Wyong Shire Council
CENTRAL COAST

RZ/12/2014

C. Interim Ecological Inventory

EcoLogical 2012

INTERIM ECOLOGICAL INVENTORY REPORT

Darkinjung Local Aboriginal Land Council North Wyong Land holdings 2010-2012

Prepared for
Darkinjung Local Aboriginal Land Council

30 November 2012

DOCUMENT TRACKING

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Project Manager	Robert Humphries 02 8536 8620 4/2-4 Merton Street, Sutherland NSW 2232
Prepared by	Antony Von Chrismar, Andrea Sabella, Gordon Patrick, Joanne Daly, Robert Humphries
Approved by	Robert Humphries
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Abbreviations

ABBREVIATION	DESCRIPTION
ALR Act	NSW *Aboriginal Land Rights Act* 1983
APZ	Asset Protection Zones
BBAM	Biobanking Assessment Methodology
BCAM	Biodiversity Certification Assessment Methodology
BOS	Biodiversity Offset Strategy
BOP	Biodiversity Offset Package
CL Act	NSW *Crown Land Act* 1993
CMA	Catchment Management Authority
DECCW	former NSW Department of Environment, Climate Change and Water (now OEH)
DLALC	Darkinjung Local Aboriginal Land Council
DoP	Former NSW Department of Planning
DP&I	NSW Department of Planning and Infrastructure
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Populations and Communities
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
IoM	Improve or Maintain
LALC	Local Aboriginal Land Council
LGA	Local Government Area
MNES	Matters of National Environmental Significance (EPBC Act)
NPW Act	*NSW National Parks and Wildlife Act* 1975
OEH	NSW Office of Environment and Heritage
RBVT	Revised Biometric Vegetation Type
RCP	Regional Conservation Plan
SSS Study	State Significant Site Study
TSC Act	NSW *Threatened Species Conservation Act* 1995

1 Introduction

Darkinjung Local Aboriginal Land Council (DLALC) commissioned Eco Logical Australia (ELA) in October 2010 to commence undertaking ecological investigations of its land holdings at Bushells Ridge as part of a Part 3A Development Application.

At around the same time, the then Department of Planning (DoP), now the Department of Planning and Infrastructure (DP&I), released its draft North Wyong Structure Plan („structure plan") (DoP 2010). The structure plan identifies where and when development is planned to occur in the North Wyong area and ensures that sufficient land exists to meet regional housing and employment targets. The structure plan provides detail to the Central Coast Regional Strategy 2006-31 (DoP 2008) which also identified that a Central Coast Regional Conservation Plan (RCP) will be prepared by the NSW Office of Environment and Heritage (OEH).

Darkinjung"s Bushells Ridge land holdings represent a component of its overall land holdings which are in excess of 3,000 ha"s of which over 1,000 ha"s are in the North Wyong area, with a further 9,000 ha of yet to be determined land claims. The land council is one of the largest non-government land owners in the region.

The majority of Darkinjung"s north Wyong land holdings are identified in the structure plan as "*Green Corridor and habitat networks*", part of which are further identified as "*strategically located, constrained sites, subject to further investigation and offset strategies to define conservation requirements and development potential*".

Accordingly, the land council has recognised the need to establish a DLALC Land Strategy to identify development opportunities and conservation outcomes that complement and help achieve the targets in the structure plan and yet to be released RCP.

ELA brief was thus expanded to investigate development opportunities and conservation values of all DLALC land holdings in the structure plan area.

At this stage, DLALC and ADW Johnson have identified potential development precincts at Bushells Ridge and Railcorp/Link Road Employment Estate (employment lands) and Bushells Ridge East, Lake Munmorah and Halekulani (residential lands) totalling approximately 373 ha. Similarly some 719 ha of conservation lands have also been identified with a possible further 631 ha subject to land claims (**Figure 1)**.

This report provides a summary of the conservation values assessed between October 2010 and November 2012 and is intended to guide ongoing discussions between DLALC, Wyong Council, the OEH and the DP&I regarding the further development of the land councils development proposal. The ecological investigations are ongoing and the analysis of current data is not yet complete.

As these lands each represent significant projects that would be developed over long timeframes (10-25 years) and require rezoning, the recently gazeted Biodiversity Certification Assessment Methodology (BCAM) (DECCW 2011) is proposed to be used to „biodiversity certify" the proposed development lands and provide certainty for future development. The BCAM is a transparent and quantitative methodology used to assess the impacts to biodiversity for large scale projects and demonstrate conservation outcomes consistent with NSW and Commonwealth offset policies, including a „improve or maintain" (IoM) outcome. It is noted that the proposed development areas largely avoid red flag vegetation communities and species and that the offset requirements can be fully met by the land council current land holdings and claims prioritised for determination.

The BCAM (OEH 2011) provides a framework to determine whether large scale projects such as those proposed, including proposed conservation measures, will meet an IoM outcome. If the Minister for the Environment is satisfied that an IoM outcome has been achieved, the Minister may „biodiversity certify" the proposal, allowing development to proceed without further biodiversity assessment on the condition that certain identified lands are protected and managed as proposed in the application and in accordance with a Biodiversity Conservation Strategy. An application must be made by a planning authority (i.e. the Department of Planning or Wyong Council) and must be prepared in accordance with the rules established under the methodology.

Then following sections provide a brief overview of the surveys methods implemented and the results obtained to date. These results have been used to inform DLALC in their identification of development precincts and ongoing discussions with DP&I, OEH and Wyong Council. Once development precincts are confirmed, formal biocertification assessments will be undertaken using the results of the surveys.

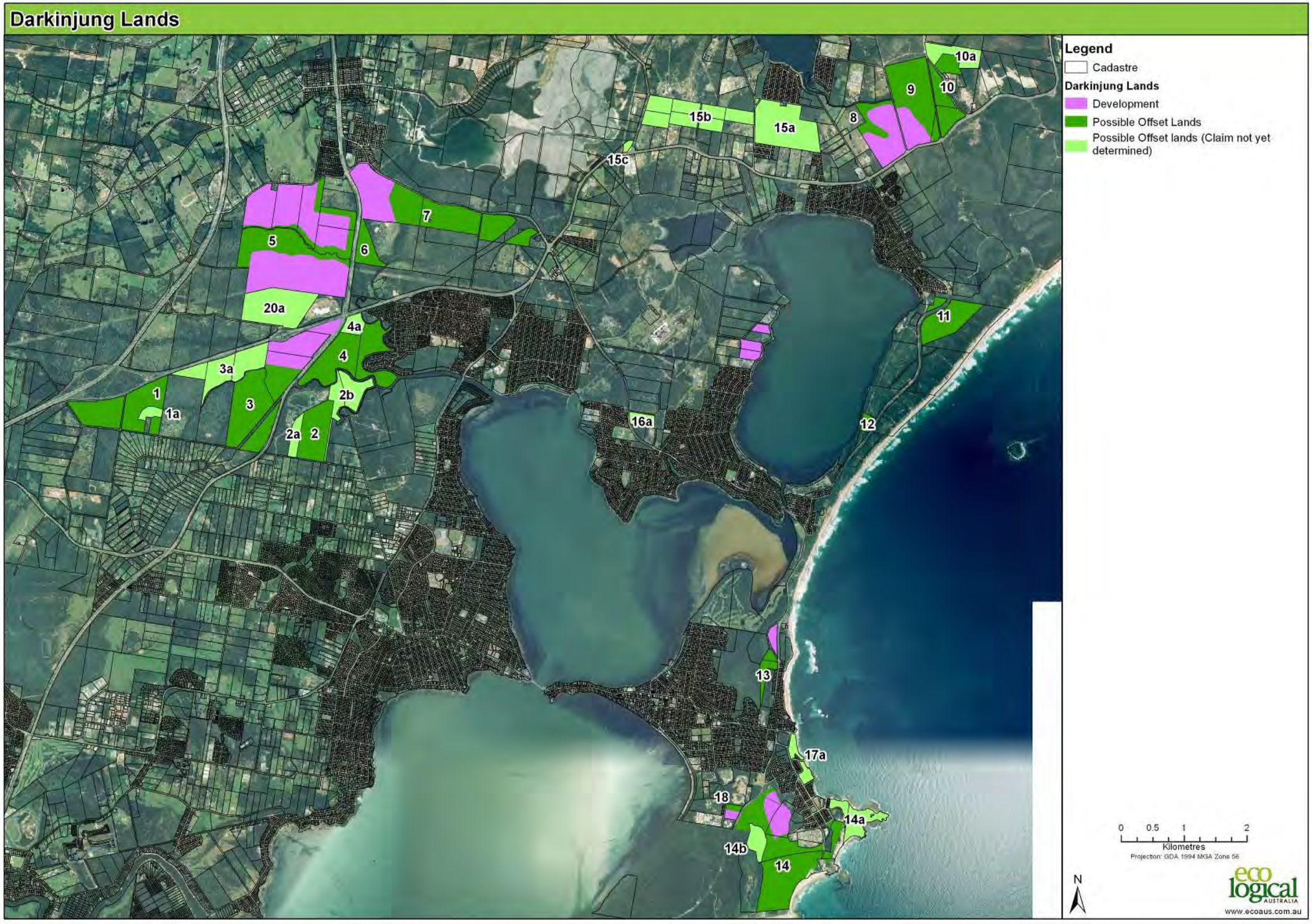

Figure 1: DLALC North Wyong Land holdings and indicative development and conservation outcomes

2 Methods

2.1 BIOCERTIFICATION

All flora and fauna investigations to date have been undertaken in accordance with the BCAM (DECCW 2011) and the „*Threatened Biodiversity Survey and Assessment Guidelines for developments and activities*‟ (DEC 2004). These investigations have been undertaken by teams supervised by accredited biobanking/biocertification assessors so that a formal biocertification assessment can be undertaken.

2.2 VALIDATION OF WYONG LGA VEGETATION MAPPING

The boundaries of vegetation communities according to the Wyong Local Government Area (LGA) vegetation mapping (Bell 2002) were mapped onto high resolution, recent aerial photographs. This mapping was then extensively ground-truthed by experienced field ecologists and any updates/modifications required were marked using a GPS.

ArcMap Version 9.2, a Geographic Information System (GIS), was used to map and interpret data in this report. Vegetation communities and records of threatened species were plotted onto geo-referenced aerial photographs and other maps at scales of 1:10,000 or better.

As Revised Biometric Vegetation Types (RVBTs) are the only vegetation types used in biocertification assessments, each of the Bell 2002 map units were converted to the corresponding biometric vegetation in the Hunter Central Rivers CMA region (DECC 2008). Some vegetation observed in the field did not fit neatly into any of the RBVTs listed for the Hunter – Central Rivers CMA (e.g., where the vegetation lies in an ecotone between two types). In such cases, the professional judgment of the assessor was used to select the closest matching RBVT. The Bell 2002 map units corresponding to each biometric vegetation type are shown in **Table 1.**

Biocertification Condition Assessment

The condition of each of the RVBTs was categorised as being in either biometric „moderate – good‟ or „low‟ condition or „cleared‟ land, thus creating „Biocertification Vegetation Zones‟.

Ancillary Codes were also assigned to each of the Vegetation Zones in moderate - good condition (i.e. regrowth, recently burnt, weedy, under scrubbed etc) to create the Threatened Species Sub-zones. No Ancillary Codes were assigned to vegetation in „low‟ condition.

Table 1: Biometric vegetation types and corresponding Bell 2002/Wyong Vegetation map units

Wyong LGA Map Unit (Bell 2002)	Biometric Vegetation Community	EEC	BCAM Red Flag
Coastal Sand Blackbutt - Apple Forest	Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin and South East Corner		
Coastal Sand Wallum Heath Scrub	Banksia dry shrubland on coastal sands of the North Coast		
Alluvial Riparian Blackbutt Forest	Blackbutt - Smooth-barked Apple shrubby open forest on coastal sands of the southern North Coast		
Munmorah Impeded Sand Sedgland	Broad-leaved Paperbark - Wallum Bottlebrush - sedge wet heath on sand, southern North Coast and northern Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Coastal Holocene Banksia Scrub / Coastal Sand Foredune Acacia Scrub / Coastal Sand Beach Spinifex	Coast Banksia - Coast Wattle dune scrub, Sydney Basin and South East Corner		
Narrabeen Coastal Alluvial Sedgeland	Coastal floodplain sedgelands, rushlands, and forblands of the North Coast	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Alluvial Floodplain Swamp Paperbark Thicket	Coastal freshwater lagoons of the Sydney Basin and South East Corner	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Coastal Sand Wallum Heath-Scrub	Fern-leaved Banksia - Melaleuca sieberi Wallum Heath	Low woodland with heathland on indurated sand at Norah Head	Yes
Alluvial Floodplain Shrub Swamp Forest	Forest Red Gum - Rough-barked Apple open forest on poorly drained lowlands of the Central Coast, Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
Narrabeen alluvial drainage line complex / Costal Sand Wallum Heath Scrub	Melaleuca nodosa closed shrubland on alluvium of the Central Coast, Sydney Basin	Low woodland with heathland on indurated sand at Norah Head	Yes
Munmorah Impeded Sand Sedgeland	Melaleuca sieberi - Tall Saw-sedge closed shrubland in drainage lines on the Central Coast, Sydney Basin		
Alluvial Bluegum-Paperbark Mesic Palm Forest	Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin		
Munmorah Impeded Sand Sedgeland / Narabeen Impeded Wet Heath	Paperbark heath on indurated sands at Norah Head on the Central Coast, Sydney Basin	Low woodland with heathland on indurated sand at Norah Head	Yes
Coastal Sand Mahogany - Paperbark Swamp Forest / Coastal Sand Bangalay - Paperbark Forest	Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes

Narrabeen Doyalson Coastal Woodland	Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin		
Narrabeen Doyalson Coastal Woodland / Coastal Sand Blackbutt Forest	Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin		
Narrabeen Dooralong Spotted Gum - Ironbark Forest	Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin		
Munmorah Palm Apple Dry Drainageline Forest	Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes
	Sydney Peppermint - Smooth-barked Apple shrubby open forest on coastal hills and plains of the southern North Coast and northern Sydney Basin		
Coastal Sand Littoral Rainforest	Tuckeroo - Yellow Tulipwood Littoral Rainforest	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Yes

2.3 BIOMETRIC PLOTS

Quadrat surveys were 0.04ha (20m x 20m) and recorded presence of all vascular flora species (native and exotic). Habitat features were determined over 0.1 ha survey (50m x 20m quadrat); including recording of number of hollow bearing trees and length of fallen dead timber greater than 10 cm diameter. Within the 0.1 ha quadrats, projected foliage cover of each strata level and exotic flora was assessed along a 50m transect.

To date, 97 biometric vegetation condition plots have been undertaken across the investigation area. Each plot was randomly placed within each vegetation zone in accordance with the minimum number of plots required by the BCAM (see Table 11 of the BCAM).

Figure 2 shows the location of each of the vegetation quadrats throughout the investigation area. Detailed maps of each land parcel are provided separately.

Any specimens unidentifiable in the field were retained and later identified. Any specimens that were thought to be threatened species or for which identification was problematic were sent to the Herbarium at the Royal Botanic Gardens, Sydney for verification.

2.4 THREATENED SPECIES SURVEYS

2.4.1 Target Species

The Biocertification Credit Calculator requires targeted survey for threatened flora and threatened fauna that are not predicted to occur in certain vegetation types. In order to determine which species required targeted survey and what months to undertake these surveys, each of the biometric vegetation types within the investigation area were entered into the biocertification tool. **Table 2** shows which species required targeted survey in accordance with BCAM and the acceptable months to undertake these surveys. It is noted that under the BCAM, targeted surveys for many threatened fauna species known to occur in the investigation area (e.g. Powerful Owl, Masked Owl and Squirrel Glider) **are not required** as these species are considered ecosystem species and are assumed to occur in designated vegetation

types of particular patch size and condition in certain localities. However, where these species were opportunistically recorded, there presence has been noted.

Targeted threatened flora surveys have been undertaken in December 2010, January, February 2011, October and November 2011, July, September, October and November 2012 to date.

Targeted threatened fauna surveys have been undertaken in February, March, April and May 2012 to date.

Except where specifically noted, the field survey was undertaken using hand-held GPS units, which were used to take GPS point locations of flora and fauna observed in the field. It is noted that these units can have errors in the accuracy of the locations taken of approximately 20m (subject to availability of satellites on the day).

Table 2: Species requiring targeted survey and acceptable survey periods

Threatened Flora

Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia bynoeana	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Angophora inopina	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Astrotricha crassifolia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Caladenia porphyrea	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Caladenia tessellata	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Callistemon linearifolius	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Corybas dowlingii	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No
Cryptostylis hunteriana	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
Cynanchum elegans	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diuris bracteata	No	No	No	No	No	No	No	Yes	Yes	No	No	No
Diuris praecox	No	No	No	No	No	No	Yes	Yes	No	No	No	No
Eucalyptus camfieldii	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus parramattensis subsp. decadens	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus parramattensis subsp. parramattensis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus oblonga - endangered population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Genoplesium insignis	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Grevillea parviflora subsp. parviflora	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maundia triglochinoides	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes
Melaleuca biconvexa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Melaleuca groveana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prostanthera askania	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Rutidosis heterogama	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Syzygium paniculatum	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tetratheca glandulosa	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No
Tetratheca juncea	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Thelymitra sp. Adorata	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Zannichellia palustris	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Threatened Fauna (excluding marine and inter-tidal species)

Scientific name	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Botaurus poiciloptilus	Australian Bittern	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Callocephalon fimbriatum	Gang Gang Cockatoo	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chalinolobus dwyeri (Breeding)	Large-eared Pied Bat	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Crinia tinnula	Wallum Froglet	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes
Ephippiorhynchus asiaticus	Black-necked Stork	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Heleioporus australiacus	Giant Burrowing Frog	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Hieraaetus morphnoides	Little Eagle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hoplocephalus bitorquatus	Pale-headed Snake	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
Hoplocephalus bungaroides	Broad-headed Snake	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Irediparra gallinacea	Comb-crested Jacana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ixobrychus flavicollis	Black Bittern	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Litoria aurea	Green and Golden Bell Frog	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Litoria brevipalmata	Green-thighed Frog	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Litoria littlejohni	Littlejohn"s Frog	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Lophoictinia isura	Square-tailed Kite	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Miniopterus australis (Breeding)	Little Bentwing-bat	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
Miniopterus schreibersii oceanensis (Breeding)	Eastern Bentwing-bat	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Mixophyes iteratus	Giant Barred Frog	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes
Myotis macropus (formally Myotis adversus) (Breeding)	Large-footed Myotis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nettapus coromandelianus	Cotton Pygmy-Goose	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Pandion haliaetus	Osprey	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Petrogale penicillata	Brush-tailed Rock-wallaby	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phascogale tapoatafa	Brush-tailed Phascogale	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Planigale maculata	Common Planigale	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudophryne australis	Red-crowned Toadlet	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pteropus poliocephalus (Breeding)	Grey-headed Flying Fox	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Varanus rosenbergi	Rosenberg"s Goanna	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
Vespadelus troughtoni (Breeding)	Eastern Cave Bat	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2.4.2 Targeted threatened flora surveys

Random meanders for threatened flora species were undertaken in accordance with DECCW guidelines (DEC 2004). The location of random meanders were determined in the field based on suitable habitat. Existing records from the Atlas of NSW Wildlife was used to indicate previous recordings guidance to potential threatened species locations. The locations and months of all flora survey undertaken, as recorded by hand held GPS, are shown in **Figures 4-27**.

Over 500 person hours of targeted threatened flora survey has been undertaken to end November 2012.

2.4.3 Targeted threatened fauna surveys

The location and survey technique of all fauna survey undertaken within the investigation area to date is shown in **Figures 4-27**. Survey effort and techniques was tailored to target threatened fauna considered to potentially occur in the study area as determined by the biodiversity certification tool. DEC (2004) and other documents were then consulted to determine the most appropriate survey technique and minimum survey effort required.

Following a review of those threatened fauna species requiring targeted survey in accordance with the BCAM, hair tubes, pitfall trapping, anabat / stag watching and targeted amphibian surveys were used as the primary methods of detecting threatened fauna species. The location of survey sites using these methods is shown in **Figure 3**.

Hair tubes

Hair tubes were placed in pairs along transects with 10 stations. Hair tubes were left in place for between 10 and 14 nights resulting in between 200 and 280 trap nights per transect.

Over 3,000 hair tube trap nights have been undertaken to end November 2012.

Hans Brunner, an experienced expert in analysis of fauna hair samples, was engaged to analyse the data collected by the hairtubes, in accordance with the techniques described by Brunner and Coman (1974).

Trapping

To date Elliot traps have only been used at the Halekulani site. A total of 64 arboreal trap nights have been completed.

Pitfall Trapping

Pitfall trapping was used to target Planigale, Eastern Chestnut Mouse and Eastern Pygmy Possum at the Norah Head precinct. To date, 48 trap nights have been completed.

Frog call play back

A combination of nocturnal call playback and listening for frog calls, plus spotlighting, was used to survey for targeting frog species in specific suitable habitat. Calls were identified using reference recordings available on the Amphibian Research Centre website (online). Surveys were undertaken during optimal weather conditions, i.e. after heavy rainfall events in summer months to target Giant Burrowing Frog, Giant Bared Frog and Green-thighed Frog. Sites of aquatic habitats such as dams, wetlands, soaks and seepages were targeted.

Over 150 person hours of targeted threatened amphibian survey has been undertaken to end November 2012.

Anabat analysis

Survey for microchiropteran (microbats) bat species included the use of ultrasonic Anabat detectors equipped with ZCAIM recording devices. Recordings containing less than three pulses were not analysed (Law et al. 1999). To date, 52 anabat nights have been completed.

Stag watching

The identification of potential roosting and/or breeding sites for microchiropteran bats focused on identifying potential roosting / nesting trees during the survey period and stag watching with an Anabat directed at the stag hollow prior to dusk and 30 minutes after dusk to capture calls from any emerging microchiropteran species. To date, 52 anabat / stagwatch nights and have been completed. In addition, over 150 person hours of spotlighting has been undertaken to end November 2012.

Opportunistic bird survey

Survey for diurnal birds was opportunistic with observers moving through vegetation communities supporting potential habitat for diurnal birds over the entire survey period.

2.4.4 Limitations

The survey effort and study design optimised the potential for species to be recorded during a range of climatic situations and over a number of seasons. Nonetheless, it is not possible to record every species that may either be resident or transitory across a site as generally some species may have been inactive, dormant or with cryptic habits, or some may be nomadic or migratory in nature. Additionally, some fauna species are mobile or transient in their use of resources. Consequently, it is likely that not all species would have been recorded during the study period even though it extended from October 2010-2012 and, therefore, the likelihood of occurrence within the study area of some threatened species was assessed based on the presence of potential habitat.

Given the limitations associated with all surveys, this assessment was not intended to provide an inventory of all species present across the site but instead aims to provide an overall assessment of the ecological values of the site with particular emphasis on threatened species, endangered ecological communities and key fauna habitat features.

2.5 PROJECT STAFF AND EXPERTISE

ELA has deployed an extensive team of ecologists to undertake the field surveys. Additionally, technical specialists analysed field records to create a comprehensive anthology of high-quality scientific data.

Table 3: ELA staff, project role and key

Project Team	Role	Expertise
Robert Humphries	Project Director	BCAM/BBAM
Antony Von Chrismar	Project Planning & field work	Accredited Biobanking and Biocertification Assessor
Darren James	Advice, Credit Calculations	Accredited Biobanking and Biocertification Assessor
Gordon Patrick	Field work	Senior Botanist
Lachlan Copeland	Field work	Senior Botanist
Michael Ward	Field work	Botanists
Andrea Sabella	Field work	Ecologist
Ross Wellington	Field work	Herpetologist
Daniel McKenzie	Field work	Junior Ecologist
Niels Rueegger	Field work	Ecologist
Prudence Coffey	Field work	Ecologist
Liz Brown	Field work	Senior Botanist
Rochelle Basham	Field work	Ecologist
Peter Knock	Field work & Anabat analysis	Anabat Analysis
Hans Brunner	Hair Analysis	Hair Tube Analysis
Joanne Daly	GIS Analysis & Support Credit Calculations	GIS Analysis & Support Credit Calculations
Vivian Hamilton	GIS Analysis & Support	GIS Analysis & Support

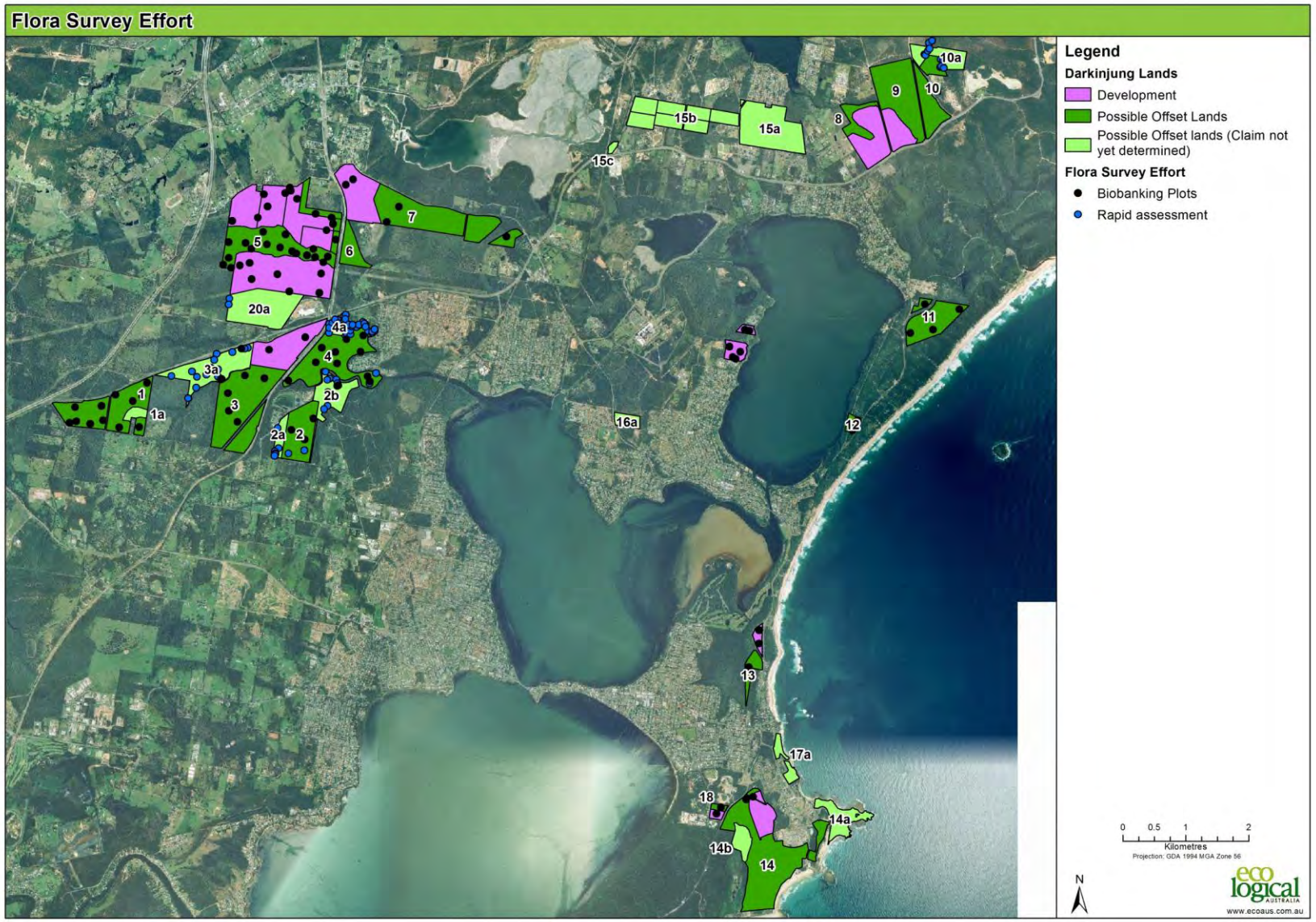

Figure 2: Distribution of biometric plots and threatened flora survey effort within the investigation area (October 2010-2102)

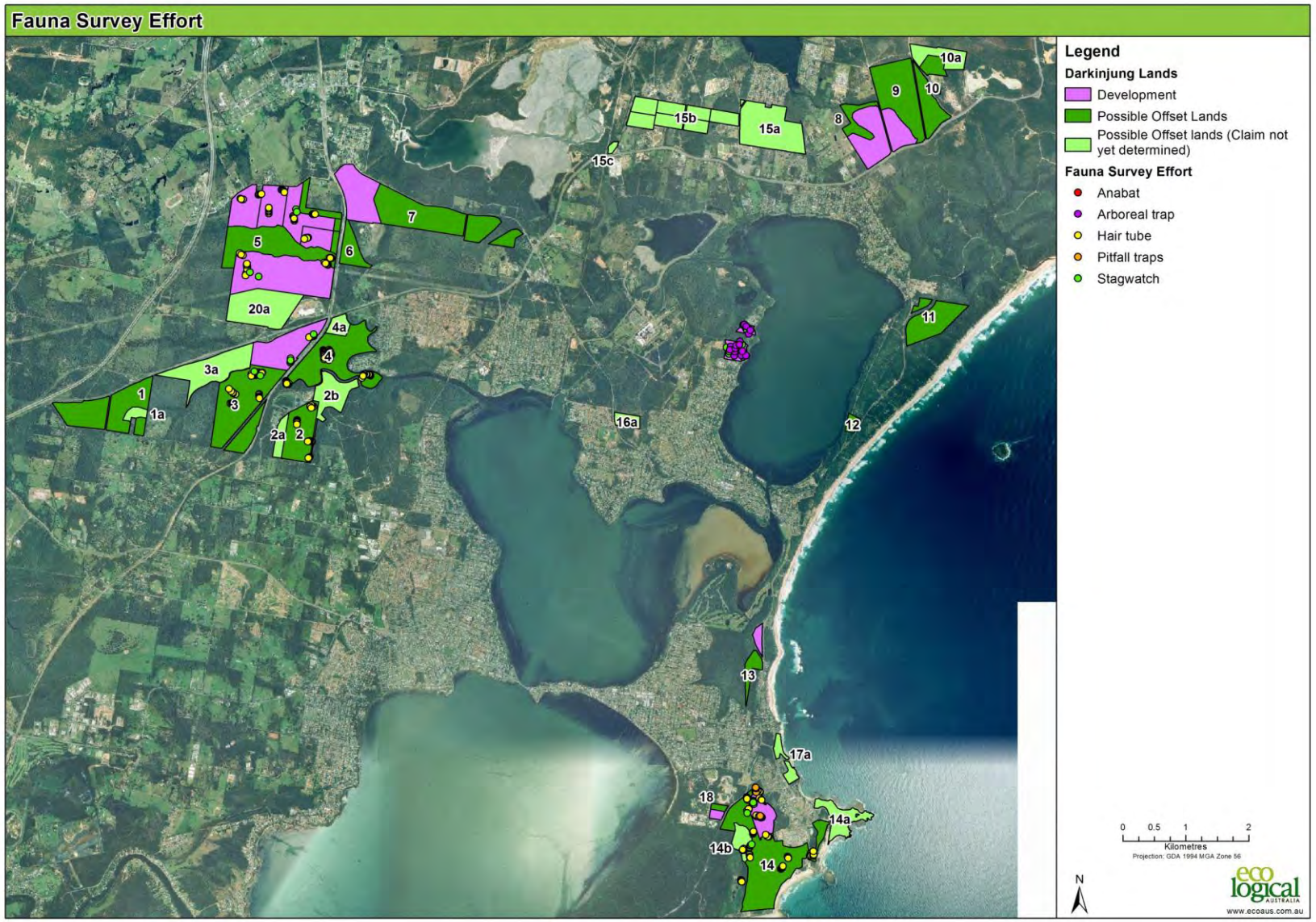

Figure 3: Threatened fauna survey effort and techniques across the investigation area (October 2010-2012)

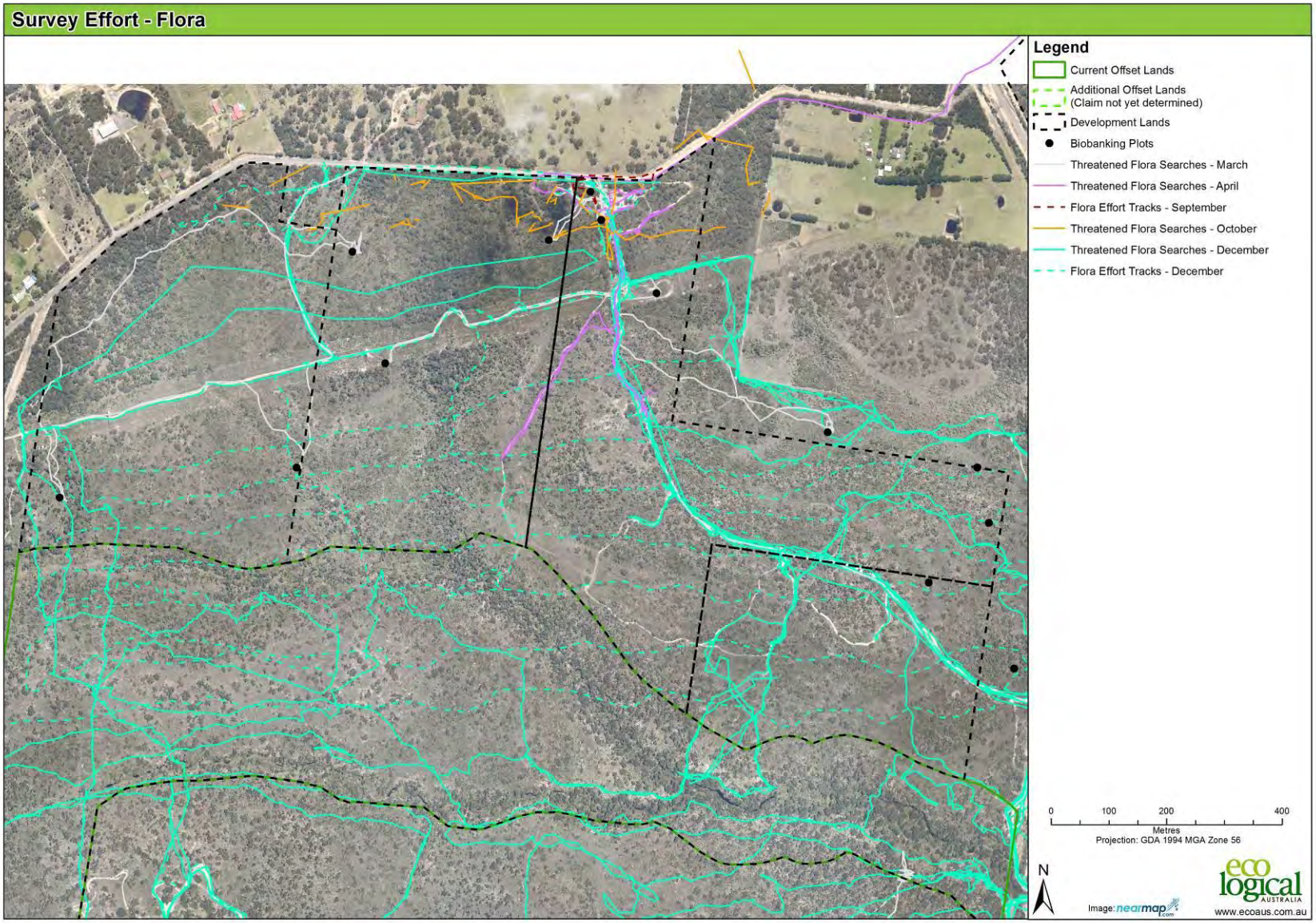

Figure 4: Flora survey effort Bushells Ridge North proposed development precinct

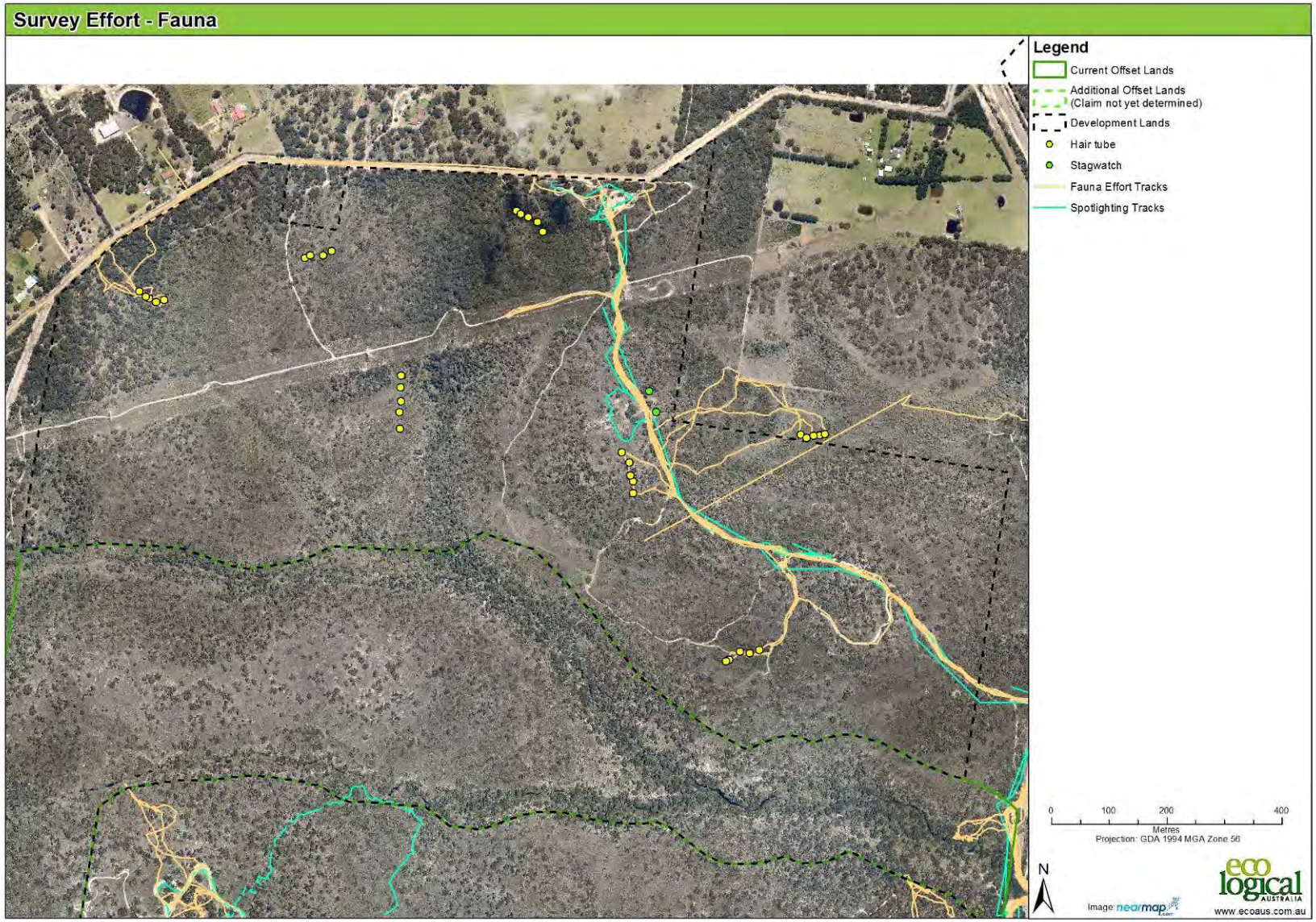

Figure 5: Fauna survey effort Bushells Ridge North proposed development precinct

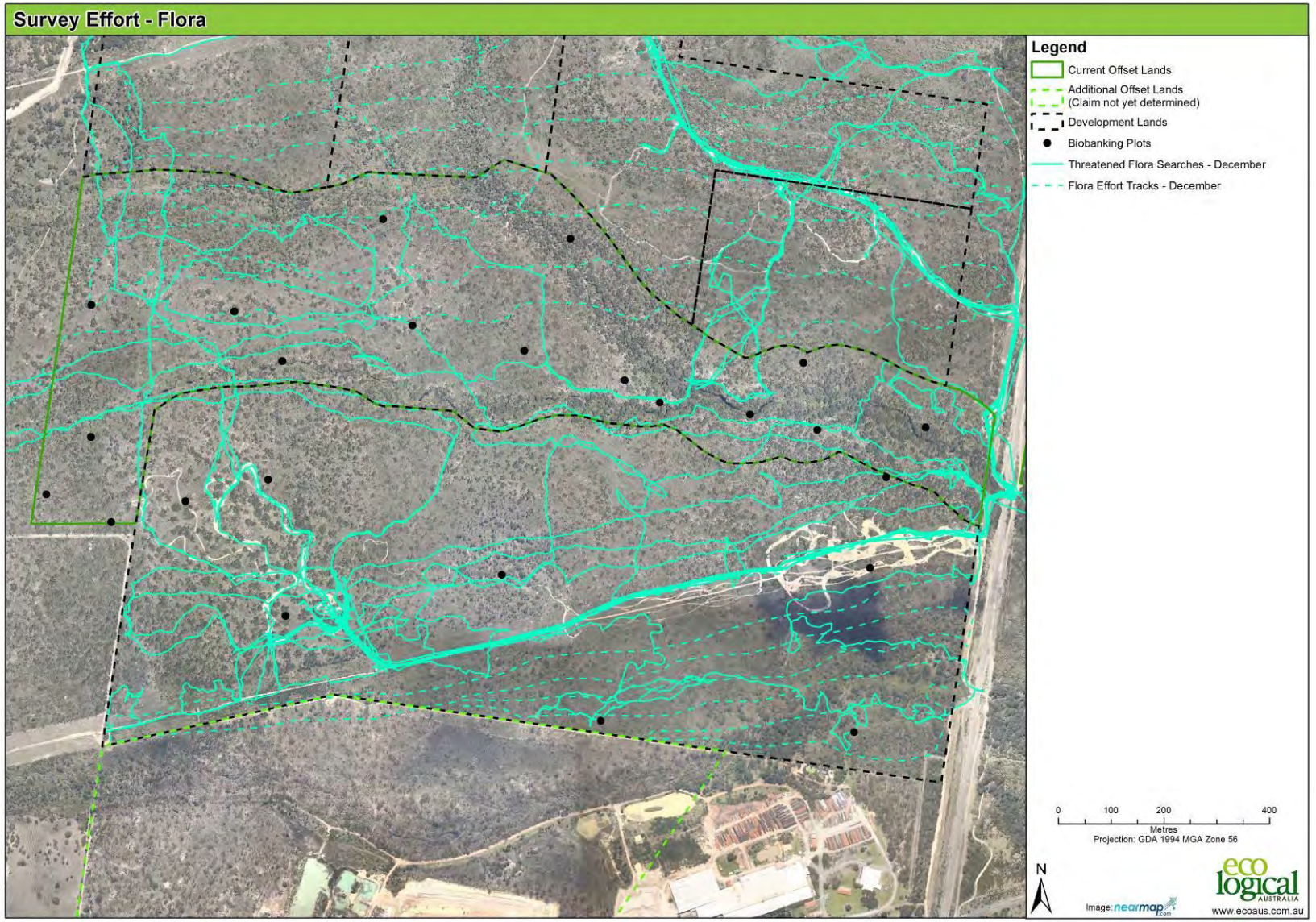

Figure 6: Flora survey effort Bushells Ridge South proposed development precinct

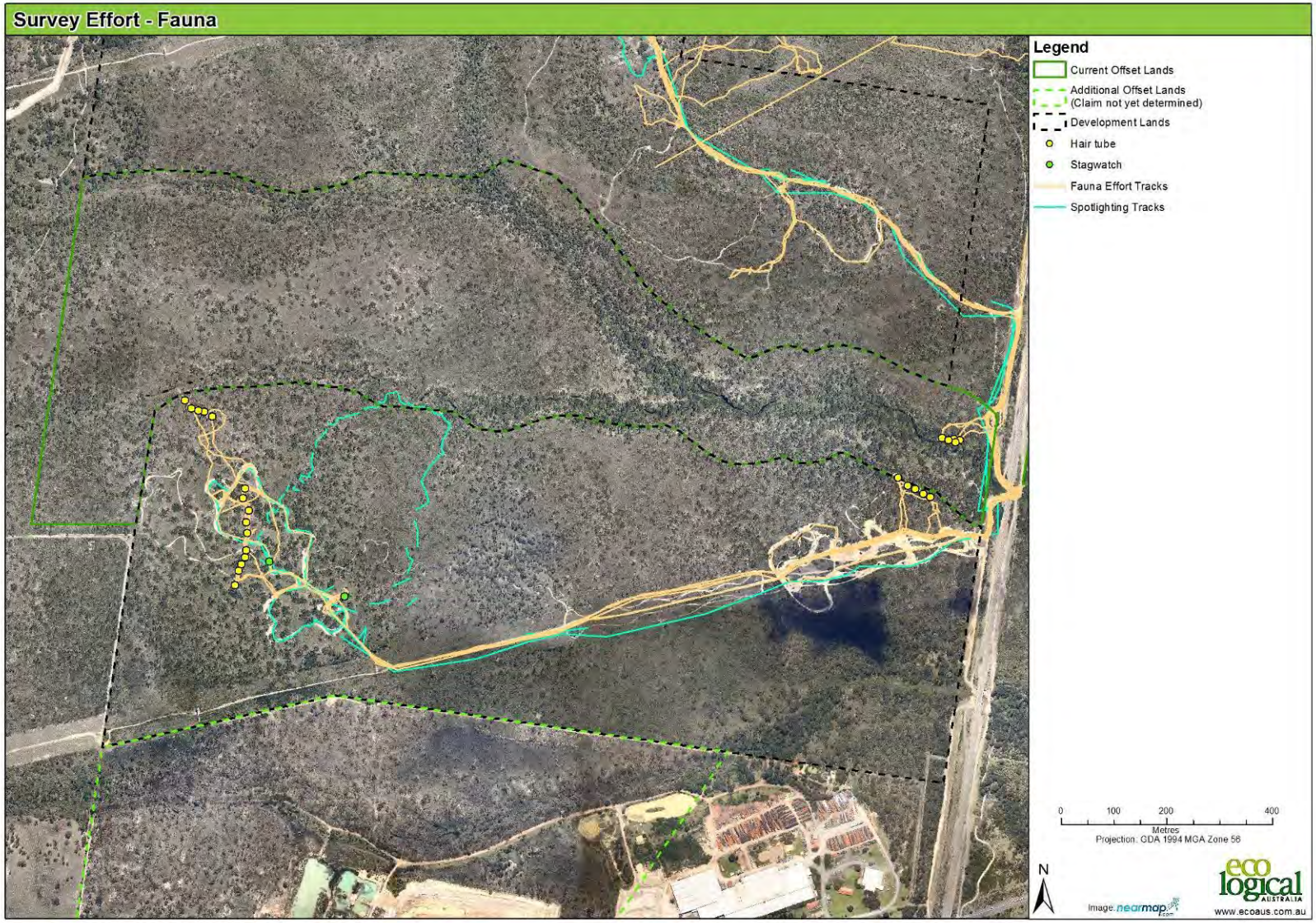

Figure 7: Fauna survey effort Bushells Ridge South proposed development precinct

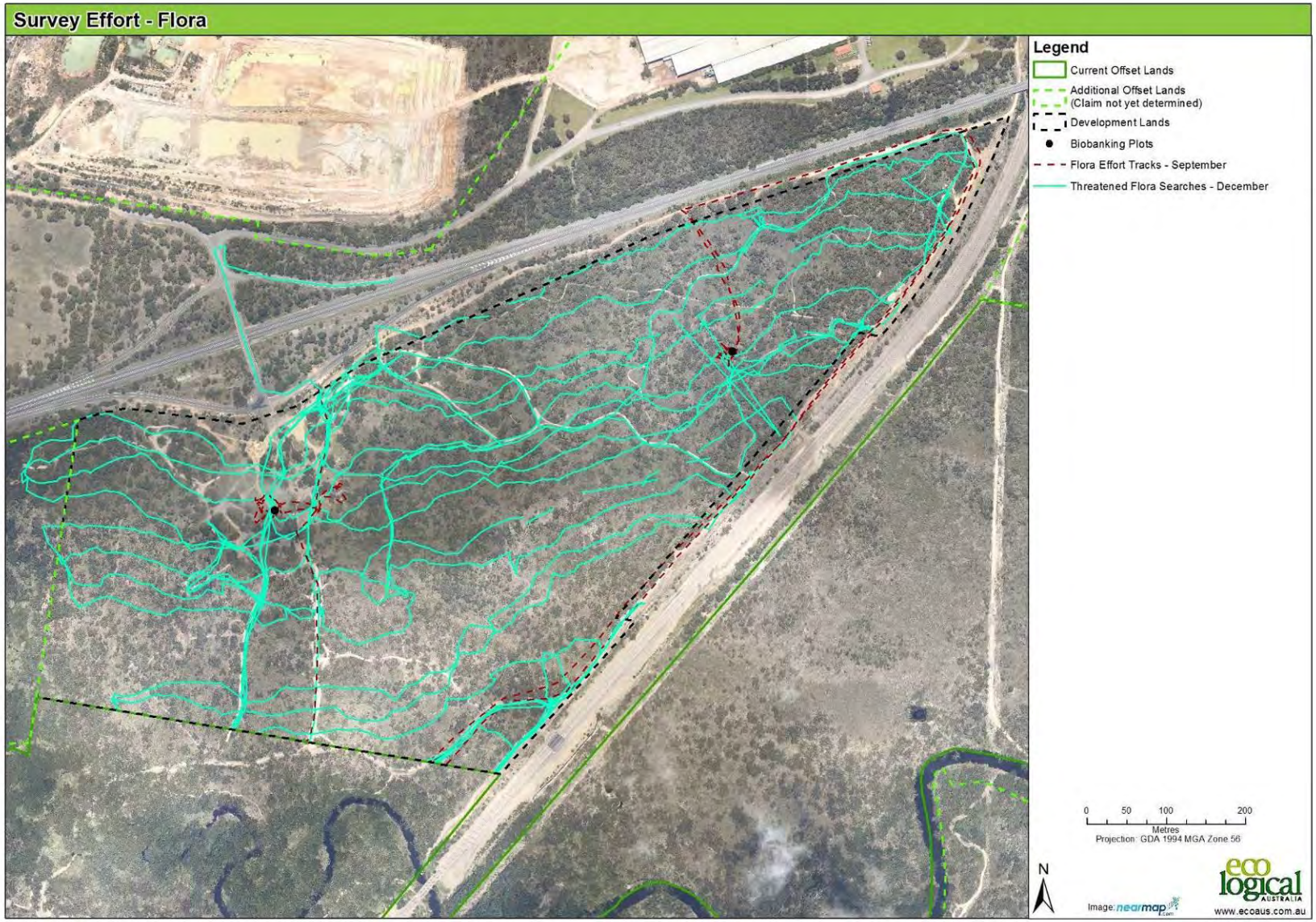

Figure 8: Flora survey effort Railcorp proposed development precinct

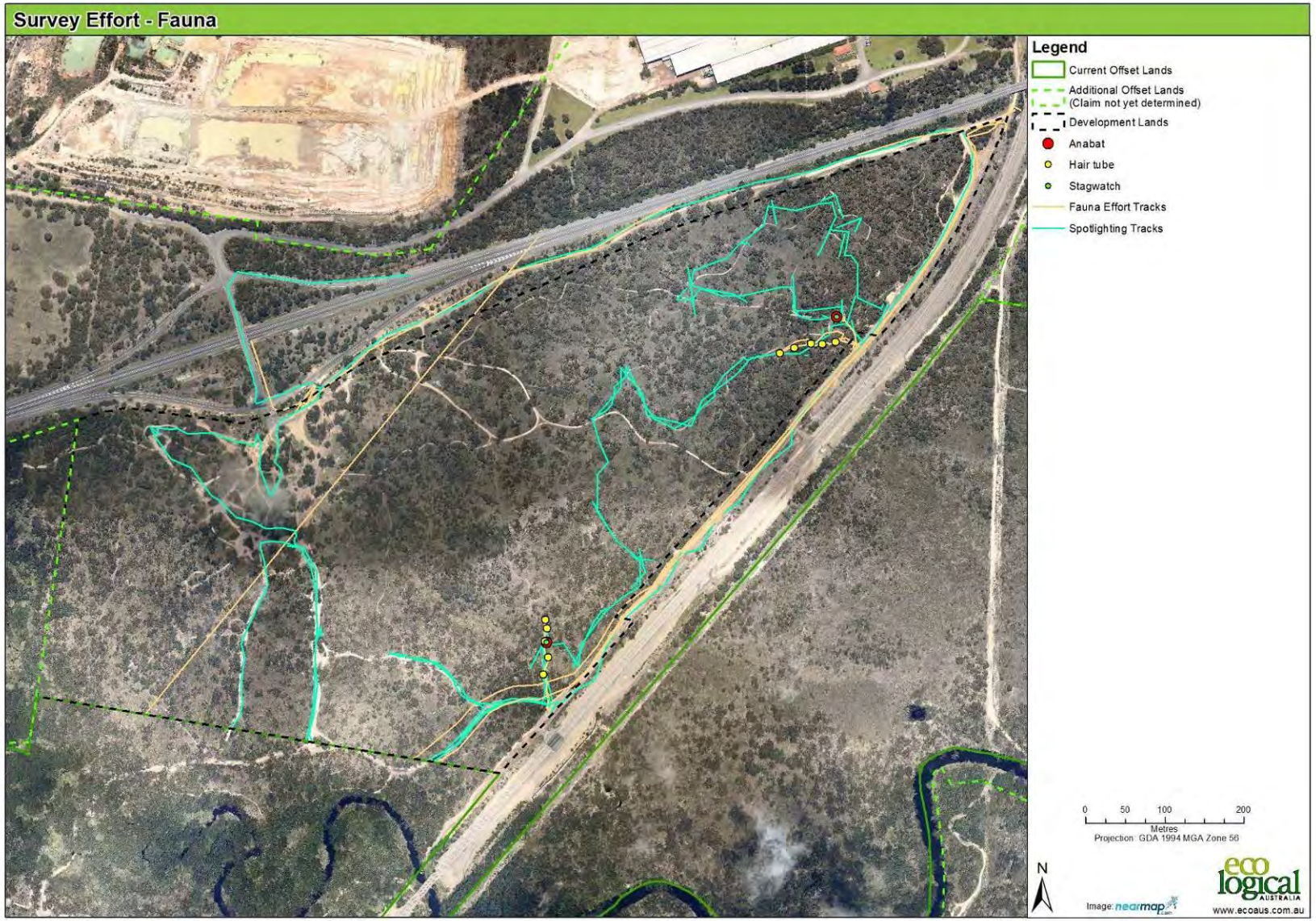

Figure 9: Fauna survey effort Railcorp proposed development precinct

Figure 10: Flora survey effort proposed offset lands 1

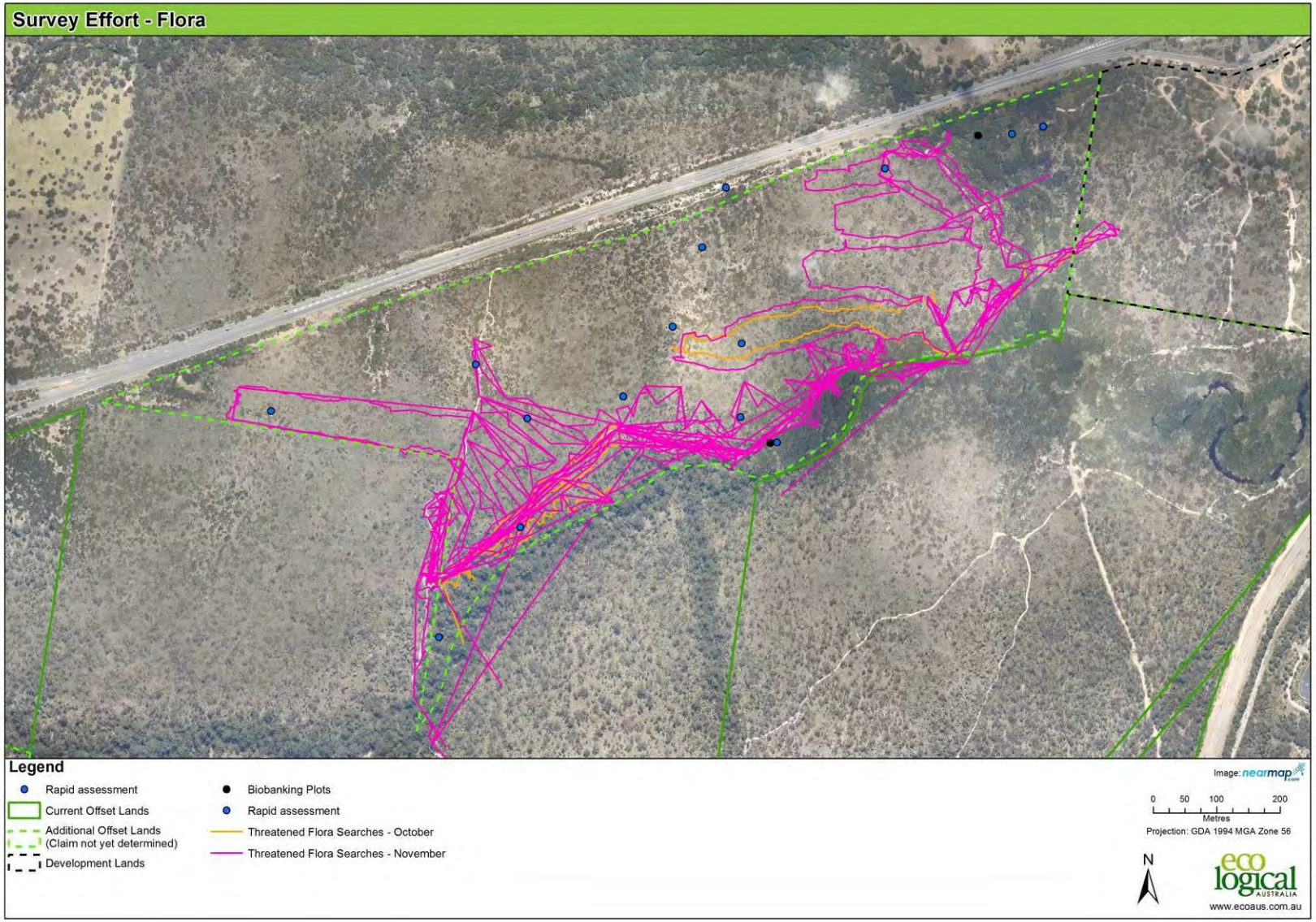

Figure 11: Flora survey effort proposed offset lands 3a

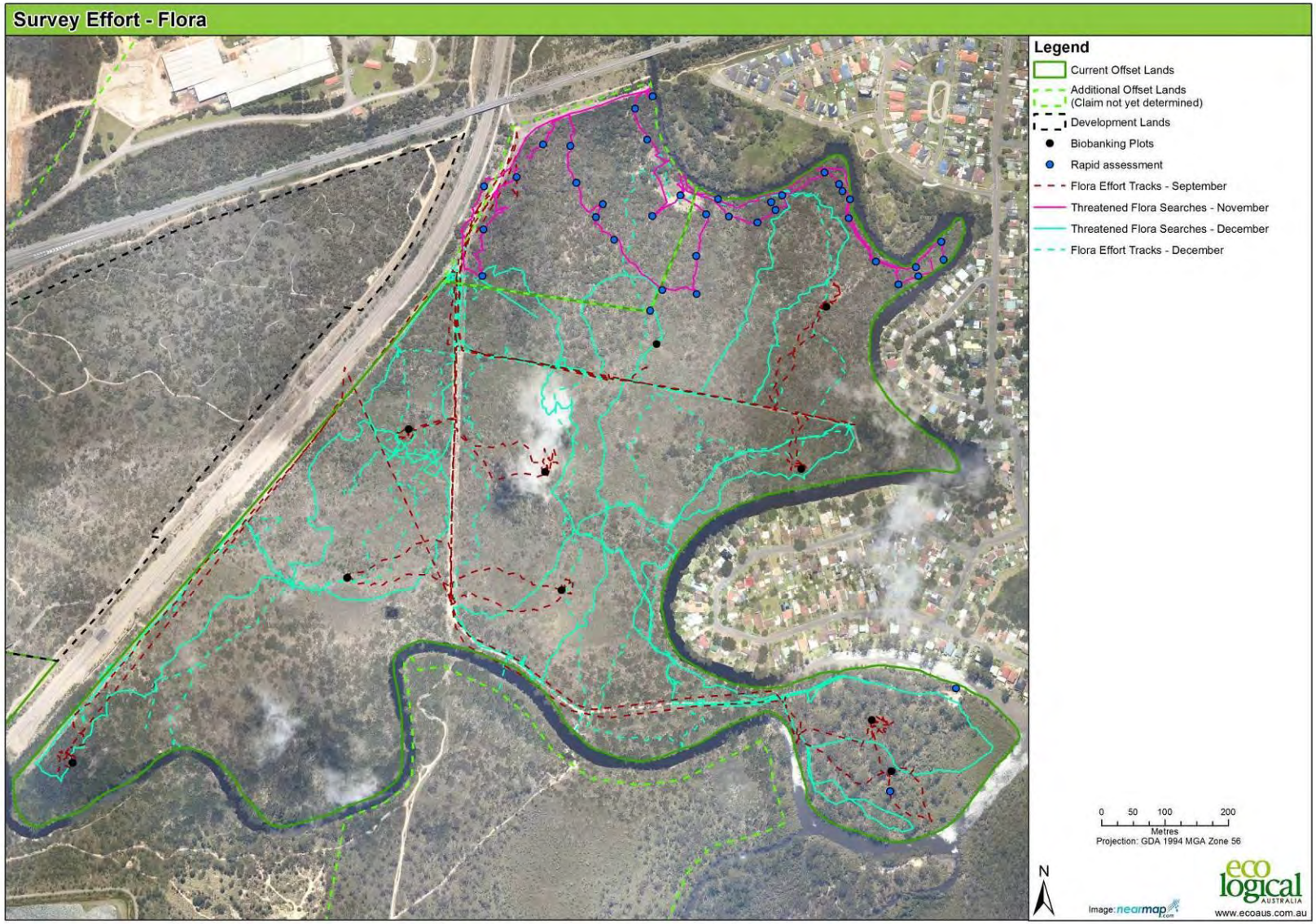

Figure 12: Flora survey effort proposed offset lands 4

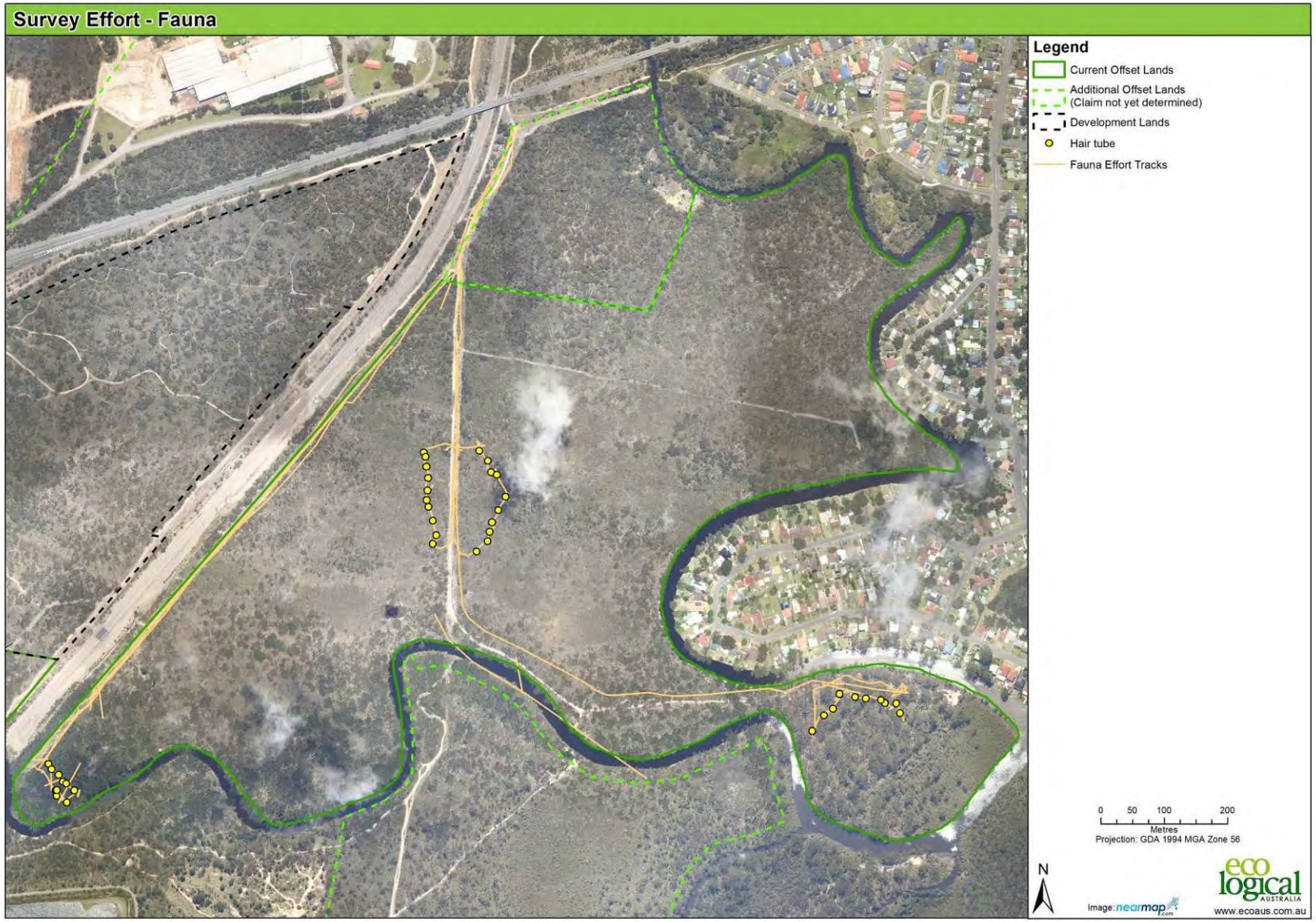

Figure 13: Fauna survey effort proposed offset lands 4

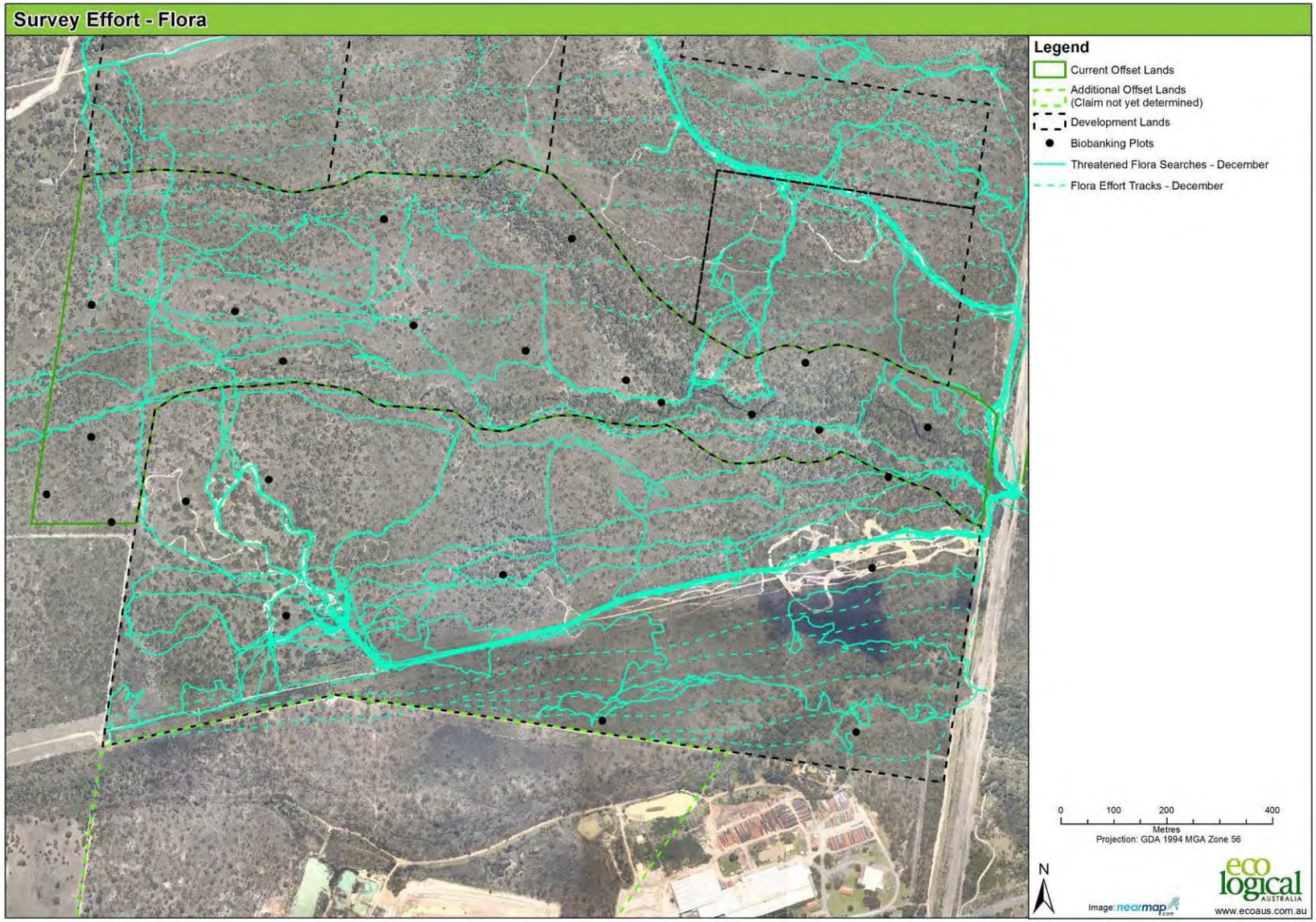

Figure 14: Flora survey effort proposed offset lands 5

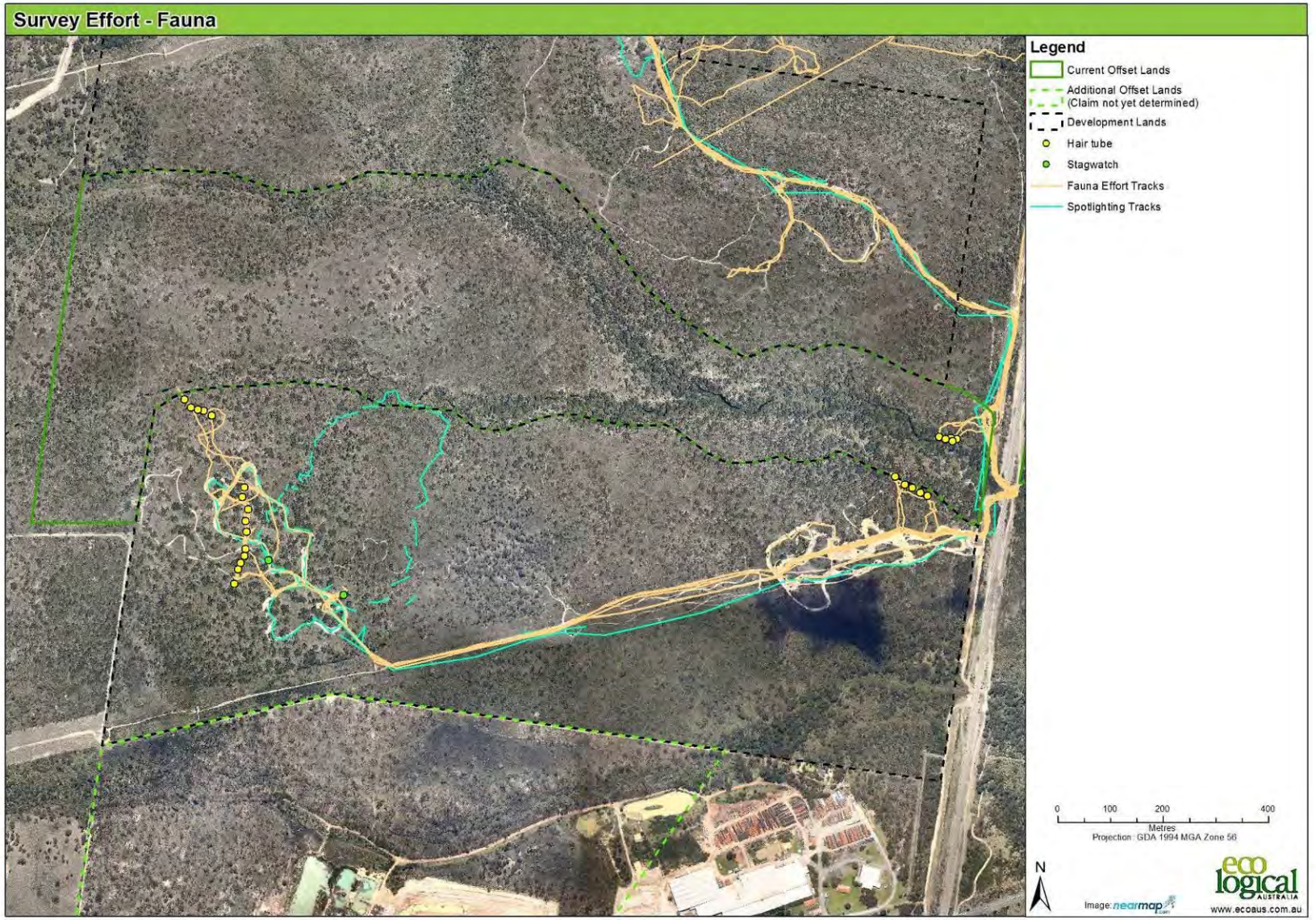

Figure 15: Fauna survey effort proposed offset lands 5

Figure 16: Flora survey effort proposed offset lands 7

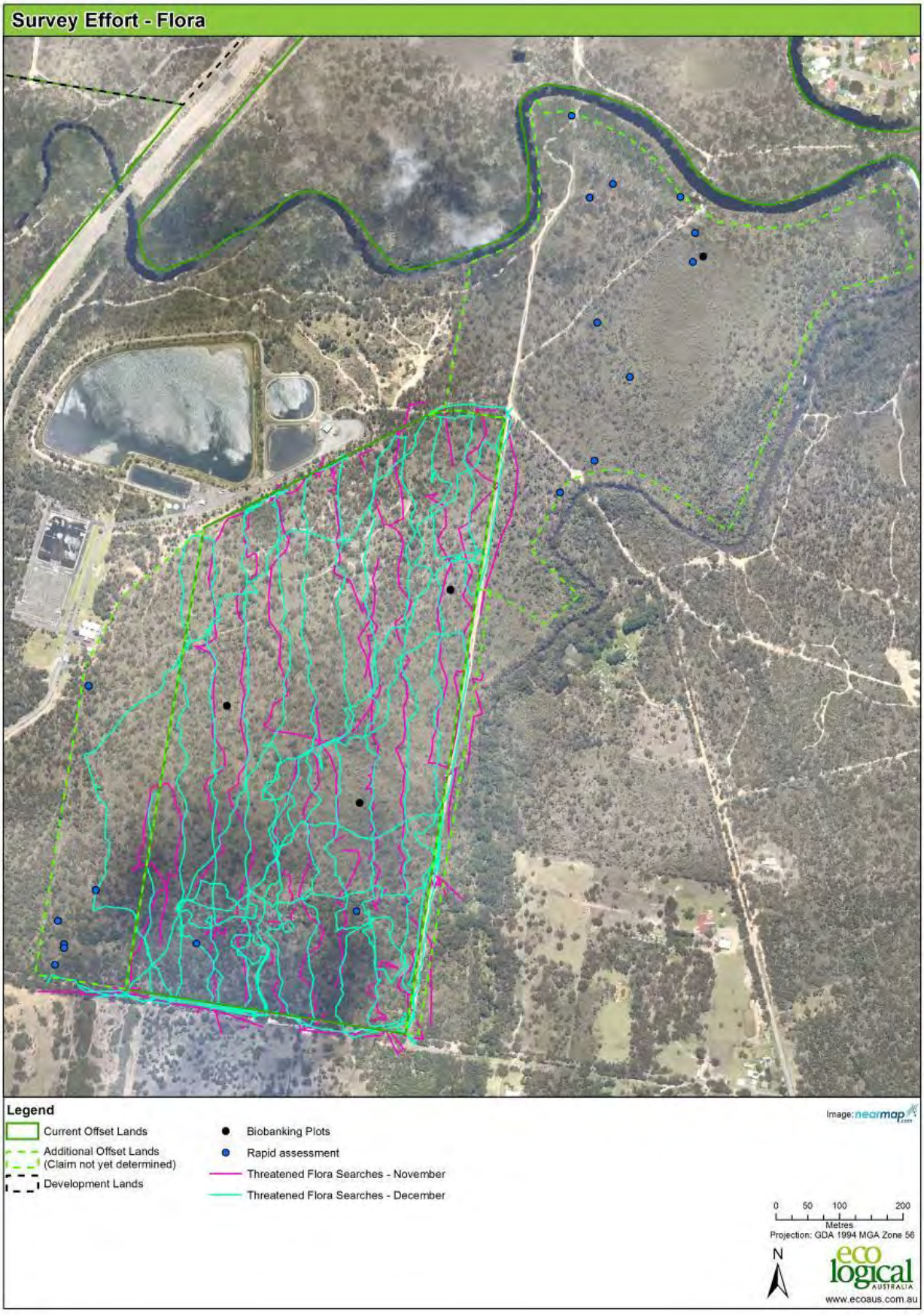

Figure 17: Flora survey effort proposed offset lands 2

Figure 18: Fauna survey effort proposed offset lands 2

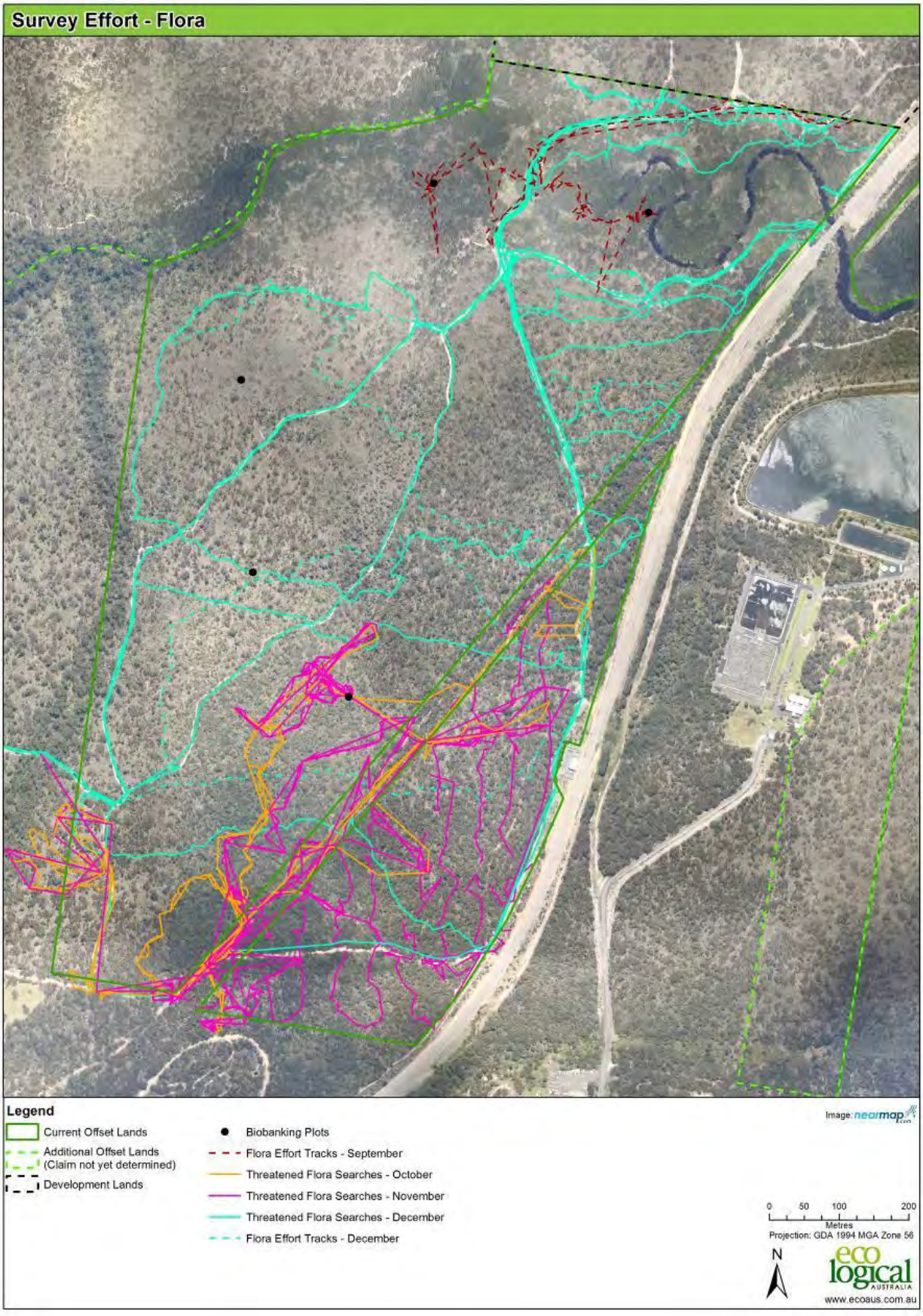

Figure 19: Flora survey effort proposed offset lands 3

Figure 20: Fauna survey effort proposed offset lands 3

Figure 21: Flora survey effort proposed offset lands 6

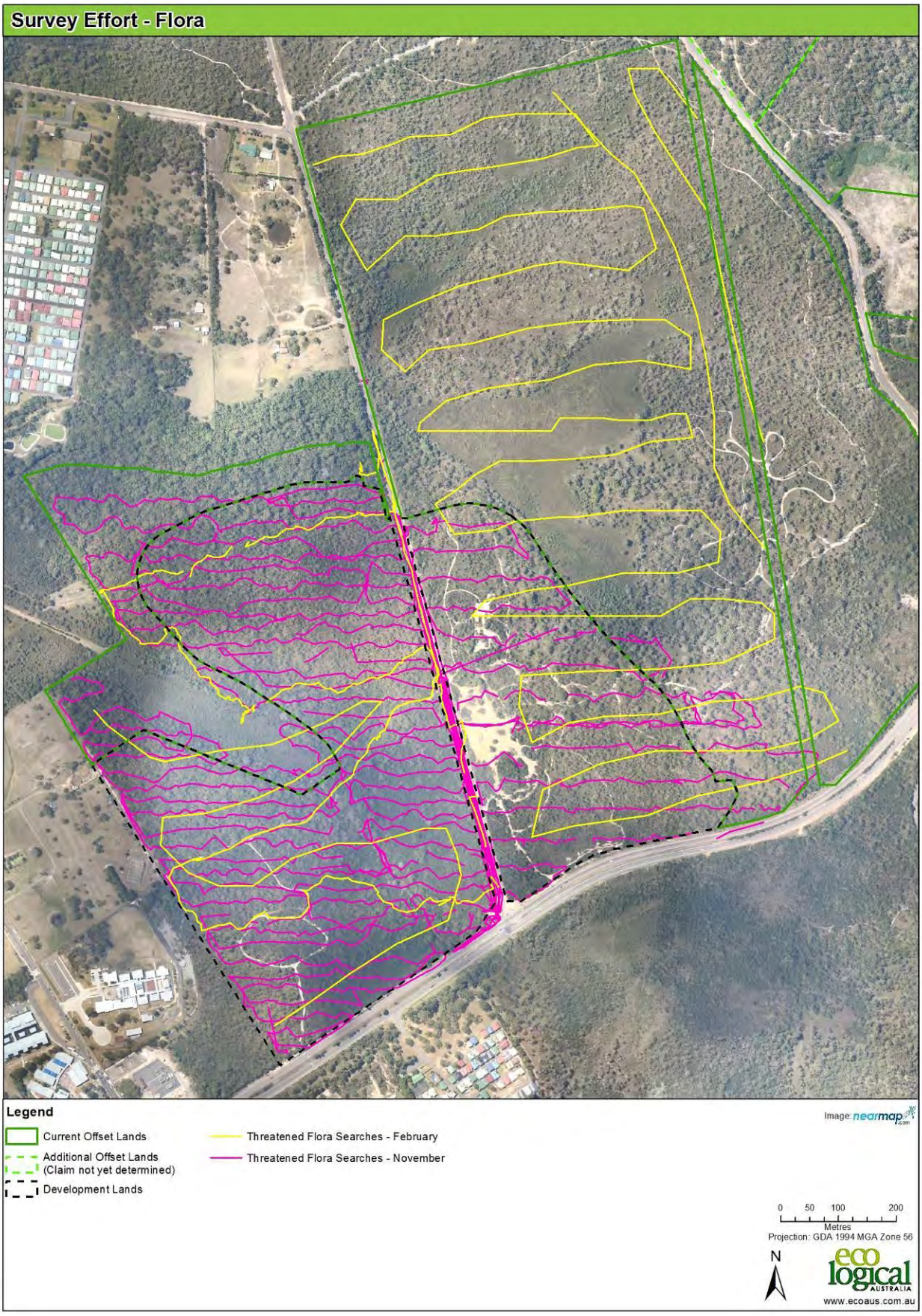

Figure 22: Flora survey effort proposed offset lands 8 & 9

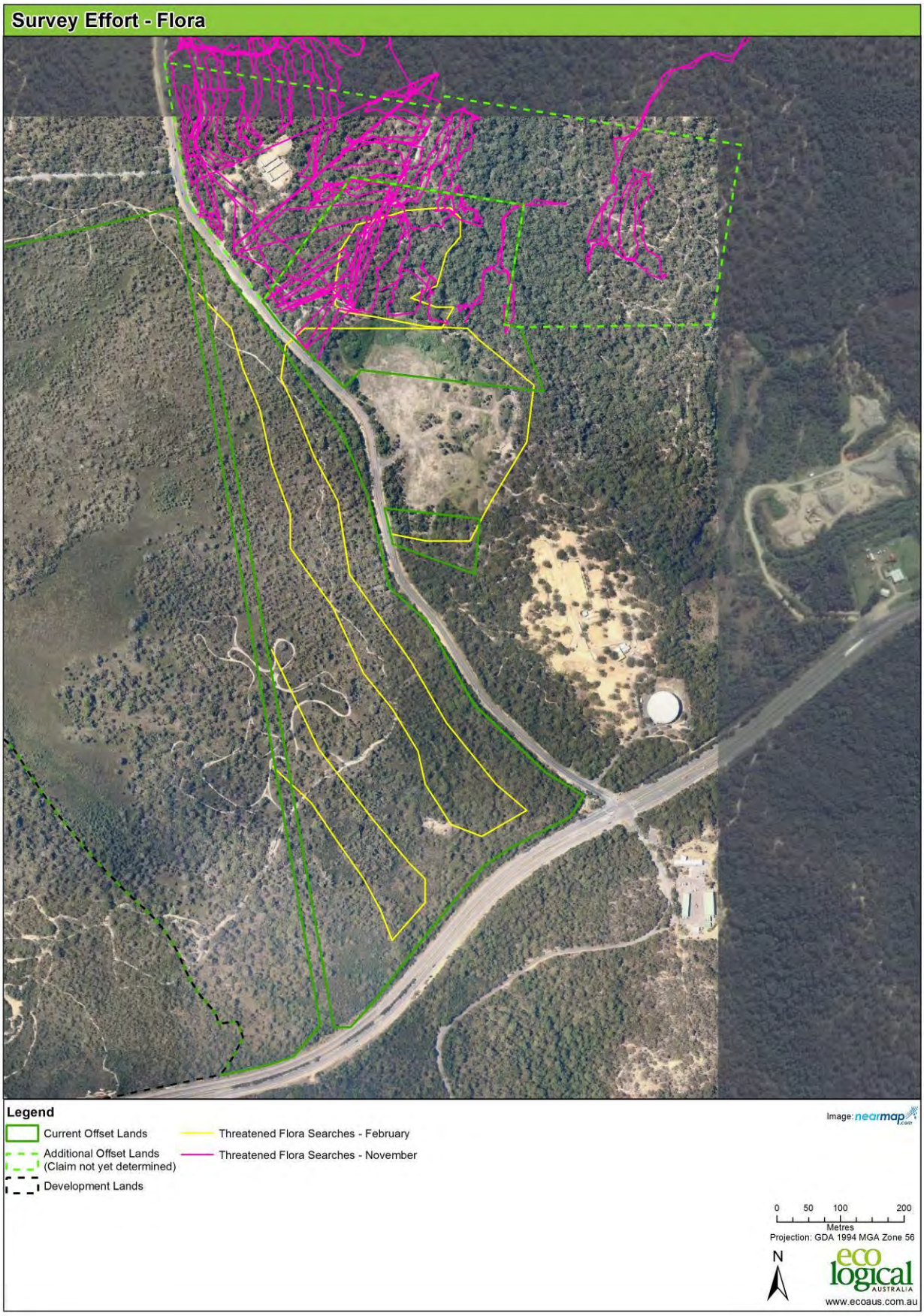

Figure 23: Flora survey effort proposed offset lands 10

Figure 24: Flora survey effort proposed offset lands 11 & 12

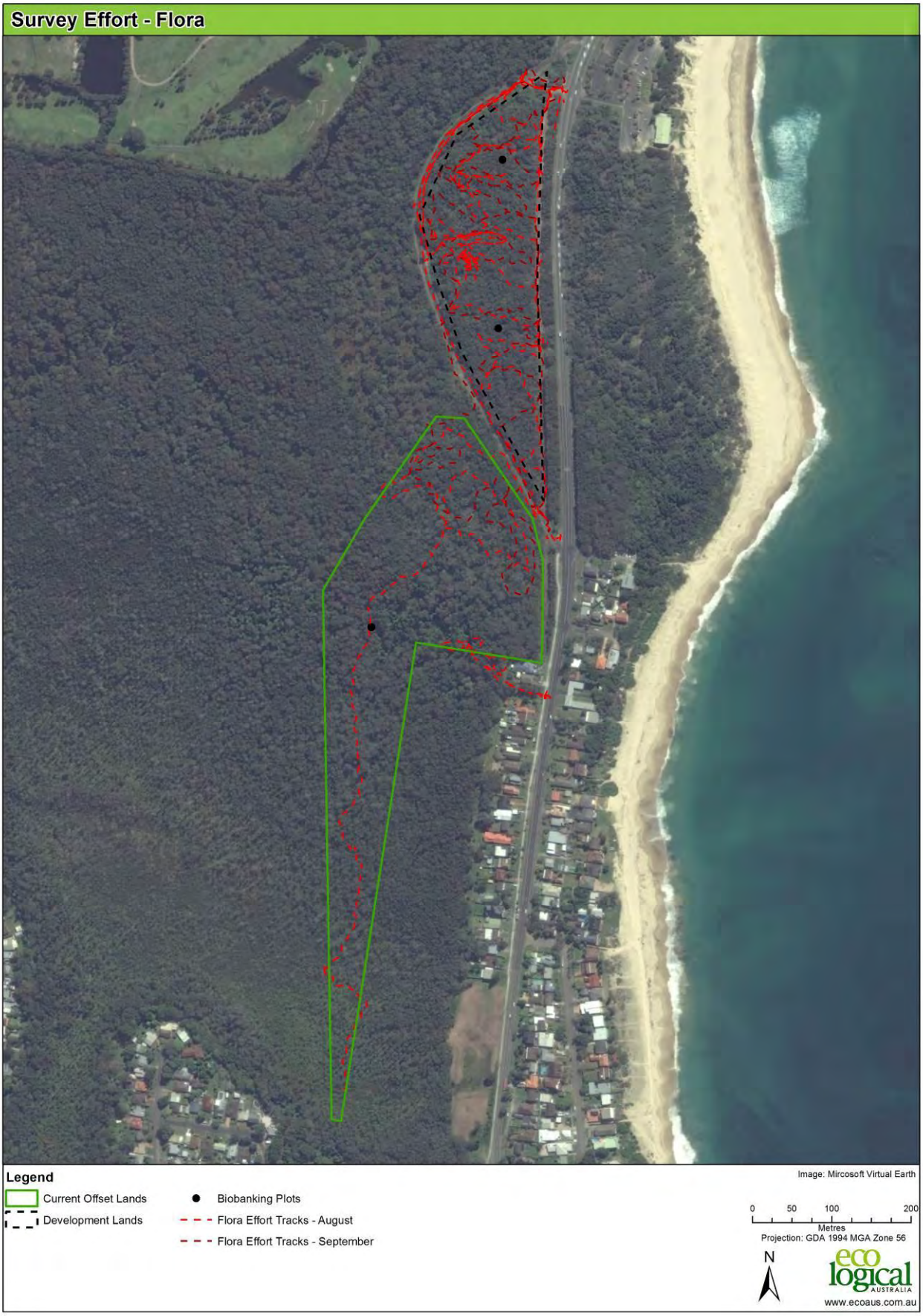

Figure 25: Flora survey effort proposed offset lands 13

Figure 26: Flora survey effort Norah Head proposed development precinct

Figure 27: Fauna survey effort Norah Head proposed development precinct