Act, V - NCA); *Melaleuca uxorum* (E - NCA); *Plectranthus amoenus* (V - NCA); *Prostanthera albohirta* (CE - EBC Act, E - NCA); *Prostanthera clotteniana* (CE - EBC Act, E - NCA).

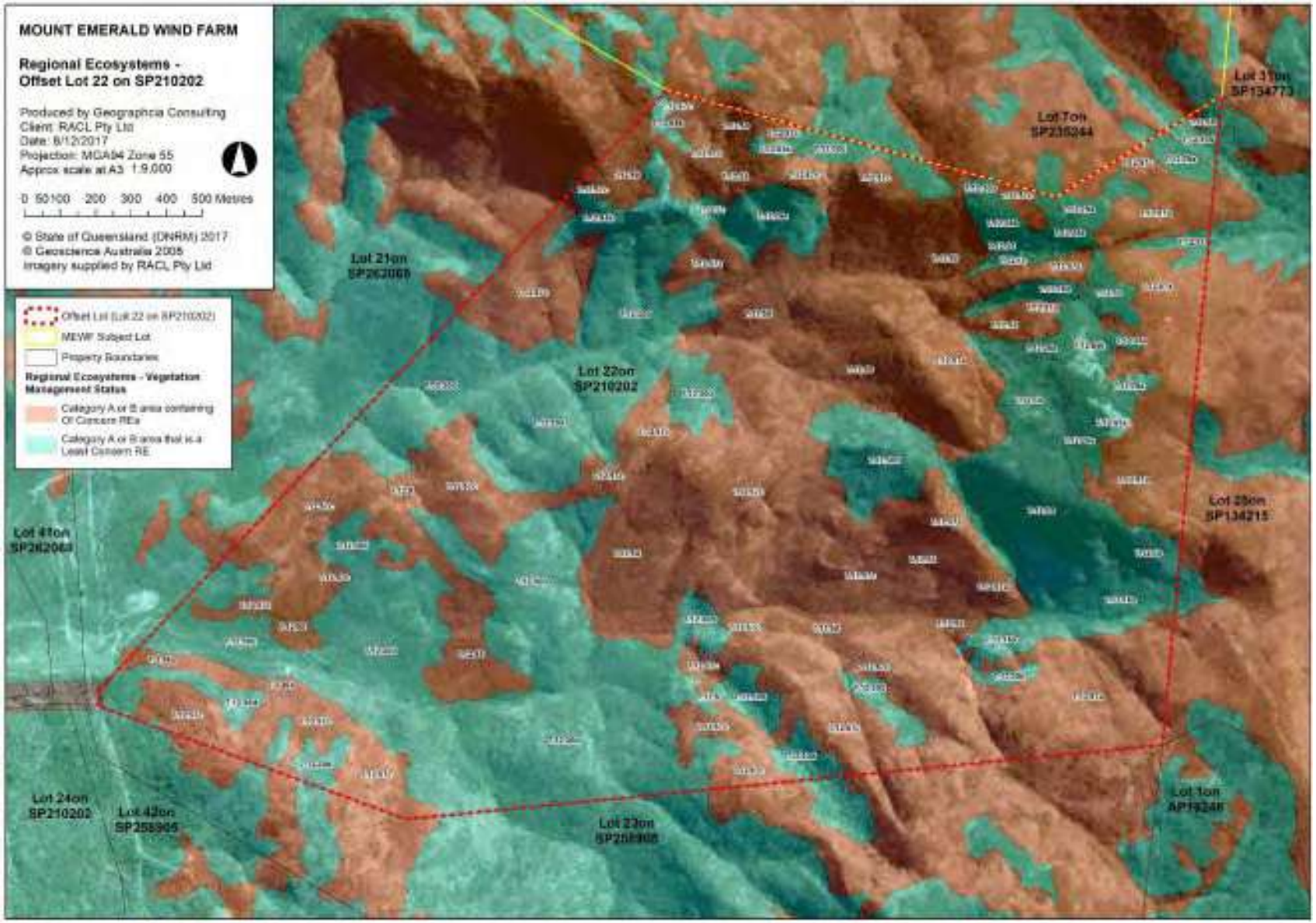

Figure 2 MEWF Regional Ecosystems on Offset Lot

2.0 Methods

The following sections detail the methods employed for the 2018 ecological offset area monitoring program. The methods employed as part of this monitoring program are consistent with those outlined in the MEWF Offset Area Management Plan (RPS, 2016).

Field surveys were conducted on site over four days between 3 July - 18 July 2018.

Total rainfall across the Mount Emerald range was recorded as 21 mm over that period. Minimum temperatures were 11°C and maximum temperatures were 35°C with average nightly temperature falling to 17°C. Daily temperatures averaged 25°C. Winds were calm, with a mix of overcast and sunny days throughout the survey.

2.1 Targeted Fauna Surveys for Conservation Significant Fauna

2.1.1 Northern Quoll (Dasyurus hallucatus)

2.1.1.1 Methods

Camera Traps

The most suitable method for determining the presence of Northern Quoll is by undertaking a Camera Trapping Survey. This method follows that of Eyre *et al* (2014). Survey sites replicated those of the 2016 surveys conducted by RPS (2016) and 4 Elements Consulting (2017) shown in **Figure 3**.

A total of 19 camera traps (Scout Guard Boly units) were used for the camera trapping survey. At each survey site a single camera trap was attached horizontally to the trunk of a tree with a 'dbh' (diameter at breast height) of at least 15 cm with a metal angle bracket, at ~1 m above the ground so the camera faced the ground. Directly beneath the camera, a bait holder, consisting of a Rain Harvesting ™ PVC toilet vent pipe cap with a 50 mm PVC pipe insert, baited with two chicken necks and a single hand rolled ball of general fauna bait (oats, honey and peanut butter) was affixed to the ground with a 30 cm, 5 mm diameter tent peg.

Each camera was set at the medium-level trigger sensitivity. All loose vegetation (e.g. grass stalks, forbs and shrub branches) within the field of view of each camera were removed to minimize false triggers. Camera traps were active for a minimum period of 14 days.

Habitat Assessments

Habitat assessments were conducted at each site.

Measurements of habitat will also be made. Parameters monitored:

- Evidence of fire;
- Nature and extent of erosion;
- Extent of weed species;
- Presence of feral animals;
- Type of groundcover;
- Structure and floristics of vegetation cover; and
- Number of habitat trees.

2.1.2 Spectacled Flying Fox (*Pteropus conspicillatus*)

2.1.2.1 Methods

Diurnal searches for roosts and feeding signs were undertaken over a large proportion of the project site per Eyre *et al* (2014). Surveys followed meandering transects while completing camera trapping, and

targets surveys concentrated on regional ecosystems with a high likelihood of flowering myrtaceous species. A botanical assessment of the presence of feed trees and the percentage currently flowering (during this survey) across the site was undertaken by a qualified botanist.

As with previous surveys the terrain on the site is extremely rugged and hazardous with large cliff overhangs. The total number of spot-lighting transects as recommended by DEE (2014b) were unachievable (i.e. 5 hours per 50 ha/night = a total of 365 hrs of spotlighting).

Previously survey efforts RPS (2016) and 4 Elements Consulting (2017) have focused on foraging of Spectacled Flying-fox in suitable forage trees located during diurnal site traverse for nocturnal spotlighting efforts. This year the survey effort relied solely on recording availability of forage trees as an indicator of habitat suitability for the Spectacled Flying Fox and nocturnal spotlighting was not conducted.

2.1.3 Bare-rumped Sheathtail Bat (Saccolaimus saccolaimus nudicluniatus)

2.1.3.1 Methods

Three ultrasonic bat call detectors (Anabat Swifts) were placed across the site (**Figure 3**), to determine presence and species composition of bats within the Offset Site. The bat call detectors were programmed to turn on automatically at 6 pm each evening and record for a 12 hour period.

All call analysis was conducted by Kelly Matthews from Green Tape Solutions, Brisbane. Ms Matthews is a recognised expert on bat call analysis and has an extensive library of reference calls from the FNQ Bioregion. Survey limitations identified bat detectors failures preventing recording across the full site during the full fortnight duration. Functioning bat detectors identified large numbers of bat calls.

2.2 Targeted Weed Surveys

The weed assessment of the offset site concentrated on the access track from Lemontree Drive to the small clearing adjacent to a tributary of Oaky Creek. The entire length of the track was traversed on foot. Additional spot observations of weed presence in remnant, undisturbed vegetation were undertaken previously in 2016, 2017 and during the current survey effort.

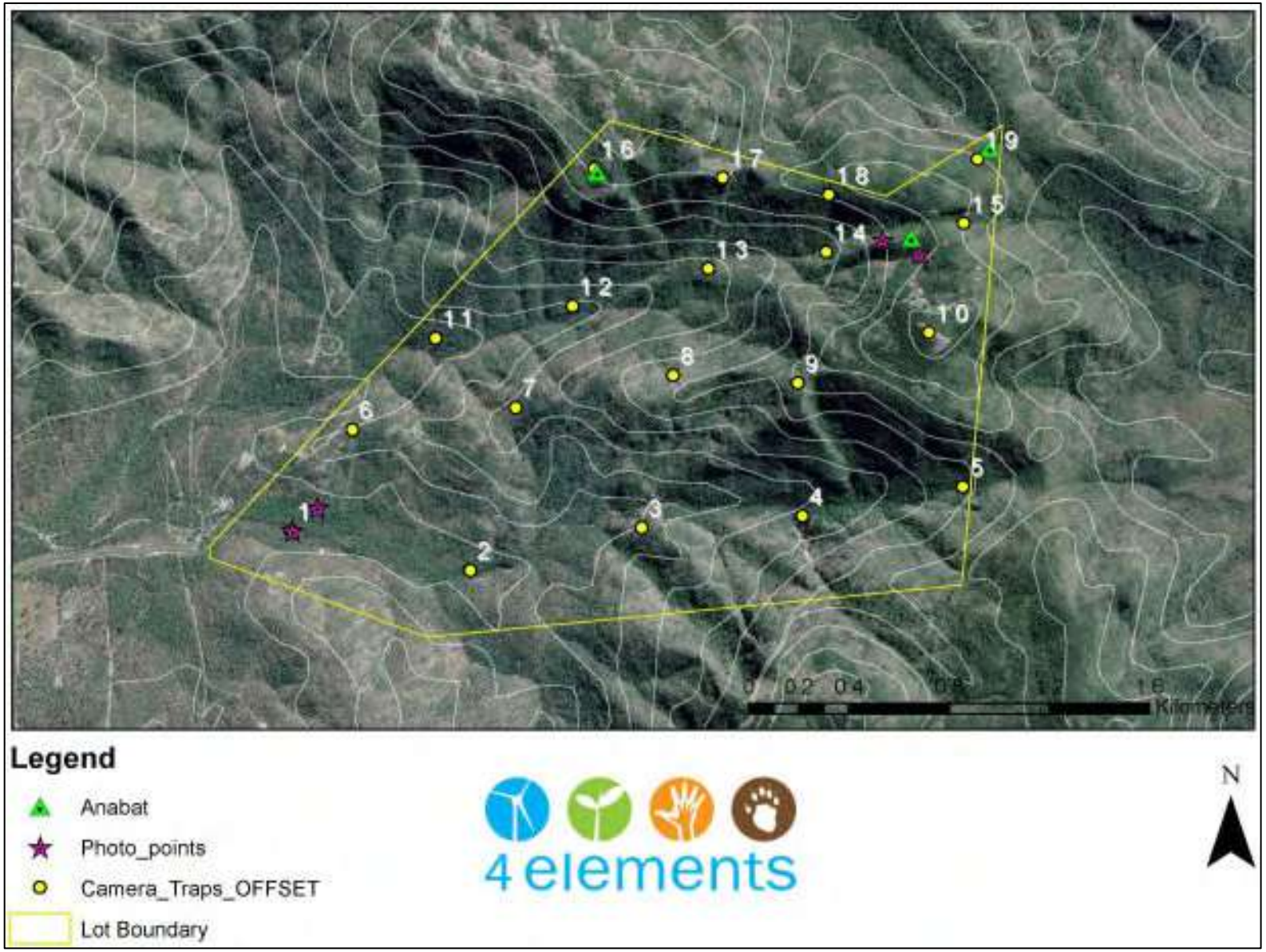

Figure 3 Monitoring Points on Offset Lot

2.3 Opportunistic Assessment

Fauna were monitored at 19 sites. Parameters monitored:

- Diurnal bird;
- Herpetofauna;
- Terrestrial mammal; and
- Threatened species presence.

2.4 Photo-monitoring points

Four photo monitoring points were established within the offset area to enable a visual assessment of changes over time (**Figure 3**). Each point was:

- Marked with flagging tape and the GPS points recorded;
- Annual photographs in north, south east and west directions.

Maintain a record of the photographs, including GPS co-ordinates, date and time of each photograph, the direction in which the photograph was taken; and the height above the ground at which the photograph was taken.

2.5 Pest Vertebrate Assessment

2.5.1 Camera trap Locations

Secondary monitoring data was achieved from camera traps set at 19 Quoll monitoring traps (refer to **Section 2.1**). Pigs, feral dogs and cats are all known to be attracted to this bait.

Data collection included:

- Species identification (feral pigs and other animals);
- Number of each species;
- Age class of feral pigs; and
- Sex of feral pigs.

2.6 Results and Discussion

2.6.1 Northern Quoll

A total of 266 camera trap nights were conducted on the offsets site and all units captured images. A total of 16 Northern Quolls were recorded during the camera trapping survey and many of the quolls revisited the same site on multiple nights. All individuals showed evidence of good condition. This total is an increase from 10 individuals in the previous year 4 Elements Consulting (2017) and from 2016 baseline surveys of 13 individuals RPS (2016). From experience at the MEWF site this result is most likely due to the time of year at which the survey was conducted. A higher number is expected to be recorded earlier in the breeding season (July 2018) as opposed to later in the season (September 2018) with males rapidly dying off after completion of their breeding season (Burnett *et al*, 2013). Three animals were located at multiple monitoring locations, identified from the unique spot marking on their backs.

Site 2 recorded the highest number (4) Northern Quolls of the sites surveyed with Site 11 and Site 13 recording (4) individuals. These sites were all within the more productive lower elevation creek lines lower with a large number of hollows and available habitat. The distribution of the population across the offset site is similar to 2016 and 2017, with the majority of monitoring sites recording Northern Quoll activity in both sampling years regardless of vegetation composition and elevation.

Plate 1 Northern Quoll

The Offset Site has maintained its integrity and the habitat was observed to be high quality with large refugial areas of rock outcrops, tree hollows and fallen logs for Northern Quoll. The seasonal creeks from the Mt Emerald massif contained a large number of rocky pools this early dry season with abundant fish and insect fauna being recorded.

2.6.2 Spectacled Flying-fox

Targeted diurnal search for the SFF habitat concentrated in areas where vegetation was either in fruit or flower. As with the previous year the lower creek lines were considered important as they contained fruiting Burdekin Plum (*Pleigynium timorense*). A single induvial SFF was found flying low overhead near to Fauna Site 2 in the lower creek line at midday on the first day of the field survey (3 July 2018).

Flowering Eucalypt trees were also recorded during other survey work. A high proportion of species were recorded throughout the site with *Corymbia abergiana* and *Corymbia leichardtii* flowering in high numbers along the higher ridgelines across site. Lower more fertile areas also had high proportions of *Eucalyptus crebra* and *Corymbia citriodora* in flower.

Approximately 20-25% of available foraging trees were flowering or commencing flowering across the site due to recent rainfall and were of high quality. As identified the OAMP (RPS, 2016) and 4 Elements (2017) foraging habitat is available across the offset site and is considered in moderate to high quality. It is highly likely each species will utilise the site widely when available vegetation is flowering.

Based on SFF being recorded foraging across site in low numbers last year 4 Elements Consulting (2017) and the single overhead record this year, with high quality foraging habitat availability the offset site continues to provide refuge for the SFF.

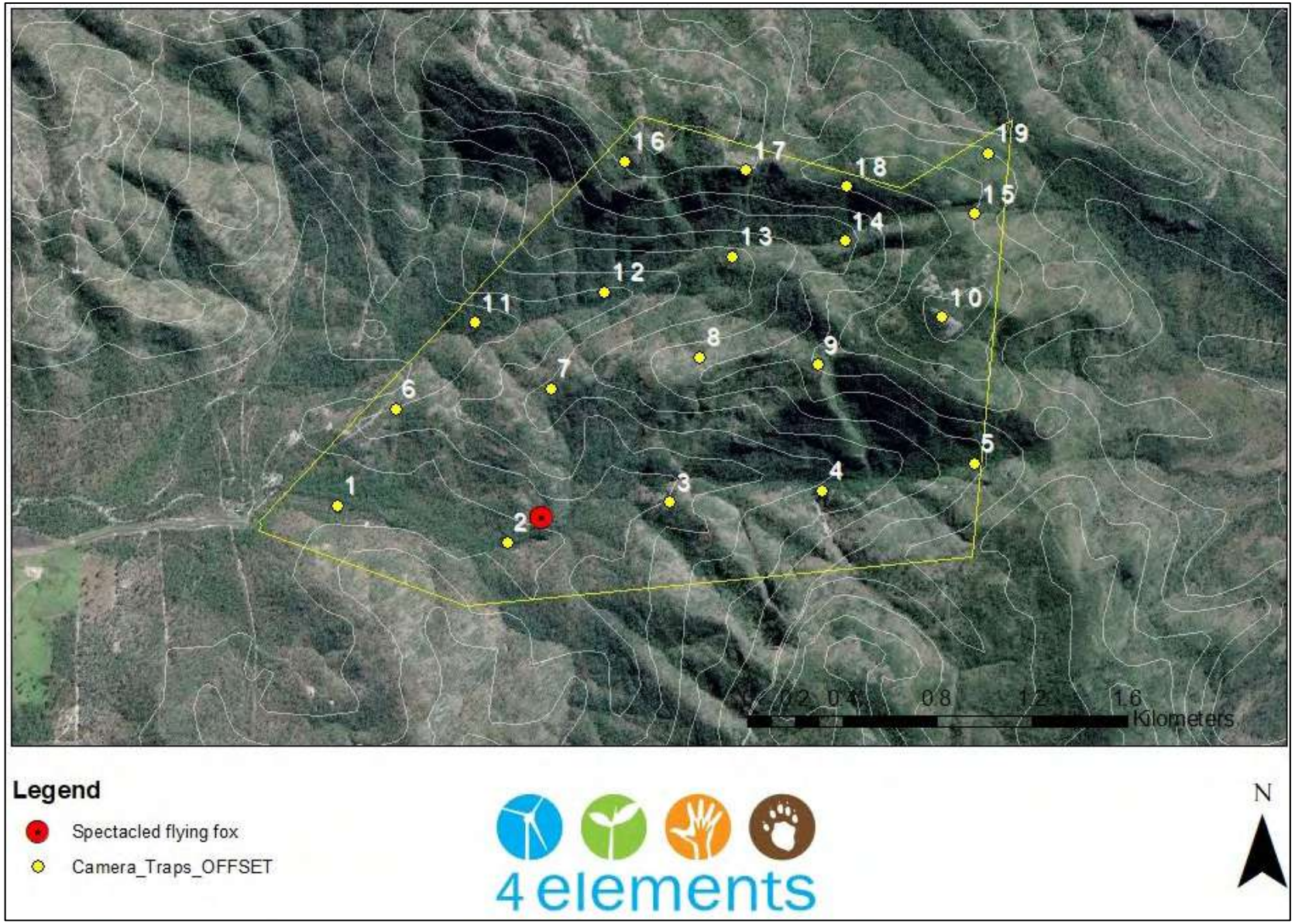

Figure 4 Potential Spectacled Flying Fox Habitat on Offset Lot

2.6.3 Bare-rumped Sheathtail Bat (*S. saccolaimus*)

A total of 39 detector nights of microchiropteran bat call surveys were conducted within the project site between 4 and 17 July.

A total of seven (7) microbat species were detected as a definite occurrence within the site. A total of two (2) microbat species were identified as probable records on site (**Table 2**).

The presence of Bare-rumped Sheathtail Bat (BRSB), listed as Endangered under NC Act, and listed as Vulnerable under EPBC Act, was analysed. This species could not be definitely confirmed due the similarity in call with sympatric species and overlap in their distribution. This species also presents a number of call variations which makes it difficult to confirm its presence using only echolocation techniques. However, a number of calls presented harmonics that were a probable match for BRSB. Based on previous confirmed records of this species within the locality in recent years, we would consider BRSB is highly likely to occur within the surveyed area (**Appendix A**).

Characteristic call attributes of BRSB include:

- A dominant harmonic with characteristic frequency around 22-25 kHz;
- At least three and up to five distinct harmonics at approximately 13 kHz intervals (1 below and up to 3 above the dominant harmonic); and
- Call pulses sometimes in “triplet” sets with pulse intervals of approximately 10-20 ms between first and second pulses and 20-40 ms between second and third pulses and an inter-triplet interval of about 80100 ms (**Appendix A**).

In both 2016 and 2017, probable calls were recorded at Site 19 which is the high altitude *Corymbia citriodora* (lemonscented gum) +/- *Eucalyptus portuensis* (white mahogany) woodland to open forest aspect of the site. Again, in this round of survey the Bat was a probable detection in the same location.

All bats identified on the site were expected to be present within the region. Bat activity levels at the site are considered to be similar compared to other surveys within similar areas in the surrounding region. A total of nine (9) species being recorded this year is four (4) fewer species than were identified during the previous year’s effort. Baselines surveys in 2016, recorded the lowest number with seven (7) species being recorded therefore no trend can be concluded other than general michrochiropteran bat diversity is relatively consistent on site. Weather conditions were with low wind, good insect availability due to relatively recent rain were good for collecting bat call data during this survey period.

Table 2 summarises the Call Analysis.

Table 2 Summary of Call Analysis

Species	Status EPBC	Status NCA	Confidence
Austronomus australis	Least Concern	NOC	Definite
Chaerophon jobensis	Least Concern	NOC	Definite
Chalinobus nigrogiseus	Least Concern	NOC	Definite
Miniopterus australis	Least Concern	NOC	Definite
Miniopterus orianae oceanensis	Least Concern	NOC	Definite
Mormopterus ridei	Least Concern	NOC	Definite
Nyctophilus sp	Least Concern	NOC	Probable
Rhinolophus megaphyllus	Least Concern	NOC	Definite
Saccolaimus saccolaimus	Vulnerable	Endangered	Probable

2.7 General Fauna

From a combination of camera trap and opportunistic sightings during site traverses a total of 44 species were able to be positively identified with three of these species listed under the EPBC and NC Act as those targeted: Northern Quoll, Spectacled Flying-fox and the Bare-rumped Sheathtail Bat. No other threatened species were identified. This consisted of 22 birds 19 mammals, 3 reptiles (**Appendix C**).

The birds included species such as the Pheasant Coucal (*Centropus phasianinus*) and Noisy Friarbird (*Philemon corniculatus*) Little Eagle (*Hieraaetus morphnoides*) Golden Whistler (*Pachycephala pectoralis*).

The cryptic Mareeba Rock-wallaby (*Petrogale mareeba*) was identified on the mid mountain slopes at site 14. The Echidna *Tachyglossus aculeatus* and Melomys (*Melomys burtoni)* were distributed in multiple locations across the site.

A total of three reptile species were identified in diurnal site traverse:

- 1 Rainbow Skink (Carlia munda) and
- 2 Lined Dragon (Diporiphora bilinieata)
- 1 Green Tree Snake (Dendrelaphis punctulatus)

A complete list of fauna species is provided in **Appendix C**.

2.8 Baseline BioCondition Surveys

The first round of BioCondition monitoring was undertaken in May 2018. Eight sites representing a variety of regional ecosystems representative of both the MEWF Offset Site and MEWF were assessed using the BioCondition methodology (Eyre *et al* and Nelder *et al* 2017). The exception to this being the vine forest communities RE 7.3.26a and RE 7.12.9 only being found on the MEWF Offset site. All sites assessed were considered to be of a high integrity with only minimal weed incursion being recorded at some sites. These results will used as a baseline to monitor for any changes in these communities across site in future annual monitoring. Full report is attached in **Appendix B**.

2.9 Weed Control

Since the initial weed survey conducted in January 2018 a population of Grader Grass (*Themeda triandra*) had established along the main access track from Lemon Tree Drive. This species is readily detectable and had not previously been recorded on site including earlier during the January 2018 weed survey. The Grader Grass population extended along the access track entry gate along the entire length of the track to the vehicle turnaround at the end. The Grader Grass population concentrated at the vehicle turn around with individual plants being recorded directly adjacent to the track cutting.

This infestation was removed (15 May, 2018) by hand pulling all plants by carefully removing roots, leaf and seed material. This was then placed into large 80 L garbage bags and disposed off site. A total of five (5) 80 L garbage were filled with material during this process.

Subsequent visits to the access track and site traverses have not recorded any other visible populations of Grader Grass. As the population was setting mature seed at the time of removal and given the fast rate of establishment of this species, it is recommended that a further survey be undertaken prior to the wet season and a further, more critical survey be conducted mid-wet season. It is expected that this population will return once wet conditions persist later in the year.

Grader Grass is considered a priority weed species to be managed for the MEWF Offset Site. It is a prolific species and is quick to establish. It initially colonises disturbed areas such as vegetation clearing and track formation. This species once established has the potential to penetrate areas of undisturbed open woodland where it can outcompete native flora species and alter recruitment of native vegetation.

3.0 Pest Vertebrate Monitoring

The availability of freshwater pools throughout the site appears to have influenced the presence of large feral animals in the 2018 monitoring season. Evidence of pig (*Sus scrofa*) activity was found close to Site 9, Site 16 and Site 18. This included a recently constructed grass nest and some extensive foraging.

Feral pig observations are provided in **Table 3** below.

Table 3 Evidence of Feral Pigs on Offset Site

Survey	Location	Species	Number
Rooting	Site 9, 16, 18	Pig	3
Nesting	Site 18	Pig	1

Plate 2 Evidence of pig rooting 13 July, 2018 near to Fauna site 18

Plate 3 Fresh pig nest recorded 13 July, 2018 near to Fauna Site 18

No evidence of feral cats or feral dogs were recorded during this year's field survey.

3.1 Photo Monitoring Points

A visual assessment was undertaken at four photo monitoring points. These locations were selected based on habitat quality, Regional Ecosystem attribute and location. **Table 4** below summarises the characteristics of these sites where photographs are oriented towards the North, South, East and West facing directions. Whilst the photo will aid in the broad comparisons over time, they are best used in combination with floristic data (Gleed, 2017) as they are unlikely to show fine scale changes on their own.

Table 4 Photo Monitoring Points

Site ID	Description	Photograph from North, South, East, West	
Photo Point 1 Location :0327999, 8096486	Mapped as RE 7.3.26a Site only partially conforms to mapped RE absence of *Allocasuarina cunninghammii* in community however some key associates were present in canopy and shrub layer. Alluvial sandy loam on riverine wetland. Canopy of *Eucalyptus tereticornis*, *Corymbia Leichardtii* with a sparse shrub layer containing *Lophostemon grandiflorus*, *Bursaria tenuifolia*, *Exocarpus cupressiformis, Callitris intratropica, Acacia spp.* with a ground layer containing *Heteropogon triticeus*, *Sarga spp.* and *Themada triandra*. Weeds present *Stylo guianensis*	 North	 South
		 East	 West

Site ID	Description	Photograph from North, South, East, West	
Photo Point 2 Location: 0328099, 8096579	Mapped 7.12.30d Site conforms to RE containing dominant canopy and key lower level associates. Rocky slopes on granite and rhyolite. Canopy *Eucalyptus cloeziana*, *Corymbia leichardtii* and Eucalyptus *crebra* with a very sparse shrub layer containing *Petalostigma pubescens*, *Coelospermun reticulatum, Persoonia falcata, Grevillea parrallela* and a ground layer containing *Heteropogon triticeus*, *Sarga spp.* and *Themada triandra*. Weeds present *Melenis repens*	 North	 South
		 East	 West

Site ID	Description	Photograph from North, South, East, West	
Photo Point 3 Location 0330501, 8097591	Site conforms to RE 7.12.57a containing low open woodland to shrubland containing key canopy and lower level associates. High uplands slopes on granite and rhyolite. Tall shrub/ low tree layer *Syncarpia glomulifera, Corymbia abergiana, Eucalyptus portuensis, Eucalyptus crebra, Allocasuarina littoralis. Banksia aquilonia. Ground layer Xanthorrea johnsoni, Themeda triandra, Imperata cylindrical, Pteridium esculentum,*	 North	 South
		 East	 West

Site ID	Description	Photograph from North, South, East, West	
Photo Point 4 Location: 0330355, 8097647	Mapped as RE 7.12.16a Site conforms to mapped RE containing simple to complex notophyll vine forest with emergent *Agathis microstachya* on granite and rhyolite in the uplands of the moist rainfall zone.	 North	 South
		 East	 West

4.0 Management Actions

4.1 Comparison to Previous Monitoring

Since the baseline monitoring collection in 2016 and previous years field investigations the conditions of the site have changed very little. The absence of fire improving the condition of some habitat on the site in combination with availability of freshwater pools has increased the availability of resources and mobility for some species. Fauna distribution and population of target species is very similar and although no statistical analysis could be undertaken, there was no indication of a population decline in Northern Quoll, Spectacled Flying-fox, or Bare-rumped Sheathtail Bat due to habitat impacts on the offset site.

4.2 Biodiversity Management Issues

Several minor biodiversity management issues were identified during monitoring. These include the state of the access track, and signs of feral pigs within the Biodiversity Offset Area.

4.2.1 Access Track

Since the baseline monitoring data was collected in 2016, the conditions of access tracks within the Biodiversity Offset Site have been improved through the securing of perimeter fencing. The tracks were showing signs of rill erosion, as well as disturbance by unauthorised vehicular access (primarily motorbikes). Unauthorised access by vehicles has not stopped with fencing however as the main entrance gate to the site remains unlocked. Further weed incursion has been recorded on this track with a new population of Grader Grass (*Themeda quadrivalvis*) and Hyptis (*Hyptis suaveolens*) recorded and subsequently hand removed during late January 2018. This main track will require further ongoing weed monitoring prior to the wet season and again during the wet season to prevent the reestablishment of further populations at the same location or spreading to other locations on site.

4.2.2 Pest Species

The biodiversity offset area is considered to contain a low density of pest fauna species, predominately pigs. This is based on the observations of tracks, nests and rooting's sightings across the site. Considerable damage to mid-slope vegetation resulting in Aerial shooting and the MEWF pest management plan should target this offset site in the next round of pest management activities.

Camera traps should be selectively used to record feral pig activity across the site. This will give an indication of the proportion of pigs which are impacting the habitat. The employment of bait stations will assist in obtaining more accurate records of feral pig visitation rates.

4.2.3 Timing

It is recommended further monitoring surveys be conducted in April – July 2019, close to the end of the wet season to encompass full flowering of plants to ensure feeds trees are available and fauna are most mobile throughout their range.

5.0 Summary

The ecological surveys undertaken in the MEWF offset site during 2018 provide the second round of annual monitoring data that can be directly compared with the baseline and first year of data collected in 2016 and 2017. The ecological monitoring surveys include information that will be used with weed survey information to fulfil obligations to include in the annual reporting required for the conservation agreement with DEE and DES. A total of three threatened species were recorded in the MEWF Offset site in 2017:

- Northern Quoll (*Dasyurus hallucatus*)
- Spectacled Flying Fox (*Pteropus conspiculatus*)
- Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus*).

Fauna habitat resources remain abundant within the MEWF offset site and the habitat is of high quality.

The site has a high density of the large hollows that several nocturnal birds of prey, bat and large mammal species require for breeding. In addition, small mammals (terrestrial and arboreal), which are the respective prey of a number of predatory species, were identified throughout the site. Canopy tree species and understorey shrubs within the site provide abundant foraging resources such as foliage, seeds, pollen, nectar and invertebrates for variety of species on a seasonal basis and may potentially influence the occurrence and abundance of arboreal mammal species and birds.

Groundcover has improved since baselines surveys due to increased rainfall and rehabilitation since a fire event therefore small reptiles and amphibians have increasingly utilised a wider distribution of the offsets site.

Feral pigs are evident on the site and are at a stage that management actions require appropriate measures.

Weed surveys indicated there are currently no priority listed weed species on site, however vigilance will be required along the access track and road entry to ensure there are no access points for these threats. Continued management measures to remove weeds from tracks and external site boundaries will reduce the risks significantly.

The ecological condition of the MEWF Offset site has been maintained since baselines surveys were conducted in 2016.

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Appendix A Bat Call Analysis Report

Greentape Solutions – 29/08/2018

Green Tape Solutions

Quality, Integrity, Experience

Bat Call Analysis Report

Mt Emerald Wind Farm

Prepared for Four Elements Consulting Pty Ltd

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Document Records - Quality

TITLE	Bat Call Analysis – Mt Emerald Wind Farm
FILED AS	PR18097_BA_VerA

Revision	Date	Prepared by (name/title)	Reviewed by (name/ title)	Approved by (name/title)
Version A	20/08/2018	Kelly Matthews, Director / Principal Ecologist	Kelly Matthews, Director / Principal Ecologist	Melissa Jess from Four Elements Consulting
Version B	29/08/2018	Kelly Matthews, Director / Principal Ecologist	Kelly Matthews, Director / Principal Ecologist	Melissa Jess from Four Elements Consulting

Table of Content

TABLES

FIGURES

1.0 Introduction

1.1 Background

An assessment on the likelihood of the presence of microbat species using three echolocation detectors (Anabat Swift) was conducted during an ecological survey (two weeks) at Mt Emerald Wind Farm. The site is located in Mareeba Shire, Queensland.

1.2 Scope of Works

The specific scope of works for this report includes the following:

- Outline the methodology used to survey microbat species within the subject site;
- Analyse and provide an assessment of the likelihood of occurrence of threatened microbat species listed under State and Commonwealth legislation; and,
- Identify of local statutory considerations relevant to ecological aspects (relevant to bats) of the site.

2.0 Methodology

2.1 Capture

Data was collected over thirteen nights from 4 July 2018 using three Anabat Swifts. The original call files display Australian Eastern Standard Time. The majority of calls were considered to be of medium to good quality calls.

Data was received on the 3rd August 2018 and was analysed using Kaleidoscope Pro. In total, 10,424 call sequence files were recorded but only 1,212 marked as containing recognisable bat calls.

2.2 Call Identification

Call identification for this dataset was based on call keys and descriptions published for Queensland (Reinhold, 2001) and Northern Territory (PWCNT, 2002) with reference to descriptions for New South Wales (Pennay et al., 2004).

Species' identification was further refined using the probability of occurrence of each species based on their geographic distribution (Churchill, 2008, Van Dyck and Strahan, 2008). Species nomenclature used in this report follows Churchill (2008).

The reliability of identification is as follows:

- **Definite** - one or more calls where there is no doubt about the identification of the species;
- **Probable** - most likely to be the species named, low probability of confusion with species that use similar calls; and,
- **Possible -** call is comparable with the named species, with a moderate to high probability of confusion with species of similar calls.

2.3 Survey Limitations

The ability to detect call and accurately identify them to species level can vary greatly with the surrounding environment and the location of the echolocation device. The survey undertaken as part of this assessment only represents a ‘snapshot’ in time and therefore, may not provide a true indication of species presence at the site. Hence, this survey should not be regarded as conclusive evidence that certain protected microbats species do not occur at the site.

2.4 National Standard

The format and content of this report complies with the nationally accepted standards for the interpretation and reporting of Anabats and Songmeters data (Reardon, 2003), which is currently available from the Australasian Bat Society at www.ausbats.org.au.

3.0 Results

3.1 Total of Species Recorded

A total of 1,212 call sequence files were marked as recognised bat calls.

A total of seven microbat species were definitely identified being present on site and an additional two (2) species were potentially recorded on site.

One threatened species, *Saccolaimus saccolaimus,* listed under the *Nature Conservation Act 1992* as Endangered and under the *Environmental Protection and Biodiversity Act 1999* as Vulnerable was likely recorded on site. This species cannot be definitely confirmed due the similarity in call with sympatric species and overlap in their distribution. The full spectrum of three recorded calls were clustered closely with those of *S. saccolaimus* and harmonics would probably be attributed to *S. saccolaimus*.

A summary of the species present on site is provided in **Table 1**. The microbats species calls are separated by devices. The devices remained at the same location for the period of the survey. It is noted that three devices were deployed but one failed to record any bats.

Table 1: Summary of bat calls

Species	NC Act	EPBC Act	Anabat 4	Anabat 5	Anabat 7
Austronomus australis	LC	NOC	Definite	Definite	
Chaerephon jobensis	LC	NOC		Definite	Definite
Chalinolobus nigrogriseus	LC	NOC	Definite		Definite
Miniopterus australis	LC	NOC	Definite	Definite	Definite
Miniopterus orianae oceanensis	LC	NOC	Definite	Definite	Definite
Mormopterus ridei	LC	NOC			Definite
Nyctophilus sp	LC	NOC	Probable		Probable
Rhinolophus megaphyllus	LC	NOC	Definite	Definite	Definite
Saccolaimus saccolaimus	Endangered	Vulnerable			Probable

3.2 Analysis of the presence of Saccolaimus saccolaimus

The purpose of the bat survey was to identify the presence of *S. saccolaimus* on site. Characteristic call attributes of *S. saccolaimus* (PWCNT, 2002) include:

- A dominant harmonic with characteristic frequency around 22-25 kHz;

- At least 3 and up to five distinct harmonics at approximately 13 kHz intervals (1 below and up to 3 above the dominant harmonic); and
- Call pulses sometimes in “triplet” sets with pulse intervals of approximately 10-20ms between first and second pulses and 20-40ms between second and third pulses and an inter-triplet interval of about 80-100ms.

A total of three sequence files were recorded that may be representative of *S. saccolaimus* and this call show all the harmonic characteristics. While it is not possible to reliably separate this species from several sympatric species with similar call attributes (i.e. *T. troughtoni*), *S. saccolaimus* was previously recorded within the site and it is considered that *S. saccolaimus* would still probably occur on site.

3.3 Samples of Calls / Sequences Files

Samples of call extracted from the dataset for each species identified is provided in the following figures.

Figure 1: Definite *Austronomus australis*

This species is one of the few bat species with calls audible to human ears. This species exhibits a characteristic frequency ranging from 10.5 to 15 kHz (Pennay *et al,* 2004).

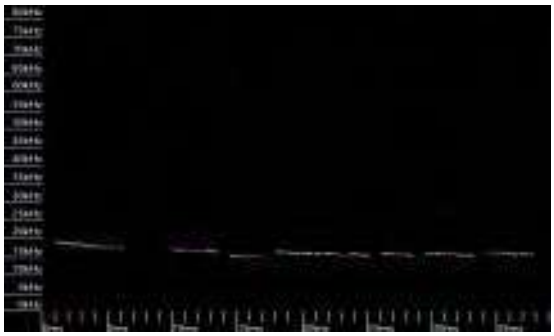


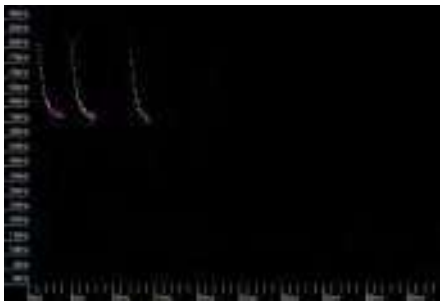
Figure 2: Definite *Chaerephon jobensis*

Their characteristic frequency average 19.8 kHz (range 16.12-23.6kHz). C. jobensis produce paired call pulses at alternating frequencies with intermittent, “excited”, linear pulses. This pattern is probably the result of bats interacting with each other.

Figure 3: Definite *Chalinolobus nigrogriseus*

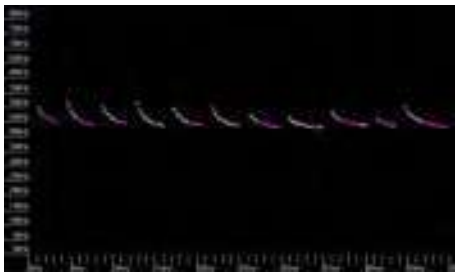
Curved shape with characteristic frequency 37 to 40kHz (Reinhold *et al,* 2001). Usually has no tail. Characteristic section and tail takes up at least 2/3 if the time of the pulse when in search phase.

Figure 4: Definite *Miniopterus australis*



This species displays a characteristic frequency between 54.5 – 64.5 kHz with a curved, usually down-sweeping tail (Pennay et al 2004). It overlaps in frequency with *Vespadelus pumilus* between 57 – 58 kHz but the latter exhibits curved up-sweeping tail.

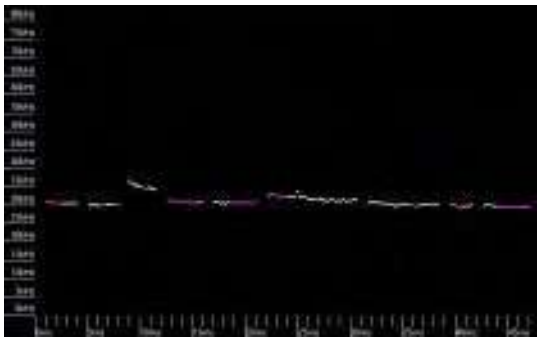
Figure 5: Definite *Miniopterus orianae oceanensis*



The species call is characterised by its relatively long curved pulse with a small down-sweeping tail and its frequency 43-47kHz (Reinhold, 2001).

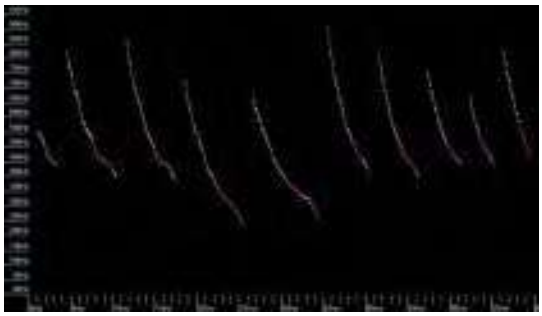
Pulse shape and time between calls usually variable within a sequence.

Figure 6: Definite *Mormopterus ridei*



Characteristic frequency 30 to 36 kHz. May be flat but sometime with short initial and down-sweeping tail (Reinhold *et al,* 2001).

Figure 7: Probable *Nyctophilus sp.*



This species displays a near-vertical pulse, characteristic frequency between 80 and 35KHz (Pennay *et al*, 2004). The call of these species cannot be distinguished from each other.

There are three species of *Nyctophilus spp* occurring within the site area. *N. geoffroyi, N. gouldi* and *N. bifax*.

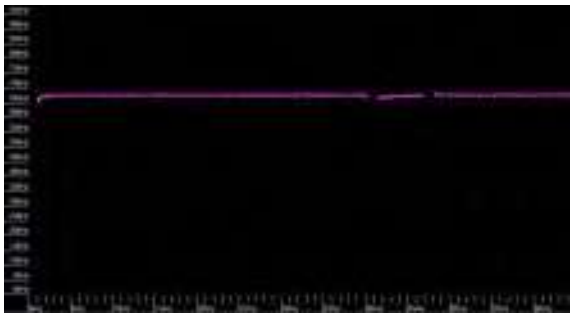
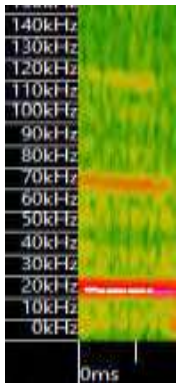


Figure 8: Definite *Rhinolophus megaphyllus*

The species call cannot be misidentified with any other species. Pulses have an up-sweeping initial section a perfectly flat, relatively long characteristic section and a down sweeping tail (Reinhold, 2001). Characteristic frequency ranges from 66 to 72 kHz.



Harmonics

Figure 9: Probable *Saccolaimus saccolaimus*

Three sequence files were recorded on site that may be representative of *Saccolaimus saccolaimus*.

Echolocation calls for *S. saccolaimus* have peak energy in the range 23-25kHz, similar to the frequency band of other large sheathtail bats in Australia. *S. flaviventris* pulses have one harmonic at about 30kHz which we cannot see here.*T. troughtoni* also produces a flat type call pulse at the same frequency as *S. saccolaimus*. It is typically long and straight or slightly curved and almost horizontal, similar to *S. saccolaimus.*

4.0 Conclusion

A total of seven microbat species were detected as definitely occurring within the site. Two other microbat species were probably recorded on site.

The presence of *S. saccolaimus,* listed as Endangered under NC Act, and listed as Vulnerable under EPBC Act, was analysed. This species also presents a number of call variation which makes it difficult to confirm its presence using only echolocation techniques. However, a total of three calls presented harmonics that could probably be attributed to S. *Saccolaimus* and therefore, we would consider that *S. saccolaimus* probably occurs within the surveyed area.

All bats identified on the site were expected to be present within the region. Bat activity levels at the site are considered to be similar compared to other surveys within similar areas in the surrounding region.

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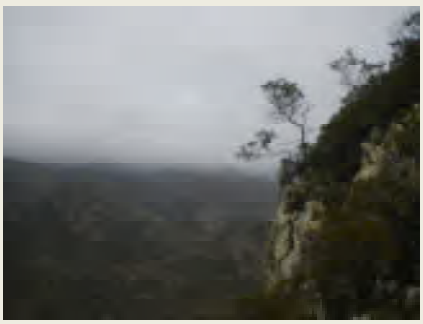
Appendix B BioCondition Surveys 2018

S Gleed – June 2018



Mt Emerald Wind Farm Offset Site BioCondition Surveys 2018

Report prepared for 4 Elements Consulting for the Mt Emerald Wind Farm

S. Gleed, June 2018

Reference: SG1804

Mt Emerald Wind Farm Offset Site BioCondition Surveys 2018

Mt Emerald Wind Farm

Report prepared for 4 Elements Consulting for the Mt Emerald Wind Farm

by

Simon Gleed

ATRATA

22nd June 2018

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This document is confidential and its contents or parts thereof cannot be disclosed to any third party without the written approval of the author.

Simon Gleed undertook the fieldwork and preparation of this document in accordance with specific instructions from 4 Elements Consulting, to whom this document is addressed. This report has been prepared using information and data supplied by the Mt Emerald Wind Farm, 4 Elements Consulting and other information sourced by the author.

The conclusions and recommendations contained in this document reflect the professional opinion of the author based on the data and information supplied and available at the time of the work. The author has used reasonable care and professional judgment in the interpretation and analysis of the data. The conclusions and recommendations must be considered within the agreed scope of work, and the methodology used to perform the work, both of which are outlined in this report.

Document Status

Document Status	Author	Reviewer	Date of Issue
Draft Report (SG1804)	S. Gleed	M. Jess (4 Elements Consulting)	22nd June 2018

Distribution

Company	Copies	Contact Name
4 Elements Consulting	1 (electronic: PDF)	Via email to M. Jess
ATRATA	1 (electronic)	S. Gleed

CONTENTS

FIGURES

1.0 INTRODUCTION

The Mt Emerald Wind Farm offset site is located on land described as Lot 22 on SP210202 and by road is accessed via Lemontree Drive. The offset site has an area of 434.9 ha and is entirely covered by remnant vegetation in near-pristine condition.

A series of BioCondition assessments were undertaken in the offset site during May 2018.

Climatic conditions were deemed suitable to accurately identify plants to species rank, with the exception of some obscure grasses carrying insufficient fertile material to make an accurate identification. These were typically identified to the rank of genus.

1.1 Limitations

We were unable to gain access to the north-east section of the offset site due to its remote location and the demise of the vehicle track because of the previous wet season. Consequently, the following regional ecosystems (REs) were not surveyed in this area: 7.12.29a, 7.12.57a and 7.12.34.

Also, surveying RE 7.12.26e was considered to pose an unacceptable safety risk due to the precipitous terrain over which the community occurs.

Given the remoteness of remnant areas in the offset site, a modified level of assessment was undertaken because of time constraints (i.e. most sites required long walks to gain access). Four days were allocated to field surveys.

Benchmarks were not set for remnant communities in the offset site because the limited time available for fieldwork precluded completing the minimum three surveys per regional ecosystem as recommended by Eyre *et al*. (2017). Undertaking this level of survey would require a minimum of two week's fieldwork. Based on comparative observations and numerous spot surveys across the offset site and the Mt Emerald Wind Farm site over the previous three to ten years, the information collected is nevertheless representative and typical of the communities on both sites.

1.2 Definitions

The following definitions are used in this document.

Attribute	Description
Recruitment of dominant canopy species	Proportion of the dominant canopy (ecologically dominant layer) species with evidence of recruitment.
Native plant species richness	The number of species expected in four life form groups, i.e. tree, shrub, grass, forbs and other species.
Tree strata: • Canopy • Sub-canopy • Large trees	A tree is defined as a woody plant, single stemmed >2 m tall. • Height – median height in metres. • Cover - percentage cover (assessed as opaque crowns). • DBH (Diameter at Breast Height) – For large trees only; dbh threshold (cm). • Typical tree species.
Shrub strata: • Native shrub cover	A shrub is defined as a woody plant, multi-stemmed from base or single stemmed and <2 m tall.

Attribute	Description
	• Cover - percentage cover (assessed as opaque crowns). • Typical shrub species
Ground cover: • Native perennial grass cover • Litter cover	• Cover – percentage cover (assessed as projected foliage cover). • Typical ground cover species.
Coarse woody debris	• Total length in metres of woody debris > 10 cm diameter and > 0.5 m per hectare.
Non-native plant cover	• Cover – The percentage cover of non-native plants. • Typical non-native species listed with common names and declared pest status if applicable.

2.0 METHODOLOGY

The methods used for the BioCondition assessments followed those described by Eyre *et al*. (2017) and Neldner *et al*. (2017).

The method works on a series of plots and transects nested within survey area of 10,000 m^2 (1 ha).

2.1 Modification of Assessment Methodology

The following modifications were made to the survey methodology in order to complete the work within the allocated timeframe:

- Tree and shrub cover was estimated. This was necessary because of the uneven ground and high risk of trips and falls over steep terrain.
- An improved, less subjective method of recording ground cover attributes was adopted and based on advice from the Queensland Herbarium. The method used a tape measure intersect instead of visual estimates of cover within 1 x 1 m quadrats.
- For some REs (e.g. 7.12.65k) a 100 m transect within the plot was not possible due to the area representation and configuration of the community. A 50 m transect was used instead in these situations and data extrapolated to the 1 ha survey area.
- Tree basal area was not recorded.

3.0 RESULTS

Eight sites were assessed using the BioCondition methodology. With the exception of the vine forest communities, the balance of the sites are representative of the same types of vegetation found on the Mt Emerald Wind Farm. The locations of the surveys within the offset site are shown in **Figure 1** and the corresponding Regional Ecosystems (REs) in **Figure 2**. Results of these assessments are given in the following sections.

Figure 1. Location of 2018 BioCondition surveys in the Mt Emerald Wind Farm offset site.

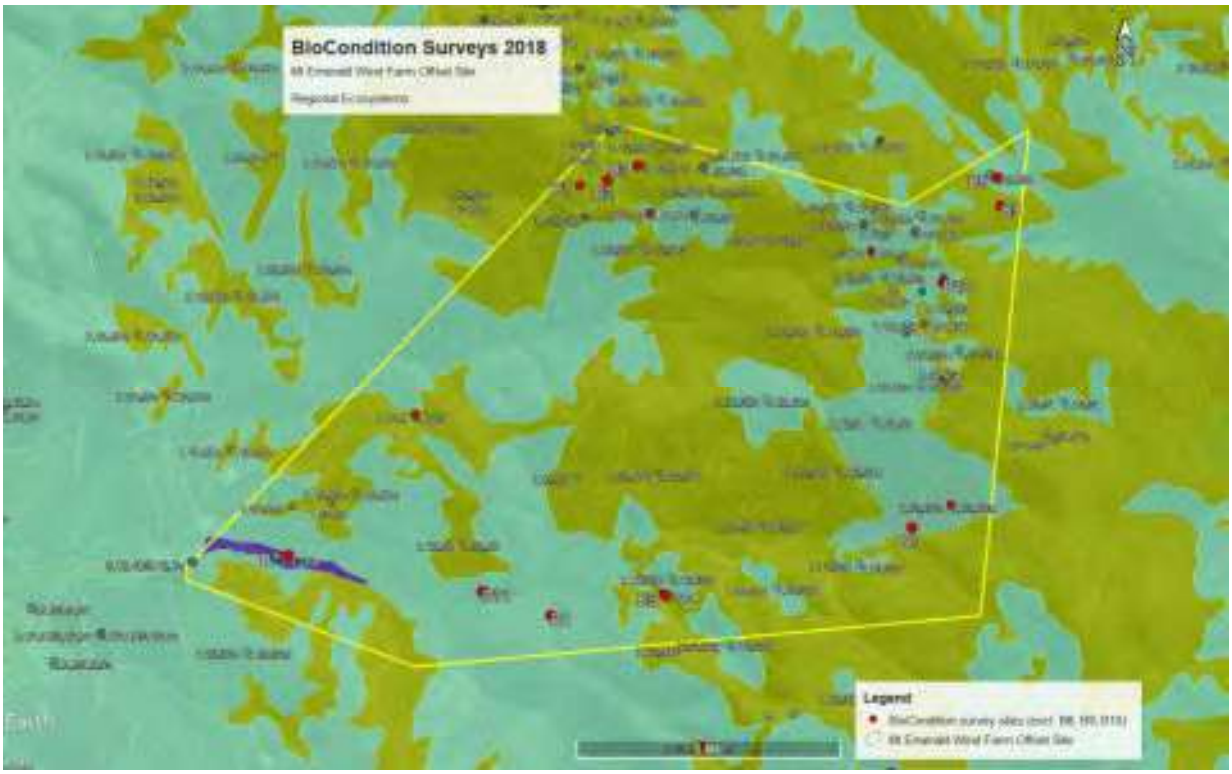

Figure 2. Regional ecosystems corresponding with the location of 2018 BioCondition surveys.

3.1 BioCondition Site: B1

Date of Survey: 25 May 2018

Plot origin: Zone: 55 K easting: 329103 northing: 8097846 Elev. 1039 m

Plot centre: Zone: 55 K easting: 329142 northing: 8097874 Elev. 1034 m

Plot bearing: NE **Plot alignment:** Parallel with contour of hill.

North

South

East

West

Habitat description: Woodland of *Eucalyptus reducta* on 40 degree south-facing rocky slope. Low heathy shrub layer of *Acacia calyculata*, *Monotoca scoparia* and *Leptospermum amboinense*.

Regional ecosystem (mapped): 7.12.58: *Eucalyptus reducta* +/- *E. granitica* +/- *Corymbia dimorpha* +/- *C. citriodora* woodland to open forest on granite and rhyolite.

Attributes

Recruitment of dominant canopy species (%):			100
Native plant species richness:		Trees:	3
		Shrubs:	12
		Grasses:	3
		Forbs and other:	4
Trees:	Tree canopy	Tree canopy median height (m):	9
		Tree canopy cover (%):	19
	Tree sub-canopy	Tree sub-canopy median height (m):	0
		Tree sub-canopy cover (%):	0
	Large trees	Large eucalypt tree dbh threshold (cm):	35
		Number of large eucalypt trees per hectare:	14
		Large non-eucalypt tree dbh threshold (cm):	0
		Number of large non-eucalypt trees per hectare:	0
Typical tree species:	*Corymbia intermedia*, *Eucalyptus reducta*, *Syncarpia glomulifera*.		
Shrubs:		Native shrub cover (%):	42
Ground cover (%):		Native perennial grass cover (%):	15
		Forbs and non-grass (%):	1
		Shrubs (%)	42
		Organic litter cover (%):	11
		Rock (%):	21
		Bare ground (%):	10
		Cryptograms (%)	0
Coarse woody debris:	Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare:		221
Non-native plant cover (%):			0
Typical non-native species:	None		

Native species richness:

Trees: *Corymbia intermedia*, *Eucalyptus reducta*, *Syncarpia glomulifera.*

Shrubs: *Leptospermum amboinense*, *Pultenaea millarii*, *Pseudanthus ligulatus*, *Exocarpos cupressiformis*, *Acacia calyculata*, *Monotoca scoparia*, *Comesperma anemosmaragdinum*, *Xanthorrhoea johnsonii*, *Platysace valida*, *Persoonia falcata*, *Acacia falciformis*, *Melichrus urceolatus.*

Grasses: *Aristida* sp., *Cleistochloa subjuncea*, *Eriachne mucronata*, *E. pallescens.*

Forbs and other species: *Pimelea linifolia*, *Lepidosperma laterale*, *Hovea nana*, *Usnea baileyi*.

Non-native species: None.

3.2 BioCondition Site: B2

Date of Survey: 24 May 2018

Plot origin: Zone: 55 K easting: 329249 northing: 8097871 Elev. 1019 m

Plot centre: Zone: 55 K easting: 329250 northing: 8097921 Elev. 1034 m

Plot bearing: North **Plot alignment:** Upslope across rock pavement.

North

South

East

West

Habitat description: Rhyolite rock pavement sloping to south. Surrounding/adjacent woodland of *Eucalyptus reducta* over *Acacia falciformis* and *Monotoca scoparia*.

Regional ecosystem (mapped): 7.12.65k: Granite and rhyolite rock outcrop, of dry western areas, associated with shrublands to closed forests of *Acacia* spp. and/or *Lophostemon* spp. and/or *Allocasuarina* spp. In the Mount Emerald area, shrubs may include *Acacia umbellata*, *Melaleuca borealis*, *Homoranthus porteri*, *Leptospermum neglectum*, *Melaleuca recurva*, *Melaleuca uxorum*, *Grevillea glossadenia*, *Corymbia abergiana*, *Eucalyptus lockyeri*, *Sannantha angusta*, *Pseudanthus ligulatus* subsp. *ligulatus*, *Acacia aulacocarpa*, *Leptospermum amboinense*, *Xanthorrhoea johnsonii* and *Jacksonia thesioides*. Ground-cover species may include *Borya septentrionalis*, *Lepidosperma laterale*, *Eriachne* spp., *Cleistochloa subjuncea*, *Boronia occidentalis*, *Cheilanthes* spp., *Coronidium newcastlianum*, *Schizachyrium* spp., *Tripogon loliiformis*, *Gonocarpus acanthocarpus* and *Eragrostis* spp. Dry western areas. Granite and rhyolite. (BVG1M: 29b)

Attributes

Recruitment of dominant canopy species (%):				25
Native plant species richness:			Trees:	4
			Shrubs:	21
			Grasses:	8
			Forbs and other:	10
Trees:	Tree canopy	Tree canopy median height (m):		NA
		Tree canopy cover (%):		NA
	Tree sub-canopy	Tree sub-canopy median height (m):		NA
		Tree sub-canopy cover (%):		NA
	Large trees	Large eucalypt tree dbh threshold (cm):		NA
		Number of large eucalypt trees per hectare:		NA
		Large non-eucalypt tree dbh threshold (cm):		0
		Number of large non-eucalypt trees per hectare:		0
Typical tree species:		In adjacent RE: *Corymbia abergiana*, *Eucalyptus atrata*, *E. lockyeri*, *E. reducta*.		
Shrubs:		Native shrub cover (%):		4
Ground cover (%):		Native perennial grass cover (%):		6
		Forbs and non-grass (%):		0
		Shrubs (%)		7
		Organic litter cover (%):		0
		Rock (%):		80
		Bare ground (%):		3
		Cryptograms (%)		4
Coarse woody debris:	Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare:			0
Non-native plant cover (%):				<1
Typical non-native species:	*Praxelis clematidea*.			

Native species richness:

Trees: *Corymbia abergiana*, *Eucalyptus atrata*, *E. lockyeri*, *E. reducta*.

Shrubs: *Acacia aulacocarpa*, *A. calyculata*, *A. falciformis*, *Acrothamnus spathaceus*, *Astroloma* sp. (Baal Gammon B.P.Hyland 10341), *Astrotricha pterocarpa*, *Commersonia dasyphylla*, *Eucalyptus lockyeri*, *Hibbertia concinnum*, *Homoranthus porteri*, *Jacksonia thesioides*, *Keraudrenia lanceolata*, *Leucopogon* sp. (Border Island), *Leptospermum amboinense*, *Monotoca scoparia*, *Notelaea punctata*, *Platysace valida, Pseudanthus ligulatus*, *Sannantha angusta*, *Xanthorrhoea johnsonii*, *Zieria cytisoides.*

Grasses: *Aristida* sp., *Arundinella setosa*, *Cleistochloa subjuncea*, *Eragrostis schultzii*, *Eriachne mucronata*, *Schizachyrium pachyarthron*, *Themeda triandra*, *Tripogon loliiformis.*

Forbs/other: *Boronia occidentalis*, *Cladia muelleri, C. retipora*, *Drynaria rigidula*, *Gonocarpus acanthocarpus*, *Lepidosperma laterale*, *Plectranthus amoenus*, *P. parviflorus*, *Praxelis clematidea**, *Usnea baileyi*.

Non-native species: *Praxelis clematidea**.

3.3 BioCondition Site: B3

Date of Survey: 25 May 2018

Plot origin: Zone: 55 K easting: 329366 northing: 8097925 Elev. 1033 m

Plot centre: Zone: 55 K easting: 329361 northing: 8097949 Elev. 1020 m

Plot bearing: NNW **Plot alignment:** Upslope across centre of vegetation type.

North

South

East

West

Habitat description: Heathland to shrubland over patches of rock pavement**.**

Regional ecosystem (mapped): 7.12.57c: Shrubland/low woodland (1.5-9 m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *Corymbia abergiana*, *E. portuensis*, *E. reducta*, *E. lockyeri*, *C. leichhardtii*, *Callitris intratropica*, *E. atrata*, *E. pachycalyx*, *E. shirleyi*, *E. drepanophylla* and *Homoranthus porteri*, on rhyolite and granite. There is occasionally a very sparse to sparse secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Persoonia falcata*, *Exocarpos cupressiformis* and *Melaleuca viridiflora* var. *viridiflora*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Coelospermum reticulatum*, *Xanthorrhoea johnsonii*, *Acacia humifusa*, *Dodonaea lanceolata* var. *subsessilifolia*, *Grevillea dryandri* subsp. *dryandri*, *Grevillea glossadenia*, *Acacia umbellata* and Ericaceae spp.

The ground layer may be dominated by species such as *Themeda triandra*, *Xanthorrhoea johnsonii*, *Eriachne pallescens* var. *pallescens*, *Cleistochloa subjuncea*, *Borya septentrionalis*, and *Eriachne* spp. Includes open rocky dominated by herbs and grasses. This RE includes areas of 7.12.65k (rocky areas with shrubby/herbaceous cover) which are too small to map. Rocky slopes on granite and rhyolite. (BVG1M: 9d)

Attributes

Recruitment of dominant canopy species (%):				100
Native plant species richness:			Trees:	3
			Shrubs:	18
			Grasses:	6
			Forbs and other:	9
Trees:	Tree canopy	Tree canopy median height (m):		0
		Tree canopy cover (%):		0
	Tree sub-canopy	Tree sub-canopy median height (m):		0
		Tree sub-canopy cover (%):		0
	Large trees	Large eucalypt tree dbh threshold (cm):		42
		Number of large eucalypt trees per hectare:		4
		Large non-eucalypt tree dbh threshold (cm):		0
		Number of large non-eucalypt trees per hectare:		0
Typical tree species:		In adjacent RE: *Eucalyptus lockyeri*, *E. reducta*. *Allocasuarina inophloia*		
Shrubs:		Native shrub cover (%):		57
Ground cover (%):		Native perennial grass cover (%):		31
		Forbs and non-grass (%):		2
		Shrubs (%)		57
		Organic litter cover (%):		1
		Rock (%):		9
		Bare ground (%):		0
		Cryptograms (%)		0
Coarse woody debris:	Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare:			0
Non-native plant cover (%):				0

Typical non-native species: None.

Native species richness:

Trees: *Allocasuarina inophloia*, *Eucalyptus lockyeri*, *E. reducta*.

Shrubs: *Acacia aulacocarpa*, *A. calyculata*, *Astrotricha pterocarpa*, *Hakea benthamii*, *Hibbertia bicarpellata*, *H. concinnum*, *Keraudrenia lanceolata*, *Leucopogon* sp. (Border Island), *Leptospermum amboinense*, *Melichrus urceolatus*, *Monotoca scoparia*, *Notelaea punctata*, *Platysace valida, Persoonia falcata*, *Pseudanthus ligulatus*, *Pultenaea millarii*, *Sannantha angusta*, *Xanthorrhoea johnsonii*.

Grasses: *Cleistochloa subjuncea*, *Eragrostis schultzii*, *Eriachne ciliata*, *E. mucronata*, *Panicum simile*, *Themeda triandra*.

Forbs and other species: *Cheilanthes nudiuscula*, *Cladia retipora*, *Coronidium newcastleanum*, *Cyperus pulchellus*, *Dendrobium speciosum*, *Gonocarpus acanthocarpus*, *Hibbertia longifolia*, *Lepidosperma laterale*, *Tricoryne anceps*.

Non-native species: None

3.4 BioCondition Site: B4

Date of Survey: 4 May 2018

Plot origin: Zone: 55 K easting: 329045 northing: 8096211 Elev. 666 m

Plot centre: Zone: 55 K easting: 329047 northing: 8096257 Elev. 655 m

Plot bearing: NW **Plot alignment**: Parallel with hill contour.

North

South

East

West

Habitat description: Steep rocky rhyolite slope with *Eucalyptus pachycalyx*, *Callitris intratropica* and *Corymbia leichhardtii*.

Regional ecosystem (mapped): 7.12.30d: Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *C. citriodora*, *E. portuensis*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. reducta*, *C. intermedia* and *E. shirleyi*. There is often a very sparse to mid-dense secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens*, *Persoonia falcata*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina inophloia*, *Petalostigma pubescens* and *Grevillea glauca*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Xanthorrhoea johnsonii* and *Grevillea glossadenia*.

The ground layer may be dominated by species such as *Themeda triandra*, *Heteropogon triticeus*, *Mnesithea rottboellioides*, *Arundinella setosa*, *Cleistochloa subjuncea*, *Eriachne pallescens* var. *pallescens*, *Lepidosperma laterale* and *Xanthorrhoea johnsonii*. Rocky slopes on granite and rhyolite. (BVG1M: 9d).

Attributes

Recruitment of dominant canopy species (%):			5
Native plant species richness:		Trees:	5
		Shrubs:	21
		Grasses:	11
		Forbs and other:	10
Trees:	Tree canopy	Tree canopy median height (m):	12
		Tree canopy cover (%):	23
	Tree sub-canopy	Tree sub-canopy median height (m):	7
		Tree sub-canopy cover (%):	4
	Large trees	Large eucalypt tree dbh threshold (cm):	35
		Number of large eucalypt trees per hectare:	6
		Large non-eucalypt tree dbh threshold (cm):	25
		Number of large non-eucalypt trees per hectare:	4

Typical tree species: *Eucalyptus cloeziana*, *E. pachycalyx*, *Corymbia leichhardtii*, *Callitris intratropica*, *Allocasuarina inophloia*.

Shrubs:	Native shrub cover (%):	22
Ground cover (%):	Native perennial grass cover (%):	11
	Forbs and non-grass (%):	0
	Shrubs (%)	22
	Organic litter cover (%):	24
	Rock (%):	26
	Bare ground (%):	13
	Cryptograms (%)	4

Coarse woody debris: Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare: 15

Non-native plant cover (%): 0

Typical non-native species: None

Native species richness:

Trees: *Eucalyptus cloeziana*, *E. pachycalyx*, *Corymbia leichhardtii*, *Callitris intratropica*, *Allocasuarina inophloia*.

Shrubs: *Acacia calyculata*, *A. purpureopetala*, *A. whitei*, *Hibbertia stirlingii*, *Jacksonia thesioides*, *Grevillea glossadenia*, *Psydrax saligna*, *Denhamia cunninghamii*, *Acacia nesophila*, *Dodonaea dododecandra*, *Alyxia spicata*, *Xanthorrhoea johnsonii*, *Acacia umbellata*, *Acacia humifusa*, *Grevillea dryandri*, *Larsenaikia ochreata*, *Bursaria incana*, *Breynia oblongifolia*, *Dodonaea lanceolata*, *Gompholobium nitidum*, *Acacia galioides*.

Grasses: *Cleistochloa subjuncea*, *Eriachne ciliata*, *Cymbopogon bombycinus*, *Schizachyrium fragile*, *Panicum simile*, *Triodia microstachya*, *Themeda triandra*, *Eriachne mucronata*, *Arundinella setosa*, *Heteropogon contortus*, *Aristida benthamii*.

Forbs and other species: *Gonocarpus acanthocarpus*, *Hibbertia longifolia*, *Tricoryne anceps*, *Phyllanthus virgatus*, *Cheilanthes nitida*, *Sedopsis* sp. (Bulimba Station), *Fimbristylis dichotoma*, *Wahlenbergia queenslandica*, *Cyanthillium cinereum*, *Pterocaulon redolens.*

Non-native species: None

3.5 BioCondition Site: B5

Date of Survey: 10 May 2018

Plot origin: Zone: 55 K easting: 329465 northing: 8096347 Elev. 725 m

Plot centre: Zone: 55 K easting: 3294483 northing: 8096336 Elev. 726 m

Plot bearing: SE **Plot alignment:** Upslope through wide, boulder-strewn gully.

North

South

East

West

Habitat description: Vine forest along rocky stream terrace.

Regional ecosystem (mapped): 7.12.9: *Acacia celsa* (brown salwood) open forest to closed forest. Foothills, uplands and highlands on granites and rhyolites, of the very wet and wet rainfall zone. (BVG1M: 5d)

Attributes

Recruitment of dominant canopy species (%):				65
Native plant species richness:			Trees:	21
			Shrubs:	8
			Grasses:	2
			Forbs and other:	20
Trees:	Tree canopy	Tree canopy median height (m):		16
		Tree canopy cover (%):		80
	Tree sub-canopy	Tree sub-canopy median height (m):		8
		Tree sub-canopy cover (%):		54
	Large trees	Large eucalypt tree dbh threshold (cm):		0
		Number of large eucalypt trees per hectare:		0
		Large non-eucalypt tree dbh threshold (cm):		25
		Number of large non-eucalypt trees per hectare:		33
Typical tree species:	*Olea paniculata*, *Pleiogynium timorense*, *Gossia bidwillii*, *Chionanthus ramiflorus.*			
Shrubs:		Native shrub cover (%):		4
Ground cover (%):		Native perennial grass cover (%):		2
		Forbs and non-grass (%):		6
		Shrubs (%)		4
		Organic litter cover (%):		32
		Rock (%):		48
		Bare ground (%):		6
		Cryptograms (%)		2
Coarse woody debris:	Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare:			57
Non-native plant cover (%):				3
Typical non-native species:	*Lantana camara**, *Solanum seaforthianum**, *Emilia sonchifolia**, *Praxelis clematidea**, *Ageratum conyzoides**.			

Native species richness:

Trees: *Wilkiea pubescens*, *Olea paniculata*, *Gossia bidwillii*, *Pleiogynium timorense*, *Chionanthus ramiflorus*, *Alectryon tomentosus*, *Euroschinus falcata*, *Drypetes deplanchei*, *Psydrax dallachiana*, *Ficus rubiginosa*, *Ficus virens*, *Pittosporum venulosum*, *Lophostemon grandiflorus*, *Acronychia laevis*, *Larsenaikia ochreata*, *Acacia celsa*, *Sersalisia sericea*, *Callitris intratropica*, *Atractocarpus fitzalanii*, *Bursaria tenuifolia*, *Elaeodendron melanocarpum.*

Shrubs: *Alyxia ruscifolia*, *Dendrocnide moroides*, *Alyxia spicata*, *Ozothamnus cassinioides*, *Wikstroemia indica*, *Myrsine variabilis*, *Flueggea virosa*, *Turraea pubescens.*

Grasses: *Oplismenus compositus*, *Arundinella setosa.*

Forbs and other species: *Parsonsia straminea*, *Tetrastigma nitens*, *Adiantum atroviride*, *Neoachmandra cunninghamii*, *Cyanthillium cinereum*, *Cissus oblonga*, *Smilax calophylla*, *Tectaria confluens*, *Adiantum hispidulum*, *Plectranthus amoenus*, *P. mirus*, *Asystasia* sp., *Proiphys amboinensis*, *Scleria mackaviensis*, *Dioscorea transversa*, *Drynaria rigidula*, *Abrus precatorius*, *Ventilago ecorollata*, *Dockrillia teretifolium*, *Paraceterach muelleri*.

Non-native species: *Lantana camara**, *Solanum seaforthianum**, *Emilia sonchifolia**, *Praxelis clematidea**, *Ageratum conyzoides*.*

3.6 BioCondition Site: B6

Date of Survey: 9 May 2018

Plot origin: Zone: 55 K easting: 330389 northing: 8096572 Elev. 793 m

Plot centre: Zone: 55 K easting: 330409 northing: 8096598 Elev. 792 m

Plot bearing: E **Plot alignment:** Crosses braided watercourse channel.

North

South

East

West

Habitat description: Vine forest across rocky stream and terrace.

Regional ecosystem (mapped): 7.12.16a: Simple notophyll vine forest on wet and moist uplands, granite and rhyolite. Uplands of the cloudy wet to moist rainfall zones. Granite and rhyolite. (BVG1M: 6b)

Attributes

Recruitment of dominant canopy species (%):				70
Native plant species richness:			Trees:	22
			Shrubs:	6
			Grasses:	2
			Forbs and other:	17
Trees:	Tree canopy	Tree canopy median height (m):		17
		Tree canopy cover (%):		75
	Tree sub-canopy	Tree sub-canopy median height (m):		10
		Tree sub-canopy cover (%):		55
	Large trees	Large eucalypt tree dbh threshold (cm):		0
		Number of large eucalypt trees per hectare:		0
		Large non-eucalypt tree dbh threshold (cm):		28
		Number of large non-eucalypt trees per hectare:		23
Typical tree species:	*Olea paniculata*, *Agathis robusta*, *Pleiogynium timorense*.			
Shrubs:		Native shrub cover (%):		4
Ground cover (%):		Native perennial grass cover (%):		2
		Forbs and non-grass (%):		10
		Shrubs (%)		4
		Organic litter cover (%):		16
		Rock (%):		40
		Bare ground (%):		4
		Cryptograms (%)		24
Coarse woody debris:	Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare:			18.7
Non-native plant cover (%):				<1
Typical non-native species:	*Praxelis clematidea**			

Native species richness:

Trees: *Olea paniculata*, *Agathis robusta*, *Pleiogynium timorense*, *Pittosporum venulosum*, *Euroschinus falcata*, *Guioa acutifolia*, *Harpullia pendula*, *Cupaniopsis anacardioides*, *Psydrax lamprophyllum*, *Psychotria dallachiana*, *Gossia bidwillii*, *Elaeodendron melanocarpum*, *Chionanthus ramiflorus*, *Ligustrum australianum*, *Polyalthia nitidissima*, *Drypetes deplanchei*, *Sersalisia sericea*, *Acronychia laevis*, *Atractocarpus fitzalanii*, *Bursaria tenuifolia*, *Ganophyllum falcatum*, *Polyscias elegans*.

Shrubs: *Myrsine porosa*, *Alyxia ruscifolia*, *Wikstroemia indica*, *Dendrocnide moroides*, *Ficus opposita*, *Myrsine porosa*.

Grasses: *Oplismenus compositus*, *Entolasia stricta.*

Forbs and other species: *Parsonsia rotata*, *Myrsine porosa*, *Melodinus australis*, *Adiantum atroviride*, *Hippocratea barbata*, *Smilax calophylla*, *Dioscorea transversa*, *Adiantum hispidulum*, *Proiphys amboinense*, *Ventilago ecorollata*, *Melodinus australis*, *Tectaria confluens*, *Cissus oblonga*, *Trophis scandens*, *Plectranthus mirus*, *Microsorum punctatum*, *Colysis sayeri.*

Non-native species: *Praxelis clematidea**.

3.7 BioCondition Site: B7

Date of Survey: 11 May 2018

Plot origin: Zone: 55 K easting: 328005 northing: 8096481 Elev. 596 m

Plot centre: Zone: 55 K easting: 328056 northing: 8096475 Elev. 596 m

Plot bearing: SE **Plot alignment:** Follows flow path of braided watercourse across sand and rock bars.

North

South

East

West

Habitat description: Braided seasonal watercourse with sandy and rocky bars.

Regional ecosystem (mapped): 7.3.26a: *Casuarina cunninghamiana*, *Eucalyptus tereticornis*, *Lophostemon suaveolens*, *Melaleuca leucadendra*, *M. fluviatilis*, *Buckinghamia celsissima*, *Mallotus philippensis* woodland and forest with an understorey of *Melaleuca viminalis* and *Bursaria tenuifolia*. Fringing forests of larger streams. Riverine wetland or fringing riverine wetland. (BVG1M: 16a).

NB. This RE is mapped incorrectly; nevertheless, the type does occur further downstream on Oakey Creek in a similar landscape setting.

Attributes

Recruitment of dominant canopy species (%):				25
Native plant species richness:			Trees:	19
			Shrubs:	12
			Grasses:	11
			Forbs and other:	19
Trees:	Tree canopy	Tree canopy median height (m):		14
		Tree canopy cover (%):		18
	Tree sub-canopy	Tree sub-canopy median height (m):		7
		Tree sub-canopy cover (%):		5
	Large trees	Large eucalypt tree dbh threshold (cm):		45
		Number of large eucalypt trees per hectare:		3
		Large non-eucalypt tree dbh threshold (cm):		24
		Number of large non-eucalypt trees per hectare:		2

Typical tree species: *Eucalyptus crebra*, *E. tereticornis*, *Corymbia clarksoniana*, *C. dallachiana*, *C. leichhardtii*, *Lophostemon grandiflorus.*

Shrubs:	Native shrub cover (%):	7
Ground cover (%):	Native perennial grass cover (%):	29
	Forbs and non-grass (%):	3
	Shrubs (%)	7
	Organic litter cover (%):	10
	Rock (%):	49
	Bare ground (%):	2
	Cryptograms (%)	0

Coarse woody debris: Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare: 60

Non-native plant cover (%): 2

Typical non-native species: 6

Native species richness:

Trees: *Eucalyptus crebra*, *E. tereticornis*, *Corymbia clarksoniana*, *C. dallachiana*, *C. leichhardtii*, *Lophostemon grandiflorus*, *Bursaria tenuifolia*, *Planchonia careya*, *Canarium australianum*, *Santalum lanceolatum*, *Callitris intratropica*, *Alphitonia excelsa*, *Drypetes deplanchei*, *Petalostigma banksii*, *Larsenaikia ochreata*, *Petalostigma pubescens*, *Grevillea parallela*, *Sersalisia sericea*, *Acacia flavescens.*

Shrubs: *Acacia multisiliqua, Dodonaea lanceolata, Exocarpos latifolia, Acacia disparrima, Ficus opposita, Trema aspera, Acacia nesophila, Grevillea glossadenia, Acacia humifusa, Clerodendrum floribundum, Wikstroemia indica*, *Flueggea virosa*.

Grasses: *Arundinella setosa*, *Themeda triandra*, *Cleistochloa subjuncea*, *Heteropogon contortus*, *Melinis repens**, *Heteropogon triticeus*, *Eriachne pallescens*, *Eragrostis schultzii*, *Chrysopogon fallax*, *Aristida queenslandica*, *Mnesithea rottboellioides.*

Forbs and other species: *Proiphys amboinense*, *Dianella nervosa*, *Heliotropium tabuliplagae*, *Jacksonia thesioides*, *Cajanus acutifolius*, *Pterocaulon redolens*, *Stylosanthes scabra**, *Praxelis clematidea**, *Breynia oblongifolia*, *Phyllanthus fuernrohrii*, *Dodonaea dododecandra*, *Tricoryne anceps*, *Hibiscus meraukensis*, *Crotalaria goreensis**, *Senna aciphylla*, *Cassytha filiformis*, *Grewia retusifolia*, *Chamaecrista rotundifolia**, *Scleria mackaviensis.*

Non-native species: *Lantana camara**, *Melinis repens**, *Stylosanthes scabra**, *Praxelis clematidea**, *Crotalaria goreensis**, *Chamaecrista rotundifolia**.

3.8 BioCondition Site: B8 (not surveyed)

Regional ecosystem (mapped): 7.12.29a: *Corymbia intermedia*, *Eucalyptus tereticornis*, *E. drepanophylla* open forest to low open forest and woodland with *Allocasuarina torulosa*, *A. littoralis*, *Lophostemon suaveolens*, *Acacia cincinnata*, *A. flavescens*, *Banksia aquilonia* and *Xanthorrhoea johnsonii*. Uplands, on granite and rhyolite. (BVG1M: 9c).

3.9 BioCondition Site: B9 (not surveyed)

Regional ecosystem (mapped): 7.12.57a: Shrubland and low woodland mosaic with *Syncarpia glomulifera*, *Corymbia abergiana*, *Eucalyptus portuensis*, *Allocasuarina littoralis* and *Xanthorrhoea johnsonii*. Uplands and highlands on granite and rhyolite, of the moist and dry rainfall zones. (BVG1M: 9d).

3.10 BioCondition Site: B10 (not surveyed)

Regional ecosystem (mapped): 7.12.34: *Eucalyptus portuensis* (white mahogany) and/or *E. drepanophylla* (ironbark), +/- *C. intermedia* (pink bloodwood) +/- *C. citriodora* (lemon-scented gum), +/- *E. granitica* (granite ironbark) open woodland to open forest. Uplands on granite, of the dry rainfall zone. (BVG1M: 9d)

3.11 BioCondition Site: B11

Date of Survey: 11 May 2018

Plot origin: Zone: 55 K easting: 328826 northing: 8096354 Elev. 630 m

Plot centre: Zone: 55 K easting: 328788 northing: 8096345 Elev. 624 m

Plot bearing: SW **Plot alignment:** Parallel with contour of rounded hill.

North

South

East

West

Habitat description: Grassy woodland on rocky hill.

Regional ecosystem (mapped): 7.12.30d: Open woodland to open forest (10-20m tall) mosaic with variable dominance, often including *Eucalyptus cloeziana*, *C. citriodora*, *E. portuensis*, *E. lockyeri*, *C. leichhardtii*, *E. atrata*, *E. pachycalyx*, *E. reducta*, *C. intermedia* and *E. shirleyi*. There is often a very sparse to mid-dense secondary tree layer of *C. abergiana* and/or *C. stockeri*. A very sparse to sparse tall shrub layer may be present and can include *Acacia flavescens*, *Persoonia falcata*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina inophloia*, *Petalostigma pubescens* and *Grevillea glauca*. A sparse to dense lower shrub layer may include *Jacksonia thesioides*, *Acacia calyculata*, *Xanthorrhoea johnsonii* and *Grevillea glossadenia*. The ground layer may be dominated by species such as *Themeda triandra*, *Heteropogon triticeus*, *Mnesithea rottboellioides*, *Arundinella setosa*, *Cleistochloa subjuncea*, *Eriachne pallescens* var. *pallescens*, *Lepidosperma laterale* and *Xanthorrhoea johnsonii*. Rocky slopes on granite and rhyolite. (BVG1M: 9d).

Attributes

Recruitment of dominant canopy species (%):				40
Native plant species richness:			Trees:	9
			Shrubs:	23
			Grasses:	12
			Forbs and other:	24
Trees:	Tree canopy	Tree canopy median height (m):		10
		Tree canopy cover (%):		19
	Tree sub-canopy	Tree sub-canopy median height (m):		8
		Tree sub-canopy cover (%):		10
	Large trees	Large eucalypt tree dbh threshold (cm):		35
		Number of large eucalypt trees per hectare:		27
		Large non-eucalypt tree dbh threshold (cm):		23
		Number of large non-eucalypt trees per hectare:		11

Typical tree species: *Callitris intratropica*, *Eucalyptus shirleyi*, *E. granitica*, *E. cloeziana*, *Corymbia leichhardtii.*

Shrubs:	Native shrub cover (%):	16
Ground cover (%):	Native perennial grass cover (%):	50
	Forbs and non-grass (%):	0
	Shrubs (%)	16
	Organic litter cover (%):	24
	Rock (%):	8
	Bare ground (%):	2
	Cryptograms (%)	0

Coarse woody debris: Total length (m) of debris ≥10 cm diameter and ≥0.5 m in length per hectare: 46

Non-native plant cover (%): <1

Typical non-native species: *Praxelis clematidea*, Stylosanthes scabra*.*

Native species richness:

Trees: *Callitris intratropica*, *Eucalyptus shirleyi*, *E. granitica*, *E. atrata*, *E. cloeziana*, *Corymbia leichhardtii*, *Planchonia careya*, *Grevillea glauca*, *Corymbia erythrophloia*.

Shrubs: *Psydrax saligna*, *Jacksonia thesioides*, *Acacia calyculata*, *A. flavescens*, *Dodonaea lanceolata*, *Wikstroemia indica*, *Breynia oblongifolia*, *Acacia multisiliqua*, *Xanthorrhoea johnsonii*, *Hibbertia stirlingii*, *Denhamia cunninghamii*, *Persoonia falcata*, *Acacia humifusa*, *Antidesma parviflorum*, *Acacia disparrima*, *Acacia nesophila*, *Exocarpos cupressiformis*, *Bursaria incana*, *Pogonolobus reticulatus*, *Capparis canescens*, *Gastrolobium grandiflorum*, *Stylosanthes scabra**, *Grevillea glossadenia.*

Grasses: *Themeda triandra*, *Arundinella setosa*, *Panicum simile*, *Cymbopogon bombycinus*, *Heteropogon contortus*, *H. triticeus*, *Cleistochloa subjuncea*, *Digitaria* sp., *Mnesithea rottboellioides*, *Aristida* sp., *Triodia microstachya*, *Schizachyrium fragile*.

Forbs and other species: *Phyllanthus virgatus*, *P. fuernrohrii*, *Hibbertia longifolia*, *Cajanus marmoratus*, *Crotalaria montana*, *Commelina diffusa*, *Gompholobium nitidum*, *Crotalaria medicaginea*, *Phyllanthus collinus*, *Tephrosia filipes*, *Galactia tenuifolia*, *Tacca leontopetaloides*, *Wedelia spilanthoides*, *Pterocaulon redolens*, *Tricoryne anceps*, *Wahlenbergia queenslandica*, *Dianella nervosa*, *Cheilanthes nitida*, *Tephrosia juncea*, *Praxelis clematidea**, *Scleria brownii*, *Cyanthillium cinereum*, *Coronidium newcastleanum*, *Pimelea confertifolia.*

Non-native species: *Praxelis clematidea**, *Stylosanthes scabra**.

4.0 REFERENCES

Eyre TJ, Kelly AL and Neldner VJ (2017). *Method for the Establishment and Survey of Reference Sites for BioCondition*. Version 3. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane.

Neldner, V.J., Wilson, B.A., Dillewaard H.A. and Butler, D. W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. Version 4.0. Queensland Herbarium, Queensland Department of Science, Information Technology and Innovation, Brisbane.

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Appendix C Fauna List

A summary of species identified during survey on the MEWF Offset Site

Species	Common Name
Bird	
Alectura lathami	Australian Brush-turkey
Pachycephala pectoralis	Australian golden whistler
Milvus migrans	Black Kite
Lichmera indistincta	Brown honeyeater
Coracina tenuirostris	Common cicadabird
Colluricincla harmonica	Grey shrikethrush
Dacelo novaeguineae	Laughing kookaburra
Myiagra rubecula	Leaden flycatcher
Meliphaga lewinii	Lewin's honeyeater
Hieraaetus morphnoide	Little eagle
Philemon corniculatus	Noisy friarbird
Manorina melanocephala	Noisy miner
Platycercus adscitus	Pale-headed rosella
Centropus phasianinus	Pheasant Coucal
Strepera graculina	Pied Currawong
Merops ornatus	Rainbow Bee-eater
Malurus melanocephalus	Red-backed fairywren
Neochmia temporalis	Red-browed finch
Dicrurus bracteatu	Spangled drongo
Haliastur sphenurus	Whistling kite
Melithreptus lunatus	White-naped Honeyeater
Melithreptus albogulari	White-throated honeyeater
Mammal	
Dasyurus hallucatus	Northern Quoll
Isoodon macrourus	Northern brown bandicoot
Melomys burtoni	Melomys
Petrogale mareeba	Mareeba Rock Wallaby
Rattus fuscipes	Bush rat
Sus scrofa	Pig
Tachyglossus aculeatus	Short-beaked echidna
Uromys caudimaculatus	Giant white-tailed rat

Species	Common Name
Wallabia bicolor	Agile Wallaby
Pteropus conspicillatus	Spectacled Flying fox
Austronomus australis	White-striped free-tailed bat
Chaerophon jobensis	Northern freetail bat
Chalinobus nigrogiseus	Hoary Wattled Bat
Miniopterus australis	Little bent-wing bat
Miniopterus orianae oceanensis	Eastern Bent-wing Bat
Mormopterus ridei	Ride's Free-tailed Bat
Nyctophilus sp.	-
Rhinolophus megaphyllus	Smaller horseshoe bat
Saccolaimus saccolaimus	Bare-rumped Sheathtail Bat
Reptile	
Diporiphora bilinieata	Two Lined Dragon
Carlia munda	Rainbow-skink
Dendrelaphis punctulatus	Green Tree Snake