

# BIODIVERSITY VALUES ASSESSMENT REPORT

## STAGE 1 - BIODIVERSITY ASSESSMENT METHOD

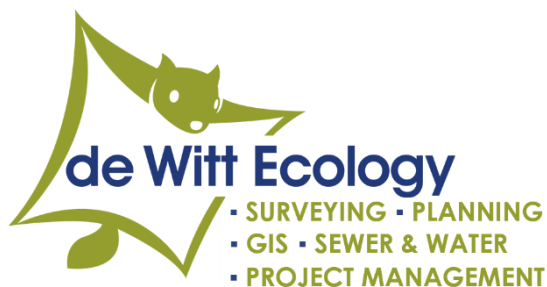
1, 18 & 51 BRICKWORKS ROAD, THORNTON



**CLIENT:** LION CIVIL/ NORTH THORNTON GROUP/ STEVENS GROUP

**DATE:** 16 July 2020

**PREPARED BY:**



ABN 94 638 012 003

7 Canberra Street Charlestown NSW 2290 | PO Box 850 Charlestown NSW 2290

87 Herbert Street Gulgong NSW 2852 | PO Box 232 Gulgong NSW 2852

02 4942 5441 | 02 6374 2911

admin@dewittconsulting.com.au

www.dewittconsulting.com.au

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## DECLARATION

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### Biodiversity Values Assessment – Stage 1 BAM

1, 18 & 51 Brickworks Road, Thornton

#### Report prepared by:

**Name** John Paul King

**Qualifications** Bachelor of Environmental Science

Bachelor of Applied Science

Biobanking Accredited Assessor

**Address** de Witt Ecology

7 Canberra Street

Charlestown NSW 2290

**Certification** I certify that I have prepared the contents of this report to the best of my knowledge:

- the document has been prepared in accordance with the *Biodiversity Conservation Act 2016*, Biodiversity Conservation Regulation 2017 and the Biodiversity Assessment Method (OEH, 2017);
- the contents of the BVA have been prepared in accordance with the legislation listed in Section 1.2 of this report;
- the document contains all available information that is relevant to the ecological assessment of the activity to which the document relates; and
- the information contained in the document is neither false nor misleading.



John Paul King

Principal Ecologist

de Witt Ecology

16 July 2020

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Revision	Date	Author	Reviewer
V01	01/01/2020	John Paul King	
V02	25/06/2020	John Paul King	Emma Mason
V03	16/07/2020	John Paul King	Marina Budisavljevic

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## 1.0 INTRODUCTION

This report presents the results of field surveys, data analysis, results, interpretation, a discussion of the results, concluding remarks and advice for the project described in Table 1.1. The conclusion within includes an assessment of the likely impacts of the rezoning on local biodiversity, and the commitments that the proponent must make to satisfy the consent authorities and stakeholders, and ultimately achieve a balanced outcome. To improve efficiencies for all parties, the report structure has been designed in a way that places all the heavy detailed data, discussions, and legislative requirements in the final section of the report called “supplementary material”. Our aim is to provide a succinct report that satisfies all but a few that need the extra detail to make decisions.

### 1.1 Site details

**Table 1.1 Description of project, relevant landscape features, data, resources, and mapping**

Feature	Size	Description	Supplementary data	Digital resource	Figure No.
<b>Location</b>	Thornton	Town		No	Figure 1.
<b>Proposal</b>	30.3ha	Commercial development plus infrastructure	Page 101	Yes (Shape,DXF)	Figure 2.
<b>Study area</b>	584 ha	Thornton and Metford Bushland not fragmented by major roads	Page 56	Yes (Shape,DXF)	Figure 2.
<b>Subject Site</b>	48.13 ha	Lot 1, 18, and 51 Brickworks Rd, Thornton	Page 56	Yes (Shape,DXF)	Figure 2.
<b>Development footprint</b>	40.208 ha	Lots and Infrastructure	Page 56	Yes (Shape,DXF)	Figure 2.
<b>General description of the site</b>	48.13 ha	Low rolling hills on Newcastle coastal ramp. Long disturbance history and brick pit and manufacturing facility	Page 56	No	Figure 2.
<b>Ibra region</b>	Na	Sydney Basin	Page 56	No	No
<b>Ibra sub-region</b>	461,000 ha	Hunter	Page 56	Yes (Shape,DXF)	No
<b>NSW Landscape region</b>	Na	Hunter Region	Page 56	Yes (Shape,DXF)	No
<b>Murphy's Landscape</b>	151,000ha	Newcastle Coastal Ramp	Page 56	Yes (Shape,DXF)	No
<b>Landscape native vegetation cover</b>	1262 ha	Hunter-Macleay Dry Sclerophyll Forests	Page 56	Yes (Shape,DXF)	Figure 3.
<b>Native vegetation-Study Area</b>	291 ha	Sclerophyll forests, Moist forests, and wetlands	Page 56	Yes (Shape,DXF)	Figure 1.
<b>Industrial and wastelands in Subject Site</b>	18.97 ha		Page 56	Yes (Shape,DXF)	Figure 4.



Feature	Size	Description	Supplementary data	Digital resource	Figure No.
<b>Original Landscape in Subject Site</b>	27.9 ha	Sclerophyll forests, Urban and infrastructure	Page 56	Yes (Shape,DXF)	Figure 5.
<b>Vegetation Cover Subject Site</b>	26.95 ha	Sclerophyll forests, wetlands, regenerating communities, and exotic	Page 56	Yes (Shape,DXF)	Figure 6.
<b>Native vegetation-Subject Site</b>	19.9 ha	Sclerophyll forests, regenerating communities, and wetlands	Page 56	Yes (Shape,DXF)	Figure 6.& 6.2
<b>Remnant mature native vegetation-Subject Site</b>	12.22 ha (25% of total area)	Sclerophyll forests	Page 56	Yes (Shape,DXF)	Figure 7 & 7.2
<b>Disturbed regenerating native vegetation- - Subject Site</b>	14.26 ha	regenerating communities, and wetlands		Yes (Shape,DXF)	Figure 8.
<b>Native vegetation retained in Development footprint</b>	6.76 ha	Sclerophyll forests		Yes (Shape,DXF)	Figure 9.
<b>Cleared Areas- Study Area</b>	462 HA	Urban, extraction, infrastructure, commercial and industrial	Page 56	Yes (Shape,DXF)	Figure 10.
<b>Cleared Areas- Subject Site</b>	21.65 ha	Extraction and infrastructure,	Page 56	Yes (Shape,DXF)	Figure 4.
<b>Cleared Areas-Development footprint</b>		Extraction and infrastructure,	Page 56	Yes (Shape,DXF)	Figure 4.
<b>Rivers Streams</b>		Four Mile Creek 20 m the west	Page 56	No	Figure 11.
<b>Wetlands</b>		In the catchment of Morpeth Swamp	Page 56	Yes (Shape,DXF)	Figure 12.
<b>Connectivity</b>		Linked to three other remnants			
<b>Geology</b>		Carboniferous conglomerate, lithic sandstone,			

## 1.2 Conservation and sustainability statutes consulted

Relevant legislation consulted and addressed in this report are detailed in Table 1.2.

**Table 1.2 Statutes addressed within report**

Legislation	Relevance	Report Section	Comments
<b>Environment Protection and Biodiversity Conservation Act 1999</b>	Matters of National Environmental Significance (MNES) are known to the local area and the habitats found on the site.	2.1 2.5 2.9 3.5	
<b>Environmental Planning and Assessment Act 1979 (EP&amp;A Act)</b>	Part 5 assessment		

<b>Biodiversity Conservation Act 2016</b>	Requires a BDAR report.
<b>Fisheries Management Act 1994 (FM Act)</b>	No Key Fish Habitat, no harm to marine vegetation, dredging, reclamation or obstruction of fish passage
<b>Local Land Services Amendment Act 2016</b>	Does not apply
<b>Water Management Act 2000</b>	No works on waterfront land.
<b>SEPP 14 – Coastal Management</b>	The site does not include any lands identified mapped under this SEPP.
<b>Koala Habitat Protection SEPP</b>	The site is mapped as koala habitat. Addressed within.

## 2.0 METHODS

### 2.1 Surveys

Field surveys were undertaken by the AEP during 2018, 2019 and 2020. Additional surveys for habitat models and vegetation mapping were undertaken in June 2020 by the author. All targeted species surveys were undertaken during ideal weather conditions and season (See supplementary material for all methods and analysis). A summary of the methods and timing of surveys can be seen in Table 2.1.

**Table 2.1 All field survey methods undertaken**

Table 2.1 All field survey methods undertaken				
Method		Number	Purpose	Timing
Floristic data	Rapid point floristic vegetation plots	15	For initial PCT and condition assignment for determining number of plots	Not undertaken
	Floristic vegetation and vegetation integrity plots	8	Species composition, PCT and condition classes and vegetation integrity	13th May 2020 14th May 2020 26 <sup>th</sup> September 2019 27 <sup>th</sup> September 2019 9 <sup>th</sup> June 2020 10 <sup>th</sup> June 2020 11 <sup>th</sup> June 2020
	Assessment of changes in vegetation	2	2m side walking transects and conjunction of review of aerials	13th May 2020 14th May 2020 26 <sup>th</sup> September 2019 27 <sup>th</sup> September 2019 9 <sup>th</sup> June 2020 10 <sup>th</sup> June 2020 11 <sup>th</sup> June 2020
	PCT descriptive data collection	8	Within above plots and transects data is collected on associations that assist PCT classification and selection	13th May 2020 14th May 2020 26 <sup>th</sup> September 2019 27 <sup>th</sup> September 2019 9 <sup>th</sup> June 2020 10 <sup>th</sup> June 2020 11 <sup>th</sup> June 2020
	Growth form, Condition, Structure data	8	Nested plots and integrity plots used to determine growth form groups, condition and function	13th May 2020 14th May 2020 26 <sup>th</sup> September 2019 27 <sup>th</sup> September 2019 9 <sup>th</sup> June 2020 10 <sup>th</sup> June 2020 11 <sup>th</sup> June 2020
	Cover, species richness and Abundance data	8	Quantitative data in whole number and percentage terms.	13th May 2020 14th May 2020 26 <sup>th</sup> September 2019 27 <sup>th</sup> September 2019 9 <sup>th</sup> June 2020 10 <sup>th</sup> June 2020 11 <sup>th</sup> June 2020
	Species name and weeds	15	Scientific and Common names and status for all species, including weeds.	13th May 2020 14th May 2020 26 <sup>th</sup> September 2019 27 <sup>th</sup> September 2019 9 <sup>th</sup> June 2020 10 <sup>th</sup> June 2020 11 <sup>th</sup> June 2020

Method	Number	Purpose	Timing
Non-native vegetation cover plots	15	Nested data recording quantitative data on non-vegetation cover	13th May 2020
			14th May 2020
			26 <sup>th</sup> September 2019
Function Plots	15	Ecological services and contextual data	27 <sup>th</sup> September 2019
			9 <sup>th</sup> June 2020
			10 <sup>th</sup> June 2020
Rapid Data Points	86	Habitat quality, disturbance history and habitat models	11 <sup>th</sup> June 2020
Threatened biodiversity	Tree Hollow data walking transects	Fauna habitat models	26 <sup>th</sup> June 2020
			27 <sup>th</sup> June 2020
	Threatened flora walking transects	To establish occupancy by targeted threatened species	28 <sup>th</sup> June 2020
			19 <sup>th</sup> March 2019
			19 <sup>th</sup> November 2019
			13th May 2020
			14th May 2020
			9 <sup>th</sup> June 2020
			10th July 2018
			9 <sup>th</sup> August 2019
22 <sup>nd</sup> August 2019			
26th August 2019			
29th August 2019			
26 <sup>th</sup> September 2019			
27 <sup>th</sup> September 2019			
22nd October 2019			
23rd October 2019			
19 <sup>th</sup> November 2019			
28 <sup>th</sup> November 2019			
10 <sup>th</sup> December 2019			
18th December 2019			
19th December 2019			
Species relevant data, i.e. winter flowering plants	15 (plots)	Fauna habitat models	None undertaken
Targeted surveys for threatened species with habitat in the study area	Bird Surveys Camera surveys Nocturnal surveys Anabat surveys Amphibian surveys Owl surveys	To establish occupancy by targeted threatened species	19 <sup>th</sup> March 2019
			18 <sup>th</sup> June 2019
			1 <sup>st</sup> July 2019
			18 <sup>th</sup> July 2019
			26 <sup>th</sup> August 2019
			29th August 2019
			18th December 2019
			19th December 2019
			07th January 2020
			16th January 2020
17th January 2020			
28 <sup>th</sup> January 2020			
10 <sup>th</sup> February 2020			
13 <sup>th</sup> May 2020			

## **2.2 Analysis of multivariant quantitative ecological data for classification, cover and species richness**

Floristic and environmental data collected in the 21 plots were analysed to identify dissimilarities between sample sites to highlight florist and structural differences that can be used to assign PCT's to the plots and develop a vegetation community map and condition zones for the study area. The location for all sample plots was determined by random number generation in GIS within broadly stratified vegetation units (e.g. Forest vs. Grassland) using rapid point floristic vegetation plots (See Table 1).

Once established all the data (as shown in Table 1) was collected and used for the analysis. Classification of communities and analysis of environmental data was undertaken using the coding environment of Anaconda -Python 2.7 (libraries- Pandas, numpy, matplotlib, seaborn, scikit-learn, and scipy.stats). Firstly, a matrix scatterplot was created to identify autocorrelation issues, further investigation of these correlations was explored with two variables only. Multidimensional scaling was used to look for groupings and finally ordination and analysis of similarities was used to produce confidence intervals. Condition classes are determined by analysis of dissimilarity using informative species in the analysis. These groupings and classifications were further used to compare with PCT and Endangered Ecological Community listings.



### 3.0 RESULTS

The study area is part of a larger habitat matrix that extends from The New England Highway in the south to Morpeth in the North and Woodberry in the east to East Maitland in the west. Beyond this, the study area is connected further to regional scale habitats, forming important corridors for biodiversity. Specifically, the study area has three structural links with immediate patches and 15 links to the wider matrix (i.e. Hunter region). Figure 2 shows the results of GIS analysis of these habitat and shows the study area contains 15% of the available habitat in this matrix. By comparison, the subject site and development footprint are 10% and 3% respectively.

Within the subject site two 3<sup>rd</sup> order streams drain in a northerly direction on the western boundary (See Figure 11). These ephemeral creeks have shallow banks and, in many places, lack definite creek line corridor vegetation, there is evidence of disturbance causing depressions and overbank flows, however wetlands were absent.

Native vegetation is the dominant vegetation form in the study area. In total, five Plant Community Types (PCT's) were recorded in the study area, including Spotted Gum Ironbark Forest, Forest Red Gum Forest a Smooth Barked Apple Forest and a small area of Freshwater Wetland. Of these, three condition classes were found. Refer to Table 3 for more details on communities and Table 3.1a & b for details on condition.

**Table 3. Vegetation communities recorded onsite**

Vegetation class	Status	PCT name	Area(ha)	Synomon	Comments
Vegetation communities	Common				
	Threatened	PCT 1598 – Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.13	Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	11
			1.64		
			0.67		
			0.34		
			0.31		
			0.21		
			0.12		
	Threatened	PCT 1600 – Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter;	0.31	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion (EEC)	11
			0.09		
			0.51		
		PCT 1592 - Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	0.957	Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion (EEC)	11
			0.869		
			0.755		
			0.736		
			0.718		
			0.671		
			0.624		
			0.549		
			0.464		
			0.372		
			0.321		
			0.268		
			0.230		
			0.193		
			0.180		

Vegetation class	Status	PCT name	Area(ha)	Synomon	Comments
			0.177 0.164 0.143 0.122 0.106 0.096 0.089 0.085 0.083 0.061 0.053 0.026 0.017 0.013 0.012 0.010		
		PCT 1618 – Smooth-barked Apple - White Stringybark - Red Mahogany – Melaleuca sieberi shrubby open forest on lowlands of the lower North Coast;	0.07	none	
	Native	PCT 1071 - Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	0.199	Sydney Freshwater Wetlands in the Sydney Basin Bioregion	
	weed risk (low)	Non-native grasses	6.2		
Non-native	weed risk (high)	Lantana, Pampas grass, Crofton Weed, Whiskey Grass	14.7		
	Man made	Roads and tracks	2.4		
	Developed	Urban	0.76		
	Industrial	Disused Pit and associated infrastructure	6.2		

### 3.1 Classification of PCT's

The classification of vegetation recorded on site into Plant Community Types (PCT's) was achieved by following government guidelines for classification and a review of publications relevant to the study area (for further details see the supplementary material). In total, 5 PCT's were recorded onsite, having 4 condition classes (Figure 6 and 6.2).

#### *Vegetation condition classes*

Vegetation community condition is described by applying vegetation condition classes to vegetation units on the subject site. There are 6 classes described by the Bradley Method, refer to Table 3.1a overleaf.

The vegetation units identified during this survey were assigned classes based on these characteristics, these are shown in Table 3.1a overleaf.

**Table 3.1a Vegetation Condition**

Class	Description
<b>Very Good</b>	Near natural condition with few weeds. Canopy in good health, little evidence of edge effects. Nearly full range of expected component plants.
<b>Good</b>	Vegetation in good condition but with some weeds evident and degradation processes evident. Almost full range of expected component species.
<b>Moderate</b>	Vegetation in reasonable condition with weeds common, evidence of degradation processes common. Some canopy dieback maybe evident. About 40-70% of expected component species are present.
<b>Poor</b>	Vegetation in poor condition with weeds common, and evidence of degradation processes common. Canopy dieback of mature trees is often evident. About 20-50% of expected component species are present.
<b>Very Poor</b>	Vegetation in a very poor condition with weeds abundant, and evidence of degradation processes widespread. Canopy dieback of mature trees is often common. About 10-30% of expected component species are present
<b>Non-Existent</b>	Little natural vegetation remains. Few scattered trees and understorey plants remain. Mostly highly disturbed and 75-95% of component species missing.

Table 3.1b outlines the PCT's onsite, their respective condition and representation onsite.

**Table 3.1b Preliminary PCT's classified onsite and determined condition classes**

PCT No.	PCT name	Condition Classes	
<b>PCT 1598</b>	<b>Forest Red Gum grassy open forest on floodplains of the lower Hunter</b>		
	<i>Description</i> Open forests with a canopy dominated by <i>Eucalyptus tereticornis</i> . The mid-storey consists of an open shrub layer. The ground layer is dominated by grasses with sparse graminoids and forbs. Open forests with a canopy dominated by <i>Eucalyptus tereticornis</i> . The mid-storey consists of an open shrub layer. The ground layer is dominated by grasses with sparse graminoids and forbs.	Very Poor	✓
		Poor	✓
		Moderate	✓
		Good	
		Very Good	
<b>PCT 1592</b>	<b>Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter</b>		
	<i>Description</i> Open forests dominated by <i>Corymbia maculata</i> ; <i>Eucalyptus fibrosa</i> . The mid-storey is typically shrubby with sparse climbers. The ground storey is dominated by grasses with scattered forbs. Mainly restricted to the lower Hunter Valley.	Very Poor	✓
		Poor	✓
		Moderate	✓
		Good	
		Very Good	
<b>PCT 1600</b>	<b>Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter</b>		
	<i>Description</i> Open forests with a canopy dominated by <i>Corymbia maculata</i> . The mid-storey consists of an open shrub layer. The ground layer is predominately grassy with various graminoids; forbs and small ferns. Restricted to the lower Hunter Valley.	Very Poor	✓
		Poor	✓
		Moderate	✓
		Good	
		Very Good	
<b>PCT 1618</b>	<b>Smooth-barked Apple - White Stringybark - Red Mahogany – Melaleuca sieberi shrubby open forest on lowlands of the lower North Coast</b>		
	<i>Description</i> Open forests characterised by an overstorey dominated by <i>Angophora costata</i> . The mid-storey is typically shrubby with a range of tall shrubs and small trees as well as diverse smaller shrubs. The ground layer is dominated by grasses along with numerous graminoids and forbs. Low coastal hills of the lower North Coast and Central Coast; mainly on sandy substrates.	Very Poor	
		Poor	✓
		Moderate	
		Good	
		Very Good	
<b>PCT 1071</b>	<b>Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion</b>		
	<i>Description</i> <i>Phragmites australis</i> and <i>Typha orientalis</i> coastal freshwater wetlands of the Sydney Basin Bioregion. Man-made water bodies, drainage lines and depressions across a wide variety of environments. Includes modified former wetlands such as Hexham Swamp. Occurs also in original form in wide variety of situations associated with coastal plains, valleys, lagoons and other sites of poor drainage.	Very Poor	
		Poor	✓
		Moderate	
		Good	
		Very Good	

**PCT 1598- Forest Red Gum grassy open forest on floodplains of the lower Hunter**

Open forests with a canopy dominated by *Eucalyptus tereticornis*. The mid-storey consists of an open shrub layer. The ground layer is dominated by grasses with sparse graminoids and forbs. Open forests with a canopy dominated by *Eucalyptus tereticornis*. The mid-storey consists of an open shrub layer. The ground layer is dominated by grasses with sparse graminoids and forbs.



**Plate 1.** Along the Southern Boundary (151.626505, -32.771976) this area consists of large (>14m) red gums, there are areas of high level of Lantana infestation, and areas of grasses and shrubs.





**Plate 2.** In other localities (151.625818, -32.770877), this community is regenerating on wasteland and industrial landscapes. In this example Reg gums are growing over coal fines, bricks and other land fill areas. Given the geological instability, poor quality soils and waste, it is unclear if these communities could reach maturity or have resilience.





**Plate 3.** There are examples of this community within the disused pit areas (151.623971, -32.768678) where it grows on a fine layer of clay or bedrock. This area is poor draining and likely anoxic at times.





**Plate 4.** This area (151.627879, -32.772846) is large patch of young forest on the southern boundary. A more diverse community than other patches, in parts of this area, the vegetation could be a derivative of Spotted Gum Ironbark community recovery form past clearing.





**Plate 5.** As above plate 4 example



***PCT 1592 Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter***

Open forests dominated by *Corymbia maculata*; *Eucalyptus fibrosa*. The mid- storey is typically shrubby with sparse climbers. The ground storey is dominated by grasses with scattered forbs. Mainly restricted to the lower Hunter Valley.



**Plate 6.** This community onsite is growing on remnant landscape areas, such as this example (151.626643, -32.768220) and on mounded and excavated areas. Open grassy understorey with areas of shrubs. This area has a lower level of weeds and die back than other patches





**Plate 7.** Another higher quality example of this community onsite (151.628169, - 32.768526). This example is within the proposed corridor. Large (>500DBH) Red Ironbark and Spotted gum, with co-dominates of Grey gum and Mahogany.





**Plate 8.** This patch is of similar age to plate 7, however agricultural and land management practices have removed habitat structure and diversity. Die back on mature trees is more evident and are more open canopy cover.





**Plate 9.** This area is located within the proposed corridor (151.628872, -32.772449). Diverse shrub cover and native grasses. Immature and regen trees and well as mature. Low level of die back recorded.





**Plate 10.** This area has a small number of Spotted gums regenerating on benched slopes on pit area cliff faces (151.630612, -32.772297). Mostly native shrubs and forbs with small cover of weeds. Trees are small (4m) and only have 5% cover.





**Plate 11.** As example plate 10 above; looking south.





**Plate 12.** This area is in the north western of the site (151.624093, -32.766907). This area is on remnant landscapes and shrub cover is dominated by weeds. Diversity is lower than that in plate 6 and 7, however tree age and health is similar.





**Plate 13.** Within the pit area there are examples where historical fill and earthmoving have created uneven disturbed grounds with moderate soil fertility (151.623864, - 32.767426). Within these areas, conditions are conducive to the natural regeneration of Spotted gum Ironbark communities. In some localities there is increased cover of Lantana and Pampas grass (lower wetter areas).





**Plate 14.** Across the site it is not uncommon to find industrial areas such as shown in this plate. This area of hardstand and guttering is located within a forest remnant (151.627162, -32.769258). These types of habitats cannot develop to mature native communities and have low habitat value.





**Plate 15.** This example is of the most mature trees onsite (151.625742, -32.767594), however within the urban area of the site. Managed ground layer, lack of natural succession and evidence of dieback in mature trees.





**Plate 16.** This example again shows the Lantana cover and poor diversity of some patches. (151.623543, -32.767564).



***PCT 1600 Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter***

Open forests with a canopy dominated by *Corymbia maculata*. The mid-storey consists of an open shrub layer. The ground layer is predominately grassy with various graminoids; forbs and small ferns. Restricted to the lower Hunter Valley.



**Plate 17.** This community is closely related to the above community and some examples onsite may be derivatives of that community, impacted by past clearing, pit-propping, and fencing. (151.630399, -32.768541). This example is poor quality with grazing and clearing evident.





**Plate 18.** An example of this community growing on mounded barrier to pit area. Also, likely a derivative of previous community. (151.627177, -32.768892).



***PCT 1618 Smooth-barked Apple - White Stringybark - Red Mahogany –  
Melaleuca sieberi shrubby open forest on lowlands of the lower North Coast***

Open forests characterised by an overstorey dominated by *Angophora costata*. The mid-storey is typically shrubby with a range of tall shrubs and small trees as well as diverse smaller shrubs. The ground layer is dominated by grasses along with numerous graminoids and forbs. Found on low coastal hills of the lower North Coast and Central Coast; mainly on sandy substrates.



**Plate 19.** This community is a regenerating disturbed area that is growing over sandy soils that may be the result of pit operations. Historically, this community was likely affiliated with the Spotted gum communities and changes to soils and clearing have favoured the regeneration of Smooth-barked apples over Spotted gum. However, it must be noted that there are less than 20 small Smooth-barked apples trees in total.





**Plate 20.** Typical representation of this community (151.628475, -32.772098).



***PCT 1071 Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion***

*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion. Man-made water bodies, drainage lines and depressions across a wide variety of environments. Includes modified former wetlands such as Hexham Swamp. Occurs also in original form in wide variety of situations associated with coastal plains, valleys, lagoons and other sites of poor drainage.



**Plate 21.** At the lowest elevation of the disused pit area, semi-permanent ponding has resulted in the development of wet areas supporting range of native wetland species. These associations have similarities with this community.





**Plate 22.** With the pit area there are poor draining boggy areas with conditions that support a low number of sedges, rushes and other wetland plants (151.626673, - 32.770862).



## Weeds



**Plate 23.** Mounded bunds onsite have a high cover of weeds including Lantana.





**Plate 24.** As the above example. (151.625467, -32.768113).





**Plate 25.** As the above example. (151.623971, -32.766587)



## *Wasteland Area*



**Plate 26.** Within the pit area there are lots of localities with fill, waste and rubble. These areas are dominated by a range of weeds, including, Pampas grass, Crofton weed and Lantana.





**Plate 27.** Within the pit area there are lots of localities with fill, waste and rubble. These areas are dominated by a range of weeds, including, Pampas grass, Crofton weed and Lantana.





**Plate 28.** Within the pit area there are lots of localities with fill, waste and rubble. These areas are dominated by a range of weeds, including, Pampas grass, Crofton weed and Lantana.





**Plate 29.** Within the pit area there are lots of localities with fill, waste and rubble. These areas are dominated by a range of weeds, including, Pampas grass, Crofton weed and Lantana.





**Plate 30.** Within the pit area there are lots of localities with fill, waste and rubble. These areas are dominated by a range of weeds, including, Pampas grass, Crofton weed and Lantana.





**Plate 31.** Within the pit area there are lots of localities with fill, waste and rubble. These areas are dominated by a range of weeds, including, Pampas grass, Crofton weed and Lantana.



### *Mature Vegetation Areas*



**Plate 32.** Mature vegetation on southern boundary (151.630199, -32.775060).





**Plate 33.** Mature vegetation on planned corridor.





**Plate 34.** Mature vegetation on planned corridor.





**Plate 35.** Mature vegetation on planned corridor.





**Plate 36.** Mature vegetation on north western extent of site (151.624719, -32.767045).



### 3.2 Vegetation Zones

The stratification of each PCT identified onsite into vegetation zones based on the observed condition classes shows that there are 15 vegetation patches onsite.

Refer to Figure 3.2 and Tables 3.2a - b

**Table 3.2a. PCT's, condition classes, vegetation zones and vegetation patches**

PCT	Condition Classes (Area ha)	Vegetation Zones (ID)	Vegetation patches (No.)	Vegetation patches (Class ha)
<b>1598</b>	Very Poor	1	2	<5
	Poor	2	1	<5
	Moderate	3	2	<5
	Good			
	Very Good			
<b>1592</b>	Very Poor	4	7	<5
	Poor	5	5	<5
	Moderate	6	6	<5
	Good			
	Very Good			
<b>1600</b>	Very Poor	7	2	<5
	Poor	8	1	<5
	Moderate	9	1	<5
	Good			
	Very Good			
<b>1618</b>	Very Poor			
	Poor	10	1	<5
	Moderate			
	Good			
	Very Good			
<b>1071</b>	Very Poor		1	<1
	Poor	11		
	Moderate			
	Good			
	Very Good			
	Good			



**Table 3.2b. PCT classification, prescribed vegetation zones, EEC analysis and justifications**

Plot number	Preliminary PCT applied	Condition class assigned	Geographic characteristics	PCT analysis	Final PCT	Final condition class	EEC analysis	Confidence
1(51), 8(51)	PCT 1 (1598) Forest Red Gum grassy open forest on floodplains of the lower Hunter	Very Poor	Occurs on gentle slopes of depressions and drainage flats on the Hunter Valley floor. Found within the Mitchell landscape Newcastle Coastal Ramp	Several methods are used to determine PCT's, firstly plots are compared with Vegetation Classification System and then compared with each other and benchmarks. Further to this a range of multivariate and learning analysis is undertaken including, the Non-metric MDS (nMDS) plots in 2-d and 3-d. Ordination plots of this type attempt to produce a 'map' of samples in which distances between pairs of points reflect community (or environmental) resemblances between the respective pairs of samples (the Bray-Curtis similarities). Their associated Shepard diagrams are also plotted – these show how well (or badly) the distances among samples in the low-d ordination approximate the similarities. If the 'stress' is not too large (~0.10), nMDS plots give a powerful representation of the sample patterns. Test of the overall differences among plots. The results show the ANOSIM R statistic is large (0.82 for biota, 0.71 for environmental variables), close to its maximum value of 1, implying very good clear separation of the plots, and highly significantly different from the null hypothesis value of R = 0, i.e. no plot differences. The associated plot is a histogram of the null hypothesis values of R under random permutations and shows that values not much more than R = 0.2 would be expected here if plots did not differ. ANOSIM follows this up with pairwise tests between pairs of plots, using the 5 (or in one case 7) locations in each creek as the replicate level, again showing significant and strong differences between all pairs of plots (R close to 1 in most cases, with the smallest difference between 1 & 4). Finally, the machine learning algorithm Support Vector Machine was run. The classifier separates data points using a hyperplane with the largest amount of margin. SVM finds an optimal hyperplane which helps in classifying new data points. SVM constructs a hyperplane in multidimensional space to separate different classes. SVM generates optimal hyperplane in an iterative manner, which is used to minimize an error. The core idea of SVM is to find a maximum marginal hyperplane (MMH) that best divides the dataset into classes. Here the classes being the preliminary PCT classifications. These two approaches are used because of the strength of SVM with non-linear relationships.	1598	Very Poor	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Mod
2(51)	PCT 1 (1598) Forest Red Gum grassy open forest on floodplains of the lower Hunter	Poor			1598	Poor		High
1(1)	PCT 1 (1598) Forest Red Gum grassy open forest on floodplains of the lower Hunter	Mod			1598	Mod		High
3(1), 4(18)	PCT 2 (1592) Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	Poor	Found within the Mitchell landscape Newcastle Coastal Ramp. Regionally, occurs mostly on the yellow podsolic and solodic soils of the Lower Hunter soil landscapes of Aberdare, Branxton and Neath. These substrates are said to produce 'moderately fertile' soils.		1592	Poor	Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion	Mod
1(18),2(18), 3(18)	PCT 2 (1592) Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	Mod			1592	Mod		High
2(1) 6(1)	PCT 2 (1592) Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	Very Poor			1592	Very Poor		Mod
4(1), 3(51), 10(51)	PCT 3 (1600) Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter	Very Poor			1600	Very Poor		Mod
4(51), 5(51), 6(51)	PCT 3 (1600) Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter	Poor			1600	Poor		High
7(51)	PCT 4 (1618) Smooth-barked Apple - White Stringybark - Red Mahogany – Melaleuca sieberi shrubby open forest on lowlands of the lower North Coast	Poor	The more coastal extremes of the Newcastle Coastal Ramp landscape results in a greater occurrence of these communities.		1618	Poor	None	Low
9(51), 11(51)	PCT 5 (1728) Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast.	Poor	Occurs on soils derived from unconsolidated sediments. Occurs on coastal flats, floodplains, drainage lines, lake margins, wetlands and estuarine fringes where soils are at least occasionally saturated,		1598	Poor	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Mod
5(1)	PCT 6 (1071) Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Very Poor	Wetlands, creeks and ponds of the Lower Hunter found in this landscape		1071	Very Poor	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	High



### 3.4 Vegetation Integrity Score

Vegetation integrity scores for each of the 11 vegetation zones was determined using the equations described in Appendix 6 and the BAM (2017). Summary statistics for these zones are shown in Table 3.4. Refer to the supplementary material for the code.

**Table 3.4. Results of BAM equations 8 to 16 to calculate integrity score- Appendix 6 BAM.**

Formulas	Zones										
	Z-1	Z-2	Z-3	Z-4	Z-5	Z-6	Z-7	Z-8	Z-9	Z-10	Z-11
Unweighted condition score	80	74	75	63	73	69	78	59	70	45	43
Dynamic weight for growth group	82	76	77	65	75	71	80	61	71	46	45
Composition condition score	49	45	46	39	45	42	48	36	43	28	27
Unweighted Structure condition score	69	63	65	54	62	59	67	51	60	38	37
Dynamic Structure condition score	81	75	76	64	74	70	79	60	71	45	44
Structure condition score	82	76	77	65	75	71	80	61	72	46	45
Function condition score	87	80	81	68	79	74	84	64	75	48	47
VI score for treed systems	58	53	55	46	53	50	56	43	51	33	32
VI score for Non-treed systems	75	69	70	59	68	64	72	55	65	42	40
Future VI score (treed)	84	78	79	67	77	73	82	62	73	47	46
Future VI score (Non-treed)	49	45	46	39	45	42	48	36	43	28	27

### 3.5 Habitat for Threatened Species

In the Hunter Region IBRA subregion there are 100 animals, 51 plants, 20 communities, and 4 populations that are threatened biodiversity entities. The PCT's onsite fall under 23 broad vegetation units known to be habitat for the local threatened biodiversity (see analysis in the supplementary material). This analysis shows that there is potential and suitable habitat onsite for 31 animals, 13 plants and 3 communities listed as threatened and 1 population. (refer to Table 3.5 below (continued overleaf).

**Table 3.5. Threatened species known to occupy the vegetation community types recorded onsite.**

Scientific Name	Common Name	NSW status
<b>Plants</b>		
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E1
<i>Rutidosis heterogama</i>	Heath Wrinklewort	V
<i>Tetradlea juncea</i>	Black-eyed Susan	V
<i>Maundia triglochinosoides</i>		V
<i>Lindernia alsinoides</i>	Noah's False Chickweed	E1
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V,3
<i>Eucalyptus camaldulensis</i>	Eucalyptus camaldulensis population in the Hunter catchment	E2
<i>Eucalyptus parramattensis subsp. Decadens</i>		V
<i>Rhodamnia rubescens</i>	Scrub Turpentine	E4A
<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum population in the Hunter Catchment	E2,P,2

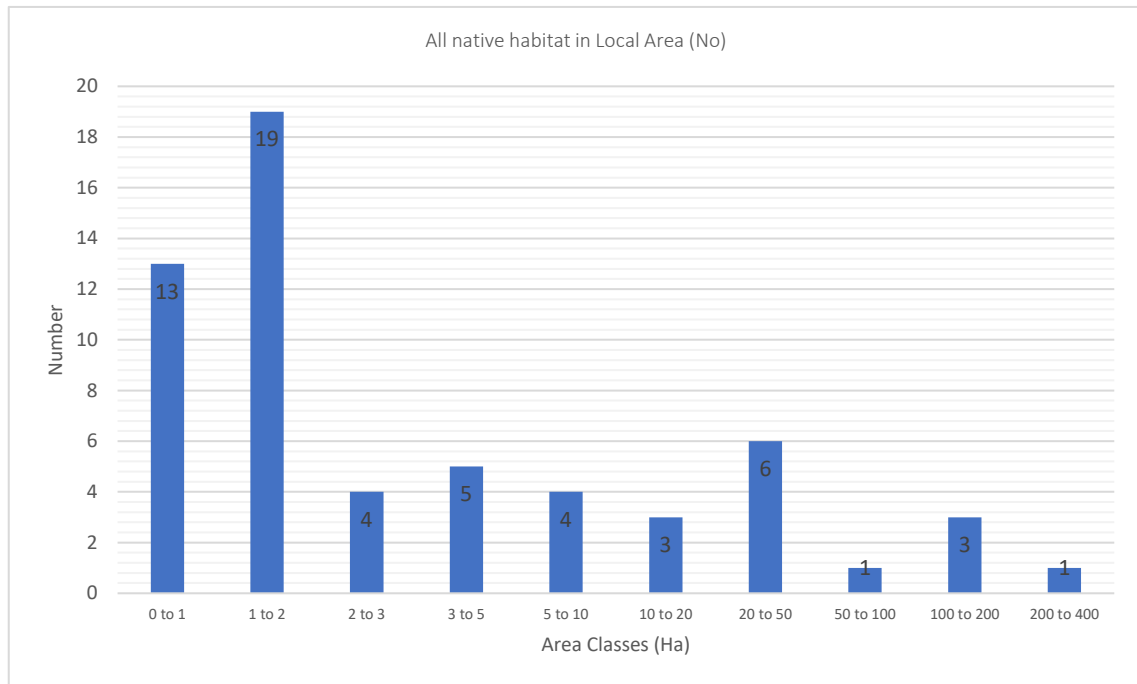


Scientific Name	Common Name	NSW status
<i>Diuris arenaria</i>	Sand Doubletail	E1,P,2
<i>Euphrasia arguta</i>		E4A
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V
<b>Fauna</b>		
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1,P
<i>Hieraaetus morphnoides</i>	Little Eagle	V,P
<i>Lophoictinia isura</i>	Square-tailed Kite	V,P,3
<i>Pandion cristatus</i>	Eastern Osprey	V,P,3
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V,P,3
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V,P,2
<i>Glossopsitta pusilla</i>	Little Lorikeet	V,P
<i>Lathamus discolor</i>	Swift Parrot	E1,P,3
<i>Neophema pulchella</i>	Turquoise Parrot	V,P,3
<i>Ninox connivens</i>	Barking Owl	V,P,3
<i>Ninox strenua</i>	Powerful Owl	V,P,3
<i>Tyto novaehollandiae</i>	Masked Owl	V,P,3
<i>Anthochaera phrygia</i>	Regent Honeyeater	E4A,P
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V,P
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V,P
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V,P
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	V,P
<i>Petroica boodang</i>	Scarlet Robin	V,P
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V,P
<i>Phascolarctos cinereus</i>	Koala	V,P
<i>Petaurus norfolcensis</i>	Squirrel Glider	V,P
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V,P
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V,P
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	V,P
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V,P
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V,P
<i>Myotis macropus</i>	Southern Myotis	V,P
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V,P
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V,P
<i>Miniopterus australis</i>	Little Bent-winged Bat	V,P
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	V,P

To estimate the respective habitat availability in the local area, the Hunter IBRA subregion and PCT known threatened species lists were correlated (i.e. duplicates removed). Using GIS the percentage of available habitat in the local area for the resultant list was calculated. This analysis shows that the site and local area provides a range of habitats for local threatened species. In total, the local area (~3864ha) has 169 remnants not separated by roads or gaps greater than 50 metres. More than 50% of the local patches are less than 2 hectares. Habitat for threatened species in the local area is only 34% of the total land area. For forest dependent species, only 17% of the local area provides habitat for these species, and when considering higher value large patches (>10ha) this is

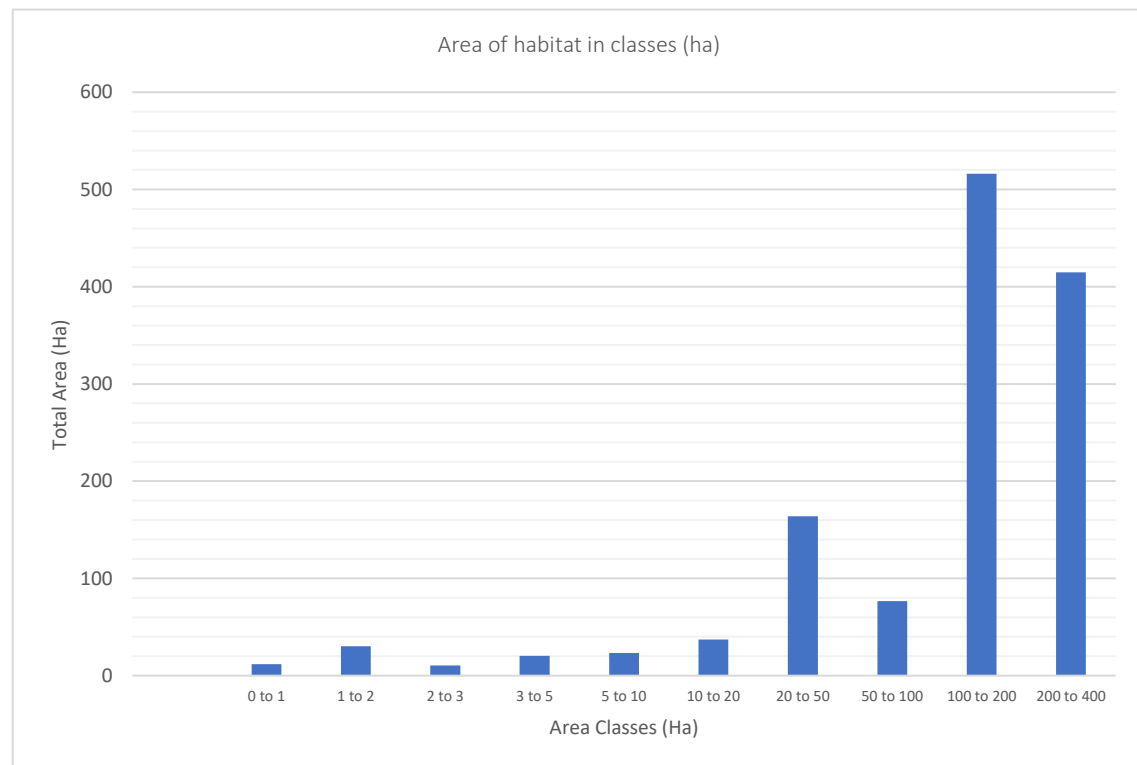


reduced further to 14% of total land area. Refer to Figures 3.5a, 3.5b, 3.5c, and 3.5d. These estimations do not consider present and pending approvals that may reduce relative habitat availability.



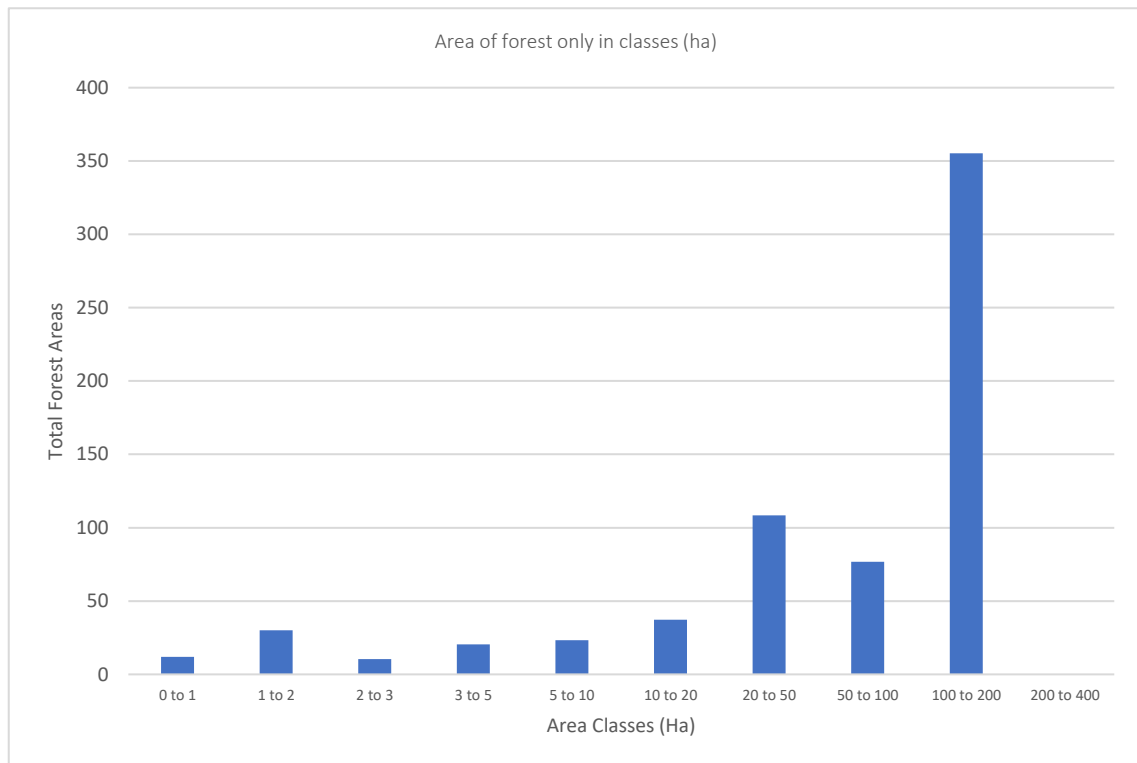
**Figure 3.5a Number of native vegetation patches in the Local Area arranged in classes from 0 ha up to a maximum area of 400ha.**

There is a low proportion of 0.04 edge to area ratio for all patches in the local area. The two largest area classes hold over 900ha of forest, indicating that networking and linking of smaller patches to these larger units will be critical.



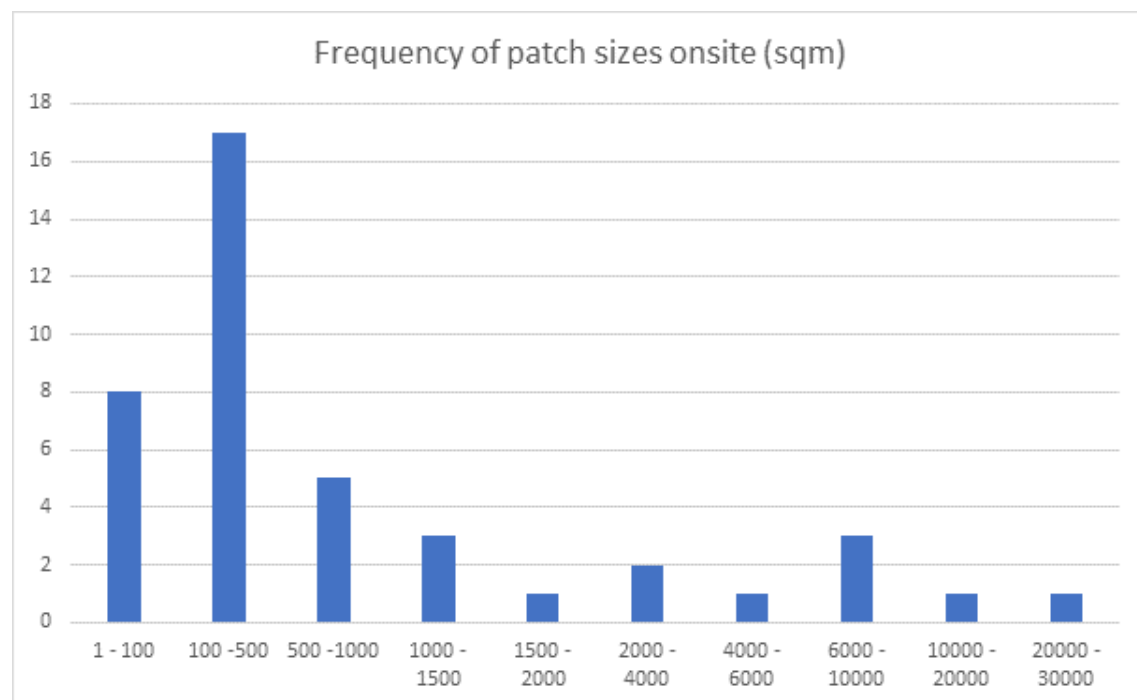
**Figure 3.5b. Total area (ha) of native vegetation in the Local Area arranged in classes from 0 ha up to a maximum area of 400ha.**

However, when comparing forests only there is a significant reduction in the total area of large area classes. Typically, the result of over clearing of developable lands on the eastern seaboard.



**Figure 3.5c Total area (ha) of native forest vegetation in the Local Area arranged in classes from 0 ha up to a maximum area of 400ha.**

Within the site, patch sizes are far more common under 500m<sup>2</sup> with only a couple of areas onsite connecting to make a habitat greater than 6 ha.



**Figure 3.5d. Frequency of patch sizes on site.**



### 3.6 Tree hollows and other micro-habitats

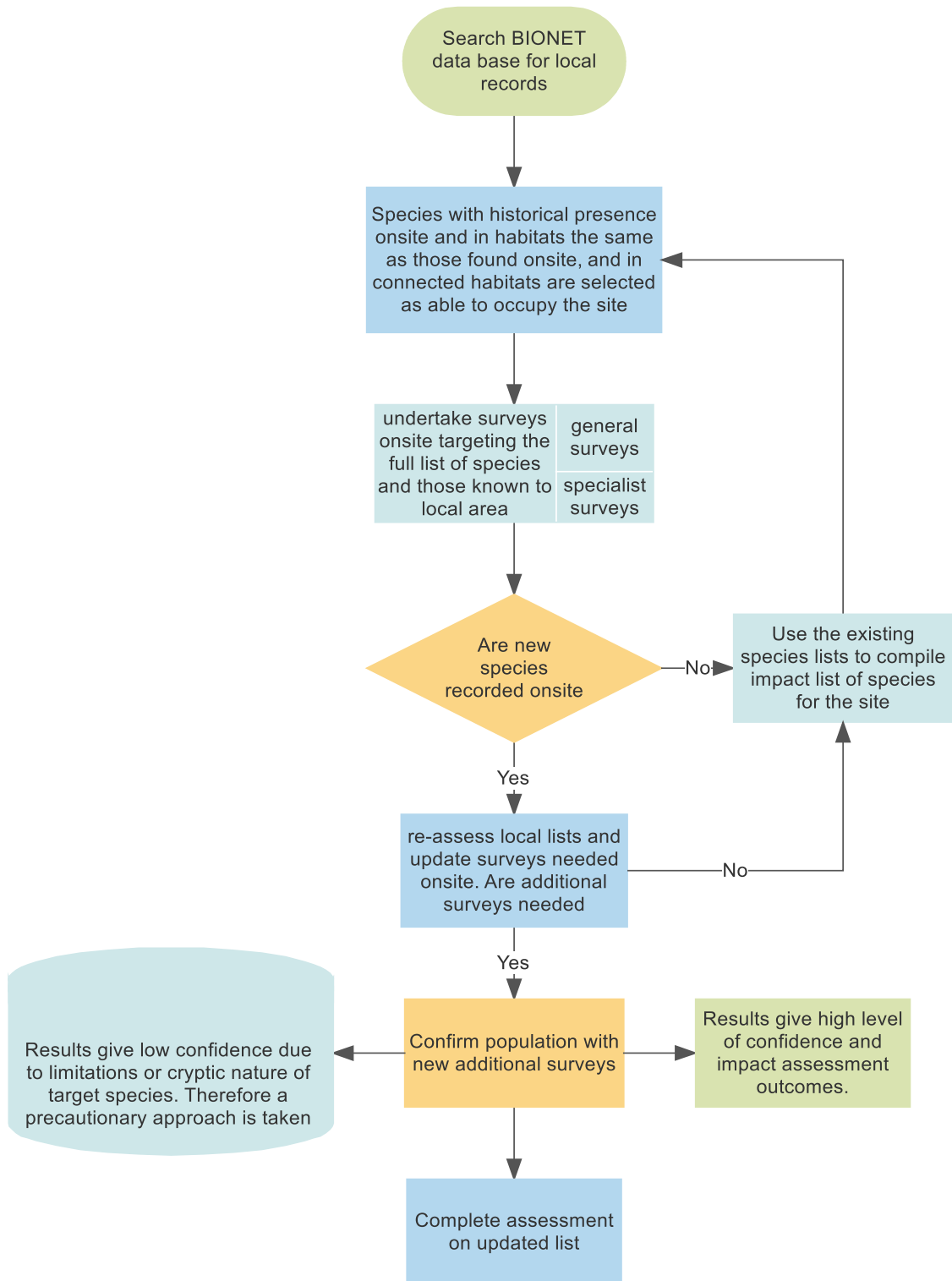
The site has a diversity of hollow resources, from abundant small hollows providing habitat for small mammals, birds, frogs, and lizards, to large vertical spouts, trunk hollows and branch hollows providing habitat for large forest owls and possums. In total, 39 trees having 70 hollows were recorded onsite, of which 27 hollow bearing trees will be retained and 12 salvaged for future use onsite, Refer to Table 3.6.

**Table 3.6. Hollows recorded on site**

GPS ID	Species	DBH (mm)	Hollows				Proposed for retention or removal
			S	M	L	XL	
127	Spotted Gum	500	2	-	-	-	Removal
128	Spotted Gum	600	2	1	-	-	Removal
330	Stag	500	3	1	-	-	Removal
331	Grey Gum	650	1	2	-	-	Retention
333	Grey Gum	700	2	3	-	-	Removal
334	Ironbark sp.	600	2	-	-	-	Retention
369	Ironbark sp.	500	1	-	-	-	Removal
370	Stringybark sp.	270	1	-	-	-	Retention
468	Spotted Gum	1000	-	2	1	-	Removal
467	Stag	600	-	-	1	-	Removed
460	Spotted Gum	800	-	-	1	-	Retention
469	Spotted Gum	850	-	2	-	-	Removed
471	Spotted Gum	850	4	3	-	1	Retention
444	Spotted Gum	450	-	-	-	1	Removed
474	Spotted Gum	500	-	1	-	-	Removed
349	Spotted Gum	750	-	1	-	-	Retention
455	Spotted Gum	850	5	-	-	-	Retention
473	Spotted Gum	750	4	2	1	-	Retention
470	Spotted Gum	850	2	2	-	-	Retention
472	Spotted Gum	450	3	1	-	-	Retention
449	Spotted Gum	1200	-	-	2	-	Removed
456	Spotted Gum	650	-	2	2	-	Removed
458	Spotted Gum	600	1	3	1	-	Retention
445	Grey Gum	650	-	1	1	-	Retention

### 3.7 Evidence of Threatened species occupancy on the site

Determining threatened species occupancy onsite is a multi-step process, with varying degrees of confidence. This process is outlined in Figure 3.7 overleaf.



**Figure 3.7. Process to determine the occupancy of the site by threatened species and the surveys required to identify presence.**



### 3.8 Constraints and limitations to occupancy

The site is bound to the Hunter Rail Line in the south and Raymond Terrace Rd in the North. These are diffuse barriers that permit movement by highly mobile species and occasional movements (Able high-risk movements) of less mobile species. These limitations separate the site from large remnants for all but highly mobile species. There are to date no fauna habitat enhancement and gap closing measures in place that link directly or indirectly with the site to large remnants south of The New England Highway. The local patch connectivity is large enough to support individuals for all local threatened species except Quoll.

### 3.9 Survey Results

Surveys recorded 14 threatened species onsite (Table 3.9). Of these, all but one has been recorded in the local area previously; based on species distribution in the local area, the remaining species were expected to be present. The surveys undertaken (refer to supplementary material) were sufficient to identify all species listed in this report as having habitat onsite, except those shown in Table 3.10 overleaf. These unsubstantiated species shown in Table 3.10 are now considered throughout to have habitat onsite, this precautionary approach is required to meet the requirements of the BC Act.

**Table 3.9. Threatened species recorded onsite during surveys**

Scientific Name	Common Name	NSW status	Comm. status	Individuals recorded (No)	Vegetation Zone recorded
<i>Ninox strenua</i>	Powerful Owl	V,P,3		1	Near by
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V,P		~	Near by
<i>Petroica boodang</i>	Scarlet Robin	V,P		1	5,6
<i>Haliaeetus leucogaster</i>	White-Bellied Sea-Eagle	V,P		1	Near by
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V,P			Near by
<i>Pandion haliaetus</i>	Eastern Osprey	V,P		1	Near by
<i>*Glossopsitta pusilla</i>	Little Lorikeet	V,P		~	4
<i>Petaurus norfolcensis</i>	Squirrel Glider	V,P		3	1,2
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	V,P			5,6,9
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	V,P		~	5,6,9
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V,P		~	5,6,9
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V,P			5,6,9
<i>Myotis Macropus</i>	Southern Fishing Bat	V,P		~1	11
<i>Miniopterus australis</i>	Little Bent-winged Bat	V,P		~!	1,2

\*Not previously recorded in the local area

### 3.10 Threatened species requiring assessment

The resultant list (Table 3.10) includes all species thought to have habitat onsite, were record onsite or are known to use the same habitats in the local area and were not recorded because of cryptic natures and migratory behaviours.

**Table 3.10. Criteria for selection of threatened species requiring formal assessment in this report**

Lot Number	Scientific Name	Common Name	Does the distribution of the species include the site and local area?	The land has no geographic constraints to presence of the species?	Do the PCT's onsite match the species habitat data collections?	Is there enough vegetation cover for the species onsite and in the local area?	Is the patch big enough for the species to use as habitat?	Are all the criteria met?
1, 51	<i>Uperoleia mahonyi</i>	Mahony's Toadlet	No exclusively coastal sands	Lacks white sands and not connected to this geology	Red gum woodland is present but not on white sands	✓	✓	No
1, 51	<i>Crinia tinnula</i>	Wallum forglet	No exclusively coastal sands	Lacks white sands and not connected to this geology	Red gum woodland is present but not on white sands	✓	✓	No
1, 18, 51	<i>Litoria brevipalmata</i>	Green-thighed Frog	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Litoria aurea</i>	Green and Golden Bell frog	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Delma impar</i>	Striped Legless lizard	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	✓	✓	✓	✓	✓	✓
1,18, 51	<i>Burhinus grallarius</i>	Bush Stone-curlew						
1, 18, 51	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Glossopsitta pusilla</i>	Little Lorikeet	✓	✓	✓	✓	✓	✓
18,	<i>Lathamus discolor</i>	Swift Parrot	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Ninox connivens</i>	Barking Owl	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Ninox strenua</i>	Powerful Owl	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Tyto novaehollandiae</i>	Masked Owl	✓	✓	✓	✓	✓	✓
18	<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	✓	✓	✓	✓	✓	✓
18	<i>Daphoenositta chrysoptera</i>	Varied Sittella	✓	✓	✓	✓	✓	✓
18	<i>Petroica boodang</i>	Scarlet Robin	✓	✓	✓	✓	✓	✓
51	<i>Pandion cristatus</i>	Eastern Osprey	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Hieraaetus morphnoides</i>	Little Eagle	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Lophoictinia isura</i>	Square-tailed Kite	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Cercartetus nantus</i>	Eastern Pigmy possum	✓	✓	✓	✓	✓	✓
1, 18,51	<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Planigale maculata</i>	Common Planigale	✓	✓	✓	✓	✓	✓
18,	<i>Phascolarctos cinereus</i>	Koala	✓	✓	✓	✓	✓	✓
1,18,51	<i>Petaurus norfolcensis</i>	Squirrel Glider	✓	✓	✓	✓	✓	✓
18,51	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	✓	✓	✓	✓	✓	✓
1,51	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	✓	✓	✓	✓	✓	✓
1,51	<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	✓	✓	✓	✓	✓	✓
1,	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	✓	✓	✓	✓	✓	✓
1, 18,51	<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	✓	✓	✓	✓	✓	✓
1,51	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	✓	✓	✓	✓	✓	✓
1, 18,	<i>Vespadelus troughtoni</i>	Eastern Cave Bat	✓	✓	✓	✓	✓	✓
1, 18,51	<i>Miniopterus australis</i>	Little Bent-winged Bat	✓	✓	✓	✓	✓	✓
1, 18,	<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	✓	✓	✓	✓	✓	✓
1, 18,51	<i>Myotis macropus</i>	Southern Myotis	✓	✓	✓	✓	✓	✓
1,18,	<i>Eucalyptus glaucina</i>	Slaty Red Gum	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Eucalyptus parramattensis subsp. decadens</i>		✓	✓	✓	✓	✓	✓
51	<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	✓	✓	✓	✓	✓	✓
51	<i>Eucalyptus castrensis</i>	Singleton Mallee	No. Only known to Singleton army Base	Not connected to known range	✓	✓	✓	No
51	<i>Eucalyptus pumila</i>	Pokolbin Mallee	No. Only known to location in Pokolbin	Not connected to known range	✓	✓	✓	No
1, 18, 51	<i>Rutidosia heterogama</i>	Heath Wrinklewort	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Acacia bynoeana</i>	Bynoe's Wattle	No the most coastal record is at Lochinvar	Not connected to known range	✓	✓	✓	No
1, 18, 51	<i>Tetradlea juncea</i>	Black-eyed Susan	✓	✓	✓	✓	✓	✓



Lot Number	Scientific Name	Common Name	Does the distribution of the species include the site and local area?	The land has no geographic constraints to presence of the species?	Do the PCT's onsite match the species habitat data collections?	Is there enough vegetation cover for the species onsite and in the local area?	Is the patch big enough for the species to use as habitat?	Are all the criteria met?
1, 18, 51	<i>Cynanchum elegans</i>	White-flowered Wax Plant	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Callistemon linearifolius</i>	Netted Bottle Brush	✓	✓	✓	✓	✓	✓
51	<i>Melaleuca groveana</i>	Grove's Paperbark	✓	✓	✓	✓	✓	✓
1,	<i>Melaleuca biconvexa</i>	Biconvex Paperbark						
1, 18, 51	<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Diuris praecox</i>	Rough Doubletail	✓	✓	✓	✓	✓	✓
1, 51	<i>Diuris tricolor</i>	Pine Donkey Orchid	✓	✓	✓	✓	✓	✓
1,18, 51	<i>Pterostylis chaetophora</i>		✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	✓	✓	✓	✓	✓	✓
1,	<i>Asperula asthenes</i>	Trailing Woodruff	✓	✓	✓	✓	✓	✓
1, 51	<i>Ozothamnus tessellatus</i>		✓	✓	✓	✓	✓	✓
1, 18, 51	<i>Pomaderris queenslandica</i>	Scant Pomaderris	✓	✓	✓	✓	✓	✓
18,	<i>Prostanthera cineolifera</i>	Singleton Mint Bush	✓	✓	✓	✓	✓	✓
1,	<i>Maundia triglochinosoides</i>		✓	✓	✓	✓	✓	✓
51	<i>Persicaria elatior</i>	Tall Knotweed	✓	✓	✓	✓	✓	✓
1,	<i>Monotaxis macrophylla</i>	Large-leafed Monotaxis	✓	Grows exclusively on hilly and rocky outcrops	✓	✓	✓	No

### **3.11 Candidate Species**

There are several limitations (constraints) identified onsite for two local species identified in Table 3.12 overleaf. North Rothbury Persoonia has a very restricted distribution in Rothbury and there are no records outside of this suburb, despite extensive survey. The relative isolation and scale of the site limits the value for Quoll's which require large patches.

### **3.12 Likelihood of occupancy by ecosystem and species credit species**

Ecosystem credit species were returned by the BAMC as being associated with the PCTs present within the development footprint. Ecosystem credit species, their associated habitat constraints, geographic limitations, and sensitivity to gain class are listed in Table 3.12. For dual listed species, only foraging habitat is included.



Table 3.12. Species credit reports for site

species	constraints	status	Survey details	Geographic limitations	Sensitivity to gain	Key habitat requirements	Correlations with vegetation zones (% area of habitat for species represented as % of overall area of the zone)					Justification for decision	Confidence
							PCT 1598 Zone 1-3	PCT 1592 Zone 4-6	PCT 1600 Zone 7-9	PCT 1618 Zone 10	PCT 1071 Zone 11		
Red-crowned Toadlet ( <i>Pseudophryne australis</i> )				The Red-crowned Toadlet has is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains.		Red-crowned Toadlet Occurs in open forests, almost exclusively on Hawkesbury and Narrabeen Sandstones. Can be found in periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter.  Red-crowned Toadlets have not been recorded breeding in waters that are even mildly polluted or with a pH outside the range 5.5 to 6.5.  Disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter. Red-crowned Toadlets are usually found as small colonies scattered along ridges coinciding with the positions of suitable refuges near breeding sites.	0	0	0	0	0	There are no suitable sandstone creeks and forests onsite	High
Green-thighed Frog ( <i>Litoria brevipalmata</i> )				Isolated localities along the coast and ranges from just north of Wollongong to south-east Queensland.		Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland. Breeding occurs following heavy rainfall from spring to autumn, with larger temporary pools and flooded areas preferred. Frogs may aggregate around breeding sites and eggs are laid in loose clumps among waterplants, including water weeds. The larvae are free swimming. The frogs are thought to forage in leaf-litter.	0	0	0	0	0	There are no forest communities onsite having seeps and ephemeral ponds suitable to hold water for periods long enough for metamorphosis and the site is not connected to suitable habitats. Whilst there are some pond areas, these semi permanent open ponds are too exposed and in poor condition for this species.	High
Bush Stone-curlew ( <i>Burhinus grallarius</i> ) BRW-2				The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania.		Typically occur in lightly timbered patches of woodland and forest. They may prefer areas where groundcover consists of short and sparse grasses with few shrubs. There can in some areas be thick leaf litter and ground debris, as long as vegetation remains open.	10	30	30	20	0	The open grassy areas of the forest communities to provide habitat, but the presence of thick Lantana reduces this potential.	High
Gang-gang Cockatoo ( <i>Callocephalon fimbriatum</i> ) BRW-2				The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes.		Preferring tall Eucalypt forests. Range individuals migrate to coastal areas during winter. I have recorded individuals many times at Weakleys Drive, considered a regular visitor of the local area.	10	50	20	5	0	The small regenerating and disturbed areas provide marginal habitat for this species. The mature forest and diverse areas are the better areas onsite for this species.	High
Glossy Black-Cockatoo ( <i>Calyptorhynchus lathami</i> )				The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina.		Woodland and open forests on low nutrient soils with a middle stratum with abundant Allocasuarina spp which they are dependent upon for food. Breed in either dead or alive hollow within woodlands or remnant woodlands. They roost in the canopy of leafy eucalypts less than one (1) kilometre from the feed site and within thirty (30) metres of the nesting tree (HANZAB, 1999).	5	5	5	5	0	There are very few Allocasuarina spp onsite. Recent increase in records in the Hunter, likely as a result of drought and the xmas bushfires increase the importance of regeneration and habitat creation for this species.	High
Little Lorikeet ( <i>Glossopsitta pusilla</i> )				The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs.		Little Lorikeet is a partial migrant nectivore that is classed as a species reliant on remnant size, and requires large old growth remnants.  Little Lorikeet requires nest-sites in mature and old-growth stands of smooth-barked gums Eucalyptus spp., within 2 km of stands of their key food trees (flowering Eucalypts). Nest-sites are tight knotholes in live trees, 2.4-15.2m above the ground; entrance dimensions are 29 to 34mm. These openings are maintained by regular biting of the regrowing bark. Breeding adults have been recorded in some areas as resident for most of the year, returning periodically in the non-breeding season to maintain and defend nest-hollows. Recent records in the Hunter Valley (by author in three locations in last 12 months) may be related to inland drought conditions and bushfire impacts.	30	50	10	5	0	This species is increasing in the local area. Retention and creation of suitable hollows will be important.	High

species	constraints	status	Survey details	Geographic limitations	Sensitivity to gain	Key habitat requirements	Correlations with vegetation zones (% area of habitat for species represented as % of overall area of the zone)					Justification for decision	Confidence
							PCT 1598 Zone 1-3	PCT 1592 Zone 4-6	PCT 1600 Zone 7-9	PCT 1618 Zone 10	PCT 1071 Zone 11		
Swift Parrot ( <i>Lathamus discolor</i> )				Throughout NSW. In the southeast mainly between March & November.		Swift Parrots live in eucalypt forests and woodlands, particularly box-ironbark forests, and feed primarily on nectar (Higgins, 1999) but also eat fruit and insects. Show a preference for sites of high soil fertility, where large treeeage high nectar production, such as along drainage lines or in isolated rural or urban remnants (Emison et al., 1987, Tzaros, 1996, 1997). On the coast they are known to feed on swamp mahogany, spotted gum and red bloodwood. Breeding in Tasmania before migrating to the mainland every autumn to winter.	30	50	10	5	0	Mature forest and remnant landscapes provide the key areas.	High
Powerful Owl ( <i>Ninox strenua</i> )				Coast and ranges. Distribution Limits - N-Border Ranges National Park. S-Eden.		Wet or dry sclerophyll forest with mature trees. Roost and breeding trees usually in densely vegetated gullies. Require a large home range (800-1000 ha). Powerful Owl is the largest of Australia’s owls (Debus & Chafer 1994). It feeds on larger arboreal mammals, megabats, and other fauna captured in trees. It forages mostly in open forests and typically roosts in tall trees in moist gullies. It nests in a very large hollow, typically in large tree in a moist gully. Pairs maintain and hunt throughout a home range that may be up to 1000 ha. (Garnett 1992, Fleay 1944).	0	70	20	0	0	Mature forest and remnant landscapes provide the key areas.	High
Masked Owl ( <i>Tyto novaehollandiae</i> )				Coast and ranges. In NSW they are recorded in most regions but occur predominantly east of the Great Divide from Murwillumbah to Ben Boyd National Park in the south (Higgins, 1999).		Inhabit a diverse range of dry eucalypt forest and woodland, especially adjacent to grassland or clearings. Require a large home range (1000 ha). Key roosting and nesting habitat must contain tall or dense mature trees with suitable hollows. Favoured nesting hollows are near-vertical spouts or large hollows in trunks of large eucalypts (Higgins, 1999). Forage mainly upon terrestrial prey in adjoining open habitat, occasionally preying upon arboreal or scansorial mammals (Higgins, 1999).	40	50	40	40	0	The use of open areas for foraging of ground mammals at a matrix of forest trees are important.	High
Brown Treecreeper (eastern subspecies) ( <i>Climacteris picumnus victoriae</i> )				Mainly found in forests and woodlands of inland plains and inland slopes of the Great Divide (HANZAB, 2001).		They occur mostly in eucalypt dominated woodlands with a variety of stringy and rough-barked species with an open understorey with a sparse shrub layer. Brown Treecreepers are sedentary and occupy their territory year round. Within their territory they are conspicuous and noisy.	40	50	40	40	0	Likely to use all Eucalypt habitats, however, the condition and age of some zones provide less ideal conditions. Recent movements by this species to more coastal locations in the Hunter are thought to be drought related (i.e. recorded by author 2km from Tomago sand beds in 2019) indicates that this species may rely on open coastal forest more in the future.	Mod
Speckled Warbler ( <i>Chthonicola sagittate</i> )				The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast.		Speckled Warblers are frequently located within the grassy ground layer of dry sclerophyll forests and woodlands, generally in box-ironbark associations. They are predominantly insectivorous but also forage on seeds and plant material when foraging through grass tussocks, leaf litter, fallen timber, low shrubs and trees. Within the Hunter Valley this species is also associated with rocky slopes which provide additional foraging substrate.	40	50	40	40	0	Potential habitat within all Eucalypt zones, however the quality is reduced due to the higher level of shrubs and weeds. In the Hunter, the locations where they are known are generally more open and sparse than this site.	Mod
						Speckled warblers are a sedentary species and are affected by the removal of timber within their home range. They generally have a home range between 2.5 and 8 hectares and spend their time foraging throughout their range spending 2-3 days in small sections.							
						Speckled warblers frequently roost in young eucalypt saplings in the open where the foliage is sparse. Nests are built in depressions on the ground amongst grass and low shrubs usually at the base of saplings sheltered by overhanging branches. When nesting, Speckled Warblers decrease their home range to within a 60 metre circumference of the nest.							



species	constraints	status	Survey details	Geographic limitations	Sensitivity to gain	Key habitat requirements	Correlations with vegetation zones (% area of habitat for species represented as % of overall area of the zone)					Justification for decision	Confidence
							PCT 1598 Zone 1-3	PCT 1592 Zone 4-6	PCT 1600 Zone 7-9	PCT 1618 Zone 10	PCT 1071 Zone 11		
Regent Honeyeater ( <i>Anthochaera Phrygia</i> )				Within NSW they have scattered records but occur mainly in the north-west plains west of the Great Divide. Occasional records in the Hunter and Central Coast regions (Higgins et al, 2001).		Forest and woodlands dominated by winter-flowering eucalypts like ironbark and box species. Found especially in moist fertile sites along creeks, river valleys and lower slopes of foothills (Higgins et al, 2001). Forage in canopy among foliage and flowers foraging on nectar and invertebrates.	40	50	40	40	0	Potential habitat within all Eucalypt zones. In the Hunter, the locations where they are known are generally higher quality than this site.	Mod
Black-chinned Honeyeater (eastern subspecies) ( <i>Melithreptus gularis gularis</i> )				Rarely recorded east of the Great Dividing Range mainly between Richmond and Grafton, although recorded in a few scattered sites around the Hunter and Central Coast regions (Higgins, Peter & Steele 2001).		Mainly forage in the upper levels of open eucalypt forests or woodlands dominated by box or ironbark species. They are sometimes recorded as occurring in riparian associations dominated by paperbarks, eucalypts and acacia's with open country nearby. They forage amongst the canopy on nectar and invertebrates. Nest is concealed in the crowns of trees and breed year-round.	0	60	10	0	0	Potential habitat within all Eucalypt zones. In the Hunter, the locations where they are known are generally higher quality than this site. Known to Black Hill area in most tall forests.	High
Grey-crowned Babbler (eastern subspecies) ( <i>Pomatostomus temporalis temporalis</i> )				The Grey-crowned Babbler is found throughout large parts of northern Australia and in south-eastern Australia. In NSW, the eastern sub-species occur on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Hay. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands.		Grey-crowned Babbler generally inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Within the Hunter Valley they often occur in Spotted Gum Ironbark forests which have a relatively open understorey with a sparse shrub layer. In the Hunter Valley they have also been found to utilise regenerating Eucalypt forest and edges of forest on lower Permian slopes, road verges and linear plantings (King 2004). The species is known to have a poor ability to recolonise habitats (Traill and Duncan 2000). They live in family groups and forage on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. Build and maintain several conspicuous, dome-shaped stick nests about the size of a football.	50	60	70	60	0	The author has recorded Grey-crowned Babbler in every remnant in the local area except this one. Even within the park areas of the old Thornton estate areas (~500m east of the site). The species relies on regenerating trees and shrubs and uses urban and small lot rural developments. Recent reduction in occupancy in the Hunter (unpublished data King 2020) may be the result of increased competition form Common Miner.	High
Varied Sittella ( <i>Daphoenositta chrysoptera</i> )				The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades.		Varied Sittella occur in eucalypt woodlands and forests where rough-barked species occur, like stringybark or ironbark species occur with either a shrubby understorey or grassy ground cover. They forage in the canopy on large branches, searching knot holes, crevices and beneath loose bark for arthropods. Foraging is usually done arboreally with Varied Sittella rarely observed on the ground.  Varied Sittellas roost in tree branches approximately 14 metres high, in clusters of up to 11 individuals. They maintain no fidelity to any one roost site and sites are scattered throughout the home range. They nest in upright branch fork, usually on dead branches. Nests are generally in Ironbark or stringybark and will nest in the same tree for many seasons. Varied Sittellas breed cooperatively.	20	60	20	20	0	Varied Sittella in the Hunter can be found in coastal foothills forests patches dominated by Mahogany, Stringybarks and Ironbark (i.e. Eagleton) and some Mesic forests with Blue gum and tall mid-stratum of mixed woods (i.e. Weakleys Drive, Beresfield). Likely that the site is largely too young and open with a higher number of smooth barks.	Mod
Olive Whistler ( <i>Pachycephala olivacea</i> )				It has a disjunct distribution in NSW chiefly occupying the beech forests around Barrington Tops and the MacPherson Ranges in the north and wet forests from Illawarra south to Victoria. In the south it is found inland to the Snowy Mountains and the Brindabella Range.		The Olive Whistler inhabits the wet forests on the ranges of the east coast. Forage in trees and shrubs and on the ground, feeding on berries and insects.  Make nests of twigs and grass in low forks of shrubs. In NSW, very occasional records are made in coastal regions, but they would be winter visitors which have moved to a lower altitude from their high country headquarters. Breeding birds in NSW and Qld are mostly restricted to the highest parts of the ranges - Kosciuszko National Park, the Brindabella Range west of Canberra, Barrington Tops, New England National Park and up above 1000 m in the Macpherson Range on the Qld border are all known areas.  Generally regarded as resident and breeding in simple pairs.	30	10	10	0	0	Zone - 1-3 are slightly wetter environments than other forest onsite, however this species is poorly understood and the lack of information makes planning problematic.	Poor
Hooded Robin (south-eastern form) ( <i>Melanodryas cucullata cucullate</i> )				The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. The south-eastern form (subspecies		Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and Mallee, often in or near clearings or open areas. Maron (2008) found that Hooded Robin was commonly found in patches of just a few hectares. Maron also found that there was no evidence that nestedness correlated with patch area. He suggested that the presence of native Noisy Miner ( <i>Manorina melanocephala</i> ) is the strongest drivers in	5	5	5	5	0	The site is really lacking in open woodland elements and high levels of debris typical of this species. Hunter records are scattered and all are associated with highly modified, open environments.	High

species	constraints	status	Survey details	Geographic limitations	Sensitivity to gain	Key habitat requirements	Correlations with vegetation zones (% area of habitat for species represented as % of overall area of the zone)					Justification for decision	Confidence
							PCT 1598 Zone 1-3	PCT 1592 Zone 4-6	PCT 1600 Zone 7-9	PCT 1618 Zone 10	PCT 1071 Zone 11		
				cucullata) is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subspecies picata. Two other subspecies occur outside NSW.		<p>the local distributions of small passerine birds in eastern Australia. This may certainly the case for Hooded Robin a species which inhabits similar habitats to Noisy miner by occupying open edge type habitats with diverse structure.</p> <p>Many species which rely on woodland still forage well out into paddocks from remnants, yet remain within retreating distance of woody vegetation. Thus, the effective area of a remnant from the perspective of a bird is often greater than the area that humans perceive and researchers typically measure. With this in mind the potential range of the Hooded Robin in the local area could include the Riparian corridor.</p>							
Scarlet Robin ( <i>Petroica boodang</i> )				The Scarlet Robin is found in south-eastern and south-western Australia, as well as on Norfolk Island. In Australia, it is found south of latitude 25°S, from south-eastern Queensland along the coast of New South Wales (and inland to western slopes of Great Dividing Range) to Victoria and Tasmania, and west to Eyre Peninsula, South Australia; it is also found in south-west Western Australia. It is also widely distributed in the south-western Pacific from Bougainville and the Solomon Islands to Vanuatu, Fiji and Western Samoa.		<p>The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.</p> <p>The Scarlet Robin lives in open forests and woodlands in Australia, while it prefers rainforest habitats on Norfolk Island. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time.</p>	40	60	60	40	0	Scarlet Robin can be found in the Hunter in a range of habitats, from open grassy forests, dense She Oak and Bull Oak forests and manmade areas (e.g Golf course). The site provides habitat and the species would be expected to use all of the local remnants.	High
Flame Robin ( <i>Petroica phoenicea</i> )				The Flame Robin is endemic to south eastern Australia, and ranges from near the Queensland border to south east South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands.		<p>Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. In winter, birds migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the western slopes and plains). In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees.</p> <p>In winter, occasionally seen in heathland or other shrublands in coastal areas. Occur singly, in pairs, or in flocks of up to 40 birds or more; in the non-breeding season they will join up with other insectivorous birds in mixed feeding flocks.</p> <p>occupies habitats with open ground layers of grass or bark, and a sparse shrub-and-sapling layer. Flame robins occupied more mesic habitats. flame robin's shows an apparent resilience to practices such as timber harvesting.</p>	40	60	60	40	0	Flame Robin is found in more mesic sites than Scarlet, however sympatric populations are common.	High
Diamond Firetail ( <i>Stagonopleura guttata</i> )				The Diamond Firetail is endemic to south-eastern Australia, extending from central Queensland to the Eyre Peninsula in South Australia. It is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Cental and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW, though is very rare west of the Darling River.		<p>Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands.</p> <p>Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.</p> <p>Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.</p> <p>Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season).</p> <p>Usually encountered in flocks of between 5 to 40 birds, occasionally more.</p> <p>Groups separate into small colonies to breed, between August and January.</p>	10	30	30	10	0	Not ideal grassy woodland habitats for this species.	Mod
Spotted-tailed Quoll ( <i>Dasyurus maculatus</i> )				The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common.		Mainly located in rainforest, forest, woodlands and coastal heath on tablelands and coastal hills where disturbance is low. This Dasyurid is the largest on the Australian mainland. This carnivorous species forages on the ground and in trees where it takes birds, small mammals and wallabies (Mansergh 1984, Green and Scarborough 1990).	20	40	20	0	0	Spotted-tailed Quoll are not known to occupy small open remnants. Recent records in Raymond Terrace could be attributed to drought conditions. The species is likely to find habitat in the larger remnants of the local area (e.g. south of New England Highway) and the site could provide a corridor for movements.	High



species	constraints	status	Survey details	Geographic limitations	Sensitivity to gain	Key habitat requirements	Correlations with vegetation zones (% area of habitat for species represented as % of overall area of the zone)					Justification for decision	Confidence
							PCT 1598 Zone 1-3	PCT 1592 Zone 4-6	PCT 1600 Zone 7-9	PCT 1618 Zone 10	PCT 1071 Zone 11		
Brush-tailed Phascogale ( <i>Phascogale tapoatafa</i> )				The distribution of Brush-tailed Phascogale within NSW has a patchy distribution around the coast of Australia up to 1500m (Soderquist, 1995). In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW. Maxwell <i>et al</i> (1996) reported that the within NSW they are most commonly recorded from Taree to Port Macquarie as well as some parts of the Hunter Valley. The distribution of Phascogale populations is correlated to the richness and abundance of arthropods which Recher et al. (1996) which are positively related to soil and foliar nutrient levels.		Brush-tailed Phascogale are agile climbers which forage arboreally in dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. They are often found at low densities as they have large home ranges, male home ranges are up to 100ha (Soderquist 1995) in continuous habitat and overlap with female intrasexually exclusive home ranges (30-60 ha). They are a hollow dwelling species which require large numbers of hollows (>30 ha <sup>-1</sup> ) within their home range (DSE, 1997). They show a preference (Rhind 2004) for utilising dead or senescent trees with suitable hollows, 25-40mm wide, lined with leaves and pungent faeces (DSE, 1997). They forage arboreally on trunks for large invertebrates including insects, spiders and centipedes (Triall & Coates 1993; Soderquist 1995; Scarff et al. 1998).	30	40	40	20	0	There is perhaps a lack of hollows onsite for Phascogale, other elements would appear suitable. Records in Anambah in Grey Box, Red gum open forests on moderate fertile soils is consistent with records in Eagleton and Taree. The site is likely low in nutrients, large trees and hollows.	Mod
Common Planigale ( <i>Planigale maculate</i> )				Coastal north-eastern NSW, coastal east Queensland and Arnhem Land. The species reaches its confirmed southern distribution limit on the NSW lower north coast however there are reports of its occurrence as far south as the central NSW coast west of Sydney.		Across its range Common Planigale occupies rainforest, eucalypt forest, heathland, marshland, grassland. Almost exclusively adjacent or nearby water. Construct nests in crevices, hollow logs, beneath bark or under rocks.	40	60	60	40	0	A difficult species to predict. Generally has low occupancy across a large range in varies habitats. Potential onsite relatively unknown.	Low
Eastern Pygmy possum ( <i>Cercartetus nanus</i> ) BRW-2				The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extents from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes.		Across its range Pygmy possum occupies a wide range of habitat types, largely a result of resource availability and competition for hollows. More locally can be found in mountain heath, and coastal forests with complex phonology. Relies on good seasonal supply of nectar and pollen including; banksias, eucalypts and bottlebrushes. Also consumes fruits and insects.	20	30	30	20	0	Seasonal phenology of nectar resources is critical for this species. Locally Spotted gum Ironbark Forest is mostly lacking in this flowering diversity. Coastal forests with tall Banksia, Xanthorrhoea and wattles along with diverse Eucalypt flowering are ideal.	Mod
Koala ( <i>Phascolarctos cinereus</i> )				Patchily distributed throughout coast, ranges and western slopes, but concentrated on north coast.		Eucalypt forest and woodland on higher and moderate nutrient soils. Although the Koala feeds on a range of tree species, a small number of eucalypt species provide its staple diet yet relies on a broader network of species in a local area.	50	40	40	10	0	Koala feed tree species recorded onsite. Mostly in Zone 1-3. All other tree species onsite would be used by Koala if it was resident.	High
Yellow-bellied Glider ( <i>Petaurus australis</i> )				Patchily distributed along the east coast.		Located in tall mature forests in high rainfall areas. Forages mainly in tall open sclerophyll forests on eucalypt sap and nectar, honeydew, manna and invertebrates. Den in leaf-lined tree hollows.	10	30	20	10	0	Not ideal habitat. Too short open and dry.	High
Squirrel Glider ( <i>Petaurus norfolcensis</i> )				Patchily distributed along ranges, western slopes, and the coast north of Sydney.		Eucalypt forest or woodland with mature or mixed-age trees, with a variety of species. The presence of winter-flowering species appears to be important.	60	80	80	30	0	Ideal habitat. Recorded and known to every patch in Thornton (authors trapping results)	High
Grey-headed Flying-fox ( <i>Pteropus poliocephalus</i> )				North to south coast		Their natural diet consists of fruits from rainforest trees, and nectar from nectiferous trees, such as Swamp Mahogany. Roost and breed in large 'camps' that are most often located in rainforests or other dense-canopied forests.	40	60	50	10	0	Ideal habitat. Recorded and known to every patch in Thornton (authors trapping results)	High
Yellow-bellied Sheathtail-bat ( <i>Saccolaimus flaviventris</i> )				Distributed over much of Australia except for south-western Australia.		Little is known about this species' life cycle except that it roosts in hollows in old trees and sometimes in the abandoned nests of sugar gliders. They usually form small colonies of up to 30. Single young births have been recorded from December to March. They forage on flying insects, including beetles eating prey as they fly. They fly quickly and are not good at twisting and turning when chasing their prey. However, they also feed on insects living in open forests and open grasslands.	40	60	50	30	30	Ideal habitat. Known to local area.	High
Eastern Coastal Free-tailed Bat ( <i>Micronomus norfolkensis</i> )				<i>Mormopterus norfolkensis</i> is thought to be 'uncommon' and distributed east of the Great Dividing Range to the coastline, and ranging in latitude from Picton (New South Wales) in the south, as far north as south-east Queensland (DEH, 1999). Most recent records come from north-eastern New South Wales		<i>Mormopterus norfolkensis</i> is a tree-dwelling (Allison & Hoyer, 1995) insectivorous bat which is often located in dry eucalypt forest and coastal woodlands, although individuals have also been captured within riparian zones, wet sclerophyll and rainforest (Allison & Hoyer, 1995). They forage above the canopy or in unobstructed corridors in open areas (Strahan, 1995) on either winged or wingless ants (Allison, 1989). Roost	40	60	50	30	30	Ideal habitat. Known to local area.	High

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				(Parnaby 1992, Gilmore and Parnaby 1994 cited in DEH 1999).		together in small colonies in hollows or under loose bark (Australian Museum, 200							
Large-eared Pied Bat ( <i>Chalinolobus dwyeri</i> )				Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes.		<p>Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Hirundo ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies.</p> <p>The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months.</p>	40	60	50	30	30	Ideal habitat. Known to local area.	High
Eastern False Pipistrelle ( <i>Falsistrellus tasmaniensis</i> )				The bat occurs along the entire east coast of Australia, into southern Queensland, southern Victoria and inhabits all of Tasmania		<i>Falsistrellus tasmaniensis</i> is an insectivorous bat which is often located in wet temperate forests with tall trees with a dense canopy and sub-canopy, foraging on beetles (Herr, 1998). Their preferred roost habitat is a mature forest with a low density of trees, with a high frequency of old mature trees with a large dbh (>100cm). The trees utilised are often older smooth-barks with large hollows with a large crown canopy (Herr, 1998). Radio tracking analysis of revealed a variable home range of between 6 ha and 336 ha, and a high roost fidelity to a group of trees rather than single trees (Herr, 1998).	40	60	50	30	30	Ideal habitat. Known to local area.	High
Greater Broad-nosed Bat ( <i>Scoteanax rueppellii</i> )				Predominantly coastal (altitudes under 500 metres) and less than 100km inland (Hoye & Richards, 1995)		The Greater Broad-nosed bats are found in a variety of habitats ranging from woodlands, to moist and dry eucalypt forest and rainforest (Hoye & Richards, 1995). They prefer open habitats in which they can fly straight and direct and are known to utilise artificial openings in forests, with their favoured habitats being river and creek corridors (Hoye & Richards, 1995). Individuals have been recorded roosting in tree hollows, cracks and fissures in the trunk and boughs of stags, and under exfoliating bark. A recent study on the north coast of NSW by Campbell (2001) found roost habitat occurred in a Melaleuca swamp woodland habitat (Wallum) in areas of low relief.	40	60	50	30	30	Ideal habitat. Known to local area.	High
Eastern Cave Bat ( <i>Vespadelus troughtoni</i> )				The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT.		<p>A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.</p> <p>Occasionally found along cliff-lines in wet eucalypt forest and rainforest.</p> <p>Little is understood of its feeding or breeding requirements or behaviour.</p>	40	60	50	30	30	Ideal habitat. Known to local area.	High
Little Bent-winged Bat ( <i>Miniopterus australis</i> )				Coast north of the Central Coast		Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites. (Law 1996, Wilson P. 1982)	40	60	50	30	30	Ideal habitat. Known to local area.	High
Large Bent-winged Bat ( <i>Miniopterus orianae oceanensis</i> )				Coast and ranges		Forages above dry and moist forest, and can be found on edges of urban areas. Roost in caves, in old mines, in tunnels, under bridges, or in similar structures. Specific maternity caves are used by females during summer to give birth.	40	60	50	30	30	Ideal habitat. Known to local area.	High
Southern Myotis ( <i>Myotis Macropus</i> ) BRW-2				The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers.		<p>Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.</p> <p>Forage over streams and pools catching insects and small fish by raking their feet across the water surface.</p> <p>In NSW females have one young each year usually in November or December.</p>	30	40	50	20	70	Ideal habitat. Known to local area.	High



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Heath Wrinklewort ( <i>Rutidosia heterogama</i> )				Scattered coastal locations between Wyong and Evans Head, and on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes.		Occurs in dry sclerophyll forest and woodland, as well as heath and on sand dunes and is often associated with disturbed areas. It does not appear to favour a particular soil type and occurs at a range of altitudes. Observed growing within open woodland ( <i>E. haemastoma</i> , <i>A. costata</i> , and <i>E. capitellata</i> ) in Wyong Shire.	40	60	50	30	0	Marginal habitat within most of the proposal area, due to most boggy soils. Known to local area.	High
Black-eyed Susan ( <i>Tetradthea juncea</i> )				Coast between Wyee and Bulahdelah		Typically eucalypt woodland or forest on conglomerate ridges but also recorded on sands and some volcanic ridges. Tetradthea juncea is often found in association with Red Bloodwood ( <i>Corymbia gummifera</i> ) dominated vegetation communities, within which Smooth-barked Apple ( <i>Angophora costata</i> ) or Scribbly Gum ( <i>Eucalyptus haemastoma</i> ) are co-dominant, with a dense understorey of herbs, forbs, grass trees and grasses (Landenberger, 2003).	30	50	40	30	0	Recorded south of New England Highway, but no records north of the Rail corridor. Habitat in Zones 4-9 moderately suitable. Known to local area.	High
Netted Bottle Brush ( <i>Callistemon linearifolius</i> )				Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Further north it has been recorded from Yengo National Park.		Grows in dry sclerophyll forest on the coast and adjacent ranges.	40	60	40	30	0	Recorded in Black Hill area in Coastal Foothills ironbark Forest, moderately suitable habitat. Known to local area.	High
Grove's Paperbark ( <i>Melaleuca groveana</i> )				Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands.		Grove's Paperbark grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry scrubby open forest and woodlands.	30	20	20	20	0	Not Ideal habitat.	High
Red Helmet Orchid ( <i>Corybas dowlingii</i> )				Corybas dowlingii is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It is known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens.		Sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m.	40	60	40	30	0	Recorded in Eagleton and Grahamstown Dam in Coastal Foothills Ironbark Forest area, moderately suitable habitat. Known to local area.	
Leafless Tongue Orchid ( <i>Cryptostylis hunteriana</i> )				Known from Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, Ben Boyd National Park.		Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum ( <i>Eucalyptus sclerophylla</i> ), Silvertop Ash ( <i>E. sieberi</i> ), Red Bloodwood ( <i>Corymbia gummifera</i> ) and Black Sheoak ( <i>Allocasuarina littoralis</i> ); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid ( <i>C. subulata</i> ) and the Tartan Tongue Orchid ( <i>C. erecta</i> ).	40	60	40	30	0	Recorded in Eagleton and Grahamstown Dam in Coastal Foothills Ironbark Forest area, moderately suitable habitat. Known to local area.	
Small Snake Orchid ( <i>Diuris pedunculata</i> )				Confined to north east NSW. It was originally found scattered from Tenterfield south to the Hawkesbury River, but is now mainly found on the New England Tablelands, around Armidale, Uralla, Guyra and Ebor.		The Small Snake Orchid grows on grassy slopes or flats. Often on peaty soils in moist areas. Also on shale and trap soils, on fine granite, and among boulders. It flowers during August-October. Pollination is mostly by sexual deception, with the Small Snake-orchid attracting mostly males of an native bee Halictus lanuginosus. However, the flowers produce nectar and emit a strong scent that attracts a range of other pollinators.	40	60	40	30	0	Recorded in Black Hill area in Coastal Foothills ironbark Forest, moderately suitable habitat. Known to local area.	High
<i>Pterostylis chaetophora</i>				Recorded in Queensland and NSW. In NSW it is currently known from 18 scattered locations in a relatively small area between Taree and Kurri Kurri, extending to the south-east towards Tea Gardens and west into the Upper Hunter, with additional records near Denman and Wingen. There are also isolated records from the Sydney region. The species occurs in two conservation reserves, Columbe National Park and Wingen Maid Nature Reserve.		The preferred habitat is seasonally moist, dry sclerophyll forest with a grass and shrub understorey. Flowers from September to November. Vegetative reproduction is not common in this group of Greenhoods, but some species may form more than one dropper annually. Fails to flower in dry seasons.	40	60	40	30	0	Recorded in Eagleton and Grahamstown Dam in Coastal Foothills Ironbark Forest area, moderately suitable habitat. Known to local area.	High
Small-flower Grevillea ( <i>Grevillea parviflora subsp. Parviflora</i> )				Sporadically distributed throughout the Sydney Basin with the main occurrence centred around Picton, Appin and Bargo (and possibly further south to the Moss Vale area). Separate		Occurs on sandy clay loam soils, often with lateritic ironstone gravels. Soils are mostly derived from Tertiary sands or alluvium. Found on crests, upper slopes or flat plains in both low-lying areas between 30-65m asl as well as on	40	60	40	30	0	Recorded in Eagleton and Pokolbin in Coastal Foothills Ironbark Forest area, Lower Hunter Ironbark Forest, and Kurri Kurri Sand Swamp Forest, moderately suitable habitat. Known to local area.	High

species	constraints	status	Survey details	Geographic limitations	Sensitivity to gain	Key habitat requirements	Correlations with vegetation zones (% area of habitat for species represented as % of overall area of the zone)					Justification for decision	Confidence
							PCT 1598 Zone 1-3	PCT 1592 Zone 4-6	PCT 1600 Zone 7-9	PCT 1618 Zone 10	PCT 1071 Zone 11		
				populations are also known further north from Putty to Wyong and Lake Macquarie on the Central Coast and Cessnock and Kurri Kurri in the Lower Hunter.		higher topography between 200-300m asl. Prefers open habitat conditions with the largest populations in open woodland and along exposed roadside areas. Competition and shading from dense growth of Tick Bush ( <i>Kunzea ambigua</i> ) appears to limit it's spread at several sites. (NPWS, 2002).							
North Rothbury <i>Persoonia pauciflora</i>				Extremely restricted distribution; all but one of the plants which make up the only known population occur within a 2.5 km radius of the original specimen at North Rothbury in the Cessnock local government area. Within this range, there are three main sub-populations which comprise approximately 90% of the total population. The other 10% of the population occurs as scattered individuals in what is a relatively disturbed landscape.		It is found in dry open forest or woodland dominated by Spotted Gum ( <i>Corymbia maculata</i> ), Broad-leaved Ironbark ( <i>Eucalyptus fibrosa</i> ) and/or Narrow-leaved Ironbark ( <i>E. crebra</i> ) and supporting a moderate to sparse shrub layer and grassy groundcover. The majority of the population is known to occur on silty sandstone soils derived from the Farley Formation. Disturbance events such as grazing, fire and slashing have impacted on both the size and age structure of the population. Plants are absent from comparable habitat that is grazed and/or frequently burnt or slashed.	30	20	20	20	0	Not Ideal habitat.	High
Trailing Woodruff <i>Asperula asthenes</i>				This small herb occurs only in NSW. It is found in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens / Wallis Lakes area / Forster (including Myall Lakes NP, New England NP, Wallingat NP and Darawnk NR).		Occurs in damp sites, often along river banks.	30	20	20	20	0	Not Ideal habitat.	High
Austral Toadflax <i>Thesium austral</i>				Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region.		Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass ( <i>Themeda australis</i> ). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	30	20	20	20	0	Not Ideal habitat.	High



## 4.0 HABITAT AND OCCUPANCY OF SITE BY CANDIDATE SPECIES

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### 4.1 Introduction

This section details the knowledge of the candidate species in the local area and the work undertaken to determine site use, potential habitat and limitations or constraints to use.

#### *Squirrel glider*

A suitable hollow density of 9 ha<sup>-1</sup> onsite indicates that hollows are not a limiting factor for gliders. Winter flowering plants and Ironbark (important for both species) have a cover of 15% and 10% respectively, suggesting that this is also not a limiting factor. Although Squirrel gliders were not positively recorded onsite during surveys, a Squirrel glider population is known to the Thornton Area (captured by the Author in every patch in Thornton) and the floristic and structural conditions are suitable. Current unpublished research (Myer and King 2020) indicates that individuals would occupy between 4 and 14 ha of forest. There is structural connectivity to the north and east from the site, with crossable gaps sufficient for occasional movements. In all, it is likely that there is 56ha of suitable habitat directly available to a local population and 78ha loosely connected. Functional connectivity is unknown, but may be limited by resources, risks in gap crossing and the urban nature of the landscape directly north of the subject site. These matters can be addressed in future reporting without impacting on Master planning.

However, Of the 12ha of forest and woodland vegetation, Squirrel gliders are expected to utilise 100% of this habitat throughout the year, depending of food availability and breeding, and the presence of many suitable hollows onsite requires more detailed assessment of breeding habitat and glider movements to address potential impacts of habitat loss on the local population.

#### *Brush-tailed Phascogale*

The distribution of Brush-tailed Phascogale within NSW has a patchy distribution around the coast of Australia up to 1500m (Soderquist, 1995). In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW. Maxwell *et al* (1996) reported that the within NSW they are most commonly recorded from Taree to Port Macquarie as well as some parts of the Hunter Valley. The distribution of Phascogale populations is correlated to the richness and abundance of arthropods which Recher *et al.* (1996) which are positively related to soil and foliar nutrient levels.

Brush-tailed Phascogale are agile climbers which forage arboreally in dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. They are often found at low densities as they have large home ranges,

male home ranges are up to 100ha (Soderquist 1995) in continuous habitat and overlap with female intrasexually exclusive home ranges (30-60 ha). They are a hollow dwelling species which require large numbers of hollows (>30) within their home range (DSE, 1997). They show a preference (Rhind 2004) for utilising dead or senescent trees with suitable hollows, 25-40mm wide, lined with leaves and pungent faeces (DSE, 1997). They forage arboreally on trunks for large invertebrates including insects, spiders and centipedes (Triall & Coates 1993; Soderquist 1995; Scarff et al. 1998).

There are only scattered local records for Brush-tailed Phascogale, which makes conservation planning difficult. Given these limitations a precautionary approach, whereby there is no increases in fragmentation and remnant vegetation is enhanced, i.e. increase hollow resources. At the local scale (Thornton, Morpeth, Metford) a combined connected area greater than 300ha of suitable forest habitat needs to be retained, enhanced and managed, which is not achievable unless connections can be made under or over rail and road.

#### ***Large arboreal Eucalypt folivores***

Koala habitat is identified on site and the site contains 3 koala feed tree species. Whilst, locally there are only a small number of koala records, the koala habitat protection SEPP aims to protect all koala habitat regardless of occupancy, therefore the final site plan will have to address the criteria for development assessment for a Tier 2 site impact. Greater glider is known locally in mountainous landscapes of the Wattagan ranges, and whilst there are suitable hollows it is unlikely to be occupied by this species, as it is now entirely restricted to elevated landscapes of the ranges.

#### ***Threatened migratory birds***

Birds were surveyed across the study area by random transects targeting periods of high bird activity, predominantly between the hours of 6 am and 9 am (supplementary material for details). Although surveys did not record any Threatened migratory birds there is suitable habitat to support these species from time to time and the value of this site for this group birds cannot be discarded. It is known that movements and use of areas by these species are driven by longitudinal climatic conditions, and occupancy or otherwise, cannot be determined on short period sampling.

#### ***Threatened non-migratory birds***

Connectivity, structure, and disturbance all play roles in the occupancy of a site by non-migratory birds. Given the site condition is poor to moderate, remains connected to large areas of bushland and includes a range of structural and floristic components, including debris, shrubs, mid-storey trees and native grassy understorey areas, there is habitat onsite for all the local threatened non-migratory species.



Scarlet Robin is a small robin that makes seasonal migrations in some parts of its range. However, within the Hunter Valley the species can be found during all seasons and is known to breed in the local area. With records onsite and in the local area the local habitats provide breeding habitat. Like all robins, a complex mix of ground debris, perching sites, open areas, and older trees are important habitat elements. Research has also identified poor dispersal for breeding female robins and detrimental impacts of nest predation from large birds, like currawongs.

Grey-crowned Babbler generally inhabits open Woodlands on range slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Within the Hunter Valley they often occur in Spotted Gum Ironbark forests which have a relatively open understorey with a sparse shrub layer. Locally, they have also been found to utilise regenerating Eucalypt forest and edges of forest on lower Permian slopes, road verges and linear plantings (King 2004). The species is known to have a poor ability to recolonise habitats (Traill and Duncan 2000).

They live in family groups and forage on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. They build and maintain several conspicuous, dome-shaped stick nests about the size of a football. Research (unpublished) by the author has identified babblers within every patch in the local area. The species benefits from habitat management and enhancement but is susceptible to predation (cats and dogs) and does not respond well to increases in forest projective foliage cover and increase cover from weeds like Lantana.

Eastern Osprey is a large bird of prey that forages over open water bodies. In recent times (last five years) the species range has expanded with movement south and further west. Locally a pair have been breeding at the Maitland Rugby Field and recorded regularly along the Hunter River between Maitland and Morpeth. The author has recorded individuals foraging over Woodberry Swamp, Hexham Swamp and Morpeth Wastewater Facility. A pair have also been recorded at Raymond Terrace and seen along rivers from Hexham to Seaham and on occasion at Seaham Swamp Reserve. The species will exclusively use elevated perch and nesting sites with a view over water. Whilst Eastern Osprey was recorded onsite, this is a record of a high-flying record presumably of an individual moving between wetlands (i.e. Morpeth WWF) and the Hunter River. It is unlikely that the site plays any major role for the local population.

The recording of both White bellied Sea Eagle and Little Eagle near the site are considered as extraneous observations, and the site is unlikely to play any major role for the local population.

### ***Nocturnal birds***

Large forest owls are top-order predators and are important indicators of system health and stability. Powerful owl is a local species, and its recorded use of the local area indicates that the lower order trophic levels can support this species. It is unclear if this species roosts in the local area (out of scope of this project), however it is known to roost and breed in the patches south of the site between Mt Vincent Road and Weakleys Drive. Regardless the site clearly provides foraging habitat. There is evidence that Sooty owl and Powerful owl will co-occupy a site, Sooty owl was not recorded onsite in this survey and suitable habitat is absent.

Barking owl use open areas, riparian areas surrounded by agricultural lands and fragmented landscapes. Although local records for Barking owl are sparse, the presence of a local glider population, and large patches containing suitable hollows indicates there is suitable foraging habitat in the local area and onsite. Habitat retention strategies onsite and in the local area must aim to retain suitable habitat for foraging and connectivity so that prey species populations can endure.

### ***Bats***

Foraging habitat is abundant for bats onsite, and all the local species recorded would be expected to occupy the site and the local area on a regular basis. Bat conservation has many challenges, but the key issues are, habitat loss, hollow retention, difficulties of identification of roost trees, light and noise pollution, and a general lack of monitoring for local populations. All need to be addressed to successfully manage local populations. The following scheme is proposed to meet these conservation objectives:

- Using thermal cameras identify roost trees onsite.
- Any roost trees be monitored and apply for licence to relocate (if required).
- Other suitable hollows be collected and reinstated in reserve areas.



## 5.0 CONCLUSION

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The total area of the site is 48.13 ha, consisting of 21 ha of cleared and degraded wasteland areas created during historical quarrying of the site. Vegetation onsite consists of 14.26 ha of disturbed regenerating vegetation (29%), 12.22 ha of mature remnant vegetation (25%) and 21.65 ha of cleared areas. The vegetation onsite is a mix of Lower Hunter Spotted Gum Ironbark communities, Lower Hunter Forest Red gum communities and a small representation of common communities that are possibly derived communities, as a result of disturbance, regeneration and the changes in geology at the base of disused brick pits.

The wasteland, industrial areas of the site (18.76 ha) will require significant repair and filling to form a usable and safe landscape. Regardless of future land use, this area requires repair. The remnant landscape areas of the site, that is areas of the site not impacted by quarrying or other excavation (27.9 ha) provides habitat for all the mature remnant vegetation recorded onsite (12.22 ha). In terms of conservation biology, strategic planning and council wide threatened species management, these remnant natural landscape areas are the most important areas of the site.

The proposal will retain 4.5 ha of mature forest, 2.52 ha of regenerating forest and rehabilitate and construct 0.75 ha of wetlands. The total area should also be enhanced and managed to improve habitats for flora and fauna. In terms of forest age and condition, the proposal will retain 65% of the best quality forest onsite. A north south connection (~ average of 82m wide) will be retained and enhanced between the Metford remnant south of the Northern Railway and north and east of the site towards Thornton North remnants. Further studies will be required to ascertain the appropriate level of enhancement needed to manage gap crossing for a range of fauna species, however this planned connection is a viable local area conservation initiative and is consistent with local planning objectives.

The biota recorded onsite is consistent with what is known of the local area and whilst there is habitat for a range of threatened species, the planned retention, connections and enhancement as part of the proposal, indicates that it will not result in a serious or irreversible impact on local biota.