Train Support Facility
Greta, NSW

ECOLOGICAL IMPACT ASSESSMENT

- May 2010

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Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
R01	12/02/10	J.Harty	C.Thomson	01/02/10	Practice Review
R02	1/03/10	C.Thomson	C.Thomson	02/03/10	Final Review
Final	6/05/10	C.Thomson	B.Watson	06/05/10	Final Report

Distribution of copies

Revision	Copy no	Quantity	Issued to
Rev01	1	1	Monteath & Powys
Final	1	1	Monteath & Powys

Printed:	11 May 2010
Last saved:	6 May 2010 05:16 PM
File name:	SKM_Ecology_GretaRailDepot_Final_02.03.10.docx
Authors:	Chris Thomson, Andrew Carty
Project manager:	Chris Thomson
Name of organisation:	Pacific National
Name of project:	Train Support Facility, Greta
Name of document:	Ecological Impact Assessment
Document version:	Final report
Project number:	EN02698

1. Introduction

1.1. Project description

Sinclair Knight Merz was commissioned by Pacific National (the Proponent) to provide an ecological impact assessment (EIA) to identify and assess the ecological impacts from the proposed development of a Train Support Facility at Greta, in the Hunter Valley, New South Wales (the Project).

The Project comprises the construction of a series of rail sidings, maintenance facilities and staff car parking on a 49.3 ha site, referred to in this document as the 'subject site', comprising a former rural property and comprising a mix of natural and regenerating bushland as well as cleared land. The report refers to the 'study area' as the land directly impacted by the proposed Project as well as immediately adjacent areas, which may be indirectly impacted by the construction and operation. Additional specifics of the Project design components are discussed throughout the report as they relate to the assessment of impacts.

1.2. Scope of the EIA

The report documents the methods and results of a survey an assessment of the impacts on flora and fauna species, communities and habitats located in the study area. The information presented is based on a review of available ecological data pertaining to the study area and supported by field surveys. The resulting data has been used to assess the significance of potential impacts from the Project on listed species, ecological communities and populations under state and national threatened species legislation, and their habitats, which are known or considered likely to occur within the study area. Consideration has been given to local and regional significance or preliminary determinations for listing where applicable.

1.3. Legislative context

The Project application is to be assessed under Part 3A of the Environmental Planning and Assessment Act, 1979 (*EP&A Act*). Other relevant legislation pertaining to the assessment in relation to listed species, communities and populations includes the Federal *Environmental Protection and Biodiversity Conservation Act*, 1999 (*EPBC Act*), and the NSW *Threatened Species Conservation Act*, 1995 (*TSC Act*).

The EIA addresses the requirements of the Director-General of the NSW Department of Planning (DGR's) in assessing the Part 3A project application. The specific matters listed in the DGR's with respect to ecology include, but are not limited to:

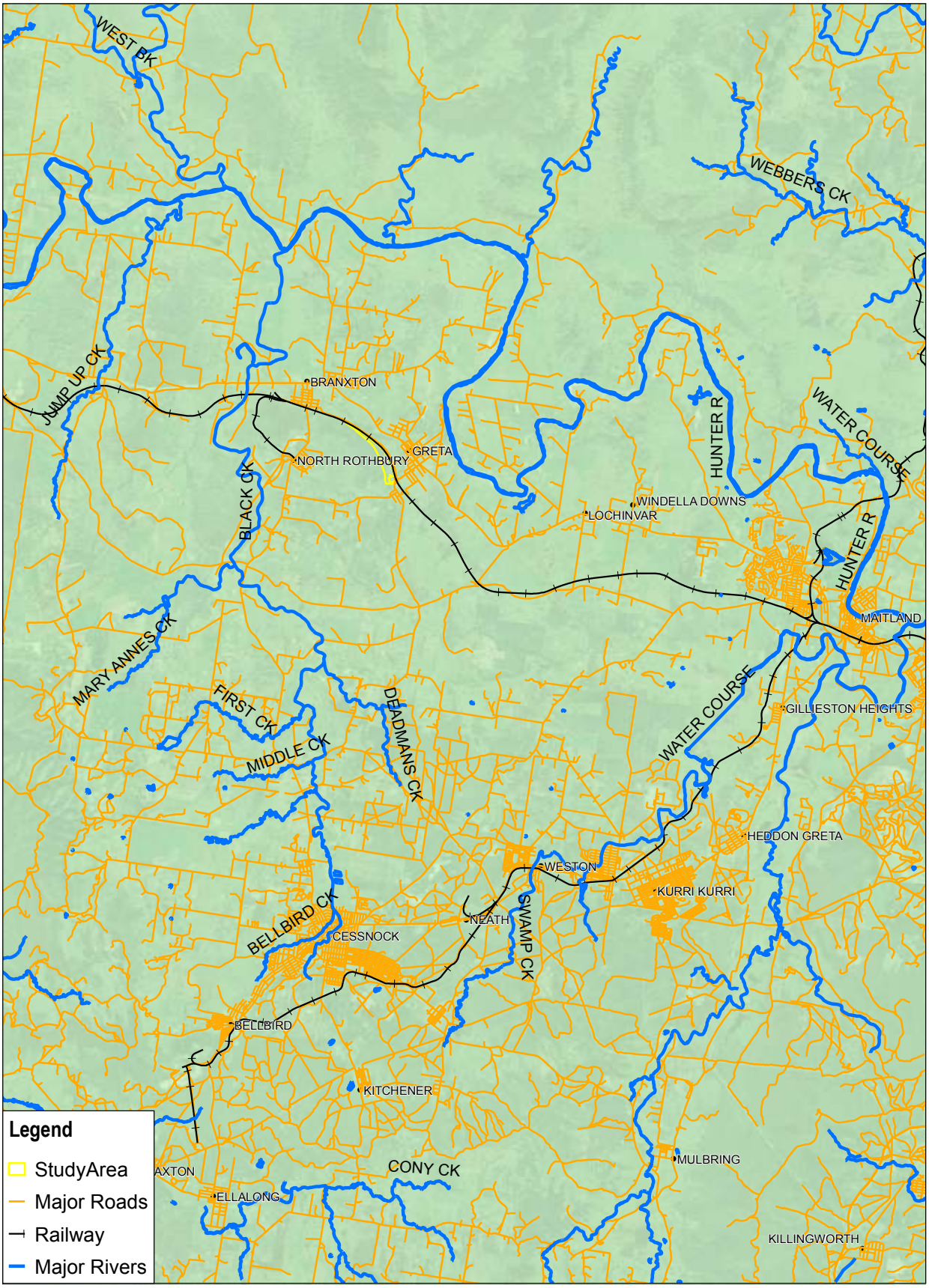
- Threatened species, populations, endangered ecological communities, and/or critical habitat;
- Surveys of identified species and habitat including Lower Hunter Spotted Gum Ironbark forest;
- Vegetation clearing (foraging, roosting, nesting, habitat loss and fragmentation), riparian impacts and operational impacts (such as lighting and noise);
- Surface and groundwater impacts and management;
- Taking into account the draft guidelines for *Threatened Species Assessment (DEC&DPI 2005)* and the *Principals for the Use of Biodiversity Offsets in NSW (DECCW, 2008)*

1.4. Environmental setting

Previous vegetation assessments conducted for the Lower Hunter and Central Coast Regional Environmental Strategy (LHCCREMS, 2003) provide the most comprehensive and broad-scale identification of the vegetation of the Lower Hunter Valley area and include the Project study area. This work links broad structural and floristic vegetation attributes to major soil types, namely alluvial, clay and sandstone parent material. This has provided the major work upon which strategic planning has been made in the Lower Hunter to date and the scientific data to support the listing of several 'endangered ecological communities' under Schedule 1 part 2 of the TSC Act.

A review of this data in relation to the Project study area indicates the likely presence of Lower Hunter Spotted Gum - Ironbark Forest (LHSIF) an Endangered Ecological Community (EEC) listed under the TSC Act. The presence of this community has been confirmed from land adjacent to the study area and approved for development of a new motorway, the Hunter Expressway (Biosis 2005). Another EEC listed under the TSC Act has also been identified in proximal lands, namely Hunter Lowlands Red Gum Forest (LHCCREMS, 2003).

The study area is on the western border of the 'Lower' Hunter Valley region, with the extent of the LHCCREMS (2003) mapping finishing approximately 2.8 km to the west, where another broad-scale mapping project for the 'Central' Hunter Valley starts (Peake 2006). Considering the proximity of the study area in relation to the confluence of these two geographical regions, the natural vegetation may comprise an ecotonal area between the Central and Lower Hunter vegetation. For example land to the west of the study area has been identified by Peake (2006) as Central Hunter Ironbark – Spotted Gum – Grey Box Forest, which is a preliminary listed EEC under the TSC Act. Field surveys have been conducted to ground-truth the identified regional vegetation mapping, and aim to identify the presence of EEC's applicable to the study area by delineating the vegetation community types.



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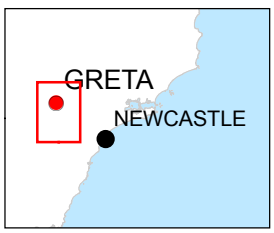

Figure 1: Project Location

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2. Methods

2.1. Background review

A review of relevant data sources was conducted as the first stage of the assessment. This included the following:

- The Atlas of NSW Wildlife (NSW Department of Environment and Climate Change and Water) for the Cessnock 1:100 000 mapsheet, accessed September 2009).
- EPBC Act Protected Matters online search tool, accessed September 2009.
- NSW National Parks and Wildlife Service (2000). Vegetation Survey, Classification and Mapping for the Lower Hunter and Central Coast Region (LHCCREMS 2000).
- The Vegetation of the Central Hunter Valley undertaken for the Hunter Central Rivers Catchment Management Authority (Peake 2006).
- Threatened species publications and species recovery plans http://www.threatenedspecies.environment.nsw.gov.au
- Results of local environmental studies, including ecological studies prepared for the F3 to Branxton Link (Hunter Expressway) (Biosis 2005).

This information was used in conjunction with the results of field investigations to prepare a list of threatened species, populations and communities that are known and considered to potentially occur on the site and therefore subject to further assessment of the significance of impacts from the Project.

2.2. Flora survey

A comprehensive flora survey was conducted to provide baseline floristic data and investigate the presence of threatened plant species, populations and / or endangered ecological communities in the study area. The data was used to predict the extent and magnitude of potential impacts, in addition to providing input into the Project design to reduce impacts and recommend measures to minimise and manage such impacts.

2.2.1. Transects and traverses

The distribution and extent of vegetation communities in the locality was initially identified from previous broad-scale vegetation maps as discussed previously (i.e. LHCCREMS, 2003 and Peake, 2006). The existing vegetation maps were overlaid on the site and ground-truthed at an appropriate scale specific to the study site. Transect sampling was conducted to identify and

refine the vegetation community boundaries. This was combined with a general traverse along vegetation community boundaries marking grid waypoints with a hand-held GPS unit.

Digital mapping of vegetation community boundaries was conducted using ArcGIS and a combination of the field waypoint data, aerial photograph interpretation and biophysical attributes such as elevation, topography and soil type. Description of the vegetation communities followed structure and dominant canopy species (Specht 1981) and compared with final and preliminary determination advice on endangered ecological communities (*TSC Act*).

2.2.2. Plot-based survey

Quantitative data was collected from a series of quadrats (400m^2) replicated across each vegetation type. The data was used to determine floristic composition and structure of the vegetation associations, and the ecological condition of the vegetation including a rating of disturbance and weed abundance. Data collected in each sample plot included:

- Dominant species in each structural layer.
- Heights of structural layers (i.e. canopy, sub-canopy, shrub and groundcovers).
- A cover abundance score of each layer (based on a modified Braun-Blanquet cover scale).
- Landscape features (i.e. slope, gully, aspect etc).
- Soil features (soil type, rocks, organic matter etc).
- Geographical coordinates and a photographic record.
- Species richness and abundance.
- An inventory of all species in the plot.
- The presence and abundance of weed species.
- The condition of the vegetation including past and present disturbances such as fire, grazing, logging, etc.
- The presence, abundance and geographic coordinates of rare and threatened plants species.

Additional to these quadrat assessments and general traverses, rapid plot-based assessments were undertaken recording dominant floristic species and vegetation structure to aid vegetation mapping. Any species which could not be identified in the field were collected for later identification or for lodgement with the National Herbarium.

2.2.3. Targeted surveys

Threatened searches were conducted for threatened species considered to potentially occur on the site, as determined by the background review and knowledge of the species habitat

requirements. Targeted surveys comprised random meanders through areas of suitable habitat, which allows for greater coverage than plot-based techniques.

2.3. Fauna survey

The assessment of impacts on terrestrial fauna has utilised quantitative and qualitative data sourced from field surveys and background reviews and knowledge of the fauna of the regional area. Data was collected on the type and distribution of fauna habitats and fauna species richness, distribution and abundance focusing on threatened species listed under the *TSC Act* and *EPBC Act*.

2.3.1. Habitat stratification

Fauna survey sites were selected to sample the range of habitat types identified on the site based on an initial stratification. Three fauna habitat types were identified on the site, comprising open forest, freshwater aquatic habitat (artificial dams and ephemeral creeks) and cleared and modified habitat, including young regrowth. The forest habitat is typically uniform across the site varying in structure according to dominant tree species and topographic relief. Two associations were recognised; a Spotted Gum / Ironbark associations on undulating slopes and a Forest Red Gum / Ironbark association in lower slopes and along drainage lines. A summary of the fauna survey effort relevant to each habitat type is provided in **section 2.3.3.**

The fauna survey was conducted during the spring season of 2009 (i.e. September-October) and was designed in general accordance with the *Draft Threatened Biodiversity Survey and Assessment Guidelines* (NSW Department of Environment and Conservation 2004) which included diurnal and nocturnal census. Habitat assessment was also conducted to provide a landscape evaluation of the habitats in the study area and surrounding or proximal areas. The location of fauna survey sites are presented in **Figure 2**.

2.3.2. Survey conditions

Weather conditions were recorded during the field surveys and detailed below. The survey period was considered optimum for the detection of the majority of the target species. Up to 14 mm of rainfall fell in the week preceding the nocturnal survey on the 8 October.

Table 1 Survey weather conditions

Dates	Mean Temp (°C)		Moon	Average winds	Weekly Total (mm)
	Min	Max			
14-18 Sept 2009	12.5	26.9	Last quarter to new moon	Calm to slight tending NNE	0.2
8 October 2009	9.5	19.5	Full moon to last quarter	Slight SE	0

2.3.3. Targeted surveys

Small terrestrial mammals

Live-trapping of small to medium sized ground-dwelling mammals was conducted at three sites (two in the Forest Red Gum / Ironbark Forest and one in Spotted Gum / Ironbark Forest). A standardised parallel transect arrangement was used (2 x 100 m) separated by 50 m and delineated by 20 Elliott type A, 33 x 10 x 9 cm, aluminium folding traps) placed 10 m apart with a cage trap (wire 30 x 30 x 60 cm) placed at opposite ends. Two Elliott type B traps, 15 x 16 x 45 cm, were placed on the ground midway along each transect (totalling 4 per site).

All traps were baited with peanut butter, rolled oats and honey and cage traps were baited with tinned sardines. Traps and cages were placed in or under cover wherever possible. Traps were opened for four-nights at each site and were checked each morning. Captured animals were measured, weighed, identified and released. The species and location of mammal scats, scratches and other evidence of fauna presence when encountered was noted to provide locality records for native and exotic species.

Arboreal mammals

Live-trapping of arboreal mammals was conducted at each of the three traps sites which involved three traps placed along each of the ground trapping transects described above (i.e. 6 traps per site) spaced 50 m apart. At each point a trap (Elliott type B, 15 x 16 x 45 cm aluminium folding trap) was mounted on a platform attached to the trunk of a tree at a height of 3.5 metres. Each trap was baited with a mixture of peanut butter, rolled oats and honey and the trunk of the tree adjacent to the trap sprayed with a mixture of water and honey to act as an attractant. Traps were inspected each morning and the tree re-sprayed with the honey-water mixture. Any animals captured were measured, weighed, identified and released at the capture site the following night. Each trap grid was active for four consecutive nights.

Spotlighting and dusk census for arboreal mammals was conducted at each trap site during the trapping period. Spotlighting was foot-based and comprised a general traverse across the site and adjacent tracks or forest edges, utilising 50W hand-held spotlights powered by 12V batteries. One observer conducted the survey for a minimum period of 1 hour per site. Stagwatching was conducted at site 3.

Additional spotlight surveys were conducted along all vehicle tracks and dams on the site and the creekline in the southern end of the site on 8th October 2009. All fauna heard or observed were recorded to species level. Observations of fauna were aided by the use of binoculars. Counts were taken on the number of fauna heard and observed during spotlighting.

Call playback for mammals

Pre-recorded calls of the koala (*Phascolarctos cinereus*), yellow-bellied glider (*Petaurus australis*) and squirrel glider (*P. norfolcensis*) were played through a 15W megaphone during spotlighting at each of the trap sites. Calls were played at the start of the spotlighting session for a total of 5 minutes for each species and followed with quiet listening and spotlighting.

Bats

A stationary ultrasonic bat call detector (Anabat II, Titley Electronics) was used with a storage ZCAIM unit to record bat calls at two locations (**Figure 2**). Calls were recorded continuously between 1800 and 0500 hours for two nights at each site. Calls were identified to genus or species level where possible using computer frequency analysis software (Analook v.4.0).

Spotlighting and listening for calls of megachiropteran bats (*Pteropus* spp) was conducted during spotlighting activities and localities recorded.

Birds

The survey method for birds was replicated across each of the trap sites and involved walking along a line transect by a single observer moving along a fixed route and recording the birds seen and heard on either side of the route. Each transect was a fixed 200 m long and 100 m wide, generating a 2 ha search area. The survey aimed to record all birds seen or heard within 50 m either side of the transect over a minimum 20 min period. Birds were also recorded opportunistically during all other site visits and field surveys activities. Binoculars were carried in the field at all times to assist in identification.

Targeted surveys for the Grey-crowned Babbler (*Pomatostomus temporalis* ssp *temporalis*), involved recording all observations of birds seen and heard. Further searches were conducted at these locations to record the distribution and abundance of characteristic nest and dormitory sites to give an indication of the spatial arrangement of family groups.

Call playback for birds

Call playback of the Powerful Owl (*Ninox strenua),* Barking Owl (*N.connivens)* and Masked Owl (*Tyto novaehollandiae)* was conducted near each mammal trap site during the nocturnal surveys. Pre-recorded calls were broadcast via a 15W megaphone for a period of five minutes for each species, followed by a five minute listening period. Spotlighting was conducted briefly between calls and then following completion of the call playback series for a period of 10 minutes. Quiet listening for dusk calls of each large forest owl species was also undertaken whilst conducting other field activities such as spotlight searches.

Reptiles and amphibians

Both nocturnal and diurnal herpetological surveys were conducted at each trap. Nocturnal herpetofauna was surveyed during spotlighting activities and included the survey of the margins of wet areas and artificial dams for active frogs and reptiles. Systematic frog searches were also carried out at artificial dams and creeks. Nocturnal surveys for frogs were conducted by one person using a spotlight (50W) and battery powered head torch.

Frogs were identified by call, and / or visual characteristics. All active frogs were captured, where possible, identified and immediately released. At potentially suitable locations throughout the study area, a period of listening for the calls of frog species was undertaken. The conditions were considered optimal for the survey of frogs.

The diurnal component of the reptile surveys consisted of hand searches for active and resting individuals under rocks, logs, bark, leaves and timber and artificial debris when encountered. Specific reptile census was conducted for 30 minutes at each of the three trap sites. Opportunistic observations were also recorded during the carrying out of other survey activities.

Fauna survey effort

The total fauna survey effort per technique and habitat unit is summarised below.

- **Table 2 Summary of fauna survey effort**

Technique	Target group	Survey effort *			
		Spotted Gum / Ironbark Forest	Forest Red Gum / Ironbark Forest	Artificial dams and creeks	Total effort
Mammal traps (tree-mounted)	Brush-tailed Phascogale and Squirrel Glider	24[1]	48[1]	-	72 trap nights
Mammal traps (small ground)	Small terrestrial mammals	80[1]	160[1]	-	240 trap nights
Mammal traps (large ground)	Medium terrestrial mammals	16[1]	32[1]	-	48 trap nights
Cage traps	Larger ground-dwelling mammals (e.g. Spotted-tailed Quoll)	8[1]	16[1]	-	24 trap nights
Bat call recording	Threatened microchiropteran bats	-	-	2[3]	2 sites (24 hrs)
Spotlighting	All groups	3[2]	3[2]	2[2]	8 person hours
Diurnal birds	Diurnal birds	1[3]	2[3]	1[3]	4 sites
Call playback	Large Forest Owls	1[3]	2[3]	-	3 sites
Call playback	Arboreal mammals	1[3]	2[3]	-	3 sites
Reptile searches	Reptiles	0.5[2]	1[2]	0.5[2]	2 person hours
Stagwatch survey	Arboreal mammals, owls and bats	1	-	-	-
Scat search	koala	1[3]	2[3]		3 sites

* 1 = trap nights; 2 = person hours; 3 = number of sites where census was conducted

Habitat assessment

A habitat assessment was conducted at each of the trap sites, by sampling a 0.25 ha quadrat and assessing the condition and abundance of a set of habitat criteria listed below. Additionally, general meanders were undertaken throughout the entire site to assess fauna habitat quality and the continuity of adjacent areas. The criteria used were considered to represent minimum attributes required for reasonable habitat health and viability and included:

- Type and structure of the vegetation, including an assessment of the 'naturalness' in terms of the presence of native remnant vegetation or planted and regrowth areas and the extent of logging.
- Presence and frequency of large mature trees, tree hollows and their size classes, standing dead trees (stags) and logs or boulders.
- Dominant flora species and a subjective assessment of floristic diversity at different structural layers, flowering and fruiting resources.
- Presence of significant keystone species and critical habitat elements for threatened fauna.
- Representation of the habitat type on a local and regional scale.
- Disturbance regimes, both past and ongoing including fire regime and weed abundance.
- Density of each vegetation strata (structural diversity).
- Presence and quality of wet areas or waterbodies, significant aquatic habitats where present.
- Size of remnant patches and extent of connectivity, movement corridors and refuge value.

The data was used in combination with field survey results to identify habitats of conservation value for fauna, in particular threatened fauna recorded from the region and site.

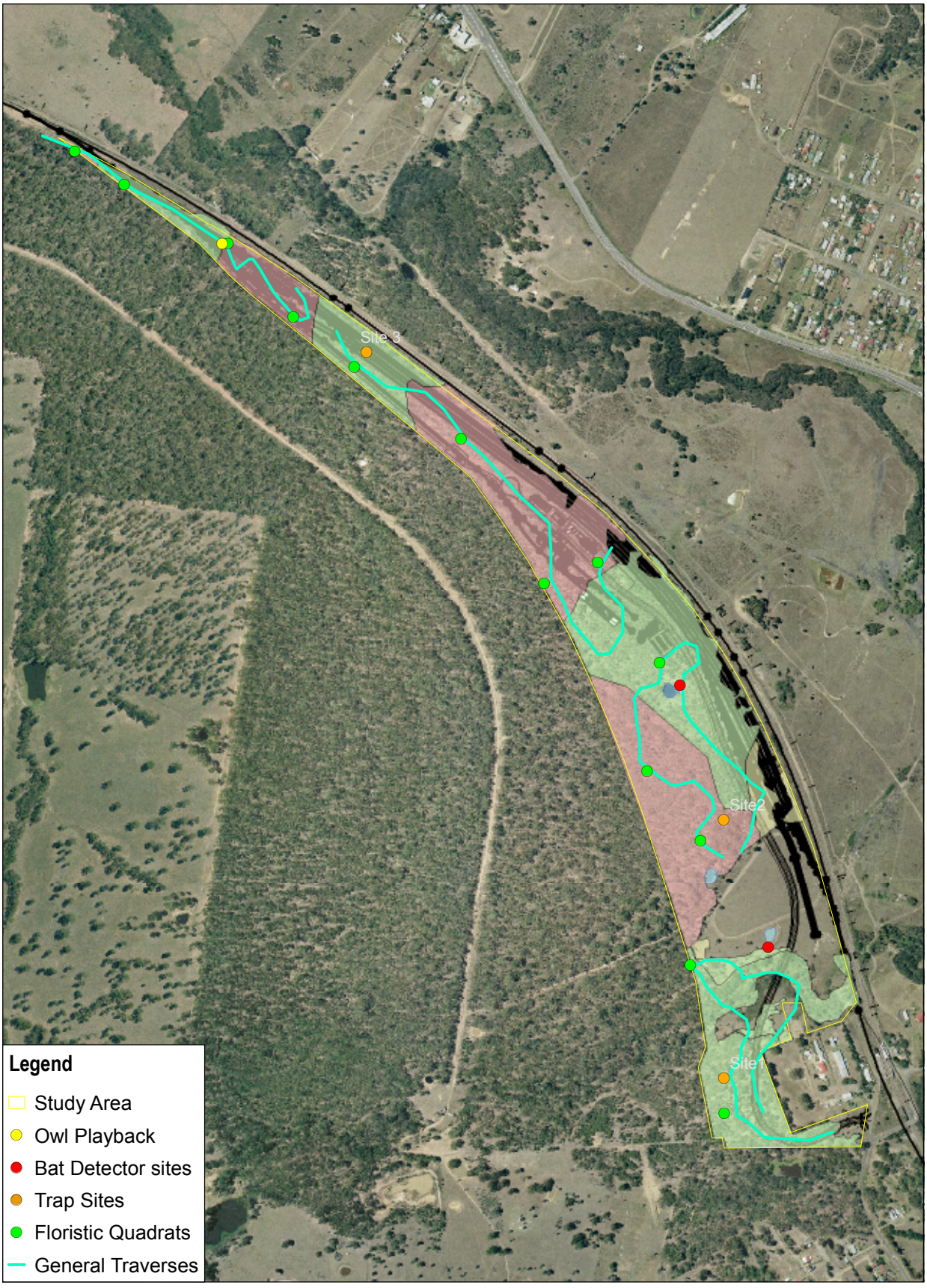
Tree hollow assessment

The density of tree hollows in the remnant habitats of the site was determined by randomly surveying three transects each 200 m x 50 m (1 ha) located at each of the three trap sites. The mean number of hollows was quantified, taking into account all hollow sizes both within dead and live trees.

Koala habitat assessment (SEPP 44)

While a formal assessment under SEPP 44 is not required for a Part 3A assessment under the EP&A Act, an assessment has been undertaken and the SEPP 44 survey approach used to identify the value and significance of the habitat on site for koalas.

The presence of koalas was targeted during spotlighting surveys and general site traverses. An additional assessment was also undertaken to investigate the presence of Potential and Core Koala Habitat (as defined under SEPP 44), which included quantifying tree species and searches for scats (faecal pellets) beneath known Koala food tree species, such as Forest Red Gum (*E.tereticornis*).



Data Sources
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Figure 2: Flora and fauna survey locations

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3. Results: Background Review

3.1.1. Endangered ecological communities

As stated previously a review of existing vegetation data (LHHCREMS 2003) in relation to the study area indicates that the vegetation on the site consists of Lower Hunter Spotted Gum - Ironbark Forest an EEC listed under the TSC Act. Two other EECs have been mapped on surrounding lands comprising Hunter Lowlands Red Gum Forest and the Central Hunter Ironbark – Spotted Gum – Grey Box Forest (LHCCREMS 2003; Peake 2006). These potentially occurring EECs are listed below in **Table 3** and their modeled distribution is displayed in **Figure 3.**

- **Table 3 Endangered ecological communities identified in the broad-scale mapping of the locality**

Endangered Ecological Community	Status	Brief Description
Lower Hunter Spotted Gum – Ironbark Forest	Endangered TSC Act	Restricted to a range of approximately 65 km by 35 km centred on the Cessnock - Beresfield area in the Central and Lower Hunter Valley (NPWS 2000) occurring principally on Permian geology. Dominated by Spotted Gum (*Corymbia maculata*) and Broad-leaved Ironbark (*Eucalyptus fibrosa*), while Grey Gum (*E. punctata*) and Narrow-leaved Ironbark (*E. crebra*) occur occasionally.
Hunter Lowlands Red Gum Forest	Endangered TSC Act	Extends from Muswellbrook to the Lower Hunter. Occurs on gentle slopes arising from depressions and drainage flats on Permian sediments of the Hunter Valley floor. The most common canopy tree species are Forest Red Gum (*Eucalyptus tereticornis*) and Grey Gum. Other frequently occurring canopy species are Rough-barked Apple (*Angophora floribunda*), Spotted Gum, Narrow-leaved Ironbark and Grey Box (*E. moluccana*).
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	Endangered TSC Act	Occurs in the central and eastern parts of the Central Hunter region. Dominated by Narrow-leaved Ironbark, Spotted Gum and Grey Box. Other tree species may be present and occasionally dominate or co-dominate including Broad-leaved Ironbark and Forest Red Gum.

3.1.2. Threatened flora

On the basis of regional records, reports and the presence of suitable habitat, a total of 6 threatened flora species potentially occur in the local area. The list of species considered for further assessment is detailed in **Table 4** along with the known geographical distribution, preferred habitats for each species and the corresponding habitats in the study area.

The locations of the recorded threatened flora species specific to the study area are illustrated in **Figure 4**. This figure only provides the confirmed records of threatened species and it is recognised that other threatened species may potentially occur.

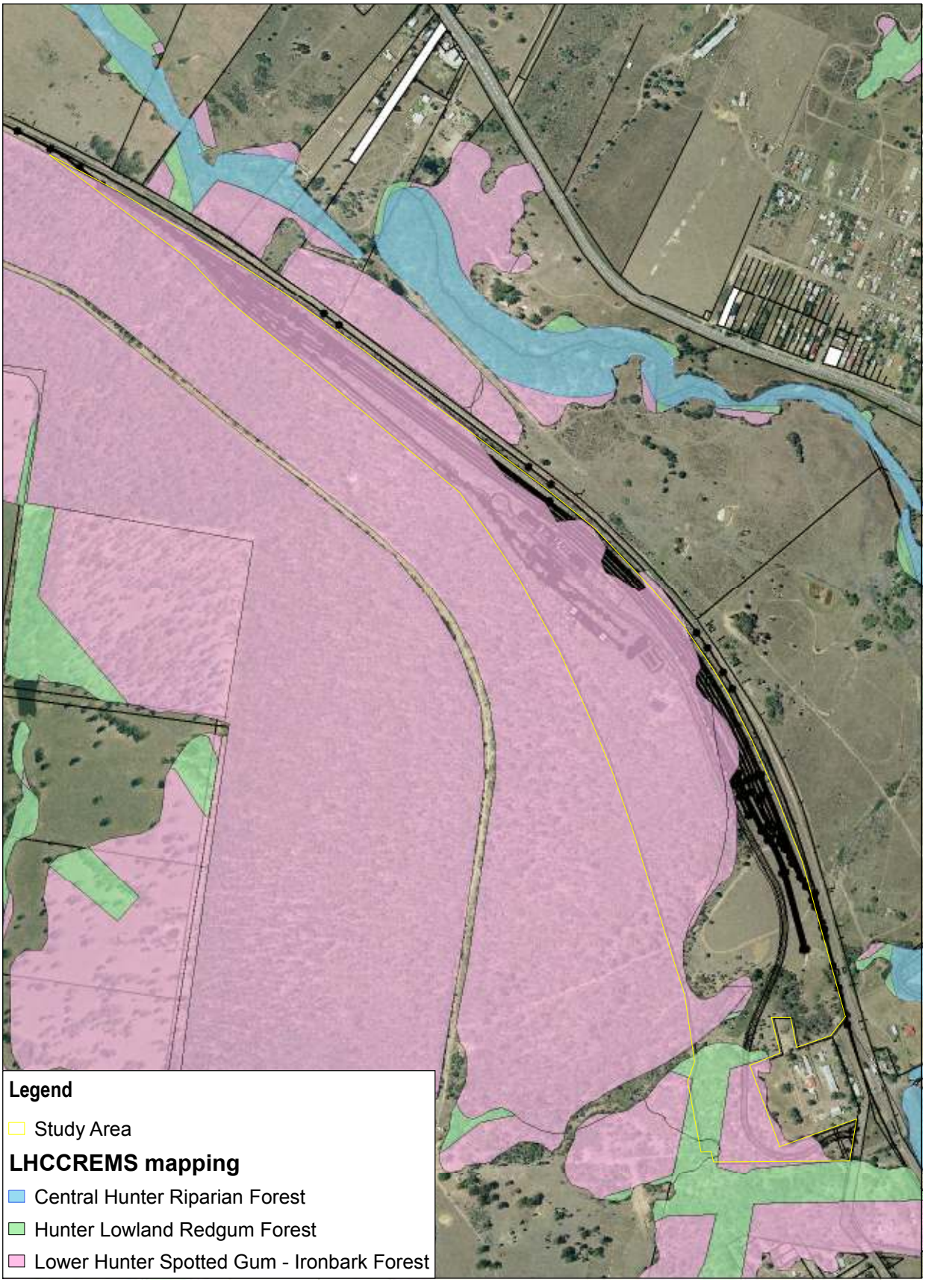

Figure 3: Regional vegetation mapping (LHHCREMS 2003)

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- **Table 4 Threatened flora known from the locality (potential subject species)**

Species	Status			Distribution and Habitat Requirements*	Number of records in locality (10 km radius)	Potential to occur in Study Area
	EPBC Act	TSC Act	RoTAP+			
Persoonia pauciflora North Rothbury Persoonia	CE	E	2E	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.	49	High
Acacia bynoeana	V	E	3VC-	Found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include *Corymbia gummifera, Eucalyptus haemastoma, Eucalyptus parramattensis, Banksia serrata* and *Angophora bakeri.*	1	Moderate-High
Cryptostylis hunteriana	V	V	3VC-	Recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra although it is uncommon at all sites. Also recorded at 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 (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black She-oak (*Allocasuarina littoralis*). Seems to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*Cryptostylis subulata*) and the Tartan Tongue Orchid (*Cryptostylis erecta*).	0	Moderate
Eucalyptus glaucina Slaty Red Gum	V	V	3VC a	Found only on the north coast of NSW and in separate districts: near Casino where it can be locally common, and farther south, from Taree to Broke, west of Maitland. Grows in grassy woodland and dry eucalypt forest, on deep, moderately fertile and well-watered soils.	41	High
Eucalyptus parramattensis subsp. decadens	V	V	2V	Occurs in two meta-populations comprising: the Kurri Kurri meta-population which is bordered by Cessnock—Kurri Kurri in the north and Mulbring—Abedare in the south; and the Tomago Sandbeds meta-population is bounded by Salt Ash and Tanilba Bay in the north and Williamtown and Tomago in the south. Generally occupies deep, low-nutrient sands,	*3*	Low

Species	Status			Distribution and Habitat Requirements*	Number of records in locality (10 km radius)	Potential to occur in Study Area
	EPBC Act	TSC Act	RoTAP+			
				often those subject to periodic inundation or where water tables are relatively high. It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland.		
Grevillea parviflora subsp. parviflora	V	V	-	Sporadically distributed throughout the Sydney Basin with the main occurrence centred around Picton, Appin and Bargo. Separate 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. Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	0	Low

CE- Critically Endangered species, E – Endangered species, V – Vulnerable species

RoTAP: 2 = geographic range in Aust less than 100 km; 3 = range greater than 100 km. E = endangered: taxon in serius risk of disappearing from the wild within 10-20 years if present. V = Vulnerable: taxon not presently endangered but a risk over a longer period (10-20 years) of disappearing from the wild. C = Reserved: at least one population within a conservation reserve. a= 1000 plants or more known to be conserved.

3.1.3. Threatened fauna

On the basis of regional records and reports and the presence of suitable habitat, a total of 35 threatened fauna species have been considered as potentially occurring in the study area. The list of species considered is detailed in **Table 5** along with the known geographical distribution, preferred habitats for each species and the corresponding habitats in the study area. The locations of known records of these species are displayed in **Figure 5.**

- **Table 5 Threatened fauna known from the locality (potential subject species)**

Species	Status		Distribution and habitat requirements*	Number of records in locality (10 km radius)	Potential to occur in the study area
	EPBC Act	*TSC Act*			
Mammals					
Brush-tailed Rock Wallaby *(Petrogale penicillilata)*	E	E	Open forest habitats on steep terrain with exposed rocks, rock overhangs and platforms.	0	Unlikely, terrain unsuitable
Brush-tailed Phascogale (*Phascogale tapoatafa*)	-	V	Dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabits heath, swamps, rainforest and wet sclerophyll forest.	2	Yes, habitat is suitable

Species	Status		Distribution and habitat requirements*	Number of records in locality (10 km radius)	Potential to occur in the study area
	EPBC Act	*TSC Act*			
Eastern Bent-wing Bat *(Miniopterus schreibersii)*	-	V	Forages in a variety of habitat types including, dry sclerophyll forests and woodlands, as well as cleared and modified urban environments, a cave roosting species requiring caves and artificial tunnels for breeding and roosting.	20	Yes, foraging habitat is present
Eastern Cave Bat (*Vespadelus troughtoni*)	-	V	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs.	2	Yes, foraging habitat is present
Eastern False Pipistrelle *(Falsistrellus tasmaniensis)*	-	V	Occurs in a variety of open forest and woodland habitats, where hollow-bearing trees are present and required for roosting, may forage in younger regrowth and modified environments.	2	Yes, foraging habitat is present
Eastern Freetail Bat *(Mormopterus norfolkensis)*	-	V	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures.	10	Yes, foraging habitat is present
Greater Broad-nosed Bat *(Scoteanax rueppellii)*	-	V	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.	4	Yes, foraging habitat is present
Grey-headed Flying-fox *(Pteropus poliocephalus)*	V	V	Forages on nectar and pollen in sclerophyll forests and on rainforest fruits and vines, orchards, gardens.	18	Yes, foraging habitat is present
Hastings River Mouse (*Pseudomys oralis*)	V	E	Dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops.	0	Unlikely, not known from the locality and habitat unsuitable
Koala *(Phascolarctos cinereus)*	-	V	Open forests and woodlands with favoured food tree species.	2	Possible, potential koala habitat occurs in the locality
Large-eared Pied Bat *(Chalinolobus dwyeri)*	V	V	Forages over a broad range of open forest and woodland habitats, this species is a cave roosting bat which favours sandstone escarpment habitats for roosting, in the form of shallow overhangs, crevices and caves.	0	Yes, foraging habitat is present
Large-footed Myotis *(Myotis adversus)*	-	V	Generally roost in groups close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools catching insects and small fish.	6	Yes, foraging habitat is present

Species	Status		Distribution and habitat requirements*	Number of records in locality (10 km radius)	Potential to occur in the study area
	EPBC Act	*TSC Act*			
Little Bent-wing Bat (*Miniopterus australis*)	-	V	Moist eucalypt forest, rainforest or dense coastal banksia scrub.	3	Yes, foraging habitat is present
Spotted-tailed Quoll *(Dasyurus maculatus)*	E	V	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated large expansive areas of habitat to sustain territory size. Requires hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	9	Low likelihood, habitat probably too disturbed and fragmented
Squirrel Glider *(Petaurus norfolcensis)*	-	V	Forest and woodland habitats, particularly areas with a diversity of eucalypt species in the canopy and other suitable food resources (shrubs and small trees). Requires tree hollows for denning.	19	Yes, habitat is suitable
Yellow-bellied Glider *(Petaurus australis)*	-	V	Tall open forest habitats, favours mature wet sclerophyll forest and dense gullies.	1	Low likelihood, habitat lacks maturity and
Birds					
Australian Painted Snipe (*Rostratula benghalensis*)	-	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	0	No suitable habitat on site
Barking Owl *(Ninox connivens)*	-	V	Forest and woodland habitats, particularly drier western slopes and riverine areas, hunts for birds and small mammals.	2	Unlikely, no local records and habitat marginal
Black Bittern (*Ixobrychus flavicollis*)	-	V	Wetlands where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	1	No suitable habitat on site
Black-necked Stork (*Ephippiorhynchus asiaticus*)	-	E	Open wetlands & adjoining agricultural areas	1	No suitable habitat on site
Brown Treecreeper *(Climacteris picumnus)*	-	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and mature hollow-bearing trees.	1	Yes, habitat is suitable
Gang-gang Cockatoo *(Callocephalon fimbriatum)*	-	V	Occurs within a variety of forest and woodland types. Usually frequents mountainous forests and steep country with old growth attributes required for nesting and roosting purposes. The Hunter Valley is the northern limit of the species distribution and records are mostly associated with the ranges from Yengo, Wollemi, Pokolbin and Broken Back Range.	2	Unlikely, not expected on the study site
Glossy Black-Cockatoo *(Calyptorhynchus*	-	V	Open forest habitats with She-oak species (*Allocasuarina* spp.) required for food.	2	Possible, potential habitat

Species	Status		Distribution and habitat requirements*	Number of records in locality (10 km radius)	Potential to occur in the study area
	EPBC Act	*TSC Act*			
lathami)					occurs in the region
Grey-crowned Babbler (*Pomatostomus temporalis temporalis)*	-	V	Woodlands, open forest	42	Yes, habitat is suitable
Little Lorikeet (*Glossopsitta pusilla*)			Dry open eucalypt forests and woodlands. They have been recorded from both old growth and logged forests in the eastern part of their range and forage on the nectar of eucalypt blossom.	3	Yes, habitat is suitable
Masked Owl *(Tyto novaehollandiae)*	-	V	Lives in dry eucalypt forests and woodlands from sea level to 1100 m.	1	Yes, habitat is suitable
Painted Honeyeater (*Grantiella picta*)	-	V	Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	1	Low likelihood, habitat too marginal
Powerful Owl *(Ninox strenua)*	-	V	Open forests with dense wet gullies and creek areas, requires large mature trees with hollows for breeding and dense areas of vegetation for prey and roosting	4	Yes, habitat is suitable
Regent Honeyeater *(Xanthomyza phrygia)*	E	E	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box and Red Ironbark in the western extent of its range, and Swamp Mahogany or Spotted Gum in the eastern parts of its range.	1	Moderate, habitat in the locality is suitable and may visit.
Speckled Warbler (*Pyrrholaemus sagittatus*)	-	V	The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	7	Yes, habitat is suitable
Varied Sitella (*Daphoenositta chrysopsitta*)	-	V	Found in a variety of forest and woodland habitats.	1	Yes, habitat is suitable
Square-tailed Kite (*Lophoictinia isura*)	-	V	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.	1	Moderate, habitat in the locality is suitable and may visit.
Swift Parrot (*Lathamus discolour*)	E	E	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include	1	Moderate, habitat in the locality is suitable

Species	Status		Distribution and habitat requirements*	Number of records in locality (10 km radius)	Potential to occur in the study area
	EPBC Act	*TSC Act*			
			winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*.		and may visit.
Amphibians					
Green and Golden Bell Frog (*Litoria aurea*)	E	E	Ephemeral and permanent freshwater wetlands, ponds, dams with an open aspect and fringed by *Typha* and other aquatics, free from predatory fish.	0	No suitable habitat on site
Southern Barred Frog (*Mixophyes iteratus*)	E	E	Giant Barred Frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m	0	No suitable habitat on site
Stuttering Frog *(Mixophyes balbus)*	-	E	Permanent streams in moist and wet sclerophyll forests	0	No suitable habitat on site

E – Endangered species, V – Vulnerable species

Source: * Distribution and habitat requirement information adapted from:

- Department of Environment and Climate Change (updated 2005) Threatened Species Website http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx)
- Australian Government Department of Environment, Water, Heritage and the Arts Website http://www.environment.gov.au/biodiversity/index.html

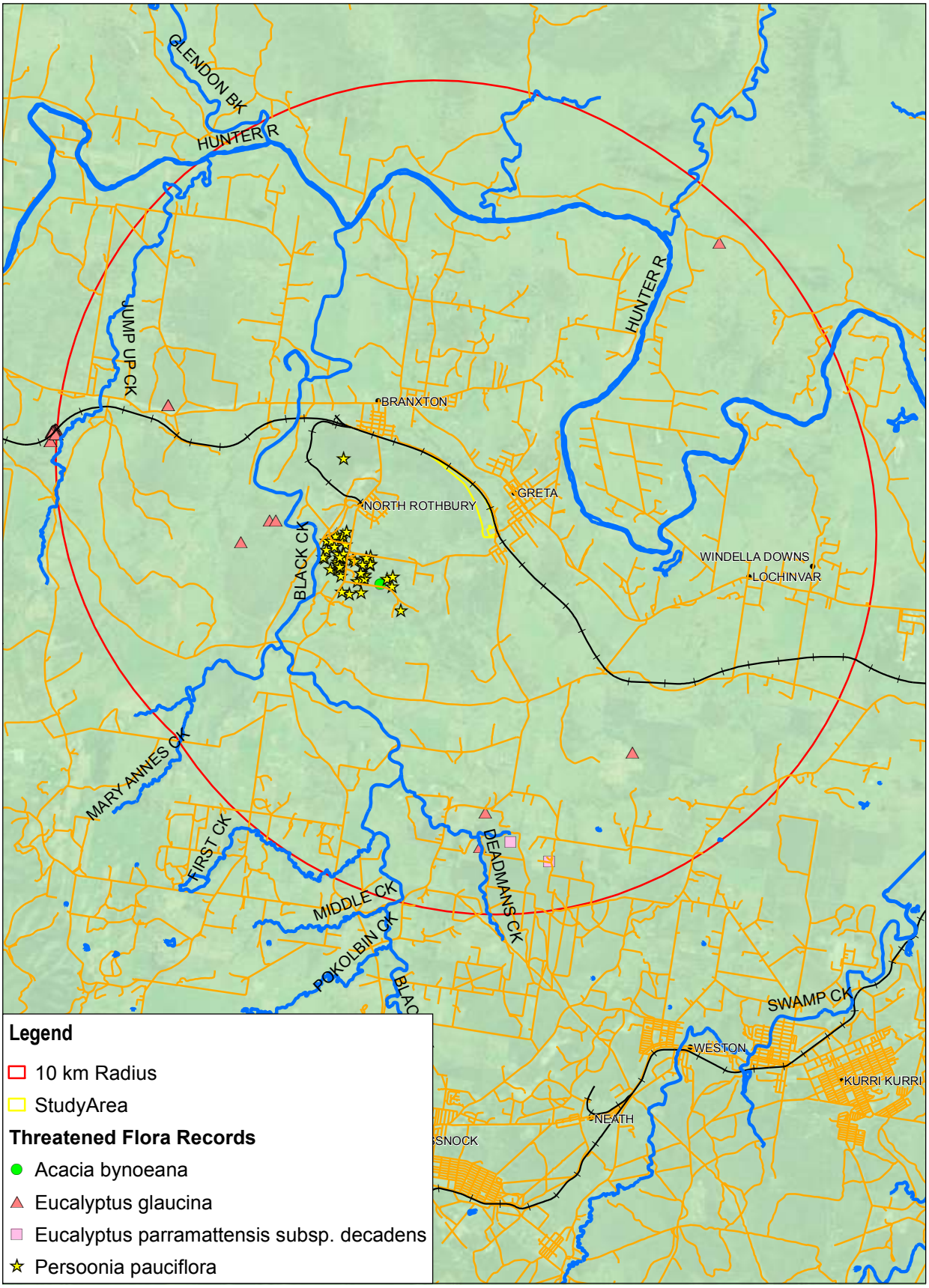
3.1.4. Migratory Fauna

A total of 12 migratory fauna species were identified in the EPBC Act Protected Matters Report (September 2009) as potentially occurring in the study area. These species along with their preferred habitat requirements and a preliminary assessment of presence in the study area is presented in **Table 6.**

Table 6 Potential occurrence of migratory species

Common Name	Species	Preferred habitat	Likely presence
Migratory Terrestrial Species			
Black-faced Monarch	*Monarcha melanopsis*	Rainforests, moist eucalypt forests and coastal scrubs	Not expected.
White-bellied Sea Eagle	*Haliaeetus leucogaster*	Predominantly ocean shores and estuaries, occasionally inland rivers and streams.	Not expected.
White-throated Needletail	*Hirundapus caudacutus*	An aerial foraging species which occupies a range of habitats from open modified	Potentially fly over and forage over the site.

Common Name	Species	Preferred habitat	Likely presence
		landscapes to woodland and forest.	
Rufous Fantail	*Rhipidura rufifrons*	Predominantly rainforest and wet forests	Not expected
Rainbow Bee-eater	*Merops ornatus*	Predominantly woodland and timbered plains	Potential to intermittently forage in the area whilst moving between better quality habitats.
Regent Honeyeater	*Xanthomyza phrygia*	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box and Red Ironbark	Low-moderate possibility.
Satin Flycatcher	*Myagra cyanoleuca*	Predominantly forests, in particular thick vegetation in gullies	Not expected.
Migratory wetland / marine species			
Latham's snipe	*Gallinago hardwickii*	Wetlands, wet meadows, flooded grassy paddocks, open grassland and drainage areas	Not expected.
Painted snipe	*Rostratula australis*)	Wetlands, reedlands, marshes and swamps	Not expected
Cattle Egret	*Ardea ibis*	Grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Often seen with cattle.	Potential habitat present in modified rural landscapes in the locality, although unlikely on the site and would not be impacted by the proposal
Great Egret	*Ardea alba*	Prefers shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	Potential habitat present in modified landscapes, although unlikely on the site
Fork-tailed Swift	*Apus pacificus*	The species breeds in Asia and migrate to Australia in the summer from which they spend their entire life-cycle on the wing, hunting, resting and sleeping.	Potential to occasionally fly over and forage in the region however unlikely to use the site and would not be impacted by the proposal.



Data Sources
LPI 2001
DECCW 2009

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kilometres

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Figure 4: Threatened Flora Records (DECCW 2009)

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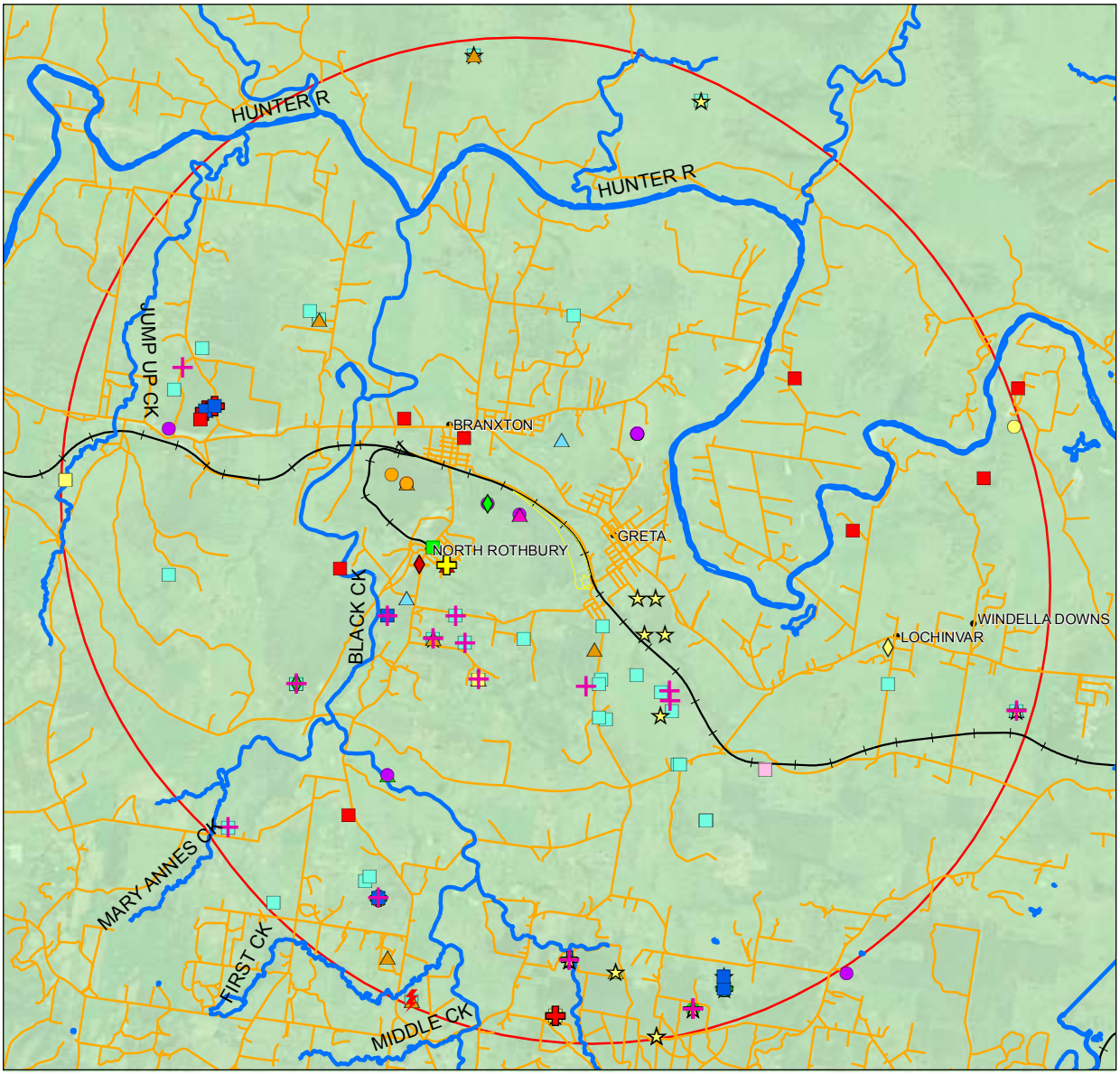

Legend

- 10 km Radius
- Study Area

Threatened Fauna Records

- Barking Owl
- Black Bittern
- Black-necked Stork
- Brown Treecreeper
- Brush-tailed Phascogale
- Eastern Bentwing-bat
- Eastern Cave Bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Gang-gang Cockatoo
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Koala
- Large-footed Myotis
- Little Bentwing-bat
- Little Lorikeet
- Masked Owl
- Painted Honeyeater
- Powerful Owl
- Regent Honeyeater
- Speckled Warbler
- Spotted-tailed Quoll
- Square-tailed Kite
- Squirrel Glider
- Swift Parrot
- Yellow-bellied Glider

Data Sources
LPI 2001
DECCW 2009

0 1.5 3
kilometres

1:150,000

GDA_1994_MGA_Zone_56

Figure 5: Threatened Fauna Records (DECCW 2009)

4. Results: Field Survey

The extent and quality of native vegetation, flora and fauna species diversity and fauna habitat were recorded from the project study area targeting threatened species, and the presence of endangered ecological communities. General vegetation and habitat data was also collected for the surrounding proximal lands in some areas.

4.1.1. Floristic Diversity

The majority of the study area supports remnant vegetation in a relatively natural ecological condition, natural regeneration also occurs in previously cleared grazing land. Some areas exhibit evidence of disturbance in the form of selective vegetation clearance, track formation and minor weed invasion as a result of past land use activities.

Native flora species richness within remnant vegetation totalled 223 species from 70 families. This total comprised 3 species of fern, 1 conifer species, 138 species of dicotyledons and 81 species of monocotyledons. Of the total species recorded, 49 species of introduced flora were identified, representing approximately 22% of the total species. A list of all flora species present within the study area has been included as **Appendix C**.

4.1.2. Vegetation Communities

Two main vegetation communities were identified within the study area comprising higher elevated drier habitats dominated by Spotted Gum (*Corymbia maculata*) and Narrow-leaved Ironbark (*Eucalyptus crebra*), and habitats within and surrounding drainage lines and open depressions dominated by Forest Red Gum (*Eucalyptus tereticornis*). The study area is within an ecotonal area between vegetation community types of the central and lower Hunter region.

Additionally there are open paddock areas supporting regenerating shrubs on the edges of remnant vegetation at the southern end of the study area. Map units identified in the study area are described below.

Map Unit 1: Spotted Gum – Ironbark Forest

This community has strong affinities to the listed EEC Lower Hunter Spotted Gum - Ironbark Forest. This community is associated with higher elevated slopes of the study area. The community supports an open canopy ranging between 15-20 m dominated by Spotted Gum (*Corymbia maculata*) and Narrow-leaved Ironbark (*Eucalyptus crebra*), with other species being co-dominant in areas including Broad-leaved Ironbark (*E. fibrosa*), Grey Gum (*E. punctata* x *canaliculata*) and Forest Red Gum (*E. tereticornis*). Some areas support a high abundance of

regenerating trees with larger trees interspersed. A low-moderate abundance of Bulloak (*Allocasuarina luehmannii*) is present throughout this community.

The understorey varies throughout the study area comprising a mix of shrub and groundcovers varying in density. A moderately dense shrub layer is present dominated by a diversity of species including Black Thorn (*Bursaria spinosa*), Gorse Bitter-pea (*Daviesia ulicifolia*), Needlebush (*Hakea sericea*), Narrow-leaved Geebung (*Persoonia linearis*), Rice Flower (*Pimelea linifolia subsp. linifolia*), Swamp Wattle (*Acacia elongata*) and Coffee Bush (*Breynia oblongifolia*). The dominant shrub species within this community varies throughout the study area and ranges from 1-3 m in height.

The groundcover of this community includes a relatively high diversity of flora species varying in density with the degree of soil moisture and shelter. Common grass species in this map unit include Puprle Wiregrass (*Aristida ramosa*), Three-awn Spear-grass (*A. vagans*), Barbed-wire Grass (*Cymbopogon refractus*), Wiry Panic (*Entolasia stricta*) and Weeping Grass (*Microlaena stipoides*) varying in dominance. Common forb species include a diversity of herbs and graminoids such as Many-flowered Mat-rush (*Lomandra multiflora*), Mulga Fern (*Cheilanthes sieberi*), White Root (*Pratia purpurascens*), *Lomandra filiformis* and Poverty Raspwort (*Gonocarpus tetragynus*).

A sparse cover of weed species are present throughout this community most likely as a result of past agricultural practices, and are most abundant on the edges of this community adjoining the rail corridor. Common weed species include Flatweed (*Hypocharis radicata*), Stinking Roger (*Tagetes minuta*) and African Olive (*Olea europaea* subsp. *cuspidata*).

One plant species listed under the Rare or Threatened Australian Plants (RoTAP) database was recorded throughout much of this community in the study area in moderate abundance comprising Kurri Spider Flower (*Grevillea montana*).

Map Unit 2: Forest Red Gum – Ironbark Forest

This community is associated with lower elevated areas of the study area, including open depressions and slopes surrounding drainage lines. The community supports an open canopy ranging between 15-20 m dominated by Forest Red Gum and Narrow-leaved Ironbark with other species being co-dominant in areas including Rough-barked Apple (*Angophora floribunda*), Grey Box, Grey Gum and Spotted Gum. Some areas support a high abundance of regenerating trees with larger trees interspersed. A moderate abundance of small-medium sized trees (4-8 m high) are present including *Melaleuca decora*, Prickly-leaved Paperbark (*Melaleuca nodosa*) and Bulloak is present throughout this community, particularly along drainage lines.

The understorey varies throughout the study area comprising a mix of shrub and groundcovers varying in density. A sparse to moderately dense shrub layer is present 1-3 m in height dominated by similar species to map unit 1. Dominant shrub species include Gorse Bitter-pea, Needlebush, Narrow-leaved Geebung, Coffee Bush, Rice Flower, *Acacia falcata*, Silver-stemmed Wattle (*Acacia parvipinnula*) and *Leptopsermum parvifolium*.

The groundcover of this community includes a relatively high diversity of flora species varying in density with the degree of soil moisture and shelter. The most dominant grass species are Weeping Grass and Barbed-wire Grass with other grasses occurring in lower abundance including Paddock Lovegrass (*Eragrostis leptostachya*), *Paspalidium distans* and Tufted Hedgehog Grass (*Echinopogon caespitosus* var. *caespitosus*). Common forb species include a diversity of herbs and graminoids such as Rough Raspwort (*Halogris heterophylla*), White Root, Mat-rush (*Lomandra longifolia*) and Blue Bottle-daisy (*Lagenophora stipitata*).

A sparse cover of weed species are present throughout this community most likely as a result of past agricultural practices, and are most abundant on the edges of this community adjoining the rail corridor and along the major drainage line at the southern end of the study area. Common weed species include several pasture species such as Carpet Grass (*Axonopus affinis*), *Lantana camara*, Flatweed and African Olive.

This community is consistent with the final determination for the EEC Hunter Lowlands Red Gum Forest based on dominant species and the soil landscapes of the study area.

Map Unit 3: Regenerating Shrubland

This area occurs on the edges of the paddock area at the southern end of the study area comprising a moderate-density of the shrub Needlebush with regenerating Eucalypt species. These areas are considered to be regenerating examples of the surrounding EECs.

4.1.3. Endangered Ecological Communities and Condition

The presence of two state listed EEC's (Schedule 1 part 3; TSC Act) was confirmed within the subject site comprising: 1) Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion (Map Unit 1); and 2) Hunter Lowlands Red Gum Forest (Map Units 2 and 3).

The presence and condition of these two vegetation communities on the subject site were identified and described, with further discussion provided in Section 5.

The quality of vegetation was assessed using parameters such as the degree of naturalness, species diversity, history of disturbance, weed invasion and health. Three categories were used to describe the condition of vegetation communities:

High: Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation is usually in a near natural state and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers. Some limited weed cover is present in edge habitats.

Moderate: Vegetation generally still retains its structural integrity but has been disturbed and has lost some component of its original species complement. Weed invasion varies from slight to significant.

Low: Vegetation that has lost most of its species and is significantly modified structurally. Often such areas now have a discontinuous canopy of the original tree cover, very few shrubs and exotic species, such as introduced pasture grasses or weeds, replacing much of the indigenous ground cover. Environmental weeds are often co-dominant with the original indigenous species

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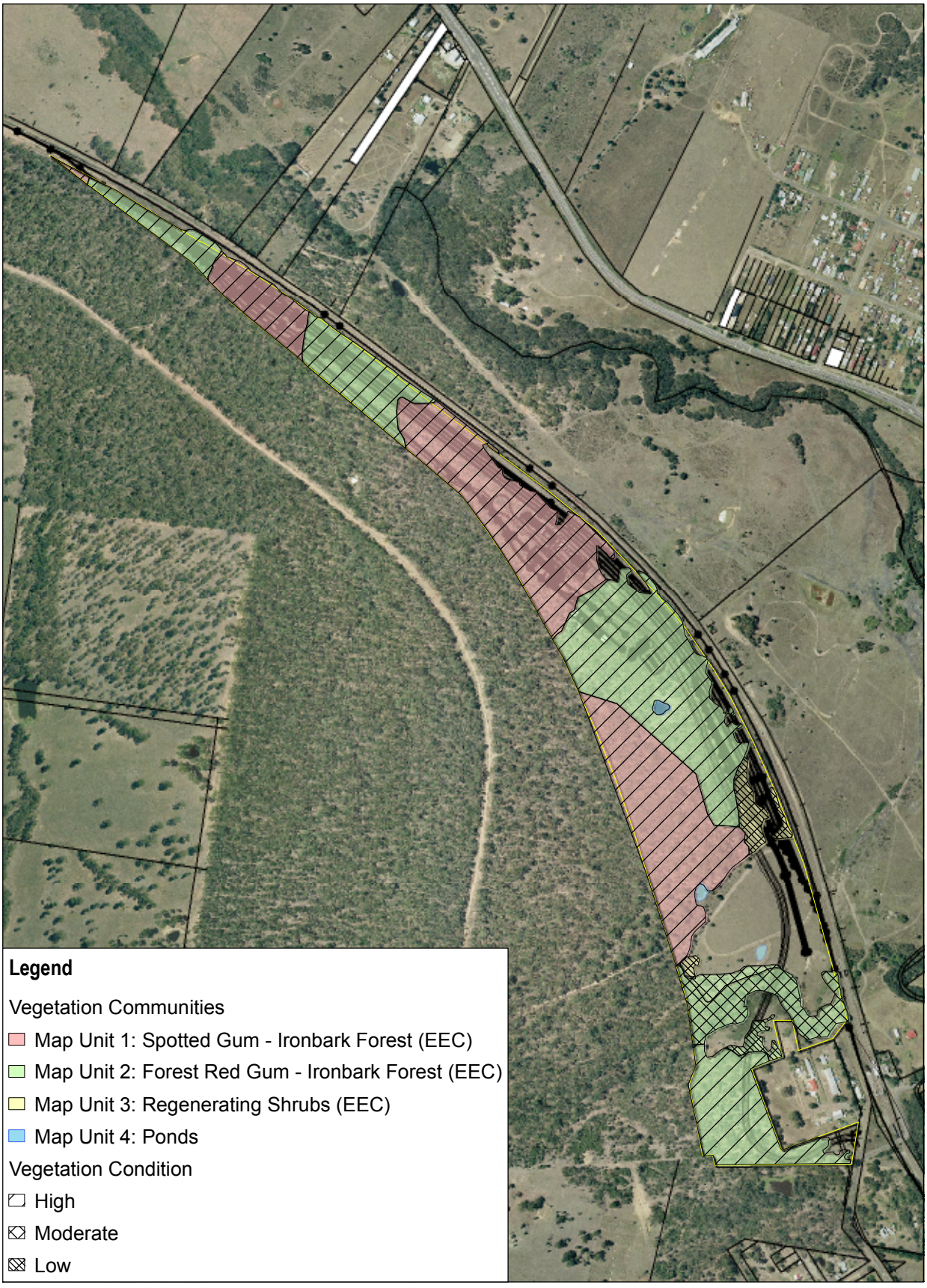

Data Sources
LPI 2001
Vegetation: SKM 2009

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Figure 6: Vegetation Communities (EECs)

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4.1.4. Rare and Threatened Flora

One rare flora species was recorded within the study area. Targeted searches were undertaken for several threatened flora species with a high-moderate potential to occur in the study area the results are provided below in **Table 7.**

■ **Table 7 Rare and threatened flora species recorded from and potentially occurring in the study area.**

Species	Status			Results
	EPBC Act	TSC Act	RoTAP	
Persoonia pauciflora North Rothbury Persoonia	CE	E	2E	Not found in the study area despite targeted searches. Habitat in the study area is suitable for this species however its distribution is extremely restricted generally occurring within a 2.5 km radius at North Rothbury. This species is unlikely to be present in the study area.
Acacia bynoeana	V	E	3VC-	Not found in the study area despite targeted searches. The study area does not provide optimal habitat for this species and it is unlikely to occur.
Cryptostylis hunteriana	V	V	3VC-	Not found in the study area despite targeted searches. The study area is unlikely to provide optimal habitat for this species and it is unlikely to occur.
Eucalyptus glaucina Slaty Red Gum	V	V	3VCa	This species was not found on the project site despite a comprehensive survey and targeted searches. The study area provides suitable habitat for this species and considering it closely resembles Forest Red Gum (*Eucalyptus tereticornis*) which is present in large numbers it could potentially be present. However a large majority of the areas supporting Forest Red Gum were surveyed with no evidence of trees with characteristic features of this species. Any individuals of this species that are present are likely to occur in very low abundance and are likely to be hybridising with Forest Red Gum.
Grevillea montana	-	-	2VC	Relatively common within higher elevated, drier areas of the study area dominated by Spotted Gum-Ironbark vegetation. Considering the abundance of this species in the study area the number of plants was not quantified.

RoTAP Codes	K = Poorly known
2 = geographic Range in Australia less than 100km	i = less than 100 plants in conservation reserves
V = Vulnerable – at risk over longer period (20-50years)	
R = Rare – uncommon plants with no current threats	EPBC Act and TSC Act Codes
C = Reserve	V = Vulnerable
a	E = Endangered
-	CE = Critically Endangered

4.1.5. Fauna Habitat and Condition

Both naturally occurring and modified fauna habitats occur on the site as a result of the past land-use history. Remnant open forest habitats dominate the northern and western portions of the site (Spotted Gum / Ironbark forest - map unit 1) mostly over undulating slopes, with Forest Red Gum (map unit 2) tending to dominate the lower lying lands, gullies and riparian areas. Several other tree species are also present in both habitats including Rough-barked Apple and Grey Gum providing seasonal nectar resources. The structural and floristic diversity of the remnant forests is moderate to high, incorporating a dense upper canopy 18-25 metres and sparse small tree layer dominated by *Acacia* spp and *Melaleuca* spp. Ground cover vegetation varies in density between open grassy understorey in the Spotted Gum dominated forests and dense shrubby understorey in the Forest Red Gum habitat.

Spotted Gum (*Corymbia maculata*) is recognised for providing a regionally important food resource for nectarivorous birds and mammals, particularly migratory species and those relying on productive winter food sources such as the Grey-headed Flying-fox (DECC 2009), Regent Honeyeater (Menkhorst *et al* 1999) and Swift Parrot (Saunders and Heinsohn 2008).

Tree hollows are moderately abundant in the remnant forests in the northern half of the site with densities of up to 5 hollow-bearing trees per hectare recorded. Conversely, densities of around 1-2 hollow bearing trees per hectare occur in the southern third of the site. Tree hollows represent important local habitat for hollow-dependent fauna, including bats, birds and mammals, including the Squirrel Glider identified on the site. There are no caves or open shafts on the site that may provide potential roosting / breeding opportunities for cave-roosting bat species, however such species may forage on the site.

The condition of the riparian habitat varies across the site, with the highest condition occurring furthest west and continuing off-site to the west. At the eastern end of the site, the condition is low and indicative of past disturbance and land use.

Open cleared grassland occurs in the central southern end of the site, with some previously cleared areas now exhibiting regenerating shrubland. This habitat is used extensively for grazing by kangaroos and several bird species common in rural landscapes. Aquatic habitat is represented by two natural creeklines, one in the northern end and one in the southern end of the site. The latter is more extensive and both creeks exhibit a sandy substrate with dense macrophyte fringing vegetation mainly sedges and rushes and provide important habitat for fauna, particularly frogs and birds. Several artificial dams are scattered throughout the site and these have also been colonised with macrophyte vegetation and provide habitat for fauna, particularly common frog and bird species.

Koala habitat

Two tree species listed under Schedule 1 of SEPP 44 are present on the site, namely Forest Red Gum (*E.tereticornis*) and Grey Gum (*E.punctata*). Forest Red Gum occurs in densities of greater than 15%of the tree cover in the alluvial forest habitat (Map Unit 2) and as such this community is considered 'potential' koala habitat. The remainder of the site is unlikely to be considered potential habitat for the species as feed tree species occur in very low densities.

No koalas or evidence of individuals were identified from the field survey and there is very limited data to suggest that an historical population occurs in the locality on the basis of two previous records. The site is considered unlikely to be regionally significant or 'core' habitat for koalas.

4.1.6. Fauna Diversity

A total of 71 fauna species were recorded, comprising 41 bird species, 13 mammal species, 8 frog species and 9 reptile species. One bird and one mammal species are introduced fauna and the remainder are native species.

The range of habitats present supports a moderate diversity of bird species represented predominantly in abundance by honeyeaters and lorikeets. Other groups include granivores, raptors and insectivores. The most common species observed during the survey included the Musk Lorikeet (*Glossopsitta concinna*), Yellow-faced Honeyeater (*Lichenostomus chrysops*), Eastern Rosella (*Platycercus eximius*), Striated Thornbill (*Acanthiza lineata*) and Grey-crowned Babbler (*Pomastomus temporalis temporalis*).

The Squirrel Glider (*Petaurus norfolcensis*) and Common Brushtail Possum (*Trichosurus vulpecula*) dominate the arboreal mammal fauna, found in both forested habitats. Yellow-footed Antechinus (*Antechinus flavipes*), Common Wombat (*Vombatus ursinus*) and Echidna (*Tachyglossus aculeatus*) are also present. Low numbers of Eastern Grey Kangaroo's (*Macropus giganteus*) were observed grazing in the cleared and modified portions of the site and the Red-necked Wallaby (*W.bicolor*) and Swamp Wallaby (*M.rufogriseus*) in the forested habitats.

The herpetofauna recorded was considered reasonably diverse considering the small size of the site and is reflective of the range of microhabitats and condition of the aquatic habitats. Several common frog species were recorded dominated by Peron's Tree Frog (*Litoria peroni*), Eastern Dwarf Tree Frog (*L. fallax*) and Broad-palmed Frog (*L.latopalmata*) particularly associated with artificial dams, and to a lesser degree the two natural creeks. The reptile assemblage comprised 5 skink species (Family Scincidae), two dragons (Agamidae), the Lace Monitor (*Varanus varius*) and Red-bellied Black Snake (*Pseudechis porphyriacus*).

4.1.7. Threatened Fauna

Two listed fauna species were identified on the site, the Squirrel Glider (*Petaurus norfolcensis*), and Grey-crowned Babbler, eastern subspecies (*Pomastomus temporalis* subsp. *temporalis*). Both species are listed under Schedule 2 vulnerable species of the NSW TSC Act. A third listed species (schedule 2 TSC Act) the Speckled Warbler (*Pyrrholaemus saggitatus*) was identified in contiguous habitat to the west of the site and is considered to utilise the Spotted Gum / Ironbark habitat on the site. Several other threatened fauna species not identified during the survey are also expected to occur given the presence of suitable habitat types and the known habitat preferences of the species. A brief description of the species and their predicted distribution on the site is discussed in Table 8.

Table 8 Threatened fauna species recorded from and potentially occurring in the study area.

Species	Site presence	Description
Squirrel Glider	Present	Squirrel Gliders were captured at site 1 (forest red gum / ironbark forest) and site 2 (spotted gum / ironbark forest) and are expected to be widespread across the forested habitats of the site as well as adjacent habitats to the east and west. The diversity of eucalypt species, as well as *Acacia* spp in the lower strata is well suited to this species in addition to an abundance of tree hollows for denning. Comparable habitats are widespread in adjacent lands and the species is known extensively from the Pokolbin and Rothbury areas through to Singleton (DECCW Atlas of NSW Wildlife; authors, *pers.obs*). This includes fragmented habitats in farm land.
Grey-crowned Babbler	Present	The Grey-crowned Babbler lives in family groups which consist of a breeding pair and offspring from previous breeding seasons. Three distinct family groups were recorded on the site (Figure 7) and typically associated with gullies in Forest Red Gum habitat, probably due to the abundance of small Melaleuca trees favoured as nesting sites by this species. Each family group identified consisted of between 5-8 individuals and several nests / dormitories were recorded within the territory of each group indicating that portions of three breeding territories intersect the site. The size of these territories is not known, although these are known to vary between 1 and 50 ha (Higgins and Peter, 2002). Comparable habitats are widespread and continuous to the west and numerous other family groups are expected. Indeed the species has been recorded at several locations throughout the Pokolbin, Rothbury, Branxton and Singleton areas (DECCW Atlas of NSW Wildlife database; authors, *pers.obs*) and is widespread in the locality.
Speckled Warbler	Present in nearby habitat	A pair of Speckled Warblers was recorded in woodland habitat adjacent to the site boundary to the southwest of the site (Figure 7). The habitat in this location is characterised by an open canopy indicative of woodland and the presence of Grey Box (*Eucalyptus molucanna*) which is not present on the site and grassy understorey favoured by this species. Potential habitat for this species on site is considered to be restricted to south of the creek and extends to the south and west from the site. No Speckled Warblers were reported in the northern portions of the site and the greater density of shrub cover over much of the site as opposed to grassy understorey is considered unsuitable.
Grey-headed Flying-	Predicted	▪ This species was not identified from the field surveys; however the survey was conducted in late spring outside of the flowering

Species	Site presence	Description
fox		period for Spotted Gum (*Corymbia maculata*). Indeed Spotted Gum has been identified as an important winter food source and critical foraging habitat for the species (DECCW 2009). While there are no roost camps on the site, the nearest known roost site is at Singleton (c.25km) and the spotted gum/ironbark habitat is expected to provide regionally important foraging habitat for the Grey-headed Flying-fox.
Swift Parrot and Regent Honeyeater	Predicted	These species were not identified from the field surveys; however the survey was conducted in late spring outside of the flowering period for Spotted Gum (*Corymbia maculata*). Indeed Spotted Gum has been identified as an important winter food source for both species in the Hunter Valley (Menkhorst *et al.* 1999). The Spotted Gum/Ironbark habitat on the site is expected to provide regionally important winter foraging habitat for both species.
Spotted-tailed Quoll	Predicted	While there are very few records of the species in the locality, this may be associated with the naturally low population levels and large home ranges of this species. All remnant forest habitats on site are considered suitable for the species
Woodland Birds (Brown Treecreeper, Black-chinned Honeyeater, Diamond Firetail and Hood Robin, Varied Sitella)	Predicted	Potential habitat for these species is restricted to the southern parts of the site and continuing of the site into contiguous habitats to the west. This is a consequence of the presence of woodland type vegetation with a sparse understory and mature age of the tree cover. The northern parts of the site with a more closed canopy and denser understorey a less suited. Large areas of potential habitat will remain on site for these species outside of the development area.
Large Forest Owls (Masked Owl, Powerful Owl, Barking Owl)	Predicted	These large forest owls typically have large home ranges and the site may provide a portion of the habitat used within the home range of a pair of owls. Indeed the remnant habitats and presence of large mature trees, plus occasional large tree hollow associated with all the forested areas on the site provide potential foraging, roosting and breeding habitat on site. In particularly the riparian areas in the southern creek traversing the site are well suited as roosting habitat for the powerful owl and barking owl.
Cave-roosting bats (Little Pied Bat, Eastern Bent-wing Bat, Little Bent-wing Bat and Large-footed Myotis)	Predicted	There are no caves or open mine shafts that may provide potential roosting habitat for these species, however all parts of the site may be used for hunting insect prey. Three moderately large artificial dams provide habitat for insect prey and are also suited to the Large footed Myotis for foraging.
Tree-roosting bats (Eastern False Pipistrelle, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat and Eastern Freetail Bat.	Predicted	Tree hollows are abundant in the remnant forest with densities of up to 5 trees per hectare recorded at the northern end of the site including a moderate proportion of dead trees. Potential roosting habitat for hollow-dependent bats is represented across all forested portions of the site except for the cleared lands and regenerating shrubland or young regrowth. Three moderately large artificial dams provide habitat for insect prey and foraging habitat is widespread across the entire site.
Brush-tailed Phascogale	Predicted	Typically prefers remnant and mature habitat with abundant tree hollows used for shelter and breeding. May utilise adjacent younger forests and regrowth. May occur in all forested parts of the site.
Little Lorikeet	Predicted	A widespread, nectivorous species which is locally nomadic and utilises seasonally available food resources. The presence of winter flowering trees (spotted gum) and other seasonal flowering eucalypts may provide important habitat for the species.

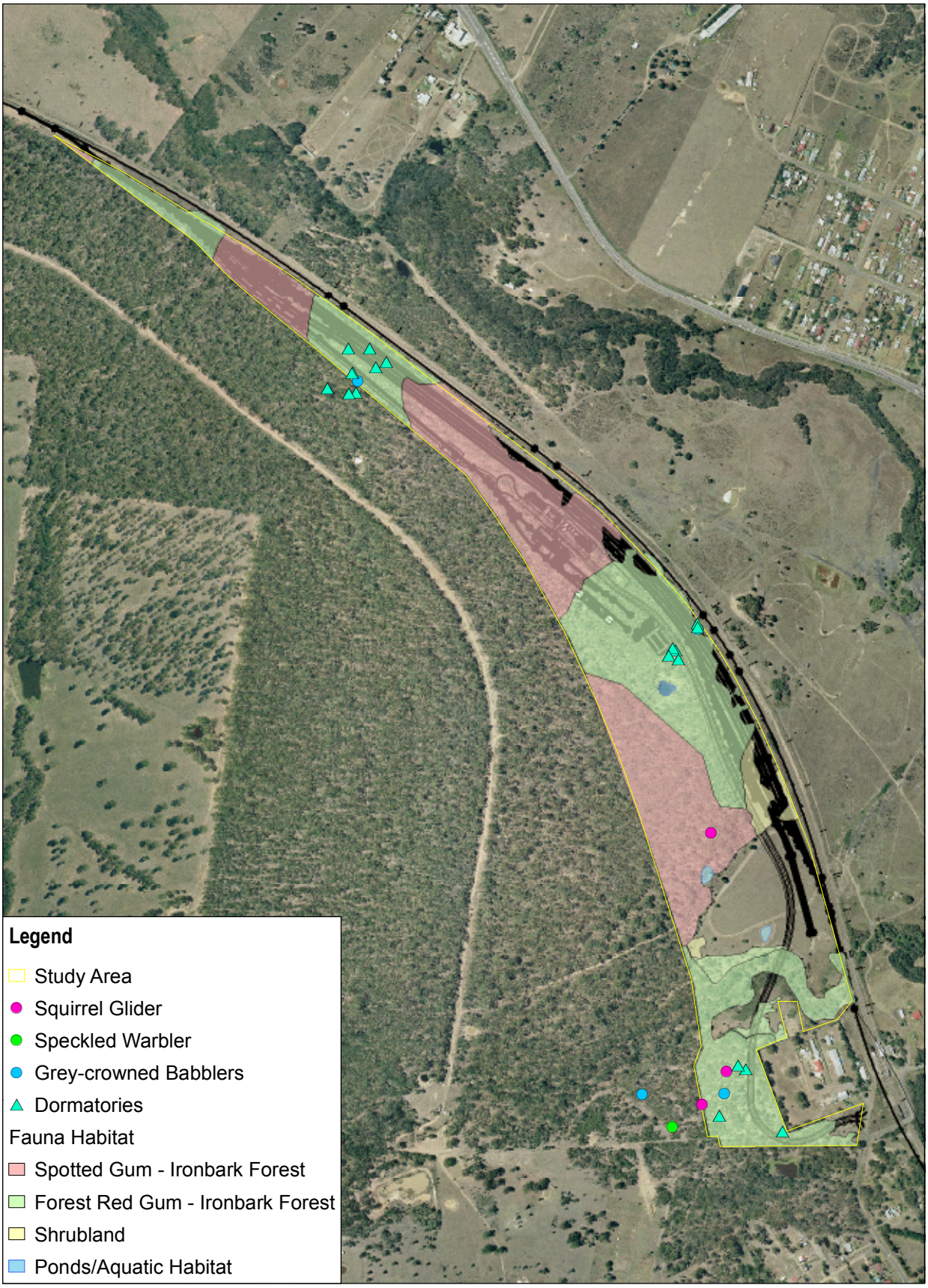
Species	Site presence	Description
Square-tailed Kite	Predicted	Widespread across lowland woodlands and coastal forests, particularly mature remnant forests which harbour large groups of birds, important prey species. No nests were recorded on the site and at presence the site provides potential feeding and roosting habitat. The species typically has a large home range and if used the site habitats would provide a small proportion of the overall habitat available for a local pair.

4.1.8. Habitat connectivity

The landscape surrounding the study area is characterised by a mosaic of open agricultural land with patches of forest and woodland including riparian vegetation and residential allotments. A network of rail and roads including unsealed tracks also traverses the landscape with the main northern rail line forming the eastern boundary of the site and the proposed Hunter Expressway forming the western boundary. The position of the site in terms of being positioned between the rail line and the future Hunter Expressway will effectively isolate the current habitat on the site and sever current habitat connectivity. This is exacerbated by the approved third rail line and dual carriage expressway such that the current connectivity on the site will be removed even in the absence of this project.

Anvil Creek is located to the east of the site on the opposite side of the rail line where it traverses close to the site at its northern end. The presence of the rail line interrupts the continuity of the habitat on the site with the riparian vegetation along Anvil Creek, although is not an absolute barrier and some movements of fauna across the rail corridor are anticipated. At present, in the absence of the Hunter Expressway, the habitat on site is continuous to the west with large expanses of comparable forest and woodland habitat on private land and as such fauna is expected to move freely between the site and adjacent properties. Clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation of habitat in the landscape.

Given the current approved projects on the boundaries of the subject site, there is no scope with the rail maintenance facility to mitigate the associated loss of connectivity. The approach to conserve and regenerate habitat on the site will provide some habitat for transient fauna such as Grey-headed Flying-fox.



Data Sources
LPI 2001
LHCCREMS/NPWS 2000

0 0.1 0.2
kilometres

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GDA_1994_MGA_Zone_56

Figure 7: Fauna habitats and records

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5. Ecological Impact Assessment

5.1. Summary of ecologically significant values

The majority of the study area supports remnant vegetation in a near natural condition, with the exception of introduced flora. Some disturbances are evident and associated with previous land-uses which date back several decades. These include the development of tracks, selective tree removal for fencing, livestock grazing and mining infrastructure. Weeds are common throughout, particularly along the edges of tracks and cleared land, in riparian areas and adjacent to existing railway infrastructure. Natural regeneration also occurs in previously cleared grazing land although these areas are in an early seral stage of regeneration and have a lower ecological value at present.

The assessment has also identified several areas of lower ecological value, comprising cleared land and land currently used for access where there is a distinct lack of vegetation including groundcover vegetation. Riparian vegetation in the eastern portions of the site were identified as degraded in condition, due to a lack of maturity and a high abundance of weeds.

The presence of two listed EECs (Schedule 1 part 3; TSC Act) was confirmed within the study area:

- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
- Hunter Lowland Redgum Forest in the Sydney Basin and North coast Bioregions

The condition of these EECs ranges from moderate to high providing habitat for a diversity of native flora and fauna species including rare and threatened species as summarised in **Table 9.** Some areas of regenerating forest were also identified which are early stages of recovery of these EEC types.

- **Table 9 Summary of ecological values recorded on the site**

Threatened Species/Communities/Habitats	Status
Lower Hunter Spotted Gum Ironbark Forest	EEC (TSC Act)
Hunter Lowland Red Gum Forest	EEC (TSC Act)
Kurri Spider Flower (*Grevillea montana)*	RoTAP*
Squirrel Glider (*Petaurus norfolcensis*)	Vulnerable (TSC Act)
Grey-crowned Babbler (eastern subsp) (*Pomatostomus t. temporalis*)	Vulnerable (TSC Act)
Speckled Warbler (*Pyrrholaemus saggitatus)*	Vulnerable (TSC Act)
Critical foraging habitat for Grey-headed Flying-Fox (Draft Recovery Plan)	Vulnerable (EPBC Act, TSC Act)
Identified habitat for several threatened fauna species	Regionally significant
Hollow-bearing trees	Locally significant

* RoTAP - Rare or Threatened Australian Plant (not currently listed)

The targeted flora survey identified that none of the threatened flora species known from the region and considered as potential subject species have been identified on the site. The results of the fauna habitat assessment indicate that potential habitat is present for several other threatened fauna species that were not identified during the fauna surveys conducted for this assessment (refer **Table 7**).

5.2. Planning and mitigation approach

The ecological values of the site were considered at the preliminary environmental and planning stages of the proposal and ecological data gathered from the background review and field surveys was considered as a guide to the refinement of the development footprint, and to devise appropriate design features and mitigation measures to avoid and minimise long-term impacts on biodiversity.

The approach adopted has considered the *Principals for the use of biodiversity offsets in NSW* (DECCW, 2008), further details are provided in the following sections.

5.2.1. Design avoidance measures

Impacts on biodiversity have been avoided where possible through consideration of the flora and fauna data gathered during the background review and field surveys. This information was used to illustrate the ecological values, constraints and opportunities for development of the site. The siting of infrastructure including internal roads, carparks and facilities were designed to avoid remnant vegetation and habitat, in particular the crossing of the creek for access to the site was selected to traverse a disturbed and degraded section of the riparian habitat. The result has been to minimise the Project footprint as much as possible and retain important vegetation on the site. The southern half of the site is to be used for the access road only which has been specifically designed to minimise impacts to remnant vegetation. The approach is consistent with Principal number 1 (DECCW, 2008).

A further survey of hollow-bearing habitat trees and nest/dormitory sites of the Grey-crowned Babbler will be required prior to the final design and construction of the internal road and facilities in an attempt to refine the footprint where possible and avoid these features.

5.2.2. Proposed mitigation measures

There is considerable scope to restore and revegetate degraded and cleared portions of the site outside of the development footprint to mitigate impacts. In this regard an Ecological Restoration / Management Plan is proposed which will focus on restoring the riparian vegetation on the site as well as active planting and regeneration techniques on currently cleared lands and the closure

and rehabilitation of existing vehicle and recreational tracks. The plan to be prepared prior to construction and will identify the areas of focus, provide a set of objectives and actions required to restore, maintain and monitor the success of the plan with an adaptive approach.

Additional mitigation measures proposed are to install speed reduction measures along the internal access road, wildlife signage and sensor lighting to minimise disturbance from noise and lighting on nocturnal fauna, particularly the Squirrel Glider. Most heavy vehicle traffic would be restricted to day time use. The revegetation plan is to include landscaping along the road verges.

5.2.3. Biodiversity offsetting measures

It is recognised that impacts on endangered ecological communities and habitat for threatened fauna species could not be avoided in the northern half of the site due to the narrow width of the site and the nature of the proposed development, being linear rail infrastructure. As such residual impacts equating to the loss of 18.5 ha of vegetation will result. The assessment has identified and quantified the impacts on biodiversity including the loss of endangered ecological communities and habitat for threatened species in keeping with Principal number 5 (DECCW 2008).

The project should aim to ensure a net improvement in biodiversity over time (Principal number 6; DECCW; 2008). To achieve this it will be necessary to offset the residual impacts with an area of vegetation of similar condition, preferably in the local area if possible, and secondly through the restoration of currently cleared or degraded portion of the site.

For further consideration it is recommended that the proposed environmental offsets are consistent with the Commonwealth Governments draft policy statement with respect to environmental offsets under the EPBC Act (DEWR 2007). In particular the following principals apply to this project;

1) Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted. In this regard the project will impact on vegetation communities containing Spotted Gum (*Corymbia maculata*) and Forest Red Gum (*Eucalyptus tereticornis*) which are recognised important or critical foraging habitat for the Grey-headed Flying-fox. Therefore it is critical that the offset site contains these same vegetation types and in similar condition; and

2) The offset should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are ‘like for like’. In this respect it will be important to target comparably vegetation / habitat types. Therefore the area of

offset should as a minimum be 18.5 ha is size and similar condition to ensure no net loss of biodiversity values.

5.3. Potential ecological impacts

The following section assesses the significance of potential impacts from the proposed rail facility project installation. The proposal comprises two components:

- Construction and operation of rail infrastructure, including lines and associated buildings for maintenance and staff; and
- Construction and operation of an internal access road.

5.3.1. Construction impacts

The assessment addresses the land directly impacted through clearing of vegetation to accommodate the proposed construction footprint, as well as adjacent areas within proximity to the development, which may be indirectly impacted by construction activities such as riparian vegetation and fauna movement corridors. Measures to avoid clearing of vegetation were incorporated into the planning phase of the project such that over 50% of the vegetation will be retained on the property. The proposed residual loss of vegetation associated with the project will equate to **18.5 ha** and a breakdown on the area of each vegetation type is summarised in **Table 10.**

The direct impacts to fauna habitat will include the clearing and removal of potential feeding, sheltering and breeding resources for a wide-range of species. Of importance to expected threatened fauna species is the loss of forest comprising Spotted Gum (up to 8 ha) an important winter food resources for insectivorous birds and bats and the loss of mature and dead hollow-bearing trees due to their habitat value for hollow-dependent species, a listed key threatening process. The project will have minimal impacts on aquatic and riparian habitats.

- **Table 10 Summary of potential ecological impacts associated with the proposal**

Map Unit	Endangered Ecological Community	Total area on site (ha)	Total vegetation loss (ha)	Total vegetation loss (ha) per condition		
				High	*Med*	*Low*
Map Unit 1: Spotted Gum - Ironbark Forest	Lower Hunter Spotted Gum - Ironbark Forest	17.5	8.0	*8.0*	-	-
Map Unit 2: Forest Red Gum - Ironbark Forest	Hunter Lowlands Red Gum Forest	21.4	9.7	*9.3*	*0.2*	*0.2*
Map Unit 3: Regenerating Shrubs	Hunter Lowlands Red Gum Forest	1.0	0.8	-	-	*0.8*
Total		**39.9**	**18.5 (46%)**	*17.3*	*0.2*	*1.0*

Riparian vegetation

Impacts to riparian vegetation will be restricted to a narrow crossing of the creek for development of the access road only. This will occur across an existing track used for access over the creek and a culvert construction will be used. The crossing point has been identified as a degraded portion of the creek in terms of the sparse presence and low condition of the riparian vegetation which is dominated by bracken fern and regrowth riparian vegetation. Areas downstream of the crossing represent the lowest quality riparian vegetation over the whole site, having previously been cleared and grazed. The resulting young regrowth is dominated by weeds. The riparian vegetation downstream of the culvert has been identified as suitable for regeneration and restoration to assist in offsetting the impacts of vegetation loss.

Habitat connectivity

The landscape surrounding the study area is characterised by a mosaic of open agricultural land with patches of forest and woodland including riparian vegetation and residential allotments. A network of rail and roads including unsealed tracks also traverses the landscape with the main northern rail line forming the eastern boundary of the site and the proposed Hunter Expressway forming the western boundary. The position of the site in terms of being positioned between the current rail line and the future Hunter Expressway will effectively isolate the site from surrounding vegetation. The project while contributing to the cumulative loss of connectivity in the area will not in itself interrupt any existing wildlife corridors.

5.3.2. Operational impacts

Indirect impacts

Given that a portion of the existing habitat on site will be retained adjacent to the project footprint it is reasonable to expect some edge effects associated with the newly created edge. The type and extent of edge effect is highly variable and may be related to abiotic and biological factors such as age, vegetation structure, aspect, matrix type and management history (Murcia 1995). There is a clear tendency of edge effects to vary with vegetation structure; they are greatest at new or induced edges and less obvious at old or inherent edges (Bali 2005). The maximum extent of edge effects for reliable indicator species is up to 50 m from the forest edge (Murcia 1995).

Edge effects are expected to be created along the border of the project footprint where ‘new’ edges would be created through currently vegetated areas. Edge effects would be greatest in the northern half of the site adjoining remnant vegetation and the least at the southern end adjoining partially cleared landscapes which are already edge affected. The result of edge effects may be an increase in weed diversity and abundance with higher light availability into currently shaded

interior areas. This may affect native plant species which are competing with weeds and associated with changes to physical attributes such as sunlight, hydrological regimes and soil nutrients. No threatened plant species were recorded on the site, although all communities are part of an endangered ecological community.

Edge effects associated with this project can potentially be reduced through general mitigation and rehabilitation measures associated with the construction and operational stages of the project. The highest priority measures aim to minimise and intersect surface water run-off into adjacent remnant vegetation. Dense landscape plantings using a diversity of local indigenous plant species would reduce the affects of rapid weed invasion into disturbed edge habitats. These measures form part of the landscape rehabilitation plan.

Cumulative impacts

At the landscape scale, the major potential ecological impacts associated with the project are likely to be the disruption of landscape processes and loss of habitat for regional biodiversity. The locality is characterised by a patchy mosaic of fragmented remnant vegetation interspersed among cleared agricultural and rural land and the proposed development would contribute to this network. As the project would in effect occur in a landscape which is already dominated by human activities, such as farming and rural development, as opposed to a completely natural forested landscape, the cumulative impacts on biodiversity could reasonably be expected to have a low detectability.

Notwithstanding this fact, the project will clear up to 18.5 ha of vegetation and therefore would contribute to increasing the ratio of cleared land to remaining habitat in the region. Impacts could be offset to a degree by the development of a biodiversity offset strategy. Any such efforts should be based on the objective of maintaining or improving biodiversity values in the project area in the long-term.

Impacts to aquatic habitats

Clearing for the project directly and indirectly effects four ephemeral watercourses on the property, this includes Sawyers Creek in the southern end of the site and three unnamed creeks in the north, all of which flow into Anvil Creek to the east of the site. Sawyers Creek has potential to provide habitat for small native fish species, while the remaining creeks are too small and ephemeral in nature. These habitats are not suited to threatened fish species listed under the *Fisheries Management Act.*

There are also a number of artificially created farm dams. These aquatic habitats provide potential habitat macroinvertebrates and macrophytes as well as amphibians. The project has potential to

impact on both the surface and groundwater environments during the construction and operational phases of the project. Potential impacts on aquatic habitats include pollution of waterways, change to the hydrological regime, and removal of in-stream woody debris. Removal of in-stream woody debris (snags) is listed as a key threatening process under the FM Act. The disturbance to Sawyers Creek will be limited to the proposed crossing location and no woody debris is present at this location. As mentioned the other creeks do not provide fish habitat.

Increased sedimentation and erosion during construction is also considered a threatening process under the *Fisheries Management Act* 1994 (FM Act). Sediment runoff will be managed under the guidance of a surface water management plan (Worley Parsons 2010).

A surface water management assessment was prepared for the project (Worley Parsons 2010) which identified the potential for these impacts to occur and provides detailed measures to mitigate such impacts such preventative measures and on-site treatment of run-off and sediments. These measures would ensure that impacts to the biodiversity associated with the creeks and dams on site are minimised.

The design for the project has been developed so that the existing groundwater hydrological regime would generally be maintained through the use of culverts where required. Detailed design of culverts on Sawyers Creek would provide appropriate fish passage. The adoption of appropriately designed and maintained water quality controls and protection measures would be implemented to minimise impact on aquatic habitats.

Noise, Light and Traffic Impacts

Increased noise, artificial light and increased traffic on the project site has potential to impact on fauna occupying the conserved habitats on the site, in particularly nocturnal species such as large forest owls and the squirrel glider.

The proponent has indicated that most heavy vehicle traffic would be restricted to day time use and that noise reduction measures have been considered. At present there is a high frequency of trains passing the site continuously and this noise factor is also likely to have some effect on fauna life-cycle activities such that further increased noise activities will be adding to this.

The increased traffic across the site has some potential to impact on fauna through potential vehicle strike. Measures to reduce the impact of artificial lights, noise and traffic are provided in the recommendations section.

5.4. Key threatening processes

The TSC Act and FM Act list Key Threatening Processes (KTP) as activities or processes that:

a) Adversely affect threatened species, populations or ecological communities, or
b) Could cause species, populations or ecological communities that are not threatened to become threatened.

It is evident that the project would instigate some key threatening processes, such as clearing of native vegetation and removal of hollow-bearing trees. Several other processes could be reasonably expected and have been discussed in **Table 11** along with proposed measures to mitigate impacts.

Table 11 Key threatening processes related to the project

Key threatening process (KTP)	Type of threat	Level of threat	Potential impacts	Impact mitigation measures
Invasion of native plant communities by exotic perennial grasses	Weed	High	Several exotic perennial grasses were identified in disturbed edges of the site through bushland areas. These species are negatively associated with edge effects.	Weed management is to be developed as part of the on-site Environmental Management (Section 6.3)
Invasion, establishment and spread of Lantana camara	Weed	High	Present but not abundant. There is a low probability that these areas would become further infested with the creation of edge effects.	Weed management is to be developed as part of the on-site Environmental Management (Section 6.3)
Competition and grazing by the feral European rabbit	Pest animal	Low-Moderate	Evidence of European rabbit was recorded in the study area. The project may provide additional areas of suitable habitat for European Rabbit.	The proposed mitigation measures would limit impacts from this KTP, in particular weed management and habitat restoration (Section 6.3).
Competition from feral honeybees	Pest animal	Low	The project may provide additional areas of suitable habitat for feral honeybees.	The proposed mitigation measures would limit impacts from this KTP, in particular weed management and habitat restoration (Section 6.3).
Predation by feral cats	Pest animal	Low-Moderate	The project may contribute to additional predation from feral cats, through habitat fragmentation.	The proposed mitigation measures would limit impacts from this KTP, in particular weed management and habitat restoration (Section 6.3).
Predation by the European Red Fox	Pest animal	Low-Moderate	The project may contribute to additional predation from European Red Fox, through habitat fragmentation.	The proposed mitigation measures would limit impacts from this KTP, in particular weed management and habitat restoration (Section 6.3).
Predation by the Plague Minnow (*Gambusia holbrooki*)	Pest animal	Low-Moderate	The project may contribute to additional predation from Plague Minnow.	None known. Difficult to prevent

Key threatening process (KTP)	Type of threat	Level of threat	Potential impacts	Impact mitigation measures
Clearing of native vegetation	Habitat loss/ change	Very High	The project would result in the clearing of up to 18.5 ha of native vegetation	Where possible vegetation clearance would be minimised. Mitigation measures are detailed in Section 5.2 and 6.3)
Loss of hollow-bearing trees	Habitat loss/ change	High	The project would result in the clearing of hollow-bearing trees with densities of between 2 and 5 trees per hectare.	Where possible hollow bearing trees would be avoided. Mitigation measures are detailed in Section 5.2 and 6.3) and include the provision of nest boxes.
Removal of dead wood and dead trees	Habitat loss/ change	High	The project would result in the removal of dead wood and dead trees.	Dead wood and dead trees would be relocated to adjacent areas of habitat (Section 6.3)
Increased sedimentation and erosion during construction	Habitat loss/ change	Low	There is potential for increased sedimentation to result due to the construction process.	The project has been designed to minimise any bank erosion or increased sedimentation.
Loss of aquatic and riparian habitats	Habitat loss/ change	Low	The project would require the removal of only a narrow width of riparian vegetation to accommodate the road crossing.	The proposed mitigation measures would limit impacts from this KTP, in particular weed management and habitat restoration (Section 6.3).
Installation of instream structures	Habitat loss/ change	Low	The project would result in the construction of a culvert which may modify the natural flow of the creek. This alteration may disrupt natural reproductive cues and natural processes of erosion and sedimentation resulting in a loss of aquatic habitat for fish and macroinvertebrates.	New watercourse crossings associated with the project need to meet NSW Fisheries Guidelines, which aim to ensure passage for aquatic biota is maintained

5.5. Impact significance assessment

The loss of vegetation and fauna habitat would negatively affect several populations of threatened fauna species through the direct loss of known habitat, increasing the fragmentation of habitat and creating barriers to movement and dispersal of individuals. An assessment of significance of impacts was conducted for known and potential subject species (i.e. listed threatened species) in accordance with the *Draft Guidelines for Threatened Species Assessment* (DECC and DPI 2005) and in the National context in accordance with the *Significant Impact Guidelines for Matters of National Environmental Significance* (DEH 2006) (refer Appendix A and Appendix B for details).

The assessment has concluded that the proposed project in itself is unlikely to impose a 'significant impact' on local populations of threatened species, endangered communities or their

habitats as listed under the TSC Act and EPBC Act, on the basis that the site will become isolated between the railway and the Hunter Expressway and that these actions will reduce the connectivity, size and value of the habitats on site. However this project will contribute significantly to the cumulative loss of habitat in the locality when added to the impacts expected from the approved Hunter Expressway and third railway. Therefore it is appropriate to offset the impacts of the project through seeking compensatory habitat of similar condition and size that will not be impacted by the suite of proposed projects in this location.

Furthermore it is evident that the project has been sensitively designed with the high conservation value of the remnant vegetation in consideration such that the proposed infrastructure has been located where possible to minimise impacts on native vegetation including threatened fauna and endangered ecological communities. Also the initiative to develop and implement a restoration plan for the degraded areas of the site and investigate compensatory habitat to further offset the impacts demonstrates a commitment towards assisting the protection of threatened species habitat in the locality.

A number of listed migratory bird species have been recorded from the Lower Hunter region which constitutes a part of the range area for migratory species such as the Satin Flycatcher, Black-faced Monarch, and White-bellied Sea Eagle.

In regards to migratory species, the habitats to be impacted do not provide unique or critical habitat, preferred habitat, or habitat of significance for an important population of a migratory species. Construction of the proposed works would not affect the visitation rates and behaviours of these migratory species in the region.

6. Conclusions and Recommendations

6.1. Significant ecological values

The majority of the study area supports remnant vegetation in a near natural ecological condition. Some disturbances are evident associated with previous land-uses which date back several decades. Weeds are common throughout, particularly along the edges of tracks and cleared land, in riparian areas and adjacent to existing railway infrastructure. Natural regeneration also occurs in previously cleared grazing land although these areas are in an early stage of regeneration and have low ecological value at present.

The assessment has also identified several areas of lower ecological value, comprising cleared land and land currently used for access where there is a distinct lack of vegetation including groundcover vegetation. Riparian vegetation in the eastern portions of the site were identified as degraded in condition, due to a lack of maturity and a high abundance of weeds.

The presence of two listed EECs (Schedule 1 part 3; TSC Act) was confirmed within the study area:

- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion (MU 1)
- Hunter Lowland Redgum Forest in the Sydney Basin and North coast Bioregions (MU 2 & 3)

The condition of these EECs ranges from low to high, with the latter providing habitat for a diversity of native flora and fauna species including rare and threatened fauna species. The targeted flora survey identified that none of the threatened flora species known from the region and considered as potential subject species occur on the site. The targeted fauna survey identified three threatened species and potential habitat for a further 25 species.

6.2. Ecological impacts

As a result of the identified significance of the vegetation and fauna habitat on the site following the field survey, a range of avoidance and mitigation measures were proposed and adopted by the Proponent in the early stages of the project. The adoption of these recommendations has significantly reduced the potential magnitude and extent of impacts from the project. The project will directly remove up to 18.5 ha of native vegetation. Operational and indirect impacts on remaining habitats will be managed through a plan to restore vegetation from absent and degraded portions of the site and under the guidance of a surface water management plan. Other potential impacts from lighting and increased traffic have been addressed through specific management recommendations.

The assessments of significance have concluded that the proposed project in itself is unlikely to impose a significant impact on local populations of threatened species, endangered communities or their habitats as listed under the TSC Act and EPBC Act, on the basis that the site will become isolated between the railway and the Hunter Expressway and that these actions will reduce the connectivity, size and value of the habitats on site. However this project will contribute significantly to the cumulative loss of habitat expected in the locality in the future when added to the impacts expected from the approved Hunter Expressway and third railway. Therefore it is appropriate to offset the impacts of the project through seeking an area of compensatory habitat of similar condition that will not be impacted by the suite of proposed projects in this location.

It is evident that the project has been sensitively designed with the high conservation value of the remnant vegetation in consideration such that the proposed infrastructure has been located where possible to minimise impacts on native vegetation including threatened fauna and endangered ecological communities. Also the initiative to develop and implement an ecological restoration plan for the degraded areas of the site and investigate compensatory habitat to further offset the impacts demonstrates a commitment towards assisting the protection of threatened species habitat in the locality.

6.3. Recommendations

The condition of the vegetation and fauna habitats in the study area and the nature of the project suggest that particular care and consideration is required during each phase of the project (i.e. pre-construction, construction and operation) to minimise threats and conserve areas of conservation value to threatened flora and fauna and endangered ecological communities. The following section provides advice and recommendations to achieve this objective:

- It is recognised that impacts on endangered ecological communities and habitat for threatened fauna species could not be avoided in the northern half of the site due to the narrow width of the site. This assessment has identified and quantified the impacts on biodiversity which includes the loss of 18.5 ha of vegetation including state listed endangered ecological communities and habitat for state and federal listed threatened fauna. The project should therefore aim to use this information in considering the selection of appropriate compensatory or offset habitat. Any proposed offset strategy should aim to replace residual impacts by seeking an area of vegetation of similar condition to that being lost in the local area if possible or in proximity to the site, which may also consider restoration of adjacent degraded areas.
- Proposed environmental offsets should consider the principals as set out in DEWR (2007). In this respect, the proposed offset site should aim to conserve a large area of remnant Spotted

Gum (*Corymbia maculata*) and/ or Forest Red Gum (*Eucalyptus tereticornis*) given their recognised value as important or critical foraging habitat for the Grey-headed Flying-fox.

- There is considerable scope to restore and revegetate degraded and cleared portions of the site outside of the development footprint. In this regard an Ecological Restoration and Management Plan should be developed that focuses on restoring the riparian vegetation as well as active planting and regeneration of currently cleared lands and the closure and rehabilitation of existing vehicle and recreational tracks. The plan should be prepared prior to construction and will identify the areas of focus, provide a set of objectives and actions required to restore, maintain and monitor the success of the plan with an adaptive approach.
- The Ecological Restoration and Management Plan should outline measures to monitor the impacts of the construction and success of the restoration activities on the flora and fauna of the site. The monitoring program should include a schedule of progress reports, bi-monthly during construction and then 12 months, 24 months and 36 months post-construction.
- A survey of hollow-bearing habitat trees as well as nest/dormitory sites for the Grey-crowned Babbler will be required prior to the final design and construction of the internal road and facilities to refine the footprint of these structures where possible to avoid these features. Data on the number of tree hollows lost could be used for developing a nestbox replacement program to be implemented as part of the ecological restoration plan. The plan should details the number a location of nest boxes to be placed on the site and target species, as well as suggestions for monitoring and maintenance.
- Install speed reduction measures along the internal access road, wildlife signage and sensor lighting to minimise disturbance from noise and lighting on nocturnal fauna, particularly the Squirrel Glider. The Restoration Plan should include landscaping along the road verges and disturbed edges of the development.
- Habitat on the site containing Spotted Gum (*Corymbia maculata*) has been identified as critical or essential foraging habitat for the Grey-headed Flying-fox (DECCW 2009) due to the fact that this tree species is productive during winter (May-Sept) at a time when food bottlenecks for flying foxes have been identified (Parry-Jones and Augee 1991 and Eby *et al* 1999). While the removal of Spotted Gum forest for this project was assessed as a non-significant impact for the long-term persistence of this species in the region, to further minimise potential impacts it is appropriate to instigate a strategy that avoids removal during the winter if possible. If not possible due to timing of approval then aim for gradual removal of Spotted Gum to allow re-adjustment by foraging Grey-headed Flying-fox as a precautionary measure. The following approach is recommended:

- If timing permits, avoid clearing the Spotted Gum / Ironbark Forest community during winter (May-Aug inclusive);
- If clearing is required in winter than this should be staged such that other forest types are cleared first or to avoid clearing large and mature Spotted Gum which are in flower until they cease flowering or as a final clearing activity. Juvenile trees can be cleared at any time. To achieve this, closely monitor the flowering of Spotted Gum on site during the winter period (note the flowering of trees may be unreliable from year to year and they may not flower at all). Identify flowering trees and any large and mature Spotted Gum by flagging prior to clearing. Continue monitoring of these during the clearing activity and remove these trees after flowering has ceased or as a final clearing activity.
- If areas containing a high density of flowering Spotted Gum are identified, this habitat should be cleared gradually over several weeks, by removing approximately 25% of the area per week.

6.4. Effectiveness of the Mitigation and Offset Measures

Potential impacts on biodiversity as a result of the proposal have been avoided and minimised where possible through interpretation of the flora and fauna data derived from the field surveys. This data was used to describe and illustrate the ecological values, constraints and opportunities and hence guide decisions relating to avoidance and minimising impacts. Finally the data was used in providing the mitigation and offset advice where impacts could not be avoided.

The key mitigation measures recommended relate to development of an Offset Strategy and secondly an Ecological Restoration and Management Plan. These plans would target the offset, management and restoration of habitat for matters of NES, in this case listed threatened and migratory fauna.

It is recommended that a minimum of at least 1:1 offset ratio be committed, consistent with the Commonwealth Governments draft policy statement with respect to environmental offsets under the EPBC Act (DEWR 2007). It is however critical that the offset site contain 'like for like' vegetation types that are in similar condition to the impact site. By offsetting using this approach, combined with the restoration efforts, this would effectively ensure a net gain in the habitat of the nationally listed threatened and migratory fauna species. This offset and mitigation would therefore considered sufficient compensation for the proposed loss of habitat.

Based on a review of the LHCCREMS (2003) vegetation map there appears to be sufficient areas of Spotted-Gum ironbark Forest and Forest Red Gum Forest in relative proximity to the project site to adequately compensate for the losses associated with the project.

Outside of the offset strategy, the recommended Ecological Restoration and Management Plan is a tool to further minimise impacts during the construction and operation of the facility. The outcome would include the restoration of currently cleared and degraded portions of the site and hence also contribute to a net gain in the biodiversity values in the area. The plan would target the planting and restoration of critical foraging habitat for the Grey-headed Flying-fox in particular.

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Appendix A Assessment of Significance (Part 3A: EP&A Act)

A.1 Endangered ecological communities

Lower Hunter Spotted Gum Ironbark Forest

How is the project likely to affect the lifecycle of a threatened species and/or population?

Not applicable

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

A total of 17.5 ha of Lower Hunter Spotted Gum – Ironbark Forest is present in the study area, of which up to 8 ha is within the project footprint and will be removed or modified. Areas of this community in the study area range from low to high condition with limited exotic weed infestations and an intact understorey supporting a diversity of native species. The LHCCREMS mapping has identified 32,366 ha of Lower Hunter Spotted Gum Ironbark Forest in the region. The proposal will remove approximately 0.02% of this regional distribution, comprising a relatively small proportion of the overall extant of this community.

Large areas of Lower Hunter Spotted Gum Ironbark Forest will remain surrounding the proposal area, including 9.5 ha within study area and areas of habitats on private property to the west of the study area. Additionally several cleared areas within the study area will be rehabilitated as part of the proposal to offset some of the impacts comprising up to 5.5 ha of cleared land of which approximately 3.5 ha would be regenerated to Lower Hunter Spotted Gum - Ironbark Forest.

Recovery strategies have been identified for this EEC which are relevant to the proposed development. The Department of Environment and Conservation has identified 9 priority actions to help recover the Lower Hunter Spotted Gum - Ironbark Forest in New South Wales. These actions are:

- Ensure that the fire sensitivity of the community is considered when planning hazard reduction and asset management burning.

- Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.
- Promote regeneration by avoiding prolonged or heavy grazing.
- Fence remnants where necessary to protect from off-road vehicle use and rubbish dumping.
- Weed control.
- Undertake restoration including bush regeneration and revegetation.

Where applicable these recovery strategies will be implemented with the proposed rail depot within retained and rehabilitated habitats which will include ongoing weed removal, fencing and restoration activities. These are to be outlined in the site restoration plan.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable

How is the Proposal likely to affect current disturbance regimes?

Some areas of the study area exhibit some evidence of previous disturbance in the form of selective vegetation clearance, track formation and minor weed invasion as a result of past land use activities. The majority of weed infestations are restricted to the existing rail corridor and have not significantly colonised areas of the adjacent remnant vegetation. A sparse cover of weed species is present throughout areas of remnant vegetation most likely as a result of past agricultural practices. Common weed species include Flatweed (*Hypochaeris radicata*); Stinking Roger (*Tagetes minuta*) and African Olive (*Olea europaea* subsp. *cuspidata*).Weed management will be implemented during the construction phase of the Proposal to limit the spread of exotic weed species.

The creation of new edges along cleared areas map lead to edge effects, in particular weed invasion. These impacts will be managed in a site restoration plan.

Several cleared areas within the study area will be rehabilitated as part of the proposal to offset some of the impacts comprising the rehabilitation of up to 5.5 ha of cleared land of which approximately 3.5 ha would be regenerated to Lower Hunter Spotted Gum - Ironbark Forest. Weed management would form part of the rehabilitation of these areas.

How is the Proposal likely to affect habitat connectivity?

The existing habitat connectivity for Lower Hunter Spotted Gum - Ironbark Forest in the study area is mainly to the west on adjacent private property, which is the approved location for the Hunter Expressway. The eastern side of the study area is bounded by the Northern Railway corridor which limits habitat connectivity and the majority of the eastern side of the rail corridor is cleared apart from a strip of riparian vegetation along Anvil Creek and areas of Lower Hunter Spotted Gum – Ironbark Forest are present at the northern end of the study area. Habitat connectivity will mainly be impacted at northern end of the study area where the entire width of the study area will be cleared fragmenting vegetation to the west (proposed Hunter Expressway location) and limiting connectivity across the rail corridor to the east. The maximum width of the clearing at the northern end of the proposal is 100 m; however it is assumed that many mobile pollinator species such as insects, bats and birds will be able to traverse the barriers created by the proposal to areas of retained habitat.

Habitat connectivity will be maintained along the northern end of the western boundary of the study area and connectivity will also be maintained with vegetation to the south of the study area where vegetation is proposed to be retained. Some level of habitat connectivity will also be maintained along Sawyers Creek. The proposed rehabilitation of cleared areas will improve and contribute to maintaining a habitat corridor from the study area to habitats to the south which connect to larger areas of habitat south of Tuckers Lane, and also along Sawyers Creek which crosses the rail corridor at the southern end of the study area and joins to Anvil Creek on the eastern side of the rail corridor.

How is the Proposal likely to affect critical habitat?

No critical habitat has been identified for this community.

Hunter Lowlands Red Gum Forest

How is the project likely to affect the lifecycle of a threatened species and/or population?

Not applicable

How is the Proposal likely to affect the habitat of a threatened species, population or ecological community?

A total of 21.4 ha of Hunter Lowlands Red Gum Forest is present on the site, of which of up to 9.6 ha is within the project footprint and will be removed or modified. Additionally approximately 0.8 ha of regenerating shrubland vegetation with affinities to Hunter Lowland Red Gum Forest will also be impacted from the proposal.

Areas of this community in the study area are in good condition with limited exotic weed infestations and an intact understorey supporting a diversity of native species. The LHCCREMS mapping has identified 4862 ha of Hunter Lowland Red Gum Forest in the region. The proposal will remove approximately 0.2% of this regional distribution.

Large areas of Hunter Lowland Red Gum Forest will remain surrounding the proposal area, including 11.8 ha within the study area and areas of private property to the west of the study area. Additionally several cleared areas within the study area will be rehabilitated as part of the proposal to offset some of the impacts comprising up to 5.5 ha of cleared land of which approximately 2 ha would be regenerated to Hunter Lowland Red Gum Forest.

Recovery strategies have been identified for this EEC which are relevant to the proposed development and where applicable recovery strategies will be implemented with the proposed rail depot within retained and rehabilitated habitats including weed removal, fire management, fencing and restoration activities.

Does the Proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable

How is the Proposal likely to affect current disturbance regimes?

Some areas of the study area exhibit some evidence of previous disturbance in the form of selective vegetation clearance, track formation and minor weed invasion as a result of past land use activities. The majority of weed infestations are restricted to the existing rail corridor and have not significantly colonised areas of the adjacent remnant vegetation. A sparse cover of weed species is present throughout areas of remnant vegetation most likely as a result of past agricultural practices.

The creation of new edges along cleared areas map lead to edge effects, in particular weed invasion. These impacts will be managed in a site restoration plan.

Several cleared areas within the study area will be rehabilitated as part of the proposal to offset some of the impacts comprising the rehabilitation of up to 5.5 ha of cleared land of which approximately 3.5 ha would be regenerated to Hunter Lowland Red Gum Forest. Weed management would form part of the rehabilitation of these areas.

How is the Proposal likely to affect habitat connectivity?

The existing habitat connectivity for Hunter Lowland Red Gum Forest in the study area is mainly to the west on adjacent private property, which is the approved location for the Hunter Expressway. The eastern side of the study area is bounded by the Northern Railway corridor which limits habitat connectivity and the majority of the eastern side of the rail corridor is cleared apart from a strip of riparian vegetation along Anvil Creek and areas of Lower Hunter Spotted Gum – Ironbark Forest (LHHCREMS 2003) are present at the northern end of the study area. Habitat connectivity will mainly be impacted at northern end of the study area where the entire width of the study area will be cleared fragmenting vegetation to the west (proposed Hunter Expressway location) and limiting connectivity across the rail corridor to the east. The maximum width of the clearing at the northern end of the proposal is 100 m; however it is assumed that many mobile pollinator species such as insects, bats and birds will be able to traverse the barriers created by the proposal to areas of retained habitat.

Habitat connectivity will be maintained along the northern end of the western boundary of the study area and also connectivity will be maintained with vegetation to the south of the proposal where vegetation is proposed to be retained. Some level of habitat connectivity will also be maintained along Sawyers Creek from retained habitats in the study area and across the rail corridor. The proposed rehabilitation of cleared areas will improve and contribute to maintaining a habitat corridor from the study area to habitats to the south which connect to larger areas of habitat south of Tuckers Lane, and also along Sawyers Creek which crosses the rail corridor at the southern end of the study area.

How is the Proposal likely to affect critical habitat?

No critical habitat has been identified for this community.

A.2 Threatened flora

No threatened flora species were identified in the study area.

A.3 Threatened fauna

- The significance of impacts on the following subject species has been assessed.

Species with similar morphological characteristics or ecological requirements have been assessed concurrently for example woodland birds and large forest owls.

Species	Listed status	
	EPBC Act	***TSC Act***
Swift Parrot (*Lathamus discolour*)	Endangered	Endangered
Regent Honeyeater *(Xanthomyza phrygia)*	Endangered	Endangered

Species	Listed status	
	EPBC Act	***TSC Act***
Spotted-tailed Quoll *(Dasyurus maculatus)*	Endangered	Vulnerable
Grey-headed Flying-fox *(Pteropus poliocephalus)*	Vulnerable	Vulnerable
Large-eared Pied Bat *(Chalinolobus dwyeri)*	Vulnerable	Vulnerable
Brush-tailed Phascogale (*Phascogale tapoatafa*)	-	Vulnerable
Eastern Bent-wing Bat *(Miniopterus schreibersii)*	-	Vulnerable
Eastern Cave Bat(*Vespadelus troughtoni*)	-	Vulnerable
Eastern False Pipistrelle *(Falsistrellus tasmaniensis)*	-	Vulnerable
Eastern Freetail Bat *(Mormopterus norfolkensis)*	-	Vulnerable
Greater Broad-nosed Bat *(Scoteanax rueppellii)*	-	Vulnerable
Large-footed Myotis *(Myotis adversus)*	-	Vulnerable
Little Bent-wing Bat (*Miniopterus australis*)	-	Vulnerable
Squirrel Glider *(Petaurus norfolcensis)*	-	Vulnerable
Brown Treecreeper *(Climacteris picumnus)*	-	Vulnerable
Little Lorikeet (*Glossopsitta pusilla*)		Vulnerable
Varied Sittella (*Daphoenositta chrysoptera*)	-	Vulnerable
Masked Owl *(Tyto novaehollandiae)*	-	Vulnerable
Powerful Owl *(Ninox strenua)*	-	Vulnerable
Speckled Warbler (*Pyrrholaemus sagittatus*)	-	Vulnerable
Square-tailed Kite (*Lophoictinia isura*)	-	Vulnerable

Swift Parrot and Regent Honeyeater

How is the project likely to affect the lifecycle of a threatened species and/or population?

The potential impacts on these species are associated with the direct loss of habitat and cumulative loss of potential habitat from the region. Potential indirect impacts on habitat such as weed invasion are not expected to significantly affect remaining habitat areas.

The distribution of records for both species in the lower Hunter Valley has been consistently associated with forests dominated by Swamp Mahogany (*Eucalyptus robusta*) or Forest Red Gum (*E.tereticornis*) or drier forests and woodlands comprising a high density of Spotted Gum (*Corymbia maculata*) (Menkhorst 1999, Saunders and Heinsohn 2008). Swamp Mahogany is not present in the study area, although the winter flowering Spotted Gum is present as a component of the Lower Hunter Spotted Gum / Ironbark Forest and Forest Red Gum is present as a component of the Hunter Lowlands Red Gum Forest. The association with these habitat types is a result of the presence of winter flowering eucalypts and the reliance by these nomadic species on the seasonally available winter food resources (nectar).

The study area would constitute non-breeding habitat for a proportion of the population of both species, however the study area is not considered a critical area for populations of regent honeyeater or swift parrot. There are no reported breeding events or aggregations in close proximity to the site, with the nearest breeding observation of the Regent Honeyeater near Kurri (Hunter Bird Observers Club Annual Report (HBOC 2006). The site may constitute potential nesting habitat for the Regent Honeyeater however the Swift Parrot breeds in Tasmania.

Records from the study area are relatively continuous extending over the last 30 years indicating that the region may constitute seasonally important foraging and refuge habitat for these species, particularly during inland droughts. The current potential for these species to occur based on the presence of potential foraging habitat is expected to remain after completion of the project such that foraging, movement and other life-cycle attributes would not be impacted.

It is likely that the clearing of 8 ha of Spotted Gum Ironbark Forest will result in a loss of Spotted Gums (*Corymbia maculata*) from the local area. This species is widely distributed throughout the lower and mid Hunter Valley region. Approximately 1600 ha of Lower Hunter Spotted Gum – Ironbark Forest occurs in Werakata National Park (Bell, 2004) and of an estimated 2800 ha of the community currently exists within State Forests of which approximately 1770 ha is excluded from timber harvesting within Forest Management Zone reserves (NSW Scientific Committee, 2005). In total the known formal reservation of Lower Hunter Spotted Gum - Ironbark Forest is

approximately 4570ha. A further 9.5 ha will remain on site with the proposal to plant additional cleared areas of the site.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

In considering the potential habitat of these two species in the study area, it is likely that the dry open forest habitats dominated by Spotted Gum and lower lying areas dominated by Forest Red Gum provide opportunities for foraging, although the habitat is not expected to be critical for breeding. The project would remove up to 8.5 ha of dry open forest and 9.6 ha of red gum forest. This loss is considered low and unlikely to be significant to populations of the swift parrot and regent honeyeater. Large areas of high quality habitat are represented in several regional State Forests, conservation reserves and rural properties. The potential for continued visitation to the region is expected following construction of the project.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The swift parrot extends from its summer breeding grounds in Tasmania, from where it disperses to over-winter in southeast mainland Australia. Some individuals range north to Queensland, but the majority over-winter in Victoria and central and eastern NSW (Saunders and Heinsohn 2008). The species returns to Tasmania in September. The study area constitutes a small percentage of the known distribution of the species and does not represent its geographical limit.

The regent honeyeater was formerly distributed in about 300 km of the eastern Australian coast from about 100 km north of Brisbane to Adelaide (Franklin *et al.* 1989); however, it is no longer found in South Australia (Franklin and Menkhorst 1988) or western Victoria (Franklin *et al.* 1987) and records from Queensland are uncommon. Sightings now centre on a few sites in north-eastern Victoria, along the western slopes of the Great Dividing Range to Tenterfield, the Warrumbungle Ranges and Parkes in the west, and the central coast of NSW. The total population is estimated at close to 1500 individuals (Webster and Menkhorst 1992).

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise

the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

How is the project likely to affect habitat connectivity?

In contrast to the large areas of habitat to the west of the study area associated with the production forests of Pokolbin and Putty, the landscape surrounding the site and the Greta township in heavily cleared and remaining bushland fragmented. The vegetation on the site is part of a large fragment of vegetation, albeit patchy in parts, which stretches to the west linking Black Creek in the west to Anvil Creek in the east, near Greta.

The impact of the project on habitat connectivity is complex as a result of the impacts of the approved development of the Hunter Expressway which adjoins the site to the west. Following the development of the expressway, the site will in fact be an isolated area of vegetation located between the rail line and the link road. Mobile species with large home ranges such as bats and birds will be able to access the site habitat; however species with small restricted home ranges will be mostly affected. In the context of surrounding development, the clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation of habitat in the landscape although the clearing for the actual project will not affect current habitat connectivity due to the future presence of the Hunter expressway.

How is the project likely to affect critical habitat?

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW under the TSC Act.

Grey-headed Flying-fox

How is the project likely to affect the lifecycle of a threatened species and/or population?

The potential impacts on these species are associated with the direct loss of habitat and cumulative loss of potential habitat from the region. Potential indirect impacts on habitat such as weed invasion are not expected to significantly affect remaining habitat areas. The species is adapted to foraging in habitat associated with noise and artificial lighting, particularly the Singleton populations which is roosting in a suburban park.

The Grey-headed flying-fox is a habitat specialist that occurs widely throughout the Hunter Valley and surrounding areas. There were no camps or roost sites identified in the study area and the nearest known camp is at Singleton (c.25km northwest). The Grey-headed flying-fox inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. Camps are often located in gullies, typically close to water, in vegetation with a dense canopy.

This species was not identified from the field survey, however the survey was conducted in late spring outside of the flowering period for Spotted Gum (*Corymbia maculata*). Spotted Gum has been identified as an important winter food source and critical foraging habitat for the species (DECCW 2009). While there are no roost camps on the site, the spotted gum/ironbark habitat is expected to provide regionally important foraging habitat for the Grey-headed Flying-fox.

The Grey-headed flying-fox feeds on nectar and pollen of a range of native trees, in particular species form the plant genera *Eucalyptus, Melaleuca*, *Banksia* and *Ficus* and fruits of rainforest trees and vines. There are extensive areas of potential foraging habitat for the species throughout the region and the clearing of about 18 ha of potential foraging habitat for this species represents a relatively minor impact in the context of the range of the species. In relation to the available habitat in adjacent surrounding areas, the project is not considered likely to affect this species at the local level. The proposed action is unlikely to affect the feeding, breeding or gestation lifecycles of local Grey-headed Flying-fox populations.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

As stated, the project will remove up to 18 ha of forest habitat expected to provide potential food resources for local populations of the Grey-headed Flying-fox. There is a known roosting colony 25 km northwest in Singleton which is within the foraging range of the species (DECCW 2009).

Up to 9.5 ha of spotted gum / ironbark forest and 11.8 ha of red gum / ironbark forest will remain on the site. Additional areas will be planted and regeneration with spotted gum as part of the site restoration plan. The total vegetation removal will equate to a very small proportion of the current distribution of foraging habitat for this species through the range of the colony. The proposed action would not result in the decrease in size of the population in the local area and would not impact on a known roost site.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The distribution ranges across eastern coastal Australia from Gladstone in Queensland to south Gippsland and Melbourne in Victoria. The Hunter Valley lies centrally within this distribution.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

How is the project likely to affect habitat connectivity?

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How is the project likely to affect critical habitat?

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Squirrel Glider

How is the project likely to affect the lifecycle of a threatened species and/or population?

Squirrel Gliders were recorded in both of the forest habitats on the site (i.e. Forest Red Gum / Ironbark Forest and the Spotted Gum / Ironbark Forest) and are expected to be widespread across the study area including adjacent lands to the east and west of the site which contain comparable habitats. Very few individuals were recorded (n=2) despite trapping and extensive spotlighting across a large proportion of the site and it is possible that the species exhibits naturally low population levels in the locality. Indeed the results of other fauna surveys conducted at the Singleton Training Area for the Department of Defence (SKM 2006), in similar habitat and approximately 10 km from the site, reported a single Squirrel Glider on the 1300 ha site. The result was despite an intensive survey effort of over 360 trap nights and 16 person hours of spotlighting. There has been no study of Squirrel Glider population densities in the locality.

The diversity of eucalypt species in the canopy, as well as acacia species in the mid-strata is suited to this species for providing seasonal food resources. Additionally an abundance of tree hollows is required for shelter and breeding habitat and this is also provided at the site. Habitats comparable to this are widespread in the broader locality and the species is known extensively from the Pokolbin and Rothbury areas northwest through to Singleton where it is commonly associated with habitats containing Forest Red Gum (DECCW Atlas of NSW Wildlife; authors, *pers.obs*). This includes fragmented habitats across farmland.

The lifecycle activities of this species rely on the presence of den trees (tree hollows) for shelter and breeding, the presence of seasonal food resources (nectar and tree sap) and habitat connectivity to access these and for social interaction. The proposed project will remove up to 18 ha of potential habitat for this species and is likely to remove a number of current den trees as well as contribute to the cumulative loss of food resources in the locality. Potential den sites also occur outside the project footprint particularly along riparian areas and the loss would be a percentage of the tree hollows available local populations. The approved Hunter Expressway will also remove habitat for this species.

The project would increase the degree of fragmentation of habitat for local populations and remove a small percentage of the hollows and food resources. It is likely that populations would remain stable in broader locality given the extent of suitable habitat however it would be desirable to compensate the loss of habitat from the project on this species through the regeneration of degraded areas which may include the provision of nest boxes to temporarily replace lost tree hollows and considering compensatory habitat.

The potential impacts on these species are associated with the direct loss of habitat and cumulative loss of potential habitat from the region. Potential indirect impacts on habitat such as weed invasion are not expected to significantly affect remaining habitat areas. Other potential impacts such as artificial lighting and site traffic have been addressed through appropriate management.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

The project is likely to remove a portion of the home range territory of at least 1-2 family groups of gliders, based on the field survey results however it may include more groups not detected. This impact would include the loss of probable den trees and sap feeding trees. There is no specific data on the home range of Squirrel Glider groups or known den trees on the actual site, so the extent of this impact on the local population is not known, although data on the species suggest home ranges can extend to around 6 ha (Sharpe and Goldingay 2007) so the site could potentially support a small number of family groups. The groups identified in the project area would be part of a larger population which extends into the surrounding habitats, particularly to the west linking to North Rothbury where other family groups have been reported (*author; pers obs*). These observations indicate that the subject animals on the site are part of a larger population which extends through to the locality.

The long-term persistence of squirrel gliders requires a landscape mosaic of old growth trees which meets both their foraging and sheltering needs. Such habitat is present throughout portions of the site and adjacent landscape. The project has been designed to minimise the footprint required to be cleared with the aim of protecting such habitat for this species including suitably large areas of potential habitat which will remain on site. As a further measure to provide habitat for this species hollow-trees are to be marked prior to clearing to determine if they can be retained, particularly along the access road and that a proposed restoration plan is prepared that would aim to provide locally native plant species used by these species for food (e.g. acacia and eucalypt spp).

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The squirrel glider has a patchy distribution being found along coastal eastern Australia and inland slopes of the Great Dividing Range from central Cape York to near Stanwell in Queensland, southeast Queensland to Sydney, NSW and northern Victoria. The species is not at the limit of its distribution in the study area.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

How is the project likely to affect habitat connectivity?

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How is the project likely to affect critical habitat?

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Spotted-tailed Quoll

How is the project likely to affect the lifecycle of a threatened species and/or population?

Preferred habitat for the spotted-tailed quoll includes a diversity of dry and moist sclerophyll forests where they den in rock caves, hollow logs or trees and will feed in nearby cleared areas (State Forests of NSW 1995a). The species is an opportunistic predator and will feed on a variety of prey including macropods, birds, reptiles, arboreal mammals and small terrestrial mammals (Mansergh 1983). The project would remove potential habitat for the species prey, leading to further reduction and fragmentation of hunting habitat, a known threat to the species. The habitat on the site may provide potential breeding habitat however opportunities for den sites are limited or absent due to the lack of caves and rocky habitat and large hollow logs. The habitat would be considered marginal for breeding.

Breeding, foraging and movement life-cycle opportunities would remain in the region and likely to sustain local populations.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

Preferred habitat includes dry and moist sclerophyll forests where they den in rock caves, hollow logs or trees and will feed in nearby cleared areas (State Forests of NSW 1995a). Suitable habitat is well represented in the larger fragments of forest in the study area, particularly state forests, adjoining private properties and conservation reserves. The project would remove potential habitat for the species and its prey, leading to further fragmentation of habitat, a known threat to the species. The project would result in the removal of up to 18 ha of potential habitat for this species. The overall reduction of habitat is a small proportion of the available potential habitat.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The spotted-tailed quoll occurs throughout eastern Australia through Queensland, NSW, Victoria and Tasmania and the study area is not the limit of distribution for this species.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation

clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

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How is the project likely to affect critical habitat?

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Brush-tailed Phascogale

How is the project likely to affect the lifecycle of a threatened species and/or population?

The species is reported in a wide range of habitats including the open forest and woodland types which are well represented in the broader locality and indeed the wider Hunter Valley. The brush-tailed phascogale is largely arboreal, occupying a variety of habitats, particularly open dry sclerophyll forest with little groundcover (Cuttle 1982). The home range of the species is exclusive and densities are correspondingly low. Female brush-tailed phascogales occupy a home range of 37 ha, and males occupy 86 ha with their home ranges overlapping the female home range (Traill

and Coates 1993; Soderquist 1995). Evidence of local populations in the study area has not been identified, however suitable habitat is widespread and common and populations are considered to persist following development of the project.

The diet of this species consists mainly of arthropods, such as spiders and centipedes, as well as small invertebrates including cockroaches, beetles and bull ants (Cuttle 1982). Phascogales will also forage on the ground and eucalypt nectar is extensively utilised when trees are flowering (Traill and Coates 1993). The diet is not particularly specialised to a degree that clearing for the project would significantly affect foraging requirements.

The brush-tailed phascogale has a three week mating season which occurs mid May to early July. Following mating, the pair nests in tree hollows with narrow entrances. After forming the nest, the male will soon die through what is believed to be stress related illness induced by excessive copulative behaviour (Traill and Coates 1993). The project would remove hollow-bearing trees suitable as nesting sites for the species and lead to further fragmentation and reduction of mature forest from the region. Suitable habitat is widespread and common providing continued habitat for local populations.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

The brush-tailed phascogale is largely arboreal, occupying a variety of habitats, particularly open dry sclerophyll forest with little groundcover (Cuttle 1982). Such habitats are well represented in the region, particularly on ridges and low hills where clearing has been less severe than river flats. The project would result in the removal of up to 18 ha for this species. The overall reduction of habitat is a small proportion of the available potential habitat. Populations are considered to persist following development of the project.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The brush-tailed phascogale occurs throughout eastern Australia to the western slopes of the Great Divide from southern Queensland, NSW and Victoria (NPWS 2002) and the study area is not the limit of distribution for this species.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire

regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

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How is the project likely to affect critical habitat?

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW under the TSC Act.

Large Forest Owls (Powerful Owl, Masked Owl, Barking Owl)

How is the project likely to affect the lifecycle of a threatened species and/or population?

None of these bird species were recorded in the study area, although their presence is inferred from a review of regional records and habitat assessment. Indeed the powerful owl and masked owl are widespread throughout the region being recorded in a range of habitats including the open forest and riparian habitats typical of the study area. The barking owl is less commonly

reported. The habitat is most suited to the masked owl and only marginal for the powerful owl and barking owl.

Prey species for the Powerful Owl (typically arboreal mammals) are present on the site although limited to Squirrel Gliders (*Petaurus norfolcensis*) and Brushtail Possum (*Trichosurus vulpecula*). Common ringtail possums (*Psedocheirus peregrinus*) are very scarce and their low density may negatively affect the availability of habitat for Powerful Owls. Prey species for the Masked Owl include small ground-dwelling fauna and smaller arboreal mammals which are present in low abundance. Barking owls prey on birds and small mammals, both of which are common.

Similarly very large tree hollows, which are required for nesting and roosting, were observed to be uncommon in contrast to small and medium sized hollows and the habitat within the study area may not support potential nest sites for these wide ranging species or constitute regionally important habitat but in fact support only a proportion of the foraging home range.

Whilst these species are known to occasionally roost by day in dense thickets of vegetation or foliage their nesting requirements are more specialised being totally dependent on suitably large tree-hollows generally found in the trunks of tall and mature trees. Their dependence on this specific habitat feature restricts the local distribution of the species at least for breeding life-cycle requirements and highlights their vulnerability to increased clearing and fragmentation of habitat. Generally foraging territory is more widespread and may occur throughout a variety of habitat types depending on the species, with the powerful owl ranging from swamp forest to wet and dry sclerophyll, preferably in wet gullies for roosting and the masked owl and barking owl favouring the more open forest and woodland types for foraging, particularly on the edge of open lands such as agricultural lands and potentially riparian areas for nesting.

The project will remove habitat for these species prey which may potentially impact on the home range of a small number of owl pairs. This would have the greatest impact if conducted during the gestation, breeding and young rearing life-cycle stages. Although there is some evidence to suggest that clearing vegetation has a short-term benefit for the Masked owl due to the displacement of small terrestrial prey such as rats.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

None of these bird species were recorded in the study area, although their presence is inferred from a review of regional records and habitat assessment. Indeed the powerful owl and masked owl are widespread throughout the region being recorded in a range of habitats including the open forest and riparian habitats typical of the study area. The barking owl is less commonly

reported. The habitat is most suited to the masked owl and only marginal for the powerful owl and barking owl.

The project will remove habitat for these species prey which may potentially impact on the home range of a small number of owl pairs. However very large tree hollows, which are required for nesting and roosting, were observed to be uncommon in contrast to small and medium sized hollows and the habitat within the study area may not support potential nest sites for these wide ranging species or constitute regionally important habitat but in fact support only a proportion of the foraging home range.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

All three species occur throughout eastern Australia through Queensland, NSW and Victoria and the study area is not the limit of distribution for these species.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

How is the project likely to affect habitat connectivity?

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How is the project likely to affect critical habitat?

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Square-tailed Kite

How is the project likely to affect the lifecycle of a threatened species and/or population?

Not recorded in the study area, presence inferred from a review of regional records and habitat assessment. The species is recorded in a wide range of habitats including the open forest types which dominate the study area and surrounding landscape. No nest sites were reported from a general traverse of the site and the project is not expected to negatively impact on breeding life-cycle events.

The square-tailed kite prefers coastal and sub-coastal open forest and woodlands on fertile soils with abundant prey species being present (Debus *et al*. 1993). A common feature of the kite's habitat is the presence of profuse eucalypt blossom and attendant nectivorous birds (Debus *et al*. 1993) on which the square-tailed kite preys. On the coast, the kite appears to prefer the drier forest types on the foothills and coastal plains. Records of the species appear to be associated with the extensive dry sclerophyll forest habitats on low hills.

No nest sites were located from the surveys nor have been reported in the vicinity of the study site. The project would not impact on breeding activities of local populations of the square-tailed kite. Potential habitat for foraging and roosting is very common and widespread for this species in the region and the impacts on this life-cycle activity is expected to be minimal.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

The square-tailed kite prefers coastal and sub-coastal open forest and woodlands on fertile soils with abundant prey species (Debus *et al*. 1993). Dry sclerophyll forest habitats are common and

widespread throughout the region particularly west and north of the study area extending Pokolbin and Putty State Forest that would be considered suitable habitat for this species. The project would remove up to 18 ha of open forest considered suitable for this species for hunting. This total is a small percentage of the habitat available in the region.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

It occurs throughout eastern and northern Australia. The study area is not the limit of distribution for this species.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

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Tree-roosting microchiropteran Bats

Eastern False Pipistrelle (*Falsistrellus tasmaniensis)*
Eastern Freetail-Bat (*Mormopterus norfolkensis)*
Greater Broad-Nosed Bat (*Scoteanax rueppellii)*
Yellow-bellied Sheathtail-Bat (*Saccolaimus flaviventris)*

How is the project likely to affect the lifecycle of a threatened species and/or population?

Vegetation in the study area provides potential foraging and roosting habitat for the assessed species. These bat species frequent a variety of habitat types ranging from rainforest to wet and dry sclerophyll forest, woodland and open modified landscapes.

Important life-cycle activities include roosting and breeding and both are typically associated with tree hollows as well as foraging for insect prey which occurs in a variety of habitat types. The size of local populations is not known, although expected to be moderately large given the expanses of suitable habitat and tree hollow densities, particularly small hollows which are preferred by bats. The project would remove about 18 ha of forest habitat which is potentially used by these species, this will include the removal of tree hollows. Comparable habitats are well represented throughout the locality and regional area and it is unlikely that the project would have a significant impact on the foraging or roosting life-cycle events for local populations of these bat species and continued presence in the locality could be expected.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

Vegetation in the study area provides potential foraging and roosting habitat for the assessed species. The project would remove about 18 ha of forest habitat which is potentially used by these species, this would include the removal of tree hollows and potentially affect populations of insect prey. Comparable habitats are very well represented throughout the locality and regional area and it is unlikely that the loss of habitat would have a significant impact.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

None of these tree roosting threatened bat species are at the limit of their distribution in the study area. Dry and moist sclerophyll forest habitats are very common and widespread throughout the region particularly further west of the study area.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

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The impact of the project on habitat connectivity is complex as a result of the impacts of the approved development of the Hunter Expressway which adjoins the site to the west. Following the development of the expressway, the site will in fact be an isolated area of vegetation located betweent the rail line and the link road. Mobile species with large home ranges such as bats and birds will be able to access the site habitat, however species with small restricted home ranges will be mostly affected. In the context of surrounding development, the clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation of habitat in the landscape although the clearing for the actual project will not affect current habitat connectivity due to the future presence of the Hunter expressway.

How is the project likely to affect critical habitat?

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW under the TSC Act.

Cave-roosting microchiropteran Bats

Eastern Bent-Wing Bat (*Miniopterus schreibersii oceanenis)*
Little Bentwing-Bat (*Miniopterus australis)*
Large-footed Myotis (*Myotis adversus)*
Large-eared Pied Bat (*Chalinolobus dwyeri*)

How is the project likely to affect the lifecycle of a threatened species and/or population?

The study area provides known and potential foraging habitat for the assessed species. These species are predominantly cave-roosting bats, although a small colony of Little Bentwing-bats has been observed roosting in a hollowed tree trunk (Schulz 1997) and Large-footed Myotis have been recorded roosting under old timber bridges. No timber bridges would need to be removed to accommodate the project. Similarly no caves or abandoned mine shafts have been recorded on the site and the project is not expected to impact on the roosting life-cycle activities of these species. The location of any roost sites for these species in the locality is not known.

The project would remove about 18 ha of forest habitat and which provides known and potential foraging habitat. Comparable habitats are very well represented throughout the locality and regional area and it is unlikely that the project would have a significant impact on the foraging life-cycle events for a local population of these bat species and continued foraging over the site and adjacent lands could be expected. Large-footed Myotis hunt over water bodies for small fish and invertebrates and may frequent the creek habitats in the study area. Impacts on foraging habitat would result from the project however the overall magnitude of impact is small.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

Impacts on known or potential roosting habitat are not expected. The project would remove about 18 ha of forest habitat and which provides potential foraging habitat. Comparable habitats are very well represented throughout the locality and regional area and it is unlikely that the loss of potential foraging habitat would have a significant impact on local population of these bat species and continued foraging over the site and adjacent lands could be expected. Impacts on foraging habitat would result from the project however the overall magnitude of impact is small. The project is not expected to impact on the roosting life-cycle activities of these species. The location of any roost sites for these species in the locality is not known

Does the project affect any threatened species or populations that are at the limit of its known distribution?

None of these cave-roosting threatened bat species are at the limit of their distribution in the study area.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

How is the project likely to affect habitat connectivity?

In contrast to the large areas of habitat to the west of the study area associated with the production forests of Pokolbin and Putty, the landscape surrounding the site and the Greta township in heavily cleared and remaining areas of bushland fragmented. The vegetation on the site is part of a large fragment of vegetation, albeit patchy in parts, which stretches to the west linking Black Creek in the west to Anvil Creek in the east, near Greta.

The impact of the project on habitat connectivity is complex as a result of the impacts of the approved development of the Hunter Expressway which adjoins the site to the west. Following the development of the expressway, the site will in fact be an isolated area of vegetation located between the rail line and the link road. Mobile species with large home ranges such as bats and birds will be able to access the site habitat; however species with small restricted home ranges will be mostly affected. In the context of surrounding development, the clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation of habitat in the landscape although the clearing for the actual project will not affect current habitat connectivity due to the future presence of the Hunter expressway.

How is the project likely to affect critical habitat?

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW under the TSC Act.

Woodland Birds

Black-chinned Honeyeater (*Melithreptus gularis gularis)*
Brown Treecreeper (*Climacteris picumnus)*
Diamond Firetail (*Stagonopleura guttata)*
Grey-crowned Babbler (*Pomatostomus temporalis temporalis)*
Hooded Robin (*Melanodryas cucullata)*
Speckled Warbler (*Pyrrholaemus sagittatus)*

How is the project likely to affect the lifecycle of a threatened species and/or population?

Suitable woodland habitat for these species is represented in the far southern end of the site and extends to the west and south into more open woodland dominated by Grey Box and Ironbark. The denser riparian areas and Forest Red Gum habitats over the site are not typical of these species. Areas of more open canopy and sparse understorey may be used where ironbarks are dominant. Generally the potential habitat for these species will remain outside of the development footprint and the project is not expected to involve a significant loss of habitat or negatively impact on life-cycle requirements as the majority of the project will only affect marginal habitat.

The loss may impact on the home range territory of several pairs, remove a percentage of the shelter and foraging resources for these birds and potentially disrupt a breeding season. The number of animals affected in relation to the size of local population is not known, however records are widespread and it could be reasonably expected the proportion of the population impacted would be minor and not lead to a significant impact on the population as a whole.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

The proposal removal of up to 18 ha of potential habitat may result in the loss of foraging and breeding habitat and may have a short term impact on food resources. However the habitats suited to these species are particularly well represented in the region, particularly to the west of the study area. The overall reduction of habitat is considered a small proportion of the available potential habitat. Populations are considered to persist following development of the project. The lack of records of these species reported from the field survey suggests that the habitat to be removed is only marginal.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The study area is not at the limit of distribution for any of these woodland bird species. Species such as the Speckled Warbler and Black-chinned Honeyeater approach the coast in northern NSW and southern Queensland, elsewhere there distribution is inland.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes

How is the project likely to affect habitat connectivity?

In contrast to the large areas of habitat to the west of the study area associated with the production forests of Pokolbin and Putty, the landscape surrounding the site and the Greta township in heavily cleared and remaining areas of bushland fragmented. The vegetation on the site is part of a large fragment of vegetation, albeit patchy in parts, which stretches to the west linking Black Creek in the west to Anvil Creek in the east, near Greta.

The impact of the project on habitat connectivity is complex as a result of the impacts of the approved development of the Hunter Expressway which adjoins the site to the west. Following the development of the expressway, the site will in fact be an isolated area of vegetation located between the rail line and the link road. Mobile species with large home ranges such as bats and birds will be able to access the site habitat; however species with small restricted home ranges will be mostly affected. In the context of surrounding development, the clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation of habitat in the landscape although the clearing for the actual project will not affect current habitat connectivity due to the future presence of the Hunter expressway.

How is the project likely to affect critical habitat?

None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW under the TSC Act.

Little Lorikeet

How is the project likely to affect the lifecycle of a threatened species and/or population?

Little lorikeets are known to occupy a diversity of forest and woodland habitats, including old-growth and logged forests, and remnant woodland patches and roadside vegetation (Pizzey & Knight 1997, DECC 2008). The species is generally considered to be nomadic, with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability (DECC 2008). However, they do exhibit some site fidelity, with breeding pairs resident from April to December, and even during their non-resident period some individuals will return to the nest area for short periods if there is some tree-flowering in the vicinity. No individuals were reported during the September survey on the site, despite several other nectivorous parrot species being present such as the Musk and Rainbow Lorikeet, suggesting that a resident population does not occur.

They feed in small flocks, often with other species of lorikeet, primarily on nectar and pollen in the tree canopy. They prefer profusely flowering eucalypts but will also feed in other species such as melaleucas and mistletoes. The species breeds in tree hollows in living trees, during May to September, raising clutches of three to five eggs (DECC 2008). They likely commence breeding at one year, and live for approximately 10 years in the wild.

Major threats to little lorikeets are loss of breeding sites and food resources from ongoing land clearing. The study area would constitute breeding and non-breeding habitat for the little lorikeet. The loss of hollow-bearing and feed trees would directly affect the species opportunity to feed and breed in the area. However the study area is not considered a critical breeding area for the little lorikeet as extensive areas of suitable habitat occur elsewhere in the region. The current potential for the species to occur based on the presence of potential foraging and breeding habitat is expected to remain after completion of the project such that foraging, movement and other life-cycle attributes would not be impacted.

How is the project likely to affect the habitat of a threatened species, population or ecological community?

In considering the potential habitat for the species in the study area, it is likely that all the open forest habitats present at the study area, provide opportunities for foraging and breeding. The project would remove up to 18 ha of open forest. This loss is considered low and of little significance to populations of the little lorikeet. Large areas of high quality habitat are represented outside the project site and in several State Forests, conservation reserves and rural

properties. The potential for continued visitation to the region is expected following construction of the project.

Does the project affect any threatened species or populations that are at the limit of its known distribution?

The distribution of the little lorikeet extends from just north of Cairns, around the east of Australia, to Adelaide (DECC 2008). In NSW the species is distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range. Hence the study area is not at the limit of the species known distribution.

How is the project likely to affect current disturbance regimes?

A range of disturbance regimes currently exist and reflect the historical and current land-uses of the study area, such as loss of mature forest and tree hollows, weed invasion, inappropriate fire regimes, and presence of introduced predators. The introduction of a new development in the locality has the potential to further affect some of these disturbance regimes through vegetation clearing and altering hydrological regimes. The design planning process was designed to minimise the severity of disturbance regimes by appropriate placement of infrastructure. Further measures to reduce the residual impacts include construction and operational management practices, drainage design and sediment control, weed management and rehabilitation of degraded areas. The inclusions of these measures suggest minimal additional affect of the disturbance regimes beyond the current situation.

How is the project likely to affect habitat connectivity?

In contrast to the large areas of habitat to the west of the study area associated with the production forests of Pokolbin and Putty, the landscape surrounding the site and the Greta township in heavily cleared and remaining areas of bushland fragmented. The vegetation on the site is part of a large fragment of vegetation, albeit patchy in parts, which stretches to the west linking Black Creek in the west to Anvil Creek in the east, near Greta.

The impact of the project on habitat connectivity is complex as a result of the impacts of the approved development of the Hunter Expressway which adjoins the site to the west. Following the development of the expressway, the site will in fact be an isolated area of vegetation located between the rail line and the link road. Mobile species with large home ranges such as bats and birds will be able to access the site habitat; however species with small restricted home ranges will be mostly affected. In the context of surrounding development, the clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation

of habitat in the landscape although the clearing for the actual project will not affect current habitat connectivity due to the future presence of the Hunter expressway.

How is the project likely to affect critical habitat?

No critical habitat has been identified for this species.

Appendix B Assessment of Significance (EPBC Act)

No nationally threatened flora species were recorded on the site. This assessment relates to threatened fauna and migratory species only.

B.1 Endangered species

Swift Parrot and Regent Honeyeater

Lead to a long-term decrease in the size of a population;

Both species are occasional visitors to the region during peak flowering events of the dominant trees, particularly the winter flowering Spotted Gum (*Corymbia maculata*). There are no resident populations known from the actual site or immediately surrounding lands and the habitat on site would constitute a small percentage of the available non-breeding habitat for transient populations.

Records from the study area are relatively continuous extending over the last 30 years indicating that the region may constitute seasonally important foraging and refuge habitat for transient populations of these species, particularly during inland droughts. The current potential for these species to occur based on the presence of potential foraging habitat is expected to remain after completion of the project such that foraging, movement and other life-cycle attributes would not be impacted suggesting that the project would not lead to a long-term decrease in the size of populations of either species.

Reduce the area of occupancy of the species;

Both species are occasional visitors to the region and there are no known permanent populations on the site. Any use of the site could potentially occur across all vegetated areas including habitat to be retained and restored on the site

Fragment an existing population into two or more populations;

Both species are occasional visitors to the region and there are no known resident populations using the habitats on site.

Adversely affect habitat critical to the survival of a species;

The distribution of records for both species in the lower Hunter Valley has been consistently associated with forests dominated by Swamp Mahogany (*Eucalyptus robusta*) or Forest Red Gum (*E.tereticornis*) or drier forests and woodlands comprising a high density of Spotted Gum (*Corymbia maculata*) (Menkhorst 1999, Saunders and Heinsohn 2008). Swamp Mahogany is not

present in the study area, although the winter flowering Spotted Gum is present as a component of the Lower Hunter Spotted Gum / Ironbark Forest and Forest Red Gum is present as a component of the Hunter Lowlands Red Gum Forest. The association with these habitat types is a result of the presence of winter flowering eucalypts and the reliance by these nomadic species on the seasonally available winter food resources (nectar).

The habitats on the actual project site would constitute non-breeding habitat for a proportion of the population of both species although is not considered critical habitat for populations of regent honeyeater or swift parrot. There are no reported breeding events or aggregations in close proximity to the site, with the nearest breeding observation of the Regent Honeyeater near Kurri (Hunter Bird Observers Club Annual Report (HBOC 2006). The site may constitute potential nesting habitat for the Regent Honeyeater however the Swift Parrot breeds in Tasmania.

Records from the study area are relatively continuous extending over the last 30 years indicating that the region may constitute seasonally important foraging and refuge habitat for these species, particularly during inland droughts. The current potential for these species to occur based on the presence of potential foraging habitat is expected to remain after completion of the project such that foraging, movement and other life-cycle attributes would not be impacted.

Disrupt the breeding cycle of a population;

There are no reported breeding events or aggregations in close proximity to the site, with the nearest breeding observation of the Regent Honeyeater near Kurri (Hunter Bird Observers Club Annual Report (HBOC 2006). The site may constitute potential nesting habitat for the Regent Honeyeater however the Swift Parrot breeds in Tasmania.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

There are no resident populations in this immediate locality and the habitats on the project site would constitute non-breeding habitat for a proportion of the population of both species although is not considered critical habitat for populations of regent honeyeater or swift parrot.

It is likely that the clearing of 8 ha of Spotted Gum Ironbark Forest will result in a loss of Spotted Gums (*Corymbia maculata*) from the local area. This species is widely distributed throughout the lower and mid Hunter Valley region. Approximately 1600 ha of Lower Hunter Spotted Gum – Ironbark Forest occurs in Werakata National Park (Bell, 2004) and of an estimated 2800 ha of the community currently exists within State Forests of which approximately 1770 ha is excluded from timber harvesting within Forest Management Zone reserves (NSW Scientific Committee, 2005). In total the known formal reservation of Lower Hunter Spotted Gum - Ironbark Forest is

approximately 4570ha. A further 9.5 ha will remain on site with the proposal to plant additional cleared areas of the site.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

There is potential for further small scale invasion of weeds and feral animals during the clearing and construction of the project. This risk would be managed during construction and it is considered unlikely that any extensive degradation would result or that any invasive species would become established. The proposal to prepare and implement a site restoration plan will further ensure that the remaining habitats are buffered from the impacts of invasive species.

Introduce disease that may cause the species to decline; or

It is considered unlikely that the project would introduce any diseases.

Interfere with the recovery of the species.

The proposed loss of vegetation will contribute to the cumulative loss of habitat in the region. Measures to minimise clearing and restore habitat have been included to minimise and offset the loss of habitat. The proposed offsetting of habitat is consistent with the objectives of the recovery plan and it unlikely that the project would interfere with the recovery of these species.

Spotted-tailed Quoll

Lead to a long-term decrease in the size of an important population

Preferred habitat for the spotted-tailed quoll includes a diversity of dry and moist sclerophyll forests where they den in rock caves, hollow logs or trees and will feed in nearby cleared areas (State Forests of NSW 1995a). The species is an opportunistic predator and will feed on a variety of prey including macropods, birds, reptiles, arboreal mammals and small terrestrial mammals (Mansergh 1983). The project would remove potential habitat for the species prey, leading to further reduction and fragmentation of hunting habitat, a known threat to the species. The habitat on the site may provide potential breeding habitat however opportunities for den sites are very limited or completely absent due to the lack of caves and rocky habitat and large hollow logs. The habitat would be considered marginal for breeding.

Breeding, foraging and movement life-cycle opportunities would remain in the region and likely to sustain local populations such that there is unlikely to be a long-term decrease of local populations associated with this project. Large areas of suitable habitat remain in the locality in rural holdings and cumulative development pressures in not currently expected.

Reduce the area of occupancy of an important population

The species typically has a large home range and occupies a diversity of habitat types. It is therefore difficult to identify the area of occupancy. Theoretically, Quolls could occur in any of the larger forest fragments of the broader locality. Preferred habitat includes dry and moist sclerophyll forests and may include adjacent modified patches of forest on farmland. Suitable habitat is well represented in the larger fragments of forest in the study area, particularly state forests and adjoining private properties to the west. The project would remove potential habitat for the species however the overall reduction of habitat is a small proportion of the available potential habitat.

Fragment an existing important population into two or more populations

In contrast to the large areas of habitat to the west of the study area associated with the production forests of Pokolbin and Putty, the landscape surrounding the site and the Greta township in heavily cleared and remaining areas of bushland fragmented. The vegetation on the site is part of a large fragment of vegetation, albeit patchy in parts, which stretches to the west linking Black Creek in the west to Anvil Creek in the east, near Greta.

The impact of the project on habitat connectivity is complex as a result of the impacts of the approved development of the Hunter Expressway which adjoins the site to the west. Following the development of the expressway, the site will in fact be an isolated area of vegetation located between the rail line and the link road.

In the context of surrounding development, the clearing of vegetation for the Hunter Expressway and within the site itself will contribute to the cumulative fragmentation of habitat in the landscape although there is no direct evidence to infer that this will fragment populations of the spotted-tailed quoll.

Adversely affect habitat critical to the survival of the species

- Habitat critical to the survival of a species refers to areas that are necessary for activities such as
  - Foraging, breeding, roosting, or dispersal.
  - For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.
  - To maintain genetic diversity and long-term evolutionary development.

- For the reintroduction of populations or recovery of the species.

Some of the larger habitats represented in the study area are suitable for populations of spotted-tailed quoll however, they do not constitute habitat that is critical for the long-term maintenance of the species.

Disrupt the breeding cycle of an important population

Given the typically large home range of this species, potentially only a small number of individuals may be present in the lands surrounding the study area. There are no cave sites or suitably large logs present that may be considered to provide potential den sites for breeding. The project is therefore unlikely to impact on the breeding cycle of an important population.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Suitable habitat is well represented in the larger fragments of forest to the west of Greta and Rothbury within Pokolbin and Putty state forest. These very large fragments of habitat also contain sandstone escarpments, rocks, caves and overhangs suitable for breeding sites and are likely to contain viable populations of spotted-tailed quoll. Indeed the fragmented farmland around Greta is considered only marginal for the species compared to that described. Given the large home range of this species and the presence of only marginal habitat, potentially only a small number of individuals may utilise the habitat to be impacted.

The project would remove potential habitat for this small number of individuals, leading to further fragmentation of habitat. The impacts are not likely to cause the species to decline in the region.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

The potential for weed invasion is considered possible with a project of this nature and appropriate controls are required during the construction and operation of the project to reduce this threat as it may have long term implication for the habitat of threatened species. The management of invasive species would be managed under the guidance of the restoration plan.

Introduce disease that may cause the species to decline

There are no known diseases issues affecting this species. The project is unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Interferes substantially with the recovery of the species

The project would not conflict with the recovery of this species, as it will only have an effect on marginal habitat and would not impact on potential breeding habitat.

B.2 Vulnerable Species

Grey-headed flying-fox

Lead to a long-term decrease in the size of an important population

The Grey-headed flying-fox is a habitat specialist that occurs widely throughout the Hunter Valley and surrounding areas. There were no camps or roost sites identified in the study area and the nearest known camp is at Singleton (c.25km northwest) within the foraging range of the species. This species was not identified foraging on the site during the field survey however the survey was conducted in late spring outside of the flowering period for Spotted Gum (*Corymbia maculata*). Spotted Gum has been identified as an important winter food source and critical foraging habitat for the species (DECCW 2009). While there are no roost camps on the site, the spotted gum/ironbark habitat is expected to provide potentially important foraging habitat for the Grey-headed Flying-fox Singleton population.

The Grey-headed flying-fox feeds on nectar and pollen of a range of native trees, in particular species form the plant genera *Eucalyptus, Melaleuca*, *Banksia* and *Ficus* and fruits of rainforest trees and vines. There are extensive areas of potential foraging habitat for the species throughout the broader locality and the clearing of around 18 ha of potentially important foraging habitat for this species represents a relatively minor impact in the context of the foraging range of the local population. In relation to the available habitat in adjacent surrounding areas, the project is not considered likely to affect this species at the local level. The proposed action is unlikely to affect the feeding, breeding or gestation lifecycles of local Grey-headed Flying-fox populations.

The three important aspects considered in assessing the impacts on this population from the project relate to relevant actions as listed in the draft National Recovery Plan for the Grey-headed Flying Fox (DECCW 2009) and whether the proposal is consistent with these actions. These considerations are;

1. Identify and protect foraging habitat critical to the survival of the Grey-headed Flying-fox across their range
2. To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes
3. To identify roosting habitat critical to the survival of Grey-headed Flying-foxes.

The project is considered consistent with the third objective, in that the proposed activity will not directly impact on an identified roost camp. In terms of objectives 1 and 2, forests that contain spotted gum are considered critical foraging habitat (DECCW 2009) due to the flowering period which coincides with the final weeks of gestation, and during the weeks of birth, lactation and conception of the grey-headed flying-fox (Sept-May) and the fact that the site is within a 50km range of the Singleton roost camp. It is therefore appropriate to avoid removal of spotted gum during the period Sept-May and supplement trees lost with restoration of degraded areas as is proposed. A further 9.5 ha will remain on site with the proposal to plant additional cleared areas of the site.

It is likely that the clearing of 8 ha of Spotted Gum Ironbark Forest will result in a loss of Spotted Gums (*Corymbia maculata*) from the local area. This species is widely distributed throughout the lower and mid Hunter Valley region. Approximately 1600 ha of Lower Hunter Spotted Gum – Ironbark Forest occurs in Werakata National Park (Bell, 2004) and of an estimated 2800 ha of the community currently exists within State Forests of which approximately 1770 ha is excluded from timber harvesting within Forest Management Zone reserves (NSW Scientific Committee, 2005). In total the known formal reservation of Lower Hunter Spotted Gum - Ironbark Forest is approximately 4570ha. Al of these areas is within a 50 km radius of the Singleton roost camp.

Reduce the area of occupancy of an important population

As stated, the project will remove up to 18 ha of forest habitat (8 ha of spotted gum / ironbark forest) expected to provide potential food resources for local populations of the Grey-headed Flying-fox. There is a known roosting colony 25 km northwest in Singleton which is within the foraging range of the species (DECCW 2009).

Up to 9.5 ha of spotted gum / ironbark forest and 46.8 ha of red gum / ironbark forest will remain on the site. Additional areas will be planted and regeneration with spotted gum as part of the site restoration plan. The proposed action would reduce the available foraging habitat for local population by a very small percentage when considering the total known area of this resource. Indeed this includes an area of some 4570 ha known in formal reserves. The project is not expected to significantly impact on food resources available for local populations of the grey-headed flying-fox. This species is wide ranging a capable of exploiting seasonally available and wide spread food resources.

Fragment an existing important population into two or more populations

The project would contribute to the cumulative fragmentation of habitat in the landscape by currently impacting on contiguous forest. Highly mobile species such as bats and birds are expected to be less impacted by fragmentation and the grey-headed flying-fox is particularly well adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal fruits and blossom. The project would not fragment an important population of the Grey-headed flying-fox.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of a species refers to areas that are necessary for activities such as:

- Foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.
- To maintain genetic diversity and long-term evolutionary development.
- For the reintroduction of populations or recovery of the species.

Forests that contain spotted gum are considered critical foraging habitat for the Grey-headed Flying-fox (DECCW 2009) due to their flowering period which coincides with the final weeks of gestation, and during the weeks of birth, lactation and conception of the grey-headed flying-fox (Sept-May) and the fact that the site is within a 50km range of the Singleton roost camp. . The project will remove up to 8 ha of this habitat, with a further 9.5 ha remaining on site. There are no confirmed roost camps on the site.

The project will therefore adversely affect a relatively small area of habitat that could be considered critical for the local population. It is therefore appropriate to avoid removal of spotted gum during the period Sept-May and supplement trees lost with restoration of degraded areas as is proposed for this project.

Disrupt the breeding cycle of an important population

No evidence of a roosting colony of the grey-headed flying-fox occurs on the study site. The removal of potential foraging habitat during the weeks of birth, lactation and conception of the grey-headed flying-fox (Sept-May) may have a negative impact on the breeding cycle of the species and should be avoided.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

As stated, the project will remove up to 18 ha of forest habitat (8 ha of spotted gum / ironbark forest) expected to provide potential food resources for local populations of the Grey-headed Flying-fox. Up to 9.5 ha of spotted gum / ironbark forest and 46.8 ha of red gum / ironbark forest will remain on the site and additional areas will be planted and regenerated with spotted gum as part of the site restoration plan.

The proposed action would decrease the available foraging habitat for local population by a very small percentage when considering the total known area of this resource. Indeed this includes an area of some 4570 ha known in formal reserves. The project is not expected to isolate access to the remaining habitat on site for this wide-ranging and highly mobile species.

It is unlikely that this project would directly lead to the decline of the species in the broader locality, although it will contribute to the cumulative loss of habitat and therefore it is appropriate to consider offsetting the habitat loss in conjunction with the proposed restoration of degraded portions of the site.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

The potential for weed invasion is considered possible with a project of this nature and appropriate controls are required during the construction and operation of the project to reduce this threat as it may have long term implications for the habitat of threatened species. The management of invasive species would be managed under the guidance of the proposed restoration plan.

Introduce disease that may cause the species to decline

There are no known disease issues affecting this species. The project is unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Interferes substantially with the recovery of the species

The project would not conflict with the recovery of this species if the proposed restoration plan and habitat offsetting is implemented. The project footprint has been selected on the basis of avoiding as much habitat as possible.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

Lead to a long-term decrease in the size of an important population

The project would remove about 18 ha of vegetation comprising dry open forest habitats which could potentially be used by these species for foraging. The species roosts in caves or underground mineshafts. There are no caves on the site and although there are known to underground mine shafts potentially present, no surface openings (cracks or fissures) have been located and the site does not appear to provide potential roosting habitat. Therefore the potential impact is represented by a loss of potential foraging habitat. The proposed removal of 18 ha is considered a sustainable loss of potential foraging habitat in the context of available habitat in the surrounding region, including several large State Forests and conservation reserves and considering the broad foraging requirements of the species. The proposed action would not result in a decrease in the size of a local population and would not impact on a known roost site.

Reduce the area of occupancy of an important population

The project would remove about 18 ha of vegetation comprising dry open forest habitats potentially used by this species for foraging. This is a small percentage of the foraging habitat available throughout the distributional range of the species and there is currently no evidence to indicate that an important population is resident in the locality. The project is not expected to significantly impact on food resources available for local populations and would not impact on potential roosting habitat.

Fragment an existing important population into two or more populations

The project would contribute to the cumulative fragmentation of habitat in the landscape by currently impacting on contiguous forest. Highly mobile species such as bats are expected to be less impacted by fragmentation, particularly as existing vegetation will remain on-site. The project would not fragment an important population of the Large-eared Pied Bat.

Adversely affect habitat critical to the survival of the species

Habitat critical to the survival of a species refers to areas that are necessary for activities such as:

- Foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators.
- To maintain genetic diversity and long-term evolutionary development.
- For the reintroduction of populations or recovery of the species.

The proposed area of disturbance represents a very small fraction of the potential foraging habitat for the large-eared pied bat. As the species is a cave-roosting bat and there are no caves in the study area, there would be no impact on potential roosting habitat.

Disrupt the breeding cycle of an important population

No evidence of a roosting colony of the large-eared pied bat occurs in proximity to the study area and the project would not impact on breeding cycles or potential breeding habitat.

Modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The project would remove about 18 ha of vegetation potentially used by this species for foraging. There would be a decrease in the availability of habitat in the region however this decrease represents a very small fraction of the potential foraging habitat for the species. No potential roosting habitat will be impacted as the species roosts in caves, which are not present on the site.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat

The potential for weed invasion is considered possible with a project of this nature and appropriate controls are required during the construction and operation of the project to reduce this threat as it may have long term implication for the habitat of threatened species. The management of invasive species would be managed under the guidance of the proposed restoration plan.

Introduce disease that may cause the species to decline

There are no known disease issues affecting this species. The project is unlikely to increase feral animal abundance or the potential for significant disease vectors to affect local populations.

Interferes substantially with the recovery of the species

a) The project would not conflict with the recovery of this species if the proposed restoration plan and habitat offsetting is implemented. The project footprint has been selected on the basis of avoiding as much habitat as possible and preserving habitat on site.

B.3 Migratory Species

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

No listed migratory bird species (EPBC Act) were identified from the field investigation; however three species the Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot (*Lathamus discolour*) and White-throated Needletail (*Hirundapus caudacutus*) are considered to potentially occur based on the habitat assessment.

The White-throated Needletail is an aerial forager that is generally observed in the air and has no specific or documented habitat preferences. There is no evidence to suggest that an area of important habitat exists in the study area for this species.

In terms of the Regent Honeyeater and Swift Parrot, these species are only occasional visitors to the region during peak flowering events of the dominant trees, particularly the winter flowering Spotted Gum (*Corymbia maculata*). There are no breeding records from the site or surrounds and the extent of habitat remaining in the study area would provide sufficient resources to sustain future visitation. The project would not reduce populations of either species nor substantially reduce the extent of potential habitat in the region.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species

There is no evidence to suggest that an area of important habitat exists in the study area for any listed migratory species. Suitable measures would be incorporated into the project to control the spread of weeds during the construction and operation and these are to be detailed in a habitat restoration plan.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

There is no evidence to suggest that an area of important habitat exists or that the study area is occupied by an ecologically significant proportion of a population of a migratory species.

Appendix C Flora Species

Classification/ Scientific name	Common Name	
Ferns		
ADIANTACEAE		
Adiantum aethiopicum	Maidenhair Fern	
Cheilanthes sieberi subsp. *sieberi*	Slender Cloak-fern	
DENNSTAEDTIACEAE		
Pteridium esculentum	Bracken	
Conifers		
CUPRESSACEAE		
Callitris endlicheri	Black Cypress Pine	
Flowering Plants - Dicotyledons		
ACANTHACEAE		
Brunoniella australis	Blue Trumpet	
Pseuderanthemum variable	Pseuderanthemum	
AMARANTHACEAE		
Alternanthera denticulata	Lesser Joyweed	
AMYGDALACEAE		
Prunus spp.		
ANACARDIACEAE		
Schinus areira	Pepper tree	i
APIACEAE		
Centella asiatica	Swamp Pennywort	
Foeniculum vulgare	Fennell	i
Hydrocotyle peduncularis	Hairy Pennywort	
APOCYNACEAE		
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	i
Parsonsia straminea	Common Silkpod	
ASTERACEAE		
Ambrosia spp.	Ragweed	i
Aster subulatus	Wild Aster	i
Bidens pilosa	Cobblers Peg	i
Brachycome multifida	Cut-leaf Brachycome	
Calotis cuneifolia	Purple Burr-daisy	
Calotis lappulacea	Yellow Burr-daisy	
Cassinia spp.		
Chrysocephalum apiculatum	Yellow Buttons	
Chrysocephalum semiapposum	Yellow Buttons	
Cirsium vulgare	Spear Thistle	i
Conyza spp.	Fleabane	i
Cotula australis	Lawn Cotula	
Epaltes australis	Spreading Nut-heads	
Facelis retusa	Facelis	i
Gamochaeta americana	Cudweed	i
Hypochaeris radicata	Flatweed	i
Lagenophora stipitata	Bottle-daisy	
Ozothamnus diosmifolius	Tall Paperdaisy	

Classification/ Scientific name	Common Name	
Senecio madagascariensis	Fireweed	i
Soliva anthemifolia	Button Burweed	i
Sonchus oleraceus	Common Sow-thistle	i
Tagetes minuta	Stinking Roger	i
Vernonia cinerea var. *cinerea*	Vernonia	
CACTACEAE		
Opuntia stricta	Prickly Pear	i
CAMPANULACEAE		
Wahlenbergia communis	Tufted Bluebell	
Wahlenbergia gracilis	Sprawling Bluebell	
CARYOPHYLLACEAE		
Spergularia spp.		i
CASUARINACEAE		
Allocasuarina luehmannii	Bulloak	
Casuarina glauca	Swamp Oak	
CELASTRACEAE		
Maytenus silvestris	Forest Maytenus	
CHENOPODIACEAE		
Einadia hastata	Shrubby Berry-saltbush	
CLUSIACEAE		
Hypericum gramineum	Narrow-leaf St. Johns Wort	
CONVOLVULACEAE		
Dichondra repens	Kidney Weed	
CRASSULACEAE		
Crassula sieberiana	Australian Stonecrop	
DILLENIACEAE		
Hibbertia diffusa	Prostrate Guinea-flower	
Hibbertia fasciculata	Clustered Guinea-flower	
Hibbertia obtusifolia	Blunt-leaf Guinea-flower	
Hibbertia pedunculata	Peduncle Guinea-flower	
DROSERACEAE		
Drosera peltata	Rosette Sundew	
Drosera spathulata	Common Sundew	
ERICACEAE		
Lissanthe strigosa	Peach Heath	
Melichrus spp.	Urn Heath	
EUPHORBIACEAE		
Breynia oblongifolia	Breynia	
Phyllanthus hirtellus	Thyme Spurge	
Poranthera microphylla	Small Poranthera	
FABACEAE		
FABOIDEAE		
Aotus ericoides	Common Aotus	
Daviesia ulicifolia	Gorse Bitter-pea	
Glycine clandestina agg.	Twining Glycine	
Glycine tabacina agg.		
Hardenbergia violacea	Purple Twining-pea	
Jacksonia scoparia	Dogwood	
Lotus angustissimus	Slender Birds-foot Trefoil	
Podolobium scandens	Netted Shaggy-pea	
Pultenaea paleacea	Narrow-leaf Bush-pea	

Classification/ Scientific name	Common Name	
Pultenaea spinosa	Whorled Bush-pea	
Trifolium repens	White Clover	i
MIMOSOIDEAE		
Acacia elongata var. *elongata*	Swamp Wattle	
Acacia falcata	Sickle Wattle	
Acacia longifolia	Sydney Golden Wattle	
Acacia parvipinnula	Silver-stemmed Wattle	n
Acacia prominens	Gosford Wattle	
GOODENIACEAE		
Goodenia paniculata	Panicled Goodenia	
Goodenia rotundifolia		
HALORAGACEAE		
Gonocarpus tetragynus	Poverty Raspwort	
Haloragis heterophylla	Variable Raspwort	
LAURACEAE		
Cassytha pubescens	Devils Twine	
LOBELIACEAE		
Lobelia alata	Angled Lobelia	
Pratia purpurascens	White Root	
LOGANIACEAE		
Mitrasacme alsinoides		
LORANTHACEAE		
Dendrophthoe vitellina	Creeping Mistletoe	
LYTHRACEAE		
Lythrum hyssopifolia	Hyssop Loosestrife	
MALVACEAE		
Pavonia hastata	Pavonia	i
Sida rhombifolia	Paddys Lucerene	i
MELIACEAE		
Melia azedarach	White Cedar	
MYOPORACEAE		
Eremophila debilis	Winter Apple	
MYRSINACEAE		
Anagallis arvensis	Pimpernell	i
MYRTACEAE		
EUCALYPTS		
Angophora floribunda	Rough-barked Apple	
Corymbia maculata	Spotted Gum	
Eucalyptus canaliculata	Large-fruited Grey Gum	
Eucalyptus crebra	Narrow-leaf Ironbark	
Eucalyptus eugenioides	Thin-leaved Stringybark	
Eucalyptus fibrosa	Broad-leaf Ironbark	
Eucalyptus globoidea	White Stringybark	
Eucalyptus moluccana	Grey Box	
Eucalyptus punctata x canaliculata	Grey Gum	
Eucalyptus tereticornis	Forest Red Gum	
OTHER MYRTACEAE		
Backhousia myrtifolia	Grey Myrtle	
Callistemon linearis	Narrow-leaved Bottlebrush	
Callistemon rigidus	Stiff Bottlebrush	

Classification/ Scientific name	Common Name	
Calytrix tetragona	Fringe-myrtle	
Kunzea ambigua	Tick Bush	
Leptospermum parvifolium	Small-leaf Tea-tree	
Leptospermum polygalifolium	Yellow Tea-tree	
Leptospermum polygalifolium subsp. *cismontanum*	Yellow Tea-tree (riparian form)	
Melaleuca decora	White Feather Honey-myrtle	
Melaleuca linariifolia	Snow-in-Summer	
Melaleuca nodosa	Ball Honey-myrtle	
OLEACEAE		
Ligustrum sinense	Small-leaf Privet	i
Olea europaea subsp. *africana*	African Olive	i
OXALIDACEAE		
Oxalis exilis	Yellow Oxalis	
Oxalis perennans		
PITTOSPORACEAE		
Bursaria spinosa	Blackthorn	
Pittosporum undulatum	Native Daphne	
PLANTAGINACEAE		
Plantago lanceolata	Plantain	i
POLYGONACEAE		
Persicaria decipiens	Slender Knotweed	
Rumex brownii	Swamp Dock	
PROTEACEAE		
Grevillea montana	Kurri Spider-flower	r
Grevillea robusta	Silky Oak	n
Hakea sericea	Silky Hakea	
Persoonia linearis	Narrow-leaf Geebung	
RANUNCULACEAE		
Clematis aristata	Toothed Clematis	
Clematis glycinoides	Entire-leaf Clematis	
ROSACEAE		
Rubus fruticosus agg.	Blackberry	i
Rubus parviflorus	Small-leaf Bramble	
RUBIACEAE		
Opercularia aspera	Common Stinkweed	
Opercularia hispida	Hairy Stinkweed	
Pomax umbellata	Pomax	
Richardia brasiliensis	Mexican Clover	i
RUTACEAE		
SCROPHULARIACEAE		
Gratiola pedunculata		
Veronica plebeia	Trailing Speedwell	
SOLANACEAE		
Cestrum parqui	Green Cestrum	i
Lycium ferocissimum	African Boxthorn	i
Solanum mauritianum	Wild Tobacco	i
Solanum nigrum	Black Nightshade	i
Solanum prinophyllum	Forest Nightshade	
STACKHOUSIACEAE		
Stackhousia muricata		
THYMELEACEAE		

Classification/ Scientific name	Common Name	
Pimelea linifolia subsp. *linifolia*	Slender Rice Flower	
ULMACEAE		
Trema tomentosa	Native Peach	
VERBENACEAE		
Lantana camara	Lantana	i
Verbena bonariensis	Purple Top	i
Flowering Plants - Monocotyledons		
ALISMATACEAE		
Damasonium minus	Star-fruit	
ANTHERICACEAE		
Arthropodium milleflorum	Vanilla Lily	
Caesia parviflora var. parviflora	Pale Grass-lily	
Laxmannia gracilis	Grass Wire-lily	
ASPARAGACEAE		
Myriophyllum asparagoides	Florists Smilax	i
CENTROLEPIDACEAE		
Centrolepis fascicularis	Centrolepis	
COMMELINACEAE		
Commelina cyanea	Scurvy Weed	
CYPERACEAE		
Baumea articulata	Jointed Twig-rush	
Bolboschoenus caldwellii	Caldwell's Club-rush	
Carex appressa	Tussock Tassel-sedge	
Cyperus eragrostis	Umbrella Sedge	i
Cyperus polystachyos	Bunchy Flat-sedge	
Eleocharis dietrichiana	Spike-rush	
Fimbristylis dichotoma	Common Fringe-rush	
Gahnia spp.	Saw-sedge	
Lepidosperma laterale	Variable Sword-sedge	
Ptilothrix deusta	Ptilanthelium	
IRIDACEAE		
Romulea rosea var. *australis*	Onion Grass	i
Sisyrinchium sp. A	Scourweed	i
JUNCACEAE		
Juncus acutus	Spiny Rush	i
Juncus cognatus	Rush	i
Juncus polyanthemus	Many-flowered Rush	
Juncus prismatocarpus	Branching Rush	
Juncus usitatus	Common Rush	
JUNCAGINACEAE		
Triglochin procerum sens. st.	Twisted Water Ribbons	
LOMANDRACEAE		
Lomandra confertifolia subsp. *rubiginosa*	Slender Mat-rush	
Lomandra cylindrica		
Lomandra glauca subsp. *glauca*	Glaucous Mat-rush	
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush	
Lomandra filiformis subsp. *coriacea*	Wattle Mat-rush	
Lomandra longifolia subsp. *longifolia*	Spiny Mat-rush	
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	

Classification/ Scientific name	Common Name	
ORCHIDACEAE		
Caladenia catenata	White Fingers	
Diuris punctata var. *punctata*	Purple Double-tails	
Microtis unifolia	Onion-orchid	
Thelymitra spp.	Sun-orchid	
PHILYDRACEAE		
Philydrum lanuginosum	Frogsmouth	
PHORMIACEAE		
Dianella spp.	Flax Lily	
Dianella caerulea var. *caerulea*	Leafy Blue Flax Lily	
Dianella revoluta var. *revoluta*	Black-anther Flax Lily	
Stypandra glauca	Nodding Blue Lily	
POACEAE		
Aristida ramosa	Three-awned Spear Grass	
Aristida vagans	Three-awned Spear Grass	
Austrodanthonia spp	Wallaby Grass	
Axonopus affinis	Carpet Grass	i
Briza maxima	Quaking Grass	i
Briza minor	Shivery Grass	i
Chloris ventricosa	Tall Windmill Grass	
Cymbopogon refractus	Barbed Wire Grass	
Cynodon dactylon	Common Couch	n
Dichelachne micrantha	Short-hair Plume Grass	
Digitaria parviflora	Small-flower Finger Grass	
Echinopogon caespitosus	Hedgehog Grass	
Ehrharta erecta	Panic Veldtgrass	i
Entolasia marginata	Margined Panic	
Entolasia stricta	Wiry Panic	
Eragrostis brownii	Brown's Lovegrass	
Eragrostis curvula	African Lovegrass	i
Eragrostis elongata	Narrow Lovegrass	
Eragrostis leptostachya	Paddock Lovegrass	
Imperata cylindrica	Blady Grass	
Lachnagrostis filiformis	Blown Grass	
Lolium spp. (hybrid swarm)	Rye Grass	i
Melinis repens	Red Natal Grass	i
Microlaena stipoides var. *stipoides*	Weeping Grass	
Oplismenus aemulus	Broad-leaf Beard-grass	
Panicum effusum	Hairy Panic	
Panicum simile	Two-colour panic	
Paspalidium distans	Paspalidium	
Paspalum dilatatum	Paspalum	i
Phragmites australis	Common Reed	
Poa labillardieri	Tussock Grass	
Setaria gracilis	Slender Pigeon Grass	i
Sporobolus africanus	Parramatta Grass	i
Themeda australis	Kangaroo Grass	
Vulpia bromoides	Foxtail Grass	i
POTAMOGETONACEAE		
Potamogeton spp.	Pondweed	
Potamogeton crispus	Curly Pondweed	

Classification/ Scientific name	Common Name
SPARGANIACEAE	
Sparganium subglobosum	Floating Bur-reed
TYPHACEAE	
Typha orientalis	Broad-leaf Cumbungi
XANTHORRHOEACEAE	
Xanthorrhoea johnsonii	Johnsons Grass-tree
TOTALS	
Total Flora Species	*223*
Total Number of Families	*70*
Total Monocotyledons	*81*
Total Dicotyledons	*138*
Total Fern Species	*3*
Total Conifer & Cycad Species	*1*
Total Exotic Species	*49*
Total Non-indigenous Species	*3*
Total RoTAP Species	*1*

ABBREVIATIONS:
i = introduced (i.e. not indigenous to Australia)
n = native Australian species not considered to be indigenous to the site
c = cultivated (i.e. planted on the site)
t = listed as a threatened species under State and/or Commonwealth legislation
spp. = unidentified species[4]
sp. aff. = unidentified species with characteristics similar to the indicated species or genus[3]
? = unconfirmed species[4]
r = RoTAP species (Briggs and Leigh 1996)
var. = variety
subsp. = subspecies
cv. = cultivar (i.e. a anthropogenic form of the species)
agg. = an aggregate of several yet to be defined species

NOTES:
1. Recent 'synonyms' include misapplied names.
2. A sample flora assemblage obtained from a short term survey, such as the present one, cannot be considered to be comprehensive, but rather indicative of the actual flora assemblage. It can take many years of flora surveys to record all of the plant species occurring within any area, especially species that are only apparent in some seasons.
3. Not all species can be accurately identified in a 'snapshot' survey due to absence of flowering or fruiting material, etc.

SCIENTIFIC NAMES & AUTHORITIES:
Scientific names & families are those used in the *Flora of New South Wales* as maintained by the Royal Botanic Gardens (http://.plantnet.rbgsyd.gov.au).
Orders and higher taxa are based on Angisperm Phylogeny Group (2003).
For sake of simplicity, scientific names in this list do not include authorities. These can be found in the *Flora of New South Wales*.

Appendix D Fauna Species

Observation Type		Habitat Type	
O	observed	1	Spotted Gum / Ironbark forest
F	tracks / scratchings	2	Forest Red Gum / Ironbark forest
K	dead	3	Dams / creeks
T	trapped	4	Cleared lands
P	scat	**Status**	
W	heard call	V	Vulnerable species (TSC Act)
E	nest/roost	I	Introduced species

Family / Scientific name	Common name	Status	1.	2.	3.	4.
BIRDS						
Anatidae						
Chenonetta jubata	Australian Wood Duck				O	
Anas superciliosa	Pacific Black Duck				O	
Falconidae						
Falco cenchroides	Nankeen Kestrel					
Columbidae						
Phaps chalcoptera	Common Bronzewing		O			
Ocyphaps lophotes	Crested Pigeon					O
Cacatuidae						
Cacatua galerita	Sulphur-crested Cockatoo		O			
Eolophus roseicapillus	Galah					O
Psittacidae						
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet		O, W	O, W		
Glossopsitta concinna	Musk Lorikeet			O, W		
Platycercus adscitus eximius	Eastern Rosella		O	O		O
Psephotus haematonotus	Red-rumped Parrot					O
Cuculidae						
Cacomantis flabelliformis	Fan-tailed Cuckoo			O, W		
Chalcites lucidus	Shining Bronze-Cuckoo			W		
Strigidae						
Ninox boobook	Southern Boobook		W			
Podargidae						
Podargus strigoides	Tawny Frogmouth			W		
Alcedinidae						
Dacelo novaeguineae	Laughing Kookaburra		O			
Maluridae						
Malurus cyaneus	Superb Fairy-wren			O		
Pardalotidae						
Pardalotus punctatus	Spotted Pardalote		W	W		
Pardalotus striatus	Striated Pardalote			W		
Acanthizidae						
Gerygone olivacea	White-throated Gerygone			O, W		

Family / Scientific name	Common name	Status	1.	2.	3.	4.
Acanthiza lineata	Striated Thornbill			O, W		
Acanthiza pusilla	Brown Thornbill		O, W	O, W		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill			O		
Pyrrholaemus saggitatus	Speckled Warbler	V		O, W		
Meliphagidae						
Lichenostomus chrysops	Yellow-faced Honeyeater		O	O		
Manorina melanocephala	Noisy Miner		O, W	O, W		
Anthochaera chrysoptera	Little Wattlebird		O, W	O, W		
Philemon corniculatus	Noisy Friarbird			O, W		
Pomatostomidae						
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern ssp)	V		O, W, E		
Pachycephalidae						
Pachycephala rufiventris	Rufous Whistler		O, W	O, W		
Colluricincla harmonica	Grey Shrike-thrush		O			
Dicruridae						
Rhipidura albiscapa	Grey Fantail		O, W	O, W		
Rhipidura leucophrys	Willie Wagtail					O
Grallina cyanoleuca	Magpie-lark		O	O		O
Campephagidae						
Coracina novaehollandiae	Black-faced Cuckoo-shrike		O, W			
Oriolidae						
Oriolus sagittatus	Olive-backed Oriole			O, W		
Artamidae						
Cracticus nigrogularis	Pied Butcherbird		O, W			
Gymnorhina tibicen	Australian Magpie		O	O		O
Corvidae						
Corvus coronoides	Australian Raven		O, W	O, W		O
Corcoracidae						
Corcorax melanorhamphos	White-winged Chough		O, W			
Sturnidae						
Sturnus vulgaris	Common Starling	I				O
MAMMALS						
Tachyglossidae						
Tachyglossus aculeatus	Short-beaked Echidna		F			
Dasyuridae						
Antechinus flavipes	Yellow-footed Antechinus			T		
Vombatidae						
Vombatus ursinus	Common Wombat		F			
Petauridae						
Petaurus norfolcensis	Squirrel Glider	V	T	T		
Phalangeridae						
Trichosurus vulpecula	Common Brushtail Possum		O	O		
Macropodidae						
Wallabia bicolor	Swamp Wallaby			O		

Family / Scientific name	Common name	Status	1.	2.	3.	4.
Macropus rufogriseus	Red-necked Wallaby			O		
Macropus giganteus	Eastern Grey Kangaroo					O
Molossidae						
Tadarida australis	White-striped Freetail-bat					W
Vespertilionidae						
Nyctophilus sp.	Gould's Long-eared Bat				CR	
Chalinolobus gouldii	Gould's Wattled Bat				CR	
Vespadelus vulturnus	Little Forest Bat				CR	
Leporidae						
Oryctolagus cuniculus	Rabbit	I				O
FROGS						
Myobatrachidae						
Limnodynastes peronii	Brown-striped Frog				W	
Limnodynastes tasmaniensis	Spotted Grass Frog				W	
Crinia signifera	Common Eastern Froglet				W	
Uperoleia laevigata	Smooth Toadlet			W	W	W
Hylidae						
Litoria dentata	Bleating Tree Frog			W	W	
Litoria fallax	Eastern Dwarf Tree Frog				O, W	
Litoria latopalmata	Broad-palmed Frog				O, W	
Litoria peronii	Peron's Tree Frog				O, W	
REPTILES						
Agamidae						
Pogona barbata	Bearded Dragon		O	O		
Amphibolurus muricatus	Jacky Lizard		O			
Varanidae						
Varanus varius	Lace Monitor			O		
Scincidae						
Carlia vivax	Tussock Rainbow-skink		O			
Cryptoblepharus virgatus	Cream-striped Shinning-skink		O	O		
Lampropholis delicata	Dark-flecked Garden Sunskink		O	O		
Morethia boulengeri	South-eastern Morethia Skink			O		
Tiliqua scincoides	Eastern Blue-tongue		O			
Elapidae						
Pseudechis porphyriacus	Red-bellied Black Snake				O	

Appendix E Example Table of Content for Flora and Fauna Management Plan

Flora and Fauna Management Plan - Contents