In addition to the general fauna survey sites, targeted surveys were undertaken for a number of threatened fauna species known to occur in the locality, and considered likely to occur within the study area. Those species targeted are listed in Table 8.

Table 8. Threatened Fauna Species known to occur in the Locality, and habitat locations specific to each species.

Common Name	Scientific Name	Survey Site Locations
Black-necked Stork	*Ephippiorhynchus asiaticus*	Dams
Swift Parrot	*Lathamus discolor*	Flowering eucalypts
Australasian Bittern	*Botaurus poiciloptilus*	Dams
Black Bittern	*Ixobrychus flavicollis*	Dams
Superb Fruit-Dove	*Ptilinopus superbus*	No suitable habitat
Glossy Black Cockatoo	*Calyptorhynchus lathami*	Open Forest / Woodland
Masked Owl	*Tyto novaehollandiae*	Open Forest / Woodland
Barking Owl	*Ninox connivens*	Open Forest / Woodland
Powerful Owl	*Ninox strenua*	Open Forest / Woodland
Painted Honeyeater	*Grantiella picta*	Flowering mistletoe
Green & Golden Bell Frog	*Litoria aurea*	Dams
Giant Barred Frog	*Mixophyes iteratus*	Riparian streams
Green-thighed Frog	*Litoria brevipalmata*	Floodplain swamps
Wallum Froglet	*Crinia tinnula*	Swamp, inundated areas
Koala	*Phascolarctos cinereus*	Open Forest / Woodland
Squirrel Glider	*Petaurus norfolcensis*	Open Forest / Woodland
Grey-headed Flying-fox	*Pteropus poliocephalus*	Flowering trees
Eastern Freetail Bat	*Mormopterus norfolcensis*	Open Forest, open areas
Little Bent-wing Bat	*Miniopterus australis*	Open Forest, open areas
Eastern Bent-wing Bat	*Miniopterus schriebersii*	Open Forest, open areas
Large-footed Myotis	*Myotis adversus*	Open Forest, dams
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Open Forest
Eastern Falsistrelle	*Falsistrellus tasmaniensis*	Open Forest
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Remnant Forest, open areas

Following is a description of the survey procedures employed for each fauna group.

2.3.1 Birds

Three strategies were adopted to survey for bird species:

- diurnal 20 minute census recording all bird species observed or heard at each survey site;
- opportunistic sampling whilst undertaking other activities, and
- nocturnal census involving quiet listening for calls of nocturnal birds followed by playback of pre-recorded calls of threatened owls.

2.3.1.1 Diurnal Survey

This technique involves recording all bird species observed, or heard calling within a one hectare quadrat at each survey site in the study area. This survey is undertaken for a minimum of 20 minutes each morning or evening. Each site is sampled on one occasion, typically between the hours 0600 to 0900, or 1600 to 1700 hours. Diurnal investigations also include searches for whitewash or regurgitation pellets of owls, particularly in close proximity to mature trees with large hollows.

2.3.1.2 Opportunistic Sampling

Opportunistic sampling of bird species is conducted whilst undertaking other field activities and consist of identification of calls heard in the area or observed directly.

2.3.1.3 Nocturnal Survey

The nocturnal survey was conducted at selected survey sites and involved stag-watching at dusk and a 60 minute nocturnal bird census.

* Stag-watching involves sitting beneath mature trees with large hollows at dusk to observe any owls departing a hollow.

Nocturnal census follows the standardised survey methodology. This involves quiet listening for calls of owls following dusk for a period of approximately 15 minutes to determine the presence of nest or roost sites on, or in close proximity to the survey site. Following the 15 minute census period, playback of pre-recorded calls of the threatened Sooty Owl, Powerful Owl, Masked Owl, and Barking Owl are broadcast through a 20 watt portable amplifier from the survey site into adjacent bushland.

Calls of each species are broadcast for a period of five minutes, coupled with short periods of quiet listening for any vocal response from the owls. Following playback calls, a period of 10 minutes quiet listening for vocal responses, and 15 minutes spot-lighting the area is undertaken.

Nocturnal bird investigations are typically conducted within the first two hours following dusk. No surveys for owls were conducted on evenings with strong winds and rainfall as these conditions adversely affect the detectability of all nocturnal bird species.

2.3.2 Non-flying Mammals

Surveys for the presence of mammals include trapping for small terrestrial and arboreal mammals, spot-lighting for terrestrial and arboreal mammals, examination of scratch marks on tree trunks, searches for characteristic diggings, burrows and other indirect evidence including collection of scats and analysis of hair samples collected in hair tubes.

2.3.2.1 Small to Medium Terrestrial Mammals

Trapping was undertaken at each fauna survey sites with Elliott Type A traps (8 x 10 x 33 centimetre) baited with a mixture of peanut butter, rolled oats and honey. At each sites, 25 small traps were set for three consecutive nights. In addition, five cage (cat size) traps were also set for three nights.

Terrestrial mammal surveys by trapping was conducted during the October 2003 survey.

2.3.2.2 Arboreal Mammals

Arboreal trapping for possums and gliders was undertaken with Elliott Type B (15 x 16 x 45 cm) folding aluminium traps mounted on platforms attached to the tree trunk. At survey sites 1,2,3 and 4, ten (10) Elliott type B traps were mounted at a height of four 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.

Spotlight searches undertaken by foot at each survey site for 30 - 40 minutes with a 55 watt spotlight, followed by quiet listening in darkness to detect any animal movements or vocalisations. Particular attention

was paid to trees in flower as these provide a source of blossom and nectar for arboreal mammals such as gliders.

Arboreal mammal trapping and spotlight surveys were conducted during the October and November 2003 surveys.

2.3.2.3 SEPP 44 (Koala Habitat) Assessment

Potential Koala habitat as defined in the Act is a vegetation community with a minimum of 15 per cent of trees in the upper and lower strata which are species listed in Schedule 2 of SEPP 44. The upper strata is those trees in the forest canopy, and the lower strata is those trees in mid-understorey or sub-canopy trees. The list of tree species in Schedule 2 of SEPP 44 is listed below in Table 9.

Table 9. Schedule 2 Tree Species, SEPP 44 (Koala Habitat Protection)

Scientific Name	Common Name	Tree Species in Study Area
Eucalyptus albens	White Box	No
Eucalyptus camaldulensis	River Red Gum	No
Eucalyptus haemastoma	**Broad-leaved Scribbly Gum**	**Yes**
Eucalyptus microcorys	Tallowwood	No
Eucalyptus populnea	Bimble Box	No
Eucalyptus punctata	Large-fruited Grey Gum	No
Eucalyptus robusta	**Swamp Mahogany**	**Yes**
Eucalyptus signata	Scribbly Gum	No
Eucalyptus tereticornis	**Forest Red Gum**	**Yes**
Eucalyptus viminalis	Ribbon Gum	No

The estimation of percentage tree species is typically undertaken by counting all tree species in the upper and lower strata within a series of 20 x 20 metre plot. Alternatively, counts of all tree species intersected by a one hundred metres line transect is another approach. This is considered more quantitative, and results in a greater proportion of the study area being sampled. Trees are counted to score a percentage cover, identified to species and allocated to a size class.

If the subject land is not considered potential Koala habitat based on absence of Schedule 2 tree species, the consent authority may grant development consent. If potential Koala habitat is identified, further investigations are required to determine if the subject land supports core Koala habitat.

Core Koala Habitat is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females and recent sightings of, and historical records of a koala population.

2.3.2.4 Large Terrestrial Mammals

Surveying for the presence of large terrestrial mammals include:

- Spotlight searches undertaken by foot at each survey site for 30 - 40 minutes with a 55 watt spotlight, followed by quiet listening in darkness to detect any animal movements or vocalisations. Searches were also conducted of all adjoining bushland areas.
- Searches for indirect evidence to suggest the presence of a species, including collection of scats, examination of burrows, diggings and hair tube samples.

2.3.3 Bats

Surveys for megachiropteran (flying foxes) and microchiropteran (insectivorous) bat species consisted of:

i Harp trapping undertaken at suitable sites for two nights to determine the presence of sub-canopy species.
ii Detection of echolocation calls via Anabat II detectors onto audio cassettes and digital memory cards for subsequent computer analysis.
Iii Spotlighting for flying foxes and large microchiropteran bats.

Sampling for microchiropteran bats by Anabat echolocation calls and harp trapping was conducted in October and November 2003. The location of microchiropteran bat survey sites is presented below in Table 10 and Figure 4.

Table 10. Location of Microchiropteran Bat Survey Sites, Warnervale Town Centre.

Site	Habitat	Survey Site	Easting	Northing	Date Surveyed
AnaBat 1	Blackbutt Angophora Open Forest	1	356930	6321130	27-28/10/03
AnaBat 2	Spotted Gum Stringybark Open Forest	2	356070	6320790	27/10/03
AnaBat 3	Spotted Gum Ironbark Open Forest	2	356322	6321149	28/10/03
AnaBat 4	Smooth-barked Apple Woodland	3	357240	6321234	29-30/10/03
AnaBat 5	Swamp Oak Forest	4	356400	6319340	29-30/10/03
AnaBat 6	Scribbly Gum Stringybark Woodland	5	356390	6319410	18-19/11/03
Harp 1	Blackbutt Angophora Open Forest	1	356954	6321121	27-28/10/03
Harp 2	Spotted Gum Stringybark Open Forest	2	356080	6320880	27/10/03
Harp 3	Spotted Gum Ironbark Open Forest	2	356208	6321002	28/10/03
Harp 4	Smooth-barked Apple Woodland	3	357240	6321234	29-30/10/03
Harp 5	Swamp Oak Forest	4	356400	6319340	29-30/10/03
Harp 6	Scribbly Gum Stringybark Woodland	5	356390	6319410	18-19/11/03

2.3.3.1 Captures

Harp traps are designed to capture low flying bats in the study area. At each site within the study area, one harp trap was active for two consecutive nights in October and November 2003, for a total of 20 harp trap nights. Traps were checked each morning for captured bats, which are identified and measured prior to being released.

2.3.3.2 Echolocation Calls

Echolocation calls of microchiropteran bats were recorded at 7 survey sites. Calls are recorded onto either an audio cassette recorder or digital memory card via an Anabat II detector. Calls recorded onto either audio cassette or digital memory card are “call activated”, in that bat calls are recorded from dusk until dawn. Restricting Anabat recordings for just 45 minute continuous recording following dusk will not detect bat species that occur in the study area until later in the evening. Their absence earlier in the evening is either because their roosts are distant from the study area, or because their activity levels vary throughout the night. “Call activated” recordings effectively sample the duration of the night, and potentially provides a more complete record of the bat species utilising a site.

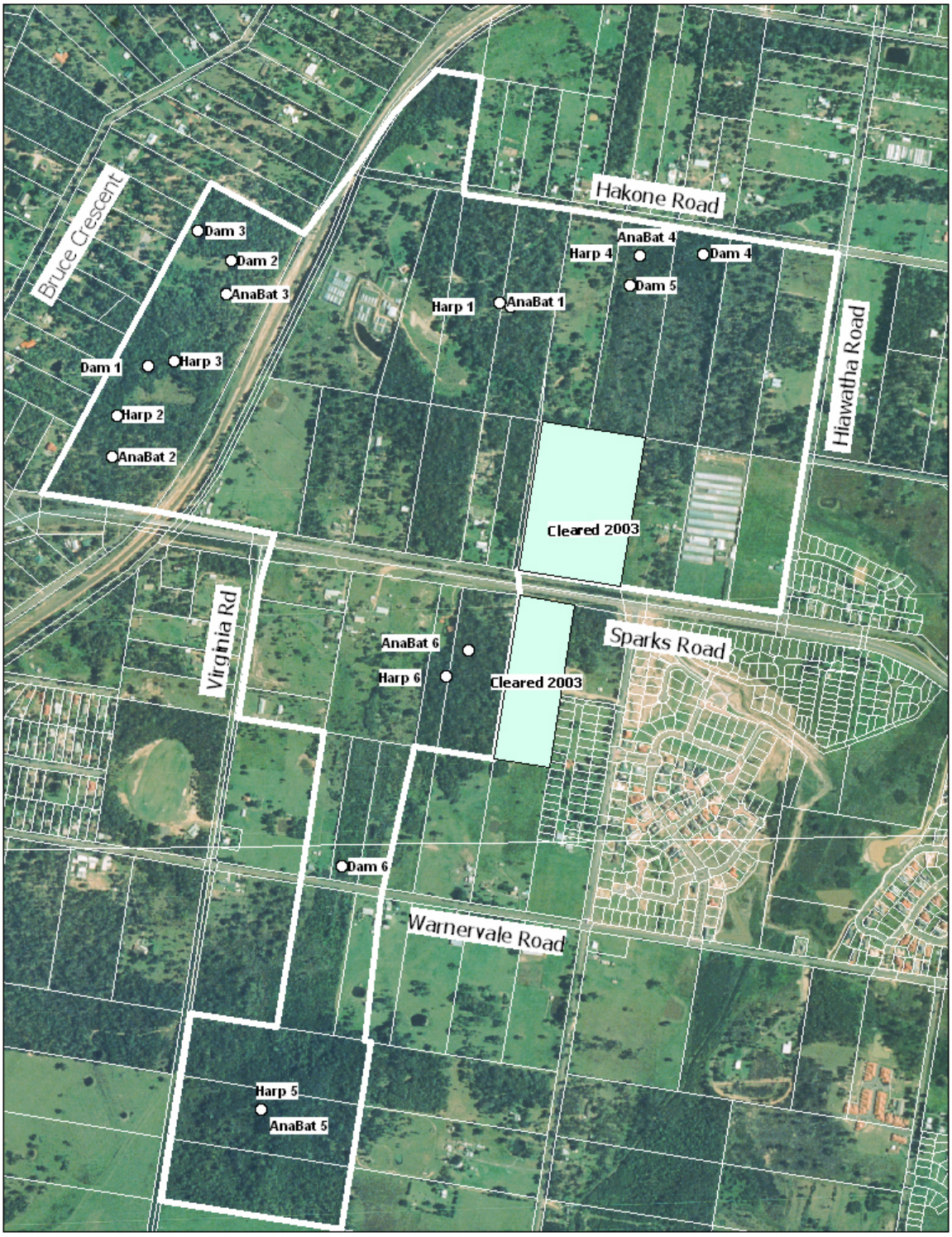

Figure 4. Microchiropteran Bat and Amphibian Survey Sites, Warnervale Town Centre.

All recorded calls are down loaded to computer for analysis. Some insectivorous bat species have distinctive echolocation calls unlikely to be confused with other species. However, other bat species overlap in both call frequency and structure making identification problematic in some cases. The degree of confidence attached to call identifications will depend on the quality of the recorded call as well as the activity of the bat at the time of recording and its direction of flight.

For example, echolocation calls of the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) and Gould's Long-eared Bat (*Nyctophilus gouldi*) cannot be reliably differentiated. Any calls recorded from either are not distinguished to species level, only *Nyctophilus spp.*

2.3.3.3 Spotlight Searches

Flying-foxes are surveyed by spotlighting of potential food trees and by identification of their characteristic social calls. The presence of flying bats is also monitored by activity at dusk each day by visually watching the skyline for bats.

2.3.4 Reptiles

Diurnal investigations for reptiles involved searching beneath ground litter, such as sheets or iron, fallen timber, leaf litter, decorticated bark on tree trunks and on the ground, tuft of vegetation and stones. Searches incorporated both opportunistic searches as well as intensive searches within an area for approximately 30 to 60 minutes. Nocturnal spotlight searches for reptiles were undertaken on foot in conjunction with arboreal mammals.

Sampling for reptiles by diurnal and nocturnal searches was conducted in October and November 2003.

2.3.5 Amphibians

Surveys were undertaken of water bodies (ie dams) and drainage lines of the area to identify frog species, which may include those species not recorded during other surveys.

Nocturnal searches involve walking along drainage lines and through swamp habitat involving standard techniques such as spotlighting around water bodies and along creek lines, identification of individuals present by audible call, eliciting of responses to play-back of calls and searches in likely microhabitats.

Sampling for amphibians by diurnal and nocturnal searches, and playback of frog calls, was conducted in October and November 2003. The location of amphibian survey sites is presented below in Table 11 and Figure 4 above.

Table 11. Location of Amphibian Survey Sites, Warnervale Town Centre.

Site	Habitat	Survey Site	Easting	Northing	Date Surveyed
Dam 1	Spotted Gum Ironbark Open Forest	2	356150	6320990	27-28/10/03, 18/11/03
Dam 2	Spotted Gum Ironbark Open Forest	2	356335	6321224	27-28/10/03; 18/11/03
Dam 3	Spotted Gum Ironbark Open Forest	2	356260	6321290	27-28/10/03; 19/11/03
Dam 4	Smooth-barked Apple Woodland	3	357382	6321239	29-30/10/03; 19/11/03
Dam 5	Smooth-barked Apple Woodland	3	357218	6321170	29-30/10/03; 20/11/03
Dam 6	Low Swamp Woodland		356580	6319880	29/10/03; 20/11/03

A summary of total survey effort for fauna is indicated in Table 12 below.

Table 12. Fauna Survey Effort, Warnervale Town Centre, 2003.

Fauna Group	Survey Sites	Technique	Survey Effort	Total Survey Effort
Small Mammals	All sites	Elliott A	25 traps / night for 3 nights	375 trap nights
Larger Mammals	1, 2, 3, 5	Cage Trap	2 traps / site for 3 nights	24 trap nights
Arboreal Mammals *	1, 2, 3, 5	Elliott B arboreal	10 traps / site for 3 nights	120 trap nights
	All sites	Spotlight Searches	30mins per site (Oct, Nov)	6.0 hours
Bats	All sites	Harp Trap	2 trap nights per site	10 harp trap nights
	All sites	Anabat Recording	2 all night recordings per site x 2 sample periods	20 nights
Reptiles	All sites	Diurnal searches	1 hr searches per site	5 hours
Amphibians	All sites	Nocturnal searches	30min searches of specific habitats (dams, creek lines)	2.5 hours

** No arboreal trapping was undertaken at Site 4 due to unsuitable habitat (Swamp Oak Forest) for Squirrel Gliders.

2.4 Research Licences

The survey and research of flora and fauna was undertaken under the following licences and approvals in accordance with the National Parks & Wildlife Act (1967) and Animal Research Act (1991).

Michael Murray – Forest Fauna Surveys Pty Ltd

NSW National Parks and Wildlife Scientific Licence	A1765
NSW Agriculture Animal Research Authority	AW94/056
NSW Agriculture Director-General's Animal Care and Ethics Committee	DG ACEC 78/99

Stephen Bell – Eastcoast Flora Survey

NSW National Parks and Wildlife Scientific License	S11115

3.0 SURVEY RESULTS

3.1 Weather Conditions

The weather conditions during the fauna survey period are presented in Table 13 below.

Table 13. Weather Conditions, Warnervale Town Centre.
Data collected from Norah Head Weather Station (10 kms to the north-east of site)

			Wind Speed (knots) and Direction				
Date	**Min. Temp °C**	**Max. Temp °C**	**9 am**	**3 pm**	**Cloud Cover**	**Rainfall (mm) 24 hrs**	**Moon**
27/10/03	14	19	W 2	ENE 7	2/8	0.0	0/4
28/10/03	16	21	Calm	NE 3	3/8	0.0	0/4
29/10/03	17	25	WSW 10	W 12	1/8	0.0	0/4
30/10/03	12	23	W 2	SW 5	1/8	0.0	0/4
18/11/03	14	21	SSW 2	SE 5	0/8	10.0	¼
19/11/03	15	18	SSW 3	S 6	5/8	0.0	¼
20/11/03	14	19	SW 5	S 5	4/8	0.0	¼

No rainfall was experienced during the fauna survey in October 2003 survey. However, the study area received regular rainfall during the October period, with 19 of the 31 days experiencing rainfall. Rainfall figures were average for the study area during October 2003, with no heavy rainfall recorded (Bureau of Meteorology). Surface water was present in low lying parts of the study area. Conditions for amphibian surveys were good, with warm nights and moderate humidity levels recorded during the survey.

In November 2003, rainfall was experienced on Monday 17 November, with fieldwork commencing Tuesday 18 November. Conditions remained dry following the rainfall, with no pools of standing water formed.

3.2 Flora Survey Results

3.2.1 General Flora Survey

A total of over 285 plant species was recorded from the study area, including 31 (11%) weed species. In general, much of the site supports vegetation that is of a regrowth nature, although some of this is now of considerable age. There are, however, some important stands of remnant vegetation which are in good condition.

3.2.2 Vegetation Mapping

Mapping of vegetation communities was undertaken initially in October 2003, but has been continually amended with subsequent field inspections. Previous mapping of the vegetation undertaken within a Shire-wide context (Bell, 2002a) was used as a reference, although improvements to this layer were made where required. Communities present on the site were attributed to one of the 43 communities delineated in Bell (2002a), using the community profiles developed as part of that project as a guide. Levels of disturbance and weed invasion were also noted. Figure 5 shows the revised vegetation mapping for the site.

Nineteen standard vegetation survey plots were censused in the study area. These were each of 0.04ha in size (nominally 20 x 20m), and recorded all vascular plant species present. The location of each plot was chosen to sample representative elements of the vegetation diversity, and assisted in the determination of vegetation communities present. Regrowth stands of vegetation were also censused in this way.

Eight vegetation communities have been described for the study area, together with disturbed elements of three communities:

Table 14. Area of Vegetation Communities, Warnervale Town Centre.

Vegetation Unit	Description (Bell, 2002a)	Area (hectares)
3b	Estuarine Swamp Oak Forest (Regrowth)	9.2
14	Freshwater Wetlands	0.6
15b	Alluvial Redgum Footslopes Forest	0.6
15Xs	Alluvial Redgum Footslopes Forest (Regrowth	1.5
20	Alluvial Floodplain Shrub Swamp Forest	0.1
20f	Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant)	4.1
27	Narrabeen Coastal Blackbutt Shrubby Forest	6.7
28	Narrabeen Buttonderry Footslopes Forest	17.7
28Xr	Narrabeen Buttonderry Footslopes Forest (Disturbed)	16.7
30	Dooralong Spotted Gum – Ironbark Forest	11.1
30Xr	Dooralong Spotted Gum – Ironbark Forest (Disturbed)	1.6
Xr	Unspecified Canopy-only	22.5
Xs	Unspecified Regrowth	9.5
Cleared	Cleared	75.8
	Total	**177.7**

Following is a general description of each vegetation type recorded in the study area.

3b: Estuarine Swamp Oak Forest (Regrowth) [Unit 3b in Bell 2002a] – much of the southern section of the study area off Virginia Road supports this vegetation type, which is evidently regrowth from earlier clearing many years previously. The 1941 aerial photograph of this section shows a very different vegetation structure, and one that probably supported considerably more *Eucalyptus robusta* and *Eucalyptus tereticornis* in an open swampy woodland habitat. Currently, this area is dominated by nearly monospecific stands of *Casuarina glauca*, with very occasional *Eucalyptus tereticornis* and *Melaleuca* spp also present. Understorey vegetation here is variable, but includes several weed species. The vine *Parsonsia straminea* is noteably abundant on most trees of *Casuarina glauca*, and in moister parts the sedge *Lepidosperma quadrangulata* is clearly dominant.

14: Freshwater Wetlands [Unit 14 in Bell 2002a] – several abandoned farm dams throughout the area now support Freshwater Wetlands of various types. Colonisation by wetland plants has been opportunistic, with some dominated by *Schoenoplectus validus*, while others support *Eleocharis sphacelata, Philydrum lanuginosum, Typha orientalis* and *Phragmites australis*.

15b: Alluvial Redgum Footslopes Forest [Unit 15b in Bell 2002a] – a small area at the very southern edge of the study area supports an area dominated by *Eucalyptus tereticornis* over a grassy understorey. It is likely that this area has been lightly grazed in the past, but it remains in reasonably good condition. This area aligns best with the community of the same name in Bell (2002a), although the dense subcanopy of *Melaleuca* species is not present here. It is possible that this area represents a disturbed example of the nearby Unit 20f, where *Xanthorrhoea fulva* dominates the understorey, but further investigation is required.

15Xs: Alluvial Redgum Footslopes Forest (regrowth) [Unit 15b in Bell 2002a] –areas with dense sub-canopies of *Melaleuca nodosa* and few mature *Eucalyptus tereticornis* occur in close proximity to the Unit 15 polygons, and these have been coded 15Xs. These represent regrowth areas of the Alluvial Redgum Footslops Forest, although it is difficult to determine original vegetation type in some areas.

20: Alluvial Floodplain Shrub Swamp Forest [Unit 20 in Bell 2002a] – a small area immediately north of the access lane parallel to Sparks Road supports vegetation that equates reasonably well with the Alluvial Swamp Forest Complex of Bell (2002a). Here, *Eucalyptus robusta* is present with scattered *Eucalyptus resinifera* and a small tree layer of various paperbarks (*Melaleuca linariifolia, Melaleuca decora*) is characteristic, and in parts is particularly dense. The ground layer includes *Gahnia clarkei, Lomandra longifolia* and *Hemarthria uncinata* var*. uncinata*, and the surface is very uneven (referred to as 'pock-marked undulations' by Payne 1998). Weed species are clearly evident in this patch, and components of it appear to be opportunistic in response to past disturbance.

20f: Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant) [Unit 20f in Bell 2002a] – the southern portion of the site off Virginia Road supports an interesting and significant variation of the Alluvial Floodplain Shrub Swamp Forest as described in Bell (2002a). Here widely spaced individuals of *Eucalyptus tereticornis* occur over a dense shrub layer of *Xanthorrhoea fulva, Lepidosperma quadrangulatum* and *Melaleuca thymifolia*. This wet heath understorey is most similar to unit 20f in Bell (2002a), although *Lepidosperma quadrangulata* replaces *Schoenus brevifolius*, and the canopy of *Eucalyptus tereticornis* is absent. This variation has not been recognised elsewhere in Wyong, and is consequently considered of regional significance. Further investigation is currently underway into the relationship of this wet heath with other similar habitats in the region.

27: Narrabeen Coastal Blackbutt Shrubby Forest [Unit 27 in Bell 2002a] – the abandoned quarry in the north of the study area off Hakone Road supports the northern limit of this vegetation type within Wyong Shire. Here, *Eucalyptus pilularis* is clearly dominant, and occurs with *Corymbia gummifera, Angophora costata*, and *Banksia serrata*, over a heathy understorey. This location represents one of only two known within Wyong, and although parts are comprised of regrowth and are being invaded by weed species, the area still supports examples of this vegetation in good condition, and occupies around 5.5ha at this location.

28: Narrabeen Buttonderry Footslopes Forest [Unit 28 in Bell 2002a] – a reasonably good stand of this vegetation type occurs in the DIPNR land immediately north of Sparks Road, although here it is ecotonal with the Dooralong Spotted Gum – Ironbark Forest, and supports part of a large population of the vulnerable *Rutidosis heterogama*. Other good examples occur south of Sparks Road immediately west of the newly created urban release area, which appears to have remained unburnt for a considerably long period, and consequently is floristically different to previously recognised stands. There are also small stands of *Eucalyptus haemastoma* within this patch, which suggests an ecotonal area with unit 31 of Bell (2002a), although for the present purposes this area has been included within unit 28.

28Xr: Narrabeen Buttonderry Footslopes Forest (Disturbed) [Unit 28 in Bell 2002a] – several disturbed examples of this community occur to the north of Sparks Road. Remnant trees of *Angophora costata, Eucalyptus capitellata, Eucalyptus fibrosa* and *Eucalyptus resinifera* occur over a variably disturbed understorey, which may include very dense stands of *Melaleuca nodosa*, or more open grassy areas.

30: Dooralong Spotted Gum-Ironbark Forest [Unit 30 in Bell 2002a] –the northern section of the DIPNR land immediately west of the Main Northern Railway supports this vegetation type, where Spotted Gum (*Corymbia maculata*) dominates the canopy, associated with the ironbark *Eucalyptus paniculata* subsp. *paniculata*. The understorey is dominated by grassy species such as *Themeda australis* and *Entolasia stricta*, and also supports part of the *Rutidosis heterogama* population.

30Xr: Dooralong Spotted Gum-Ironbark Forest (Disturbed) [Unit 30 in Bell 2002a] – small portions of this type occur in the northern section of the DIPNR land immediately west of the Main Northern Railway. Spotted Gum (*Corymbia maculata*) dominates the canopy, associated with the ironbark *Eucalyptus*

paniculata subsp. *paniculata,* but the understorey is dominated by dense stands of *Lantana camara* and other exotic species (mapped as 30Xx). A tall shrub layer dominated by *Melaleuca nodosa* is present in some areas, and the ground layer includes many weed species, such as *Briza maxima, Conyza sp,* and *Bidens pilosa*.

Xr: Unspecified Canopy-only –some areas have been underscrubbed in the past, and now support a canopy-only vegetation of widely-to-densely spaced emergent trees, with a highly disturbed understorey, and which is difficult to attribute to any of the recognised units.

Xs: Unspecified Regrowth – there are some portions of the study area that have been heavily disturbed in the past, and now support a regrowth vegetation that is highly opportunistic, and is difficult to attribute to any of the recognised units.

Figure 5. Vegetation communities present in the study area, Warnervale Town Centre.

3.3 Fauna Habitat Attributes

Five distinct fauna habitat occur within the study area, Swamp Forest, Low Swamp Woodland, Open Forest, Open Woodland, Open Grassland Areas and Dams. Following is a general description of each of the fauna habitats within the study area.

3.3.1 Swamp Forest

This habitat is situated on low lying land at the southern extension of Virginia Road, occurring along a drainage line. This habitat correlates with the Estuarine Swamp Oak Forest and Alluvial Floodplain Shrub Swamp Forest, and comprises a tall dense stand of Swamp Oak *Casuarina glauca* and *Melaleuca spp.*, with scattered Forest Red Gum (*E. tereticornis*) and tall *Melaleuca nodosa* in the more elevated parts. Groundlayer vegetation is sparse to very dense, depending upon elevation, comprising scattered *Gahnia spp., Lomandra longifolia*, grasses and herbs in the more elevated parts, and very dense sedges in the drainage areas.

Table 15. Fauna Habitat Attributes, Site 4 (Swamp Forest)

	% Canopy Cover	**Tree Size Class (dbh in cm)**			
Tree Species (20 metres in height)		**0-20**	**21-40**	**41-80**	**>80 cm**
Swamp Oak (*Casuarina glauca*)	81.6%	61.2%	20.4%		
Melaleuca decora	18.4%	0.0%	5.0%		
Understorey Species (To 15 metres in height)					
Melaleuca nodosa	4.0%%	4.0%			
Trees with Large Hollows (>10cm)	None		-	-	-
Trees with small hollows (<10cm)	None	-	-	-	-
No. flowering trees (during survey)	None	-	-	-	-
Ground Layer Vegetation (To 1.0 metre in height)					
Grasses	80.0%				
Sedge (*Gahnia sp.*)	18.0%				
Lomandra longifolia	2.0%				
Disturbance	weeds (Blackberry, Lantana), domestic dumping				

This habitat does not support mature trees with hollows for hollow dependant fauna. However, foraging resources for a variety of avian species, such as bird and bats species is abundant. Ground litter is abundant to sparse, depending upon elevation. In parts with dense sedge groundcover, numerous runways are evident. In contrast, in the Swamp Oak forest, ground litter is very sparse. Disturbance is associated with weed infestation, with infestation by lantana and blackberry thickets in parts. Fire does not appear to have impacted upon this habitat for a long period of time. Habitat for aquatic species was sparse, with no flowing water and small pools and soaks present. Shallow and deeper undulations were evident in this habitat.

3.3.2 Low Swamp Woodland

This habitat is situated in low lying areas along natural drainage lines, particularly in proximity to Warnervale Road and Virginia Road. This habitat correlates with the Alluvial Floodplain Shrub Swamp Forest, and comprises a low dense stand of *Melaleuca nodosa*, with no emergent eucalypt or angophora trees. Groundlayer vegetation comprises dense stands of sedges, with grasses and herbs in the elevated parts away from the drainage line. Emergent sedges and rushes fringe the wetter parts and small water bodies along the drainage lines.

Table 16. Fauna Habitat Attributes, Low Swamp Forest

	% Canopy Cover	Tree Size Class (dbh in cm)			
Tree Species (20 metres in height)		**0-20**	**21-40**	**41-80**	**>80 cm**
Understorey Species (To 6 metres in height)					
Melaleuca nodosa	64.0%%	100.0%			
Trees with Large Hollows (>10cm)	None		-	-	-
Trees with small hollows (<10cm)	None	-	-	-	-
No. flowering trees (during survey)	None	-	-	-	-
Ground Layer Vegetation (To 1.0 metre in height)					
Grasses	60.0%				
Sedge (*Gahnia sp.*)	18.0%				
Phragmites australis	12.0%				
Typha orientalis	8.0%				
Lomandra longifolia	2.0%				
Disturbance	weeds (Blackberry, Lantana)				

This habitat does not support emergent trees with hollows for fauna. However, foraging resources for a variety of species such as birds and small mammals is abundant along the drainage lines. Ground litter is sparse for small terrestrial vertebrates. However, dense sedges provide cover in proximity to the drainage lines. Disturbance is associated with dense weed infestation by lantana and blackberry thickets, and grazing by horses. Fire has not impacted upon this habitat. Habitat for aquatic species was present, with small pools and soaks present, and flowing water along the drainage lines.

3.3.3 Open Forest

Three survey sites were located in this fauna habitat type, Site 1 in Blackbutt Angophora Open Forest, Site 2 in Spotted Gum Ironbark Forest, and Site 5 in Smooth-barked Apple Red Bloodwood Open Forest.

Site 1. Blackbutt Angophora Open Forest

This habitat is situated in the northern elevated part of the study area off Hakone Road. The dominant tree species in this location is a mixture of Blackbutt (*E. pilularis*), Smooth-barked Apple (*Angophora costata*) and Red Bloodwood (*C. gummifera*). This habitat correlates with the Bell (2002a) vegetation community Narrabeen Coastal Blackbutt Shrubby Forest (Unit 27).

Table 17. Fauna Habitat Attributes, Site 1 (Blackbutt Angophora Open Forest)

	% Canopy Cover	Tree Size Class (dbh in cm)			
Tree Species (15 - 25 metres in height)		**0-20**	**21-40**	**41-80**	**>80 cm**
Eucalyptus pilularis	51.0%	25.0%	15.6%	10.4%	
Corymbia gummifera	23.9%	10.4%			13.5%
Angophora costata	25.0%	3.1%			21.8%
Understorey Species (< 10 metres in height)					
Acacia longifolia	3.0%	100.0%			
Allocasuarina torulosa	76.0%	100.0%			
Glochidion ferdinandi	4.0%		100.0%		
Trees with Large Hollows (>10cm)	3.0 / ha		-	-	-
Trees with small hollows (<10cm)	3.0 / ha	-	-	-	-
No. flowering trees (during survey)	None	-	-	-	-
Ground Layer Vegetation (To 1.0 metre in height)					
Sedge (*Gahnia sp.*)	7.0%				

Disturbance	weeds (Blackberry, Lantana, Pampas grass), dumping of domestic rubbish, disused quarry with roads and tracks, regrowth from former cleared land

This habitat supports a mixed age forest structure, with mature trees and dead stags with small and large hollows, and also dense stands of regrowth trees. Foraging resources for fauna is abundant. Ground litter is abundant, with fallen trees, tree limbs, leaf litter and domestic rubbish providing shelter for ground vertebrates and invertebrates. Disturbance is associated with weed infestation, with dense lantana, pampas grass and blackberry thickets evident, vehicle tracks and a disused quarry. Fire does not appear to have impacted upon this habitat for a long period of time.

Site 2. Spotted Gum Ironbark Forest

This habitat is situated on the western side of the Main Northern Railway. The dominant tree species in this location is Spotted Gum (*Eucalyptus maculata*) and Ironbark (*E. paniculata*) in the more elevated parts of the study area, which intergrade into Forest Red Gum (*E. tereticornis*) Rough-barked Apple (*Angophora floribunda*) and Woolybutt (*E. longifolia*) in proximity to the drainage line. The Spotted Gum Ironbark Open Forest correlates with the Dooralong Spotted Gum – Ironbark Forest (Unit 30).

Table 18. Fauna Habitat Attributes, Site 2 (Spotted Gum Ironbark Open Forest)

	% Canopy Cover	**Tree Size Class (dbh in cm)**			
Tree Species (20 – 25 metres in height)		**0-20**	**21-40**	**41-80**	**>80 cm**
Eucalyptus maculata	95.1%	22.3%	51.4%	21.3%	
Ironbark	4.8%	0.0%	4.8%	0.0%	
Eucalyptus punctata	0.0%				
Understorey Species (< 10 metres in height)					
None recorded in transect					
Trees with Large Hollows (>10cm)	3.0 / ha		-	-	-
Trees with small hollows (<10cm)	2.0 / ha	-	-	-	-
No. flowering trees (during survey)	None	-	-	-	-
Ground Layer Vegetation (To 1.0 metre in height)					
Grasses	100.0%				
Sedge (*Gahnia sp.*)	22.0%				
Disturbance	weeds (Blackberry, Lantana, Pampas grass), dumping of domestic rubbish, roads and tracks, fire.				

This habitat supports a mixed age forest structure, with mature trees and dead stags with small and large hollows, and also regrowth trees. Foraging resources for fauna is abundant. Ground litter is sparse, with scattered fallen trees, tree limbs, thin leaf litter and domestic rubbish providing shelter for ground vertebrates and invertebrates. Disturbance is associated with weed infestation, with dense lantana, pampas grass and blackberry thickets evident, vehicle and pedestrian tracks. Fire has occurred recently, but most appear localised spot fires rather than extensive wildfire's.

Site 5. Smooth-barked Apple Red Bloodwood Forest

This habitat is situated near the corner of Sparks Road and Minnesota Road. The dominant tree species in this location is Smooth-barked Apple (*Angophora costata*), Red Bloodwood (*C. gummifera*) and Brown Stringybark (*Eucalyptus capitellata*). This habitat correlates with the Narrabeen Buttonderry Footslopes Forest vegetation communities described by Bell (2002a).

Table 19. Fauna Habitat Attributes, Site 5 (Smooth-barked Apple Red Bloodwood Forest)

	% Canopy Cover	Tree Size Class (dbh in cm)			
Tree Species (15 metres in height)		**0-20**	**21-40**	**41-80**	**>80 cm**
Angophora costata	27.2%	23.9%	3.2%		
Brown Stringbark	9.8%	4.3%	5.4%		
Red Bloodwood	14.1%	10.8%	3.2%		
Allocasurina littoralis	48.9%	45.6%	3.2%		
Understorey Species (< 6 metres in height)					
Hakea teretifolia	45.9%	100.0%			
Trees with Large Hollows (>10cm)	1.0 / ha		-	-	-
Trees with small hollows (<10cm)	2.0 / ha	-	-	-	-
No. flowering trees (during survey)	None	-	-	-	-
Ground Layer Vegetation (To 1.0 metre in height)					
Xanthorrhoeae sp.	14.0%				
Grass / sedge	82.0%				
Disturbance	Limited, edge effects from recent residential development				

This habitat supports a mixed age woodland structure, with very scattered mature trees with small and large hollows, and dense stands of understorey. Foraging resources for fauna is abundant. Ground litter such as fallen trees and tree limbs is dense, with thick leaf litter providing shelter for ground vertebrates and invertebrates. Disturbance is very limited on this site, apart from scattered weeds along the interface with adjacent residential development. Fire does not appear to have impacted upon this habitat for a long period of time.

3.3.4 Open Woodland

One fauna survey sites were located in this habitat type, Site 3 in Smooth-barked Apple Woodland.

Site 3. Smooth-barked Apple Woodland

This habitat is situated on the southern side of Hakone Road. The dominant tree species in this location is Smooth-barked Apple (*Angophora costata*), with very scattered Brown Stringybark (*Eucalyptus capitellata*) in proximity to the drainage line. This habitat correlates with the Narrabeen Buttonderry Footslopes Forest vegetation communities described by Bell (2002a)(Unit 28).

Table 20. Fauna Habitat Attributes, Site 3 (Open Woodland)

	% Canopy Cover	Tree Size Class (dbh in cm)			
Tree Species (15 - 25 metres in height)		**0-20**	**21-40**	**41-80**	**>80 cm**
Angophora costata	28.0%	29.2%	0.0%	0.0%	70.8%
Understorey Species (< 10 metres in height)					
Allocasuarina torulosa	25.0%	100.0%			
Saplings	6.0%	100.0%			
Melaleuca nodosa	4.0%	100.0%			
Leptospermum trinervium	13.0%	100.0%			
Trees with Large Hollows (>10cm)	1.0 / ha		-	-	-
Trees with small hollows (<10cm)	1.0 / ha	-	-	-	-
No. flowering trees (during survey)	None	-	-	-	-
Ground Layer Vegetation (To 1.0 metre in height)					
Sedges (unknown)	59.0%				

Sedge (*Gahnia sp.*)	31.0%	
Disturbance	weeds (Lantana, Pampas grass), regrowth from former cleared land	

This habitat supports a very mixed age woodland structure, with very scattered mature trees with small and large hollows, and dense stands of regrowth understorey. Foraging resources for fauna is abundant. Ground litter such as fallen trees and tree limbs is sparse, with thick leaf litter providing shelter for ground vertebrates and invertebrates. Disturbance is very limited on this site, apart from scattered weeds. Fire does not appear to have impacted upon this habitat for a long period of time.

3.3.5 Open Grassland

This habitat occupies the remainder of the study area, on land that has been cleared for rural residential landholdings. Rural residential activities consist of cleared and mowed paddocks supporting grasses for grazing livestock (predominantly horses). Trees are scattered throughout this habitat, either as small stands of canopy trees, or single trees in grassland paddocks.

This habitat has scattered mature trees for hollow dependant fauna. Foraging resources for a small number of bird and flying bat species is present, particularly in proximity to patches of remnant trees. Ground litter is sparse, with limited sheltering for ground vertebrates and invertebrates. Disturbance is associated with weed infestation, dumping of domestic rubbish and disused materials, grazing by livestock (horses). Fire has not impacted upon this habitat.

3.3.6 Dams

A number of small and larger dams occur within the study area. The location of each dam is presented above in Table 11 and Figure 4 on page 16, and a description of each dam investigated is presented below in Table 21.

Table 21. Description of Amphibian Survey Sites, Warnervale Town Centre.

Site	Description	Dimensions	Easting	Northing
Dam 1	Small dam with permanent standing water and emergent aquatic vegetation to 1.0 metre high. No open water, with fringing aquatic and terrestrial vegetation present. Overhanging forest cover. Groundcover present. No presence of *Gambusia holbrookei* noted.	20 m x 20 m	356150	6320990
Dam 2	Small ephemeral dam with water present and emergent aquatic vegetation to 300mm high. No open water, and no fringing aquatic and terrestrial vegetation cover present. Open position in proximity to forest cover. No presence of *Gambusia holbrookei* noted. On second inspection in November 2003, the dam was dry with emergent vegetation drying out.	20 m x 20 m	356335	6321224
Dam 3	Large deep dam with fringing aquatic vegetation to 1.5 – 2.0 m high. Large area of open water in centre. Open position fringed by tall open forest with dense understorey. No presence of *Gambusia holbrookei* noted, although difficult to observe open water due to density of fringing vegetation. Sparse ground cover surrounding dam, although forest immediately adjacent.	50m x 40m	356260	6321290
Dam 4	Medium sized dam with permanent standing water and dense emergent aquatic vegetation to 1.0m high. Small area of open water in centre, with dense fringing aquatic vegetation (sedges and rushes). Open position in proximity to woodland with dense understorey (*Melaleuca sp. / Leptospermum sp.*) along	50 m x 30 m	357382	6321239

Site	Description	Dimensions	Easting	Northing
	drainage line. No presence of *Gambusia holbrookei* noted.			
Dam 5	Smaller dam with semi-permanent standing water and dense emergent aquatic vegetation to 1.0 high. No areas of open water, with sparse fringing aquatic vegetation. Open position in proximity to woodland with sparse understorey (*Melaleuca sp. / Leptospermum sp.*) along drainage line. No presence of *Gambusia holbrookei* noted.	20m x 20m	357218	6321170
Dam 6	Small farm dam on rural residential property adjacent to Warnervale Road. Large area of open water with no emergent aquatic vegetation and no fringing ground layer cover.	50m x 50m	356580	6319880

Note: Easting / Northing readings in AMG projection (AGD66)

3.3.7 Habitat Trees

No systematic mapping of habitat trees was undertaken due to the size of the study area, and abundance of mature trees with hollows. However, a number of significant habitat trees with hollows were identified within the study area, and their details are listed below in Table 22. It is recommended that detailed mapping of all habitat trees in each allotment be undertaken for flora and fauna investigations at the Development Application stage.

Table 22. Key Habitat Trees, Warnervale Town Centre.

Tree ID	Easting	Northing	Species	% Dead	DBH (cm)	Height (m)	Hollow Type	Target Species
1	357020	6320887	*Angophora costata*	50%	108.2	6m	Trunk hollow 500mm diameter	Likely Masked Owl roost tree
2	356937	6321121	*Eucalyptus pilularis*	40%	98.3	22m	Large branch spout 500mm diameter ~ 18m above ground.	Likely Powerful Owl nest tree
3	356290	6320990	Dead stag	60%	65cm	15m	Small gap between dead timber and bark on main trunk. Many bats (>100 individuals) observed to emerge from gap at dusk.	Confirmed Gould's Long-eared Bat roost tree

Note: Easting and Northing Coordinates are in AMG (AGD66 Zone 56)

3.4 Fauna Survey Results

3.4.1 Birds

Within the Warnervale Town Centre study area, a total of 76 bird species were recorded during investigations in 2003. This compares with 73 species recorded during investigations of a wider area during January / February 2001 by Payne & Murray, 2001. Within the locality (5km radius of the study area), a total of 115 bird species have been recorded, based on records held with the National Parks and Wildlife Atlas, and Wyong Fauna database. Several of these records include bird species associated with estuarine and aquatic habitats, such as the nearby Tuggerah Lakes. No habitat for estuarine bird species occur within the study area. However, a number of estuarine and aquatic bird species were observed flying over the study area, and were documented in Appendix 3.

One threatened bird species (listed on Schedule 2 of the TSC Act 1995) was recorded during the survey. A roost of the Powerful Owl (*Ninox strenua*) was located in forest at Site 1 (Council Quarry) off Hakone Road.

An inspection of all habitat trees within 100m radius of the roost located a mature Blackbutt (*Eucalyptus pilularis*) with a large hollow suitable as a nesting site for the species. The location of the potential nest tree is indicated above in Table 22.

An individual was observed foraging in the Planning NSW land west of the Main Northern Railway on the evening of 20 November 2003. The individual flew east over the railway line into the disused Quarry site off Hakone Road. No evidence of the species was noted by surveys using playback of pre-recorded calls of the species.

A list of all bird species recorded in the study area during this survey, and known from records in the locality, is presented in Appendix 3.

3.4.2 Mammals

10 native and 8 introduced non-flying mammals, and 7 bat species were recorded in the study area during the October and November 2003 surveys.

3.4.2.1 Small to Medium Terrestrial Mammals

Two native small mammal were recorded by trapping in the study area, the Brown Antechinus (*Antechinus stuartii*) and the Swamp Rat (*Rattus lutreolus*). The Brown Antechinus was captured at Sites 1, 2, 3 and 5, and the Swamp Rat was captured in dense sedges at Sites 3 and 4 during the survey in 2003.

Introduced small mammals captured in the study area at sites 1, 2 and 4 include the House Mouse (*Mus musculus*) and Black Rat (*Rattus rattus*).

One native and 3 introduced medium sized terrestrial mammal were recorded in the study area. Bandicoot diggings were evident at Sites 1, 2, 3 and 5 in the study area, although no individuals were captured to confirm the identification. Based on the habitats present, it is likely that the Northern Brown Bandicoot (*Isoodon macrourus*) occurs in the study area. The NPWS Atlas lists both the Northern Brown and Long-nosed Bandicoot recorded in the locality. The one record of Southern Brown Bandicoot (*Isoodon obesulus*) on the NPWS Atlas is an unreliable identification.

Domestic cats and dogs were observed in the study area. Many properties in the study area had domestic cats and dogs as pets, and unrestrained individuals are likely to stray into adjacent bushland. The European Rabbit and Brown Hare are widespread in the study area, particularly on large lots with open grassland.

3.4.2.2 Arboreal Mammals

Four species of arboreal mammals were recorded in the study area, Common Ringtail Possum (*Pseudocheirus peregrinus*), Common Brushtail Possum (*Trichosurus vulpecula*), Sugar Glider (*Petaurus breviceps*) and Squirrel Glider (*Petaurus norfolcensis*). The Common Ringtail Possum and Common Brushtail Possum were recorded at most survey sites. The Common Ringtail Possum was common in areas of dense understorey, whilst the Common Brushtail Possum was associated with mature trees with larger hollows. The Squirrel Glider was captured at two sites, Site 3 (Smooth-barked Apple Woodland) and 5 (Scribbly Gum - Stringybark Forest). The Squirrel Glider was also detected by spotlight on the Planning NSW land during a previous survey of the study area by Payne and Murray (2001).

Two Sugar Gliders were captured during the 2001 survey by Payne and Murray in arboreal traps at Site 1 (disused Quarry off Hakone Road). The species was detected during spotlight searches in October and November 2003.

3.4.2.3 SEPP 44 (Koala Habitat) Assessment.

Evidence of Koala populations in the study area was undertaken by review of all records of the species on the NPWS Wildlife Atlas and Wyong Fauna Database. Past records of Koala occur in Kanwal (1967) to the east of the study area, and a record occurs in the Wyong Council Quarry (Site 1) in 1994. Other records include near Mardi (1994) (NPWS Atlas records). No evidence of the species was determined from scat searches at each of the survey sites, and opportunistic searches in areas with Schedule 2 tree species.

A summary of tree species recorded in each of the survey sites, with the relative percentages of Schedule 2 tree species, is presented below in Table 23.

Table 23. Percentage Tree Species (SEPP 44 Assessment), Warnervale Town Centre Study Area.

Study Site	Tree Species	Scientific Name	% Composition
Site 1 Blackbutt Angophora costata Open Forest	Blackbutt	*Eucalyptus pilularis*	51.0%
	Red Bloodwood	*Corymbia gummifera*	23.9%
	Smooth-barked Apple	*Angophora costata*	25.0%
Site 2 Spotted Gum Ironbark Open Forest	Spotted Gum	*Eucalyptus maculata*	95.1%
	Ironbark	*Eucalyptus siderophloia*	4.8%
Site 3 Angophora costata Open Woodland	Smooth-barked Apple	*Angophora costata*	100.0%
Site 4 Swamp Oak Forest	Swamp Oak	*Casuarina glauca*	81.6%
		Melaleuca decora	18.4%
Site 5 Smooth-barked Apple Red Bloodwood Open Forest	Smooth-barked Apple	*Angophora costata*	27.2%
	Red Bloodwood	*Corymbia gummifera*	14.1%
	Brown Stringybark	*Eucalyptus capitellata*	9.8%

None of the survey sites supports potential habitat as defined by SEPP 44 (ie. greater than 15% Schedule 2 tree species). No evidence of core habitat was recorded in the study area. No evidence of Koalas was detected by spotlight and scat searches in the study area. No fresh or old scats were evident to suggest the site is utilised by foraging or dispersing Koalas. One record of Koala is known from the study area in 1994, whilst other records in the locality include;

- Porter's Creek Wetland in 1994 and 2003 (approximately 2.3 kilometres to the west).

Robert Payne from Ecological Survey and Management located an individual Koala in swamp forest off the Warnervale Airport in November 2003 (Scott Duncan, personal communications). It has been suggested that a small remnant population existed in this area for some time, although positive identification of individuals, or groups of individuals, have not been confirmed since 1994. The size of this Koala population is unknown, but is considered to be small and isolated, with the F3 Freeway providing a significant barrier to adjoining Koala populations in the west of the Shire.

3.4.2.4 Large Terrestrial Mammals

Two macropod species were recorded in the study area during investigations, the Swamp Wallaby (*Wallabia bicolor*) and Eastern Grey Kangaroo (*Macropus giganteus*). Introduced large mammals recorded in the study area include domestic Dog, Red Fox and Horse.

A summary of all terrestrial mammal species recorded in the study area is presented below in Table 24.

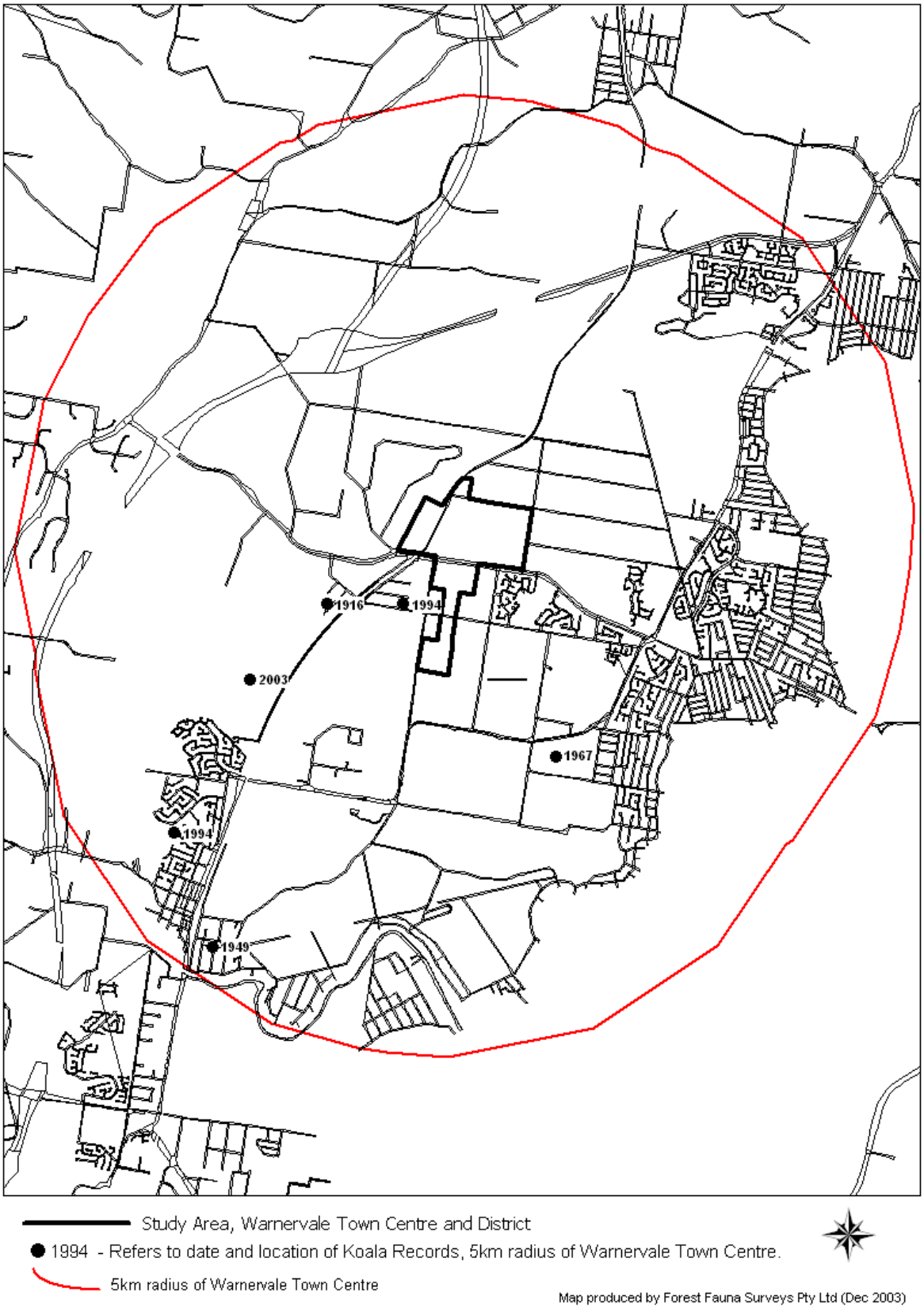

Figure 6. Koala Records within the Locality, Warnervale Town Centre.

Table 24. Summary of Terrestrial Mammals recorded in Study Area.

Common Name	Survey Site Recorded	Technique	Date Recorded
Brown Antechinus	1, 2, 3, 5	Elliott trapping	Oct 2003
Swamp Rat	3, 4.	Elliott trapping	Oct 2003
Bandicoot spp.	1, 2, 3, 5.	Diggings observed	Oct, Nov 2003
House Mouse**	1, 2	Elliott trapping	Oct 2003
Black Rat **	1, 4	Elliott trapping	Oct 2003
Common Ringtail Possum	1, 2, 3, 4, 5	Spotlight observation	Oct, Nov 2003
Common Brushtail Possum	1, 2, 3, 5	Spotlight observation	Oct, Nov 2003
Squirrel Glider	2	Spotlight observation	Jan 2001
	3, 5.	tree trapping	Oct 2003
Sugar Glider	1	Spotlight observation	Oct 2003
	1	tree trapping	Jan 2001
Swamp Wallaby	1, 2	Observation	Oct 2003
Eastern Grey Kangaroo	1	Observation	Oct 2003

* denotes introduced species.

3.4.2.5 Microchiropteran and Megachiropteran Bats

A total of 7 species of microchiropteran bats were recorded in the study area during surveys in October and November 2003. Two species of microchiropteran bats were recorded by harp trapping, the Chocolate Wattled Bat (*Chalinolobus morio*) and Gould's Long-eared Bat (*Nyctophilus gouldii*). Highest captures were recorded in the Spotted Gum Ironbark Open Forest on the Planning NSW land west of the Main Northern Railway, with 25 individuals of Gould's Long-eared Bats captured on one morning. These individuals were released and observed to fly into a roost tree nearby. This roost tree has been located and mapped, and is presented above in Table 22.

Echolocation call detection resulted in the detection of an additional five species, and the White-striped Freetail Bat was also heard from audible call. The list of bat species recorded in the study area is presented below in Table 25.

Table 25. Microchiropteran Bat Species recorded in Study Area, Warnervale Town Centre.

Common Name	Scientific Name	Survey Site#	Method
White-striped Freetail-bat	*Nyctinomus australis*	1, 2, 3, opportunistic	Audible call, Anabat
Freetail Bat	*Mormopterus sp. 2*	1	Anabat
Eastern Broad-nosed Bat	*Scotorepens orion*	1,2	Anabat
Gould's Long-eared Bat	*Nyctophilus gouldii*	2, 5	Harp Trap
Gould's Wattled Bat	*Chalinolobus gouldii*	1,2,3	Anabat
Chocolate Wattled Bat	*Chalinolobus morio*	4, 5	Harp Trap, Anabat
Little Forest Bat	*Vespadelus vulturnus*	4, 5	Anabat

The Spotted Gum Ironbark Open Forest recorded the highest diversity and activity of bats by Anabat recordings to the other survey sites, with the Swamp Oak Forest at Site 4 recorded the lowest number of captures and call recordings.

No flying fox activity was noted during this survey, but both the Little-reddish and Grey-headed Flying Fox would occur in the study area during flowering of *Eucalyptus* and *Angophora* tree species.

3.4.3 Reptiles

Six reptile species were recorded during the October and November 2003 fauna study, the Eastern Long-necked Tortoise (*Chelodina longicollis*), Jacky Lizard (*Amphibolurus muricatus*), Eastern Water Skink (*Eulamprus qouyii*), Garden Skink (*Lampropholis delicata*), Eastern Water Dragon (*Physignathus lesueurii*) and Red-bellied Black-snake (*Pseudechis porphyriacus*). A list of reptile species recorded in the study area, and known to occur, is presented in Appendix 3.

Analysis of NPWS wildlife atlas for reptiles indicates 12 reptile species recorded within five kilometres of the study area. Micro-habitat for reptiles in the study area varies, with remnant forest habitat is containing high density of ground litter, particularly where mature trees have dropped limbs, and there is dumping of domestic rubbish. The open grassland areas provided much lower densities of natural ground litter, but this was often replaced by domestic rubbish such as car bodies.

3.4.4 Amphibians

Eight species were recorded in the study area during fieldwork in October and November 2003. The highest number of species were associated with the small and larger dams. A total of 18 species have been recorded in the locality, based on records in the NPWS Wildlife Atlas and Wyong Fauna Database. A list of frog species recorded in the study area, and known to occur based on local records, is presented in Appendix 3. Micro-habitat for frogs within the study area include open forest, small dams and soaks along drainage lines. The small dams in the forest and open areas contained fringing vegetation and ground cover. None of the dams inspected, or small pools along the drainage lines appeared to support populations of the introduced Mosquito Fish (*Gambusia holbrooki*). The Mosquito Fish is listed as a key threatening process for amphibians, due to its predation on tadpoles.

Within the Swamp Oak Forest at Site 4, there was evidence of the “pock mark undulations” described by Payne (1994). These undulations have been noted in other localities nearby, and provide significant areas of breeding habitat for many frog species.

3.5 Threatened Species Recorded in Study Area

One threatened and one rare plant, and two threatened fauna species were recorded during investigations in 2003. A further threatened species, the Wallum Froglet, was not recorded during 2003, but was located during previous investigations of the study area in 2001 (Payne and Murray, 2001). In addition, the Masked Owl was located in the wider Warnervale District during the 2001 investigations, but was not located in the study area during 2003.

Additional records of threatened species within the study area are listed on the NPWS Wildlife Atlas, including Koala, Eastern Bent-wing Bat and Eastern Freetail Bat. Other records in the immediate vicinity include Greater Broad-nosed Bat, Little Bent-wing Bat and Green and Golden Bell Frog. However, no details are provided on those records to provide an accompanying discussion.

3.5.1 Rutidosis heterogama

During this study, the presence of the Vulnerable *Rutidosis heterogama* (Asteraceae) was noted immediately west of the Main Northern Railway, off Sparks Road. This species was formerly unknown south of the Hunter Valley (Harden 1992), and its occurrence at Warnervale represents a significant disjunct population extending its geographical range onto the Central Coast botanical subdivision. *Rutidosis heterogama* is listed as Vulnerable on both the *TSC Act 1995* and the *EPBC Act 1999.* Accordingly, an additional study into the distribution, population size and habitat within the wider Warnervale area has been commissioned as an extension to the current project (refer to separate assessment in Appendix 2 of this document). Additional studies are also being conducted by Stephen Bell in collaboration with Colin Driscoll (EcoBiological) on this species in the Lake Macquarie and Cessnock regions.

3.5.2 Macrozamia flexuosa

Two specimens of this cycad were noted in Lot 58 DP 7738 south of Hakone Road. The plants were located at the top of the ridgeline immediately north of the recently constructed Mary Mackillop College. This species reaches its southern distributional limit in the Warnervale area (Bell 2002a), where it occurs very sporadically. Although not currently listed as a threatened species, *Macrozamia flexuosa* carries a conservation risk code of 2K, which signifies a poorly known species with a distributional range of less than 100km (Briggs and Leigh 1996). It is unlikely that this species will become listed as a threatened species, as large populations are known in the Cessnock area (see Bell 2001).

3.5.3 Powerful Owl

The Powerful Owl was recorded in the study area, with the finding of a roost site where a number of regurgitated pellets were collected, and visual observation of the species. The amount of pellet material collected at the roost site suggests that this is a regular roost for the species. The species forages widely, and would utilise the forested habitats in the Warnervale Town Centre study area as part of its foraging range.

3.5.4 Squirrel Glider

The Squirrel Glider was captured at two sites (Site 3 and Site 5) during the fauna survey within the Warnervale Town Centre in October and November 2003. One individual was observed by spotlight on the DIPNR site in Spotted Gum - Ironbark Open Forest during previous investigations of the study area by Payne and Murray (2001). The glider captured at Site 3 was in Open Woodland dominated by Smooth-barked Apple (*Angophora costata*). A number of mature trees were present in this habitat, but canopy cover is very open, only 28%. This open nature would favour the glider, but in parts, the tall trees are too spaced to

enable movement between trees. The habitat at Site 5 is denser forest with presence of foraging resources (*Banksia sp., Acacia sp.*) in the understorey and ground layer.

Within the DIPNR site where the Squirrel Glider was recorded by spotlight in 2001, limited abundance of *Banksia* was noted, but the winter flowering Spotted Gum was recorded. However, Spotted Gum is not a reliable nectar source, and is known to not flower consistently in winter.

3.5.5 Wallum Froglet

The Wallum Froglet was heard calling in a small depression on the DIPNR site adjacent to the Main Northern Railway in 2001. No evidence of the species was noted in 2003. Habitat where the species was recorded was a small drainage line with several small ephemeral soaks adjacent to the Main Northern Railway. The dominant canopy vegetation was *Melaleuca nodosa* to five metres height, with open understorey and dense ground layer vegetation consisting of *Gahnia* sp. and sedges.

3.5.6 Masked Owl

The Masked Owl is known from the Wadalba area to the south (NPWS Atlas, 2000). A Masked Owl was found as a road kill on the F3 Freeway and Sparks Road interchange on Tuesday 12 March 2001 (Robert Payne, personal record). Within the Warnervale Town Centre, there are extensive areas of suitable habitat consisting of open forest with many mature trees, and open understorey with abundant foraging resources. The mature trees contain large hollows suitable as roost and nesting sites, particularly the Sydney Red Gum (*Angophora costata*), Scribbly Gum (*Eucalyptus haemastoma*) and Spotted Gum (*Corymbia maculata*) tree species. One suitable roost or nest tree was located within the Warnervale Town Centre study area, and the location and description is presented above in Table 22.

The locations of threatened species recorded within, or immediately adjacent to the study area, is presented below in Figure 7.

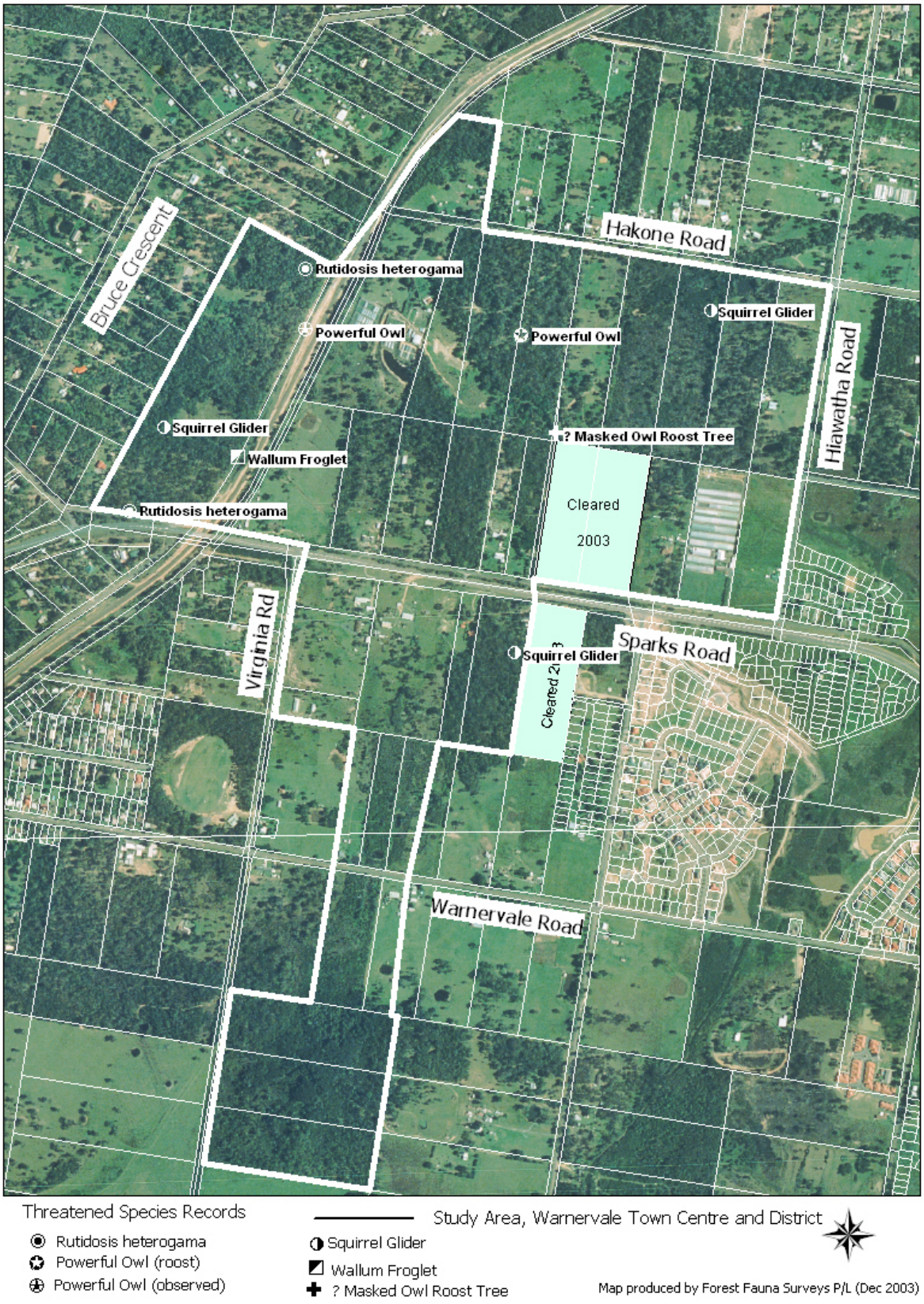

Figure 7. Location of Threatened Species, Warnervale Town Centre.

3.6 Threatened Species recorded in Locality (<5km radius of Study Area)

A number of threatened species occur within a five kilometre radius of the study area. The list of threatened species recorded in the locality, and also their status, is presented below in Table 26.

Under the federal *Environment Protection and Biodiversity Conservation Act 1999*;
- 2 endangered fauna,
- 7 vulnerable plant species, and
- 3 vulnerable fauna species.

Under the NSW *Threatened Species Conservation Act 1995*;
- 1 endangered plant species,
- 5 endangered fauna,
- 6 vulnerable plant species, and
- 20 vulnerable fauna species.

Table 26 Status of Threatened Species recorded in 5km radius of Warnervale Town Centre.
Data Source: NPWS Wildlife Atlas (June 2004); Wyong FAUNA DATABASE (2002); personal records.

Common Name	Scientific Name	TSC Act 1995	EPBC Act 1999
Flora			
Bynoe's Wattle	*Acacia bynoeana*	Endangered	Vulnerable
Scrub Apple	*Angophora inopina*	Vulnerable	Vulnerable
Camfield's Gum *	*Eucalyptus camfieldii*	Vulnerable	Vulnerable
Leafless Tongue Orchid	*Cryptostylis hunteriana*	Vulnerable	Vulnerable
Bottlebrush	*Callistemon linearifolius*	Vulnerable	Vulnerable
Paperbark	*Melaleuca biconvexa*	Vulnerable	Vulnerable
Black-eyed Susan	*Tetratheca juncea*	Vulnerable	Vulnerable
Birds			
Black-necked Stork	*Ephippiorhynchus asiaticus*	Endangered	n/a
Swift Parrot	*Lathamus discolor*	Endangered	Endangered
Australasian Bittern	*Botaurus poiciloptilus*	Vulnerable	n/a
Black Bittern	*Ixobrychus flavicollis*	Vulnerable	n/a
Superb Fruit-Dove	*Ptilinopus superbus*	Vulnerable	n/a
Glossy Black Cockatoo	*Calyptorhynchus lathami*	Vulnerable	n/a
Masked Owl	*Tyto novaehollandiae*	Vulnerable	n/a
Barking Owl	*Ninox connivens*	Vulnerable	n/a
Powerful Owl	*Ninox strenua*	Vulnerable	n/a
Painted Honeyeater	*Grantiellia picta*	Vulnerable	n/a
Amphibians			
Green & Golden Bell Frog	*Litoria aurea*	Endangered	Vulnerable
Giant Barred Frog	*Mixophyes iteratus*	Endangered	Vulnerable
Green-thighed Frog	*Litoria brevipalmata*	Vulnerable	n/a
Wallum Froglet	*Crinia tinnula*	Vulnerable	n/a
Mammals			
Southern Brown Bandicoot	*Isoodon obesulus*	Endangered	Endangered
Koala	*Phascolarctos cinereus*	Vulnerable	n/a
Squirrel Glider	*Petaurus norfolcensis*	Vulnerable	n/a
Grey-headed Flying-fox	*Pteropus poliocephalus*	Vulnerable	Vulnerable
Eastern Freetail Bat	*Mormopterus norfolcensis*	Vulnerable	n/a
Little Bent-wing Bat	*Miniopterus australis*	Vulnerable	n/a
Eastern Bent-wing Bat	*Miniopterus schriebersii*	Vulnerable	n/a

Common Name	Scientific Name	TSC Act 1995	EPBC Act 1999
Large-footed Myotis	*Myotis adversus*	Vulnerable	n/a
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Vulnerable	n/a
Eastern Falsistelle	*Falsistrellus tasmaniensis*	Vulnerable	n/a
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Vulnerable	n/a

* Note that the forms of *Eucalyptus camfieldii* present on the Central Coast are not pure (Hill 2003), and are the subject of continuing taxonomic studies by Stephen Bell in collaboration with the National Herbarium.

Following in Table 27 is a brief summary of whether suitable habitat exists within the study area of the Warnervale Town Centre for each of those threatened species listed above in Table 26.

Table 27. Likely Occurrence of Threatened Species recorded within five kilometre radius of Warnervale Town Centre.

Data Source: NPWS Wildlife Atlas (June 2004); Wyong FAUNA DATABASE (2002); personal records.

Common Name	Likely Occurrence in Study Area	Potential or Actual Habitat in Study Area
Acacia bynoeana	None	Records of this species in the region are from heathy open woodland dominated by *Eucalyptus haemastoma* and *Corymbia gummifera* (Bell & Driscoll in review), which is absent in the study area.
Angophora inopina	None	Potentially within the swamp forest areas in the south off Virginia Road, although within the region this habitat supports very few individuals of this species, and most of this area consists of regrowth vegetation.
Eucalyptus camfieldii	Low	May occur in the Narrabeen Buttonderry Footslopes Forest vegetation, although until taxonomic studies on this and related species is completed, identification would be uncertain.
Cryptostylis hunteriana	None	Within the region, this species is known from the Narrabeen Doyalson Coastal Woodland (Bell 2001), which is not present in the study area.
Callistemon linearifolius	Low	Potentially within any of the non-swamp communities, although habitat not ideal.
Melaleuca biconvexa	Moderate	Potentially within any of the swamp communities in the south of the study area off Virginia Road
Tetratheca juncea	Moderate	Potentially within the Narrabeen Buttonderry Footslopes Forest.
Black-necked Stork	Low	Most dams densely vegetated on fringe, unlikely to be utilised by the species
Swift Parrot	Low	Flowering *Eucalyptus* trees in Open Forest and Open Woodland.
Australasian Bittern	Moderate	Several dams densely vegetated, potential for occurrence.
Black Bittern	Low	Preference for mangrove and wetland habitat, none occurring in study area.
Superb Fruit-dove	Low	No suitable habitat in study area.
Glossy Black Cockatoo	Moderate	Abundant *Casuarina* food trees in study area.
Masked Owl	High	Suitable foraging habitat within study area.
Barking Owl	Low	Potential foraging habitat within study area.
Powerful Owl	Recorded in Study Area	Suitable foraging habitat and nest trees present.
Painted Honeyeater	Low	Potential foraging habitat (mistletoe) present within study area.

Common Name	Likely Occurrence in Study Area	Potential or Actual Habitat in Study Area
Green and Golden Bell Frog	Moderate	Potential occurrence due to absence of *Gambusia* in several small dams and aquatic habitat, known from nearby records.
Giant Barred Frog	Low	No suitable habitat in study area.
Green-thighed Frog	Low	No suitable habitat in study area.
Wallum Froglet	Recorded in study area	Limited suitable habitat in study area, recorded population small in size.
Southern Brown Bandicoot	Low	Record is unreliable. Outside distribution of species. Likely mis-identification.
Koala	Low	Limited foraging habitat in study area, no recent records.
Squirrel Glider	Recorded in study area	Species recorded in and adjacent to study area.
Grey-headed Flying-fox	High	Foraging habitat in study area
Eastern Freetail Bat	High	Foraging habitat in study area.
Little Bent-wing Bat	High	Foraging habitat in study area.
Eastern Bent-wing Bat	High	Foraging habitat in study area.
Large-footed Myotis	Moderate – High	Potential foraging habitat in study area.
Yellow-bellied Sheathtail-bat	Low	Potential foraging habitat in study area.
Eastern Falsistrelle	Low	No habitat in study area.
Greater Broad-nosed Bat	High	Foraging habitat in study area.

In addition to the threatened species listed above in Tables 26 and 27, additional threatened species have been recorded outside the locality, and may potentially occur within the study area due to the high mobility. The likelihood of their occurrence is listed below in Table 28.

Table 28. Threatened Species recorded outside locality (<5km radius), with potential for occurrence.

Common Name	Potential Occurrence in Study Area	Potential or Actual Habitat in Study Area
Microtis angusii	None	Jones (1996) described this species as known only from a location in Ingleside in Sydney. Specimens collected from the Munmorah area in northern Wyong Shire have been attributed to this species. However, current information suggests that the Wyong specimens may be a different taxon. Jones (1996) noted that the Sydney *Microtis angusii* occurred in lateritic shale on the Wianamatta Shale formation, among grass in low woodland. The Wyong specimens occur on Triassic Narrabeen sediments on the edge of swampy heath (P. Norris, NPWS, pers. comm.). Consequently, it is not considered likely that *Microtis angusii* (the type or Wyong specimens) would occur on the proposed site.
Caladenia porphryea	None	Jones (1999) reports that this species grows in heath and heathy forest and woodland, sometimes on exposed headlands, on grey to white sands and sandy loams. The species is known from Norah Head, but habitat at Warnervale is not considered to be suitable for this species.
Regent Honeyeater	Low	Flowering *Eucalyptus* trees, and *Casuarina glauca* trees in Swamp Forest and Open Forest / Woodland may provide seasonal foraging resources for the species.

3.7 Endangered Ecological Communities, Regional and Locally Significant Vegetation

3.7.1 Endangered Ecological Community

The small portion of Alluvial Floodplain Shrub Swamp Forest (Unit 20) described and mapped in this report arguably falls within the description of the Sydney Coastal Estuary Swamp Forest Complex. This community is listed on the *Threatened Species Conservation Act 1995* as an Endangered Ecological Community, and is therefore legally protected in New South Wales. Figure 5 shows the location of this community. Only a small portion of the study area supports this vegetation type, which is itself becoming increasingly impacted upon by weed species.

3.7.2 Regionally Significant Vegetation

The Alluvial Redgum Footslopes Forest (Unit 15) is identified as regionally significant due to the extent of past clearing of this vegetation type. Approximately 86.2% of this vegetation type has been cleared in Wyong Shire. Within the Warnervale Town Centre study area, the location of this community is below the 1:100 AEP flood level, which may in fact assist in conserving this community.

The Narrabeen Coastal Blackbutt Shrubby Forest (Unit 27) reaches its known northern limit of distribution within the Warnervale Town Centre site, and is considered regionally significant. Although parts of it are disturbed, there are important undisturbed portions which are floristically distinct from other areas in the locality.

The variant of the Alluvial Floodplain Shrub Swamp Forest (Unit 20f) present in the south of the site is considered a regionally significant vegetation community, although it arguably does not fall within the above EEC. This variant is recognised here as being unusual in Wyong Shire, particularly in relation to the understorey of *Xanthorrhoea fulva* and *Lepidosperma quadrangulata*, and should be protected from any development. This community differs floristically from the listed Hunter Lowlands Redgum Forest EEC, which occurs between Muswellbrook and the lower Hunter Valley (NPWS, 2000).

One ROTAP (Rare and Threatened Australian Plant) was located within the study area, *Macrozamia flexuosa.* This species is not listed as threatened, but carries a conservation risk code 2K, signifying a poorly known species with a distributional range less than 100 kilometres.

The Estuarine Swamp Oak Forest (Unit 3b) is described in this report as the Porters Creek variant of Vegetation Unit 3. Subsequent investigations since the Natural Vegetation of Wyong LGA (Bell, 2002a) has confirmed that this vegetation type occurring in the study area is a secondary vegetation type in response to past land clearing, and opportunistic colonisation by *Casuarina glauca*. Consequently, the highly restricted nature of Unit 3b in Bell (2002a) can now be regarded as a disturbance category of the true Estuarine Swamp Oak Forest, lessening the regional significance of that variation.

3.7.3 Locally Significant Vegetation

The Alluvial Redgum Footslopes Forest (Unit 15) is also considered locally significant due to the extent of past clearing, with many remnants unrepresentative of original condition due to impacts such as grazing. Development of the Town Centre above the 1:100 AEP flood level would not result in loss of this vegetation type by clearing.

The Narrabeen Coastal Blackbutt Shrubby Forest (Unit 27) occurs on the ridgeline of the disused tip site off Hakone Road. Development of the Warnervale Town Centre will result in a reduction of area of this vegetation type. However, parts of the Town Centre are planned for Open Space / Vegetation Corridors, which may assist in conservation of pockets of this vegetation type.

The Narrabeen Buttonderry Footslopes Forest (Unit 28) occurs predominantly within the central portion of the study area. This community is unlikely to be conserved to any extent by development of the Town Centre.

The vegetation type Dooralong Spotted Gum – Ironbark Forest (Unit 30) occurs on the ridgeline of the DIPNR site. This community is considered locally significant by Bell (2002a) due to lack of formal protection in the local area and region. However, previous investigations of the Town Centre have identified this community as significant due to high fauna and visual / aesthetic values. Pockets of this vegetation type would be conserved as areas of open space within the Town Centre.

3.8 Other Significant Flora

Hybrid specimens of *Eucalyptus pilularis* X *Eucalyptus capitellata* were recorded at two locations within the study area; north and south of Sparks Road. These individuals were large trees with a 'stringybark' appearance, but with smooth upper branches and possessing clustered fruit most similar to *Eucalyptus pilularis*. All other stringybark trees present on the site have been attributed to *Eucalyptus capitellata*, despite recent hybrids of this species with the vulnerable *Eucalyptus camfieldii* being reported (see Hill 2003). Note that taxonomic studies into the *Eucalyptus camfieldii-agglomerata* group are shortly to commence in collaboration with the National Herbarium, with the aim of clarifying the taxonomic position of the *Eucalyptus camfieldii* records from the Wyong coastal plain.

Several plant species were recorded during the surveys which may be considered to be locally significant within the LHCC region (HRBG in prep.) due to their known distributional limits lying within the Hunter Valley or Central Coast bioregion. These species are generally common and widespread in Wyong Shire.

3.9 Summary of Threatened Species Locations

Based on the results of surveys, coupled with habitat assessment of threatened species known to occur in the locality, the following threatened species require further assessment under the EPBC Act 1999, and TSC Act, 1995. Those species requiring assessment are listed below in Table 29.

Table 29. Threatened Species requiring Impact Assessment under EPBC Act 1999, and or TSC Act 1995.

Threatened Species	**EPBC Act Status**	**TSC Act Status**	**Recorded in Study Area**
Rutidosis heterogama	Vulnerable	Vulnerable	Yes, require assessment
Tetratheca juncea	Vulnerable	Vulnerable	No, require assessment
Melaleuca biconvexa	Vulnerable	Vulnerable	No, require assessment
Australasian Bittern		Vulnerable	No, require assessment
Glossy Black Cockatoo		Vulnerable	No, require assessment
Masked Owl		Vulnerable	No, require assessment
Powerful Owl		Vulnerable	Yes, require assessment
Green & Golden Bell Frog	Endangered	Endangered	No, require assessment
Wallum Froglet		Vulnerable	Yes, require assessment
Koala		Vulnerable	Yes, require assessment
Squirrel Glider		Vulnerable	Yes, require assessment
Grey-headed Flying-fox	Vulnerable	Vulnerable	No, require assessment
Eastern Freetail Bat		Vulnerable	No, require assessment
Eastern Bent-wing Bat		Vulnerable	No, require assessment
Little Bent-wing Bat		Vulnerable	No, require assessment
Large-footed Myotis		Vulnerable	No, require assessment
Greater Broad-nosed Bat		Vulnerable	No, require assessment
Endangered Ecological Community			
Sydney Coastal Estuary Swamp Forest Complex		Endangered EEC	Yes, requires assessment

Following in Section Four is a detailed discussion of the likely effect of rezoning and subsequent development of the land in the Warnervale Town Centre for development upon those threatened species known, or likely to occur in the study area.

4.0 IMPACT ASSESSMENT

The scope of the current study was to undertake flora and fauna investigations within the study area defined as the Warnervale Town Centre, to identify and assess potential ecological constraints associated with the rezoning and subsequent development of that land.

The ecological investigation sought to identify the presence of protected and threatened species, and endangered ecological communities within the study area. Threatened species and endangered ecological communities are those listed on Schedules One and Two of the national *Environment Protection and Biodiversity Conservation Act 1999*, and also Schedules One and Two of the NSW *Threatened Species Conservation Act 1995*.

This investigation is also required to assess the potential, or actual effect of development within the Warnervale Town Centre on those threatened species, or their habitat. The assessment of potential or actual effect of the proposal under the *EPBC Act 1999* requires consideration of several Matters of National Significance. In addition, the proposal also requires consideration of impact under s.5A of the *NSW Environmental Planning and Assessment Act 1979* (as amended by the *Threatened Species Conservation Act 1995*). The proposal also requires consideration of any key threatening processes listed on Schedule 3 of the *EPBC Act 1999*, and *EP&A Act 1979*.

Following from the review of previous studies in the locality, coupled with flora surveys, habitat assessments and fauna surveys for threatened species within the study area, a number of threatened species were identified, and also considered likely to occur. These flora and fauna species were identified for consideration with regard to future development of the study area. Three threatened species were recorded on, or immediately adjacent to the study area during ecological investigations undertaken in 2001 (Payne and Murray 2001). In addition, a further 2 species were recorded during investigations for this study. In addition, several threatened species have been recorded in the locality (<5km radius of the study site), and require consideration under:

- Matters of National Significance listed on the national *Environment Protection and Biodiversity Conservation Act 1999*, and
- s.5A of the *Environmental Planning and Assessment Act 1979*.

4.1 Environment Protection and Biodiversity Conservation Act 1999.

This Act requires the Commonwealth Environment Minister's approval for an Action that will have or is likely to have a detrimental / adverse impact(s) on a Matter of National Environmental Significance, or on Commonwealth land unless the action is exempt. Matters of National Environmental Significance currently include World Heritage properties, Ramsar Wetlands of international importance, Listed threatened species and communities, Listed migratory species, Nuclear Actions, Commonwealth marine environment, and other matters prescribed by the Regulations.

Guidelines have been prepared in order to decide whether an action is likely to have a significant impact, it is necessary to take into account the nature and magnitude of potential impacts. In determining the nature and magnitude of an action's impact, it is important to consider matters such as:

- all on-site and off-site impacts,
- all direct and indirect impacts,
- the frequency and duration of the action,
- the total impact which can be attributed to that action over the entire geographic area affected, and over time,

- the sensitivity of the receiving environment, and
- the degree of confidence with which the impacts of the action are known and understood.

The Act provides that the Minister must, in deciding whether an action is likely to have a significant impact on a matter of national environmental significance, take account of the precautionary principle. Accordingly, the fact that there is a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on a matter of national environmental significance.

Matters of National Environmental Significance relevant to the proposed development of the Warnervale Town Centre include Listed Threatened Species and Migratory Species. No World Heritage properties, Ramsar Wetlands, Commonwealth Marine Areas, Nuclear Actions or Listed Ecological Communities, or other matters, apply to the study area.

4.1.1 Listed Threatened Species and Communities

One listed threatened species, *Rutodosis heterogama* on Schedule One and Two of the *EPBC Act 1999* was recorded in the study area during this investigations. In addition, several threatened species have been recorded in the locality, and could potentially utilise habitats within the study area. Those nationally threatened species either recorded, or considered likely to occur in the study area are listed above in Tables 26 and 27. A summary of those species likely to occur in the study area is also presented below in Table 30.

Table 30. Assessment of Proposed Development of Land within the Warnervale Town Centre on Listed Threatened Species (*EPBC Act, 1999*).

Common / Scientific Name	**Potential Occurrence in Study Area**	**Potential or Actual Habitat in Study Area**
Rutodosis heterogama	Recorded	Located in the DIPNR land west of the Main Northern Railway (refer to Figure 8 above).
Tetratheca juncea	Moderate	Potentially within the regrowth Narrabeen Doyalson Coastal Woodland in study area.
Melaleuca biconvexa	Moderate	Potentially occurring within any of the swamp communities in the south of the study area off Virginia Road extension.
Green and Golden Bell Frog	Low - moderate	Potential occurrence due to absence of *Gambusia* in small dams and aquatic habitat, known from nearby records.
Grey-headed Flying Fox	High	Potential foraging habitat in study area.

The assessment guidelines on significance were applied to each of the species listed above in Table 29, and is presented below.

*4.1.1.1 Assessment of Significance on **Rutodosis heterogama**.*

***Criteria 1**. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.*

Rutidosis heterogama has only recently been discovered on the Central Coast, with the populations at Warnervale currently representing the southern known distributional limit. Current research into the populations on the Central Coast, in both Wyong and Lake Macquarie LGA's, reveal the population within the study area to be an 'important population', both because of its size (~1,000 individuals) and its occurrence at the southern distributional limit. Any disturbance to the lands supporting this species will most likely result in a long-term decrease in the size of this population, and constitutes a significant impact.

Criteria 2. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.*

The currently known occupancy area for *Rutidosis heterogama* within the study area is approximately 5ha, the majority of which lies within Lot 1 DP357408. A small population also exist to the immediate east of the Main Northern Railway (Lot 152, DP597725) (refer to Appendix 2 – Supplementary report), suggesting that the rail line has dissected the population in the past. Any development proposed for Lot 1 DP357408 will reduce the area of occupancy of this important population, and consequently constitutes a significant impact.

Criteria 3. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.*

Depending on the future use of the land, particularly Lot 1 DP357408, is likely to fragment the existing population of *Rutidosis heterogama*. The population is, however, already fragmented, as the northern sub-population is separated from the southern one by a natural drainage line. The existing rail line also fragments the eastern extremities of the population, and Bruce Crescent (outside of the study area to the west) is also aligned through the population. It is likely, therefore, that a significant impact will be felt through fragmentation.

Criteria 4. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.*

Current research on *Rutidosis heterogama* in the Central Coast and lower Hunter Valley has revealed a number of habitats in which this species occurs (Bell & Driscoll, unpubl. data). As it is still unclear in the literature why certain rare plants occur in one location, yet are absent in seemingly suitable habitat elsewhere, it is difficult to assign priorities to different habitats with respect to specific species. The habitat in which this species occurs at Warnervale fits within the broad structural framework of habitats known to date, but does differ in floristic composition. However, these differences are not considered significant, and development would not adversely affect habitat critical to the survival of the species.

Criteria 5. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.*

The population at Warnervale within the study area is considered an 'important population', and any development within this area will likely result in a significant impact. Although seeds of *Rutidosis heterogama* are wind-dispersed, research on the related *Rutidosis leptorrhynchoides* and *Rutidosis leiolepis* has shown that seed dispersal is very low, occurring less than 1 metre from the parent plant (Young *et. al.* 1999; Young *et al*. 2002). It is also believed that *Rutidosis heterogama* (like *R. leptorrhynchoides*) is self-incompatible, meaning that fertile seed production requires cross-pollination between genetically distinct individuals. It is therefore crucial for the long term survival of this population that as many individuals of *Rutidosis heterogama* be retained as possible, to boost genetic diversity and the chances of producing fertile seed.

Criteria 6. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

Although there is much to be learnt about the ecology of *Rutidosis heterogama*, there are some broader trends surfacing in regard to preferred habitat. Most records of the species within the Central Coast and lower Hunter Valley occur within open forest where *Corymbia maculata* and *Eucalyptus capitellata* are obvious, in contrast to the heath vegetation mentioned in Harden (1992). In theory, therefore, it is possible

that any open forest habitat containing these species may qualify as potential habitat, the development of which may cause the species to decline.

Criteria 7. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

Fragmentation and development of the habitat supporting this species may allow the invasion of exotic species, which could threatened the survival of the species. These would take the form of exotic perennial grasses and shrubs which could out-compete *Rutidosis* for vital growth requirements, including light. It is also likely that once established in potential habitat, the presence of exotic perennial grasses would exclude germination of any wind-dispersed seeds of *Rutidosis*.

Criteria 8. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

Rutidosis heterogama is known from several sites in the Central Coast – lower Hunter Valley area (unpubl. data, see Appendix), with at least three populations known from the Warnervale area. It is also present in areas of the North Coast of NSW. Combined, the bioregional population is not expected to be adversely affected by the potential loss of one population at Warnervale, such that the recovery of the local population would be substantially affected. Locally, however, the population within the study area forms an important component of the Central Coast meta-population, the loss of which may impact on the long-term recovery of the species.

Summary
The proposal to develop Lot 1 DP357408 is likely to directly impact on a locally significant population of *Rutidosis heterogama*.

4.1.1.2 Assessment of Significance on ***Black-eyed Susan (Tetratheca juncea)****.*

Criteria 1. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.*

An "important" population is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

No individuals or populations of the species *Tetratheca juncea* were found in study area. However, plant clumps are known from other locations in Warnervale, and potentially could occur in the study area. Based on the extent of potential habitat within the study area, the likely size of the potential population would not, in isolation, be considered to constitute an 'important population'.

Criteria 2. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.*

No individuals or populations of the species *Tetratheca juncea* were found in study area. If a population is found to exist, the likely size of this population is considered to be small, based on the extent of suitable habitat. As such, any population within the study area would not be considered to constitute an 'important population', but may form part of a meta-population within the wider Warnervale area.

Criteria 3. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.*

The proposal for rezoning and development of the land is not likely to further fragment any populations of the species. Past land uses have resulted in the study area supporting fragmented patches of remnant forest.

Criteria 4. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.*

No individual plants of *Tetratheca juncea* were found in the study area. The extent of potential habitat critical to the survival of is very small within the study area, such that it is unlikely to significantly impact upon the regional extent of habitat of the species.

Criteria 5. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.*

No individuals or populations of *Tetratheca juncea* were found within the study area, and hence the rezoning and subsequent development of the study area is unlikely to disrupt the breeding cycle.

Criteria 6. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

No individual plants of Tetratheca juncea were found in the study area. The likely size of any potential population is considered to be small. Any reduction in population from development of the land is unlikely to modify, destroy, remove or isolate or decrease the extent of habitat such that the species would decline in the locality or region.

Criteria 7. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

Much of the study area is already fragmented and invaded by weed species. However, disturbance to the potential habitat that does exist for this species may introduce some invasive species, but they are not considered to represent species not already established in the area.

Criteria 8. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

No individuals or populations of *Tetratheca juncea* have been found in the study area. The potential population that could be supported by habitat within the study area is likely to be small, such that loss of that population would not interfere substantially with the recovery of the species.

Summary

The proposal is unlikely to impact (either directly or indirectly) on any potential populations of *Tetratheca juncea*. No individuals, or populations of the plant were identified within the study area. Seasonal targeted surveys for the species have failed to detect any individuals, despite their presence recorded in adjacent lands (pers. obs.). However, the proposed rezoning (and subsequent development of the land) is not considered likely to significantly impact upon the habitat of an 'important population' of *Tetratheca juncea.*

4.1.1.3 Assessment of Significance on ***Melaleuca biconvexa***

Criteria 1*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.*

An "important" population is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

No individuals or populations of the species *Melaleuca biconvexa* were found in study area. However, the species is known from other locations in Warnervale, and potentially could occur in the southern sections of the study area, off Virginia Road. Based on the extent of potential habitat within the study area, the likely size of the potential population would not, in isolation, be considered to constitute an 'important population'.

Criteria 2*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.*

No individuals or populations of the species *Melaleuca biconvexa* were found in study area. If a population is found to exist, the likely size of this population is considered to be small, based on the extent of suitable habitat. As such, any population within the study area would not be considered to constitute an 'important population', but may form part of a meta-population within the wider Warnervale area.

Criteria 3. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.*

The proposal for rezoning and development of the land is not likely to further fragment any populations of the species. Past land uses have resulted in the study area already supporting fragmented patches of remnant swamp forest.

Criteria 4*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.*

No individual plants of *Melaleuca biconvexa* were found in the study area. The extent of potential habitat critical to the survival of this species is very small within the study area, such that it is unlikely to significantly impact upon the regional extent of habitat of the species.

Criteria 5*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.*

No individuals or populations of *Melaleuca biconvexa* were found within the study area, and hence is unlikely to disrupt the breeding cycle. However, should the species be present it is most likely to occur in the swamp habitats in the south of the study area off Virginia Road. Development of this area will impact on the breeding cycle for the local population, but would not impact on the regional occurrence of the species.

Criteria 6*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

No individual plants of *Melaleuca biconvexa* were found in the study area. The likely size of any potential population is considered to be small, since available habitat is restricted. Any reduction in population from development of the land is unlikely to modify, destroy, remove or isolate or decrease the extent of habitat such that the species would decline in the locality or region.

Criteria 7. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

Much of the study area is already fragmented and invaded by weed species. However, disturbance to the potential habitat that does exist for this species may introduce some invasive species, but they are not considered to represent species not already established in the area.

Criteria 8. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

No individuals or populations of *Melaleuca biconvexa* have been found in the study area. The potential population that could be supported by habitat within the study area is likely to be small, such that loss of that population would not interfere substantially with the recovery of the species.

Summary

The proposal is unlikely to directly impact on populations of *Melaleuca biconvexa,* since suitable habitat is restricted to the extreme southern portion of the study area off Virginia Road. Approximately 19.84 hectares (or approximately 11.0% of the study area) is subject to flood inundation. Development of this area within the 1:100 year flood level is likely to be restricted, or no development, which may conserve habitat for the species.

*4.1.1.4 Assessment of Significance on **Green and Golden Bell Frog (Litoria aurea)**.*

Criteria 1. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.*

No individuals of the Green and Golden Bell Frog were found in study area during investigations for this study. No local populations are presently known to occur within the study area or locality. The species has not been recorded in the locality since 1994. Areas of potential habitat (small and larger dams) occur within the study area to suggest the likely presence of the species. The development of the land within the study area is not considered to impact significantly upon the potential habitat of the Green & Golden Bell Frog, such that it would lead to a long term decrease in the size of the local population. It is considered likely that potential habitat (small and larger dams) within the study area would be retained as storm water management structures following development of the land, which may provide habitat for the species in the longer term.

Criteria 2. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.*

No populations of the Green & Golden Bell Frog were found in the study area during surveys associated with this study, or previous surveys of the study area. The action is not considered to reduce the area of suitable habitat for the species.

Criteria 3. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.*

Known populations of the species are known from the Wyong Racecourse area, and the Wadalba area in the early 1990's. No recent populations of the species are known from the locality. The area of the proposed

Warnervale Town Centre is not situated such that it would fragment any adjoining populations of the species.

Criteria 4. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.*

The majority of the Warnervale Town Centre study area does not constitute habitat critical to the survival of the species. The dams and small soaks present may provide potential habitat for the species, but no evidence of the species was noted during investigations in both 2001 and 2003. It is envisaged that most of the potential habitat of the Green & Golden Bell Frog within the study area would be retained for stormwater management, and hence, provide potential long term habitat for the species.

Criteria 5. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.*

No breeding individuals or population found in, or near the study area during the study. The condition of areas of potential habitat within the study area appears suitable. However, no evidence of the species was noted during investigations for the species in both 2001 and 2003. The study area is considered unlikely to support breeding populations of the species.

Criteria 6. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

The proposal to rezone and subsequently develop the land within the study area may impact upon the quality of habitat within drainage lines. This may occur based on issues such as increased volume discharge and high sediment yields following development of the land.

Criteria 7. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

Most of the water bodies (dams, small drainage lines) of the study area appear absent of invasive species such as Mosquito Fish (*Gambusia holbrooki*). Factors considered to limit occupation of the study area by the Green & Golden Bell Frog is the absence of an important populations nearby. The only invasive species likely to impact upon the species is the Mosquito Fish. No evidence of the Mosquito Fish was observed during investigations, but that does not indicate the absence of the species from the system. Other factors such as clearing of habitat, and contraction of the Chytrid fungus, are also likely to have contributed to a decline in the species in the local area. The presence of the Chytrid fungus has been confirmed in the locality, which has recently been isolated from frogs collected from the Porters Creek Wetland (Dr. Michael Mahony, Uni. Newcastle, personal communications). The proposed rezoning and development of the land would not in itself contribute to the occurrence and spread of the Chytrid fungus between frog populations.

Criteria 8. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

The proposed action (i.e. the rezoning and subsequent development of the land within the Warnervale Town Centre) is not considered to interfere with the recovery of the species. Preservation of the small and larger dams within the study area may contribute toward the recovery of the species, subject to surviving individuals being present in the study, or local area.

Summary

The Green and Golden Bell Frog was not recorded during surveys for the species for this and previous investigations. The species is known from the local area, with records of the species known within 5km of the study area. Other known populations occur on land off Pollock Avenue, to the south of the study area (Payne, 1994). Much of the habitat within the study area is unsuitable for the Green and Golden Bell Frog.

4.1.1.5 Assessment of Significance on ***Grey-headed Flying-fox (Pteropus poliocephalus).***

An "important" population is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

Criteria 1*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.*

No individuals were recorded in the study area during investigations in October and November 2003. The species was also not recorded in the wider area during investigations undertaken in January 2001. No breeding colonies, or "camps" occur within the study area, such that development of the land would impact upon breeding habitat of the species. Removal of habitat by the subsequent development of the land is considered unlikely to impact on an 'important population', such that it would result in a long-term decrease of that population in the locality and region. However, the development of the land, with the associated clearing of native vegetation, will contribute to the cumulative loss of foraging resources for the species in the locality.

Criteria 2*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.*

The maximum extent of habitat that may be potentially cleared for development is 83 hectares. The loss of this habitat is unlikely to significantly impact upon the species, such that it would reduce the area of occupancy of an 'important population'.

Criteria 3*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.*

The Grey-headed Flying-fox is capable of traversing long distances between roost sites and foraging habitat, upwards of 50km per night. The clearing and subsequent development of land within the Warnervale Town Centre would not result in fragmentation of any populations of the species.

Criteria 4*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.*

The study area does not constitute habitat critical, as defined in the *EPBC Act 1999*. Therefore, the action is unlikely to adversely affect habitat critical to the survival of the species.

Criteria 5. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.*

No breeding individuals or population presently occur within, or near the Warnervale Town Centre.

Criteria 6*.* *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

Development of the Warnervale Town Centre will result in removal of up to 83 hectares of foraging habitat for the species. This action will contribute to a loss of habitat within the locality, but is unlikely to result in the decline of the species in the locality.

Criteria 7. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.*

Much of the study area within the proposed Warnervale Town Centre presently supports invasive species such as weeds. These invasive species are unlikely to impact on the Grey-headed Flying-fox.

Criteria 8. *An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.*

Factors interfering with the recovery of the Grey-headed Flying-fox are not associated with the study area.

Summary
The action (development of the Warnervale Town Centre) is unlikely to impact (either directly or indirectly) on local populations of the Grey-headed Flying-fox. No breeding or roost camps occur within, or in immediate vicinity of the study area. The species may forage within the study area during flowering of *Eucalyptus* and *Angophora* tree species. The proposed rezoning of land, and the subsequent development of that land, is not considered to impact upon an 'important population' of the Grey-headed Flying-fox.

4.1.2 Listed Migratory Species

The List of Migratory Species on the Environment Protection and Biodiversity Conservation Act 1999 that occur, or that could potentially occur within the study area, is presented below in Table 31.

Table 31. Listed Migratory Species that occur, or potentially occur within the study area.

FAMILY / *Scientific Name*	**Common Name**
ACCIPITRIDAE	
Pandion haliaetus	Osprey
Aviceda subcristata	Pacific Baza
Elanus axillaris	Black-shouldered Kite
Haliastur sphenurus	Whistling Kite
Haliaeetus leucogaster	White-bellied Sea-eagle
Circus approximans	Swamp Harrier
Accipiter fasciatus	Brown Goshawk
Accipiter novaehollandiae	Grey Goshawk
Accipiter cirrhocephalus	Collared Sparrowhawk
ANATIDAE	
Chenonetta jubata	Australian Wood Duck
Anas superciliosa	Pacific Black Duck
Anas gracilis	Grey Teal
Anas castanea	Chestnut Teal
Aythya australis	Hardhead
CHARADRIIDAE	
Elseyornis melanops	Black-fronted Dotterel
Vanellus miles	Masked Lapwing
FALCONIDAE	

FAMILY / *Scientific Name*	**Common Name**
Falco berigora	Brown Falcon
Falco longipennis	Australian Hobby
Falco peregrinus	Peregrine Falcon
Falco cenchroides	Nankeen Kestrel
CAMPEPHAGIDAE	
Coracina tenuirostris melvillensis	Cicadabird
CUCULIDAE	
Cuculus saturatus	Oriental Cuckoo
APODIDAE	
Hirundapus caudacutus	White-throated Needletail
MEROPIDAE	
Merops ornatus	Rainbow Bee-eater
RALLIDAE	
Rallus pectoralis clelandi	Lewin's Rail
MALURIDAE	
Stipiturus malachurus intermedius	Southern Emu-wren
MELIPHAGIDAE	
Xanthomyza phrygia	Regent Honeyeater

The assessment guidelines on significance for migratory species was applied to each of the species listed above in Table 31, and is presented below.

Criteria 1. *An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species.*

Disturbance and or clearing of vegetation communities and fauna habitats within the study area would not result in a significant impact upon the habitats of those migratory species listed above.

Criteria 2. *An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species.*

Much of the study area already supports invasive species, including heavy infestations of weeds such as Blackberry and Lantana. This is not considered to have significantly impacted on the migratory species indicated above.

Criteria 3. *An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.*

Disturbance and or clearing of vegetation communities and fauna habitats within the study area would not result in a significant impact upon the lifecycles of those migratory species listed above.

4.2 Environmental Planning and Assessment Act 1979

Any activity likely to have a significant effect on threatened species, populations and ecological communities, or their habitat, will require assessment under section 5A ("the eight point test")(or its amendments) of the *Environmental Planning and Assessment Act 1979* (as amended by the *Threatened Species Conservation Act 1995*).

4.2.1 Listed Threatened Species and Communities

Five threatened species have been identified within the study area during this and previous investigations of the study area. In addition, a number of additional threatened species are known from the local area (including the study site), or are considered likely to occur based on presence of suitable habitat. Those threatened species known, or likely to occur were listed in Tables 26, and an assessment on their potential occurrence was discussed in Tables 27 and 28. Only those species either recorded, or considered to have a moderate to high likelihood of occurrence in the study area were considered for assessment under Section 5A of the *EP&A Act*.

4.2.1.1 Rutidosis heterogama

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Potential development of the area supporting this species will disrupt the life cycle of those plants directly involved, and it may place the local (Warnervale-Charmhaven) population at risk of extinction. Seeds of *Rutidosis heterogama* are wind-dispersed, but probably occur at dispersal distances of less than 1 metre. The additional two known populations of this species (outside of the current study area) occur on privately owned land, and consequently the long term survival of the local population is at risk.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

Rutidosis heterogama is listed in NSW as Vulnerable on Schedule 2 of the TSC Act 1995. No endangered populations of this species are listed in the TSC Act, 1995 for the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The habitat in which *Rutidosis heterogama* has been found falls within the broad Dooralong Spotted Gum – Ironbark Forest, a vegetation type with an extant distribution of 824 ha in Wyong Shire (Bell 2002a). At present, the extent of known populations of the species within the region is 3 populations, of which the study area population is the largest (~1,000 plants) of the three Warnervale - Charmhaven populations.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

The three populations of *Rutidosis heterogama* in the Warnervale area occur between 1 and 2 km from each other. As a consequence, there appears to be no continuum of occurrence of the species, as each appears to exist as distinct entities. Any future development, and subsequent fragmentation of habitat, will not isolate the species any more than is current.

(e) whether critical habitat will be affected;

No critical habitat for *Rutidosis heterogama* is currently listed on the *Threatened Species Conservation Act 1995*.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

Rutidosis heterogama is currently not known from any conservation reserve on the Central Coast, nor in the Hunter Valley. There is some scope for the species to be present within the recent additions to Werakata National Park near Cessnock (Bell 2004), although clarification of final reserve boundaries is required. Further afield, Briggs and Leigh (1996) list this species as being adequately conserved in Bundjalung and Yuraygir National Parks, coastal reserves both of which occur on the far North Coast, on sand-based substrates. Other populations occur in Torrington State Conservation Area (L. Copeland, UNE, pers comm.) and Broadwater National Park.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to *Rutidosis heterogama* include:

- Clearing of native vegetation;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- Invasion of native plant communities by exotic perennial grasses.

The major threatening processes, clearing of native vegetation, operates within the Warnervale Town Centre study area. Development of the study area will result in further clearing of vegetation and habitat for this species. Invasion by exotic perennial grasses is a continuing threat in urban areas, and *Rutidosis heterogama* is in fact singled out as an example of a species impacted upon by this process in the determination. High frequency fire is unlikely to occur within the study area vicinity, due to the high visibility of the area in which *Rutidosis* occurs. This threat does, however, remain current as it is currently unknown how *Rutidosis* responds to fire.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Rutidosis heterogama currently reaches its southern known distributional limit within the study area, established during the current study. Two other populations are known within a 5km radius of Warnervale, one at Hakone Road and the other at Arizona Road. The nearest extant population outside of the Warnervale area is at Cooranbong in south-western Lake Macquarie.

This Section 5A assessment concludes that development of:

Lot 1 (DP357408)
Lot 152 (DP594725)

within the Warnervale Town Centre is **likely** to impact upon the local population of *Rutidosis heterogama*. Development of cleared allotments within the remainder of the Warnervale Town Centre is **unlikely** to impact upon the local population of the species.

4.2.1.2. Black-eyed Susan (Tetratheca juncea)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Clearing of habitat potentially supporting *Tetratheca juncea* will unavoidably disrupt the life cycle of this species should it be present. Records of *Tetratheca juncea* in the vicinity of the study area do exist, but they are sporadic.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

No endangered populations of *Tetratheca juncea* are listed in the TSC Act 1995.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

Tetratheca juncea reportedly occurs in a range of habitats. Payne (2000) has examined in detail several aspects of the ecology of this species, as part of the Lake Macquarie Conservation Management Plan. His study has revealed that *Tetratheca juncea* has a preference for ridgetops on south-east to south-westerly aspects on Munmorah Conglomerate geology and the Awaba soil landscape. Further, Payne (2000) states that the species primarily grows in dense undisturbed understorey vegetation, in open forest dominated by *Angophora costata, Corymbia gummifera, Eucalyptus haemastoma*, and *Eucalyptus capitellata*. However, the species is known from several other habitat types (see Table 2 in Payne, 2000; and also Payne, 1993; Winning, 1992; Kidd, 1991; Bartim & Martin, 1986), including Spotted Gum – Ironbark forests. NPWS (2000) have indicated that approximately 17,000ha of Coastal Foothills Spotted Gum – Ironbark Forest remains in the region, and hence the loss of approximately 15ha is not significant. Approximately 824ha of Dooralong Spotted Gum – Ironbark Forest occurs within Wyong Shire (Bell 2002b).

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Tetratheca juncea is not known from the study area, and is known only sporadically from the Warnervale vicinity. Suitable habitat is present in lands elsewhere in Warnervale, and hence isolation is unlikely.

(e) whether critical habitat will be affected;

No critical habitat has yet been declared for this species under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

Within the region, *Tetratheca juncea* occurs in at least six conservation reserves. These include Awabakal NR (<100 plants: Payne, 1993), Glenrock SRA (>1000 plants: Winning, 1992; Bell 1998b), Karuah NR (unknown population size: Bell 2002b), Lake Macquarie SRA (unknown population size: Bell, 1998a), Munmorah SRA (<400 plants: Payne, 1993), Wallaroo NR (unknown populations size: Bell 2002b). In addition, many populations of this species occur within secure conservation zonings within the relevant Council LEP's.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to *Tetratheca juncea* include:

- Clearing of native vegetation;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;

The major threatening processes of clearing of native vegetation operates within the Warnervale Town Centre study area. Development of the study area will result in the clearing of vegetation and habitat for this species. High frequency fire is unlikely to occur within the study area vicinity, due to the high visibility of the area to local residents.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Tetratheca juncea occurs in dry sclerophyll forests, sandy heaths and occasionally swampy heaths, from Bulahdelah to Lake Macquarie. Populations within the Wyong area can be considered as the southern limit of distribution, although historically the species also occurred from Port Jackson to Botany Bay, where it is most likely extinct (Gardner & Murray 1992). Recent records of the species (2001) exist for Charmhaven to the east (Bell 2002b).

This Section 5A assessment concludes that it is **unlikely** *Tetratheca juncea* will be impacted by the rezoning and proposed development of the Warnervale Town Centre.

4.2.1.3 Melaleuca biconvexa

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

No specimens of *Melaleuca biconvexa* were recorded on the Warnervale Town Centre study area. At this stage, planning for the future development of the Warnervale Town Centre is at the conceptual stage, and there is presently no plans for clearing of habitat. However, clearing of the habitat potentially supporting *Melaleuca biconvexa* would unavoidably disrupt the life cycle of this species. Records of *Melaleuca biconvexa* in the immediate local area do exist, specifically on the eastern side of Warnervale airport near Sparks Road (pers. obs.), and the species is common in alluvial swamp forests elsewhere in Wyong (Duncan 2001; Bell 2002b).

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

No endangered populations of *Melaleuca biconvexa* are listed in the TSC Act 1995.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

Melaleuca biconvexa occurs in a range of habitats within Wyong Shire, but most commonly within the Alluvial Bluegum-Paperbark Mesic Palm Forest (MU16) and the Alluvial Robusta-Paperbark Sedge Palm

Forest (MU17) of Bell (2002a). These habitats respectively occupy 493ha and 1,837ha within Wyong Shire (Bell 2002b), none of which is present within the current study area.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Melaleuca biconvexa is not known from the Warnervale Town Centre study area. However it does occur nearby on the eastern side of Warnervale airport on Sparks Road. If it is present in the study area, then it would occur within 2-4km from the nearest other known occurrence, and hence isolation is unlikely.

(e) whether critical habitat will be affected;

No critical habitat has yet been declared for this species under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

Within the region, *Melaleuca biconvexa* is not known from formal conservation reserves (Bell 2002b). However, the habitat in which it occurs includes areas of SEPP14 wetlands as well as secure conservation zonings within relevant Council LEP's (particularly Wyong and Gosford Councils).

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to *Melaleuca biconvexa* include:

- Clearing of native vegetation;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;

The major threatening processes of clearing of native vegetation, presently operates within the Warnervale Town Centre study area. Development of the study area will result in the clearing of vegetation and habitat for this species. High frequency fire is unlikely to occur within the study area vicinity, due to the high visibility of the area to local residents. The latter process is unlikely to impact on *Melaleuca biconvexa*, as fire is not common in moist swamp habitats.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Melaleuca biconvexa occurs from Jervis Bay to the Port Macquarie district, although the main population is within the Gosford-Wyong region (Duncan 2001; Wilson 2002). Any occurrence of the species within the proposed Warnervale Town Centre study area would therefore fall within the centre of its distribution.

This Section 5A assessment concludes that it is **unlikely** *Melaleuca biconvexa* will be impacted by the rezoning and proposed development of the Warnervale Town Centre.

4.2.1.4. Australasian Bittern (Botaurus poiciloptilus)

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Factors likely to disrupt the life cycle of the Australasian Bittern are loss or modification of wetland and riparian habitat, which provide foraging resources, roost and nest trees.

Foraging
The Australasian Bittern is a cryptic species occurring in shallow, freshwater or brackish wetlands vegetated with tall dense beds of reeds, sedges or rush species (Marchant and Higgins, 1990). The species is considered sedentary in permanent wetlands, but also known to utilise ephemeral wetlands as drought refuges, or during movements (Marchant and Higgins, 1990; Garnett, 1992).

Breeding
Limited data suggests breeding occurs between October to February in deep, densely vegetated freshwater swamps and pools (Marchant and Higgins, 1990).

The development of the Warnervale Town Centre is considered unlikely to directly impact upon potential habitat of the Australasian Bittern. Several small and medium sized dams occur along drainage lines within the study area. These dams may be utilised by the species as foraging and sheltering habitat. However, it is considered likely that these small dams would be retained for stormwater management, so it is anticipated there is no direct impact of habitat loss. Indirect impacts to these dams may include increased stormwater flows from the upstream catchment following development of the study area. This potential flooding is not considered to significantly disrupt the life cycle of a local population of the Australasian Bittern.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Australasian Bittern is listed as Vulnerable in NSW on Schedule 2 of the TSC Act 1995. No endangered populations of the Australasian Bittern are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The development of the Warnervale Town Centre is not anticipated to result in a net loss of potential habitat for the Australasian Bittern. Development of the study area may result in modification to potential habitat through increased water discharge from the impervious upstream catchment. However, this may be offset by an increase in stormwater management structures associated with development. Any loss or modification of potential habitat is unlikely to significantly impact upon the Australasian Bittern, particularly in relation to the extent of known habitat in the wider area, such as the Porters Creek Wetland complex.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

The development of the Warnervale Town Centre would not result in known, or potential habitat for the Australasian Bittern becoming isolated from interconnecting or proximate areas of habitat. No major wetlands or riparian areas occur within the study area to prevent isolation of habitat for the species.

(e) whether critical habitat will be affected;

No critical habitat for the Australasian Bittern is currently listed on the *Threatened Species Conservation Act 1995*.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

Most of the former habitat of the Australasian Bittern (ie, freshwater and estuarine wetlands) within the Sydney Bio-region has been modified or drained. Known conservation reserves in the Sydney Bio-region include Blue Mountains National Park, Hexham Swamp Nature Reserve and Kooragang Island Nature Reserve. However, within this system of reserves, the extent of known and suitable habitat is unknown. Within the Wyong Shire, the most significant habitat for the species is the Porters Creek Wetland, which does not occur in the existing system of conservation reserves on the Central Coast.

Although Garnett (1992) considers the species is known from numerous wetland reserves in New South Wales, the Australasian Bittern is not considered adequately represented in conservation reserves in the Sydney Bio-region.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes with relevance to the Australasian Bittern include:

- Clearing of native vegetation
- Predation by the Red Fox
- Predation by the Feral Cat

The major threatening processes, clearing of native vegetation presently occurs within the Warnervale Town Centre study area. As indicated above, it is anticipated that development of the study area would not impact directly upon loss of habitat for the Australasian Bittern, as most of its habitat (dams) would be retained as stormwater management structures.

Predation by the Red Fox and Feral Cat is unlikely to be significant.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Australasian Bittern is widespread, but considered scarce throughout New South Wales, except in the far north-west. The species is most numerous in the Murray - Darling basin and often recorded near the coast (Marchant and Higgins, 1990).

Records of the Australasian Bittern in the Wyong area are not at the limit of its known distribution in New South Wales.

This Section 5A assessment concludes that development within the Warnervale Town Centre is **unlikely** to impact upon the local population of the Australasian Bittern.

4.2.1.5 Glossy Black Cockatoo (Calyptorhynchus lathami)

The Glossy Black Cockatoo was not recorded by survey during investigations in 2003 or 2001. The species is known from 3 records within the locality, with records at Bushells Ridge, Watanobbi and Wyong River. The species may forage in parts of the study area, particularly on allotments with remnant vegetation supporting key foraging resources, particularly *Allocasuarina* and *Casuarina* trees.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Factors likely to disrupt the life cycle of the Glossy Black Cockatoo is loss or modification of forest and woodland habitat providing foraging resources, and mature trees with hollows as nest sites.

Foraging
Preferred habitat of the Glossy Black Cockatoo is eucalypt woodlands and forests associated with *Allocasuarina* and *Casuarina* species in the understorey. The primary food source throughout their range is the seed of *Allocasuarina* species, including *A. torulosa* and *A. littoralis* (Clout, 1989). The local distribution of Glossy Black Cockatoo reflect this scattered resource, as they are rarely recorded away from these stands (Clout, 1989). Observations of foraging bouts indicate the Glossy Black Cockatoo were selective in their choice of trees supporting cones, with trees containing higher densities of cones used (Clout, 1989). The species is considered characteristic in its selection for forests occurring on sites with low soil-nutrient status (State Forests of NSW, 1995).

Breeding
Mature tree with large hollows are required for nesting sites.

Development of the Warnervale Town Centre is considered unlikely to directly impact upon potential habitat of the Glossy Black Cockatoo. Foraging resources are plentiful on several allotments within the study area, particularly Lot 1 DP 357408. Several mature trees with hollows suitable as nesting sites were observed within the study area. However, the species is more commonly associated with forest and woodlands within the western portion of Wyong Shire, particularly the state forests and reserves in the ranges.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Glossy Black Cockatoo is listed in NSW as Vulnerable on Schedule 2 of the TSC Act 1995. No endangered populations of Glossy Black Cockatoo are listed for the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

At present the extent of habitat to be cleared for development of the Warnervale Town Centre is unknown. However, development of the Warnervale Town Centre will result in the loss of potential foraging habitat for the Glossy Black Cockatoo. Within the Sydney Bio-region, this is unlikely to be significant in relation to the extent of known habitat. However, within the Wyong Shire, the Glossy Black Cockatoo is modelled within the distribution class 2c, indicating the species preferred habitat is well represented in national parks in the bio-region (Smith *et al.,* 2002). The loss of about 83 hectares of habitat within the Warnervale Town Centre is unlikely to significantly impact upon the local population of the Masked Owl.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the Warnervale Town Centre may result in habitat for the Glossy Black Cockatoo becoming isolated from interconnecting or proximate areas of habitat. The study area has not been identified as a component of the Wyong Corridors Strategy, suggesting vegetation linkage to adjoining habitat may be reduced or lost in the longer term. The Glossy Black Cockatoo is capable of traversing open expanses of non-suitable habitat, with the higher quality habitat for the species occurring in the ranges in the western portion of the Shire. Development of the Warnervale Town Centre would not result in a local population becoming isolated from proximal populations, or individuals.

(e) whether critical habitat will be affected;

No critical habitat for the Glossy Black Cockatoo is currently listed on the *Threatened Species Conservation Act 1995*.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The Glossy Black Cockatoo has been recorded in a number of conservation reserves within the Sydney Bio-region. Populations of the species are known in several of the large conservation reserves including Wollemi National Park (492,220 hectares), Yengo National Park (165,449 hectares) and Goulburn River National Park (70,102 hectares). Several smaller reserves such as Dharug National Park, Brisbane Water National Park and Bouddii National Park, and State Forests in the region also support populations of the species.

The species is listed in Distribution Class 2c, indicating the species preferred habitat is well represented in national parks in the bio-region (Smith *et al.,* 2002).

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Glossy Black Cockatoo include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Competition from Feral Honeybees
- Removal of dead wood and dead trees.

Development of the Warnervale Town Centre may result in the clearing of potential habitat for the Glossy Black Cockatoo. This is unlikely to impact upon the extent of habitat in the locality, as more extensive areas of preferred habitat for the species occur in the system of State Forests and Conservation reserves in the ranges in the west of the Shire.

Competition from Feral Honeybees could result in nest sites being occupied by colonies of Feral Bees.

Removal of dead trees may reduce the availability of potential nesting sites in the locality. It is presently unknown if breeding records exist for the Glossy Black Cockatoo in the locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The distribution of the Glossy Black Cockatoo extends along the east coast and ranges from Victorian to Queensland border, also occurring inland as far as the Riverina and Pilliga region of NSW (Blakers *et al.,* 1984). Thinly distributed with highest population densities occurring in the coastal ranges and coast of northern New South Wales (Mount King Ecological Surveys 1992, State Forests of NSW, 1995). The Glossy Black Cockatoo is not at the limit of its known distribution in Wyong Shire.

This Section 5A assessment concludes that development within the Warnervale Town Centre is **unlikely** to impact upon the local population of the Glossy Black Cockatoo.

4.2.1.7 Masked Owl (Tyto novaehollandiae)

The Masked Owl was not recorded by survey during investigations in 2003, but an individual was recorded as a roadkill off Sparks Road Interchange in January 2001. The species is also known from records within the locality. A mature tree with a large vertical hollow was located and inspected within the study area, and appears to be a suitable roost site for the Masked Owl. The species would likely forage throughout the study area, particularly on allotments with remnant vegetation supporting prey species.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Factors likely to disrupt the life cycle of the Masked Owl within the Warnervale Town Centre study area is loss of mature trees that provide roost and nest sites for the species, and loss of their principal prey, ie. small to medium sized terrestrial mammals.

The loss of habitat, with relatively abundant foraging resources (small terrestrial mammals and birds), in addition to a number of potential nest and roost sites, may disrupt the life cycle of a local population of the Masked Owl. No evidence of the species was recorded during surveys for the species in 2001 and 2003, but the species utilises a large area for it's requirements (in excess of 1,000 hectares). It is considered likely the Warnervale Town Centre study area forms a component of a larger home range for the species. Development of the study area would not result in the local population being placed at risk of extinction, but the loss of habitat would contribute toward the reduction in suitable habitat within the locality for the Masked Owl.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Masked Owl is listed in NSW as Vulnerable on Schedule 2 of the TSC Act 1995. No endangered populations of Masked Owl are listed in the TSC Act, 1995 for the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

At present the extent of habitat to be cleared for development of the Warnervale Town Centre is unknown. However, development of the Warnervale Town Centre will result in the loss of habitat for the Masked Owl. Within the Sydney Bio-region, this is unlikely to be significant in relation to the extent of known habitat. However, within the Wyong Shire, the Masked Owl is modelled within the distribution class 2b, indicating the species whose preferred habitat is poorly represented in national parks in the bio-region (Smith *et al.,* 2002). The loss of habitat within the Warnervale Town Centre maybe offset to a degree by retention of remnant vegetation along natural drainage lines, which may retain small areas of foraging habitat for the local population of the Masked Owl.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the Warnervale Town Centre may result in habitat for the Masked Owl becoming isolated from interconnecting or proximate areas of habitat. The study area has not been identified as a component of the Wyong Corridors Strategy, suggesting vegetation linkage to adjoining habitat may be reduced or lost in the longer term. The Masked Owl is capable of traversing open expanses of non-suitable habitat, and has been documented utilising a mix of urban and bushland habitats as a component of its overall home range (Kavanagh and Murray, 1996). Development of the Warnervale Town Centre would not result in a local population becoming isolated from proximal populations, or individuals.

(e) whether critical habitat will be affected;

No critical habitat for the Masked Owl is currently listed on the *Threatened Species Conservation Act 1995*.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The Masked Owl has been recorded in a number of conservation reserves within the Sydney Bio-region. Populations of the species are known in several of the large conservation reserves including Wollemi National Park (492,220 hectares), Yengo National Park (165,449 hectares) and Goulburn River National Park (70,102 hectares). Several smaller reserves such as Dharug National Park, Brisbane Water National Park and Kuring-gai Chase National Park, and State Forests in the region also support populations of the species.

The species is listed in Distribution Class 2b of Smith *et al.,* (2002) for the Wyong Shire, indicating the preferred habitat of the Masked Owl is poorly represented in national parks in the bio-region.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Masked Owl include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Competition from Feral Honeybees
- Removal of dead wood and dead trees.

Development of the Warnervale Town Centre may result in the clearing of habitat for the Masked Owl. This is unlikely to impact upon the extent of habitat of the Masked Owl in the locality. However, a habitat tree was identified as potentially a roost (and possibly nest) tree for the species. Development of the study area would contribute to a reduction in local availability of potential, or actual roost and nest trees for the local population of the Masked Owl.

Competition from Feral Honeybees could result in tree roosts and nest sites of the species being lost by occupation by colonies of Feral Bees.

Removal of dead trees may reduce the availability of potential roost and nest sites for the Masked Owl in the locality. It is presently unknown if the species roosts or breeds within the study area.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

From data collected on the Masked Owl, it is primarily a species of coastal and sub-coastal open forests and woodlands and adjacent clearings, but extending far inland in riparian woodland with mature trees, and gorge country which provide caves for roost and sheltering sites (Debus, 1993). In 1994, there were 150 known localities of this species in New South Wales (Debus and Rose, 1994). Widespread surveys to target the occurrence of this species recorded the Masked Owl at only 7.1 per cent of 719 widely distributed sites in northern and south-eastern New South Wales (Kavanagh and Peake, 1993b; Kavanagh and Bamkin, 1995; Kavanagh *et al.,* 1995). The number of records, road kills and surveys suggest the Masked Owl is not as rare as commonly supposed, at least in coastal NSW, though nevertheless scarce (Debus and Rose, 1994).

The Masked Owl recorded in the wider Warnervale area is not at the limit of its known range.

This Section 5A assessment concludes that development of the allotments with remnant native vegetation would result in loss of foraging (and possibly nesting habitat) for the Masked Owl within the Warnervale Town Centre. Loss of habitat is **likely** to impact upon the local population of the Masked Owl through reduction in foraging resources and potential nest sites. Development of cleared and partially cleared lots in the remainder of the study area is **unlikely** to impact upon the local population of the species.

4.2.1.8 Powerful Owl (Ninox strenua)

The Powerful Owl was observed foraging on Lot 1 (DP 357408) in November 2003 during investigations for this study. A roost of the species was located on Lot 55 (DP 7527), and a habitat tree suitable as a nest tree for the species was also located on this lot. The species is considered to forage throughout the study area, particularly on allotments with remnant vegetation supporting prey species.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Factors likely to disrupt the life cycle of the Powerful Owl by development of the Warnervale Town Centre is loss of roost habitat and nest trees, and loss of their principal prey, ie. small to medium sized arboreal mammals such as possums and gliders. The extent of suitable habitat within the study area is about 100 hectares, with about 83 hectares suitable for development. This would constitute about 10% of the home range of a pair of Powerful Owls (~ 800 - 1,000 hectares). A number of mature trees with large hollows suitable as nesting sites occur within the study area, with a potential nest tree occurring on Lot 55 DP 7527. This tree has been identified as potential nest tree due to its proximity to an identified roost site. At this stage, it is unknown if additional nesting sites for the species occur within, or in proximity of the Warnervale Town Centre. Clearing of mature habitat trees with large hollows may impact on the local availability of breeding habitat for the species.

Further investigations are warranted during the breeding period (May – September) to confirm use of the study area as breeding habitat by the Powerful Owl. The loss of approximately 83 hectares of habitat, with relatively abundant foraging resources, may disrupt a portion of the life cycle of a local population of the Powerful Owl.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Powerful Owl is listed in NSW as Vulnerable on Schedule 2 of the TSC Act 1995. No endangered populations of Powerful Owl are listed in the TSC Act, 1995 for the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

At present, the extent of habitat to be cleared for development of the Warnervale Town Centre is unknown. The extent of suitable habitat for the Powerful Owl within the study area is about 102 hectares. Of the 102 hectares, at least 83 hectares of land could potentially be developed. Development of the Warnervale Town Centre will result in the loss of local habitat for the Powerful Owl. Within the Sydney Bio-region, this is unlikely to be significant in relation to the extent of known habitat. Within the Wyong Shire, the Powerful Owl is modelled within the distribution class 2c, indicating species whose habitat is well represented in national parks in the bioregion (Smith *et al.,* 2002). The Warnervale Town Centre has some scope for conservation of remnant vegetation, particularly along drainage lines, that may retain small areas of potential foraging habitat for the local population of the Powerful Owl.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the Warnervale Town Centre may result in habitat for the Powerful Owl becoming isolated from interconnecting or proximate areas of habitat. The study area has not been identified as a component of the Wyong Corridors Strategy, suggesting vegetation linkage to adjoining habitat may be reduced or lost in the longer term. The Powerful Owl is capable of traversing open expanses of non-suitable habitat, and individuals would not become isolated by development of the Town Centre. Extensive areas of habitat occur to the north of the study area, which extend to the Bushells Ridge Conservation Area. To the south-west, the Porters Creek Wetland supports habitat for the species, and an individual was observed in this area (Chris Thomson, Sinclair Knight Merz, personal communications).

(e) whether critical habitat will be affected;

No critical habitat for the Powerful Owl is currently listed on the *Threatened Species Conservation Act 1995*.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The Powerful Owl has been recorded in a number of conservation reserves within the Sydney Bio-region. Populations of the species are known in several of the large conservation reserves including Wollemi National Park (492,220 hectares), Yengo National Park (165,449 hectares) and Goulburn River National Park (70,102 hectares). Several smaller reserves such as Dharug National Park, Brisbane Water National Park and Kuring-gai Chase National Park, and State Forests in the region also support populations of the species.

The species is listed in Distribution Class 2c of Smith *et al.,* (2002) for the Wyong Shire, indicating the habitat of the Powerful Owl is well represented in national parks in the bio-region.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Powerful Owl include:

- Clearing of native vegetation;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- Predation by the Red Fox and Feral Cat, and
- Competition from Feral Honeybees.
- Removal of dead wood and dead trees.

The major threatening processes, clearing of native vegetation and competition from feral honeybees both operate within the Warnervale Town Centre study area. Development of the study area will result in the clearing of vegetation and habitat for the species. The Powerful Owl breeds in large hollows in mature trees, and would compete against the Feral Honeybee for occupancy of tree hollows.

The minor threat, high frequency fire, has not occurred in parts of the Warnervale Town Centre for a number of years, although is always a potential threat to the study area.

Predation by the Red Fox and Feral Cat is unlikely to be significant, but may reduce population abundance of some prey species.

Removal of dead trees may reduce the availability of potential nest sites for the Powerful Owl in the locality. It is presently unknown if the species breeds within the study area.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Within New South Wales, the Powerful Owl occurs in a broad coastal and subcoastal strip from the Queensland to Victorian border. The owl occurs at all altitudes less than 1,500 metres in eastern New South Wales, and is not restricted solely to mountain gullies associated with coastal sites compared to the drier inland sites (Debus and Chafer 1994).

The Powerful Owl in the Warnervale Town Centre is not at the limit of the species known range.

This Section 5A assessment concludes that development of the allotments presently supporting remnant native vegetation would result in loss of foraging (and possibly nesting habitat) for the Powerful Owl within the Warnervale Town Centre. The potential loss of a nest sites on Lot 1 DP 376264 (south of Hakone Road on disused Council quarry) requires further investigation to identify the significance of this tree to the local pair.

Development of cleared lots in the remainder of the study area is **unlikely** to impact upon the local population of the species.

4.2.1.9 Green and Golden Bell Frog (Litoria aurea)

No evidence of the Green & Golden Bell Frog has been recorded in the study area during this, and previous investigations, including historical records. Nevertheless, potential habitat has been identified within a number of small dams within the study area. Based on the presence of historical records in the locality (<5km radius), and potential habitat within the study area, the species was included for assessment.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

The Green and Golden Bell Frog is mainly an aquatic species occurring in a variety of conditions and habitats, including swamps, wetlands, marshes, rivers, streams, creeks, lakes, lagoons, ponds and farm dams (Cogger 1992, Pyke and White 1996). Breeding sites were significantly different in habitat to locations where the species has been found. A higher proportion of breeding sites occurred in ephemeral ponds rather than fluctuating or permanent ponds. Breeding success was also correlated with the absence of the predatory Mosquito Fish, which is recorded to predate on tadpoles of this species. A significant proportion of locations where Green and Golden Bell Frog occur have been disturbed or modified by human activities (Pyke and White 1996).

Individuals are usually found in areas with tall emergent vegetation such as Typha spp. and Eleocharis spp. (Markwell and Knight 1986). They are also locatable under debris on river flats which are frequently flooded, and has been recorded in habitats regarded as sub-optimal (Cogger 1992). The Green and Golden Bell Frog will also occasionally inhabit ornamental ponds and farm dams where these occur close to preferred habitat (Robinson 1994). Favoured water are usually in open areas which receive a large amount of sunlight (Greer 1994).

With regard to the study area, a number of small and medium sized dams were considered potential habitat for the species. The locations of all dams within the study area are presented above in Table 20. The Green and Golden Bell Frog was also recorded up until 1984 in the Porters Creek Wetland complex, but has not been recorded since that time.

Factors responsible for the decline of the species in the Wyong area would be consistent with those occurring throughout the range of the species. Within the study area, the Mosquito fish was noted to be absent from several of the dams inspected during the 2003 survey. The Chytridae fungus has also contributed to population decline, particularly in areas away from a maritime influence. This fungus has recently been isolated in several frog species occurring within the Porters Creek Wetland complex (Dr. Michael Mahony, Dept. Biological Sciences, University of Newcastle).

The absence of confirmed individuals or populations over the preceding 20-30 years suggests no populations exist within the study area. It is considered development of the Warnervale Town Centre is unlikely to disrupt the lifecycle of a local population of the species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

No consideration under this part of the assessment is required. No Endangered Populations of the Green and Golden Bell Frog relate to the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The development of the Warnervale Town Centre is not anticipated to result in a net loss of potential habitat for the Green & Golden Bell Frog. Development of the study area may result in modification to potential habitat through increased water discharge from the impervious upstream catchment. However, this may be offset by an increase in stormwater management structures associated with development.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

No areas of known habitat for the Green & Golden Bell Frog occurs within the Warnervale Town Centre study area. Development of the study area is unlikely to isolate populations from interconnecting or proximate areas of habitat.

(e) whether critical habitat will be affected;

No assessment under this part is required, as no declared critical habitat for the Green and Golden Bell Frog has been nominated in NSW.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is not considered to be adequately conserved in the current system of conservation reserves, as most known populations exist on private lands, or lands with no conservation zoning. The only known population within a conservation reserve in the Sydney Bio-region is Wambina Nature Reserve at Avoca, and Kooragang Island in the Hunter River. The species was known to occur within the Myall Lakes National Park in the North Coast bio-region.

The species is listed in Distribution Class 3b of Smith *et al.,* (2002) for the Wyong Shire, indicating the preferred habitat of the Green & Golden Bell Frog is poorly represented in the existing system of national parks in the bio-region.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes with relevance to the Green and Golden Bell Frog are listed below:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Clearing of native vegetation
- Predation by the Mosquitofish *Gambusia holbrookei*
- Predation by the Red Fox
- Predation by the Feral Cat
- Infection of frogs by amphibian chytrid causing the disease *Chytridiomycosis*

The threatening process alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands, would operate by development of the Warnervale Town Centre. At present, small ephemeral drainage lines drain in a southern direction from the main east west ridgeline off Hakone Road. These small drainage lines eventually drain into the Porters Creek Wetland system. Development of the study area will result in modification to the natural drainage flow, with channelling and concentration of water at specific drainage points. This is likely to modify the existing flow of water off-site, and possibly scouring and siltation of small creeks and wetlands downstream of development areas.

Predation by the Red Fox and Feral Cat is likely to impact on any local populations of the species. Development of the study area will likely increase the density of domestic cats, which may predate on any local populations of the species. Several of the small dams inspected indicated the absence of the Mosquito Fish, and efforts should be made to maintain areas free of the species.

The presence of the Chytrid fungus has been confirmed in the locality, which has recently been isolated from frogs collected from the Porters Creek Wetland (Dr. Michael Mahony, Uni. Newcastle, personal communications). The proposed rezoning and development of the land would not in itself contribute to the occurrence and spread of the Chytrid fungus between frog populations.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The species occurs at lower altitudes along eastern and south-eastern New South Wales from approximately Byron Bay to the Victorian border (Cogger 1992, Greer 1994, White and Pyke 1996). It is presently known from at least 43 coastal localities in New South Wales, with populations thought to be extinct in the southern tablelands of NSW and the ACT. During the period since 1990 the Green and Golden Bell Frog has apparently disappeared from at least 113 locations in New South Wales. The largest known extant populations of *Litoria aurea* in New South Wales occur in the Greater Sydney region, with only four locations within the state supporting populations of greater than 20 individuals (White and Pyke 1996).

The Green and Golden Bell Frog is not at the limit of its distribution in the Warnervale Town Centre study area.

This Section 5A assessment concludes that development within the Warnervale Town Centre is **unlikely** to impact upon the local population of the Green & Golden Bell Frog.

4.2.1.10 Wallum Froglet (Crinia tinnula)

A small chorus (<10 individuals) of the Wallum Froglet was heard calling in a small soak on Lot 1 DP 357408 (DIPNR land) in January 2001. No evidence of the species was heard at this site, or in any of the other survey sites during investigations in October and November 2003. The extent of habitat suitable for the species is considered limited within the majority of the study area. However, Lots 36, 40 and 44 DP 7091 (off the Virginia Road extension) support low swamp forest / sedge habitat that may provide habitat for the species. No evidence of calling adults or breeding sites was observed during October and November 2003 in this area.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

The potential effects/ impacts of development and the associated loss / modification of habitat on the lifecycle aspects of the Wallum Froglet is discussed below:

Foraging
The foraging habitat of the species has been discussed in detail by Payne (1996a). The species is associated with acid paperbark swamps and similar vegetation types. In the Vales Point and Munmorah areas, the species occurs in open graminoid heathland on clay loam soils that are seasonally wet. The species is considered to traverse to such habitats for breeding during wet periods.

Breeding / Shelter
The Wallum Froglet is an amphibian specialising in acid water conditions, although in Wyong it will tolerate a water pH up to 6.0 (Payne, 1997). One small congregation of less than 10 individuals was recorded within the study area during previous investigations (Payne and Murray, 2001). This population is likely to be small and relatively isolated from larger aggregations of the species, such as the Porters Creek Wetland to the south west. Potential breeding habitat may occur within the lots associated with the 1:100 year flood level, which supports Swamp Forest of *Allocasuarina sp.* and *Melaleuca sp*. However, this habitat is not the characteristic acid paperbark swamps where the species is more commonly encountered.

Development of the Warnervale Town Centre is not considered to disrupt the life cycles of a significant local population of the species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Wallum Froglet is listed in NSW as Vulnerable on Schedule 2 of the TSC Act 1995. No endangered populations of Wallum Froglet are listed in the TSC Act, 1995 for the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The majority of the Warnervale Town Centre study area does not support suitable habitat for the species, such that a significant area of known habitat is likely to be modified or removed. Areas of suitable habitat occur in the southern portion of the study area, which is unlikely to be developed due to flooding constraints. It is considered that development of the Warnervale Town Centre is unlikely to impact significantly upon the habitat of the species.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the Warnervale Town Centre is unlikely to impact upon suitable habitat for the Wallum Froglet. The small population on Lot 1 DP 357408 is not regarded as a significant local population of the species. Development of the Warnervale Town Centre area will not isolate populations of the Wallum Froglet.

The Warnervale Town Centre study area does not form part of the regional Wildlife Corridor Strategy. However, retention of remnant vegetation along the larger drainage lines will enable dispersal of adult and juvenile individuals into areas of more suitable habitat.

(e) whether critical habitat will be affected;

No critical habitat for the Wallum Froglet is currently listed on the *Threatened Species Conservation Act 1995*.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). There is presently no estimate on population size of the Wallum Froglet in the current system of conservation reserves. Populations of the species are known in several conservation reserves in the Sydney Bio-region, including Lake Munmorah State Conservation Area, Lake Macquarie State Conservation Area and Wyrrabalong Nature Reserve.

The species is listed in Distribution Class 2b of Smith *et al.,* (2002) for the Wyong Shire, indicating the preferred habitat of the Wallum Froglet is poorly represented in national parks in the Sydney bio-region.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes with relevance to the Wallum Froglet include the following:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Anthropogenic climate change
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation by the Mosquitofish *Gambusia holbrookei*
- Predation by the Red Fox
- Predation by the Feral Cat
- Infection of frogs by amphibian chytrid causing the disease *Chytridiomycosis*

The threatening process alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands, would operate by development of the Warnervale Town Centre. At present, small ephemeral drainage lines drain in a southern direction from the main east west ridgeline off Hakone Road, which eventually drain into the Porters Creek Wetland system. Development of the study area will result in modification to the natural drainage flow, with channelling and concentration of water at specific drainage points. This is likely to modify the existing flow of water off-site, and possibly scouring and siltation of small creeks and wetlands downstream of development areas.

Clearing of native vegetation may remove foraging and sheltering habitat for the species, although the extent of habitat for the Wallum Froglet within the study area is considered minimal.

Predation by the Red Fox and Feral Cat may impact on a small number of individuals in the local population.

Predation by the Mosquito-fish may impact on breeding and recruitment of juveniles into the population.

The presence of the Chytrid fungus has been confirmed in the locality, which has recently been isolated from frogs collected from the Porters Creek Wetland (Dr. Michael Mahony, Uni. Newcastle, personal communications). The proposed rezoning and development of the land would not in itself contribute to the occurrence and spread of the Chytrid fungus between frog populations.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Wallum Froglet is near the southern coastal limit of its distribution. The most southern population is known from Kurnell in Botany Bay. The northern limit of distribution in New South Wales is the Queensland border.

This Section 5A assessment concludes that development of the Warnervale Town Centre is **unlikely** to impact upon the local population of the Wallum Froglet.

4.2.1.11 Koala (Phascolarctos cinereus)

No evidence of Koala by spotlight and scat searches was recorded in either site. However, there are four records of Koala recorded during the period 1994 to 2003 within five kilometres of the Warnervale Town Centre. One record is near the disused Quarry site off Hakone Road in 1994(refer to Figure 7), another record near Mardi in 1994, and a recent record by Robert Payne in 2003 of an individual in the Porters Creek Wetland near the Warnervale Airport (Scott Duncan, personal communications, 2003). No potential habitat, as defined in SEPP 44 was identified within the study area.

Based upon the habitat and SEPP 44 Koala habitat assessment, it is considered the 1994 record of Koala recorded near the disused Quarry off Hakone Road in 1994 was a dispersing individual, possibly from the Porters Creek Wetland. The Porters Creek Wetland supports potential habitat for the species.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Factors likely to disrupt the life cycle of the Koala is clearing of habitat (foraging resources), fragmentation of habitat and isolation of populations.

Foraging
Koalas inhabit forests of medium to tall *Eucalyptus*, that is greater than 10 metres in height, with canopy cover between 10 and 70 percent and medium height forests with greater than 70 percent cover of *Eucalyptus* and rainforest genera (Reed *et al*, 1990). These forests occur on higher nutrient soils and are characterised by preferred feed trees. In New South Wales, koalas are associated with the following feed trees, Forest Red Gum (*Eucalyptus tereticornis*), Tallowwood (*E. microcorys*), Ribbon Gum (*E. viminalis*), Grey Gum (*E. punctata*) and River Red Gum (*E. camaldulensis*) (Reed *et al*, 1990). Swamp Mahogany (*E. robusta*) is also identified as a primary feed species. Within the study area, limited preferred feed trees exist to suggest the study area provides foraging habitat for the species.

Breeding
The koala is essentially a solitary animal, moving infrequently and living in a small area or group of trees within the available habitat for long periods or time (Mitchell, 1990). Estimates of home ranges in Victoria are 1.7 hectares for males and 1.18 hectares for females with extensive overlap (Mitchell, 1990). They occur in low densities and a breeding population may consist of as few as 5 or 6 individuals (Callaghan *et al*, 1994).

Fragmentation
One major barrier to dispersal of individual Koalas occurs within the study area, the Main Northern Railway. The fence along the length of the Main Northern Railway is considered to prevent movement of Koala. However, analysis of records of the Koala in the locality, and habitat assessment of the study area, indicate a significant local population of the species does not exist. It is considered the study area does not constitute part of a movement corridor between patches of preferred habitat.

Development of the Warnervale Town Centre will result in clearing of habitat, but this is considered unlikely to impact upon the life cycle of a local population of the Koala.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Koala is listed as Vulnerable in NSW on Schedule 2 of the *TSC Act 1995*. No endangered populations of the Koala are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

Analysis of records of the Koala in the locality, and habitat assessment of the study area, indicate a significant local population of the species does not exist. The study area does not support known habitat for the Koala. Development of the Warnervale Town Centre is unlikely to be significant in relation to the extent of known habitat in the Sydney Bio-region.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

No areas of known (or preferred) habitat were identified within the study area. Development of the Warnervale Town Centre is unlikely to isolate currently interconnecting or proximate areas of habitat for the Koala.

(e) whether critical habitat will be affected;

No critical habitat for the Koala is currently listed on the *Threatened Species Conservation Act 1995.*

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

Within the Wyong Shire, the Koala is modelled within the distribution class 3b, indicating the species preferred habitat is poorly represented in national parks in the bio-region (Smith *et al.,* 2002). Records of the species have been recorded in the following conservation reserves, Brisbane Water National Park, Dharug N.P., Wollemi and Yengo N.P., Watagans N.P. However, the size and status of these populations is largely unknown.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Koala include:

- Clearing of native vegetation

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation by the Red Fox

Development of the Warnervale Town Centre would result in the clearing of native vegetation (habitat), and is therefore a class of development or activity that is listed as a threatening process under the *Threatened Species Conservation Act 1995*.

High frequency fire will reduce foraging resources, and impact upon local populations by mortality of adult and juveniles.

The introduced Red Fox may predate on the Koala within study area, particularly juvenile Koalas.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Koala in NSW has a northern distribution limit at the Queensland border, and the southern distribution limit on the Victorian border. Inland, the species extends to the Pilliga.

The local Koala population recorded in the Warnervale area is not at the limit of the species known range.

This Section 5A assessment concludes that development of the Warnervale Town Centre is **unlikely** to impact upon the local population of the Koala.

4.2.1.12 Squirrel Glider (Petaurus norfolcensis)

The Squirrel Glider was captured at two sites within the Warnervale Town Centre study area during investigations for this study. The species was also recorded in 1999 as part of the Wyong Sub-regional Squirrel Glider study (Smith, 2000), and observed by spotlight on the DIPNR land west of the Main Northern Railway in January 2001. One glider was captured near Site 2 of this study, and also recorded by spotlight searches in 1999 and 2003.

To assist in the impact assessment of development of the Warnervale Town Centre on the Squirrel Glider, the *Interim Ecological Assessment Information required to Assess Clearing Impacts within Squirrel Glider Habitat in Wyong Shire* (Wyong Shire Council, August 2000) were referred to. This assessment is reproduced in Appendix 4 of this document.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Factors likely to disrupt the life cycle of the Squirrel Glider is clearing of habitat (foraging resources and habitat trees as den sites), fragmentation of habitat and isolation of populations.

Foraging

Within the Wyong Shire, Smith (2000) rated the foraging habitat of the Squirrel Glider based on the vegetation assemblages. The Spotted Gum / Ironbark / Gum habitat in the northern part of the study area is rated as optimal in relation to glider density. In contrast, the Scribbly Gum / Smooth-barked Apple / Red Bloodwood Forest with banksia understorey occurring in the central part of the study area is considered to support lower density of gliders per hectare (Smith, 2002). The Swamp Forest and Low Swamp Woodland are not considered to provide habitat for the Squirrel Glider, and no evidence of the species was recorded by surveys for the species.

Breeding
The Squirrel Glider is dependent upon mature trees with hollows to provide shelter and breeding sites. Within the majority of the study area, apart from the Swamp Forest and Low Swamp Woodland in the southern portion of the study area, mature trees with hollows were present.

Fragmentation
Two major barriers to dispersal of individual gliders occur within the study area. Sparks Road is considered to isolate sub-populations of the Squirrel Glider, one to the north and south of Sparks Road. The Main Northern Railway also divides sub-populations between the western and eastern portion of the study area. Smith (2000) identified a distance of 50 metres as a potentially isolating distance for the Squirrel Glider. However, the habitat of each sub-population is presently continuous with remnant vegetation outside of the study area.

Development of the study area will result in clearing of habitat that could potentially further fragment populations of the species. The small population within Lots 7 DP 739910 and Lot 1 DP 781737 south of Sparks Road is potentially isolated from adjoining populations by areas of unsuitable habitat (Low Swamp Woodland and Swamp Forest).

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Squirrel Glider is listed as Vulnerable in NSW on Schedule 2 of the *TSC Act 1995*. No endangered populations of the Squirrel Glider are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

At present the extent of habitat to be cleared for development of the Warnervale Town Centre is unknown. However, development of the Warnervale Town Centre will result in the loss of habitat for the Squirrel Glider. Within the Sydney Bio-region, this is unlikely to be significant in relation to the extent of known habitat. However, within the Wyong Shire, the Squirrel Glider is modelled within the distribution class 1a, indicating the minimum viable population size and habitat has been quantified (Smith *et al.,* 2002). However, the Wyong Conservation Plan was not adopted by Wyong Council, hence, the species habitat within the Shire remains unsecured. The potential loss of about 83 hectares of habitat by development of the Warnervale Town Centre may result in the loss of a local population.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

As indicated in test (a) above, two major barriers to dispersal of individual gliders occur within the study area. Sparks Road is considered to isolate sub-populations of the Squirrel Glider, one to the north and south of Sparks Road. The Main Northern Railway also divides sub-populations between the western and eastern portion of the study area. Smith (2000) identified a distance of 50 metres as a potentially isolating distance for the Squirrel Glider. However, the habitat of each sub-population is presently continuous with remnant vegetation outside of the study area.

Development of the study area will result in clearing of habitat that could potentially further fragment populations of the species. The small population within Lots 7 DP 739910 and Lot 1 DP 781737 south of Sparks Road is potentially isolated from adjoining populations by areas of unsuitable habitat (Low Swamp Woodland and Swamp Forest).

Development of Lot 1 DP 357408 (DIPNR land) may also isolate a sub-population of the species from habitat to the north. Clearing of habitat within lots off Bruce Crescent, in concert with development of the Town Centre, may remove existing linkage to larger sub-populations to the north of Lot 1 DP 357408.

(e) whether critical habitat will be affected;

No critical habitat for the Squirrel Glider is currently listed on the *Threatened Species Conservation Act 1995.*

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The Squirrel Glider is considered to be one of the least represented species in protected areas within the Wyong Shire (Smith *et al.,* 2002). Within the Sydney Bio-region, the species is considered inadequately reserved in the current system of conservation reserves. Populations of the species in the Wyong Shire are known from Wyrrabalong Nature Reserve, Lake Munmorah State Conservation Area and Lake Macquarie Foreshore Park. One of the strategies of the Wyong Conservation Plan was to secure and protect significant areas of habitat for the Squirrel Glider (and other protected and threatened species). As a consequence of the failure to adopt the Wyong Conservation Plan, the habitat of the species remains unsecured.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Squirrel Glider include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Invasion of native plant communities by Bitou Bush
- Predation by the Red Fox
- Predation by the Feral Cat
- Competition from Feral Honeybees
- Removal of dead wood and dead trees

Development of the Warnervale Town Centre would result in the clearing of native vegetation (habitat), and is therefore a class of development or activity that is listed as a threatening process under the *Threatened Species Conservation Act 1995*.

The introduced Red Fox and Feral Cat may be a significant introduced predator on the Squirrel Glider within study area, particularly when the gliders forage low to the ground on low *Banksia* or *Acacia* shrubs, or are required to cross areas of open grassland or across roads, between patches of remnant vegetation.

Competition for natural and artificial hollows occurs between the introduced Feral Honeybee and the Squirrel Glider. The extent of occupation of Feral Honeybees in natural tree hollows can be quite high in remnant forest.

Removal of dead trees may reduce the availability of potential den sites for the Squirrel Glider in the study area and locality.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Squirrel Glider is patchily distributed along Great Dividing Range, inland to Pilliga and Coonabarabran, and along the coastal region from south of Sydney to the Queensland border.

The Squirrel Glider recorded in the Warnervale Town Centre is not at the limit of the species known range.

This Section 5A assessment concludes that development of allotments presently supporting remnant vegetation will result in loss of foraging and roosting habitat for the Squirrel Glider. Loss of habitat is **likely** to impact upon the local population of the Squirrel Glider through reduction in foraging resources, den sites and fragmentation of sub-populations.

Development of cleared allotments in the remainder of the study area is **unlikely** to impact upon the local sub-populations of the species.

4.2.1.13 Grey-headed Flying-fox (Pteropus poliocephalus)

The remnant vegetation within the Warnervale Town Centre study area constitutes foraging habitat for the Grey-headed Flying-fox, particularly during the flowering periods of eucalypt and angophora tree species. However, this use is dependent upon the seasonal availability of this resource, which is likely be limited to several months of the year.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

The Grey-headed Flying-fox was not recorded in the study area during this study, or previous investigations in 1991 (Payne and Murray, 2001). However, the species has been recorded in the locality (<5 km radius) (NPWS Atlas, June 2004). Therefore, use of the study area by this species would be for foraging during the flowering periods of particular tree species.

Threats affecting the Grey-headed Flying-fox in the study area is related to the loss of habitat by past clearing, which has reduced the extent of foraging resources. Important aspects of the lifecycles of the Grey-headed Flying-fox include foraging, roosting, breeding and movement/ dispersal. The impact of development of the Warnervale Town Centre on the lifecycle of the Grey-headed Flying-fox is discussed below:

Foraging

The Grey-headed Flying-fox prefers foraging on the blossom of eucalypts and other native trees, as well as native fruiting trees (including figs, palms, and other rainforest trees). They are also adapted to foraging on the nectar of cultivated and landscaped plants, such as banana and palm flowers, and feed on cultivated fruits, including orchards. They generally commute daily to foraging areas, mostly within 15 kilometres of their camping site, but some individuals may travel for up to 50 kilometres between camps and foraging areas.

The study area is utilised by foraging fruit-bats during flowering periods of each tree species. During investigations in October and November 2003, and previously in January 2001, no flowering trees were evident. The use of this resource is expected to be limited in duration due to the seasonal abundance of nectar and pollen. Therefore, development of the study area is not considered likely to affect the foraging behaviour of the local Grey-headed Flying-fox population.

Roosting/ Breeding
Individuals require closed canopy communities, often near water for roosting. Within the study area, there is no known or likely roosting habitat for this species. As breeding is restricted to maternity camps, it is not expected that the breeding behaviour of any local populations would be impacted.

Movement
The species moves widely across the landscape between roost and foraging areas and between camps. These movements may involve daily flights of up to 50 kilometres, and seasonal movements of many hundreds of kilometres. These movements may include movements across urban areas, grassland or cleared landscapes. Development of the study area would not disrupt or cause the modification of movement dynamics of this species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Grey-headed Flying-fox is listed as Vulnerable in NSW on Schedule 2 of the *TSC Act 1995*. No endangered populations of the Grey-headed Flying-fox are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

No camps occur within the study area. The maximum extent of habitat that may be modified by development of the Warnervale Town Centre is 83 hectares, which is small when considering the movement and foraging dynamics of this species, and the resources available in the local area and region. The resources provided by larger areas of open and closed forest remnants in the locality and Sydney Bio-region provides extensive areas of foraging habitat. Therefore, the study area is not considered regionally significant habitat.

Development of the Warnervale Town Centre is not expected to result in the modification of a regionally significant area of habitat for the Grey-headed Flying-fox.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

The species is adapted to moving up to 50 kilometres through various habitat types to access feeding areas from camps, and can move hundreds of kilometres during seasonal movement patterns. Development of the study area is not likely to interrupt or modify movement dynamics of local populations of this species.

(e) whether critical habitat will be affected;

No critical habitat for the Grey-headed Flying-fox is currently listed on the *Threatened Species Conservation Act 1995.*

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is subjected to pressures from deliberate and illegal persecution, and is sensitive to a range of threatening processes that are probably not managed.

Populations of the species are known in several of the large conservation reserves including Blue Mountains National Park (264,850 hectares), Wollemi National Park (492,220 hectares), Yengo National Park (165,449

hectares) and Goulburn River National Park (70,102 hectares). Several smaller reserves such as Dharug National Park, Brisbane Water National Park and Kuring-gai Chase National Park, and State Forests in the region also support populations of the species.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Grey-headed Flying-fox include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Competition from Feral Honeybees

Development of the Warnervale Town Centre would result in the clearing of native vegetation (habitat), and is therefore a class of development or activity that is listed as a threatening process under the *Threatened Species Conservation Act 1995*.

High frequency fire may modify and disrupt the floristics and structure of foraging areas. Development of the Warnervale Town Centre would not increase the incidence of high frequency fire because the majority of existing habitat would be cleared, resulting in large areas with very low fuel loads.

The Feral Honeybee may compete with the Grey-headed Flying-fox for foraging resources (nectar).

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Grey-headed Flying-fox occurs through the coastal belt from Rockhampton to Melbourne. It is occasionally reported from land to the west of the Great Dividing Range, and is not at its limit of distribution in the study area.

This Section 5A assessment concludes that development of the Warnervale Town Centre is **unlikely** to impact upon the local population of the Grey-headed Flying-fox.

4.2.1.14 Eastern Freetail Bat (Mormopterus norfolkensis)

The study area provides the following values for the Eastern Freetail Bat, remnant forest providing foraging habitat for the species, and potential roost sites in large mature trees with hollows. The species was not detected in the study area by two surveys in October and December 2003, nor previously in January 2001. However, the species has been recorded in the locality (<5km radius) (NPWS Atlas, June 2004, Wyong Fauna Database).

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

The Eastern Freetail Bat has been recorded in the study area and locality. Use of the study area by the Eastern Freetail Bat would be foraging and potentially roost and maternity sites, as a number of large mature trees (particularly Spotted Gum) with hollows may be utilised.

The key threat affecting the Eastern Freetail Bat is related to the extent of clearing of native vegetation in the past, which has reduced the extent of remnant vegetation in the study area. Important aspects of the

lifecycles include foraging, roosting, breeding and movement/ dispersal. The impact of development of the Warnervale Town Centre on the lifecycle of the Eastern Freetail Bat is discussed below:

Foraging
The Eastern Freetail Bat forages in open forest and woodland, which is present in the study area. The species may be resident within the study area, or its occurrence associated with foraging. The extent of seasonal usage of the study area for the species is presently unknown.

Roosting/ Breeding
Individuals require large mature trees with hollows for roosting. Within the study area, this resource is present in the northern portion of the study area, including Lot 1 357408 (DIPNR land), and the lots off Hakone Road along the ridgeline. Development of the study area may reduce the abundance of roosting habitat. Breeding is restricted to small clusters of individuals, and the breeding behaviour of a local population may be impacted.

Movement
The species moves widely across the landscape between roost and foraging areas, and between regions. These movements may include movements across urban areas, grassland or cleared landscapes. Development of the Warnervale Town Centre is unlikely to disrupt, or cause modification of movement dynamics of this species.

In summary, development of the Warnervale Town Centre may impact upon the roosting and breeding behaviour of the Eastern Freetail Bat by loss of roost and breeding habitat.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Eastern Freetail Bat is listed as Vulnerable in NSW on Schedule 2 of the *TSC Act 1995*. No endangered populations of the Eastern Freetail Bat are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The extent of habitat that may be modified by development of the Warnervale Town Centre is 83 hectares. However, this is unlikely to be significant when considering the movement and foraging dynamics of this species, and the resources available in the local area and region. The resources provided by larger areas of forest remnants in the locality and Sydney Bio-region provides extensive areas of foraging habitat. Therefore, the study area is not considered regionally significant habitat.

Development of the Warnervale Town Centre is not expected to result in the modification of a regionally significant area of habitat for the Eastern Freetail Bat.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the Warnervale Town Centre is unlikely to interrupt or modify movement dynamics of local populations of this species. The study area does not form part of a local corridor network between adjacent large remnants presently being considered by Wyong Council.

(e) whether critical habitat will be affected;

No critical habitat for the Eastern Freetail Bat is currently listed on the *Threatened Species Conservation Act 1995.*

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The conservation status of the Eastern Freetail Bat in the Sydney bio-region is unknown. The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is subjected to pressures from habitat clearing for agricultural activities and urban expansion. Within Wyong Shire, the Eastern Freetail Bat is modelled within the distribution class 2c, indicating the species preferred habitat is well represented in national parks in the bio-region (Smith *et al.,* 2002).

Populations of the species are known in several of the large conservation reserves in the Sydney Bio-region, including Blue Mountains National Park (264,850 hectares), Wollemi National Park (492,220 hectares), Yengo National Park (165,449 hectares) and Goulburn River National Park (70,102 hectares). Several smaller reserves such as Dharug National Park, Brisbane Water National Park and Kuring-gai Chase National Park, and State Forests in the region also support populations of the species.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Eastern Freetail Bat include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Competition from Feral Honeybees
- Removal of dead wood and dead trees

Development of the Warnervale Town Centre would result in the clearing of native vegetation (habitat), and is therefore a class of development or activity that is listed as a threatening process under the *Threatened Species Conservation Act 1995*.

High frequency fire may modify and disrupt the floristics and structure of foraging areas, and destroy potential roost sites in dead stags and tree hollows. However, development of the Warnervale Town Centre would not increase the incidence of high frequency fire, as the majority of study area would be cleared of vegetation, resulting in large areas with very low fuel loads.

Competition for natural and artificial hollows is likely to occur between the introduced Feral Honeybee and the Eastern Freetail Bat. The extent of occupation of Feral Honeybees in natural tree hollows can be quite high in remnant forest.

Removal of dead trees may reduce the abundance of roost trees utilised by the Eastern Freetail Bat in the study area and locality. Felling of dead trees may also result in mortality of roosting individuals of the species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Eastern Freetail Bat occurs along the coastal belt east of the Great Dividing Range, from south of Sydney to the Queensland border (Klippel, 1992). It is occasionally reported from land to the west of the Great Dividing Range. It is not at its limit of distribution in the study area.

This Section 5A assessment concludes that development of allotments presently supporting remnant vegetation is **likely** to impact upon the local population of the Eastern Freetail Bat, through loss of foraging habitat, and loss of mature trees with hollows as roost and breeding sites.

Development of the cleared lots within the remainder of the Warnervale Town Centre study area is **unlikely** to impact upon the local population of the species.

4.2.1.15 Eastern Bent-wing Bat (Miniopterus schreibersii)

The Eastern Bent-wing Bat was not recorded in the study area during these investigations, but has been recorded in the locality (<5 km radius) (NPWS Atlas, June 2004). It is anticipated that use of the study area by the Eastern Bent-wing Bat is for foraging only, as the study area does not support any suitable attributes (ie. caves, culverts, etc), which could be utilised as roosting sites.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Important aspects of the lifecycles of the Eastern Bent-wing Bat include foraging, roosting, breeding and movement/ dispersal. The potential effects/ impacts of the development of the Warnervale Town Centre on these lifecycle aspects is discussed below:

Foraging
The Eastern Bent-wing Bat forages in open forest woodland and open spaces adjoining remnant forest, and is considered to utilise the study area by foraging individuals. The species was not recorded during surveys for this report, but has been recorded in the locality. Development of the Warnervale Town Centre, which will result in the loss of foraging habitat, is unlikely to impact on the local population of the Eastern Bent-wing Bat.

Roosting/ Breeding
Individuals require caves and similar structures (ie. culverts) for roosting. Within the study area, there is no known or likely roosting habitat for this species. Development of the Warnervale Town Centre would not impact on roosting resources. As breeding is restricted to maternity caves, it is not expected that the breeding behaviour of any local populations would be impacted.

Movement
The species forages relatively widely across the landscape between roost and foraging areas. These movements may include movements across urban areas, grassland or cleared landscapes. Development of the study area would not disrupt or cause the modification of movement dynamics of this species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Eastern Bent-wing Bat is listed as Vulnerable in NSW on Schedule 2 of the *TSC Act 1995*. No endangered populations of the Eastern Bent-wing Bat are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The extent of habitat that may be modified by development of the Warnervale Town Centre is 83 hectares. However, this is unlikely to be significant when considering the movement and foraging dynamics of this species, and the resources available in the local area and region. The extent of resources in larger forest

remnants in the locality and Sydney Bio-region, provide extensive areas of foraging habitat for the species. Therefore, the study area is not considered regionally significant habitat for the Eastern Bent-wing Bat.

Development of the Warnervale Town Centre is not expected to result in the modification of a regionally significant area of habitat for the Eastern Bent-wing Bat.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the study area is not likely to interrupt or modify movement dynamics of local populations of this species. Development would remove foraging habitat for the species, but would not alter the local movement dynamics of the species. The study area does not form part of a local corridor network between adjacent large remnants presently being considered by Wyong Council.

(e) whether critical habitat will be affected;

No critical habitat for the Eastern Bent-wing Bat is currently listed on the *Threatened Species Conservation Act 1995.*

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The conservation status of the Eastern Bent-wing Bat in the Sydney bio-region is poorly known. The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is subjected to pressures across its regional distribution from habitat clearing for agricultural activities and urban expansion, and disturbance to nursery caves and roost sites.

Populations of the species are known in the smaller coastal conservation reserves in the Wyong Shire and Sydney Bio-region, including Brisbane Water National Park, Kuring-gai Chase National Park, Wyrrabalong Nature Reserve and Munmorah State Conservation Area. Within Wyong Shire, the Eastern Bent-wing Bat is modelled within the distribution class 2c, indicating the species preferred habitat is well represented in national parks in the bio-region (Smith *et al.,* 2002).

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Eastern Bent-wing Bat include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

Development of the Warnervale Town Centre would result in the clearing of native vegetation (habitat), and is therefore a class of development or activity that is listed as a threatening process under the *Threatened Species Conservation Act 1995*.

High frequency fire may modify and disrupt the floristics and structure of foraging areas. However, development of the Warnervale Town Centre would not increase the incidence of high frequency fire, as the majority of study area would be cleared of vegetation, resulting in large areas with very low fuel loads.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Eastern Bent-wing Bat occurs from the Queensland to Victorian border, extending from the coast to the Great Dividing Range (Strahan 1995). It is not at its limit of distribution in the study area.

This Section 5A assessment concludes that development of the Warnervale Town Centre is **unlikely** to impact upon the local population of the Eastern Bent-wing Bat.

4.2.1.16 Little Bent-wing Bat (Miniopterus australis)

The Little Bent-wing Bat has been recorded in the locality (<5 km radius) (NPWS Atlas, June 2004). It is anticipated that use of the study area by the Little Bent-wing Bat is for foraging only, as the study area does not support any suitable attributes (ie. caves, culverts, etc), which could be utilised as roosting sites.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

Important aspects of the lifecycles of the Little Bent-wing Bat include foraging, roosting, breeding and movement/ dispersal. The potential effects/ impacts of the development of the Warnervale Town Centre on these lifecycle aspects is discussed below:

Foraging
The Little Bent-wing Bat forages in open forest woodland and open spaces adjoining remnant forest, and is considered to utilise the study area by foraging individuals. The species was not recorded during surveys for this report, but has been recorded in the locality. Development of the Warnervale Town Centre, which will result in the loss of foraging habitat, is unlikely to impact on the local population of the Little Bent-wing Bat.

Roosting/ Breeding
Individuals require caves and similar structures (ie. culverts) for roosting. Within the study area, there is no known or likely roosting habitat for this species. Development of the Warnervale Town Centre would not impact on roosting resources. As breeding is restricted to maternity caves, it is not expected that the breeding behaviour of any local populations would be impacted.

Movement
The species forages relatively widely across the landscape between roost and foraging areas. These movements may include movements across urban areas, grassland or cleared landscapes. Development of the study area would not disrupt or cause the modification of movement dynamics of this species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

The Little Bent-wing Bat is listed as Vulnerable in NSW on Schedule 2 of the *TSC Act 1995*. No endangered populations of the Little Bent-wing Bat are listed in the Wyong Shire.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The extent of habitat that may be modified by development of the Warnervale Town Centre is 83 hectares. However, this is unlikely to be significant when considering the movement and foraging dynamics of this species, and the resources available in the local area and region. The foraging resource within larger forest remnants in the locality, and within the Sydney Bio-region, provides extensive areas of foraging habitat for

the species. Therefore, the study area is not considered regionally significant habitat for the Little Bent-wing Bat.

Development of the Warnervale Town Centre is not expected to result in the modification of a regionally significant area of habitat for the Little Bent-wing Bat.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Development of the study area is not likely to interrupt or modify movement dynamics of local populations of this species. Development would remove foraging habitat for the species, but would not alter the local movement dynamics of the species. The study area does not form part of a local corridor network between adjacent large remnants presently being considered by Wyong Council.

(e) whether critical habitat will be affected;

No critical habitat for the Little Bent-wing Bat is currently listed on the *Threatened Species Conservation Act 1995.*

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The conservation status of the Little Bent-wing Bat in the Sydney bio-region is poorly known. The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is subjected to pressures across its regional distribution from habitat clearing for agricultural activities and urban expansion, and disturbance to nursery caves and roost sites.

Populations of the species are known in the smaller coastal conservation reserves in the Wyong Shire and Sydney Bio-region, including Brisbane Water National Park, Kuring-gai Chase National Park, Wyrrabalong Nature Reserve and Munmorah State Conservation Area. Within Wyong Shire, the Little Bent-wing Bat is modelled within the distribution class 2c, indicating the species preferred habitat is well represented in national parks in the bio-region (Smith *et al.,* 2002).

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes listed on the *Threatened Species Conservation Act 1995* with relevance to the Little Bent-wing Bat include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

Development of the Warnervale Town Centre would result in the clearing of native vegetation (habitat), and is therefore a class of development or activity that is listed as a threatening process under the *Threatened Species Conservation Act 1995*.

High frequency fire may modify and disrupt the floristics and structure of foraging areas. However, development of the Warnervale Town Centre would not increase the incidence of high frequency fire, as the majority of study area would be cleared of vegetation, resulting in large areas with very low fuel loads.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Little Bent-wing Bat populations on the Central Coast are approaching the southern limit of the species in New South Wales. The distribution extends from the Queensland border to approximately Sydney, being restricted to the coastal plain and lower foothills.

This Section 5A assessment concludes that development of the Warnervale Town Centre is **unlikely** to impact upon the local population of the Little Bent-wing Bat.

4.2.1.17 Large-footed Myotis (Myotis adversus)

The Large-footed Myotis is a cave roosting bat which has been recorded in colonies of 10 to 15 individuals, and occasionally hundreds. Roosts are typically caves, mines or tunnels, under bridges and buildings, dense foliage and occasionally tree hollows. These roost sites are typically in close proximity to water, ranging from rainforest streams to large lakes and reservoirs (Richards, 1995). The Large-footed Myotis forages over the surface of smooth water to catch large aquatic insects and small fish (Ferrier *et al*, undated).

The Warnervale Town Centre study area provides foraging habitat in several of the larger dams and along drainage lines, and in remnant open forest.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

The key threats affecting the Large-footed Myotis with relation to further development of the Warnervale Town Centre study area is loss of foraging habitat, and potentially loss of roost sites in large mature trees with hollows.

Important aspects of the lifecycles of the Large-footed Myotis include foraging, roosting, breeding and movement / dispersal. The potential impacts / effects of further development of the study area on the lifecycle aspects is discussed below.

Foraging
The Large-footed Myotis forages over the surface of smooth water to catch large aquatic insects and small fish, and is seldom captured far from bodies of water such as creeks, rivers, dams and lakes. Suitable foraging habitat for the species exists within the study area, with a number of small and medium sized dams, drainage lines and remnant open forest. The cleared portions of the study area is unlikely to provide foraging resources, apart from small dams in open paddocks.

Clearing of remnant vegetation within the study area would not result in the loss of a significant area of potential foraging habitat for the Large-footed Myotis.

Roosting / Breeding
The Large-footed Myotis roosts in caves, mines or tunnels, under bridges and buildings and dense foliage, where colonies of 10 to 15 individuals, and occasionally hundreds congregate. These roost sites are typically in close proximity to water (Richards, 1995). No suitable cave roosting type structure occurs within the study area, but a number of large mature trees with hollows may provide roosting habitat for the species.

Movement
The cleared parts of the study area is unlikely to provide suitable habitat as a movement corridor for the species, but the remnant forest and woodland would provide cover between areas of preferred foraging habitat. The study site may provide a movement corridor between patches of preferred foraging habitat, such as Porters Creek Wetland to the south, and Buttonderry Creek to the north.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

No consideration under this part of the assessment is required. No Endangered Populations of the Large-footed Myotis relate to the study area.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The extent of suitable foraging habitat within the study area is associated with remnant forest (102 hectares) and small and medium sized dams for the Large-footed Myotis. More extensive areas of preferred foraging habitat is associated with the Porters Creek Wetland to the south, and Buttonderry Creek to the north. The maximum extent of habitat that may be modified by development of the Warnervale Town Centre is 83 hectares, which is small in relation to the locality and region. The study area is not considered regionally significant foraging habitat for the species.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

The species forages along riparian areas and wetlands, such as the Porters Creek Wetland complex to the south west, and Buttonderry Creek to the north. Further development of the Warnervale Town Centre study area is unlikely to interrupt or modify movement dynamics of local populations of this species. Development of the study area would not remove important foraging habitat.

(e) whether critical habitat will be affected;

No assessment under this part is required, as no declared critical habitat for the Large-footed Myotis occurs in the study area.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The conservation status of the Large-footed Myotis in the Sydney bio-region is poorly known. The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is presently considered inadequately conserved (Smith *et al,* 2002), with a criteria assigned to Class 2b, species whose preferred habitat is poorly represented in national parks in the bioregion. The species is subjected to pressures from habitat clearing for agricultural activities and urban expansion.

Populations of the species are known in Wyrrabalong Nature Reserve, Popran National Park and Dharug National Park. State Forests in the region also support populations of the species.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes with relevance to the Large-footed Myotis include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Anthropogenic climate change
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition

- Predation by the Red Fox
- Predation by the Feral Cat
- Competition from Feral Honeybees
- Removal of dead wood and dead trees

High frequency fire may modify and disrupt the floristics and structure of riparian areas where the species forages, and may remove mature trees with hollows, which may be utilised as roost and breeding locations for the species. However, the proposal would not increase the incidence of high frequency fire because the majority of proposed study area would be cleared of remnant vegetation, resulting in large areas with very low fuel loads.

Predation by the introduced predators the Feral Cat and Red Fox may occur where roost locations are accessible by these predators. The Feral Cat may climb trees, and both may enter cave structures and predate on any roosting individuals, or may capture flying individuals departing roosts (such as caves, culverts and storm water drains) at dusk.

Clearing of native vegetation has been assessed previously in parts (a) and (c). Approximately 57.3% of the study area supports remnant forest and woodland, which is considered less optimal foraging habitat for the species. Clearing of native vegetation within the study area is unlikely to result in a significant effect at bioregional scale. However, clearing of remnant vegetation in the study are may reduce the extent of foraging habitat for the species. There may also be loss of potential or actual roost sites in large mature trees with hollows.

Competition for natural and artificial hollows may occur between the introduced Feral Honeybee and individual Large-footed Myotiss that roost in trees. The extent of occupation of Feral Honeybees in natural tree hollows can be quite high in remnant forest.

Removal of dead trees may reduce the abundance of roost trees utilised by the Large-footed Myotis in the study area and locality. Felling of dead trees may also result in mortality of roosting individuals of the species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The Large-footed Myotis occurs from the Queensland to Victorian border, extending from the coast to the Great Dividing Range (Richards, 1995). The Large-footed Myotis is not at its limit of distribution in the Warnervale Town Centre study area.

This Section 5A assessment concludes that development within the Warnervale Town Centre is **unlikely** to impact upon the local population of the Large-footed Myotis.

4.2.1.18 Greater Broad-nosed Bat (Scoteanax rueppellii)

The Greater Broad-nosed Bat has not been recorded within the Warnervale Town Centre study area during investigations for this study in 2003, nor previous investigations in 2001 (Payne & Murray, 2001). There are no published records of the species within the Warnervale Town Centre study area held on the NSW National Parks Wildlife Atlas, or the Wyong Fauna Database. However, the species has been recorded in the locality, and is considered likely to utilise the study area as part of its larger foraging range, and possibly roost habitat.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

The key threats affecting the Greater Broad-nosed Bat in the study area is related to the extent of past clearing for the Warnervale Town Centre study area, which has reduced the extent of remnant vegetation to about 57.3%. Important aspects of the lifecycle of the species include foraging, roosting, breeding and movement/ dispersal. The potential effects / impacts of development of the Warnervale Town Centre on these lifecycle aspects is discussed below:

Foraging
The Greater Broad-nosed Bat forages in open forest and woodland. Remnant forest and open areas within the study area is likely to be utilised by foraging individuals throughout the year, and particularly during periods of high insect activity. Further development of the Warnervale Town Centre is likely to reduce the extent of potential foraging habitat in the locality for the local population of the Greater Broad-nosed Bat.

Roosting/ Breeding
Individuals require mature trees with hollows, or similar structures (ie. roof cavities) for roosting. Within the remnant forest and woodland in the study area, there is several mature trees with hollows that may provide roosting habitat for this species. Further development of the study area will reduce the local abundance of roosting resources. Breeding occurs in tree hollows, and clearing of habitat trees during the breeding period may impact on the local population.

Movement
The species forages relatively widely across the landscape between roost and foraging areas. These movements may include movements across urban areas, grassland or cleared landscapes. Further development of the Warnervale Town Centre is unlikely to disrupt or cause the modification of movement dynamics of this species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

No consideration under this part of the assessment is required. No Endangered Populations of the Greater Broad-nosed Bat relate to the study area.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The extent of remnant vegetation suitable as foraging habitat is about 102 hectares. The aerial space within the cleared area of the Warnervale study area may also provide foraging habitat for the species. The extent of habitat that is likely to be modified by the proposal includes the entire study area (178 hectares). The loss of 178 hectares of habitat for the species is not considered significant at the bio-regional scale, but will contribute to loss of habitat for the species in the locality. The study area is likely to provide foraging habitat, and possibly roost and maternity sites for the Greater Broad-nosed Bat.

Further development of the Warnervale Town Centre is not considered to result in the modification of a regionally significant area of habitat, but may impact on locally significant habitat for the species.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

Further development of the Warnervale Town Centre is unlikely to interrupt or modify movement dynamics of local populations of this species, even though the development of the Warnervale Town Centre may remove at least 102 hectares of potential foraging habitat.

(e) whether critical habitat will be affected;

No assessment under this part is required, as no declared critical habitat for the Greater Broad-nosed Bat occurs in the study area.

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The conservation status of the Greater Broad-nosed Bat in the Sydney bio-region is poorly known. The extent of conservation reserves within the bio-region is >10% (Thackway and Cresswell, 1995). The species is subjected to pressures from habitat clearing for agricultural activities and urban expansion, particularly in the Wyong Shire presently subjected to high growth rates.

Populations of the species are known in Yengo National Park (165,449 hectares), and smaller reserves such as Wyrrabalong Nature Reserve, Dharug National Park, Wambina Nature Reserve, and State Forests in the region also support populations of the species.

The species is presently considered adequately conserved in the existing system of conservation reserves (Smith *et al,* 2002), with a criteria assigned to Class 2c, preferred habitat is well represented in national parks in the bioregion.

(g) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Key threatening processes with relevance to the Greater Broad-nosed Bat include:

- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Predation by the Red Fox
- Predation by the Feral Cat
- Competition from Feral Honeybees
- Removal of dead wood and dead trees

Clearing of native vegetation has been assessed previously in parts (a) and (c). Approximately 57.3% of the study area supports remnant forest and woodland, which is considered potential foraging habitat for the species. Clearing of native vegetation within the study area is unlikely to result in a significant effect at bioregional scale. However, clearing of remnant vegetation in the study area may reduce the extent of foraging habitat in the locality. There may also be loss of potential or actual roost sites in large mature trees with hollows.

High frequency fire may modify and disrupt the floristics and structure of riparian areas where the species forages, and may remove mature trees with hollows, which may be utilised as roost and breeding locations for the species. However, the proposal would not increase the incidence of high frequency fire because the majority of proposed study area would be cleared of remnant vegetation, resulting in large areas with very low fuel loads.

Predation by the introduced predators the Feral Cat and Red Fox may occur where roost locations are accessible by these predators. The Feral Cat may climb trees and predate on roosting individuals.

Competition for natural and artificial hollows may occur between the introduced Feral Honeybee and individual Greater Broad-nosed Bat that roost in trees. The extent of occupation of Feral Honeybees in natural tree hollows can be quite high in remnant forest.

Removal of dead trees may reduce the abundance of roost trees utilised by the Greater Broad-nosed Bat in the study area and locality. Felling of dead trees may also result in mortality of roosting individuals of the species.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

Extends along the coast from Maryborough in Queensland to Orbost in Victoria (Klippel, 1992). The Greater Broad-nosed Bat is regarded as uncommon to sparse, based on the current lack of knowledge of its distribution. The species is not at its limit of distribution in the study area.

This Section 5A assessment concludes that development of allotments within the study area that presently support remnant vegetation is **likely** to impact upon the local population of the Greater Broad-nosed Bat.

Development of cleared allotments in the remainder of the Warnervale Town Centre is **unlikely** to impact upon the local population of the species.

4.1.2 Endangered Ecological Community – Sydney Coastal Estuary Swamp Forest Complex

A small remnant (0.1ha) of Sydney Coastal Estuary Swamp Forest Complex (SCESFC) occurs in the south-eastern corner of Lot 2 DP7738, adjacent to Sparks Road. No other occurrence is present within the investigation area.

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

SCESFC is not a threatened species.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;

SCESFC is not an endangered population.

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;

The total area of SCESFC present within the Warnervale Town Centre study area is approximately 0.1ha, and occurs only on Lot 2 DP7738. Within the Wyong LGA, there are approximately 2,000ha, and with over 12,500ha in the Central Coast – Lower Hunter Valley region (NPWS 2000; Bell 2002b). This percentage of 0.005% for the LGA, and 0.0008% for the region is not considered significant.

(c) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

The area of SCESFC within the study area occurs in Lot 2 DP7738 adjacent to Sparks Road, and between cleared and modified grazing lands. It is therefore already isolated, and also consists of regrowth vegetation. To the east and west, topography rises and soil type changes such that no further occurrence of

SCESFC is known for some distance. Further stands of SCESFC incorporating *Eucalyptus robusta* are known from other proximate locations associated with the Porters Creek Wetland complex.

(d) whether critical habitat will be affected;

No critical habitat has yet been declared for this community under Part 3 Division 1 of the Threatened Species Conservation Act 1995.

(e) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the regional environment of the species, population or community;

The NSW Scientific Committee (2000) indicates that only small areas of SCESFC are represented in conservation reserves, including Cockle Bay Nature Reserve, Garigal National Park and Royal National Park. However, other known sites include Karuah Nature Reserve (Bell 2002b), Lake Macquarie State Conservation Area (Bell 1998a), and Munmorah Nature Reserve (Payne 1997b). All sites support only limited amounts of this vegetation type, and would not be considered adequately represented.

(f) whether the development or activity that is proposed is of a class of development or activity that is recognised as a threatening process;

Clearing of native vegetation was listed as a key threatening process on the Threatened Species Conservation Act 1995 in September 2001. Under this listing, 'clearing of native vegetation' is defined as "the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands" (NSW Scientific Committee 2001). Under this definition, the potential development of Lot 2 DP7738 would be deemed as a key threatening process.

(g) whether any threatened species, population or ecological community is at the limit of its known distribution.

SCESFC occurs within the Sydney Basin bioregion, and extends from the LGA's of Lake Macquarie in the north, to Shellharbour and Kiama in the south (NSW Scientific Committee 2000). There are also further stands of swamp forest that would equate to SCESFC in the Great Lakes local government area (Karuah NR: Bell 2002b), well north of Wyong. The site in Lot 2 DP7738 in the Warnervale Town Centre proposal is therefore not at the limit of distribution for SCESFC.

This Section 5A assessment concludes that development of the Warnervale Town Centre is **unlikely** to impact upon the endangered ecological community *Sydney Coastal Estuary Swamp Forest Complex*.

4.2 Summary of Impact Assessment under EPBC Act 1999 and TSC Act 1995.

A summary of the impact assessment of the proposed rezoning, and subsequent development of the land under the *EPBC Act 1999* and *TSC Act 1995* is presented below in Table 32.

Table 32. Summary of Impact Assessment, Threatened Species.

Environment Protection & Biodiversity Conservation Act 1999		
Common Name	**Scientific Name**	**Summary of Impact**
-	*Rutidosis heterogama*	Significant
Black-eyed Susan	*Tetratheca juncea*	None
Grey-headed Flying Fox	*Pteropus poliocephalus*	None
Green and Golden Bell Frog	*Litoria aurea*	None
Threatened Species Conservation Act 1995		
Common Name	**Scientific Name**	**Summary of Impact**
-	*Rutidosis heterogama*	Significant
Black-eyed Susan	*Tetratheca juncea*	None
Paperbark	*Melaleuca biconvexa*	None
Australasian Bittern	*Botaurus poiciloptilus*	None
Glossy Black Cockatoo	*Calyptorhynchus lathami*	None
Masked Owl	*Tyto novaehollandiae*	Potential Impact
Powerful Owl	*Ninox strenua*	Potential Impact
Green and Golden Bell Frog	*Litoria aurea*	None
Wallum Froglet	*Crinia tinnula*	None
Koala	*Phascolarctos cinereus*	None
Squirrel Glider	*Petaurus norfolcensis*	Likely Impact
Grey-headed Flying Fox	*Pteropus poliocephalus*	None
Eastern Freetail Bat	*Mormopterus norfolkensis*	Likely Impact
Eastern Bent-wing Bat	*Miniopterus schreibersii*	None
Little Bent-wing Bat	*Miniopterus australis*	None
Large-footed Myotis	*Myotis adversus*	None
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Likely Impact
Sydney Coastal Estuary Swamp Forest		None

The assessment on threatened species and endangered ecological communities concluded that the following species would likely be impacted by development of the Warnervale Town Centre study area:

- *Rutidosis heterogama* – loss of a significant population (> 1,000 plants)
- Masked Owl – potential nest / roost tree within study area, requires further investigation
- Powerful Owl – potential nest tree and roost location within study area, requires further investigation
- Squirrel Glider – impact on local population by loss and fragmentation of habitat,
- Eastern Freetail Bat – impact on local population by loss of foraging, and potential roost trees, and
- Greater Broad-nosed Bat - impact on local population by loss of foraging, and potential roost trees.

5.0 DISCUSSION

Flora and fauna investigations were undertaken during 2003 to identify actual or potential constraints to development of the Warnervale Town Centre in Wyong Shire. The study area defined for this investigation is 178.4 hectares in area, bordered by Hiawatha and Minnesota Road to the east, Hakone Road to the north, Bruce Crescent to the west, and the extension of Virginia Road to the south. Approximately 57.5% of the study area presently supports remnant native vegetation, with the remainder large rural residential allotments with cleared grassland with scattered trees, or residential estates.

Flora investigations identified 8 vegetation communities within the study area, together with an additional 3 communities supporting disturbed elements. A small area (0.086 hectare) of an endangered ecological community, the Sydney Coastal Estuary Swamp Forest Complex (SCESFC) was located within the study area. The size, disturbed condition, and isolation from more extensive areas of this endangered community, indicate this patch is of little conservation significance.

A total of 76 bird species, 18 mammals, 7 bat species, 6 reptiles and 8 frog species were recorded within the study area during this, and previous investigations of the study area. Five threatened fauna species were recorded in the study area during this and previous investigations, and a number of additional threatened species have been recorded in the locality (<5km radius).

With regard to the development of the Warnervale Town Centre, the Warnervale District Planning Strategy summarised the following issues relating to ecology and habitat;

- Ridgetops and other topographic features, particularly those areas that are well vegetated, should be kept free of development to serve as primary urban form determinates;
- Ridgetops and other woodland areas should be reconnected to remnant woodlands and the floodplain via drainage swales and small scale valleys that establish the overland stormwater drainage pattern off the higher ground, and
- Areas with dense stands of remnant vegetation should be preserved as wildlife corridors and open space where possible, to provide visual relief and promote habitat protection (Woods Bagot, 2001).

Following is a discussion on the impact of development of the Warnervale Town Centre in relation to issues identified from this report, and previous investigations of the study area.

The Warnervale District is part of the Coastal Plain and The Floodplains Landscape Zones identified in the Natural Vegetation mapping undertaken by Bell (2002a). The coastal plain and floodplain areas have been the focus of future residential, commercial and industrial development in the Shire since the 1980's, with limited areas of conservation.

Vegetation mapping of the Shire identified 43 communities, of which 8 vegetation communities were identified within the Warnervale study area. The Floodplains Landscape Unit historically supported substantial areas of wetlands and swamp forests. Areas of better drainage supported swamp forests, whilst creek lines on the edge of floodplains supported sedge palm forests. On the coastal plain away from alluvial floodplains, open woodlands and forests would have extended across much of the undulating terrain.

Within the 2 landscape units within the Warnervale Town Centre study area, a number of vegetation communities of state, regional and local significance have been identified.

5.1.1 Threatened Flora Species

Threatened flora is those species considered at risk of extinction either nationally, or within NSW. One threatened plants species, listed on the national *Environment Protection and Biodiversity Conservation Act 1999*, and NSW *Threatened Species Conservation Act 1995*, was located in the study area. The small daisy *Rutidosis heterogama* was located principally on land west of the Main Northern Railway. This species has not been previously recorded within Wyong Shire, with no records south of the Hunter Valley. Since discovery of this species, additional populations have been located in Wyong LGA (2) Lake Macquarie LGA (4), and Cessnock LGA (2). The population within the study area is the largest in Wyong Shire (greater than 900 plants, and occurs in the least disturbed and fragmented habitat of the 3 known – See Appendix 2 for full discussion).

Impact of Development of Warnervale Town Centre on Threatened Flora Species.

Any disturbance to parts of Lot 1 DP 357408 off Sparks Road supporting individuals, or small groups of this plant, would most likely result in the loss of a regionally significant population of this threatened species. Development would constitute a detrimental / adverse impact on a Matter of National Environmental Significance under the meaning of the national *Environment Protection & Biodiversity Conservation Act 1999.* Development of Lot 1 DP 357408 would also have a significant effect under the meaning of the NSW *Environmental Planning & Assessment Act 1979,* as amended by the *Threatened Species Conservation Act 1995.*

5.1.2. Endangered Ecological Communities

One endangered ecological community, Sydney Coastal Estuary Swamp Forest Complex, occurs within the study area. In the absence of formal Recovery Plans for this community, a precautionary conservation target of 100% applies to prevent further loss, except on an extremely limited basis. This approach was undertaken to assist Wyong Shire Council in resolution of 'eight part tests of significance' considerations.

Impact of Development of Warnervale Town Centre on Endangered Ecological Community.

A small area (0.086 hectare) of the Endangered Ecological Community (Sydney Coastal Estuary Swamp Forest Complex), is located on Lot 2 DP7738 on the northern side of Sparks Road. Within the Wyong LGA, there are approximately 2,000ha, and with over 12,500ha in the Central Coast – Lower Hunter Valley region (NPWS 2000; Bell 2002b). However, the size of this community within the study area is too small and fragmented to consider significant in relation to conservation of vegetation. Clearing of this small community for development of the land is not considered to have a significant effect on the viability of this community in the locality.

5.1.2 Vegetation of Regional Significance

Vegetation of regional significance was identified following preparation of the Natural Vegetation of Wyong Shire (Bell, 2002a). Within Wyong Shire, 9 vegetation communities were identified as regionally significant. Three regionally significant vegetation types occur within the study area;

- Unit 15 – Alluvial Redgum Footslopes Forest;
- Unit 20(f) – Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant)
- Unit 27 – Narrabeen Coastal Blackbutt Shrubby Forest.

One ROTAP (Rare and Threatened Australian Plant) was located within the study area, *Macrozamia flexuosa.* This species is not listed as threatened, but carries a conservation risk code 2K, signifying a poorly known species with a distributional range less than 100 kilometres.

Impact of Development of Warnervale Town Centre on Regionally Significant Vegetation.

The Alluvial Redgum Footslopes Forest (Unit 15) occurs within the 1:100 AEP flood level, providing a 'de facto' conservation tenure. Development of the Town Centre above the 1:100 AEP flood level would not result in loss of this vegetation type by clearing.

The sedge-scrub variant of the Alluvial Floodplain Shrub Swamp Forest (Unit 20f) is present in the south of the study area. This community is also within the 1:100 AEP flood level, providing a 'de facto' conservation tenure. Development of the Town Centre above the 1:100 AEP flood level would not result in loss of this vegetation type by clearing.

The Narrabeen Coastal Blackbutt Shrubby Forest (Unit 27) occurs on the ridgeline of the Wyong Council disused tip site off Hakone Road. This vegetation community is only one of two known locations in Wyong Shire, and although compromised by regrowth and invaded by weed species, the site still supports an example of this community in good condition. It is estimated that 80.8% of this habitat has been lost in Wyong Shire by previous clearing (Wyong Shire Council, 2002a). However, parts of the Town Centre are planned for Open Space / Vegetation Corridors, which may assist in conservation of pockets of this vegetation type.

5.1.3 Vegetation of Local Significance

Vegetation Communities of Local significance were also identified within the Natural Vegetation of Wyong Shire (Bell, 2002a). A total of 29 communities within Wyong Shire were nominated for consideration as locally significant, of which 4 communities were recorded in the Warnervale Town Centre study area;

- Unit 15 - Alluvial Redgum Footslopes Forest,
- Unit 27 – Narrabeen Coastal Blackbutt Shrubby Forest,
- Unit 28 – Narrabeen Buttonderry Footslopes Forest, and
- Unit 30 – Dooralong Spotted Gum – Ironbark Forest.

Impact of Development of Warnervale Town Centre on Locally Significant Vegetation.

As indicated above in the regionally significant vegetation, the Alluvial Redgum Footslopes Forest (Unit 15) occurs within the 1:100 AEP flood level, providing a 'de facto' conservation tenure. Development of the Town Centre above the 1:100 AEP flood level would not result in loss of this vegetation type by clearing.

The Narrabeen Coastal Blackbutt Shrubby Forest (Unit 27) occurs on the ridgeline of the disused tip site off Hakone Road. Development of the Warnervale Town Centre will result in a reduction of area of this vegetation type. However, parts of the Town Centre are planned for Open Space / Vegetation Corridors, which may assist in conservation of pockets of this vegetation type.

The Narrabeen Buttonderry Footslopes Forest (Unit 28) occurs predominantly within the central portion of the study area. This community is unlikely to be conserved to any extent by development of the Town Centre.

The vegetation type Dooralong Spotted Gum – Ironbark Forest (Unit 30) occurs on the ridgeline of the DIPNR site. Previous investigations of the Town Centre have identified this community as significant due to high fauna and visual / aesthetic values. Pockets of this vegetation type would be conserved as areas of open space within the Town Centre.

The locations of regionally significant communities and threatened species populations is presented below in Figure 8.

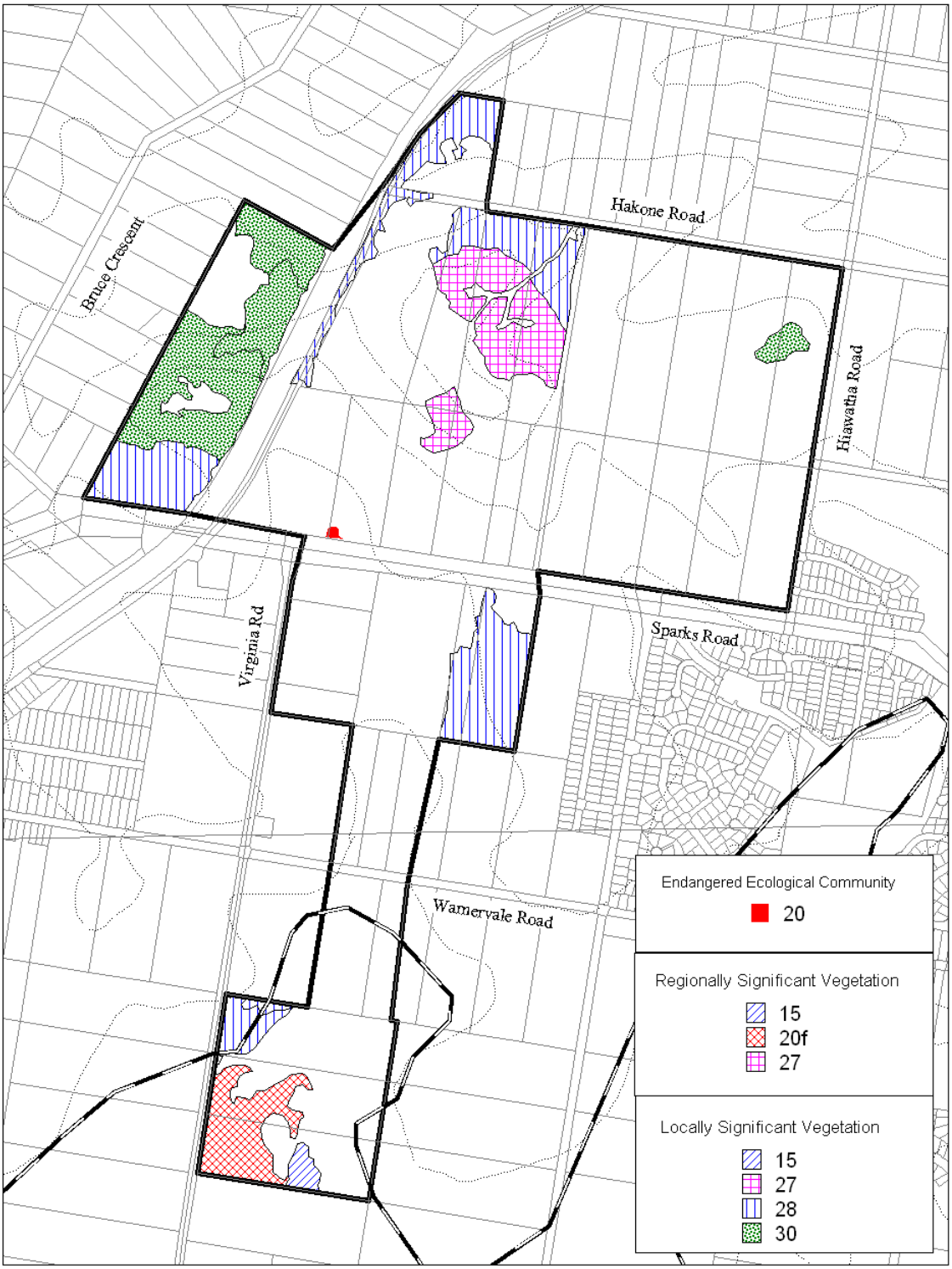

Figure 8. Location of Endangered Ecological Communities, Regionally and Locally Significant Vegetation Communities and Threatened Flora Species, Warnervale Town Centre.

5.1.5 Regional *Tetratheca juncea* Management Plan

A conservation management plan has been prepared for *Tetratheca juncea*, which has identified many major populations in Wyong Shire (Payne, 2001). No populations of this species were located within the Warnervale Town Centre study area during investigations in 2003, and previously in 2001. It is considered the *Tetratheca juncea* Management Plan has no application to the study area defined for this report.

5.1.6 *Angophora inopina* Conservation Management Plan.

A conservation management plan has been prepared for *Angophora inopina*, which has a restricted distribution from Wyong in the south to Port Stephens in the north (Bell, 2001). No populations of this species were located within the Warnervale Town Centre study area during investigations in 2003, and previously in 2001. It is considered the *Angophora inopina* Management Plan has no application to the study area defined for this report.

5.1.7 Threatened and Locally Significant Ground Orchid Strategy

An investigation into ground orchids of conservation significance in Wyong Shire was undertaken. It was possible to delineate broad vegetation types and landscapes in which target ground orchid species are distributed in Wyong Shire (Gunninah, 2002). The outcome of the ground orchid strategy is based on conservation of large areas of habitat, as well as planning at the catchment level for particular species. A number of distinct vegetation types have been correlated with the presence of particular ground orchids, including:

- Units 6, 7a, 8b, 9
- Unit 28 - Narrabeen Buttonderry Footslopes Forest,
- Unit 30 – Dooralong Spotted Gum Ironbark Forest,
- Unit 31 – Scribbly Gum Woodland.

Impact of Development of Warnervale Town Centre on Threatened and Locally Significant Ground Orchids.

Field investigations over the period September 2003 to February 2004 did not located the presence of any significant ground orchids listed on threatened species legislation, or identified in the Ground Orchid Strategy. The extent of each of the vegetation types mapped within the study area that may potentially support significant ground orchids is listed below.

Vegetation Unit as Potential Ground Orchid Habitat	Extent of Vegetation Unit in Study Area (ha)
Unit 28 - Narrabeen Buttonderry Footslopes Forest	34.44
Unit 30 – Dooralong Spotted Gum Ironbark Forest	12.73

However, it must be recognised that much of the study area supports vegetation types with varying degrees of disturbance to the ground layer. Hence, the area of each vegetation community is not representative of the total amount of potential habitat for ground orchids, due to this disturbance by grazing and soil disturbance.

5.1.8 Squirrel Glider Conservation Management Plan

The Wyong Shire Squirrel Glider population has been identified as the most significant population in Australia, based on known information of the species. The favoured habitat of the species is coastal forest and woodlands, most of which occurs on private land. Habitat clearing and fragmentation is the greatest threat to populations of the Squirrel Glider in Wyong Shire. Occurrence of populations of the species is significantly correlated with remnant vegetation size, proximity to, and size of, adjoining patches of remnant vegetation. Models of habitat to sustain a viable population in the long term (>100 years) indicate a network of vegetation covering about 7,500 hectares is required to ensure persistence of the species. This network of vegetation requires patches of 200 hectares or more linked by protected and managed corridors. Patches of vegetation less than 200 hectares will require active management to ensure persistence. Until a network of habitat is established in Wyong Shire, applications to clear Squirrel Glider habitat will require individual assessment (WSC, 2003b).

Guidelines to clear Squirrel Glider habitat assessment are classified as having Class 1 – 4 impacts.

Class 1 impacts will generally be refused or require preparation of species impact statements.

Class 1 impacts are;

(a) clearing or modification of glider habitat in mapped corridor areas, interim corridor areas or any connecting corridors or pathways between major remnants being considered by Council for inclusion in a protected corridor network;

(b) clearing or modification of Squirrel Glider habitat in interim conservation areas or any areas being considered by Council for inclusion in future Squirrel Glider conservation areas.

Class 2 impacts will be considered on individual merits, but generally require a species impact statement if scheduled for implementation before Squirrel Glider habitat protection and management targets are met.

Class 2 impacts are;

(a) clearing or adverse modification of glider habitat in any major remnant or corridor linking major remnants outside interim conservation areas under consideration for possible inclusion in Squirrel Glider conservation or corridor areas.

(b) any clearing or modification of a minor Squirrel Glider habitat remnant with a resident breeding Squirrel Glider population that is connected to a remnant (or effective remnant) greater than 100 hectares in area by isolation classes 1-3.

(c) any network of minor Squirrel Glider habitat remnants connected by isolation classes 1-3 that together comprise 100 hectares or more in area.

Class 3 impacts will be assessed on individual merit, but will not generally be considered significant within the meaning of the 8 part test (ie. Not require an SIS). Conditions may be imposed on developments to compensate for habitat loss.

Class 3 impacts are:

(a) clearing or modification of small remnants (< 20 hectares) with resident breeding Squirrel Gliders and an isolation score for the remnant of 4-5.

(b) all other impacts that are not class 1,2 or 4.

Class 4 impacts not generally considered likely to have a significant impact on the Squirrel Glider.

Class 4 impacts are;

(a) clearing or modification of small remnants (<20 hectares) without resident breeding Squirrel Gliders, and an isolation score for the remnant of 4-5.

The Squirrel Glider Conservation Management Plan identified remnants of vegetation greater than 90 hectares in area that score low isolation levels (ie, 0, 1 and 2 – refer to Smith, 2000 for description of isolation scores). Ten major remnants were mapped for the northern part of Wyong Shire.

Impact of Development of Warnervale Town Centre on Squirrel Glider Conservation Management Plan.

The Warnervale Town Centre study area is not considered part of the network of major remnants identified by Smith (2000, 2002). Applications to clear Squirrel Glider habitat in the study area will require individual merit based assessment.

Within the study area, populations of the Squirrel Glider are likely to occur within most of the vegetation remnants. However, there are two significant barriers to dispersal of Squirrel Glider, Sparks Road and the Main Northern Railway. The study area is effectively dividing into three sectors, with the north-eastern and north-western sector supporting large, well connected fragments of vegetation. The extent of habitat within the north-eastern sector (north of Sparks Road, east of Main Northern Railway) is approximately 58 hectares of remnant vegetation, with isolation scores of 1 and 2 (i.e. good connectivity). Outside of this sector, more extensive areas of Squirrel Glider habitat occur with isolation classes of 1-3. Application of class impact merit assessment (refer to Appendix 4 for full assessment) indicates clearing or modification of vegetation remnants supporting Squirrel Glider habitat within the north-east sector would constitute a Class 2b impact, and require preparation of a species impact statement.

In the north-western sector (north of Sparks Road, west of Main Northern Railway), the extent of Squirrel Glider habitat within the study area is approximately 17 hectares, with more extensive areas of suitable habitat continuous with Lot 1 DP 357408. Application of class impact merit assessment (refer to Appendix 4 for full assessment) indicates clearing or modification of vegetation supporting Squirrel Glider habitat within the north-west sector would constitute a Class 2b impact, and require preparation of a species impact statement.

Within the southern sector (south of Sparks Road) the habitat for Squirrel Glider consists of smaller fragments with high isolation scores (4-5). Areas of suitable habitat for Squirrel Glider in Lots 7 DP 739910 and Lot 1 DP 781737 off Sparks Road is isolated from adjoining habitat south of Warnervale Road by cleared areas and low swamp forest. Tree cover within the swamp forest is sparse, which may provide cover for dispersing individuals, but would not constitute habitat suitable as regular (i.e. daily) foraging movements by the Squirrel Glider. Application of class impact merit assessment (refer to Appendix 4 for full assessment) indicates clearing or modification of vegetation supporting Squirrel Glider habitat within the southern sector would constitute a Class 3 impact, and not require preparation of a species impact statement.

5.1.9 Vegetation and Wildlife Corridors

A number of corridors have been identified to connect large patches of remnant vegetation within Wyong Shire, and to adjoining local government areas (Payne, 2002). The aim of these corridors is to maintain habitat continuity within the major terrestrial ecosystem types in Wyong Shire. Payne (2002) defined a number of categories of wildlife corridors for Wyong Shire, regional wildlife pathways, sub-regional corridors and stepping stone corridor for dispersal species and pollinators.

Impact of Development of Warnervale Town Centre on Wildlife Corridor Strategy.

In relation to the study area defined for this investigation, no vegetation corridors identified in the Wyong Shire Corridors Strategy occur within the Warnervale Town Centre study area. The focus of significant corridors within the wider Warnervale District is a sub-regional corridor to the west of Bruce Crescent. The width of this corridor is recommended to be 200 – 300 metres, and its location is presented in Figure 3 of the Payne & Murray (2001) report.

However, a number of vegetation corridors were identified and mapped in the Warnervale District Planning Strategy Joint Issues Paper (Woods Bagot, 2001). These corridors are narrow in width, 20-40 metres, and follow major drainage lines. The scope of these corridors is to fulfil a limited function for wildlife, but also a passive recreation and visual role.

It was considered that a functional wildlife corridor was not a viable option through the Warnervale District area, due to size requirement to cater for the variety of flora and fauna species presently utilising the study area. To ensure long term conservation of these species, a corridor width of at least 200-300 metres is considered essential. A corridor of this width would prevent development at the intensity envisaged for the Town Centre. The recommendation was incorporation of passive corridors into the design of the Town Centre to retain important remnants of native vegetation.

A list of allotments within the study area with drainage lines that potentially provide vegetated corridors is presented below in Table 33. This table also lists allotments supporting cleared areas or remnant vegetation along drainage lines. Those allotments without remnant vegetation will be required to restore remnant vegetation along drainage lines to restore visual / aesthetic form, and connectivity for flora and fauna corridor function.

Table 33. Allotments identified for Vegetation Corridors

Lot Number	Location	Remnant Vegetation Along Drainage Line
Lot 1 DP 357408	DIPNR Land off Sparks Road	Yes
Lot 128 DP 24673	Off Hakone Road	Yes
Lot 54 DP 7527	Off Hakone Road	Yes
Lot 55 DP 7527	Off Hakone Road	Yes
Lot 56 DP 663082	Off Hakone Road	No
Lot 57 DP 7738	Off Hakone Road	Yes
Lot 58 DP 7738	Off Hakone Road	Yes
Lot 59 DP 7738	Off Hakone Road	Yes
Lot 1 DP700096	Off Sparks Road	No
Pt 3 DP 748588	Cnr Sparks & Virginia Road	No
Lot 111 DP 705880	Off Virginia Road	No
Lot 1E DP 24673	Off Virginia Road	No
Lot 14 DP 371162	Off Warnervale Road	No
Lot 14A DP 371162	Off Warnervale Road	Yes
Lot 101 DP 829060	Off Warnervale Road	Yes

5.1.10 Threatened Fauna Species

A number of threatened fauna species have been recorded in the study area during this and previous investigations. Those species include Powerful Owl, Masked Owl, Squirrel Glider, Koala and Wallum Froglet. Additional threatened species recorded nearby, or within the locality (<5km) and could potentially occur in the study area, include Black-necked Stork, Swift Parrot, Australasian Bittern, Black Bittern, Superb Fruit-dove, Glossy Black Cockatoo, Barking Owl, Painted Honeyeater, Green & Golden Bell Frog, Giant Barred Frog, Green-thighed Frog, Grey-headed Flying-fox, Eastern Freetail Bat, Eastern Bent-wing Bat, Little Bent-wing Bat, Large-footed Myotis, Greater Broad-nosed Bat.

Impact assessments were conducted on those threatened species either recorded, or considered likely to occur within the study area. The following local populations of threatened species were considered likely to be impacted by the development of the Warnervale Town Centre:

- Masked Owl *(Tyto novaehollandiae)*
- Powerful Owl (*Ninox strenua*)
- Masked Owl (*Tyto novaehollandiae*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Eastern Freetail Bat (*Mormopterus norfolcensis*)
- Eastern Broad-nosed Bat (*Scoteanax rueppellii*).

6.0 Conclusion

Ecological investigations of the Warnervale Town Centre have identified the presence of one threatened ecological community, Sydney Coastal Estuary Swamp Forest Complex, which is listed on the *Threatened Species Conservation Act 1995.* The extent of this community is 0.086 hectare, located on Lot 2 DP 7738, off Sparks Road. The EEC is small in size, in poor condition, and is isolated from more extensive areas of this endangered community type. It is considered that the loss of this small pocket would not significantly impact upon the regional distribution of this community.

One threatened plant, *Rutidosis heterogama,* was recorded on Lot 1 DP 357408 off Sparks Road. Two populations of the species were recorded. This species has not previously been recorded in Wyong Shire, and represents a southern range extension of the species. Development of Lot 1 DP 357408 would constitute a detrimental / adverse impact on a Matter of National Significance (threatened species) under the national *Environment Protection & Biodiversity Conservation Act 1999.* In addition, loss of this population would constitute a significant impact under s.5A of the *Environmental Planning & Assessment Act 1979*, as amended by the *Threatened Species Conservation Act 1995*.

Five threatened fauna species have been recorded within the Warnervale Town Centre during this, and previous investigations. Those species include Powerful Owl, Masked Owl, Squirrel Glider, Koala and Wallum Froglet. A number of additional fauna threatened species have been recorded in the locality (<5km radius), and could potentially utilise habitats within the study area as a component of their home range.

Development of the Warnervale Town Centre, and associated disturbance to native vegetation and Squirrel Glider habitat, would constitute a Class 2(b) Impact under the Squirrel Glider Conservation Management Plan. Clearing of habitat on land north of Sparks Road, and each side of the Main Northern Railway, would require preparation of a species impact statement. In contrast, land supporting Squirrel Glider habitat south of Sparks Road would constitute a Class 3 or 4 Impact, and require a merit based assessment.

Development of the Warnervale Town Centre would impact upon a number of regional, and locally significant vegetation types identified in the Natural Vegetation of Wyong LGA (Bell, 2002a). Those significant vegetation types are presented below.

Regionally Significant.
Unit 15 – Alluvial Redgum Footslopes Forest
Unit 20(f) – Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant)
Unit 27 – Narrabeen Coastal Blackbutt Shrubby Forest.

Locally Significant.
Unit 15 – Alluvial Redgum Footslopes Forest
Unit 27 – Narrabeen Coastal Blackbutt Shrubby Forest.
Unit 28 – Narrabeen Buttonderry Footslopes Forest.
Unit 30 – Dooralong Spotted Gum – Ironbark Forest.

The Warnervale Town Centre study area is not considered part of the Wildlife Corridors Strategy. No regional, sub-regional or stepping stone corridors were considered for incorporation into the planning of the Town Centre. The only corridors considered for the study area follow natural drainage lines, and function as vegetation / visual / open space corridors, rather than functioning wildlife corridors.

7.0 REFERENCES

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APPENDIX 1 PLANT SPECIES LIST

All species recorded during plot sampling, targeted seasonal surveys and miscellaneous records have been included in this list. A small number of additional species recorded by Robert Payne and reported on in Payne and Murray (2001) are also marked, although that study included a wider study area than the current one. Weed and non-endemic species are marked '*'.

Class	Family	Genus and Species
Filicopsida (Ferns)	Adiantaceae	*Cheilanthes sieberi subsp. sieberi*
	Dennstaedtiaceae	*Pteridium esculentum*
	Dicksoniaceae	*Calochlaena dubia*
	Lindsaeaceae	*Lindsaea linearis*
	Schizaeaceae	*Schizaea bifida*
	Sinopteridaceae	*Pellaea falcata*
Cycadopsida (Cycads)	Zamiaceae	*Macrozamia flexuosa* [ROTAP]
		Macrozamia reducta
Magnoliopsida (Flowering Plants)		
Subclass Magnoliidae (Dicotyledons)	Acanthaceae	*Brunoniella australis*
		Brunoniella pumilio
		Pseuderanthemum variabile
	Amaranthaceae	*Alternanthera denticulata* [recorded by R. Payne 2001]
	Apiaceae	*Actinotus minor*
		Centella asiatica
		Hydrocotyle bonariensis * [recorded by R. Payne 2001]
		Hydrocotyle laxiflora
		Hydrocotyle peduncularis
		Platysace lanceolata
		Trachymene incisa subsp. incisa
		Xanthosia tridentate
	Apocynaceae	*Parsonsia straminea*
	Araliaceae	*Polyscias sambucifolia subsp. A*
	Asteraceae	*Ageratina adenophora* *
		Brachyscome angustifolia
		Cassinia uncata
		Chrysocephalum apiculatum
		Craspedia variabilis
		Eclipta platyglossa
		Epaltes australis
		Hypochaeris radicata
		Lagenifera stipitata
		Olearia tomentosa
		Ozothamnus diosmifolius
		Rutidosis heterogama [EPBC Act; TSC Act]
		Senecio madagascariensis *

	Tagetes minuta *
	Taraxacum officinale *
	Vernonia cinerea var. cinerea
Caprifoliaceae	*Lonicera japonica* * [recorded by R. Payne 2001]
Casuarinaceae	*Allocaruariina torulosa* [recorded by R. Payne 2001]
	Allocasuarina littoralis
	Casuarina glauca
Clusiaceae	*Hypericum gramineum*
Convolvulaceae	*Dichondra repens*
	Ipomoea cairica *
	Polymeria calycina
Dilleniaceae	*Hibbertia aspera subsp. aspera*
	Hibbertia empetrifolia subsp. empetrifolia
	Hibbertia serpyllifolia [recorded by R. Payne 2001]
	Hibbertia vestita
Epacridaceae	*Epacris pulchella*
	Melichrus procumbens
	Monotoca scoparia
	Woollsia pungens [recorded by R. Payne 2001]
Euphorbiaceae	*Breynia oblongifolia*
	Glochidion ferdinandi var. ferdinandi
	Phyllanthus hirtellus
Fabaceae (Faboideae)	*Bossiaea ensata* [recorded by R. Payne 2001]
	Bossiaea obcordata
	Daviesia corymbosa
	Daviesia squarrosa
	Daviesia ulicifolia
	Desmodium rhytidophyllum
	Dillwynia retorta
	Erythrina X sykesii *
	Glycine clandestina
	Glycine microphylla
	Glycine tabacina
	Gompholobium latifolium
	Hardenbergia violacea
	Kennedia rubicunda
	Mirbelia rubiifolia
	Oxylobium aciculiferum [recorded by R. Payne 2001]
	Podolobium scandens
	Pultenaea ferruginea
	Pultenaea paleacea
	Pultenaea tuberculata (syn. species H)
	Senna pendula var. glabrata *
	Sphaerolobium minus
Fabaceae (Mimosoideae)	*Acacia falcata*
	Acacia irrorata subsp. irrorata
	Acacia longifolia
	Acacia myrtifolia

	Acacia suaveolens
	Acacia terminalis subsp. angustifolia
	Acacia ulicifolia
Goodeniaceae	*Dampiera stricta*
	Goodenia hederacea var. hederacea
	Goodenia heterophylla subsp. heterophylla
	Scaevola ramosissima
	Velleia spathulata
Haloragaceae	*Gonocarpus tetragynus*
	Gonocarpus teucrioides [recorded by R. Payne 2001]
Lauraceae	*Cassytha glabella forma glabella*
	Cassytha melantha
	Cassytha pubescens
	Cinnamomum camphora *
Lobeliaceae	*Lobelia alata*
	Lobelia dentata
	Pratia purpurascens
Malvaceae	*Sida rhombifolia* *
Myrtaceae	*Angophora costata*
	Angophora floribunda
	Callistemon linearis
	Callistemon pinifolius
	Callistemon rigidus
	Callistemon salignus
	Corymbia gummifera
	Corymbia maculata
	Eucalyptus agglomerata [recorded by R. Payne 2001]
	Eucalyptus capitellata
	Eucalyptus crebra
	Eucalyptus fibrosa
	Eucalyptus globoidea
	Eucalyptus haemastoma
	Eucalyptus longifolia
	Eucalyptus pilularis
	Eucalyptus resinifera
	Eucalyptus siderophloia [recorded by R. Payne 2001]
	Eucalyptus tereticornis
	Kunzea ambigua
	Leptospermum juniperinum
	Leptospermum polygalifolium subsp. cismontanum
	Leptospermum trinervium
	Melaleuca decora
	Melaleuca ericifolia
	Melaleuca linariifolia
	Melaleuca nodosa
	Melaleuca quinquenervia
	Melaleuca sieberi
	Melaleuca thymifolia

	Syncarpia glomulifera
Oleaceae	*Ligustrum lucidum* *
	Ligustrum sinense *
Oxalidaceae	*Oxalis perennans*
Pittosporaceae	*Billardiera scandens var. scandens*
	Bursaria spinosa
	Pittosporum revolutum
	Pittosporum undulatum
Plantaginaceae	*Plantago lanceolata* *
Polygalaceae	*Comesperma ericinum*
Polygonaceae	*Persicaria decipiens*
	Persicaria strigosa [recorded by R. Payne 2001]
Proteaceae	*Banksia oblongifolia*
	Banksia serrata
	Banksia spinulosa var. collina
	Grevillea sericea
	Hakea laevipes
	Hakea sericea
	Isopogon anemonifolius
	Lambertia formosa
	Lomatia silaifolia
	Persoonia lanceolata [recorded by R. Payne 2001]
	Persoonia laurina subsp. laurina
	Persoonia levis
	Persoonia linearis
	Petrophile pulchella
Ranunculaceae	*Ranunculus plebeius*
Rosaceae	*Rubus vulgae* * [recorded by R. Payne 2001]
Rubiaceae	*Opercularia aspera*
	Opercularia diphylla
	Opercularia varia
Rutaceae	*Boronia polygalifolia*
Santalaceae	*Exocarpos cupressiformis*
Sapindaceae	*Cardiospermum sp.* * [recorded by R. Payne 2001]
	Dodonaea triquetra
Scrophulariaceae	*Veronica plebeia*
Solanaceae	*Solanum pseudocapsicum* *
Thymelaeaceae	*Pimelea linifolia subsp. linifolia*
Tremandraceae	*Tetratheca thymifolia*
Verbenaceae	*Lantana camara* *
	Verbena bonariensis *
Violaceae	*Hybanthus monopetalus*
	Viola betonicifolia
	Violia hederaceae

Magnoliopsida (Flowering Plants)

Subclass Liliidae (Monocotyledons)	Anthericaceae	*Arthropodium minus*
		Caesia parviflora var. parviflora
		Caesia parviflora var. vittata
		Laxmannia gracilis
		Sowerbaea juncea
		Thysanotus tuberosus subsp. tuberosus
		Tricoryne elatior
	Araceae	*Zantedeschia aethiopica* *
	Colchicaceae	*Burchardia umbellata*
	Commelinaceae	*Commelina cyanea*
		Tradescantia fluminensis *
	Cyperaceae	*Baumea articulata*
		Baumea juncea
		Baumea rubiginosa
		Carex appressa
		Carex inversa
		Cyathochaeta diandra
		Cyperus eragrostis
		Eleocharis sphacelata
		Gahnia aspera
		Gahnia clarkei
		Gahnia radula
		Isolepsis cernua
		Lepidosperma laterale
		Lepidosperma neesii [recorded by R. Payne 2001]
		Lepidosperma quadrangulatum
		Ptilothrix deusta
		Schoenoplectus validus
		Schoenus apogon
		Schoenus melanostachys
		Scleria mackaviensis
	Haemodoraceae	*Haemodorum corymbosum*
		Haemodorum planifolium
	Iridaceae	*Patersonia glabrata*
		Patersonia sericea
		Watsonia meriana cv. Bulbillifera *
	Juncaceae	*Juncus cognatus* *
		Juncus continuus
		Juncus usitatus
	Lomandraceae	*Lomandra confertifolia subsp. pallida*
		Lomandra cylindrica
		Lomandra filiformis subsp. coriacea
		Lomandra filiformis subsp. filiformis
		Lomandra glauca
		Lomandra longifolia

	Lomandra multiflora subsp. multiflora
	Lomandra obliqua
Orchidaceae	*Caladenia carnea*
	Caladenia catenata
	Calochilus campestris
	Calochilus paludosus
	Calochilus robertsonii
	Cryptostylis erecta
	Cryptostylis subulata
	Cymbidium suave
	Dipodium punctatum
	Diuris aurea
	Lyperanthus suaveolens
	Microtis parviflora
	Orthoceras strictum
	Prasophyllum elatum
	Pterostylis longifolia
	Thelymitra 'angustifolia' ms
	Thelymitra ixioides var. ixioides
	Thelymitra pauciflora
Philydraceae	*Philydrum lanuginosum*
Phormiaceae	*Dianella caerulea var. assera*
	Dianella caerulea var. caerulea
	Dianella longifolia [recorded by R. Payne 2001]
	Dianella revoluta var. revoluta
	Thelionema caespitosum
Poaceae	*Agrostis aemula*
	*Andropogon virginicus **
	Anisopogon avenaceus
	Aristida ramosa
	Aristida vagans
	Aristida warburgii
	Austrodanthonia setacea
	Austrodanthonia tenuior
	Austrostipa ramosissima
	*Axonopus fissifolius **
	*Briza maxima **
	*Cortaderia selloana **
	Cymbopogon refractus
	Cynodon dactylon
	Deyeuxia quadriseta
	Dichelachne micrantha
	Digitaria parviflora
	Echinopogon caespitosus var. caespitosus
	Echinopogon ovatus
	*Ehrharta erecta **
	Entolasia marginata
	Entolasia stricta

		Eragrostis brownii
		Hemarthria uncinata var. uncinata
		Imperata cylindrica var. major
		Isachne globosa [recorded by R. Payne 2001]
		Joycea pallida
		Microlaena stipoides var. stipoides
		Oplismenus aemulus
		Oplismenus imbecillis
		Panicum simile
		*Paspalum dilatatum **
		*Paspalum urvillei **
		Phragmites australis
		Poa labillardierei var. labillardierei
		*Setaria glauca ** [recorded by R. Payne 2001]
		Themeda australis
	Restionaceae	*Lepyrodia scariosa*
	Xanthorrhoeaceae	*Xanthorrhoea fulva*
		Xanthorrhoea latifolia subsp. latifolia
		Xanthorrhoea macronema
Total species		287

APPENDIX 2

APPENDIX 3 FAUNA SPECIES RECORDED IN STUDY AREA

FAMILY Scientific Name	Common Name	EP&BC Act 1999	TSC Status	Jamba Camba	Recorded in Study Area	5km radius Record
BIRDS						
PHASIANIDAE						
Coturnix ypsilophora	Brown Quail					*
ANATIDAE						
Biziura lobata	Musk Duck					*
Chenonetta jubata	Australian Wood Duck				+	*
** Anas platyrhychos*	* Mallard					
Anas superciliosa	Pacific Black Duck				+	*
Anas castanea	Chestnut Teal					*
PHALACROCORACIDAE						
Phalacrocorax melanoleucos	Little Pied Cormorant					*
Phalacrocorax sulcirostris	Little Black Cormorant					*
Phalacrocorax carbo	Great Cormorant					*
PELECANIDAE						
Pelecanus conspicillatus	Australian Pelican				overhead	*
ARDEIDAE						
Egretta novaehollandiae	White-faced Heron				+	*
Egretta garzetta	Little Egret					*
Ardea pacifica	White-necked Heron					*
Ardea alba	Great Egret			J	+	*
Ardea intermedia	Intermediate Egret					*
Ardea ibis	Cattle Egret			J		
Ixobrychus flavicollis	**Black Bittern**		V			*
Botaurus poiciloptilus	**Australasian Bittern**		V			*
PLATALEIDAE						
Threskiornis molucca	Australian White Ibis					*
Threskiornis spinicollis	Straw-necked Ibis					*
Platalea regia	Royal Spoonbill					*
CICONIIDAE						
Ephippiorhynchus asiaticus	**Black-necked Stork (Jabiru)**		E			*
ACCIPITRIDAE						
Aviceda subcristata	Pacific Baza				+	
Elanus axillaris	Black-shouldered Kite				+	*
Haliastur sphenurus	Whistling Kite				+	
Circus approximans	Swamp Harrier					*
Accipiter fasciatus	Brown Goshawk					*
Accipiter novaehollandiae	Grey Goshawk					*
Aquila audax	Wedge-tailed Eagle				+	*
Hieraaetus morphnoides	Little Eagle					*
FALCONIDAE						
Falco berigora	Brown Falcon					*
Falco longipennis	Australian Hobby					*
Falco cenchroides	Nankeen Kestrel				+	*
RALLIDAE						
Rallus pectoralis	Lewin's Rail					*
Porzana pusilla	Baillon's Crake					*
Porphyrio porphyrio	Purple Swamphen				+	*

FAMILY Scientific Name	Common Name	EP&BC Act 1999	TSC Status	Jamba Camba	Recorded in Study Area	5km radius Record
CHARADRIIDAE						
Elseyornis melanops	Black-fronted Dotterel					*
Vanellus miles	Masked Lapwing				+	*
LARIDAE						
Larus novaehollandiae	Silver Gull					*
Sterna bergii	Crested Tern					*
COLUMBIDAE						
** Columba livia*	* Rock Dove				+	
Columba leucomela	White-headed Pigeon					*
** Streptopelia chinensis*	* Spotted Turtle-dove				+	*
Ocyphaps lophotes	Crested Pigeon				+	*
Geopelia striata	Peaceful Dove					*
Geopelia humeralis	Bar-shouldered Dove				+	*
Ptilinopus superbus	**Superb Fruit-dove**		V			*
Lopholaimus antarcticus	Topknot Pigeon					*
CACATUIDAE						
Calyptorhynchus lathami	**Glossy Black-Cockatoo**		V			*
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo					*
Cacatua roseicapilla	Galah				+	*
Cacatua tenuirostris	Long-billed Corella					*
Cacatua sanguinea	Little Corella				+	*
Cacatua galerita	Sulphur-crested Cockatoo				+	*
PSITTACIDAE						
Trichoglossus haematodus	Rainbow Lorikeet				+	*
Alisterus scapularis	Australian King Parrot				+	*
Platycerus eximius	Eastern Rosella				+	*
CUCULIDAE						
Cuculus pallidus	Pallid Cuckoo					*
Cacomantis flabelliformis	Fan-tailed Cuckoo				+	*
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo				+	
Eudynamis scolopacea	Common Koel				+	
Scythrops novaehollandiae	Channel-billed Cuckoo				+	*
CENTROPODIDAE						
Centropus phasianinus	Pheasant Coucal				+	*
STRIGIDAE						
Ninox strenua	**Powerful Owl**				+	
Ninox novaeseelandiae	Southern Boobook				+	*
TYTONIDAE						
Tyto novaehollandiae	**Masked Owl**		V			*
Tyto alba	Barn Owl					*
PODARGIDAE						
Podargus strigoides	Tawny Frogmouth				+	*
AEGOTHELIDAE						
Aegotheles cristatus	Australian Owlet-Nightjar				+	
APODIDAE						
Hirundapus caudacutus	White-throated Needletail			J	+	*
HALCYONIDAE						
Dacelo novaeguineae	Laughing Kookaburra				+	*
Todiramphus sancta	Sacred Kingfisher				+	*
MEROPIDAE						

FAMILY Scientific Name	Common Name	EP&BC Act 1999	TSC Status	Jamba Camba	Recorded in Study Area	5km radius Record
Merops ornatus	Rainbow Bee-eater			J		*
CORACIIDAE						
Eurystomus orientalis	Dollarbird				+	*
CLIMACTERIDAE						
Climacteris leucophaea	White-throated Treecreeper				+	*
MALURIDAE						
Malurus cyaneus	Superb Fairy-wren				+	*
Malurus lamberti	Variegated Fairy-wren				+	
PARDALOTIDAE						
Pardalotus punctatus	Spotted Pardalote				+	*
Sericornis frontalis	White-browed Scrubwren				+	*
Gerygone olivacea	White-throated Gerygone				+	
Acanthiza pusilla	Brown Thornbill				+	*
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				+	*
Acanthiza lineata	Striated Thornbill				+	
MELIPHAGIDAE						
Anthochaera carunculata	Red Wattlebird				+	
Anthochaera chrysoptera	Little Wattlebird				+	*
Philemon corniculatus	Noisy Friarbird				+	*
Xanthomyza phrygia	**Regent Honeyeater**	E	E			*
Manorina melanophrys	Bell Miner					*
Manorina melanocephala	Noisy Miner				+	*
Lichenostomus chrysops	Yellow-faced Honeyeater				+	*
Lichenostomus penicillatus	White-plumed Honeyeater					*
Melithreptus brevirostris	Brown-headed Honeyeater					*
Grantiella picta	**Painted Honeyeater**		V			*
Phylidonyris novaehollandiae	New Holland Honeyeater				+	*
Phylidonyris nigra	White-cheeked Honeyeater				+	*
Acanthorhynchus tenuirostris	Eastern Spinebill				+	*
Myzomela sanguinolenta	Scarlet Honeyeater				+	*
PETROICIDAE						
Eopsaltria australis	Eastern Yellow Robin				+	*
CINCLOSOMATIDAE						
Psophodes olivaceus	Eastern Whipbird				+	*
PACHYCEPHALIDAE						
Pachycephala pectoralis	Golden Whistler				+	
Pachycephala rufiventris	Rufous Whistler					*
Colluricincla harmonica	Grey Shrike-thrush				+	*
DICRURIDAE						
Myiagra rubecula	Leaden Flycatcher				+	*
Grallina cyanoleuca	Magpie-Lark				+	*
Rhipidura rufifrons	Rufous Fantail					*
Rhipidura fuliginosa	Grey Fantail				+	*
Rhipidura leucophrys	Willie Wagtail				+	*
Dicrurus bracteatus	Spangled Drongo					*
CAMPEPHAGIDAE						
Coracina novaehollandiae	Black-faced Cuckoo-shrike				+	*
Coracina tenuirostris	Cicadabird				+	
Lalage sueurii	White-winged Triller					*
ORIOLIDAE						

FAMILY Scientific Name	Common Name	EP&BC Act 1999	TSC Status	Jamba Camba	Recorded in Study Area	5km radius Record
Oriolus sagittatus	Olive-backed Oriole				+	*
ARTAMIDAE						
Artamus leucorhynchus	White-breasted Woodswallow					*
Artamus cyanopterus	Dusky Woodswallow					*
Cracticus torquatus	Grey Butcherbird				+	*
Cracticus nigrogularis	Pied Butcherbird					*
Gymnorhina tibicen	Australian Magpie				+	*
Strepera graculina	Pied Currawong				+	*
CORVIDAE						
Corvus coronoides	Australian Raven				+	*
CORCORACIDAE						
Corcorax melanorhamphos	White-winged Chough					*
PTILONORHYNCHIDAE						
Sericulus chrysocephalus	Regent Bowerbird					*
MOTACILLIDAE						
Anthus novaeseelandiae	Richard's Pipit				+	*
PASSERIDAE						
** Passer domesticus*	* House Sparrow				+	
Neochmia temporalis	Red-browed Firetail				+	*
Lonchura castaneothorax	Chestnut-breasted Mannikin					*
HIRUNDINIDAE						
Hirundo neoxena	Welcome Swallow				+	*
Hirundo nigricans	Tree Martin					*
Hirundo ariel	Fairy Martin					
SYLVIIDAE						
Megalurus gramineus	Little Grassbird					*
Cisticola exilis	Golden-headed Cisticola				+	*
ZOSTEROPIDAE						
Zosterops lateralis	Silvereye				+	*
STURNIDAE						
** Sturnus vulgaris*	* Common Starling				+	
** Acridotheres tristis*	* Common Myna				+	*
MAMMALS						
TACHYGLOSSIDAE						
Tachyglossus aculeatus	Short-beaked Echidna					*
DASYURIDAE						
Antechinus stuartii	Brown Antechinus				+	*
PERAMELIDAE						
Isoodon obesulus	**Southern Brown Bandicoot**		E			?
Isoodon macrourus	Northern Brown Bandicoot				+	*
Perameles nasuta	Long-nosed Bandicoot					*
PHASCOLARCTIDAE						
Phascolarctos cinereus	**Koala**		V			*
PETAURIDAE						
Petaurus breviceps	Sugar Glider				+	*
Petaurus norfolcensis	**Squirrel Glider**		V		+	*
PSEUDOCHEIRIDAE						
Petauroides volans	Greater Glider					*
Pseudocheirus peregrinus	Common Ringtail Possum				+	*

FAMILY Scientific Name	Common Name	EP&BC Act 1999	TSC Status	Jamba Camba	Recorded in Study Area	5km radius Record
ACROBATIDAE						
Acrobates pygmaeus	Feather-tail Glider					*
PHALANGERIDAE						
Trichosurus vulpecula	Common Brushtail Possum				+	*
MACROPODIDAE						
Macropus giganteus	Eastern Grey Kangaroo				+	*
Macropus rufogriseus	Red-necked Wallaby				+	
Wallabia bicolor	Swamp Wallaby				+	*
PTEROPODIDAE						
Pteropus poliocephalus	Grey-headed Flying-fox					*
Pteropus scapulatus	Little Red Flying-fox					*
EMBALLONURIDAE						
Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**		V			*
MOLOSSIDAE						
Mormopterus norfolkensis	**Eastern Free-tail Bat**		V			*
Mormopterus sp. 2	Freetail Bat				+	
Nyctinomus australis	White-striped Freetail-bat				+	*
VESPERTILIONIDAE						
Miniopterus australis	**Little Bent-wing Bat**		V			*
Miniopterus schreibersii	**Eastern Bent-wing Bat**		V			*
Nyctophilus geoffroyi	Lesser Long-eared Bat					*
Nyctophilus gouldi	Gould's Long-eared Bat				+	*
Chalinolobus gouldii	Gould's Wattled Bat				+	*
Chalinolobus morio	Chocolate Wattled Bat				+	*
Myotis adversus	**Large-footed Myotis**		V			*
Scoteanax rueppellii	**Greater Broad-nosed Bat**		V			*
Scotorepens orion	Eastern Broad-nosed Bat				+	
Vespadelus darlingtoni	Large Forest Bat					*
Vespadelus pumilus	Eastern Forest Bat					*
Vespadelus vulturnus	Little Forest Bat				+	*
MURIDAE						
Hydromys chrysogaster	Water Rat					*
* *Mus musculus*	* House Mouse				+	*
Rattus fuscipes	Bush Rat					*
Rattus lutreolus	Swamp Rat				+	*
* *Rattus rattus*	* Black Rat				+	*
CANIDAE						
* *Canis familiaris*	* Dog				+	*
* *Vulpes vulpes*	* Fox				+	*
FELIDAE						
* *Felis catus*	* Cat (stray domestic)				+	*
LEPORIDAE						
* *Lepus capensis*	* Brown Hare				+	*
* *Oryctolagus cuniculus*	* Rabbit				+	*
EQUIDAE						
* *Equus caballus*	* Horse				+	

REPTILES						
CHELIDAE						
Chelodina longicollis	Long-necked Tortoise				+	
GEKKONIDAE						
Diplodactylus vittatus	Wood Gecko					*
AGAMIDAE						
Amphibolurus muricatus	Jacky Lizard				+	*
Physignathus lesueurii	Eastern Water Dragon				+	
VARANIDAE						
Varanus varius	Lace Monitor					*
SCINCIDAE						
Ctenotus robustus	Striped Skink					*
Cyclodomorphus casuarinae	Oak Skink					*
Eulamprus quoyii	Eastern Water Skink				+	*
Lampropholis delicata	Garden Skink				+	*
Tiliqua scincoides	Eastern Blue-tongued Lizard					*
ELAPIDAE						
Hemiaspis signata	Black-bellied Snake					*
Pseudechis porphyriacus	Red-bellied Black Snake				+	*
Pseudonaja textilis	Eastern Brown Snake					*
AMPHIBIANS						
MYOBATRACHIDAE						
Crinia signifera	Common Eastern Froglet				+	*
Crinia tinnula	**Wallum Froglet**		V		+	*
Limnodynastes dumerilii	Eastern Banjo Frog					*
Limnodynastes peronii	Brown-striped Frog				+	*
Limnodynastes tasmaniensis	Spotted Grass Frog					*
Mixophyes iteratus	**Giant Barred Frog**	E	E			*
Paracrinia haswelli	Haswell's Frog					*
Pseudophryne bibronii	Brown Toadlet					*
Uperoleia fusca	Dusky Toadlet				+	*
Uperoleia laevigata	Smooth Toadlet					*
HYLIDAE						
Litoria aurea	**Green & Golden Bell Frog**	V	E			*
Litoria brevipalmata	**Green-thighed Frog**		V			*
Litoria dentata	Bleating Tree Frog					*
Litoria fallax	Eastern Dwarf Tree Frog				+	*
Litoria freycineti	Freycinet's Frog					*
Litoria latopalmata	Broad Palmed Frog				+	*
Litoria peronii	Peron's Tree Frog				+	*
Litoria phyllochroa	Leaf Green Tree Frog					*
Litoria verreauxii	Whistling Tree Frog				+	

Appendix 4 Squirrel Glider Habitat Impact Assessment

Squirrel Glider habitat in the proposed Warnervale Town Centre study area was assessed according to Wyong Shire Council's *Habitat Information to Assist Assessment of Significance of Development Impacts on Squirrel Glider Habitat* (Appendix 1 of the Squirrel Glider Conservation Management Plan (Smith, 2002).

Appendix 4.1 Habitat Information required to Assist in Making any Merit Based Assessment.

The following survey based information should be made available to council:

- *Detailed plan of remnant patch showing locations of adjacent patches and main vegetation assemblages.*

The mapping of vegetation in the study area is presented in Figure 4 on page 23 of this report. The mapping of fragments and size of vegetation remnants is provided below in Figure A4.1.

- *Microhabitat features of each vegetation assemblage should be described such as dominant species, mature trees, percentage cover of different plant species, presence of introduced species.*

The microhabitats of the study area are presented in Section 3.3 of the report (pages 24 - 29).

- *Map locations of habitat trees (trees with visible hollows >5cm diameter*

Due to the size of the study area (178.4 hectares), it was not feasible to map all habitat trees suitable for the Squirrel Glider. However, a general description of the density of habitat trees per habitat type is presented in Section 3.3 of this document. It is recommended that mapping of all habitat trees be undertaken at the development application stage on individual allotments.

- *Show area to be disturbed by development proposal and outline any mitigative measures (clearing, under scrubbing, boring, grazing).*

At present, the proposal to develop the land is conceptual, and no development applications have been lodged for the study area.

- *Show level of disturbance and discuss disturbance history.*

The degree of disturbance to vegetation is illustrated in Figure 4, and described in Section 3.2 and 3.3 of this report.

- *Provide distance measurements to adjoining areas of remnant vegetation and size (area) of adjoining patches.*

Refer to Figure A4.1 below.

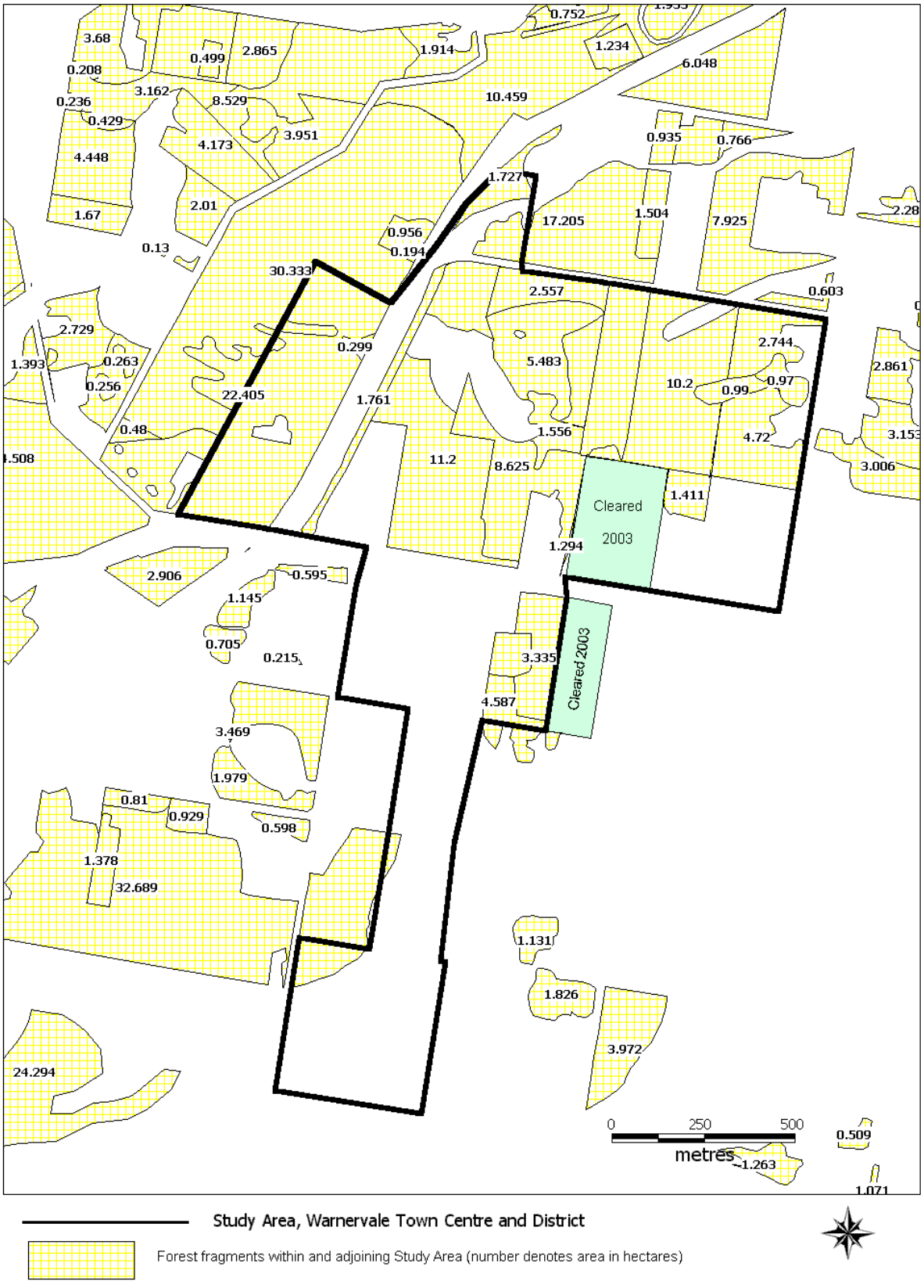

Figure A4.1 Size and Distance of Adjoining Habitat Fragments.

Appendix 4.1.1 Habitat Suitability

(a) Habitat Quality

Assess relative predominance of optimum Squirrel Glider microhabitat types according to vegetation assemblage type:

	Habitat Area	% habitat type in patch
1. Stringybark/Gum with Acacia/Melaleuca/Grass understorey		
2. Spotted Gum / Ironbark / Gum	12.73	45.46%
3. Stringybark with Banksia / Allocasuarina / Melaleuca understorey		
4. Sydney Red Gum / Scribbly Gum with Allocasuarina / Melaleuca understorey		
5. Sydney Red Gum / Scribbly Gum with Banksia understorey	7.922	100.0%
6. If plant assemblage type does not fit well with the above describe below: Narrabeen Coastal Blackbutt Shrubby Forest Alluvial Redgum Footslopes Forest Grassland	 6.672 2.08	 11.5% 10.0%
Total		

(b) Remnant Patch Size

Assess patch size(s) on site according to the scale outlined below:

Patch < 5 hectares in size	
Patch > 5 but less than 10 hectares in size	**7.92**
Patch > 10 but less than 30 hectares in size	**22.405**
Patch > 30 but less than 90 hectares in size	**60.62**
Patch > 90 hectares	

(c) Density Habitat Trees

Average number of trees with hollows per hectare < 2 habitat tree / hectare	
Average number of trees with hollows per hectare > 2 habitat tree / hectare	**3.0**

(d) Abundance of Food Plants of Squirrel Glider

Quantitatively assess using plot based data, the proportion of Squirrel Glider food plants which occur on the site and show plot locations on map. Field survey effort for measuring food plant abundance should be applied as per Councils Flora and Fauna Guidelines for Development (see section on survey effort for vegetation plots). A summary of locally occurring food resources for Squirrel Gliders is provided below:

Local Food Plants in Study Area		Food Item	Av. Number of plants / hectare	% of vegetation assemblage
Angophora	*costata*	Sap, nectar & pollen		-
Eucalyptus	*haemastoma*	Sap, nectar & pollen		-
	racemosa	Sap, nectar & pollen		-
	robusta	Sap, nectar & pollen		
	siderophloia / paniculata	Sap, nectar & pollen		
	fibrosa	Sap, nectar & pollen		
	tereticornis	Sap, nectar & pollen		
	maculata	Sap, nectar & pollen		
Corymbia	*gummifera*	Sap, nectar & pollen		
Melaleuca	*linariifolia*	Nectar & insect bark food		
	nodosa	Nectar & insect bark food		
	quinquenervia	Nectar & insect bark food		
	decora	Nectar & insect bark food		
	Sieberi	Nectar & insect bark food		
Acacia	*Parvipinnula*	Seeds and gum		
Banksia	*Spinulosa*	nectar & pollen		
	Serrata	nectar & pollen		
	Integrifolia	nectar & pollen		
	Oblongifolia	nectar & pollen		
Xanthorrhoea	*spp.*	nectar & potential pollen		

Appendix 4.1.2 Habitat Vulnerability

Factors to be assessed include area, edge/area ratio of the habitat, presence of disturbed or weed invaded vegetation within remnant patch, presence of threatening processes and impact of surrounding land use proposals. Assessment criteria are outlined below.

(a) Edge to Width Ratio

Which shape is the patch size 7.92 hectares most similar to?

Round

Oval Shaped

Narrow Linear Fragment

Which shape is the patch size 22.405 hectares most similar to?

Round

Oval Shaped

Narrow Linear Fragment

Which shape is the patch size 60.62 hectares most similar to?

Round

Oval Shaped

Narrow Linear Fragment

(b) Habitat Disturbance

What % of the patch area has experienced disturbance by weed invasion, under scrubbing, fire or other understorey disturbance?

Approximately 60% of the study area is subjected to disturbance impacts, such as past clearing of remnant vegetation for rural / residential activities, weed infestation, dumping of domestic rubbish.

c Proximity to Existing or Future Residential Development

Is the fragment within 200 metres of an existing or future residential development? **Yes** No

Appendix 4.1.3 Resident Breeding Squirrel Gliders

Presence / absence of resident breeding Squirrel Gliders in patch? **Yes** No

Applicants must supply details from trapping program.

No gliders trapped during survey in October and November 2003. Several individuals trapped within the study area during previous investigations of the Wyong region in 1999.

Date	Location	Easting	Northing	Species	Sex	Wt (g)
7/09/1999	cnr Minnesota and Wallarah Road, Warnervale	357100	6320450	Squirrel Glider	M	218
8/09/1999	cnr Minnesota and Wallarah Road, Warnervale	357100	6320450	Squirrel Glider	M	191
8/09/1999	cnr Minnesota and Wallarah Road, Warnervale	357100	6320450	Squirrel Glider	M	205

Appendix 4.1.4 Summary

The study area is approximately 178.4 hectares in area, with remnant forest contiguous with the study area in the north-eastern and western part. The quality of the foraging habitat for the Squirrel Glider is high, with many habitat trees with hollows to provide sheltering sites for the species, and good connectivity (<75m width) between adjoining vegetation remnants.

The Warnervale Town Centre study area is not considered part of the network of major remnants identified by Smith (2000, 2002). However, applications to clear Squirrel Glider habitat in the study area will require individual merit based assessment.

Within the study area, populations of the Squirrel Glider are likely to occur within most of the vegetation remnants. However, there are two significant barriers to dispersal of Squirrel Glider, Sparks Road and the Main Northern Railway. The study area is effectively dividing into three sectors, with the north-eastern and north-western sector supporting large, well connected fragments of vegetation. The extent of habitat within the north-eastern sector (north of Sparks Road, east of Main Northern Railway) is approximately 58 hectares of remnant vegetation, with isolation scores of 1 and 2 (i.e. good connectivity). Outside of this sector, more extensive areas of Squirrel Glider habitat occur with isolation classes of 1-3. Application of class impact merit assessment indicates clearing or modification of vegetation remnants supporting Squirrel Glider habitat within the north-east sector would constitute a Class 2b impact, and require preparation of a species impact statement.

In the north-western sector (north of Sparks Road, west of Main Northern Railway), the extent of Squirrel Glider habitat within the study area is approximately 17 hectares, with more extensive areas of suitable habitat continuous with Lot 1 DP 357408. Application of class impact merit assessment indicates clearing or modification of vegetation supporting Squirrel Glider habitat within the north-west sector would constitute a Class 2b impact, and require preparation of a species impact statement.

Within the southern sector (south of Sparks Road) the habitat for Squirrel Glider consists of smaller fragments with high isolation scores (4-5). Areas of suitable habitat for Squirrel Glider in Lots 7 DP 739910 and Lot 1 DP 781737 off Sparks Road is isolated from adjoining habitat south of Warnervale Road by cleared areas and low swamp forest. Tree cover within the swamp forest is sparse, which may provide cover for dispersing individuals, but would not constitute habitat suitable as regular (i.e. daily) foraging movements by the Squirrel Glider. Application of class impact merit assessment (refer to Appendix 4 for full assessment) indicates clearing or modification of vegetation supporting Squirrel Glider habitat within the southern sector would constitute a Class 3 impact, and not require preparation of a species impact statement.