

Figure 4: Aerial photo of study area
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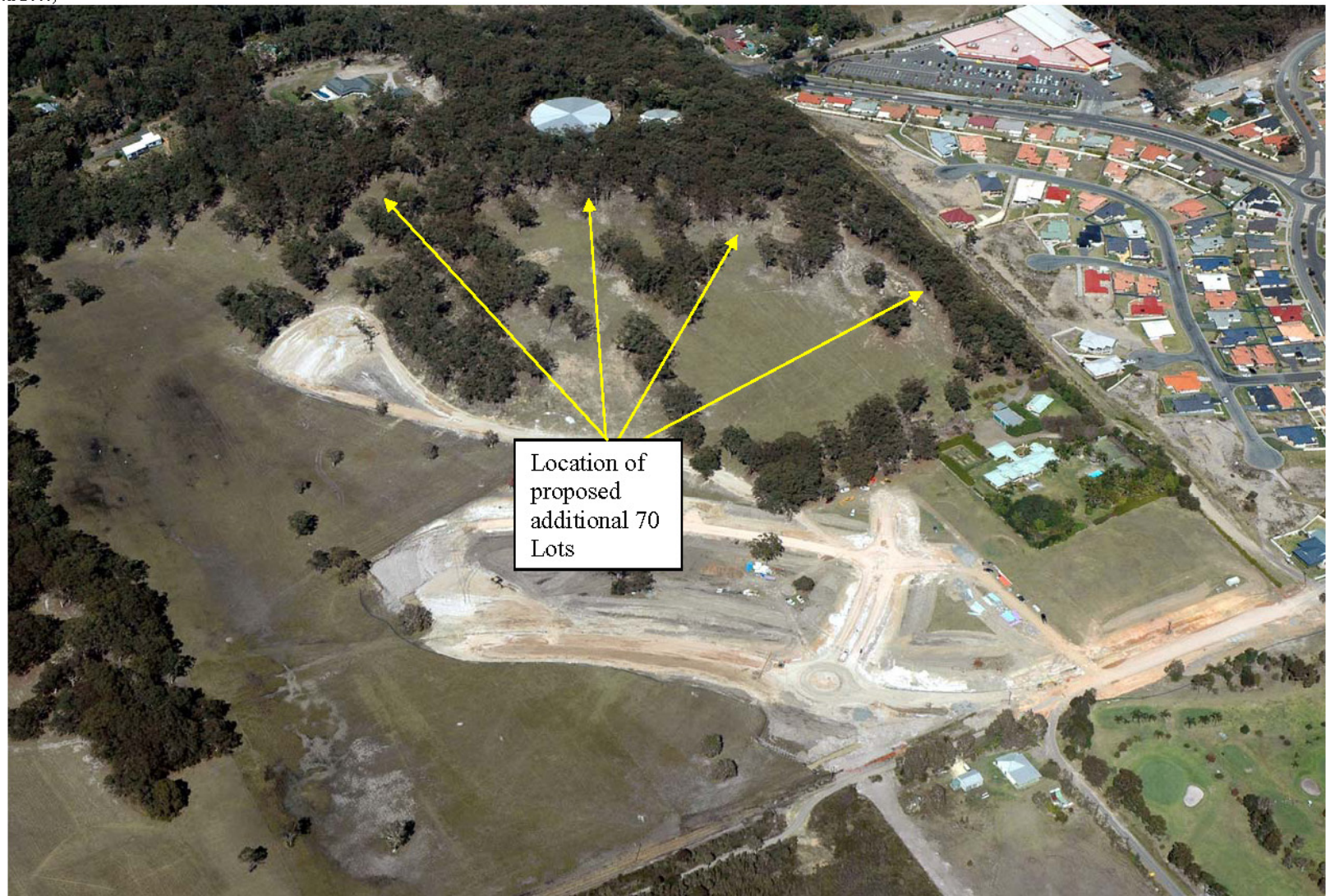
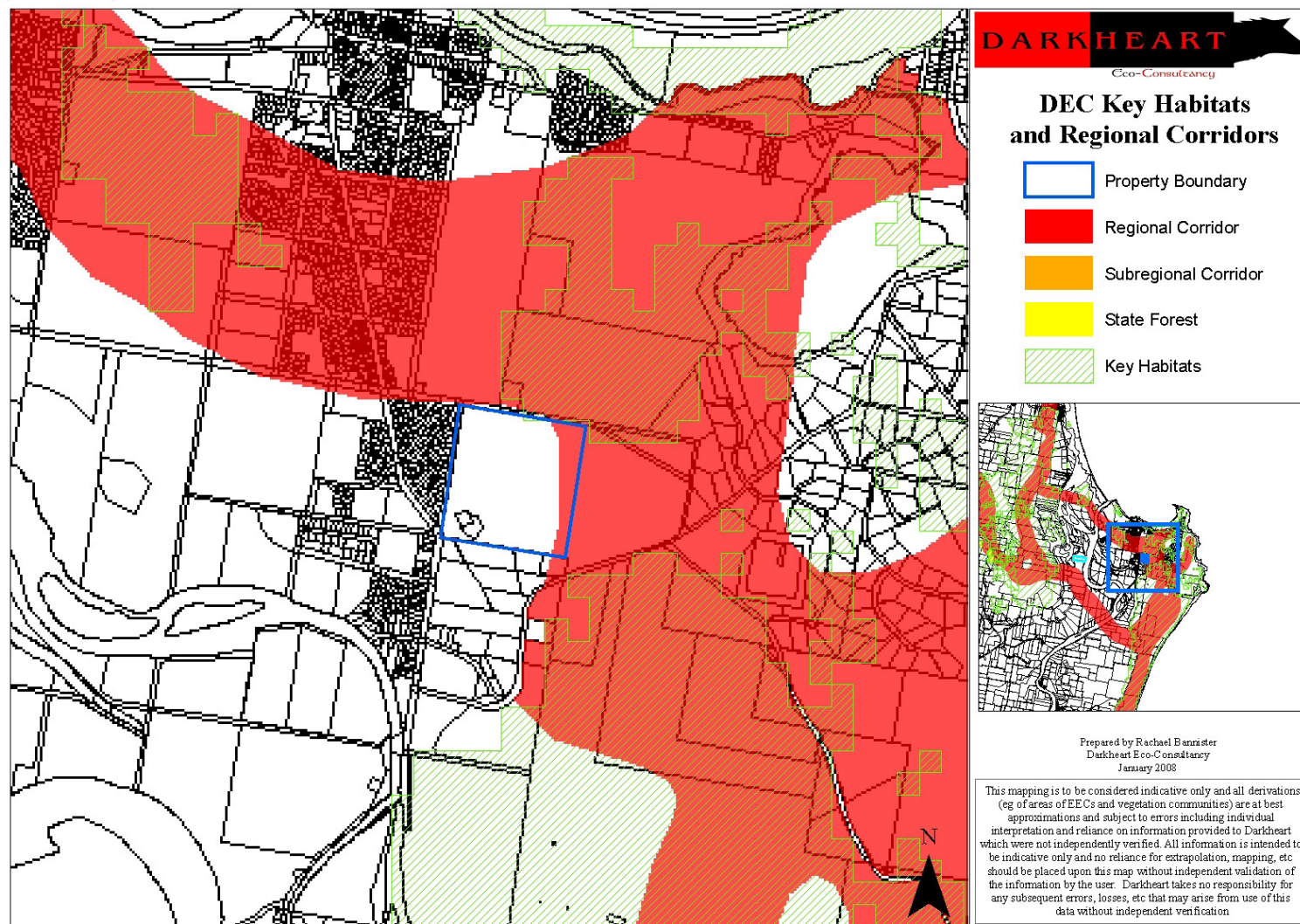


Figure 5: Regional/Sub-Regional Corridors and Key Habitats
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3.5.1 Habitat Links

Refer to the aerial photograph in figure 4. The connectivity of the site/property with surrounding habitat is summarised below:

- *North/Northeast*: No significant linkages due to the extent of previous clearing and pastoralism. Current tentative linkage via linear stands of trees broken via impending removal for approved stages of the subdivision, and lack of connectivity to vegetation north of the property.
- *South*: Maintains excellent connectivity to extensive area of fragmented forest.
- *West*: Effectively isolated via relatively recent (<15yrs) residential development.
- *East*: Maintains excellent connectivity with an extensive area of intact forest.

This extent of available habitat as well as the extent of forest indicates the site/property and adjacent linkages to the south and west may be suitable for dispersal by a wide variety of species including terrestrial fauna (excluding those dependent on well developed groundcover due to the lack of development of this component) to more mobile species capable of traversing cleared or forested habitats. Species present on site/property with large home ranges are also likely to extend their range onto this adjacent habitat, and potentially interbreed with members of other populations in the area due to the connectivity with similar habitat on adjacent land eg dry sclerophyll forest extends to the west and south.

3.5.2 DECC Wildlife Corridors and Key Habitats

3.5.2.1 General

The DECC has modelled and mapped corridors at a regional scale throughout northern NSW and the corresponding map for the locality was accessed via the website (www.maps.nationalparks.nsw.gov.au/keyhabs/default.htm) and is shown in figure 5.

3.5.2.2 Regional Corridors and Sub-Regional Corridors

Regional corridors are typically >500m wide and provide a link between major and/or significant areas of habitat in the region. Ideally they are of sufficient size to provide habitat in their own right and at least twice the width of the average home range area of fauna species identified as likely to use the corridor (DEC 2007c, Scotts 2002). Sub-regional corridors connect larger landscaped features and are of sufficient width to allow movement and dispersal (generally >300m), but may not provide substantial species habitat (DEC 2007c, Scotts 2002).

Figure 5 shows the eastern margin of the property falls just inside regional corridor which generally falls over Hat Head National Park in the east and continues north (then northeast) and south along the coast line, with a branch heading west (over residential land) just north of the property. Linkages to the west are very poor due to extensive residential development, hence the functional effectiveness of the corridor in this direction is considered at best limited. Habitat to the west is likely to be more suitable as a movement corridor due to its connectivity with habitat in all directions ie the site is fragmented internally and has limited habitat linkage to the northeast and east.

The site/property is not mapped as forming part of any sub-regional corridor.

3.5.2.3 Local Corridors

Local corridors provide connections between remnant patches of habitat and landscape features. Due to their relatively small area and width (they may be <50m) these corridors are subject to edge effects (DEC 2004b).

As stated in section 3.5.1, the site/property only has substantial connectivity via forest to the south and west, with connectivity to the west hampered by residential development, and via pasture and future residential land to the north. The forest which dominates the south to southwest corner of the property forms part of a fragmented body of forest extending south and west, eventually interlinking to Hat Head National Park.

3.5.2.4 Key Habitats

Key habitats are defined as “*areas of predicted high-conservation value for priority forest fauna assemblages, endemic forest vertebrates or endemic invertebrates*” (Scotts 2002).

As shown in figure 5, the remaining forest on the property is not mapped as Key Habitat, nor is most of the remaining forest to the south.

3.6 FAUNA SURVEY RESULTS

3.6.1 Call Playback, Identification and Recording

3.6.1.1 Birds

Call playback failed to gain a response from any of the target birds (ie Bush-Stone Curlew, Barking, Powerful and Masked Owls). Some common birds were detected by call identification (see table 3).

3.6.1.2 Frogs

Frog calls were heard in the dam after a sufficient level of rain which occurred during the survey. Despite these conditions, only the Common Eastern Froglet was detected which was reasonably expected given the tolerance of this frog for modified habitats (Cogger 2002, Anon 2002, Anstis 2002).

3.6.1.3 Mammals

3.6.1.3.1 Arboreal Mammals

No Yellow-Bellied Gliders responded to either recorded Yellow-Bellied Glider territorial calls or Powerful Owl calls. Koala and Squirrel Glider call playback also failed to gain any responses. No response was made to these calls from adjoining land.

3.6.2 Trapping and Hair Tube Results

Elliot B trapping resulted in the capture of a single adult male Squirrel Glider and a single Sugar Glider along the ridge line adjacent to the water towers. This species is listed as Vulnerable under the TSCA.

Hair tubes and Elliot A trapping failed to record any results.

3.6.3 Spotlighting, Secondary Evidence and Opportunistic Observations

3.6.3.1 Spotlighting and Torch Searches

Elliot B trapping resulted in the capture of a single adult male Squirrel Glider and a single Sugar Glider along the ridge line adjacent to the water towers. This species is listed as Vulnerable under the TSCA.

Hair tubes and Elliot A trapping failed to record any results.

3.6.3.2 Secondary Evidence

3.6.3.2.1 Scratches

Tracks and scratches were observed on smooth bark species though the intensity of scratching did not indicate high use. Scratches were most likely due to Laced Monitor, possum and glider activity with no Koala scratches detected.

3.6.3.2.2 Bones, Scats and Tracks

No scats, tracks or bones of any threatened species were detected on site. Scats from the Eastern Grey Kangaroo were commonly observed. Scat detection was hindered by the heavy rainfall experienced over the survey period.

3.6.3.2.3 Feeding Signs

(i) *Sap Sucking - Arboreal Mammals*

Only a handful of small incisions were noted in some Scribbly Gums on the ridgeline. The small size and position on the tree suggested Squirrel Gliders or Sugar Gliders not the Yellow-Bellied Glider were responsible (NPWS 2003c).

(ii) *Digging and Burrowing*

No diggings or burrows were detected during the survey.

(iii) *Chewed Allocasuarina Cones:*

No chewed cones indicative of foraging by the Glossy Black Cockatoo were found.

3.6.3.3 Opportunistic Observations

3.6.3.3.1 General

Table 3 lists all the species detected by this survey on and directly adjacent to the study site by spotlighting, call detection, opportunistic recordings and habitat inspections. A total of 8 birds, 4 mammals, 2 reptile and 1 frog were recorded.

3.6.3.3.2 Birds

No threatened or migratory birds under the EPBCA or TSCA were recorded during the survey. The recorded species were predominantly woodland species (eg Eastern Rosella, Willie Wagtail, Laughing Kookaburra, Noisy Miner, etc).

3.6.3.3.3 Reptiles

No reptiles were observed by the survey, though common Grass Skinks were observed in previous visits.

3.6.3.3.4 Mammals

The Eastern Grey Kangaroo was the only mammal opportunistically recorded during the survey.

3.6.3.3.5 Frogs

The Common Eastern Froglet was heard calling as listed previously.

Table 5: Fauna recorded on and/or adjacent to the site

bold indicates threatened species under the TSCA; # indicated threatened species under the EBPCA; * indicates introduced species.

GROUP	COMMON NAME	SCIENTIFIC NAME
BIRDS	Eastern Rosella	<i>Platycercus eximius</i>
	Laughing Kookaburra	<i>Dacelo novaeguineae</i>
	Willie Wagtail	<i>Rhipidura leucophrys</i>
	Grey Fantail	<i>Rhipidura fuliginosa</i>
	Australian Magpie	<i>Gymnorhina tibicen</i>
	Australian Raven	<i>Corvus coronoides</i>
	Australian Wood Duck	<i>Chenonetta jubata</i>
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
MAMMALS	Eastern Grey Kangaroo	<i>Macropus giganteus</i>
	Squirrel Glider	<i>Petaurus norfolkensis</i>
	Sugar Glider	<i>Petaurus breviceps</i>
REPTILES	Grass Skink	<i>Lampropholis delicata</i>
	Laced Monitor	<i>Varus varius</i>
FROGS	Common Eastern Froglet	<i>Crinia signifera</i>

3.7 DISCUSSION OF FAUNA SURVEY RESULTS

3.7.1 General

Despite the evidence of at times significant habitat modification and unfavourable weather conditions during the survey, the fauna assemblage detected on the site/property is generally consistent with species detected in similar habitats (see 3.7.2) in the Grassy Heads, Stuarts Point and South West Rocks area (Darkheart 2006f, 2006j, 2004f, 2004j, 2004x, 2000a, 2000b, 2000c, 2002a, Parker 1996, O'Neil and Williams 2003).

Arboreal mammal diversity was limited compared to nearby sites though generally typical of the habitat type as evidenced by surveys of similar habitat in the locality (Darkheart 2006f, 2006j, 2004f, 2000a, 2000b, 2000c, 2002a, Parker 1996, O'Neil and Williams 2003). Lack of moist sclerophyll is a limitation on the occurrence of some other species (eg Ringtail Possum), though the Brushtailed Phascogale was expected to be detected given local records in identical habitat within 1km (Darkheart 2004f, 2004j). Small terrestrial mammals were reasonably expected to be at best in low abundance and diversity due to the limited extent of dense groundcover and other refugia (Johnson *et al* 2007, Deacon 1998) – the failure to detect any is probably a combination of habitat quality and the poor weather. The very poor diversity of reptiles detected is also considered to be a reflection of these factors.

Bird abundance and diversity was limited as expected given the lack of well developed lower strata over most of the study area, and lack of specific habitats such as rainforest, wetlands and estuarine habitats. Weather would have also played a major role on activity and detectability, as would the availability of flowering trees. Similarly for the frogs, the lack of a range of habitats precludes most species.

3.7.2 Comparisons With Other Surveys

3.7.2.1 Other Surveys of Seascope Grove

Umwelt (2004) conducted the most extensive survey of the larger portion of the property, with some limited work undertaken by ERM (2006b, 2007).

Umwelt recorded 16 bird, 3 frog (*Limnodynastes peronii* and *L. tasmaniensis*), 10 mammals (7 Microchiropteran bats including the Eastern Freetail Bat, Common Bent-Wing Bat and Little Bent-Wing Bat; and the Grey Headed Flying Fox) and 1 reptile (*Laced Monitor*) species. The other birds detected were mainly other agricultural woodland species or common wet pasture species ie Straw-Necked Ibis.

ERM (2006b, 2007) did not record any fauna.

3.7.2.2 Other Surveys of Similar/Identical Habitat in the Locality

Darkheart (2004f) provides the most comprehensive list of fauna detected in forest and woodland identical to that on site/property. This and other studies by the consultant and others have recorded the following species:

Table 6: Fauna recorded locally in identical habitat

Bold indicates listed as threatened under TSCA, * indicates listed as Migratory under EPBCA, # indicates introduced

GROUP	COMMON NAME	SCIENTIFIC NAME
BIRDS	Whistling Kite	<i>Milvus sphenurus</i>
	Square Tailed Kite	<i>Lophoictinia isura</i>
	Glossy Black Cockatoo	<i>Calyptorhynchus lathamii</i>
	Yellow-Tailed Black Cockatoo	<i>C. funereus</i>
	Sulphur-Created Cockatoo#	<i>Cacatua galerita</i>
	Galah#	<i>C. roseicapilla</i>
	Eastern Rosella	<i>Platycercus eximius</i>
	Laughing Kookaburra	<i>Dacelo novaeguineae</i>
	Black-Faced Cuckoo Shrike	<i>Coracina novaehollandiae</i>
	Grey Fantail	<i>Rhipidura fuliginosa</i>
	Rufous Fantail*	<i>R. rubiginosa</i>
	Golden Whistler	<i>Pachycephalia pectoralis</i>
	Red-Browed Finch	<i>Neochmia temporalis</i>
	Eastern Yellow Robin	<i>Eopsaltria australis</i>
	Silvereye	<i>Zosterops lateralis</i>
	Superb Fairy Wren	<i>Malurus cynaeus</i>
	White-Browed Scrubwren	<i>Sericornis frontalis</i>
	Leaden Flycatcher	<i>Myiagra rubecula</i>
	Restless Flycatcher	<i>M. inquieta</i>
	Brown Flycatcher/Jacky Winter	<i>Microeca flavigaster</i>
	Brown Thornbill	<i>Acanthiza pusilla</i>
	White-Cheeked Honeyeater	<i>Phlidonyria nigra</i>
	Lewins Honeyeater	<i>Meliphaga lewinii</i>
	Australian Pipit/Richard's Pipit	<i>Anthus novaeseelandiae</i>
	White-Throated Treecreeper	<i>Cormobates leucophaeus</i>
	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>
	Spangled Drongo	<i>Dicrurus bracteatus</i>
	Brush Wattlebird	<i>A. chrysoptera</i>
	Noisy Miner	<i>Manorina melanocephala</i>
	White-Throated Warbler/Gerygone	<i>Gerygone oliveacea</i>
	Dollarbird	<i>Eurystomus orientalis</i>
	Fantailed Cuckoo	<i>Cuculus flabelliformis</i>
	Pallid Cuckoo	<i>C. pallidus</i>
	Wonga Pigeon	<i>Leucosarcia melanoleuca</i>
	Crested Pigeon	<i>Geophaps lophotes</i>
	Peaceful Dove	<i>G. striata</i>
	White Headed Pigeon	<i>Columba leucomela</i>
	Australian Raven	<i>Corvus coronoides</i>
	Pied Currawong	<i>Strepera graculina</i>
	Magpie	<i>Gymnorhina tibicen</i>

	Magpie Lark Grey Butcherbird Forest Kingfisher Southern Boobook Tawny Frogmouth Masked Owl	<i>Grallina cyanoleuca</i> <i>Cracticus torquatus</i> <i>Todiramphus macleayii</i> <i>Ninox novaeseelandiae</i> <i>Podargus strigoides</i> <i>Tyto novaehollandiae</i>
MAMMALS	Squirrel Glider Sugar Glider Brushtail Possum Ringtail Possum Brushtailed Phascogale Red-Necked Wallaby Eastern Grey Kangaroo Short-Beaked Echidna Long-Nosed Bandicoot Northern Brown Bandicoot Dog [#] Fox [#] Cat [#] Eastern Freetail Bat Beccari's Freetail Bat ("possible" call ID) Undescribed Freetail Bat Hoary Bat Gould's Wattled Bat Chocolate Wattled Bat Little Bent-Wing Bat Large Bent-wing Bat a Forest Bat a Forest Bat Eastern Broad-Nosed Bat Undescribed Broad-Nosed Bat Greater Broad-Nosed Bat White-Striped Freetail Bat Brown Antechinus Dusky Antechinus Swamp Rat Bush Rat Common Dunnart	<i>Petaurus norfolcensis</i> <i>P. breviceps</i> <i>Trichosurus vulpecula</i> <i>Pseudocheirus peregrinus</i> <i>Phascogale tapoatafa</i> <i>Macropus rufogriseus</i> <i>M. giganteus</i> <i>Tachyglossus aculeatus</i> <i>Perameles nasuta</i> <i>Isoodon macrourus</i> <i>Canis familiaris</i> <i>Vulpes vulpes</i> <i>Felis cattus</i> <i>Mormopterus norfolkensis</i> <i>M. beccarii</i> <i>Mormopterus</i> sp. 2 <i>Chalinolobus nigrogriseus</i> <i>Chalinolobus gouldii</i> <i>C. morio</i> <i>Miniopterus australis</i> <i>Miniopterus schreibersii oceanensis</i>[#] <i>Vespadelus pumilis</i> <i>V. vulturinus</i> <i>Scotorepens orion</i> <i>Scotorepens</i> sp. <i>S. rueppellii</i> <i>Tadarida australis</i> <i>Antechinus stuartii</i> <i>A. swainsonii</i> <i>Rattus lutreolus</i> <i>R. fuscipes</i> <i>Sminthopsis murina</i>
REPTILES	Garden Skink Common Bearded Dragon Nobby Dragon Laced Monitor Eastern Brown Snake Green Tree Snake Red-Bellied Black Snake	<i>Lampropholis guichenoti</i> <i>Pogona barbata</i> <i>Gemmatophora nobbi</i> <i>Varanus varius</i> <i>Pseudonaja textilis textilis</i> X <i>Pseudechis porphyriacus</i>
FROGS	Common Eastern Froglet Red-Backed Toadlet Dusky Toadlet Green Tree Frog Striped Marsh Frog Dwarf Tree Frog Bleating Tree Frog	<i>Crinia signifera</i> X <i>Uperoleia fusca</i> <i>Litoria caerulea</i> <i>Limnodynastes peronii</i> <i>Litoria fallax</i> <i>L. dentata</i>

Table 4 thus shows that the species recorded on the site/study area are a sub-set of local diversity, and that additional species may occur depending on season, weather, forage availability (eg flowering trees), etc (DEC 2004a).

3.7.3 Recorded Threatened Species: Site Occurrence Assessment

The Squirrel Glider and Grey Headed Flying Fox were the only threatened species confirmed to occur on the site/study area during the survey. Umwelt (2004) also recorded the Little Bent-Wing, Eastern Freetail Bat and Common Bent-Wing Bats on the larger property that the site is part of. The occurrence and significance of the site to these species is evaluated below.

As mentioned previously a number of other threatened species have been recorded in the locality, and some of these are considered a potential occurrence at least at some time, on the site/study area. This is discussed further in sections 3.7.4, 10.1 and Appendix 1.

3.7.3.1 Squirrel Glider

3.7.3.1.1 Ecological Profile

Inhabits dry sclerophyll forest and woodland (Suckling 1992, Lindenmayer 2002) though it has been recorded in areas bordering wet forest and rainforest (Lindenmayer 2002, Smith *et al* 1995). In NSW, the species has been recorded in a range of communities eg Blackbutt, Forest Red Gum and Red Bloodwood, Coastal Banksia heathland and Grey Gum/Spotted Gum/Grey Ironbark on central coast. On the mid-north coast, it has been recorded in Blackbutt-dominated coastal forest (AMBS 1996, Davey 1984, Quinn 1993); Needlebark-Blackbutt forest, Broad-Leaved Paperbark/Swamp Mahogany/Needlebark woodland (Bray, pers. comm. 1999); Scribbly Gum-Blackbutt dry sclerophyll (Berrigan 2002c, 2000d, 2000e, 2000f, Darkheart 2004c); in open dry sclerophyll forest dominated by *E. siderophloia* with *E. propinqua* and *E. acmenoides* near dry rainforest at Gowings Hill (Berrigan 2003a); dry sclerophyll dominated by White Mahogany associated with Grey Ironbark and Pink Bloodwood (Berrigan 1999a, Darkheart 2004a), though the latter may be an artificial population established by rehabilitated releases. In areas west of the Dividing Range, Squirrel Gliders have been recorded in long linear road reserves, surrounded by cleared agricultural land (Gibbons and Lindenmayer 2002).

Arboreal and hollow-dwelling, this species feeds on eucalypt sap, nectar, pollen, Acacia gum, honeydew, insect exudates, and arthropods (particularly Coleoptera and Lepidoptera larvae), but has also been recorded killing and eating nesting and roosting birds and their eggs (Lindenmayer 2002). Prefers smooth-bark gums due to higher invertebrate diversity and propensity to develop hollows. Areas containing Winter flowering flora, eg eucalypts, Banksia (eg *B. integrifolia* and *B. serrata*), and gum-producing Acacia species are considered by some as likely to be key habitat (Menkhorst *et al* 1988, Quin 1993, Quinn 1995). Xanthorrhoea may also be used for nectar.

Hollows occur in live and dead trees, with the entrance size generally preferred to be just big enough to allow the animal and exclude predators (eg Laced Monitor) and competitors (eg Brushtailed Possum) (Gibbons and Lindenmayer 2002). Hollow-bearing trees occur in forest to woodland, though isolated trees have been known to be used (Gibbons and Lindenmayer 2002, Law *et al* 2000). Like the Sugar Glider, the Squirrel Glider is also a den-swapping species (utilising a number of hollows, not just one, within its home range), due to lifecycle stages, predation, parasite build-up and season (and hence varying insulative properties of hollows) (Lindenmayer 2002, Gibbons and Lindenmayer 2002). The Sugar Glider uses up to 5 hollows in its range, and by inference (Gibbons and Lindenmayer 2002), the Squirrel Glider is likely to use a comparative figure.

The Squirrel Glider has been studied in Limeburners Creek Nature Reserve living in small groups (generally 1 male, at least 2 females plus juveniles) on home ranges of 2-4ha (densities approximately 0.9-1.5 individuals/hectare), which overlap with other groups to form a local population, which also overlaps with Sugar Gliders (Quin 1993). Lindenmayer (2002) provides a range of 3-5ha with a population density of 0.01-0.2/ha. Gilmore and Parnaby (1994) report a home range of 20-30ha in

southern areas. A general range of 0.65-8.55ha is generally accepted (Quinn 1995) though home range is likely to be determined by habitat quality, although males move further than females.

Breeding occurs year round depending on food availability (up to two litters p.a.), with high mortality within the first 12 months (Suckling 1992). Juveniles remain in natal range for at least a year, with juvenile males experiencing aggression from dominant males (Quinn 1995). The Squirrel Glider lives in small family groups/colonies of up to 9 individuals, with a polygynous mating system, with males utilising opportunities to mate outside their colonies (depending on factors such as seasonal food availability, habitat distribution, etc) (Lindenmayer (2002).

Squirrel Gliders also often show dominance hierarchies, determined by aggressive interactions (Lindenmayer 2002). Studies have also shown the Squirrel Glider competes successfully for critical resources such as tree hollows with their closely related cousins, the Sugar Gliders (Lindenmayer 2002).

The Squirrel Glider is a gliding mammal, with distances of up to 50m recorded. The closely related Sugar Glider has also been detected running along the ground in habitats where tree distance prevented tree-to-tree glides (Lindenmayer 2002), though this is not considered a preferred method of movement due to predatory risk. Significant predators include foxes, cats, Laced Monitors, large forest owls and the Spotted-Tail Quoll (Lindenmayer 2002).

3.7.3.1.2 Site Occurrence Evaluation

As mentioned previously, a single adult male Squirrel Glider was recorded in the 7(a) zone near the water towers along the ridge line. This result was expected given records in identical and interconnected habitat to the south and local area (eg Darkheart 2004f, O'Neil and Williams 2003). This capture confirms the presence of the species as predicted by ERM (2006b). As noted by ERM 2006b, the dry sclerophyll forest in this area has a localised concentration of hollow-bearing trees and contains Scribbly Gum and Bloodwood which have recorded to be preferred sap sources in the area (Darkheart 2004f, Berrigan 2000a, 2000b, etc). Its main limitation is the lack of a diverse understorey containing other forage resource eg banksias and wattles, hence is not likely to be capable of supporting densities recorded in other parts of South West Rocks (Darkheart 2004f).

The species was not detected on the remainder of the study area despite thorough trapping, but this may have been due to factors such as weather, lifecycle stage, and flowering incidence (Smith and Murray 2003). The species is considered highly likely to venture into the spur of trees retained as open space in the approved stage of the subdivision (especially due to the presence of suitable hollow-bearing trees), as evidenced by records in similar woodland within 1km of the site's south (Berrigan 2003a), east (Berrigan 2000c) and west (Darkheart 2006k, 2004f, Berrigan 2000a, 2000b, Bray 1999). It may also use clumps of trees and proximate individuals within the 2(a) zone which contain hollows or offer foraging resources, as part of its larger range.

As noted in section 2.3.1, the species has been recorded at a number of locations in the locality, including habitat interconnected to the site (eg Berrigan 2003a, DECC Atlas of Wildlife 2007) or nearby (Darkheart 2004f, Berrigan 2000a, 2000b, 2000c); and in the Stuarts Point-Grassy Heads area (Darkheart 2004j, 2006j, 2007g). The species appears to be abundant in dry sclerophyll forest especially where the understorey contains banksias (Darkheart 2004f, Berrigan 2002c), as consistent with other studies (Smith and Murray 2003, Sharp *in press*, Sharp and Goldingay 1998).

Given the recording of this species on site/study area, the habitat present on site/property and in the general area; and the Squirrel Glider's ecology particularly with regards to the cited home range sizes of the species and gliding ability (up to 50m between trees – Lindenmayer 2002, Engel 2004), it is considered that the site and more so the 7(a) zone is overall is capable of supporting at least one colony of this species due to the range of foraging resources and the relative abundance of hollow bearing

trees. Members of the site/property's population can also readily physically move to connected habitat to the west, southwest and south, and given the known/potential existence of other colonies in these directions, the local population of interbreeding individuals would extend beyond the site/property's extent.

3.7.3.2 Microchiropteran Bats

3.7.3.2.1 Ecological Profile

(a) Common Bent-Wing and Little Bent-Wing Bats:

Similar in appearance, these species are known to share roosting and nursery habitats. Both species mainly roost in caves, mines, culverts, tunnels, buildings etc generally located close to or within dense vegetation, although the Little Bent-Wing Bat has been recording roosting in banana bunches during Winter (Hulm 1994) and both species in tree hollows (Schultz, referred to in AMBS 1996b). Both species are limited by the availability of nursery caves. The Macleay valley has the southernmost population of Little-Bent Wing Bats, which seem to depend on a larger nursery colony of Common Bent-Wing Bats to provide environmental conditions (Dwyer 1991, 1968). These nursery caves are protected in Willi Willi National Park, and are the only Little-Bent Wing Bat maternity caves known in NSW (Smith *et al* 1995) as of 1983. Another maternity cave of the Common Bent-Wing Bat occurs near Riverton (western tablelands) (Dwyer 1966).

Most roost sites selected by colonies of the Common Bent-Wing Bat are typified by their spaciousness and usually ease of access (although some caves, eg the Willi Willi maternity cave, may have restricted entrances). Most roosts in northeast NSW are sufficiently deep to provide portions of complete darkness which these species prefer for roosting (Dwyer 1966, 1968, personal observations). Dwyer (1966, 1968) found that many caves and mines in northeastern NSW not occupied were often very small or had restricted entrances via complicated vertical drops. Small caves are typically not able to provide adequate darkness or humidity, while restricted entrances are unsuitable to these fast-flying and relatively non-manoeuvrable species (Dwyer 1966). Within a roost, bats normally occur in clusters of varying numbers arranged by sex and breeding status (Dwyer 1966, 1968).

These species move and utilise different kinds of roost according to various stages of the lifecycle (Strahan 1995, Dwyer 1996, 1968) ie:

- *Mating roosts*: Consist of a constant male colony visited by transient females (April to mid-June). The main mating cave in the region appears to be in the Willi Willi area (Carrai) and Back Creek.
- *Over-Wintering roosts*: Formed from February to July (region dependant) as the colonies appear to widely scatter over the region utilising a range of smaller roosts (possibly as individuals and small Winter colonies in smaller caves, etc, or as sizeable groups of thousands eg Wombeyan), or some larger roosts eg Yessabah, where they may enter short term torpor. Such caves are likely to offer relatively low temperatures that approximate the Winter mean for the area. This pattern continues till they (when the season warms) move to,
- *Acclimatisation roosts*: Several formed en route to maternity colonies, gradually larger with proximity to maternity caves. Used to acclimatise to high humidity levels to be experienced in maternity caves. Utilised till they move to,
- *Maternity/nursery caves*: Peaks around September to November. Where young are born and left when old enough while female forages. For both species, these are located in Willi Willi Nature Reserve, with other nearby caves also serving key functions. Females disperse to mating roosts following this season (usually by March).

Immature bats also utilise specific roosts in the first year after leaving the nursery eg Yessabah. Hulm (1994) considers all such roosts to provide key lifecycle roles, and thus have to be protected.

The Common Bent-Wing Bat is considered a habitat generalist, foraging for insects above and below the canopy in well-timbered valleys, containing wet and dry tall forest. This species may migrate large distances to maternity sites, travelling 60-70km a night (females have been recorded moving >160km and juveniles dispersing >300km), utilising its range of roosts according to seasonal needs, age and reproductive status. This species occurs in discrete territorial populations based on maternity colonies whose ranges are often determined by watershed boundaries (Smith *et al* 1995), usually within 300km (Churchill 1998). Movement between territories is unusual, though distances of 1300km have been recorded (Churchill 1998).

The Little Bent-Wing Bat and Common Bent-Wing Bat generally forages above and beneath the canopy of tropical rainforest, warm temperate rainforest, tall open forest, riparian forest and dry sclerophyll forest, and in/on the edge of clearings adjacent to forest (Dwyer 1991, Smith *et al* 1995, Berrigan 2001d). Often recorded flying along tracks under canopy or forest edge (eg Berrigan 2001d, 2001e, 1998a, 1998b).

The main cause of mortality is young falling from the roof of nursery caves. Predators include the Green Tree Frog, pythons, feral cat, fox and owls (Dwyer 2000a, 2000b).

(b) Eastern Freetail Bat:

Specific habitat requirements of the Eastern Freetail Bat are poorly known. It has been recorded in habitats ranging from rainforest to dry sclerophyll and woodland, with most recorded in the latter (Churchill 1998). It mainly roosts in small colonies in tree hollows and under loose bark; has been found under house eaves and metal caps on telegraph poles, and was recorded in 1998 roosting in a church roof at Hat Head.

It probably forages above forest or woodland canopy, and in clearings adjacent to forest (Smith *et al* 1995, Allison 1991, Churchill 1998). It has been recorded foraging on edge of pasture and forest remnants with little or no undergrowth at Valla (Berrigan 1998a, 1998b), and foraging on edge of recently underscrubbed “parkland” and denser dry sclerophyll forest at Arakoon (Berrigan 2000c). Most records are of single individuals, and is likely to occur at low densities over its range (Churchill 1998).

3.7.3.2.2 Site Occurrence Evaluation

In general, the site and adjacent habitats provide a range of potential foraging structures for the subject species (ie over the canopy in the more wooded areas, amongst the open structured vegetation, and along tracks and the interface between cleared/open areas and wooded areas).

There are no caves, cliffs, or overhangs on or directly adjacent to the site/property, which precludes species depending on such resources to breed or roost in, unless they are known to forage widely from such habitat components, or utilise alternative roosts (eg tree hollows) during non-breeding stages. Hollow bearing trees are abundant in the 7(a) zone (ERM 2006b) with many of these considered potentially structurally suitable as roosting habitat for hollow-obligate bats (depending on a complex interaction of factors such as hollow microclimate, season, sex and life cycle stage of the bat species as well predation risk and competition with other species – Churchill 1998, Smith *et al* 1995, Ms Anna Lloyd - Eco-Location, pers. comm.). The trees with decorticated bark (ie Blackbutt and Scribbly Gum) may also provide marginal temporary roosting opportunities for species capable of utilising such substrate (NPWS 2000a, Churchill 1998, Smith *et al* 1995).

Given the ecology of these species, their mobility and the extent of alternative known/potential habitat in the locality (eg Hat Head National Park, etc), the local population of all of the subject species would extend well beyond the confines of the study site/area/property.

3.7.3.3 Grey Headed Flying Fox

3.7.3.3.1 Ecological Profile

The Grey-Headed Flying Fox is an obligate nectarivore and frugivore, generally depending on a continuous nectar flow from *Eucalyptus*, *Melaleuca* and related genera, and fruits mainly from rainforest trees and vines (Eby 2000a, 2000b). In NSW, its diet is mainly flowers of Eucalypt, Melaleucas and Banksias which have more regular flowering patterns, hence the preference for these groups (Eby 2000a). Feeding on introduced flowers and fruits eg orchards mainly occurs during periods of poor native production (Eby 2000a).

The Grey-Headed Flying Fox travels long distances (generally within 20km but sometimes 50km) between roosts and foraging areas. Social roosts/camps are used daily, and locations are generally stable over many years. Roosts vary with function, with many forming an interrelated network. Roost selection is not fully understood. In NSW, they mostly occur next to a watercourse, with the dominant vegetation usually being rainforest, wet sclerophyll, Melaleucas, Casuarinas or mangroves (Eby 2000a). The nearest known roosts are at Arakoon, Clybucca and Yarrahappini (Eby 2002, pers. obs.) which are within range of the site.

Numbers of animals utilising a roost varies with season. In NSW, roosts are classified as occupied continuously (key colonial roosts); occupied annually in certain seasons; or irregularly. During poor seasons, individuals or small groups may occupy temporary roosts often within or close to the food source plants. Spring-Summer roosts are considered maternity sites (Eby 2001a).

The Grey-Headed Flying Fox is highly nomadic following fruiting seasons, with only a small portion being sedentary. Migratory movements are in order of hundreds of kilometres (Eby 2000a, 2000b). It is also a slow breeder, long lived, and has no physiological ability to withstand food shortages. The latter results in a high mortality especially of young if shortages occur during Spring, and also reduced reproductive success (Eby 2000b). Food shortages often force the Grey-Headed Flying Fox to forage in orchards, particularly lactating females (Eby 2000a, Tideman et al 1997).

3.7.3.3.2 Site Occurrence Evaluation

As mentioned previously, the Grey-Headed Flying Fox was observed foraging and flying over the larger property by Umwelt (2004). There are numerous other records of this species within a 10km radius of the site and adjacent to the south (DECC Atlas for Wildlife 2007a, Bionet 2007, Darkheart 2004f, Berrigan 2003a, personal observations, etc).

The study area provides opportunistic foraging habitat depending on flowering/fruiting incidences. Given the size of the study area/site relative to the range of the species, it has potential only to form a fraction of the wider foraging range of this species. Due to the lack of key Winter flowering species (eg Tallowood, Swamp Mahogany, etc), the site/property offers limited potential for support during this key period with most usage likely to occur in Summer when the majority of species on site usually flower. The site/property is not known nor does it have any potential to be roosting habitat.

3.7.4 Other Potentially Occurring Threatened Species

From Appendix 1, the following species are considered potential occurrences (with varying levels of probability) on/in the site/study area/property, generally using it as a small part of a wider range:

Table 7: Threatened species potentially occurring on or near the property.

SPECIES	OCCURRENCE TYPE	OCCURRENCE LIKELIHOOD Unlikely = 0 Moderate = 3 High = 5
Square-Tailed Kite	Minute portion of large foraging territory. Marginal potential nest trees.	At least moderate (foraging)
Powerful Owl	Minute portion of large foraging territory. Marginal potential nest trees.	Low to fair (foraging)
Masked Owl	Minute portion of large foraging territory. Marginal potential nest trees.	Very low to fair (foraging)
Barking Owl	Minute portion of large foraging territory. Marginal potential nest trees.	Unlikely to marginally fair (foraging)
Glossy Black Cockatoo	Minute portion of large foraging territory. Marginal potential nest trees.	Low to fair (foraging)
Brush-tailed Phascogale	Denning and foraging habitat as part of wider territory from known habitat on adjoining land to the south and west	Moderate to high – recorded in interconnected habitat
Spotted-Tail Quoll	Minute portion of large foraging territory. Potential den trees.	Unlikely to marginally fair (foraging)
Grey-Headed Flying Fox	Minute portion of large foraging territory.	Recorded on adjacent land.
Black Flying Fox	Minute portion of large foraging territory.	Fair to moderate
Little and Eastern Bent-Wing Bats	Foraging. Potential non-breeding roosting in tree hollows.	Recorded on adjacent land.
Yellow-Bellied Sheath-tail Bat	Foraging. Potential breeding/roosting in tree hollows.	Low to fair
Eastern False Pipistrelle	Foraging. Potential breeding/roosting in tree hollows.	Unlikely to marginally fair
Beccari's Freetail Bat	Foraging. Potential breeding/roosting in tree hollows.	Unlikely to marginally fair
Eastern Cave Bat	Foraging.	Low to fair
Greater Broad-Nosed Bat	Foraging. Potential breeding/roosting in tree hollows.	At least moderate
Eastern Freetail Bat	Foraging. Potential breeding/roosting in tree hollows.	Low to moderate
Hoary Bat	Foraging. Potential breeding/roosting in tree hollows.	Low to fair

These species are subject to later statutory assessment.

3.7.4.1 Factors Affecting Occurrence of Other Regionally Recorded Threatened Species

As noted above and previously in section 2.3.1, a significant number of threatened species have been recorded in the locality, including on land connected to the site/property via continuous forest habitat. A number of these species not recorded by the survey are considered potential occurrences with varying levels of probability (see Appendix 1 and above). A number of other species not yet locally recorded are also considered potential occurrences in the locality due to potential habitat (see Appendix 1).

However, there are a number of factors (which formed part of the determination of whether or not a particular species can be considered a potential occurrence) which may affect the potential occurrence of some of these and other locally recorded species. These factors are:

- *History of extensive, and at times intensive (eg near total clearing of the original communities and*

subsequent modification via grazing and underscrubbing) disturbances to habitat, resulting in:

- State of significant structural and floristic modification of the site vegetation (especially the structure and floristics of the woodland and remaining forest), resulting in:
 - Loss/modification and disturbance of potential and known habitat through clearing and underscrubbing:
 - Gross alteration to structural and floristic diversity leading to simpler communities eg even-aged regrowth, pasture, fire-tolerant species (ie Bladey Grass), colonising species, etc.
 - Displacement of resident species via loss/modification of habitat or invasion by competitors (native and exotic).
 - Impacts on invertebrate diversity and abundance.
 - Increased competition for scarce resources and habitats.
 - Impacts on ecological processes eg development of an understorey, seed establishment, etc.
 - Declining carrying capacity of the area due to habitat simplification.
- *Activity of other threatening processes on the study site is considered to have had a significant effect on the site's habitability and carrying capacity to support these species.*
 - Likely presence of feral cats and foxes known to occur on and in the direct vicinity of the site. These species have a negative impact on sensitive species such as the Long-Nosed Potoroo, Spotted-Tail Quoll, Brushtailed Phascogale and Common Planigale. Domestic cats and dogs also pose a threat to these species on site due their presence in adjacent residential and rural-residential subdivision to the southeast and east.
 - *Lack of abundance or diversity of prey species* ie small terrestrial species, etc, due to lack/loss of habitat; major interruptions to life cycle stages (eg breeding, torpor, dispersal and recruitment) caused by disturbances; loss of refuge, foraging and nesting habitat; etc, via fire, clearing and underscrubbing. This is particularly evident in the dry sclerophyll forest where Elliot A trapping recorded no catches.
 - *Insufficient time for recovery of habitats and habitat components as result of periodic disturbance (eg logging) or secondary processes eg weed invasion:* Although some habitat components exist (eg sap species and tree hollows), other key resources (eg preferred forage or prey species) are either absent, limited in development or insufficient in abundance, and thus incapable of supporting the corresponding dependent threatened species.

The site and remainder of the property shows evidence of the effects of all these processes and these may be a major influence in the current absence of some species for whom potentially suitable habitat occurs on site, as noted by Umwelt (2004) and ERM (2006b).

PART B: ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

4.0 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

4.1 THREATENED AND PROTECTED FAUNA

A significant number of pelagic seabirds, marine turtles, fish and mammals listed as Threatened and/or Migratory under the EPBCA (some are also listed as threatened under the TSCA) are known or may occur on rare occasion in the Macleay River (eg Green Turtle). However, the site does not offer suitable habitat for these species. Furthermore, no aspect of the proposal has potential to impact to any significance upon these species. Consequently, these migratory and threatened marine fish, turtles, mammals and seabirds are not considered in the following assessment due to the lack of significant habitat, occurrence likelihood and/or potential impacts on these groups of species.

4.1.1 Vulnerable and Endangered Species

No EPBCA listed threatened fauna species were recorded during the survey.

A search of the Department of Environment, Water, Heritage and Arts (DEWHA) - Matters of National Environmental Significance (MNES) website was taken to generate a list of threatened species potentially occurring in the locality of the site. These are shown in the following table, with other species previously recorded (Darkheart 2004f, 2006f, O'Neil and Williams 2005, Sandpiper Environmental 2005, Berrigan 2003a, 2000a, 2000b, 2000c) or considered by the consultant as potential occurrences in the locality due to suitable habitat. An evaluation of their likelihood of occurrence on the subject land is also provided from the evaluation table in Appendix 1.

Table 8: EPBCA threatened fauna species potential occurrence assessment

Note: Likelihood of occurrence derived from opinions of consultants in consideration of known ecology of each species (see Appendix 1); and quality of habitat on-site. * indicates listed on DEWR website search.

GROUP	COMMON NAME	SCIENTIFIC NAME	LISTING STATUS	RECORDED IN LOCALITY (10km radius)	SUITABLE HABITAT ON-SITE	LIKELIHOOD OF OCCURRENCE ON SITE
BIRDS	*Regent Honeyeater	<i>Xanthomyza phrygia</i>	E	No	Very marginal potential foraging	Unlikely to very low
	Red Goshawk	<i>Erythrotriorchis radiatus</i>	V	No	Some marginal foraging potential	Unlikely to very low
	*Swift Parrot	<i>Lathumus discolor</i>	E	Yes	Site contains no preferred species – marginal opportunistic potential	Unlikely to very low
	*Australian Painted Snipe	<i>Rostratula australis</i>	V	N	N	N
MAMMALS	*Long-Nosed Potoroo	<i>Potorous tridactylus</i>	V	N	Very limited due to poorly developed understorey and ground layers	Low to unlikely
	*Spotted-Tail Quoll	<i>Dasyurus maculatus</i>	E	Recorded at Yarrahappini. Expected to occur in Hat Head National Park.	Site offers some key resources, ie tree hollows, though lacks dense vegetation. Essentially forms cul de sac of potential habitat with high threat risk ie pets, cars.	Unlikely to marginally fair
	*Grey Headed Flying Fox	<i>Pteropus poliocephalus</i>	V	Y.	Seasonally suitable for foraging.	Highly likely as recorded adjacent to site where same forage species
	*Dwyer's/Large Pied Bat	<i>Chalinobus dwyeri</i>	V	N	Foraging only	Very low
FROGS	*Green and Golden Bell Frog	<i>Litoria aurea</i>	V	Y	N	N
	Wallum Sedge Frog	<i>L. olongburensis</i>	V	N	N	N
	Stuttering Frog	<i>Mixophyes balbus</i>	E	Y	N	N
	*Giant Barred Frog	<i>M. iteratus</i>	E	Y	N	N

REPTILES	Burrowing Skink/ Three-Toed Snake-Tooth Skink	<i>Coeranoscincus reticulatus</i>	V	N	N	N
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4.1.2 Migratory Species

The White-Bellied Sea-Eagle was the only EPBCA listed migratory species recorded during the survey flying over or near the site.

A number of other migratory bird species listed in the EPBCA have been recorded in the locality, and a search of the MNES website also produced a list of likely occurrences. All of these species plus some species previously recorded (eg Darkheart 2004f, 2006f, Sandpiper Environmental 2005) or considered by the consultant as potential occurrences in the locality and/or LGA in similar habitat to that in the study area are also shown in the following table, with an evaluation made on likelihood of occurrence based on cited ecology. Note this list excludes seabirds, wader, etc as detailed above.

Table 9: EPBCA migratory fauna species potential occurrence assessment

* indicates recorded in LGA and likely to occur in locality in consultant's opinion

COMMON NAME	SCIENTIFIC NAME	PREDICTED TYPE OF OCCURRENCE	RECORDED IN LOCALITY	HABITAT ON STUDY SITE	LIKELY TO OCCUR ON STUDY SITE
White-Bellied Sea-Eagle	<i>Haliaeetus benghalensis</i>	Species and/or habitat likely to occur within area	Y	No suitable habitat.	N
*Osprey	<i>Pandion haliaetus</i>	-	Y	No suitable habitat.	N
Latham's Snipe	<i>Gallinago hardwickii</i>	Species or habitat may occur in area	N	N	N
Painted Snipe	<i>Rostratula benghalensis (australis)</i>	Species and/or habitat may occur in area	N	N	N
Cattle Egret	<i>Egretta ibis</i>	Species/habitat may occur in area	Y	Very marginal in pasture – very low grazed	May occur on cleared land though foraging limited
Great Egret	<i>Egretta alba</i>	Species/habitat may occur in area	Y	Dam very marginal now drained	Very low to unlikely
Swift Parrot	<i>Lathamus discolor</i>	Species/habitat may occur in area	Y	Site contains no preferred species – marginal opportunistic potential	Unlikely to very low
Rufous Fantail	<i>Rhipidura rufifrons</i>	Breeding or breeding habitat may occur in area	Y	Very marginal in swamp forest	Very low to unlikely
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	Breeding or breeding habitat likely in area	Y	Marginal	Very low to unlikely
Black Faced Monarch	<i>Monarcha melanopsis</i>	Breeding or breeding habitat may occur in	Y	Marginal	Very low to unlikely

		area			
Spectacled Monarch	<i>M. trivirgatus</i>	Breeding or breeding habitat likely in area	Y	Marginal	Very low to unlikely
*Oriental Cuckoo	<i>Cuculus saturatus</i>	Species/habitat likely in area	Y	Y	At least fair
Regent Honeyeater	<i>Xanthomyza phrygia</i>	Species/habitat likely in area	N	Very marginal potential foraging	Unlikely to very low
Rainbow Bee-eater	<i>Merops ornatus</i>	Species/habitat may occur in area	Y	Y-foraging	At least fair
White-Throated Needletail	<i>Hirundapus caudacutus</i>	Species/habitat likely to occur in area	Y	Y	May occur as flyover.
Fork-Tailed Swift	<i>Apus pacificus</i>	Species/habitat may occur in area	N	Y	May occur as flyover

4.2 THREATENED FLORA

No EPBCA listed threatened plants were recorded during the survey. Only two species have been recorded in the locality:

1. *Acronychia littoralis* (Hat Head NP, Grassy Head)
2. *Cynanchum elegans* (Hat Head NP)

The following table assesses the occurrence potential of species derived from the MNES site as potential occurrences in the locality:

Table 10: EPBCA threatened flora species potential occurrence assessment

Note: Likelihood of occurrence derived from opinions of consultant in consideration of local records, known ecology of each species; and quality of habitat on-site. * indicates not recorded on ROTAP database in region as yet

COMMON NAME	SCIENTIFIC NAME	LISTING STATUS	RECORDED IN LOCALITY (10km radius)	SUITABLE HABITAT ON-SITE	LIKELIHOOD OF OCCURRENCE ON SITE
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	V	N	N	N
Scented Acronychia	<i>Acronychia littoralis</i>	E	Y	N	N
Clear Milkvine	<i>Marsdenia longilobia</i>	V	N	N	N
Hairy-Joint Grass	<i>Arthraxon hispidus</i>	V	N	N	N
Austral Toadflax	<i>Thesium australe</i>	V	N	N	N
White-Flowered Wax Plant	<i>Cynanchum elegans</i>	E	Y	N	N

4.3 THREATENED ECOLOGICAL COMMUNITIES

Of the Threatened Ecological Communities currently listed on the DEWHA website, none occur on or near the site (as determined by description and MNES website search).

4.4 KEY THREATENING PROCESSES

The following relevant EPBCA listed Key Threatening Processes currently, previously or likely to occur in the locality:

- Competition and land degradation by feral Rabbits
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis
- Land clearance
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases
- Predation by Feral Cats
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- Predation by the European Red Fox (*Vulpes vulpes*)

PART D: IMPACT ASSESSMENT AND RECOMMENDATIONS

6.0 POTENTIAL IMPACTS OF THE DEVELOPMENT

Loss of habitat is the primary threat to the recorded threatened species (Johnson *et al* 2007, Lindenmayer and Fisher 2006, NSWSC 2001d, 2007a, Smith *et al* 1995, Gibbons and Lindenmayer 2002, DECC 2007b, NPWS 1999b, Watson *et al* 2003, Gilmore and Parnaby 1994, etc). As habitat requirements are species specific, habitat loss in turn has species specific impacts. Additionally, loss of native vegetation does not automatically equate to habitat loss as some species may be advantaged ie the extent of potential habitat may be increased as a result of vegetation loss (eg species which prefer woodland habitats over forest). However, habitat loss rarely occurs in isolation from other impacts such as habitat fragmentation, isolation, degradation, altered species interactions (eg predation), etc, hence impact assessment must consider the cumulative effect of all these impacts on individual threatened species (Johnson *et al* 2007, Lindenmayer and Fisher 2006).

This section gives a general description of impacts likely to be associated with the proposal, with specific evaluation of their consequence for threatened species recorded or which could occur on the site/study area (based on habitat evaluation and local/regional records – see section 3.7.4.1 and Appendix 1) undertaken in the statutory assessments in sections 8 and 9.

6.1 HABITAT REMOVAL/MODIFICATION

6.1.1 Residential Lots

The proposed development has been detailed previously in section 1.2 and illustrated in figure 2. Figure 6 shows the layout with the location of trees to be removed/retained within stage 1C.