5.1 HABITAT MODIFICATION AND DIRECT THREATS

This section gives a general description of processes and impacts that may arise from the development proposal, with specific evaluation for threatened species that could occur on property and considered at least fairly likely to occur (as determined in Appendix 1), given in later sections. Ameliorative measures and recommendations to mitigate or avoid these impacts are provided in section 6.0.

5.1.1. Establishment of the Proposal

5.1.1.1 Proposal Design

5.1.1.1.1 General Description

(a) **Constructed Wetlands**:

As shown in figures 3A and 3B, the primary proposal is to establish an approximately 10.72ha constructed wetland surrounded by public areas and vegetation. This multifunction waterbody is primarily intended to win the fill required to raise the low lying plains to the west, northwest and north of the wetland to allow future urban development (see figure 2). In terms of local hydrology, it will be integrated with two new smaller constructed wetlands upstream (see figure 3A), the existing large lagoons (which will be rehabilitated to increase their biodiversity values), and Duchess Gully; and form the major component of the stormwater management system for future development of the total property (Cardno 2008, Luke and Co 2008), as per the UIA 14 Structure Plan and the Concept Plan Application.

In addition to its stormwater treatment role, the major waterbody has also been designed to provide a range of wildlife habitat features such as emergent vegetation along the shallow margins (especially the western side where an extensive bed of macrophytes will form a designated treatment cell), and open water. Extensive landscaping/assisted bush regeneration based on native endemic species will strategically established around its perimeter, forming part of the proposed east-west corridor. The proponent's vision for this waterbody and the existing lagoons and other proposed constructed wetlands within the Open Space/Drainage/Habitat Corridor, is to create a mosaic of artificial wetlands and swamp forest habitats similar to those at the Shortlands Wetland Centre (Luke and Co. 2008, Cardno 2008). Cardno (2008) expects that water quality in the major new wetland will be of similar high quality as the existing two large lagoons to the south.

The proposed main waterbody will modify about 10.72ha of the property, which only affects pasture with a few scattered trees ie the pasture/pastoral woodland. It does not affect any area considered by Biolink (2005c) as an EEC (see section 3.2.2).

The wetland will have an average bed level of RL 1m AHD, with a normal top height of 3.0m AHD, giving it a capacity of about 142.ML (Cardno 2008). This wetland will be connected to the existing dam/lagoon to the south, to establish the stormwater treatment chain (Cardno 2008). During normal flows (reaching above 3.4m AHD), water will flow from the existing lagoons to the new major wetland, exiting via the new weir (3.7m AHD) in the northeast to the middle of Duchess Gully to re-instate the former hydrological regime and improve water quality in this part of the creek (Cardno 2008). During higher flows, water from the existing lagoons will equally overflow the reconstructed eastern weir of the eastern lagoon to enter Duchess Gully, and will exit the northeast of the major wetland via the new weir. During larger events (eg >1:5 ARI), the new major constructed wetland has been designed to allow slow overland flow on its eastern boundary to Duchess Creek (Cardno 2008).

(b) Proposed filling:

The fill excavated from the major waterbody is primarily to be used to raise low-lying portions of the property to allow maximum residential development. Some 400 000 tonnes of material are expected

to be used for fill to allow the maximum property yield of about 66.22ha of residential development (Cardno 2008).

The estimated 49.08ha proposed filling area will predominantly only affect pasture/pastoral woodland, some drains and a small portion (0.49ha) of the *Swamp Oak Floodplain Forest* EEC in the northeast which consists of regrowth along fences and a drain, and about 0.43ha of Swamp Sclerophyll Forest on the western side. Refer to Appendix 4 for photos of the affected areas.

5.1.1.1.2 General Impacts

The development will require the removal of vegetation with the following direct **negative** potential impacts:

- Loss of about 62.85ha of pasture/woodland, drain vegetation and Swamp Oak regrowth as a result of excavation and raising the low lying plain with clean fill to establish future urban development.
- Loss of about 0.49ha of *Swamp Oak Floodplain Forest* EEC.
- Loss of about 0.43 ha of *Swamp Sclerophyll Forest* EEC.
- Loss of about 14 hollow-bearing trees within the pastoral woodland.
- Loss of two small dams which provide limited foraging habitat for some migratory birds and the potentially the Jabiru/Black-Necked Stork.
- Loss of an area of seasonally waterlogged grassy low lying plain which offers potential foraging habitat for the Jabiru, several migratory birds (eg Latham's Snipe, Great Egret, Cattle Egret, etc) and perhaps Microchiropteran bats.
- Relatively minor reduction in current terrestrial east-west connectivity due to placement of a large waterbody and clearing of scattered woodland trees.

The construction of the wetland will also have the following **positive** impacts:

- Creation of a relatively large area (about 13ha including the two small constructed wetlands) of potential habitat for waterfowl including a number of threatened species (eg Black Bittern, Australasian Bittern, Osprey), migratory species (eg Great Egret and White-Bellied Sea-Eagle); potential foraging habitat for the Southern Myotis; fish; and a range of potential habitats for frogs (most likely common species tolerant of water with residues from roads, etc).
- Increased buffering to Duchess Gully from urban and agricultural runoff from the future urbanised catchment.
- Increased linkages and habitat for a range of threatened fauna (eg Koala, Squirrel Glider, etc) due to 53.82ha of habitat creation via landscaping/bushland regeneration with native species including food species (eg Tallowwoods, Forest Red Gum and Swamp Mahogany); reinforcing linkages from the southeast dry sclerophyll to the central patch of swamp forest.

5.1.1.2 Construction

5.1.1.2.1 General

Construction is expected to take at least 6 months depending on the staging of construction and filling (Luke and Co. pers. comm.). Routine measures to comply with statutory obligations will be undertaken to address the following impacts/issues:

- Acid Sulfate Soils (ASS).
- Watertable and dewatering management.
- Erosion and sedimentation.
- Dust
- Noise.
- Pollution
- Access roads and tracks

Evaluation of potential impacts associated with these issues is detailed as follows:

5.1.1.2.2. Acid Sulfate Soils

5.1.1.2.2.1 Description and Impacts

Geotechnical investigations have determined that Potential Acid Sulfate Soils (PASS) occur on the property. Due to the complex geomorphological origins of the property, PASS lie below the groundwater surface ie >2.5m below the natural ground surface and under the watertable (Luke and Co. 2008). Hence they have not been activated by previous drainage.

(a) Construction of the Major Waterbody:

The constructed waterbody's design and location has generally been sited via mapping of the distribution of ASS to minimise risk of ASS excavation (Luke and Co. 2008, Cardno 2008). As per the *Acid Sulfate Soils Management Plan* (Cardno 2008) prepared for the project, precautionary measures will be implemented as per statutory and Council regulations during construction to ensure no fill material (if it contains PASS) is allowed to produce acidified leachate that could enter an adjacent aquatic ecosystem (Luke and Co. 2008, Cardno 2008).

Temporary lowering of the watertable (currently around 3.5m AHD) by the waterbody (surface level predicted range around 2.1-3m) should not expose ASS which are located at about 2.0 AHD on the western shoreline, and 1.0m on the eastern shoreline (Luke and Co. 2008, Cardno 2008), no more than the current invert effect created by Duchess Gully (Cardno 2008).

(b) Filling area:

PASS are located under the area proposed for filling (Cardno 2008). All ASS on the site are currently only potential (ie non-activated), hence oxidation products are not likely to be present or present in significant quantities (Luke and Co. 2008, Cardno 2008).

Cardno (2008) consider that the groundwater regime under the filling area should not be significantly affected, given geotechnical information shows that the affected soils are not likely to significantly settle under the prescribed depth of fill. Hence ASS should not be affected ie via the 'sponging' effect.

5.1.1.2.3. Watertable and Dewatering Management

5.1.1.2.3.1 Description and Impacts

(a) Watertable Issues:

Excavation in waterlogged or swampy areas can result in lowering of the watertable. This can detrimentally affect vegetation communities (eg EECs), habitats (eg of frogs) and other biophysical attributes eg salinity (NSWSC 20004a, 2004b, 2004c, 2004d, 2004e, 2004f, 2002e).

The current watertable is around 3.5m (suggesting a current influence by the existing lagoons), grading down to 1m AHD at Duchess Gully (Luke and Co. 2008). The proposed watertable level of the constructed waterbody is intended to be lower at around 3m AHD. The waterbody is predicted to have the effect of creating a parabolic phreatic surface in the existing watertable level around the western margins (as groundwater has been mapped predominantly moving west to east – Luke and Co. 2008, Cardno 2008), potentially drawing it down to the minimum waterbody level of 2.1m AHD, and exiting the waterbody's north and east at about 3m AHD till it dips again down to 1m at Duchess Creek (Luke and Co. 2008, Cardno 2008). This effect is reported to be similar to the current large lagoons and Duchess Gully hence Luke and Co (2008) and Cardno (2008) consider the new waterbody will have no significant long term effect on the watertable level. Cardno (2008) also determine that it will not expose any ASS and that construction of the wetland will be undertaken in cells during dry periods to limit local drawdown effects and allow re-flooding of each cell to 3m AHD once construction is complete to maintain the watertable and buffer PASS.

As noted in 5.3.3, the lowering of the watertable by the new wetland is localised to its immediate edges. Cardno (2008) consider it is not likely to have any deleterious impacts on the hydrological regime of the Wallum Froglet habitat in the adjacent depression (ie via reducing the length of surface inundation intervals, which could lead to breeding failure, habitat changes, etc) as the depression is dependant on direct rainfall and surface runoff not groundwater for its hydrological regime, due to its isolation from the watertable via an impermeable clay bottom.

(b) Groundwater Issues:

As the height of the water surface in the proposed (and current) waterbody is below the current watertable, there will be groundwater inflow and mixing of surface and groundwater. This will have the benefit of maintaining water levels in the waterbody in dry years, with a minimal drop in groundwater flow to Duchess Gully. This drop in recharge from groundwater is likely to be compensated by increased surface flow via discharge from the lagoon and constructed wetland especially once the property catchment is urbanised (Luke and Co. 2008).

Cardno (2008) report that based on their modelling, the proposal will not:

1. Expose ASS to oxidation.
2. Significantly affect net groundwater outflows.
3. Significantly affect the operation of the STP exfiltration.

(c) Runoff:

With full urbanisation the property, it is anticipated that runoff will increase significantly. Creation of the major new waterbody will fractionally reduce total groundwater inflow Duchess Gully (Cardno 2008). However, connection via weirs with the existing lagoon system to the south, and twin connections to Duchess Gully (storm overflow and primary discharge at the head of Duchess Gully) will result in a substantial increase in net streamflow. This will reportedly have the benefit of increasing flushing of

tertiary treated effluent deposited downstream by the STP (Cardno 2008, Luke and Co. 2008), and restoring the original hydrology of Duchess Gully (Cardno 2008).

5.1.1.2.4 Erosion and Sedimentation

5.1.1.2.4.1 Description and Impacts

Erosion and sedimentation may be an issue associated with the following areas:

- Construction of access roads/tracks.
- Erosion of the fill.
- Fill storage areas.
- Erosion of the wetland walls/edges via wave action post-development.

If unabated, erosion and sedimentation may result in sedimentation of adjacent waterways (drains, lagoons and Duchess Gully) and impact on EECs. These threats should be abated by required erosion and sedimentation measures applicable during construction and earthmoving (Cardno 2008). Specific care will have to be taken to ensure sedimentation does not occur in the existing Wallum Froglet habitat to the southwest of the wetland (see recommendations). An Erosion and Sediment Control Plan (ESCP) will be prepared as per statutory obligations (Cardno 2008), hence this impact's significance should be minimised if the ESCP is implemented effectively.

Erosion of the new wetland edges via wave action may occur if aquatic vegetation does not develop sufficiently, or is absent from some areas. This will result in turbidity and sedimentation at least in localised areas, and may impact on benthos. Establishment of aquatic vegetation and provision of rocks, etc, around the edges would reduce the effects of wave action and the severity of this impact.

5.1.1.2.5. Dust

5.1.1.2.5.1 Description and Impacts

Dust is typically associated with earthmoving activities. If unabated, dust could also impact upon adjacent watercourses and waterbodies, and associated EECs. Standard dust suppression measures are expected to be employed (Cardno 2008), hence dust should not be an issue. Dust must not be allowed to enter the Wallum Froglet habitat as it can carry disease, etc.

5.1.1.2.6. Noise

Noise associated with the construction of the wetland and filling will be substantial due to the range of associated large earthmoving machinery and extent of excavation, etc, required.

5.1.1.2.6.1 Literature Review

Noise impacts on wildlife are poorly studied and understood in Australia, as noted by an impact study, review and Species Impact Statement for a proposed shooting range at Scotts Head which potentially affects known habitat of the Yellow-Bellied Glider, Powerful Owl, Glossy Black Cockatoo, Long-Nosed Potoroo, Stuttering Frog, Wompoo Fruit-Dove and Common Bent-Wing Bat (Clancy 2001, 2003, Berrigan 2001). Some species show sensitivity especially at primary exposure, though evidence has been presented to demonstrate long term adaptation to noise eg photos of Eastern Grey Kangaroos lying on the range used by active skeet shooters, and statutory declarations reporting sightings of Glossy Black Cockatoos feeding at the end of an active shooting range (Berrigan 2001i, Clancy 2003). This consultant has also observed a Wompoo Fruit-Dove roosting in an isolated woodland tree adjacent to a busy road (Ocean Drive); Glossy Black Cockatoos foraging in a tree under which firewood was being chainsawed; Bitterns foraging on oyster leases adjacent to motorboats; and Jabiru foraging beside earthmoving machinery (at Greenmeadows, Port Macquarie) or under traffic bridges over estuaries (Lake Cathie and North Haven).

When the EIS for the Sydney's second airport location (Badgery's Creek) was exhibited, the EPA was asked to assess the impact of noise on wildlife within the Blue Mountains National Park. The review found that all major studies of noise impact on wildlife have been carried out in the USA, and very little Australian work had been done. The EPA's literature review found in summary (Paul Wilkes EPA, pers. comm. to Macksville SSAA) the following:

- Risk of hearing damage in wildlife is greatest from exposure to close or nearby blast noise rather than long-lasting exposure to continuous noise.
- Decreased responsiveness after repeated noise is frequently observed and usually attributed to habituation.
- Military and civilian blast noise (quarry and mine activity) had no unusual effects on wildlife.
- Peregrine Falcons indicate no sensitivity to blast noise, even rearing young near blast construction areas.
- An endangered mammal species, the Red Squirrel, showed no reaction to noise and blasting.
- When a new noise occurs in an area, animals initially turn towards the noise source, once determined that no harm associated with the sound, habituation occurs.
- Acoustic scaring methods such as gas guns lose their effect as target species habituate to them.
- Anecdotal accounts of terrestrial wildlife living with noise loud enough to cause pain in humans eg seabirds near airports and Ospreys near Defence Force testing areas.
- On shooting ranges, anecdotal observations of ground birds such as Plovers nesting on the ground directly near firing mounds, raptors hunting the grass areas for prey during shooting competitions, and Currawongs hunting insects on the ground during shooting.
- Raptors nesting and rearing young along side airstrips and quarries that have blasting activity.

Furthermore, this consultant has undertaken inspections of two long established shooting ranges (Kempsey and Wingham). A population of Koalas was found at Wingham, and evidence of other arboreal fauna was found at both. Another survey of a range at Coffs Harbour recorded Sugar Gliders and the Powerful Owl. The Grey Headed Flying Fox was observed at all three foraging at night (Berrigan 2002e, 2002f, Clancy 2003).

5.1.1.2.6.2 Proposal Assessment

Noise associated with the construction of the wetland and filling should be relatively short term (several months dispersed over a longer period) as the relevant portions of the site are reformed to form the wetland and filling areas. This will be limited to the programmed construction periods, and to daytime periods only (7am to 6pm Monday to Saturday – Cardno 2008).

This noise is most likely to affect fauna using the adjacent lagoons, swamp forest and dry sclerophyll forest.

Given the information in the preceding paragraphs, and the following information, it is considered unlikely that noise will have any significant effects as:

- Noise generated from the major stages of construction are short term.
- The threatened species recorded on the site, property and potentially occurring have been recorded in high human-presence environments eg the Little Bent Wing Bat (Mr Glenn Hoye pers. comm.), Grey-Headed Flying Fox (personal observations, Eby 2002, etc), Wallum Froglet (Darkheart 2005a), Squirrel Glider (Darkheart 2004n, 2004p, 2005a, 2005b, 2005d, 2005m, 2005r, 2006f, Murray 2006) and Koala (Darkheart 2004p, 2004n, Wilkes and Snowden 1998, Connell Wagner 2000b, Lunney *et al* 1999, etc) have been recorded foraging in urban bushland, and the Grey Headed Flying Fox recorded roosting within urban remnants (Eby 2002, Smith 2002, personal observations).
- Urban noise is a current presence on the southern boundary, thus fauna are likely to have some tolerance.

- Calls of the Wallum Froglet mostly take place at night when noise is minimal, hence breeding should not be interfered with.

5.1.1.2.7. Pollution

5.1.1.2.7.1 Description and Impacts

Pollution refers to contamination of aquatic ecosystems via petrochemicals, fertilisers, herbicides, etc. These chemicals generally reach adjacent habitats via contaminated runoff, spillage, sedimentation and erosion.

At the construction stage, pollution may potentially occur via:

- Storing and spillage of petrochemicals and other chemicals on the site or within the catchment area without proper measures undertaken.
- Improper use of fertilisers (eg used to establish plantings) and herbicides (eg to control weeds on the fill area) leading to contamination of runoff, soils, wetland and groundwater.

Statutory controls and provisions of a specific Environmental Management Plan (EMP) will apply to ensure these avenues of pollution do not occur (Cardno 2008). This is especially important to the Wallum Froglet population off the southwest as pollution of this finite and isolated habitat could lead to extinction of this population.

5.1.1.2.8. Access Roads and Tracks

5.1.1.2.8.1 Description and Impacts

Access roads and tracks will be required for the following:

- Machinery access to the wetland.
- Loading and transport of the fill to the fill area/stockpiles.
- Staff parking and associated temporary sheds, toilets, etc.
- Site access.

Site access and main movements of machinery will use the existing gravel road on the property, with access to Ocean Drive (thereby minimising movement of large trucks through an established residential area to the south). Due to the land's waterlogging nature, the internal tracks will need to be formalised (eg via importing road base material) to avoid bogging. Internal tracks will fall within the designated construction area hence no tracks will be established outside the footprint of the development envelope. These do not affect any significant habitat area or EEC.

5.2 SECONDARY/INDIRECT IMPACTS

The following impacts may potentially occur once the wetland is established, and are generally associated with developments.

5.2.1. Alteration of Hydrological Regime of Duchess Gully

As noted in section 5.1.1.2.3, the construction of the wetland will alter the current hydrological regime of Duchess Creek via initially reducing surface and also groundwater flows. However, as urbanisation increases, runoff is expected to increase, and the stormwater treatment chain has been designed to reinstate the original regime of the watercourse by directing most flow to the upper end of the watercourse, with the new and existing discharge point to be used during higher flows. Cardno (2008) predict that increased flushing of the system may have the positive impact of reducing nutrients, etc associated with inflows from the STP and the agricultural (and future urban) catchment, thereby promoting a healthier aquatic system.

Cardno (2008) also predict that flow velocity should not lead to scouring.

5.2.2. Eutrophication

Eutrophication is the addition of excess nutrients into aquatic ecosystems (eg via use of fertilisers in the catchment), leading to impacts such as algal blooms, toxicity to aquatic life, and excess macrophyte growth. This impact is not considered a substantial risk at the construction of the wetland, but could be a risk in the long term post-urbanisation via (DLWC 1998a, 1998b):

- Excessive nutrient loads from the wetland discharged into Duchess Gully (eg during very wet years where insufficient treatment has occurred).
- Runoff from bitumen roads containing petrochemical residues.
- Runoff from car washing.
- Illegal deposits to stormwater drains.
- Fertilisers, herbicides, etc used on domestic gardens.

These may have the following impacts on the wetland:

- Death/disease in aquatic fauna eg frogs, macroinvertebrates.
- Algal blooms, weed invasion or excessive macrophyte growth, leading to public health problems, maintenance issues, inadequate water treatment (with downstream impacts) and impacts on aquatic organisms (eg frogs, fish and macroinvertebrates).
- Sediment contamination, resulting in poisoning of fauna eg waterbirds sifting benthos.

These secondary impacts may also occur in Duchess Gully, with associated impacts on an EEC and potential prey of threatened species (eg Bitterns).

The wetland forms part of a chain of mechanisms and structures to treat stormwater, hence the water entering the wetland is expected to be of reasonable quality (Cardno 2008). In addition, the design of the major wetland incorporates macrophyte areas and a substantial waterbody to “polish” water before emission. These combined measures are reported to be sufficient to ensure the quality of water entering Duchess Gully is not inferior to current standards (Luke and Co. 2008, Cardno 2008).

5.2.3 Altered Fire Regime

The current fire regime on the property is essentially exclusion. Habitats considered at risk (ie high fuel loads) and sensitive to altered fire regime are:

- Southeast dry sclerophyll
- Paperbark/Swamp Mahogany/Swamp Oak Swamp Forest.
- Native grassland east of Duchess Creek
- Dune scrub.
- Littoral rainforest (northeast of property)

Extensive fire in these communities may either result in potential extinction (eg of the isolated populations of Eastern Chestnut Mouse, Wallum Froglet and Common Planigale), hence must be avoided or managed intensively.

The proposal is not likely to have any effect on the fire regime, hence current patterns will remain.

5.2.4. Fences

Fences can provide a physical barrier to fauna movement eg Koalas (Wilkes and Snowden 1998, AKF 2003, Connell Wagner 2000, Port Stephens Council 2001, Lunney ***et al*** 1999, NPWS 2003), or a threat eg Yellow-Bellied Gliders, Squirrel Gliders, Koalas and Grey Headed Flying Foxes have been recorded being injured or entangled leading to death (via starvation, injury, predation, exposure, etc) (Gibbons

and Lindenmayer 2002, Berrigan 2001h). Owls have also been observed being injured or killed via collisions with fences (personal observations, The Owl Pages 2002).

Other than temporary construction fences around the development envelope, no fence is proposed to be constructed. These are not considered likely to pose a threat to any fauna or pose any substantial barrier.

The proposal will also have the positive impact of seeing fencing removing from parts of the property to allow machinery access. This will remove this barrier/hazard from these areas.

5.2.5. Increased Human Activity

Human presence on the site/property will significantly increase from periodic to permanent. This may discourage the activity of some fauna, while others may become accustomed. In general, those threatened species which have some potential to occur on the site (Grey-Headed Flying Fox, Microchiropteran bats and Square-Tailed Kite) are known to be active in urban environments and are unlikely to be deterred from using the site.

The Common Planigale and Eastern Chestnut Mouse typically have small home ranges (Smith *et al* 1995) and could be displaced by continuing disturbances to the habitat in the south-eastern and south-western sections of the property.

Increased human presence and activity also has potential to impact on flora on the property particularly by creation of tracks which can result in soil compaction, physical damage to plants and introduction of weeds. In general, the Swamp Oak community is likely to be resistant to such intrusions due to its closed canopy and location on wet areas which are unlikely to be significantly used for tracks. The wet sclerophyll on the property is more susceptible to damage due to its small area, although its location away from the area of residential development is unlikely to attract attention and the dense edge vegetation will inhibit access to it. Northern sections of the dry sclerophyll forest are easily accessed but as the community continues south, it becomes increasingly dense and is unlikely to be accessed. In addition this community's close proximity to the STP is likely to reduce human interest in the area.

5.2.6 Noise

Noise impacts on wildlife are poorly studied and understood in Australia, as noted by an impact study, review and Species Impact Statement for a proposed shooting range at Scotts Head which potentially affects known habitat of the Yellow-Bellied Glider, Powerful Owl, Glossy Black Cockatoo, Long-Nosed Potoroo, Stuttering Frog, Wompoo Fruit-Dove and Common Bent-Wing Bat (Clancy 2001, 2003, Berrigan 2001d). Some species show sensitivity especially at primary exposure, though evidence has been presented to demonstrate long term adaptation to noise, eg photos of Eastern Grey Kangaroos lying on the range used by active skeet shooters, and statutory declarations reporting sightings of Glossy Black Cockatoos feeding at the end of an active shooting range (Berrigan 2001d, Clancy 2003). This consultant has also observed a Wompoo Fruit-Dove roosting in an isolated woodland tree adjacent to a busy road (Ocean Drive), Glossy Black Cockatoos foraging in a tree under which firewood was being cut by chain-saw, Bitterns foraging on oyster leases adjacent to motorboats, and Jabiru foraging beside earthmoving machinery (at Greenmeadows, Port Macquarie) or under traffic bridges over estuaries (Lake Cathie and North Haven).

In a review of overseas studies on noise impacts, Mitchell McCotter (ERM 1996) generalised that "*fauna may experience only limited effects of noise below 50dB(A), with some reaction between 50dB(A) and 70dB(A), and strong reactions above 70dB(A).*" Background noise at Bonny Hills has been measured at 49-52dB(A) (ERM 1996) and similar levels are expected to occur at the site post-development. During the construction phase the noise levels due to heavy machinery are likely to be about 70 dB(A) at 50m from the source (ERM 1996).

Overall, the levels of noise likely to be generated by the development are expected to have minimal impact on the threatened species with potential to occur on the property, particularly as they are generally mobile species which would utilise the property as a small part of a larger home range. Species with smaller ranges such as the Common Planigale have been recorded in urban remnants (Smith *et al* 1995) and are located away from the development envelope, hence are not considered likely to be significant affected by noise.

5.2.7. Exotic Fauna and Flora

5.2.7.1 Exotic Fauna

Potential impacts of exotic fauna are increased predation and competition (Austeco 1994, Smith *et al* 1995, Birds Australia 2008, etc).

The species most likely to be involved are pets such as dogs and cats, and any increase in these animals has the potential to affect wildlife by predation or by behavioural avoidance (Austeco 1994, Smith *et al* 1995, Birds Australia 2008, Dickman 1996, etc). Dog (possibly wild or wandering domestic) tracks were found in mud in the southern end of the property, but no evidence of cats was found, although they may occur. The restricted distribution of Koalas, Eastern Chestnut Mouse and Common Planigale on and near the property, and Koalas attempting to traverse the open pasture land on the property to access food trees makes these species susceptible to attack/predation.

Foxes occur locally and generally have the potential to increase their activity following developments which create new tracks or open up dense undergrowth (as occurs in fire hazard reduction. The proposal has no such effect hence will not increase the success of this predator.

Exotic rodents may compete with native fauna, although their abundance may depend on the seral stage of the habitat. These species may potential colonise landscaping around the wetland and compete or exclude native species.

Grazing cattle currently occur on-site and the property, but they are likely to be removed as development proceeds. This should allow regeneration of native vegetation which is considered a positive impact.

5.2.7.2 Exotic Flora

Weed invasion can modify vegetation structure and reduce diversity of habitats, often as an edge effect adjacent to disturbed areas (Andrews 1990, NSWSC 2003a). On the site, weeds were present throughout the grassland which was comprised largely of exotic pasture species. Lantana was also present in a number of vegetation communities on the property. It occurred along the fringes of the wet sclerophyll, Swamp Oak and Paperbark/Swamp Mahogany swamp forest communities. In sections of the southeastern Paperbark/Swamp Mahogany swamp forest, it dominated the shrub layer and producing a dense impenetrable layer. Bitou Bush was present in relatively limited abundance.

The proposal has limited potential to introduce exotic flora as fill be won from the site which is currently dominated by exotic pasture species. Weeds may potentially occur on the fill via vehicles or contamination of any seeds used to establish sediment control, but these will eventually be removed again as part of future residential subdivision.

Weed development around the edges of the wetland should be controlled by the landscape consultant as part of their contractual arrangements for the landscaping works (see section 6.0).

5.2.8. Direct Mortality

Potential mortality of native fauna typically occurs directly via habitat removal and refuge destruction. Specifically, the removal of hollow bearing trees and large fallen logs can potentially result in the

mortality of residing hollow obligate fauna (Gibbons and Lindenmayer 2002, Smith *et al* 1995, Austeco 1994) and the removal of dense groundcover can affect small terrestrial species (Smith *et al* 1995, Austeco 1994).

The proposed development will remove at least 14 hollow-bearing trees in the area of Forest Red Gum pastoral woodland with the potential for injury to threatened species such as Microchiropteran bats which could utilise these hollows as roosts. This loss will also remove potential refuges for arboreal fauna, increasing the risk of predation due to lack of shelter.

A Whistling Kite nest also occurs in the fill area, and if filling occurs during the breeding season, a clutch of this protected bird may be killed.

5.2.9 Artificial Lighting

Lighting may discourage nocturnal native species from foraging near areas of development, with a potential effect similar to the full moon on the hunting success of predators such as owls, or a behavioural avoidance impact on potential prey species. Anecdotal evidence also suggests it deters exit from tree hollows with the Squirrel Glider noted to wait until adjacent artificial lighting in an industrial area shining on the entrance switched off automatically at 9.30pm (Darkheart 2005i). However, wallabies, kangaroos, Kookaburra, Magpies, Tawny Frogmouth Owls and possums have been noted foraging under artificial lighting in the residential areas eg around Lake Innes, Port Macquarie (personal observations). Artificial lighting may also be beneficial to Microchiropteran bats by localised aggregation of insects, with these animals being observed foraging under streetlights, and even landing on lit footpaths to scamper for insects (personal observations).

Artificial lighting can also have the positive impact of increasing sight detection of fauna on roads, thus reducing risk of road kills eg Koalas (Wilkes and Snowden 1998, AKF 2003, Connell Wagner 2000, Port Stephens Council 2001, Lunney *et al* 1999, NPWS 2003a).

Artificial lighting will be minimal on site ie for security of machinery and on-site offices only during construction, hence this impact is considered inconsequential.

5.2.10 Disease

This threat is most relevant to Koalas which were not detected on the site but occur on the property. Most Koalas are naturally infected with *Chlamydia* pathogens (Sharp and Phillips 1999, Phillips 1997). This and other diseases may develop when Koalas are under stress, of which one cause is habitat loss/disturbance (NPWS 2003a).

The proposal will remove a number of mostly senescent potential Koala browse species, however identified Core Koala habitat and further Potential Koala habitat will be retained on the property reducing the potential impact of the habitat loss on the species. With consideration given to this habitat retention, that no evidence of Koala activity was found in the development envelope and any Koala occurrence is likely to be at low levels only, any potential impact on the property is likely to be minimal.

As noted in section 4.4, there are diseases which are considered Key Threatening Processes to parrots and frogs which may occur in the area, as well as plant disease, *Phytophora* spp. The latter two have a very low potential to be introduced to the site/property via landscaping plants containing the pathogen or infected individuals.

5.3 IMPACTS ON THREATENED FAUNA SPECIES

This section identifies the potential impacts and their significance to threatened species recorded on the property by this survey, or considered a reasonable chance of occurrence on the site (as determined in appendix 1). The specific significance of these impacts is evaluated in the 7 Part Tests.

5.3.1 Koala

Potential habitat for Koalas in the development envelope (the study site) consisted of a handful of Forest Red Gums scattered over pasture well away from other Potential Koala Habitat. This small area of potential habitat was considered insufficient to support a breeding aggregate. No Koala activity was detected in this area and Koalas were considered to at best rarely use these trees or the western side of the property, at most as dispersing animals due to the poor connectivity of the site to known habitats in the southeast, south and north. Consequently, the site was considered unlikely to be part of a frequently used route for dispersal and genetic exchange. Hence, the potential habitat on the site could provide at best temporary support, but was not considered to be key habitat or link for local populations of Koala at this time.

The development will require the removal of all the Forest Red Gums and hence Potential Koala Habitat from the study site, resulting in the loss of the temporary support for dispersing Koalas and therefore the loss of the site's limited potential to act as a corridor on the broader property and also a contraction of the extent of locally available Potential Koala habitat.

Animals potentially occurring outside the identified Core Koala Habitat in the southeast are most likely to be young males, and the loss is not expected to directly affect the home range of existing local breeding aggregates. Until urban development of the remainder of the property occurs, remaining scattered trees on the ridges and slopes will retain the limited corridor potential to the northwest, with other corridors via the Paperbark/Swamp Mahogany swamp forest and Duchess Gully retained. Post-development, linkage will be provided by the corridors proposed in the UIA 14 Structure Plan (Richards 2004, Luke and Co 2006).

Overall, the proposal will consist of the loss of an area of low density Potential Koala Habitat currently subject to apparently accelerated natural attrition, with recruitment prevented by agricultural maintenance. Identified Core Koala Habitat and the majority of Potential Koala Habitat as well as linkages will remain post-development. Future landscaping around the wetland based on Koala species will have a positive impact on this species via habitat creation, with the establishment of the proposed east-west corridor considered to have potential for a significant positive impact via potentially increasing genetic exchange and population size. Provisions of the UIA 14 Koala Management Plan (Biolink 2005c) will also ensure impacts on Koalas are mitigated as per the aims of SEPP 44.

5.3.2 Common Planigale and Eastern Chestnut Mouse

The proposal does not affect known or potential habitat for these species either directly or indirectly, hence is considered inconsequential to the current viability.

The creation of natural bushland around the wetland and the rehabilitation of pastoral land into a fully vegetated wildlife corridor (generally swamp forest) should create both potential habitat and enhance linkages for these species allowing the small populations to potentially expand and increase their potential viability. This is thus considered a positive impact.

Future urban development of the remainder of the property is not considered in this assessment.

5.3.3 Wallum Froglet

5.3.3.1 Western Population

The western population in the drain adjacent to the southwest dry sclerophyll is not affected in any manner by the wetland/filling project application.

5.3.3.2 Eastern Population

The population in the depression off the southwest of the proposed constructed wetland will be physically retained via location of the wetland and fill areas beyond its confines, hence the proposal should have no direct impacts upon this habitat (Cardno 2008, Luke and Co. 2008).

As noted in section 5.1.1.2.3, the localised lowering of the watertable around the constructed wetland is considered by Cardno (2008) to have no potential to alter the hydrological regime of the Wallum Froglet habitat in the adjacent depression. This is due to the fact that the hydrological regime of the depression is dependant on direct rainfall and immediate surface runoff, not groundwater levels due to a layer of impermeable clay which isolates it from the groundwater level (Cardno 2008).

Furthermore, the depression currently has a demonstrably highly variable regime from periods of prolonged surface inundation to extreme dry periods. The latter was evidenced by the slashing of the area in 2006. This regime appears to be beneficial to the Wallum Froglet in that it allows elimination of the Plague Minnow (should it enter via major storm flows) and possibly also some competitive frog species. Security of the population should also be increased by the regeneration of the heath and sedge vegetation noted in 2003, which would retain a deep layer of moist humus for the frog to survive in during these periods, as it appears to have done post-slashing in 2006. Some monitoring will be required to ensure the population and its habitat remains viable.

Sedimentation during construction and contaminated runoff from future urbanisation should not affect this habitat as drainage will be directed away from these areas to the constructed wetland, and standard erosion control measures will be put in place (Cardno 2008, Luke and Co. 2008).

Exclusion of cattle will benefit the species via reducing habitat loss via grazing. The re-establishment of swamp forest in the east-west corridor may also provide additional habitat for population expansion, and enable linkage for genetic exchange between the two populations.

5.3.4 Jabiru

This species is considered at least a fairly likely occurrence periodically foraging around the dams/lagoons and seasonally waterlogged portions of the pasture. The area affected by the Project Application only offers a relatively marginal area of seasonally waterlogged pasture which may offer a small area of foraging habitat for this species as part of its wider nomadic non-breeding range (Smith *et al* 1995, DECC 2008b, Birds Australia 2008).

The proposal will have minimal short-term impact on this species via loss of the small area of relatively marginal area of seasonally waterlogged pasture will be removed. Relative to more optimum habitat in the locality and that breeding is not likely to potentially occur on the property, this loss is considered insignificant.

The species may continue to potentially forage on other parts of the property post-development eg in the southwest drainage line and around the lagoons. Post-development with establishment of the major new wetland and macrophytes, it may potentially use the new habitat as part of its non-breeding migratory range (eg a single bird). Such usage may be deterred in the long term as well as usage around the existing

lagoons via future increased human presence (eg pedestrians) or harassment by dogs, though the species has been recorded foraging near the Stingray Creek traffic bridge in North Haven (pers. obs.).

5.3.5 Microchiropteran Bats

This and a previous survey confirmed the presence of the Little Bent-Wing Bat on the property. This species is likely to use the property for foraging and perhaps non-breeding roosting in tree hollows. The Yellow-Bellied Sheathtail Bat, Greater Broad-Nosed Bat, Common Bent-Wing Bat and Eastern Freetail Bat are considered at least fair potential occurrences using at least parts of the property for foraging. The project application site also contained 14 hollow-bearing trees which offered potential as temporary roost habitat for all five species. These hollows also have some potential as breeding habitat for the Eastern Freetail Bat, Greater Broad-Nosed Bat and possibly for the Yellow-Bellied Sheathtail Bat, although this latter species is typically recorded in southeast Australia only between January-June (Churchill 1998) and may breed elsewhere.

The Southern Myotis is considered to potentially forage over the existing large lagoons on the property and along the permanent sections of Duchess Gully, and potentially roost in tree hollows. The two small dams within the project application site are considered to offer marginal potential.

The proposal will see loss of about 62.85ha of mostly pasture with trees which includes 14 hollow-bearing trees. This will see loss of marginal foraging habitat (due to limited prey habitat) and a substantial portion of the property's tree hollows. The latter may potentially also result in direct mortality during tree felling if these trees are used as roosts at the time.

The loss of 62.85ha of rather marginal foraging habitat for these species is considered inconsequential to the extent of more optimum habitat on the remainder of the property and within the species' range (Churchill 1998, Strahan 2000, Smith *et al* 1995, Dwyer 1968, 1966). This loss is considered likely to be at least in part compensated by the new habitat with ultimately higher productivity created by the macrophytes zones of the main wetland and adjacent landscaping/bush regeneration, as well as the open water which may support fish and aquatic insects preferred by the Southern Myotis.

The loss of potential roosts is more negative impact given this is a resource which is not particularly abundant on the property and takes a prolonged period to regenerate (Gibbons and Lindenmayer 2002). However, potential roosts will remain on site (some will ultimately be removed via urbanisation) post-development and others are known to occur within range of the property (eg Darkheart 2006h, 2004q). Hence the viability of these species should not be compromised as a result of the proposal.

5.3.6 Other Species

The following species have been recorded on the property outside the project application development envelope:

- Grey Headed Flying Fox, Wompoo Fruit-Dove, Square-Tailed Kite and Swift Parrot.

The following species are considered potential occurrences on the property (generally specific sections which are continuous with other potential or known habitat):

- *Foraging as part of larger range*: Glossy Black Cockatoo, Powerful Owl, Osprey, Masked Owl, Barking Owl, Black Bittern, Australasian Bittern, Eastern Blossom Bat, Blue Billed Duck, and Squirrel Glider.
- *Potentially foraging on the property and directly adjacent habitat within larger range*: Eastern Pygmy Possum.

For all of these species, the property does not contain sufficient habitat to meet their lifecycle or ecological needs ie all would range beyond the property, with many only using it as a minute fraction of their wider range.

The proposal will have no negative impact on the following species as their potential or known habitat is outside the project application site:

- Osprey, Glossy Black Cockatoo, Eastern Pygmy Possum, Bitterns, Eastern Blossom Bat, Wompoo Fruit-Dove and Squirrel Glider.

The proposal will remove some marginal potential foraging habitat for the following species:

- Grey Headed Flying Fox, Square-Tailed Kite, Powerful Owl, Masked Owl, Barking Owl, Blue Billed Duck, and Swift Parrot.

It will also remove some (mostly marginal and isolated from other habitat) potential den and nest sites for the following species:

- Squirrel Glider, Square-Tailed Kite, Powerful Owl, Masked Owl and Barking Owl.

However none of these species is currently known or considered significantly likely to use the resources on site for this purpose due to isolation from other habitat, high inter and intra-species competition, and insufficient internal dimensions of tree hollows (ie for large forest owls and Glossy Black Cockatoo). Overall thus, the proposal will result in contraction of an area of marginal habitat for these species, and is considered relatively inconsequential.

For some species, the creation of wetland and adjacent landscaping based on native forage species will create new habitat which will be considered a positive impact ie Masked Owl, Powerful Owl, Osprey, Blue-Billed Duck, Squirrel Glider, Eastern Blossom Bat, Bitterns and Square-Tailed Kite.
Due to the mobility of these species or location of their habitat well away from the site, the proposal will not create any barrier between any areas of habitat.

5.4 IMPACTS ON FLORA

The following addresses potential impacts of the proposal on flora.

5.4.1 General

As detailed previously, the disturbance history of the property has included clearing of much of the original forest communities, pasture improvement and maintenance, drainage and ongoing cattle grazing. The majority of the site vegetation is pasture with negligible conservation value.

The loss per community as a result of the proposal is detailed in table 7. As shown in the table, the proposal does not significantly affect any intact forest communities, and connectivity will be retained for genetic dispersal vectors.

Indirect potential impacts that could affect the property’s flora include: changed fire frequency, introduction of weeds and accidental removal of threatened plants. These potential impacts can be addressed by implementation of ecologically-based management of fire and weeds.

Table 7: Estimated areas of loss per vegetation community for the Project Application

Vegetation Community/Habitat	Total Area (ha)	Area Removed (ha)	Area Retained (ha)
Blackbutt-Tallowwood-Needlebark Dry Sclerophyll Forest	1.98	0	1.98
Brushbox Wet Sclerophyll Forest	0.72	0	0.72
Blackbutt Dry Sclerophyll Forest	2.11	0	2.11
Grey Ironbark-Grey Gum Dry Sclerophyll Forest	2.39	0.02	2.37
Paperbark-Swamp Mahogany-Swamp Oak Swamp Forest/Woodland	10.45	0..86	9.59
Pasture/Pastoral Woodland	150.12	62.85	87.27
Dune Scrub	1.19	0	1.19
Swamp Oak	4.29	0.70	3.59
Aquatic	5.75	0	5.75
	179 (Approx)	64.43	114.57

5.4.2 Threatened Flora Species

The proposed development does not affect any threatened flora species as no such species has been recorded on the site or property, and no significant potential habitat for such species will be removed.

The creation of the wetland may provide potential habitat for some threatened flora species eg *Maundia triglochinoides*, which could potentially be planted in the future (eg as part of a recovery plan), or colonise habitat via dispersal vectors (eg waterbirds), hence this is considered a positive impact on the site's current habitat potential.

5.4.3 EECs

As shown in figure 12, the proposal will see the loss of approximately 0.49ha of low to medium quality (ie degraded to highly degraded) *Swamp Oak Floodplain Forest* (SOFF) EEC. This comprises 11.42% of the extent of this EEC on the property – the remainder of which will be retained, protected and enhanced by bush regeneration under the Open Space Management Strategy (Cardno 2008).

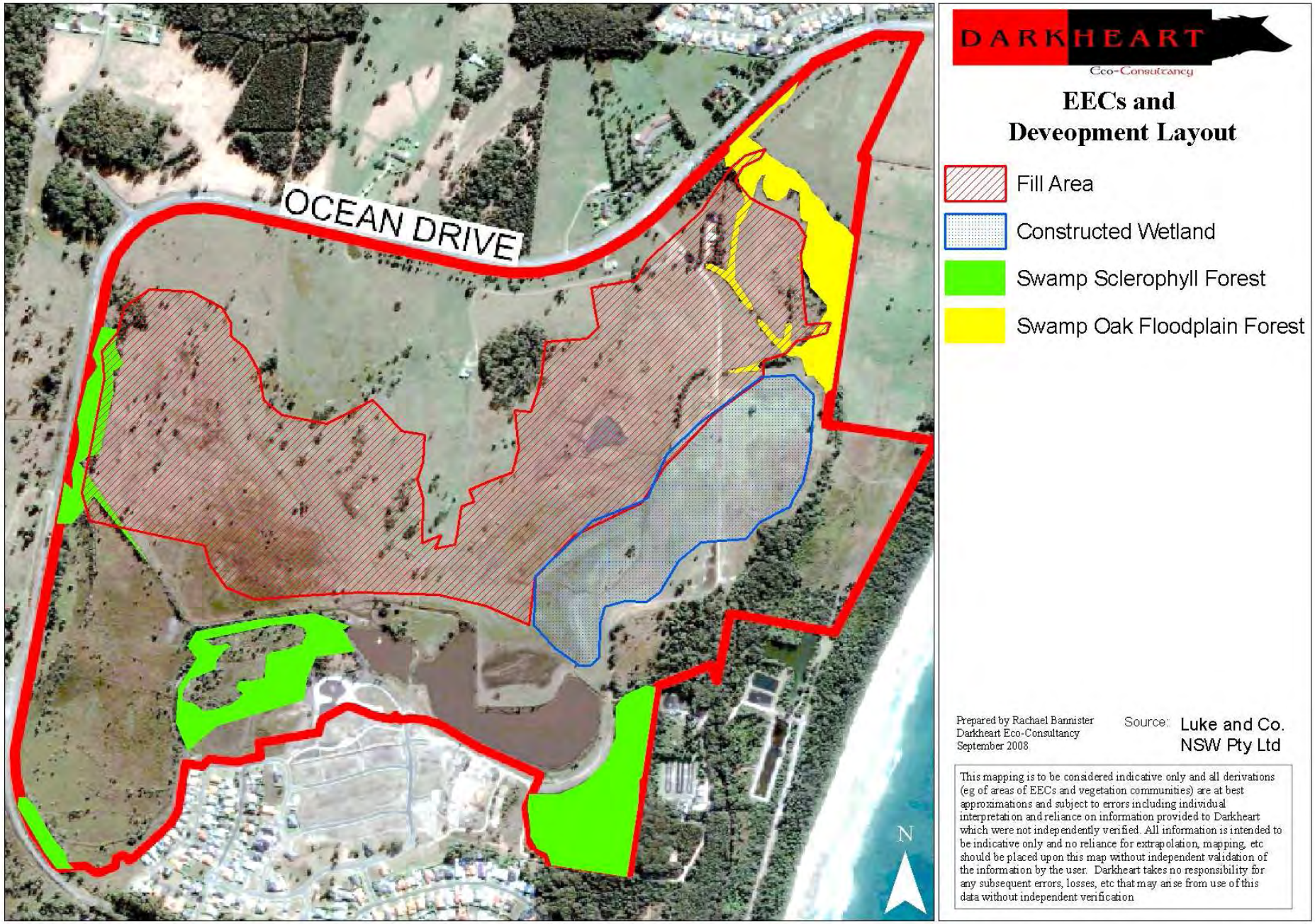
The playing fields will also trim 0..43ha of the eastern edge of the *Swamp Sclerophyll Forest* (SSF) EEC on the western side of the property. This comprises 4.11% of the total occurrence.

In general, the loss of the 0.49ha of SOFF EEC and 0.43ha of SSF EEC is considered inconsequential to the viability of these EECs on site as current processes (eg grazing, edge effects, etc) severely limit biodiversity of these areas, and hence they only consist of the most resilient pioneer flora species and common agricultural woodland fauna.

All of the other extents of EECs will be permanently retained on the property (about 13.82ha in total within the Open Space/Drainage/Habitat Corridors (Richards 2004, Cardno 2008, Biolink 2005c), hence the proposal will not see the extinction of the local occurrence of these EECs.

No new effective barrier to movement of potential fauna or exchange of genetic materials associated with these EECs will be created by the proposal eg given the east-west and northern corridors will be retained and enhanced via bush regeneration (Cardno 2008). The latter will provide greater potential for genetic exchange and diversity, hence this is considered a positive impact on the viability of the remaining EECs.

Figure 12: EECs and Development Layout



Cardno (2008) state that the proposal should have no significant negative impact on the current groundwater regime or flooding patterns, other than re-establishing more water flow through a greater length of Duchess Gully, which should restore and improve ecological conditions and processes. Groundwater level drawdown has only a localised influence around the wetlands. Consequently, the ecological processes underlying the remaining EECs should not be compromised.

Provided erosion and sedimentation are controlled, the proposal should have no substantial impact on these remaining EECs.

Future urbanisation of the remainder of the property has potential for a range of other impacts, but this is not assessed in this report as per the DGR's.

6.0 AMELIORATIVE MEASURES AND RECOMMENDATIONS

6.1 GENERAL

6.1.1 DGR's Addressed

The following Project Application DGR's are addressed section 6.1:

- *PA 4.1: Outline potential impacts on flora and fauna and their habitats (within the meaning of the Threatened Species Conservation Act 1995 across the site and where relevant provide conservation measures.*

The following Concept Plan Application DGR's are addressed in sections 6.1 and 6.2:

- *CP 7.3: Outline measures for the conservation of flora and fauna and their habitats within the meaning of the Threatened Species Conservation Act 1995.*
- *CP 7.4: Outline measures for the conservation or enhancement of existing wildlife corridors and/ or the connective importance of any vegetation on the subject land.*

6.1.2 UIA 14 Structure Plan – Open Space/Drainage/Habitat Corridors

As shown in figure 5, the UIA 14 Structure Plan (Deicke Richards 2004) has delineated an east-west and northern corridor centred along low lying plains and watercourses. This prerequisite urban design measure forms the key instrument for conserving flora and fauna habitats and connectivity (and hence addresses the DGR's) as it contains:

- The overwhelming majority of habitat, including the large Wallum Froglet population and identified Core Koala Habitat.
- The overwhelming majority of the EECs.

As shown in figure 2, these linkages have been duly incorporated in both the Concept and Project Applications. The Open Space/Drainage/Habitat Corridor covers some 53.82ha (30.06%) of the property.

The Open Space Management Strategy (Cardno 2008), which forms part of both Applications, details the specific measures (eg via a Vegetation Management Plan) that will be undertaken to formally establish and improve the ecological functioning of these corridors, with the aim to:

- enrich the current native biodiversity of existing vegetation within the Open Space Corridor;
- enhance the existing corridor values of vegetation along Duchess Gully;
- create better movement opportunities in an east-west direction for native wildlife;
- reduce the extent of existing weed infestations within the Open Space Corridor;
- protect and enhance aquatic habitat values within existing and to be constructed waterbodies within the Open Space Corridor; and

- provide an appropriate interface between native vegetation and wildlife habitats within the Open Space Corridor and adjacent areas of urban development.

More specifically, the OSMS and its component Vegetation Management Plan (VMP) and Landscape Management Plan (LMP) management objectives and actions will result in (Cardno 2008):

- the protection and improvement to the area that supports a relatively large Wallum Froglet population just below the new constructed wetland;
- increasing the prevalence of known Koala food trees and other plants with multiple-species values throughout the Open Space Corridor;
- restoration of the floristic and structural elements of degraded EECs;
- providing structural complexity and cover for ground-dwelling fauna such as the Eastern Chestnut Mouse and Common Planigale;
- reinstating degraded fauna movement corridor values throughout the Open Space Corridor; and;
- removal and management of weed infestations.

In addition to having positive impacts on the biodiversity of the property, the Open Space/Drainage/Habitat Corridor and OSMS will have positive impacts on the adjacent vegetation communities and nearby SEPP 26 area via (Cardno 2008) via:

- establishment of the Open Space Corridor will provide appropriate vegetated spatial buffers between residential development and Littoral rainforest vegetation to the east;
- stormwater control devices will be implemented within the development footprint and Open Space Corridor in order to control the quality and quantity of storm water run-off generated by the development and minimise its potential impact on surrounding environments; and
- source populations of weed species such as Lantana (*Lantana camara*) will be managed as part of a comprehensive weed management program.

6.1 PROJECT APPLICATION RECOMMENDATIONS

As noted above, by far the main measure for conservation of flora and fauna and their habitats has been the designation of most of the property's forest vegetation within the east-west and northern corridors/open space areas, as recommended by the UIA 14 structural plan (and noted above).

The following are specific recommendations to help achieve the OSMS aims, and many of have been incorporated into the OSMS (Cardno 2008), and/or have been enacted eg weed control.

6.1.1 Primary Recommendations

The following primary recommendations are made to ameliorate the risk of potentially significant impacts. They are integral to the basis of later assessment and conclusions as it is assumed they will be implemented in some form, such as an enforceable condition of consent, Development Control Plan measure, etc.

To date, many of these recommendations have already been initiated or incorporated into the Concept and Projection Applications and Open Space Management Strategy (as noted below).

6.1.1.1 Protection and Maintenance of the Wallum Froglet Habitat

The population of Wallum Froglets in the depression to the southwest of the constructed wetland is to be retained as per design of the proposal, and protected during construction and operational phases as follows:

6.1.1.1.1 Design Measures

The following design measures have been incorporated in the Project Application, Concept Plan Application and OSMS to protect the species and its habitat:

- Location of the constructed wetland and all works outside the habitat area with a sufficient buffer to erosion and sedimentation, etc.
- Location of all infrastructure (powerlines, sewage, etc) outside the above buffer zone.
- Location of footpaths, car parks, etc away from the habitat to discourage adverse human interaction.
- Provision for native species based landscaping/assisted bush regeneration around the habitat to provide a screen, filtration strip/buffer and linkage to the swamp forest to the west (part of the proposed corridor) and to the constructed wetland to the north to allow potential dispersal of the species to new habitats eg macrophytes zones in the constructed wetland.
- Diversion of untreated stormwater from the urbanised catchment away from the habitat.

6.1.1.1.2 Construction Measures

The following is to be undertaken to avoid impacts during construction:

- A proper formal buffer is to be established around this habitat, and its boundary clearly marked/ fenced off prior to earthmoving to prevent inadvertent disturbance during construction.
- Staff induction is to include information regarding the importance of this area and essential requirement for it not to be disturbed under any circumstance.
- No storage of fill, fuels, etc within the buffer zone.
- Provision of sediment detention fences on the aspect exposed to the construction area to prevent any risk of sedimentation.
- No mowing, slashing, etc, of the habitat area.

6.1.1.1.3 Operational Measures

These measures are to be implemented as part of final development of the property and under an on-going management regime (as per the OSMS):

1. **Weed control**: Weeds are not allowed to establish in the habitat and must be controlled. Physical (hand) removal is only allowed – no herbicides or machinery.
2. **Fire control**: Under no circumstance is fire to be allowed in the habitat. As per (6), monitoring is to ensure the risk of fire via arson is averted via artificial filling if required.

3. **Public and Pet Access**: Signage stating public access to the habitat is to be erected prohibiting such without Council approval eg for educational or scientific research. No cats or dogs are to be allowed in the habitat area.

4. **Interpretative signage**: A pathway leading to an observation point with interpretative signage is recommended at the Wallum Froglet habitat to encourage awareness and community stewardship of the population.

5. **Prohibition of vegetation removal**: No mowing, slashing, etc, is to occur in the habitat area at any time. The only vegetation removal allowed is of weeds by hand or selective brushcutting.

6. **Monitoring and Emergency Procedures**: Periodic inspection of the habitat is required (eg by Council's environmental officer) during seasonal drought to ensure dry intervals are not excessively prolonged to allow the risk of significant drying and induced risk of fire in the wetland. If such conditions occur, treated water from the open water section of the major wetland is to be pumped into the wetland.

6.1.1.1.4 Landscaping/Habitat Regeneration

Due to the slashing of the Wallum Froglet habitat in recent years, significant modification of the floristic structure and composition has occurred since 2003. This needs to be rectified to maximise the long term viability of this population.

The habitat is to be allowed to naturally regenerate with monitoring to ensure weeds/exotic species (including Torpedo Grass) do not become dominant (as per the OSMS). If the latter appears to be developing, appropriate weed removal and planting with native species is to be undertaken to maintain the habitat (as per the OSMS).

Monitoring of this habitat's recovery by the proponent is required to be undertaken until the habitat has regained its previous natural state at least (as demonstrated by a tall dense mixture of sedges and shrubs). Monitoring may cease when water quality/watertable monitoring associated with other aspects of the proposal has demonstrated that weeds are controlled and that the creation of the wetland has not adversely affected the hydrological regime of this habitat.

To protect this area from potential impacts associated with public visitation, appropriate groundcover, shrub and tree vegetation which discourages (ie spikey and sharp species such as Spiney Headed Matrush and Dagger Leaved Hakea) human entry is recommended to be preferentially established around the margins of the depression, to confine human activity to a specified point/areas ie the viewing area and footpath/cycleway. These plantings will form part of the designated biodiversity enrichment area #12 in the VMP component of the OSMS (Cardno 2008), as shown in figure 13.

6.1.1.2 Constructed Wetland Design

The following are measures the proponent has incorporated into the design and unless specified, are not recommendations of this assessment.

6.1.1.2.1 Macrophyte Zone

The wetland contains some 10.72ha of open water, with depth ranging from 0.25m to 2m, with an average of 1m (Cardno 2008, Luke and Co. 2008). As macrophytes such as Giant Spikerush will grow to around a depth of 1m and at times deeper (DLWC 1998a, 1998b. pers. obs.), it is expected that much of the approximately 2km perimeter of the wetland outside the designated macrophyte cell will readily become a macrophyte zone, which is to be primarily achieved via plantings (Cardno 2008). This will result in a

significant increase in habitat for waterfowl, frogs and invertebrates (DLWC 1998a, 1998b) and a positive impact on the site/property and local biodiversity.

6.1.1.2.2 Drainage Weirs and Fishways

The design includes two overflows to Duchess Gully (see figure 3B). Both will be generally dry at most times as water levels must rise above at least 3.4m AHD, hence they will pose no significant barrier to movement of terrestrial species. It is recommended that the edges of these weirs throughout their length be planted with riparian vegetation from sedges such as tussocky *Juncus* spp to overhanging trees like Broad-Leaved Paperbark, *Syzgium* spp, *Callistemon salignus*, etc, to mimic a natural riparian zone and maximise corridor connectivity. Large rocks laid along the edge, or even logs crossing the weirs would also assist in maximising corridor effectiveness and biodiversity eg via providing refugia.

Both weirs will also contain structures and design measures which will maximise their potential to be used by native fish to enter/leave the wetland system (Cardno 2008), which will further enhance biodiversity and habitat opportunities.

6.1.1.3 Erosion and Sedimentation Control

As per Council planning controls, an Erosion and Sedimentation Plan will be implemented for the construction phase of the proposal (Luke and Co 2008, Cardno 2008). This is expected to be implemented effectively by the construction contractors with follow-up compliance enforcement.

As noted previously, measures are most important to be implemented to protect Duchess Gully, adjacent EECs and the Wallum Froglet habitat from sedimentation from erosion of tracks, fill storage or spreading areas, and dewatering areas.

6.1.1.4 ASS Management

Cardno (2008) provide an *ASS Management Plan* for monitoring, control and management of any exposed PASS, and a construction plan to minimise risk of excessive watertable lowering and PASS exposure. This is expected to be implemented effectively by the construction contractors with follow-up compliance enforcement.

These measures must protect the Wallum Froglet habitat, existing lagoons, EECs, the constructed wetland and Duchess Gully.

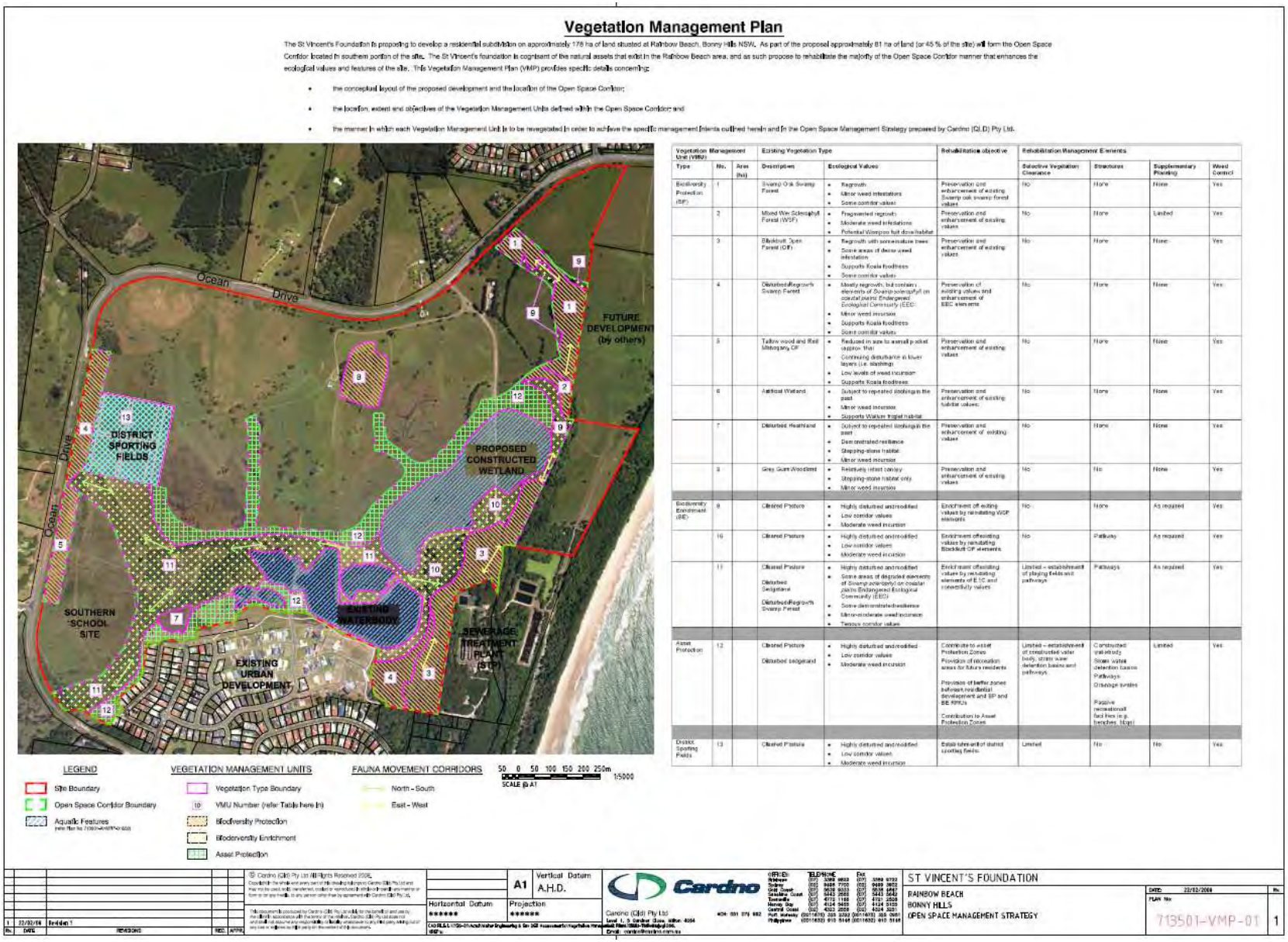
6.1.1.5 Groundwater and Surface Water Quality Management

Cardno (2008) provide *Groundwater and Surface Water Monitoring and Management Plans* for monitoring, control and management of groundwater and surface water throughout the construction period and for at least 5yrs post-development to ensure the predictions of their report are validated ie no significant adverse impacts will occur.

This is expected to be implemented effectively by follow-up compliance enforcement, and will allow early identification of any issues which require amelioration.

It is recommended that a monitoring station be established in the Wallum Froglet habitat to ensure the hydrological regime and water quality of this habitat is not adversely affected as per predictions of the Cardno (2008) report, and also to provide feedback to managers eg to initiate remedial action such as addition of freshwater to the wetland.

Figure 13: Vegetation Management Plan for the property
(Cardno 2008b)



6.1.1.6 Artificial Lighting

Artificial lighting will be required for street lighting and most likely along the footpath on some edges of the wetland.

Artificial lighting must be arranged in a manner which avoids spillage onto the constructed wetland and especially the adjacent Wallum Froglet habitat, due to the potential impacts it may have ie disturbing roosting and foraging behaviour, exposure to predation, etc.

6.1.1.7 Weed Invasion/Removal

6.1.1.7.1 Core Koala Habitat

At time of survey in 2006, the portion of identified Core Koala Habitat in the southeast adjacent to the STP was noted to have at times a very high constitution of lantana. This was considered a significant constraint on the Koala's full utilisation of this key area. The VMP identifies this area for weed removal, and works have been ongoing since 2007 with significant success with Lantana effectively under control (see Appendix 4 for example photo). Works are programmed to continue under the OSMS (Cardno 2008b) to see this key area fully restored to maximum ecological effectiveness.

6.1.1.7.2 General Weed Control

6.1.1.7.2.1 Filling and Excavation Area:

Disturbance of the study site's soils has potential to encourage weed invasion. Hence, it is recommended that:

- Machinery to be used for the work should be cleaned to remove seeds (ie on wheels, tracks, guards etc) prior to transport to and from the site.

- Measures should be taken to inhibit the establishment of weeds following the work especially in fill storage and spread areas ie via a weed management plan.

6.1.1.7.2.2 Open Space/Wildlife Corridors

The majority of the east-west linkage has a high component, consisting of Torpedo Grass. The margins of the existing dams/lagoons are particularly affected and has limited development of macrophytes (Cardno 2008).

The VMP identifies areas to be treated to reduce/control infestations of this weed, and a range of field trials testing control methods have been undertaken already eg physical removal of Torpedo Grass from the lagoons/dams. These are expected to continue in company with macrophyte and other native species planting and bush regeneration to restore native vegetation communities and maximise habitat opportunities of these wetlands.

6.1.1.8 Landscaping/Bush Regeneration

The Project and Concept Plan Applications includes provisions (via the Vegetation Management Plan and Landscape Plan) for extensive landscaping/bush regeneration around the constructed wetland for a range of purposes ie nutrient uptake, aesthetics and habitat (Luke and Co. 2008, Cardno 2009). These also form part of the east-west and northern corridors.

The following recommendations were made in a preliminary report in 2006, and have largely been incorporated into the VMP/OSMS.

6.1.1.8.1 Constructed Wetland Landscaping/Vegetation Buffers

All plantings around the wetland are to be based on native species indigenous to the LGA. Apart from lawns and ornamental gardens in specified areas, no exotic species are to be used in the fringing vegetation around the wetland.

6.1.1.8.1.1 Location, Structure and Function of Plantings

Plantings around the wetland should generally mimic natural structure ie combine trees with shrubs, etc to form a forest or woodland structure depending on location, function (eg discourage access to water) and aesthetic aims of the landscape plan/VMP.

The VMP has allowed for at least 30-50m wide plantings (incorporating facilities such as pathways and APZ) around the western edge to minimise human intrusion and maximise the buffer zone. More structured plantings will occur at the northern and southern ends to establish, formalise and/or widen corridors along Duchess Gully and link the southeast dry sclerophyll/swamp forest with the central swap forest (Cardno 2008).

Plantings in the emergent zone are to occur around the majority of the wetland's periphery to maximise water treatment and habitat creation, with the western side being a dedicated primary treatment area (Cardno 2008). Planting zones in general should be maximised in width where practical though it is appreciated that natural colonisation of suitable habitat will occur in relatively short time (DLWC 1998a, 1998b). Some of these species are also likely colonise shallow zones in the deeper portions of the wetland over time which will increase habitat complexity (as noted above).

6.1.1.8.1.2 Recommended Planting Species

Some suggested recommended species are:

- **Trees**: *Melaleuca quinquenervia, Eucalyptus robusta, E. microcorys, E. patentinervis, E. resinifera E. tereticornis, Corymbia intermedia, C. gummifera*. Littoral and subtropical rainforest species such as *Ficus coronata, Ficus macrophylla, F. rubiginosa, Syzygium australe, Cryptocarya* spp, etc are also desirable to maximise biodiversity.

- **Understorey/Shrubs**: *Callistemon pachyphyllus, M. stypheloides, M. linariifolia, M. sieberi, Babingtonia similis, Allocasuarina torulosa, A. littoralis, Acacia suaveolens, A. binervata, A. implexa, Banksia integrifolia, B. serrata, B. oblongifolia, B. robur, Trochocarpa laurina, Backhousia spp, Acmena smithii,* Cabbage Palm, *etc*

- **Groundcovers:** *Lomandra longifolia, L. hystrix, Juncus usitatus, J. polyanthemus, J. continuus, Schoenus spp, Carex appressa, Carex fascicularis, Gahnia aspera, G. clarkei, Crinium pedunculatum, Caustis recurvata, Pseudoraphis spp, Restio spp,* Bracken Fern, Bats Wing Fern, Swamp Fern, False Bracken,

Recommended species for the emergent zone are:

- *Eleocharis acuta, E. sphacelata, Triglochin procerum, Juncus spp, T. striatum, Alisma plantago-aquatica, Baumea rubiginosa, B. articulata, Carex appressa, Cyperus exaltatus, Lepironia articulata, Paspalum distichum, Phragmites australis, Schoenus spp, Schoenoplectus mucronatus, S. validus, Typha domingensis, Phragmites australis* and *Philydrum lanuginosum, Chorizandra spp, and Lepironia articulata*.

Recommended species for the submerged zone and open water are:

- *Vallisneria spp* (shallow areas), *Nymphaea spp, Ludwigia peploides, Ottelia ovalifolia,* Duck Weeds and *Triglochin spp.*

6.1.1.9 Wetland Habitat Enhancement

Some of the trees fallen during future urban development of the remainder of the property (particularly the large Forest Red Gums in the pastoral woodland) should be laid (eg via crane if the wetland has been constructed) within the wetland to provide roosts for Water Dragons, tortoises and waterfowl. Location can be selected according to maintenance requirements to avoid any problems. Provision of large rocks along some sections (eg around the Duchess Gully linkage to the east) would also enhance habitat opportunities.

6.1.2 Secondary Recommendations

The following recommendation aims to address minor impacts and enhance habitats in line with the goals of the proposal to enhance local biodiversity.

6.1.2.1 Other Koala Habitat Enhancement

The hill off the southeast of the wetland is largely cleared. This area provides excellent potential for expansion of the adjacent dry sclerophyll forest and hence Koala habitat. Recent sighting of a Koala in this area evidences this potential. Similarly, a large bund wall off the southeast of the eastern dam/lagoon is covered in Torpedo Grass, and lies adjacent to the swamp forest which is identified Core Koala Habitat. This bund requires weed control and this could also be combined with some habitat creation incorporating Primary Preferred Koala Browse Species.

A preliminary report in 2006 recommended consideration be given to the above, and this is recognised in the VMP and OSMS with provisions for planting and weed management to achieve the above programmed to proceed in due course (Cardno 2008).

6.1.2.2 Other Restrictions

The perimeter of the wetland and all adjacent habitat areas where pedestrian paths may pass through are to be designated leashed dogs only. This is required to prevent dogs harassing wildlife and swimming.

Furthermore, swimming, recreational boating and model boats should not be allowed in the constructed wetlands again to minimise disturbance to fauna.

Signage will be required to ensure compliance with these restrictions.

6.1.2.3 Hollow-Bearing Tree and Nest Removal Protocol

As noted above, a number of hollow-bearing trees are to be removed in the pastoral woodland. A Whistling Kite nest also occurs in this area.

To minimise the risk of mortality of fauna occupying dens/roosts/nests in tree hollows, the following is recommended:

(a) Hollow-bearing tree removal protocol:

> Where safe and practical, the hollow bearing trees are to be removed in a way that will minimise the risk of injury/mortality of denning/roosting fauna within the limitation of OH&S Guidelines. This is suggested to be achieved by the following general procedure (where practical and safe):

i) *Machine felling*:

- Initial bumping of subject hollow-bearing trees to initiate evacuation of any residents (subject to OH&S limits in regard to falling branches). This is to be repeated at least 3-5 times at about one minute intervals over 5-10 minutes, with progressively shorted intervals (eg 30 seconds, 15 seconds, 5 seconds) to stimulate evacuation. If animals are sighted peeking out of hollows, the bumping should be more violent to stimulate evacuation.

- The hollow-bearing tree is then to be removed via a method that does not require traditional felling. Depending on the size of the affected tree, the best method is use of an articulated pincer on a large excavator or a heavy crane to hold the trunk while the tree's base is sawn.

- The tree is subsequently to be safely and gently lowered to the ground to allow for hollow inspection for fauna. If the tree is to be destroyed, the tree is to be carefully sectioned via chainsaw to allow verification that all hollows are empty, after which the remains may be destroyed/piled. Ideally, the tree should be retained on site as a hollow-log for use by fauna.

ii) *Crane felling*:

- This consists of an arborist employing a crane to hold sections of tree/limbs which are sawn off. The limb/section is gently lowered to the ground for inspection of hollows.

- This process continues until all hollows are removed from the tree, or the tree removed.

An ecologist or OH&S certified member of FAWNA/WIRES is to be present during felling of the hollow-bearing tree and/or sectioning in case of fauna injury. Hollows are to be inspected once each tree is fallen for injured or abandoned offspring, etc, and appropriate measures undertaken eg transport to vet or care by FAWNA/WIRES at the proponent's expense, or held in a cool, dark place on site. All uninjured rehabilitated animals are to be returned into the retained vegetation on or adjacent to the site at dusk.

A written report is to be provided to Council following the removal of the hollow-bearing trees and the pre-clearing survey detailing all results and actions undertaken.

The Whistling Kite nest should be removed outside the breeding season which is generally Spring (although breeding can occur at anytime depending on food supply).

6.2 CONCEPT PLAN RECOMMENDATIONS

The following recommendations are provided for consideration for the long term development of the property as per the UIA 14 Structure Plan.

6.2.1 Duchess Gully

Duchess Gully is intended to form the northern corridor (Richards 2004, Cardno 2008, Biolink 2005c). At present the vegetation along this creek is patchy and consists of an eclectic mix of rainforest, wet sclerophyll, swamp forest, dry sclerophyll and weeds.

The 2006 preliminary report by this consultant recommended the riparian vegetation be widened where practical via stock exclusion, weed eradication and bushland regeneration. The majority of the riparian vegetation should be a wet sclerophyll forest (ie eucalypts with a rainforest understorey) to maximise biodiversity and extend on limited resources currently available in this habitat, though some areas may better be suited to swamp forest and dry sclerophyll forest. Primary preferred Koala food trees should

also be included in suitable edaphic conditions eg Tallowwoods, Forest Red Gums and Swamp Mahogany. These measures have been incorporated into the VMP/OSMS (ie areas 2 and 9 in the VMP in figure 13).

The value of this area as habitat could also be enhanced via erection of nest boxes, and placement of some hollow logs derived from the Forest Red Gums in the pastoral woodland which will eventually be cleared.

6.2.2 Restoration and Habitat Enhancement of the East-West Corridor

The proposed east-west corridor includes a significant area of degraded "*Swamp Sclerophyll Forest on Coastal Floodplains*" EEC, with condition ranging from pasture mixed with native sedges and scattered trees, to immature regrowth forest.

Restoration of this area will require some active plantings to supplement the low rate of natural recruitment, and weed control to see elimination of the established pastoral species. This will take a number of years to be established. The OSMS and component VMP have addressed this and detail the works, etc, required to restore this area to fully functional habitat. Some preliminary works have already begun eg cessation of slashing and fencing off stock from nominated regeneration areas, with exceptional response by the native vegetation as shown in Appendix 1. These preliminary measures will increase the potential viability of the southwest Common Planigale and Eastern Chestnut Mouse populations via expanding the current area of habitat and reinforcing linkages to other potential habitat.

In the medium term, subject to flooding constraints, large fallen logs from other portions of the property could be positioned in the corridors as single trees and small piles of logs to provide shelter for a range of fauna eg rodents, reptiles and the Spotted-Tail Quoll, given such key habitat components will take hundreds of years to naturally develop. Nest boxes may also be viable to place in the immature swamp forest just west of the main lagoon to provide potential dispersal/den site opportunities for Squirrel Gliders which may use the habitat in the medium term (eg when a woodland or young forest has been established).

6.2.3 Proposed Southern School Site

The current delineated area for this site includes the densely vegetated drain adjacent to the southwest patch of dry sclerophyll. As detailed in this report, this area is known to support a small population of Common Planigale, Eastern Chestnut Mouse and Wallum Froglet

It is recommended that this habitat area (the entire drain and a fully vegetated buffer zone of at least 30m to the east) be excluded from any filling, etc, within the school footprint. This area should be collectively fenced off with southwest dry sclerophyll/swamp forest, and the total area regenerated and managed appropriately for these species to maximise the potential viability of these small populations.

As for the main Wallum Froglet population, this area may be used for educational purposes but should essentially to be protected under provisions of the OSMS.

6.2.4 Proposed Eco-Tourism Site

The southern half of the generally native grassland falling within the proposed eco-tourism site was found to support the Eastern Chestnut Mouse in 2003. This area was not surveyed again in 2006, and it was completely slashed post-survey. Inspection in July 2008 found the area has been slashed again as part of the ongoing agricultural use of the land, and the limited detritus suggested slashing was occurring at regular periodic intervals which probably reduced the potential for sufficient tall groundcover to develop and attract the Eastern Chestnut Mouse. It is not known if the animal has persisted via surviving in the adjacent dune scrub and dry sclerophyll, but given slashing is likely to have long been a periodic disturbance of this area, it is not considered unlikely. Further survey may determine if the species is

present or not, and hence remains viable.

The development footprint of the Eco-Tourism site is not known at this stage. However, the buffer to the STP ensures that the residential component of the development is restricted to the northern half of Lot 5.

Any future development of this area thus must ensure either the population is extinct (in which case ecological constraints are limited), or is not placed at risk of extinction. In the latter, development and management must ensure:

- Sufficient habitat is retained to support a viable population.
- No barriers to movement/dispersal are emplaced.
- Fire/slashing is managed as required per the species ecology.

PART B: ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999: MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

7.0 RELEVANT EPBCA MNES SCHEDULES

7.1 THREATENED AND MIGRATORY FAUNA

7.1.1 Vulnerable and Endangered Species

The Grey-Headed Flying Fox (Vulnerable) was only EPBCA 1999 listed threatened species record on the property by this consultant. The Swift Parrot (Endangered) is indicated on the Atlas of Wildlife (DECC 2008a) to possibly have been recorded in the northern end of the property. These species are automatically subject to the statutory assessments in section 8.0.

A search of the Dept of Environment, Water, Heritage and the Arts (DEWHA) Matters of National Environmental Significance (MNES) website was also taken to generate a list of threatened species potentially occurring on the property. These are shown in the following table, with other species considered by the consultant as potential occurrences in the locality due to suitable habitat. An evaluation of their likelihood of occurrence is also provided.

Table 8: EPBCA listed 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 EA website search. Excludes marine mammals, reptiles, etc

GROUP	COMMON NAME	RECORDED IN LOCALITY (10km radius)	SUITABLE HABITAT ON PROPERTY	LIKELIHOOD OF OCCURRENCE
BIRDS	*Regent Honeyeater	Y – one bird recorded in Port Macquarie by Hastings Birdwatchers 2004	Forest Red Gums, Swamp Mahogany and possibly White Banksia offer some potential to support opportunistic foraging most likely during non-breeding movements.	No major occurrences known in LGA hence only very rare potential for infrequent visits. Site forms minute fraction of potential habitat in LGA. Unlikely to very low

	Red Goshawk	N	Very marginal – very open and limited prey diversity.	Very marginal – no records south of north coast. Unlikely to very low
	*Swift Parrot	Y	As for Regent Honeyeater.	**Recorded**
MAMMALS	*Long-Nosed Potoroo	N	N	No. Unlikely due to disturbance history
	*Spotted-Tail Quoll	Y	Marginal at best – too open	Marginal potential in SE corner. Low to very low as no significant habitat on property or interlinked.
	*Grey Headed Flying Fox	Y <1km	Y	**Recorded**
	*Dwyer's/Large Pied Bat	N	In broad terms for foraging only.	Marginal and very few coastal records. Foraging only. Very low to unlikely
FROGS	*Green and Golden Bell Frog	Y – Lake Innes area, Port Macquarie	Marginal in broad structural terms. Habitat is artificially created where it may not have existed before. High risk of predation	Considered unlikely as not detected by surveys despite being targeted, high risk of predation and no records in adjoining habitat
	Wallum Sedge Frog	N	Marginal in broad structural terms. Habitat is artificially created where it may not have existed before. High risk of predation	Considered unlikely as not detected by surveys despite being targeted, high risk of predation and no records in adjoining habitat or LGA
	*Stuttering Frog	N	N	N
	*Southern Barred Frog	N	N	N
REPTILES	Burrowing Skink/ Three-Toed Snake-Tooth Skink	N	N.	N

7.1.2 Migratory Species

This consultant recorded the Cattle Egret and Great Egret on the property, and the White-Breasted Sea-Eagle flying over. Clancy and Ayres (1983) recorded the White-Breasted Sea-Eagle, Fork-Tailed Swift and Rufous Fantail.

A number of other migratory bird species listed in the EPBCA have been recorded in the locality of the site and a search of the MNES website also produced a list of likely occurrences (excluding seabirds). All of these species plus some considered by the consultant as potential occurrences in the LGA in similar habitat to that on the property are also shown in the following table, with an evaluation made on likelihood of occurrence based on cited ecology.

Table 9: EPBCA listed Migratory fauna species potential occurrence assessment
(* indicates likely to occur in LGA in consultant's opinion)

COMMON NAME	SCIENTIFIC NAME	PREDICTED TYPE OF OCCURRENCE	RECORDED IN LOCALITY	HABITAT ON PROPERTY	LIKELIHOOD TO OCCUR
White-Bellied Sea-Eagle	*Haliaetus benghalensis*	Species and/or habitat likely to occur in area	Y	Large lagoons appear to contain fish, hence potential to offer minute area of foraging habitat. Isolated trees in woodland offer potential nest sites.	**Recorded** flying over property
Osprey	*Pandion cristatus*	-	Y	As above	Unlikely to low – no nests on site and very limited forage
Latham's Snipe	*Gallinago hardwickii*	Species and/or habitat likely to occur in area	Y	Seasonally flooded pasture may offer potential foraging habitat	At least fairly likely when groundcover not too low. Site used as small part of wider non-breeding range
Painted Snipe	*Rostratula benghalensis*	Species and/or habitat likely to occur in area	N	Marginal at best	Unlikely
*Cattle Egret	*Egretta ibis*	Species and/or habitat likely to occur in area	Y	Y	Y. **Recorded** on property
*Great Egret	*Egretta alba*	Species and/or habitat likely to occur in area	Y	Y	Y. **Recorded** on property.
*Swift Parrot	*Lathumus discolor*	Species and/or habitat likely to occur in area	Y	As previous	**Recorded**
Rufous Fantail	*Rhipidura rufifrons*	Breeding or breeding habitat likely to occur in area	Y	Dry sclerophyll may offer some marginal potential – likely to occur in adjacent littoral rainforest	Low to marginally fair using site for non-breeding range. Previously recorded in 1983 but habitat removed.
Satin Flycatcher	*Myiagra cyanoleuca*	Breeding or breeding habitat likely to occur in area	Y	As for Rufous Fantail	Low
Black Faced Monarch	*Monarcha melanopsis*	Breeding or breeding habitat likely to occur in area	Y	As for Rufous Fantail	Low

Spectacled Monarch	*M. trivirgatus*	Breeding or breeding habitat likely to occur in area	Y	As for Rufous Fantail	Very low
*Oriental Cuckoo	*Cuculus saturatus*	Species and/or habitat likely to occur in area	N	Y – Dry sclerophyll areas	Low to fair – small part of non-breeding range
Regent Honeyeater	*Xanthomyza phrygia*	Species and/or habitat likely to occur in area	N	As previous	Unlikely to very low
*Rainbow Bee-eater	*Merops ornatus*	Species and/or habitat likely to occur in area	Y	Dry sclerophyll offers some marginal potential	At least fair
White-Throated Needletail	*Hirundapus caudacutus*	Species and/or habitat likely to occur in area	Y	Y	Highly likely to occur
*Fork-Tailed Swift	*Apus pacificus*	Species and/or habitat likely to occur in area	Y	Y	Recorded in 1983, highly likely to occur.

A number of seabirds and estuarine waterfowl listed as Migratory under the EPBCA (some are also listed as Threatened under the TSCA) may occur in the locality eg Eastern Curlew. However, no habitat occurs on the property for these species as the site does not contain tidal habitats or suitable watercourses. The tidal sections of Duchess Gully may offer some marginal potential for some species, though habitat is better developed in downstream sections (pers. obs.).

Similarly, while several migratory marine turtles and mammals also occur or may occur in the ocean to the far east (eg Blue Whale, Long-Nosed Spinner Dolphin, Humpback Whale and Green Turtle), the site and property obviously does not offer suitable habitat for these species. The migratory marine turtles, marine mammals and wetland and seabirds (discussed above) are not considered in the later assessment due to the lack of potential impacts on these groups of species.

7.2 THREATENED FLORA

No EPBCA listed threatened plants were recorded on the site or property. A search of the DECC Rare or Threatened Plants (ROTAP) database (2008a), Bionet (2008) and available literature (eg Biolink 2003, Berrigan and Bray 2002) indicated the following EPBCA 1999 listed species occur in the locality:

- *Melaleuca biconvexa:* Lake Innes NR.
- *Acacia courtii*: Dooragan NP, Yoorigan NP
- *Grevillea caleyi:* Dooragan NP
- *Allocasuarina defungens:* Crowdy Bay NP.
- *Thesium australe:* Kattang NR, Crowdy Bay NP
- *Cynanchum elegans:* Middle Rock
- *Phaius tankervilliae:* Cowarra SF

None of these species were found or considered likely potential occurrences on site or the property (see section 3.2.1 and Appendix 1). The following table lists other species considered potential occurrences in the locality derived from the MNES site:

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 (see section 2.2.1.2 and after this table); 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 AND LIKELIHOOD OF OCCURRENCE ON SITE	SUITABLE HABITAT ON-PROPERTY AND LIKELIHOOD OF OCCURRENCE ON PROPERTY
Leafless Tongue Orchid	*Cryptostylis hunteriana*	V	N	N. Unlikely	N. Unlikely
*Frogbit Fern	*Hydrocharis dubia*	V	N	N. Unlikely	N. Unlikely
Clear Milkvine	*Marsdenia longilobia*	V	N	N. Unlikely	N. Unlikely
-	*Parsonsia dorrigoensis*	E	N	N. Unlikely	N. Unlikely
Snake Orchid	*Diuris pedunculata*	E	N	N. Unlikely	N. Unlikely

These species are assessed in Appendix 1. The other species listed in the above table is considered as follows:

- Frogbit (*Hydrocharis dubia*) is an aquatic perennial plant with emergent and floating leaves, with the plant rooted when in shallow water, or floating if in deeper water. It is found north from the Clarence River, NSW, and grows in small shallow freshwater bodies or swamps. The drains and dams/lagoons offered marginal potential habitat, but this species was not found by the survey. It is not considered a potential occurrence given the marginal habitat and lack of LGA records.

7.3 THREATENED ECOLOGICAL COMMUNITIES

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

7.4 KEY THREATENING PROCESSES

In addition the Key Threatening Processes relevant to the site and property and listed in section 3.4 the following Key Threatening Processes listed in the EPBCA are also relevant to the locality of the site:

- 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^{o} South
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28^{o} 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
- Predation by the European Red Fox (*Vulpes vulpes*)

8.0 MNES – STATUTORY ASSESSMENTS

8.1 GENERAL CONSIDERATIONS/SUMMARY

The provisions of the EPBCA 1999 require determination of whether the proposal has, will or is likely to have a significant impact on a *"matter of national environmental significance"*. These matters are listed and addressed as follows:

1. **World Heritage Properties**: The site is not listed as a World Heritage area nor does the proposal affect any such area.

2. **Ramsar Wetlands of International Significance**: No Ramsar wetland occurs on the site, nor does the proposal affect a Ramsar Wetland.

3. **EPBCA listed Threatened Species and Communities**: No EPBCA listed species are likely to be significantly affected (See section 8.2 and Appendix 1).

4. **Migratory Species Protected under International Agreements**: The site does not offer significant known or potential habitat for such migratory species and the proposal does not significantly negatively affect any such sites. The new wetland may offer a substantial area of new potential habitat.

5. **Nuclear Actions**: The proposal is not a nuclear action.

6. **The Commonwealth Marine Environment (CME)**: The site is not within the CME nor does it affect such.

7. **National Heritage**: The site is not listed as National Heritage nor does it affect any such item.

The proposal thus is not considered to require referral to the DEWHA for approval under the EPBCA 1999.

8.2 EPBCA 1999 - THREATENED SPECIES

8.2.1 Threatened Flora

As detailed in section 7.2 and table 14, no EPBCA 1999 listed flora species were found or considered likely potential occurrences on the study site, and are thus not considered further.

8.2.2 Threatened Fauna

8.2.2.1 General Consideration

The Grey Headed Flying Fox was the only EPBCA species recorded on site during surveys by this consultant, and is automatically assessed in section 8.2.2.2. The Swift Parrot has also been reported to occur on site (DECC 2008a), and is assessed in section 8.2.2.3.

A number of other EPBCA threatened species have been recorded in the locality (Bionet 2008, DECC 2008a), or are considered potential occurrences in the locality in terms of potentially suitable habitat (see Appendix 1). A significant number of others have also been recorded in the region in similar habitats to those occurring in the locality (Bionet 2008, DECC 2008a, 2008b, Strahan 2000, Smith *et al* 1995, Churchill 1998, etc). The following groups of species are not considered further as the proposal has no consequence upon them:

1. **Marine reptiles, fish and mammals** eg Grey Nurse Shark, Great White Shark, Southern Right Whale, Loggerhead Turtle, Green Turtle and Leatherback Turtle.

2. **Migratory/open ocean seabirds** eg Gould's Albatross, Southern Giant Petrel, Blue Petrel, Northern Giant Petrel, Sooty Albatross, Kermadec Petrel, Shy Albatross and Grey-Headed Albatross.

These species were considered likely to be unaffected by the development proposal due to:

- Lack of habitat affected eg pelagic species
- Extremely rare probability of occurrence near site or in locality
- Nesting or foraging habitat not potentially or significantly affected
- No threats to be introduced or enhanced.

The following species listed under the EPBCA are potential or known occurrences in the locality or LGA, and are considered for potential impacts, risk and significance in the evaluation table in Appendix 1. These species are generally dually listed under the NSW *Threatened Species Conservation Act 1995*. Species considered are:

1. Birds: Regent Honeyeater, Painted Snipe and Red Goshawk.
2. Mammals: Dwyer's Bat, Spotted-Tail Quoll, Long-Nosed Potoroo (latter two considered as entire species).
3. Frogs: *Litoria olongburensis, L. aurea, Mixophyes balbus, M. iteratus.*

None of these species were considered to have at least a fair chance of occurrence on the property overall (see Appendix 1) and were considered unlikely to be significantly affected by the development proposal for one or more of the following reasons:

- Potential habitat does not occur on or near the site/property.
- Potential habitat is not affected at all or significantly.
- Site has minimal potential to support these species to any significant extent eg key part of migratory range, breeding habitat, refugee, etc.
- Habitat loss represents negligible contraction of a marginally suitable fraction of a larger potential range.

8.2.2.2 Vulnerable Species: Grey-Headed Flying Fox

8.2.2.2.1 Factors to be Considered for Vulnerable Species

The guidelines to assessment of significance to this Matter, define an action as likely to have a significant impact on a vulnerable species, if it will:

a) Lead to a long-term decrease in the size of an important population of a species, or:
b) Reduce the area of occupancy of an important population, or:
c) Fragment an existing important population into two or more populations, or:
d) Adversely affect habitat critical to the survival of a species, or:
e) Disrupt the breeding cycle of an important population, or:
f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:
g) Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat , or:
h) Interferes substantially with the recovery of the species.

An *important population* is one that is necessary for a species' long-term recovery. This includes such populations as:

- Key populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity, and or:

- Populations that are near the limit of the species range:

8.2.2.2.2. Assessment of Significance

This section addresses each of the previous points listed.

For the purposes of discussion, the "important population" of Grey-Headed Flying Foxes is defined as that population of the species likely to depend on colonial roosts in the locality or within foraging range of the site.

a) *Lead to a long-term decrease in the size of an important population of a species*, or:

This species was recorded on the property using it as a minor fraction of its wider foraging range (Eby 2000a, 2000b, DECC 2008b). The property does not contain known roosting habitat for the Grey-Headed Flying Fox and it is unlikely to be used for roosting.

The proposal is likely to remove about two dozen scattered declining eucalypts, resulting in a minute contraction of the local foraging resource. The loss is considered unlikely to be significant to the local foraging success of the Grey-Headed Flying Fox as:

- The trees are not considered to be critical foraging habitat;
- The loss will be ameliorated by tree plantings elsewhere on the site;
- A relatively large area of similar habitat is accessible locally.

The property will retain its potential to support seasonal foraging by the Grey-Headed Flying Fox as part of a larger foraging range and since other aspects of the life cycle will not be affected the proposed development is unlikely to lead to a long-term decrease in the size of an important population of this species.

b) *Reduce the area of occupancy of an important population*, or:

The proposal will not result in the loss of any Grey-Headed Flying Fox roosting habitat and will not produce any barriers to their access to foraging habitat. Some potential foraging habitat will be removed, but the small area of loss (about two dozen scattered trees) was considered to be insignificant relative to the large area of suitable habitat accessible locally and should be replaced by landscaping plantings in the long term. Hence, the area of occupancy for populations of the Grey-Headed Flying Fox will not be effectively reduced.

c) *Fragment an existing important population into two or more populations*, or:

The Grey-Headed Flying Fox is highly mobile and known to be capable of crossing human-modified habitat. The proposal will offer no barrier to movement. Thus it will not fragment an existing important population.

d) *Adversely affect habitat critical to the survival of a species*, or:

"*Critical habitat*" refers to areas critical to the survival of a species or ecological community and may include areas that are necessary for/to:

- Activities such as foraging, breeding, roosting or dispersal.
- Succession.
- Maintain genetic diversity and long term evolutionary development, or
- Reintroduction of populations or recovery of the species/community.

As mentioned previously, the land proposed for development is not roosting habitat for the Grey-Headed Flying Fox, nor is any significant area of potential foraging habitat to be removed by the proposal.

Tree plantings on the site are expected to retain the long term potential to support seasonal foraging by the Grey-Headed Flying Fox as part of such locally abundant habitat and the site is thus not considered to be critical habitat.

e) *Disrupt the breeding cycle of an important population*, or:

The Grey-Headed Flying Fox is dependant on a sufficient extent of reliable sources of nectar, pollen and fruits for successful reproduction, and uses specific maternity roosts (Eby 2000). The site/property is not a maternity habitat, nor is it likely to be suitable as it contained limited Winter-Spring flowering species. The development will result in a minor contraction of the potential foraging resource of nectar but tree plantings should provide long term potential for seasonal foraging. Additionally, access will be retained to the relatively large areas of similar habitat in the locality. Thus local foraging success will not be significantly affected and the breeding cycle is not expected to be disrupted by the proposed development.

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

As detailed previously, only a small area of potential habitat loss will result from the development and in the long term the site is expected to effectively retain its potential to support seasonal foraging as part of a larger home range. Hence, it is unlikely that the development will impact on a local population of Grey-Headed Flying Fox to the point that it could cause a decline of the species.

g) *Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat*, or:

No new species that affects the Grey-Headed Flying Fox will be introduced.

h) *Interferes substantially with the recovery of the species*.

Ideally, the goal in threatened species recovery is to increase the number and extent of the threatened species, so that it is not at risk of becoming extinct.

The proposal as modified by the recommendations of this assessment aims to retain the current potential of the site to support opportunistic foraging by the Grey-Headed Flying Fox by removing the potential foraging habitat.

8.2.2.3 Endangered Species: Swift Parrot

8.2.2.3.1 Factors to be Considered for Endangered Species

The guidelines to assessment of significance to this Matter, define an action as likely to have a significant impact on an Endangered species, if it will:

a) Lead to a long-term decrease in the size of a population of a species, or:
b) Reduce the area of occupancy of the species, or:
c) Fragment an existing population into two or more populations, or:
d) Adversely affect habitat critical to the survival of a species, or:
e) Disrupt the breeding cycle of a population, or:
f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:
g) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat:
h) Interferes substantially with the recovery of the species.

8.2.2.3.2. Assessment of Significance

As the subject bird species is migratory, it is very difficult to qualify the "population" of the species. Unless specified thus, the population is referred to as either the remaining number of the species, or the handful of birds that may occur in the area at some time.

a) *Lead to a long-term decrease in the size of a population of a species*, or:

Habitat in the property and the general area is provided for the bird by the range of flowering species. For the Swift Parrot, the Winter to early Spring flowering species are the most important potential foraging resources eg Swamp Mahogany and Forest Red Gum.

The proposal may result in the loss of about two dozen scattered declining Forest Red Gums. This loss is considered insignificant relative to the extent of locally available habitat (eg Darkheart 2006h, 2004q) and will be compensated via replantings as part of proposed landscaping. As the species has also been recorded in modified, rural and even urban habitats (Menkhorst *et al* 1998, Olivier 1998, Smith *et al* 1995, Berrigan 2002d), this suggests the area will retain its foraging value as part of the wide migratory range of the species.

Overall, the proposal is not likely to lead to a long-term decrease in the size of a population of the Swift Parrot as the species breeds in Tasmania, and migrates northwards in Winter. Thus the site only forms a very small fraction of potential foraging habitat stretching coastally to the NSW/Qld border.

b) *Reduce the area of occupancy of the species*, or:

The proposal may result in the loss of about two dozen scattered marginal potential non-breeding foraging habitat.

The Swift Parrot is a migratory species that travels from its breeding habitat in Tasmania, to Winter foraging habitat along the east coast to the inland slopes of the Great Dividing Range of the mainland, up to Duaringa. The Swift Parrot is predicted to occur over 860 000km^2 (medium confidence), with only about 4000km^2 occupied and decreasing (low confidence) (Garnett and Crowley 2000). In this context, the loss of handful of trees scattered over about 2ha is relatively insignificant. This loss should be compensated via replantings.

c) *Fragment an existing population into two or more populations*, or:

The Swift Parrot migrates annually and has no known barriers (Smith *et al* 1995). The proposal thus will not fragment any population.

d) *Adversely affect habitat critical to the survival of a species*, or:

"*Critical habitat*" refers to areas critical to the survival of a species or ecological community may include areas that are necessary for/to:

- Activities such as foraging, breeding, roosting or dispersal.
- Succession.
- Maintain genetic diversity and long term evolutionary development, or
- Reintroduction of populations or recovery of the species/community.

As mentioned previously, the locality is not breeding habitat for the Swift Parrot. Use of the area is considered at most to be opportunistic, as part of the other potential habitat in the locality utilised as part of their migratory range. The site is thus not considered critical to the survival of the species.

e) *Disrupt the breeding cycle of a population*, or:

The Swift Parrot breeds only in Tasmania, thus the proposal has no effect on breeding.

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

The proposal will constitute the loss of about two dozen scattered eucalypts which provide marginal potential foraging habitat. This is considered insignificant given that both species range over extensive areas (as noted above), and hence it is considered rather unlikely that the proposal will contribute significantly to the decline of the species. This habitat loss will also be compensated by replantings.

g) *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat*, or:

No feral species that may affect the birds is likely to be introduced (since foxes, cats, feral cats and wild dogs are already likely to occur on or near the site).

h) *Interferes substantially with the recovery of the species*.

Ideally, the goal in threatened species recovery is to increase the number and extent of the threatened species, so that it is not in risk of becoming extinct.

The proposal will result in a relatively small area of habitat being lost/ that is considered inconsequential to the species given its ecology and extent of locally available habitat and that the loss will be regained via replantings. Given that the site it not critical to the species, it is not considered likely to interfere substantially with the recovery of the species.

8.2.2.4 Conclusion

The proposal is not considered likely to have a significant impact on any EPBCA listed threatened species.

8.3 EPBCA 1999 - Migratory Species

The following EPBCA species have been recorded on the property (Berrigan 2003h, Clancy and Ayres 1983, this survey):

- White-Breasted Sea-Eagle
- Fork-Tailed Swift
- Rufous Fantail
- Great Egret
- Cattle Egret

Other migratory bird species were considered at least a fair chance of occurrence on the site at some time, based on the presence of potential habitat eg Rainbow Bee-eater, Fork-Tailed Swift and the White-Throated Needletail.

These species are considered in the following section.

8.3.1 Factors to Be Considered

The guidelines to assessment of significance to this Matter, define an action as likely to have a significant impact on a migratory species, if it will:

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

b) *Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or;*

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

An *important area of habitat* is:

1. Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or:
2. Habitat utilised by a migratory species which is at the limit of the species range, or;
3. Habitat within an area where the species is declining.

8.3.1.1 Assessment of Significance

This section addresses each of the previous points listed.

The site is not considered likely to constitute an *important area of habitat* on the basis of the following:

1. Five migratory species have been recorded on the property. All of these species occurs widely in the locality and across the mid-north coast and the site is not considered to be an important area of habitat. The value of this habitat to all these species is as a fraction of a significant extent of similar habitat not only in the LGA, but the North Coast Bioregion. The site is not known breeding habitat for any of these species and it is not considered capable of supporting an ecologically significant proportion of any of these species (at most, only a small group or transient individuals).

2. While some migratory species occurring in the locality may be at the limits of their range, no such species were recorded in the study area. Additionally, similar habitat is known to occur both north and south of the LGA.

3. If the site were located at the limits of a species whose abundance and range is declining, it would not be considered significant as such habitat is locally abundant in the area, and habitat with greater capability occurs within 10km eg State Forest, conservation reserves, etc.

In regards to point (**a**): the proposal does not affect important habitat. The proposal will remove a small area of canopy trees and grassland. This may result in temporary reduction in the local area of marginal potential habitat for the Rainbow Bee-Eater, Great Egret and Cattle Egret, and potential prey habitat for aerial foragers such as the Fork-Tailed Swift. However, such habitat is abundant throughout the locality and the individuals are highly likely to utilise alternative foraging habitat. Conversely, the wetland will provide excellent habitat for the White-Breasted Sea-Eagle and Great Egret, and landscaping will increase habitat for other species.

In regards to point (**b**): An invasive species is one that may become established in the habitat, and harm the migratory species by direct competition, modification of habitat, or predation. No such invasive species is to be introduced by the proposal, though pet cats and dogs may potentially increase predatory rates.

In regards to point (**c**): No disruption to the lifecycle of any migratory bird is likely as:

- Habitat affected is either only marginally suitable, and/or locally abundant.

- Minimal habitat loss with majority retained or regenerated with tree plantings.
- Only a small portion of foraging habitat will be affected and this is insignificant relative to the area of potential habitat available in the locality.
- More optimum habitat for several EPBCA migratory species will be created.

In view of the above, no migratory bird is considered likely to be significantly negatively affected by the proposal. Conversely, several will be positively benefited via creation of new habitat which has been subject to major historical declines (NSWSC 2004e).

9.0 CONCLUSION

This survey has identified that the property and to a lesser extent the project application site has known and potential value for a number of threatened species with 9 threatened fauna species and two Endangered Ecological Communities found to occur on or near the property overall.

Due to the current highly modified state of the land within the development envelope, the Project Application will have relatively minimal negative impact on the capacity of the property to support the recorded and potentially occurring threatened species as it generally only remove marginal potential habitat with limited values to threatened species. The best habitat on the property will be retained after this proposal is completed and the species currently present in the retained habitat areas are recorded in modified environments such as urban remnants (eg Darkheart 2006c, 2006e, 2005a, 2005b, 2005d, 2005i, 2005m, 2004n, 2004o, 2004p, 2004u, etc), as are many of those threatened species considered potential occurrences (eg Microchiropteran bats), hence will not be significantly affected by the construction activities associated with the proposal. Furthermore, all examples of the EECs will be retained, with positive impacts on both the EECs and threatened species associated with the new habitat provided by the wetland and associated landscaping.

Overall, the Project Application will only marginally contribute incrementally and cumulatively to known threatening processes and have subsequently minor impacts on threatened species and EECs. In the long term, it has potential to have a positive impact on a range of known and potential threatened species as well as the local EECs with a net result of increased biodiversity via the extent of habitat creation/regeneration proposed. Consequently, the Project Application is not considered likely to have a significant effect on any threatened species or EEC, provided the recommendations of this report are effectively implemented in regard to the Wallum Froglet.

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APPENDIX 1: Likelihood of Occurrence

The following tables are used as a summary to address threatened species (as detailed below) in terms of potential occurrence, and likelihood of being significantly affected by the proposal. A threatened species has been assessed if it has been:

a) Recorded on-site;

b) Not recorded on site, but recorded within a 10km radius (the locality), and may occur to some degree on-site or in the study area (land within 100m of site) due to broadly suitable potential habitat, key habitat component, etc;

c) Not recorded in the locality as yet, but recorded in the bioregion, and thus may occur in the locality, and possibly to some extent, may occur on the site, due to potential habitat.

The "*habitat requirements*" column is derived from the previously listed references. Likelihood of occurrence is based on the probability of occurrence in terms of:

- Habitat extent (eg sufficient to support an individual or the local population; comprises all of home range; forms part of larger territory, etc); quality (ie condition, including an assessment of threats, historical land uses on and off-site, and future pressures); interconnectivity to other habitat; and ability to provide all the species life-cycle requirements (either the site alone, or other habitat within its range);

And:

- Occurrence frequency (ie on-site resident; portion of larger territory; seasonal migrant or transitory opportunist and thus when and how often, etc)

And:

- Usage ie breeding or non-breeding; opportunistic foraging (eg seasonal, migratory or opportunistic); marginal fringe of core range; refuge; roosts; etc.

Table 11: Likelihood of Occurrence – Flora

Note: Habitat requirements sources from previous references. Those in bold listed under EPBCA 1999.

NAME	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE
Acacia courtii	A localised species, found only on Middle and North Brother Mountains. It grows on steep, dry rocky slopes in mixed dry forest on shallow soils, often under a canopy of White Mahogany and Grey Gum. Several populations are known to occur on North Brother South Brother and Middle Brother Mountains. In Dooragan National Park, *A. courtii* occurs on dry locations on the midslopes of the mountain and has been recorded in association with the Stringybark forest and white mahogany/ ironbark associations on skeletal soils on western and northern side of the Mountains.	It is found in the locality, however the property did not contain suitable habitat for this species and it was not found. It is not considered a likely occurrence due to lack of suitable habitat, restricted distribution and disturbance history.
A. chrysotricha	A small to medium tree restricted to wet sclerophyll and rainforest in steep, narrow gullies on quartzite soil. The nearest records are north of Nambucca Heads and near Frederickton.	The property did not contain suitable habitat for this species and it was not found. Not found in the locality. It is not considered a likely occurrence.
A. ruppii	An erect or spreading shrub with smooth grey bark, found in dry sclerophyll forest and shrubland on sand. It is reportedly confined to the Grafton-Coaldale area. Recorded on Grafton database.	Possibly broadly suitable potential habitat but the plant was not found, nor is it considered to likely occur on-property due to the location being beyond the known range of the species.
Acalypha eremorum	A new species. This shrub is found in dry rainforest near Lismore. Recorded on Grafton database. Its potential range is unknown.	Suitable habitat does not occur and the plant was not found, nor is it considered to likely occur on-site due to lack of suitable habitat and location beyond the known range of the species.
Acronychia littoralis	An understorey tree found in littoral rainforest on sand. This species has been recorded in littoral rainforest at Big Hill. Recorded on Bare Point, Hastings LGA, Kempsey, Nambucca, Macksville LGA and Coffs Harbour databases.	The property does not contain suitable habitat though wet sclerophyll along part of Duchess Gully may be marginally suitable. Not known to occur in adjacent littoral rainforest. Not found nor is it considered likely to occur due to long disturbance history.
Alexfloydia repens	A creeping grass found in moist Casuarina forest and above the king tide zone above mangrove forest in the Coffs Harbour district. It is known from only 10 locations south of Coffs Harbour.	The property does not contain suitable habitat; the plant was not found; and the property is beyond the known range of this species. It is not considered a likely occurrence.
Allocasuarina defungens	A straggly oak about 2m high with blue-green foliage found in heath on sand (sometimes clay and sandstone soils), and swamp sclerophyll forest margins. This plant has been recorded on Hastings LGA, Kempsey, Bare Point, Coffs Harbour, Greater Taree City Council LGA, Bulahdelah and Camden Haven databases	It is found in the locality. The property does not contain habitat (may have in past before pastoralism etc but long since modified/cleared), and it was not found on the property despite targeted searches. Considered unlikely to occur due to extent of habitat modification via drainage, pastoralism, etc
Allocasuarina simulans	A she-oak found in heath on sand from Nabiac to Forster, with another population in the Grafton LGA. Recorded on Bare Point database.	The study property was considered not to be preferred habitat and the species was not found in a targeted search. Restricted distribution suggests not a likely potential occurrence as well
Amorphospermum whitei	An understorey tree found in littoral and warm temperate rainforest, and also wet sclerophyll forest along riparian zones. Recorded north from Macleay river.	The property was considered to be unsuitable habitat and it was not found via targeted searches. It is not considered likely to occur.

Angophora inopina	Is a small to large tree endemic to the central coast region of NSW. Ecological knowledge about this species is limited. Recorded on Bulahdelah database.	This property is beyond the known range of the species. It is not considered a likely occurrence.
Angophora robur	A small tree found on sandy soils derived from sandstone, and is mainly found northwest of Coffs Harbour and Grafton.	The species was not found and as the property is beyond the expected range and no suitable habitat hence the species was considered unlikely to occur.
Arthraxon hispidus	A grass found in (or is likely to occur in) littoral rainforest, dry rainforest, subtropical rainforest, warm-temperate rainforest, cool-temperate rainforest, wet sclerophyll forest and riparian forests (including gallery rainforests) at no particular altitude. Variable geology and various, mainly richer loams soils are favoured. Recorded on Coffs Harbour database.	The property was considered to be unsuitable habitat (Duchess Gully extremely marginal) and it was not found via targeted searches. It is not considered a likely occurrence due to lack of local records, marginal habitat and disturbance history.
Asperula asthenes	An herb found in damp sites along riverbanks and similar areas. Recorded in Bulahdelah, Great Lakes, Greater Taree, Kempsey and Hastings (in State Forest near Wilson River) LGA databases.	Some very marginal potential habitat on property along Duchess Gully, drainage lines, etc, however, the plant was not found, nor is it likely to occur due to lack of local records and disturbance history.
Babingtonia silvestris.	A shrub found in only 3 localities (Dorrigo National Park, Mt Neville Nature Reserve and a State Forest). It grows on granite and rhyolite rock outcrops in mixed shrublands. Recorded on Dorrigo database.	The property does not contain suitable habitat; the plant was not found; and the property is beyond the known range of this species.
***Bertya* sp. Cobar-Coolabah**	A shrub to small tree found from Cobar to Coolabah in shallow soils with mallee.	The property is beyond the known range; suitable habitat does not exist on-site; and the plant was not found, nor is it likely to occur.
Boronia hapalophylla	The Shannon Creek Boronia is a small straggling shrub that originally only occurred in dry woodland on sandstone hill slopes and ridge tops above Shannon Creek. Found on Camden Haven, Grafton and Bare Point Databases.	The property did not contain suitable habitat and it was not found, nor is it considered a likely occurrence.
Boronia umbellata	A shrub recorded in “scrub” in the Coffs Harbour locality.	The property is beyond the species known range; it was not found; nor is it likely to occur due to the property’s location outside the known range of the species.
Chamaesyce psammogeton	An herb that grows on fore dunes and exposed sites on headlands. Recorded on Bare Point, Kempsey, Hastings, Nambucca, Coffs Harbour and Bulahdelah LGA databases.	The property did not contain suitable habitat for this species and it was not found, nor is likely to be found due to lack of suitable habitat.
Cryptostylis hunteriana (**Leafless Tongue Orchid**)	A leafless saprophytic terrestrial orchid with a poorly developed root system. This orchid is only detectable during the flowering period of Nov-Feb (Bell 2001). It has been described from isolated records as occurring in a variety of habitats from swamp fringes to bare hillsides in eucalypt forest, with favoured soils being sandy but with records in clay (Bishop 1996). However, the habitats of known populations in Victoria and the NSW central coast were described as being either coastal plains woodland/forest with heathy understorey; heathland; or grasstree plains, all on sandy soils (Bell 2001). Flowering is inconsistent, but has been recorded 18 months to 5 years following fire (Bell 2001). Recorded on Great Lakes (Bulahdelah), Coffs Harbour and Clarence LGA databases.	The Disturbed/Regrowth Swamp Forest and disturbed sedge land on the property are marginal potential habitat in very broad terms, though both have been extensively disturbed. It is considered a n unlikely potential occurrence given habitat disturbance and modification, and lack of LGA records.

Cynanchum elegans	A twiner occurring predominately in dry rainforest, littoral rainforest and the ecotone between dry rainforest and open forest, however it has been found in the Manning Valley and Hastings in Open Forest types on specific geologies eg limestone and serpentine respectively (Garry Germon pers. comm. 2004, personal observations). It occurs on a variety of lithology's and soil types. It has been found between the altitudinal ranges of 0 to 600 metres ASL and rainfall >760mm annually (NPWS 1999). Common associated species include *Geijera parviflora, Notelaea microcarpa, Banksia integrifolia, Ficus spp., Guioa semiglauca, Melia azedarach, Streblus brunonianus* and *Pittosporum revolutum.* Recorded in Camden Haven, Hastings LGA, Grafton, Kempsey, Wingham, and Bulahdelah databases.	Recorded in locality in adjacent littoral rainforest at Middle Head. Marginally suitable habitat in very broad terms perhaps in wet and dry sclerophyll along Duchess Gully but not found by targeted survey. Considered an unlikely occurrence due to low quality habitat and extensive disturbance history.
Cyperus aquatilis	A small annual sedge found in open ephemerally wet sites north of the Evans Head area. Recorded on Grafton database.	The property is beyond the known range. Unlikely to occur.
Eleocharis tetraquetra	A spikerush found in swampy areas that has been recorded in the Boambee area, south of Coffs Harbour.	The property is beyond the known range; marginally suitable habitat occurs on property, however, the plant was not found, nor is it likely to occur.
Elyonurus citreus	A perennial tufted grass that grows in sandy soils near rivers or along the coast in wallum areas or sand dunes. It occurs north from Grafton where it is only known from several locations. Recorded on Bare Point database.	The property does not contain suitable habitat and it was not found, nor is it likely to occur.
Eucalyptus tetrapleura	A tall ironbark tree found in wet sclerophyll forest on moderately fertile soil, dry sclerophyll forest, grassy sclerophyll forest, riparian forests (including gallery rainforests), at no particular altitude and with variable geology and soils. Recorded on Kempsey, Coffs Harbour and Grafton databases.	The property does not contain significant suitable habitat and the plant was not found, nor is it likely to occur due to lack of local records and an extensive disturbance history.
Grammitis stenophylla	A fern often found on mossy wet sandstone walls in rainforest and gallery forest. Recorded on the Dorrigo database.	Suitable habitat does not exist on-site, and the plant was not found, nor is it likely to occur due to lack of suitable habitat.
Grevillea beadleana	A spreading shrub up to 3m high found on granite scarps and exposures, and is confined to the catchments of the Mole and Guy Fawkes River, and possibly Apsley River (generally Northern Tablelands region). Recorded on Grafton database.	The property is beyond the species' known range; does not contain suitable habitat; and the plant was not found, nor is it likely to occur due to lack of suitable habitat.
Grevillea caleyi	A spreading shrub usually found in woodland or open forest dominated by *Eucalyptus capitellata, Corymbia gummifera* and *E. sieberi* with an understorey dominated by plants of Proteaceae and Fabaceae families, on lateritised sandstone ridge tops in Central Coast Botanical region, but has also been recorded on North Brother near Laurieton. Recorded on Hastings LGA and Camden Haven database.	Found in locality. Suitable habitat does not exist on-site, and the plant was not found, nor is it likely to occur.
Grevillea guthrieana	A spreading shrub known from only two locations – Booral near Bulahdelah and on the Carrai Plateau south west of Kempsey. It grows in sandy loams on creek lines in moist eucalypt forest and also along cliff lines with granitic or sedimentary soils (Plantnet 2004). Recorded on Bulahdelah and Kempsey databases.	The property is beyond the species' known range; does not contain suitable habitat; and the plant was not found, nor is it likely to occur due to lack of suitable habitat.
G. masonii	A low-growing shrub that occurs on gravely loams and in sand in open eucalypt woodland. It occurs in a few locations between Grafton and Casino. Recorded on Grafton database.	The property did not contain suitable habitat and the plant was not found, nor is it likely to occur.

G. quadricuada	A shrub usually found in gravelly loam or in sand as an undershrub in Eucalypt woodland mostly along creeks and drainage lines. It has a northern NSW-Southern Qld distribution. Recorded northwest of Whiporie.	The property did not contain suitable habitat and the plant was not found, nor is it likely to occur due to its location well outside the known range.
Hakea archaeoides	A woody shrub found on steep, rocky, sheltered slopes and deep gullies in open eucalypt forest. It is restricted to hinterland around Mt Boss, Broken Bago State Forest and Landsdowne. Recorded on Camden Haven and Kempsey LGA databases.	Suitable habitat does not exist on property, and the plant was not found, nor is it likely to be found due to lack of habitat.
Harnieria hygrophiloides.	Was formerly known as *Justica* or *Calaphanoides hygrophiloides*. This is a glabrescent shrub growing in rainforest or adjacent wet sclerophyll only from Brunswick Heads to Hortons Creek in far northeastern NSW. Recorded on Grafton database and Dorrigo topographic map.	The property did not contain suitable habitat, and is well beyond the species' known range. The plant was not found
Hibbertia hexandra	A tall shrub or small tree, which occurs mainly in heath, open forest and rainforest around Mt. Warning (Harden 1993). A separate population in the Wauchope-Kendall area has plants with smaller leaves that are found in crevices and gullies in rocky terrain (NPWS 2000). Recorded on Camden Haven and Kempsey databases.	Suitable habitat does not exist on property, and the plant was not found, nor is it likely to be found due to lack of habitat.
H. marginata	A small shrub that grows in grassy or shrubby dry open eucalypt forest at low altitudes on sandstone. It occurs only in northeast NSW, where it's restricted to southern Richmond Range between Grafton and Casino.	The property does not contain suitable habitat and it is well beyond the known range of the species. The plant was not found and it is not considered a likely occurrence.
Lindernia alsinoides	Is a diffuse or erect annual herb that grows in swampy sites in sclerophyll forest and coastal heath. It occurs north from Bulahdelah. Recorded on Bulahdelah and Grafton databases.	Marginally suitable habitat may be present on property in the Disturbed/Regrowth Swamp Forest and disturbed sedge land, but the species was not found via targeted searches. Nor is it considered to occur due to lack of local records and extensive disturbance history.
Lindsaea incisa	A ground fern found in damp sandy places and open forest. Recorded on Coffs Harbour database.	No suitable habitat occurs on property, the species was not found and the known records do not extend south of Coffs Harbour.
Macrozamia johnsonii.	A cycad known only from a small area in the Dalmorton district in northern coastal NSW. It grows in wet to dry sclerophyll forest, on shallow, rocky, usually steeply sloping and poor soils, and is also occasionally cultivated as an ornamental. Recorded on Grafton database.	The property is beyond the species' known range and does not contain suitable habitat. The plant was not found and it is not considered a potential occurrence.
Marsdenia longilobia	A slender climber with clear, watery latex (sap). Occurs in rainforest and moist eucalypt forest adjoining rainforest, at no particular altitude, sometimes in areas with rock outcrops. Found at scattered sites from Barrington Tops to SE Queensland (NPWS 2000). Recorded northeast of Byabarra in the Hastings LGA and also recorded on Kempsey, Macksville, Coffs Harbour, Grafton and Bare Point databases.	The absence of local records, the location south of its known range, the lack of suitable habitat and the property's disturbance history suggests this species is not a likely chance of occurrence.
Maundia triglochinoides	An aquatic herbaceous plant found in swamps or shallow fresh water on heavy clay on the north and central NSW coast. Recorded on Hastings and Kempsey databases.	Potential habitat may occurs on property in the drainage lines, edge of dams, Duchess Gully, and during wet periods when the disturbed sedge land and pasture land become waterlogged. However, the plant was not found on property. The disturbance history of the property indicates the species is unlikely to occur.

Melaleuca biconvexa	A paperbark shrub/small tree found in damp places, often near streams, on the coast and adjacent tablelands from Jervis Bay to Port Macquarie. Recorded on Bulahdelah, Kempsey, Hastings and Camden Haven databases.	Found in the locality. Structurally suitable habitat exists on the property but not considered preferred soils. The plant was not found despite targeted searches, nor is it considered likely to occur.
Melaleuca groveana	A paperbark shrub/small tree that grows in dry sclerophyll, heath and exposed sites generally at higher elevations, though this consultant has recorded it in dry sclerophyll forest on a basalt ridge about 50m asl at Scotts Head (pers. obs.). Recorded on Bulahdelah, Camden Haven, Hastings, Kempsey and Macksville databases.	Found in the locality. The property did not contain suitable habitat and this species was not found during the threatened species searches. Due to disturbance history, low potential habitat and patchy locations of this species, it is not considered a likely occurrence.
Melaleuca tamariscina ssp *irbyana*	A paperbark shrub or small tree up to 8m high, found in open eucalypt forest on poorly drained sites north from the Casino District. Recorded on Grafton database.	The property contains marginal potential habitat but is well outside known habitat range. Considered unlikely to occur.
Melichrus hirsutus	A spreading shrub on sandstone, found near Glenreagh and the upper Clarence Valley. Recorded on Grafton and Bare Part databases.	The property is beyond the species' known range; suitable habitat does not exist on-site; and the plant was not found, nor is it likely to occur due to lack of suitable habitat.
Oberonia titania	An epiphytic orchid that grows in a tight clump in a variety of habitats from subtropical to littoral rainforest, *Melaleuca* swamps, and gorges within dry sclerophyll forest. It occurs north of Kendall. Recorded on Coffs Harbour database	Suitable habitat does not exist on-site, and the plant was not found, nor is it likely to occur due to lack of suitable habitat.
Olax angulata	A shrub up to 1m high known only from Minnie Waters on sandy soils and woodland near swamps. Recorded on Bare Point database.	Suitable habitat not present and the property is well beyond the known range of this species.
Olearia flocktoniae	A short-lived shrub found in recently disturbed sites in wet sclerophyll and warm temperate rainforest essentially in the Dorrigo area.	The property is beyond the known range of this species, and the plant was not found, nor is it likely to occur.
Parsonsia dorrigoensis	A climber found in sub-tropical and warm temperate rainforest, and sclerophyll forest often on brown clay soils on the north coast south to the Hastings River. It is associated with Blackbutt, Tallowwood, Brush Box, Crabapple, Lilly Pilly, Tree Heath and Water Gum. It may favour some disturbance, including fire. Recorded on Macksville, Kempsey, Coffs Harbour, Grafton and Camden Haven databases.	Possibly very marginal potential habitat in disturbed wet sclerophyll along Duchess Gully but not found given disturbance history and lack of proximate records, considered unlikely to occur.
Phaius tankervilliae (recorded on Hastings LGA database) and ***P. australis*** (Bare Point, Coffs Harbour)	Are orchids that generally grow in *Melaleuca quinquenervia* swamps on the coast or at sea level, as well as littoral rainforest, dunes (including stabilised dunes), riparian forests (including gallery rainforests), swamp forests, swamps (including marshes and intermittent wetlands), mainly at low altitudes. Sandy alluvium is the favoured geology and sandy, damp to humic soils are favoured.	Potentially suitable habitat occurs on-site in the swamp forest, but the plants were not found in a targeted search. Potential to occur is considered very unlikely due to lack of local records and the disturbance history.
Phyllanthus microcladus	Is a small shrub that is usually found on banks of creeks and rivers, in streamside rainforest. In NSW it is confined to a few locations in the Tweed, Brunswick, Richmond and Wilson River Valleys with an outlying population near Grafton.	The property may contain potential habitat along Duchess Gully. However, the plant was not found and the property is well beyond the known range of the species and it is not considered a potential occurrence.

Pomaderris queenslandica	A shrub 2-3m high, found in moist sclerophyll forest with shrubby understorey and occasionally along creeks. Recorded on Wingham/Taree and Hastings LGA database.	The property contains potential habitat along Duchess Gully in broad terms. It was not found and is not considered a likely potential occurrence due to lack of local records and high disturbance history.
Pultenaea maritima	A prostrate, mat-forming shrub with hairy stems. It occurs in grasslands, shrublands and heath on exposed coastal headlands. It occurs from Newcastle to Byron Bay. Found on Camden Haven database.	The property does not contain suitable habitat and the plant was not found. It is not considered a likely occurrence due to lack of suitable habitat.
***Quassia* sp. Moonee Creek**	A shrub found in dry rainforest and riparian wet sclerophyll forest. Recorded on Coffs Harbour, Grafton and Bare Point databases.	The property does not contain any particularly suitable habitat and it is beyond the known range of this species. It is not considered a likely occurrence.
Rutidosis heterogama	A perennial herb, to 30cm high, with yellow everlasting flowers, usually found in heath, often along disturbed roadsides mainly on the coast from Maclean to Hunter Valley, and inland to Torrington. Recorded on Bare Point database.	Suitable habitat does not occur on the property, and the species was not found. It is not considered a likely occurrence.
Sarcochilus dilatatus	A semi-pendant epiphyte found on trees in rainforest in coastal ranges up to 400m ASL	The property was considered to be unsuitable habitat and the plant was not found. The disturbance history and lack of local records suggest this plant is not likely to occur.
S. fitzgeraldii	A semi-pendant epilith (rarely an epiphyte) orchid found on rocks or tree bases in subtropical rainforest usually near trees from 500-700m ASL.	The subject property is below the known altitudinal range, and the plant was not found in the study area.
S. hartmannii	A semi-erect epilithic or terrestrial herb usually found on volcanic rocks often in shallow soil in dry rainforest, subtropical rainforest, wet sclerophyll forest, dry sclerophyll forest, grassy sclerophyll forest, riparian forests (including gallery rainforests), rocky crevices and scree or exposed sites 500-1000m alt., previously north from the Richmond River, but recently recorded in the Kempsey LGA. Preferred geology is mainly volcanics and various (mainly skeletal and poor) soils are favoured. Recorded on Coffs Harbour, Wingham LGA and Kempsey LGA database.	Suitable habitat does not exist on the property and the plant was not found, nor is it likely to be found.
Senna acclinis	A shrub found in or on the edges of subtropical and dry rainforest. Variable geology and soils are favoured. Recorded in Kerewong SF and Lorne SF in the Hastings LGA and also in Bulahdelah, Great Lakes, and Coffs Harbour LGA databases.	Suitable habitat was not found on property and the plant was not found, nor is it likely to be found.
Sophora tomentosa subsp. australis	A coastal shrub that occurs on recent sands on frontal coastal dunes northwards from Port Stephens. Port Macquarie has the largest known population eg Shelley and Nobby's Beaches. Recorded on Kempsey, Hastings LGA, and Bare Point databases.	No potential habitat on property. The plant was not found, nor is it likely to be found due to lack of suitable habitat.
Syzygium paniculatum	A type of Lilly Pilly, which has a shrub to small tree habit and grows in subtropical and littoral rainforest on sandy soils or stabilised dunes on the coast. It is also widely cultivated as an ornamental.	Suitable habitat does not occur on property and the plant was not found, nor is it considered a likely occurrence due the property's location well outside its known range.
Tetratheca juncea	A small shrub that grows in sandy, sometimes swampy heath, and also dry sclerophyll forest mainly along the lower end of the region around Bulahdelah.	Suitable habitat to some broad structural extent does occur on the property, but this species was not found. The lack of local records, location of the property beyond the known range and disturbance history suggest the species is not a likely occurrence.

Thesium australe	A parasitic herb commonly associated with Kangaroo Grass, and has been recorded on coastal headlands at Coffs Harbour, Hat Head, Crescent Head, Diamond Head and Perpendicular Point in Kangaroo Grass areas. Recorded on Hastings LGA, Kempsey, Bare Point, Coffs Harbour, Korogoro and Camden Haven databases.	Occurs in locality. Suitable habitat does not exist on property and the plant was not found, nor is it considered likely to occur.
Tinospora smilacina	A twiner found in dry subtropical rainforest. Recorded on Coffs Harbour and Grafton databases.	Suitable habitat does not occur on property and the plant was not found, nor is it likely to be found.
Tinospora tinosporoides	A woody climber found in wetter subtropical rainforest. Recorded on Coffs Harbour database.	Suitable habitat does not occur on property and the plant was not found, nor is it likely to be found due to lack of suitable habitat and disturbance history.
Triplarina imbricata (formerly *Baeckea camphorata*)	A shrub occurring mainly in sheltered positions on shady slopes, gorges or creek banks, within about 80km of the coast (Australian Plants Online website). This species is also commonly cultivated. Recorded on Dorrigo database.	Suitable habitat does not strictly exist on property (Duchess Gully is marginal), and the plant was not found, nor is it considered a potential occurrence due to the disturbance history and lack of local records.
Tylophora woolsii	A twiner found in wet sclerophyll and rainforest in the northern ranges and slopes of NSW from Barrington Tops NP to southern Queensland (NPWS 1999). It has also been recorded within in the Bonville-Archville area and along disturbed roadside verges (NPWS 1999). Associated species include: *Acacia melanoxylon, A. binervata, Caldcluvia, Ehretia, Schizomera, Syncarpia, Eucalyptus microcorys and E. saligna*. Recorded on Coffs Harbour database.	The plant was not found on the property, which lacks significant potential habitat. It is not considered a potential occurrence.
Typhonium sp. aff. brownii	A perennial deciduous tuberous geophyte found on rainforest margins, sheltered gullies and along creek banks. It appears to be confined to the ranges up to 30km west of Woolgoolga and Coffs Harbour.	The property is beyond the known range of this species. The plant was not found, nor is it considered likely to occur.
Z. prostrata	A shrub restricted to low coastal heath in the Coffs Harbour area.	The property is beyond the known range of this species; suitable habitat does not exist on-site; and the plant was not found, nor is it likely to occur due to lack of suitable habitat.
Zieria smithii	Diggers Head Zieria is a sprawling shrub known only from Diggers Head at Coffs Harbour. It occurs in Low Heath with Kangaroo Grass (*Themeda australis*) on a coastal headland.	The property is beyond the known range of the species and suitable habitat is not present. It was not found nor is it likely to occur.

From the above, it is determined that no flora species requires formal assessment.

Table 12: Likelihood of Occurrence – Fauna

Note: Habitat requirements sources from previous references. Those in bold listed under EPBCA 1999.

NAME	HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE
Glossy Black Cockatoo (*Calyptorhynchus lathamii*)	Dry sclerophyll forest and woodland containing preferred Allocasuarina and Casuarina, and large tree hollows. Preferred regional forage species are *A. littoralis* and *A. torulosa.* Requires sufficient extent of forage within home range to support breeding. Food trees generally have large cone crops (eg >200 cones) and young cones (easier to open and the seeds have higher protein content). Cones are not selected on size but on number of seeds per cone (to maximise foraging effort), thus a tree with a large crop is not necessarily a preferred food tree (Clout 1989). Trees may require at least 10 years of growth before being potentially utilised (Mt King Ecological Surveys 1993). Lives in loose groups ranging from 2-20 individuals, occupying a permanent area (range over 100km), following the fruiting pattern of its preferred food tree species.	Recorded in the locality but not on property by this or previous studies. The property overall has only limited potential of supporting this species as it contains only a small area of preferred forage species (thus only has potential only to form a minute proportion of foraging range). Few tree hollows on the property marginally suitable for nesting, however given the limited abundance of such hollows (thus high competition rates with common species); the potential for nesting is limited. Considered a very low to marginally fair chance of occurrence on the property as part of a broader foraging range.
Swift Parrot (*Lathumus discolor*)	Breeds in Tasmania and Winters in Victoria with some dispersal northwards. Feeds mostly on pollen and nectar of Winter flowering eucalypts, but also feeds on fruit, seeds, lerps and insect larvae (Schode and Tideman 1990). Also favours profusely flowering banksias. Favoured species are *E. robusta, Corymbia gummifera, E. globulus, E. sideroxylon, E. leucoxylon, E. labens, E. ovata, C. maculata, Banksia serrata* and *B. integrifolia*	Has been recorded in the locality and on the property. Not recorded on site or property during study. Limited foraging resources on site but preferred foraging resources are present in limited abundance on parts of property i.e. Swamp Mahogany, Forest Red Gum and *Banksia integrifolia*. Considered a low to fair chance of occurrence on site and property as seasonal forager.
Powerful Owl (*Ninox strenua*)	Wet and dry sclerophyll forests. Nests in tree hollows. Requires high diversity and abundance of medium-sized arboreal prey. Very large territory (500-5000ha).	Twice recorded within 750m of the property in the Queens Lake State Forest, however not recorded on site or property. Low prey diversity in general of the property limits the potential for the species to forage. However, given the close proximity of local records and the species large home range the property is considered a low to marginally fair chance of being part of a broader home range.
Barking Owl (*N. connivens*)	Well-forested hills and flats, eucalypt savannah (especially), and riverine woodland in coastal and subcoastal areas. Prefers hunting in more open country for mammals (rabbits, rats, mice, small bats and small marsupials) and birds (small up to Frogmouths and Magpies). Large territories. Nest in hollows.	One record of species at extremity of locality. Property offers good habitat for foraging by the species with the large areas of open country as is preferred. Presence of rats and mice offer foraging resource along with microbats and small bird species. Scope of foraging on site is limited due to lack of habitat with small birds and foraging bats making up the potential foraging resource on site. Limited potential nesting hollows present on site and property. Not detected on site or property. Very low to marginally fair chance to occur as an occasional forager on site and property.

Masked Owl (*Tyto novaehollandiae*)	Eucalypt forest and woodlands with sparse understorey. Nests in tree hollows. Requires high diversity and abundance of prey 200-600g weight. Large territory.	Not recorded on site or property. Four records of the species occurring in the locality, including within 1km of site. Suitable habitat occurs on property overall with the pasture land, grassland, woodland, swamp forest etc forming a complex mosaic. However a low diversity of prey on the study site will limit the species potential to forage on the site. At best marginal potential nesting sites for this species (thus unlikely to be utilised as nesting habitat). The number of records in the locality coupled with the species large territory suggests the species is a low to fair chance of occurrence as an occasional forager on site and property.
Sooty Owl (*T. tenebricosa*)	Rainforest and tall, moist eucalypt forest. Nests in tree hollows. Requires high diversity and abundance of medium-sized arboreal prey. Large territory.	Not recorded on site, property or in locality. Property (including the site) does not provide suitable habitat. Suitable prey species may occur but failure to detect them indicates a low diversity and abundance. Very low to unlikely potential to occur.
Eastern Grass Owl (*T. capensis*)	Inhabit coastal and inland grasslands, coastal heath, agricultural crops and swamp margins. Dependant on good numbers of rodent prey. Highly mobile.	Twice recorded in the locality but not on site or property. Native grassland possibly structurally suitable but insufficient in area to support this species. No prey species detected on site. Considered unlikely to occur.
Red Goshawk **(*Erythrotriorchis radiatus*)**	Found in tropical open woodland, taller woodland, open forests, rainforest edges and dense riparian vegetation of coastal and subcoastal drainages. Territorial and utilise same nest. Breeding territories estimated 50-220km^2. Preys on bird especially honeyeaters, parrots, kookaburras and slight waterbirds, as well as some mammals, reptiles and large insects.	Not recorded in locality, and not recorded on-site or property. Suitable habitat in broad terms may occur on the property and marginally the site. Considered unlikely to occur as this extremely rare raptor has not been reported south of the far north coast of NSW for many years (Birds Australia 2008).
Osprey (*Pandion haliaetus*)	Fish and carrion eater. Forages along coastal rivers, lakes, beaches, creeks and inlets. Requires possible nest sites near water.	Not recorded on site or property but numerous records exist within the locality. No nest detected on site or property. No suitable foraging habitat on site and only marginal potential foraging habitat on property with Duchess Gully. Considered a low to fair chance to occur on the site opportunistically.
Square-Tailed Kite (*Lophoictinia isura*)	Open forests and woodlands in coastal and subcoastal areas, rich in small birds especially honeyeaters and nestlings. Extremely large home range. Observed in urban areas foraging on sparrows and starlings (per. obs), and nesting in urban remnants.	Not recorded on site, but has been previously observed over southern end of property and recorded locally. Property contains suitable habitat which (including parts of the site) has potential to form a small part of this species extensive foraging range. No nest detected on site or property.
Wompoo Fruit Dove (*Ptilinopus magnificus*)	Sub-tropical, littoral, warm temperate and dry rainforest, and wet sclerophyll with rainforest understorey. Feeds on fruit. Known to feed on Camphor Laurel and Lantana.	Detected on property, however, no rainforest or significant presence of potential fruiting sources on property (including the site). Its presence on site was likely to be opportunistic as it moved to better habitat. Low to unlikely potential to occur as a forager.
Barred Cuckoo Shrike (*Coracina lineata*)	Gregarious rainforest/moist forest (especially creek gullies) species feeding mainly on fruit on tall rainforest trees and shrubs, and insects; generally moving with fruiting patterns.	Generally as for Wompoo Fruit Dove, but not recorded on site, property or in locality. Low to unlikely potential to occur.

Rose-Crowned Fruit Dove (*Ptilinopus. regina*)	Inhabits dense rainforest or vegetation containing fruit bearing trees, feeding on fruit. Migratory with fruiting patterns.	Generally as for Wompoo Fruit Dove, but not recorded on site, property or in locality. Low to unlikely potential to occur.
Regent Honeyeater (*Xanthomyza phrygia*)	Nomadic. Inhabits temperate eucalypt woodlands and open forest, including forest edges, woodland remnants on farmland and urban areas. Also uses *Casuarina cunninghamiana* gallery forests. Requires reliable and ample nectar supplies to support semi-permanent (core breeding) habitat. Favoured nectar sources are *E. sideroxylon, E. albens, E. melliodora, E. leucoxylon, E. robusta, E. planchoniana*, and heavy infestations of mistletoe. Also take insects and orchard fruits. Breeds in pairs or small colonies in open woodland/forest and occasionally more disturbed woodland near housing and farmland, depending on food availability, from August-January. Breeding less likely to occur if nectar flows are low or unreliable, or heavy competition with more aggressive honeyeaters eg Noisy Miner, Red Wattlebirds and Noisy Friarbirds.	Not recorded on-site, property or locality though recent record of single bird in Port Macquarie (Hastings Birdwatchers 2004). Swamp Mahogany (a preferred nectar species) is present on the property in limited abundance and at best could be used opportunistically by this bird as part of non-breeding range. Very low to unlikely potential of occurrence on site and low to unlikely chance of occurrence on property as rare transient.
Painted Honeyeater (*Grantiella picta*)	Strongly migratory and locally nomadic. Exploits almost exclusively mistletoe-infested (mainly *Amyema* genus) eucalypt forest/woodland in mainly drier areas. Leaf insects occasionally taken. May extend range or visit woodland remnants and suburban gardens during poor seasons. Breeding habitat is mistletoe-laden eucalypt forest/woodland	No significant mistletoe on site property. Not recorded on site, property or locality. Very low to unlikely potential to occur as rare transient.
Bush Stone Curlew (*Burchinus grallaris*)	Nocturnal, sedentary and territorial (when breeding) species generally inhabiting open grassy woodlands with few or no shrubs. Abundant leaf litter and fallen debris such as tree branches required for foraging and roosting. Nests in more open areas with very little groundcover (even recorded on mown lawns and golf courses). Coastally, often associated with Swamp Oak groves, saltmarsh, mangroves, *Melaleuca quinquenervia* woodlands and even golf courses, etc. May travel as far as 3km from roost site to foraging grounds.	Not recorded on site, property or locality. Potential habitat in broad terms occurs on site and the property in various communities. However, leaf litter and fallen debris is largely absent in these areas limiting potential foraging and roosting resources. Potentially suitable nesting areas occur on site and property though risk of cattle trampling and periodic slashing considered likely to displace to more optimal area where less disturbances. Overall as it is not recorded in locality, on site or on the property and given the presence of predators (i.e. feral cats, foxes and dogs), it is considered unlikely to very low to potential to occur on the property.
Brown Treecreeper (*Climacteris pciumnus*) eastern subspecies	Medium-sized insectivorous bird occupying eucalypt woodlands, particularly open woodland lacking a dense understorey. Sedentary and nests in tree hollows within permanent territories, breeding in pairs or communally in small groups (Noske 1991). Birds forage on tree trunks and on the ground amongst leaf litter and on fallen logs for ants, beetles and larvae (Noske 1979). Distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys, Coffs Harbour and Great Lakes Shire.	Not recorded on site or property, and one record in locality. Parts of property contain marginal structurally suitable habitat though not true dry sclerophyll woodland as typical of the areas where this species has been recorded is present. Very few records of the species along coastal margin and is considered unlikely to occur on site.

Grey-Crowned Babbler (*Pomatostomus temporalis temporalis*) eastern subspecies	Occupies open woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs. Builds conspicuous dome-shaped nests and breeds co-operatively in sedentary family groups of 2-13 birds (Davidson and Robinson 1992). Insectivorous and forage in leaf litter and on bark of trees. Occurs on the western slopes and plains but less common at the higher altitudes of the tablelands. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (Blakers *et al.* 1984, Schodde & Mason 1999).	Generally as for Brown Treecreeper. Not recorded on-site, property or locality. Very low to unlikely to occur.
Hooded Robin (*Melanodryas cucullata cucullata)* south-eastern form	Occupies a wide range of Eucalypt woodlands, *Acacia* shrublands and open forests, favouring open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover. Live in small family groups of pairs or trios, with relatively large home ranges (average 18ha in New England Tableland). Feeds on the ground on insects, and forages in areas with a mix of bare ground, ground cover and litter.	Generally as for Brown Treecreeper. Not recorded on-site, property or locality. Very low to unlikely to occur.
Diamond Firetail (*Stagonopleura guttata*)	Occupies eucalypt woodlands, forests and mallee where there is a grassy understorey. Build bottle-shaped nests in trees and bushes, and forages on the ground, largely for grass seeds and other plant material, but also for insects (Blakers *et al.* 1984, Read 1994). Distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain of western Sydney and the Hunter, Clarence, Richmond and Snowy River valleys (Blakers *et al.* 1984, Schodde & Mason 1999).	Generally as for Brown Treecreeper. Not recorded on-site, property or locality. Very low to unlikely to occur.
Speckled Warbler (*Pyrrholaemus sagittata*)	Inhabits mostly inland woodlands (some drier coastal areas) with grassy understorey often on ridges and gullies. Sedentary in pairs or trios, and nests on ground in grass tussocks, dense litter and fallen branches. Forages on ground or understorey for arthropods and seeds within home range of 6-12ha. Remnants <100ha not suitable.	Generally as for Brown Treecreeper. Not recorded on-site, property or locality. Very low to unlikely to occur.
Black-Necked Stork/Jabiru (*Ephippiorhynchus asiaticus*)	Lakes, swamps, freshwater pools and mangroves. Has been observed foraging around sewage ponds and farm dams.	Not recorded on the property but several records exist in the locality. Suitable habitat occurs mainly around dams and drains, with extensive parts of the Disturbed Sedgeland offering potential as opportunistic foraging habitat when prolonged inundation following heavy rain or local flooding occurs. Considered at least a fair chance of occurrence on site and property.
Brolga (*Grus rubicunda*)	Inhabits coastal and inland wetlands, shallow lakes, grassland, saltmarsh, farm and dry open land. Forages for large invertebrates, frogs, fish, seeds, green shoots and bulbs. Breeding occurs predominantly in tropical wetland and large inland swamps and irrigated grasslands at inland and central northern Australia (eg Queensland and Northern Territory), though has been recorded in the northwest and north-eastern corner of NSW and Victoria.	Not recorded on site, property or locality. Nearest record near Lakewood. Potential habitat and foraging opportunities occur on site and property similar for the Jabiru though the latter is locally more common. Limited LGA and other records indicates the species is at best a low chance of occurrence.

Comb-Crested Jacana (*Irediparra gallinacea*)	Deep, permanent water with surface/floating vegetation (eg Water Lily). Sedentary or locally nomadic. Forages on surface. Nest a raft in screened, emergent vegetation. Sensitive to water level changes and to disturbance. Breeds in response to rising water level Sep-Jan.	All dams on the property do not have sufficient floating/surface vegetation as preferred by this species. Large dams at best very marginal. Not recorded in locality and overall a very low to unlikely potential of occurrence.
Black Bittern (*Dupetor flavicollis*)	Coastal waterways and rivers lined with mangroves etc; denser paperbark woodlands near coastal swamps.	Not recorded in locality. Large dams offer limited potential as restricted cover and few trees to roost in near water. Duchess Gully (estuarine portion) is considered structurally suitable though best habitat occurs downstream of property. Low potential to occur on property but low to fair chance to occur downstream of property in Duchess Gully using it as non-breeding habitat as part of wider range.
Australasian Bittern (*Botaurus poiciloptilus*)	Extensive dense reedbeds and wetland margins.	Recorded in locality but not recorded on site or property. As for Black Bittern.
Painted Snipe (*Rostratula benghalensis*)	Prefers shallow, freshwater swamps and bogs. Most active at night, feeding on aquatic insects, grasshoppers, crickets, earthworms and various plant seeds. Usually solitary and nomadic.	Not recorded in locality, on site or property. Marginal potential habitat property in southern areas and sedge land during wet periods. Very low to unlikely chance of occurrence on property due to rarity of this species in the region.
Little Tern (*Sterna albifrons*)	Nests on beaches and sandy inlets in colonies. Feeds on wet intertidal flats on molluscs and crustaceans.	No suitable habitat on the site or property. Recorded within 10km. Unlikely to occur on site or property.
Blue-Billed Duck (*Oxyura australis*)	Inhabits deep freshwater marshes with dense vegetation; as well as more open waters in non –breeding season. Has been recorded in larger tertiary treatment ponds in sewage treatment works.	Not recorded site or property but recorded in the locality. Large dams to south are considered structurally suitable in broad terms though increased human presence to south may be a deterrent to its use. Unlikely to marginally fair potential occurrence in large dams using for non-breeding opportunistic foraging habitat.
Freckled Duck (*Stictonetta naevosa*)	Usually in small groups. Nomadic, breeds in densely vegetated freshwater wetlands with thickets of small trees, usually in western NSW. After breeding, disperses to open fresh or saline water, often in eastern NSW. Breeds Sept-Dec or after flooding rain. Nests in tree, low over water. (Morecombe 2000)	Large dams on site considered at best marginal potential habitat offering some limited potential to support non-breeding foraging. However, not recorded by this or any previous surveys or in the locality. Very low to unlikely potential occurrence in study area.
Pied Oystercatcher (*Haematopus longirostris*)	Beaches, sandy-shored bays, estuaries, exposed sand bars and mudflats.	As for Little Tern.
Sooty Oystercatcher (*H. fuliginosus*)	Mainly forages on rocky foreshores, reefs, wave-cut platforms, coral reefs and stony beaches. Rarely seen on sandy beaches. Eats limpets, periwinkles, bivalves and mussels. Breed on off-shore islands adjacent to non-breeding foraging grounds.	As for Little Tern, though not recorded in locality.
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	Appears to prefer heathland especially dense wet heath and swampy areas. Also recorded from mid-elevation grasslands, open dry and wet sclerophyll woodland. In the Port Macquarie area, associated with heathland with dense shrub layer of *Banksia ericifolia, B. serratifolia, Xanthorrhoea* spp, *Dillwynia floribunda, Boronia spp, Leptospermum flavescens* and *Melaleuca nodosa*. Requires specific fire regime and often colonises areas post fire.	Recorded on property but not site.

Long-Nosed Potoroo (*Potorous tridactylous*)	Coastal heath and shrublands; paperbark forest; woodland with dry heathy understorey; high elevation rainforest or moist hardwood forest; moist shrublands with dense or moderately dense understoreys and sedge-dominated groundcover; wet or dry sclerophyll forests where average annual precipitation exceeds 760mm. Requires thick groundcover for refuge, while foraging in open areas on ridges, slopes or gullies, typically on ecotones, and prefers sandy soils for digging. Eats roots, tubers, fungi, fleshy fruits, leaves, insects and other soil invertebrates. Optimum habitat generally considered a mosaic of regenerating dense understorey vegetation as result of patchwork of periodic low to medium intensity fires.	Not recorded on site, property or in locality. Dune Scrub on property offered marginal potential habitat, however extremely limited in extent and overall habitat in area fragmented and relatively isolated. Feral predators also present. Overall unlikely potential occurrence.
Koala (*Phascolarctos cinereus*)	Areas where preferred food species occur in sufficient concentrations and diversity, and generally on more fertile soils.	Previously recorded on property. Property contains Core Koala Habitat with Potential Koala Habitat also occurring on site and property.
Common Planigale (*Planigale maculata*)	Wide variety of habitats. Preference for areas of dense groundcover due to heat/dehydration problems. Often found on ecotones of dry/wet habitats.	Recorded on property but not site.
Brushtailed Phascogale (*Phascogale tapoatafa*)	Range of forest habitats but prefers drier sclerophyll forest. Requires tree hollows for nesting. Has been recorded in swamp forest. Phascogales reportedly have a large home range (20-100ha), generally exclusively occupied, other studies in areas of limited habitat may be much smaller eg this consultant has recorded several individuals within 8.7ha (Berrigan 2000a, 2000b) and <30ha (Berrigan 2003a).	Dry sclerophyll forest on the property in the southeast continuous with similar vegetation around the STP considered to offer the best potential habitat for this species. Rest of property's forested habitats considered at best marginal due to small extent, high levels of modification and risk of predation. Not recorded during survey or any previous surveys. Recorded in locality but not by surveys in northeast Bonny Hills or in forest along coastal strip adjacent to property. Overall a very low to unlikely potential of occurrence on property, at most an infrequent dispersing sub-adult.
Spotted-Tail Quoll (*Dasyurus maculatus*)	Various forested habitats with preference for dense forests. Requires tree hollows, hollow logs or caves for nesting. Large home range (>500ha) and may move over several kilometres in a few days.	Recorded in the locality. Property overall offers very marginal habitat as majority is open pasture, and limited extents of forest have low abundance and diversity of prey. Linkage to property from other habitat also tenuous, hence not likely to form regular part of home range. Presence of competitive feral predators. Not recorded on site or property. Considered unlikely to very low chance of occurrence.
Yellow-Bellied Glider (*Petaurus australis*)	This arboreal species feeds on honeydew, arthropods, pollen and sap of eucalypts (depending on the phenology of the forest), which generally restricts it to mature, tall eucalypt forests in temperate and sub-tropical regions with high rainfall. Occurrence is significantly influenced by the presence of a mosaic of species with overlapping flowering periods and bark shredding into long strips to provide foraging habitat for arthropods. Territory is large, around 35-65ha, being occupied by small family groups. Multiple large hollows are required for nesting and roosting. Suitable sap species and smooth-barked eucalypts with bark that peel in strips are considered most important for foraging for arthropods.	Not recorded on site or property but has been recorded in the locality <1km from site. The property has some relatively isolated patched of structurally suitable habitat including preferred sap species, and some hollows, however interconnectivity between habitats on property and adjacent lands would preclude this species. Overall considered unlikely potential occurrence.

Squirrel Glider (*P. norfolcensis*)	Dry, open forest and woodland, and occasionally wet eucalypt and rainforest. Most common in floriferous sub-coastal and coastal forests within abundant Winter flowering trees and shrubs. Most commonly recorded along the coastal margin where Banksias dominate the understorey. Home ranges of 2-4ha (densities approximately 0.9-1.5 individuals/hectare), which overlap with other groups to form a local population (suggesting low territoriality except in core areas of habitat), which also overlaps with Sugar Gliders. Gilmore and Parnaby (1994) report a home range of 20-30ha, suggesting home range may be determined by habitat quality. A range of 0.65-8.55ha is considered a general guide (NPWS 1999). Breeding occurs throughout the year, depending on food availability, with high mortality within the first 12 months.	Not detected on site or property by this survey but has been observed in contiguous habitat to the southeast around the STP hence likely to use the DSF D. Winter flowering species such as Swamp Mahogany are also prevalent in this area in the adjacent Disturbed/Regrowth Swamp Forest. Due to proximate records the species is considered at least a fair chance of occurrence in the southeast adjacent to the site.
Eastern Pygmy Possum (*Cercartetus nanus*)	Found in rainforest, sclerophyll forest, woodland and tree heath. Predominantly nectarivorous (opportunistically insectivorous and also eats fruits during flowering lulls) feeding on Banksias, Leptospermum, Melaleucas, Eucalypts and Callistemons. Nest in very small hollows, or within bark/leaf nests in tree forks (eg Melaleucas and Banksias), Myrtaceous shrubs, abandoned bird nests or under loose eucalypt bark. Often Winters in torpor.	Recorded in the locality but not on site or property. Potential habitat on property occurs in the DSF D and Dune Scrub given abundance of Banksias in this area and in adjoining habitat. The subject land and general area has been subject to an extensive disturbance history and the species is considered a unlikely occurrence on site and a very low to marginally fair potential of occurrence on the property.
Grey-Headed Flying Fox (*Pteropus poliocephalus*)	Nomadic, roosting in camps. Camps often located near rivers and in subtropical rainforest, wet sclerophyll forest, melaleucas, casuarinas or mangroves. Feeds on nectar, pollen, flowers and fruit of rainforest trees, vines, Melaleucas, eucalypts and banksias, and occasionally exotic species eg Camphor Laurel and orchard fruits.	Recorded on property by the survey. Property forms part of general foraging range. No likely roosting habitat on site or property.
Black Flying Fox (*P. alecto*)	The ecology of this species is generally as for the Grey Headed Flying Fox. Roost in mangroves but also paperbark swamps and rainforest where it roosts high and seeks dense leaf cover for shade. Moving up to 50km and prefers similar foods to the Grey Headed Flying Fox ie eucalypts, paperbarks and turpentine blossoms, as well as fruits from native and orchard species (especially mangoes). Mating occurs from March to April, with young born from August to late November, and remaining in camp until about 3 months old (Hall 2000).	Not recorded on site, property or in the locality. The property offers a potential foraging resource (including the site). No likely roosting habitat on site. Lack of records in the locality and LGA indicate the species is unlikely to very low potential to occur.
Queensland/Common/Eastern Blossom Bat (*Syconycteris australis*)	Found in well-timbered habitats. Roosts in rainforest and wet sclerophyll forest. Feeds in heathlands and paperbark swamps up to 4km from roost. Key food species include Banksia, Melaleucas, Callistemons and Bloodwoods.	Not recorded on site or property (though not specifically targeted). Recorded roosting in adjacent littoral rainforest by other study. No likely roosting habitat present on property – very marginal in Wet Sclerophyll. Forest Red Gums offer marginal potential forage – other parts of property may form small part of local range which is likely to be focussed on Banksia scrub north of Lake Cathie. Low to fair chance of seasonal occurrence on site as forager.

Dwyer's Bat/Large Eared Pied Bat (*Chalinobus dwyeri*)	Found in moderately wooded habitats such as dry sclerophyll forest, tall open eucalypt forests, woodlands, sub-alpine woodlands, edge of rainforest and wet sclerophyll forest. Roosts in caves, mines and abandoned bottle-shaped mud nests of Fairy Martins. In caves and mines, tend to roost in twilight sections near entrance. Insectivorous but habits poorly known. Fly relatively slowly, direct and manoeuvrable, low to ground or 6-10m above ground.	Not recorded on site, property, locality or LGA and few regional records. General foraging preferences of this poorly known species suggests that the property may contain some small areas of marginally suitable habitat. No caves, mines, etc on property for roosting. Not recorded within 10km radius of site (or in the LGA). Likelihood of occurrences is considered very low to unlikely.
Yellow-Bellied Sheathtail Bat (*Saccolaimus flaviventris*)	Ecology poorly known. Found in almost all habitats, particularly wet and dry sclerophyll forests and woodlands below 500m altitude, and also open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts mainly in tree hollows, but also under bark, under roof eaves and in other artificial structures. Fast flying species, believed to forage above the canopy or closer to the ground in open areas. Insectivorous. May be Summer migrant.	Property and site offers a range of potential foraging opportunities. Tree hollows on property may also provide some roosting opportunities, while decorticating bark may provide some temporary non-breeding roosting habitat in the dry Blackbutt forest. Not recorded in locality or during this or previous surveys on subject land but recorded in and near Port Macquarie. Considered a low to fair potential of occurrence.
Greater Broad Nosed Bat (*Nycticeius rueppellii*)	Forages over range of habitats including rainforests and moist forests, but prefers ecotones between riparian forest, woodland and cleared land. Requires sparse understorey and will forage over water. Roosts in tree hollows. Feeds on larger insects, small vertebrates and perhaps other bats.	Site and property contain potential foraging opportunities. Tree hollows on site and property may also provide some roosting opportunities. Not recorded by the survey but does occur in the locality. Considered a fair occurrence on site and property.
Common Bent-Wing Bat (*Miniopterus schreibersii*)	Habitat generalist - forages above well-forested areas, Banksia scrub and woodland. Roosts in old buildings, caves, mines etc. Dependant on nursery caves and communal roosts.	Not recorded on site, property but has been recorded in locality. Property offers potential foraging resource. A marginal potential roost site occurs on the property in farm buildings though tree hollows may provide some better non-breeding roosting opportunities. Considered at least fair chance of occurrence on the property.
Little Bent-Wing Bat (*M. australis*)	Forages above and below canopy of well-forested areas and woodlands. Roosts in old buildings, caves, mines etc, but also detected using tree hollows and banana bunches. Dependant on nursery caves and communal roosts.	Recorded as a "*confident'* passing on site and other part of property. Foraging and roosting opportunities as for the Common Bent-Wing.
Southern Myotis/Large-Footed Mouse-Eared Bat (*Myotis macropus/M. adversus*)	Tunnel, cave, bridges, old buildings, tree hollows, bird nests and dense foliage roosting bat which prefers riparian habitat over 500m long with nearby roosting habitat. Key habitats are streams, rivers, creeks, lagoons, lakes and other water bodies. Feeds on aquatic insects and small fish.	Not recorded on site, property but "probably" recorded in locality. Potential habitat occurs along Duchess Gully, over dams and over ephemeral water on disturbed sedgeland, with potential roosts in tree hollows. Overall thus low to fair chance of occurrence on some part of property.
Eastern Freetail Bat or Eastern Little Mastiff-Bat (*Mormopterus norfolkensis*)	Specific habitat requirements of this species are poorly known. Has been recorded in habitats ranging from rainforest to dry sclerophyll and woodland, with most recorded in the latter (State Forests 1995, Allison 1991). Roosts in small colonies under tree hollows and under loose bark; has been found under house eaves, in roofs and metal caps on telegraph poles. Recorded roosting in roof in Hat Head village. Probably forages above forest or woodland canopy, and in clearings adjacent to forest. Most records are of single individuals, and is likely to occur at low densities over its range.	Property offers range of potential foraging habitat over forests and in adjacent cleared land. Site offers marginal potential as foraging resource over cleared land adjacent to forest. Tree hollows may also provide some roosting opportunities on site and property, while decorticating bark may provide some temporary non-breeding roosting opportunities in the dry Blackbutt forest. Considered a fair chance of occurrence on property and a low to fair occurrence on site.

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	A large vespertilionid which feeds on moths and insects. Known to roost in caves, abandoned buildings, but mostly in trees hollows higher rainfall forested areas. It is suspected that some populations migrate in Winter from higher altitudes to coastal areas, or may simply enter torpor. Prefers tall forests (>20m high) and extensive movements (eg 12km recorded between foraging and roost sites). Recently recorded in Thrumster west of Port Macquarie.	Not recorded on site, property or in locality. The history of disturbance on the property has excluded or severely reduced tall (>20m) forested areas as preferred by the species. Property offers some potential roosting in farm buildings and perhaps hollows. Overall considered a low potential of occurrence on property (including the site).
Eastern Cave Bat (*Vespadelus troughtoni*)	Rare and poorly known bat. Cave dwelling bat roosting in small (5) to large (500) groups in sandstone overhang caves, boulder piles, mines, tunnels and sometimes buildings. Tend to roost in well lit portions of caves in avons, domes, cracks and crevices. Inhabits tropical mixed woodland and wet sclerophyll forest on the coast and dividing range, but extend into drier forest on western slopes and inland areas.	Not recorded on site, property or in locality. Property may contain some marginal potential foraging habitat but does not contain suitable roosting habitat. Considered unlikely to very low potential occur on site or property. More likely to use extensive forest to west closer to potential roosts in Jolly Nose.
Beccari's Freetail Bat (*M. beccarii*)	Wide range of habitats from rainforest, floodplains, tall open forest, savannah woodlands, arid shrublands and grasslands. Commonly caught along watercourses, over water and over canopy as prefers areas free of obstructions due to low manoeuvrability. Feeds above canopy in fast flight but agility on ground suggests ability to forage on flightless insects. Very few records in NSW – sporadic and possibly Summer nomadic.	Not recorded on site, property or in locality though unconfirmed record near Herons Creek. Property and site offers structurally suitable foraging habitat for this species in broad terms with hollows offering potential roosts. Given very few records south of north coast of NSW, considered very low to unlikely chance of occurrence.
Three-Toed Snake-Tooth Skink (*Coeranoscincus reticulatus*)	Poorly known ecology. Found in moist layered forest, closed forest and tall open forest (Cogger 1993). Soil type appears important – rich dark or loamy basaltic soils (SFNSW 1994). Also recorded in closed forest on silica dunes, coastal eucalypt woodlands on sand, and in logged forest with tall softwood regrowth. Usually found under leaf litter, moist rotting logs, or loose friable soil.	Not recorded on site, property or in locality. Extremely marginal potential habitat in limited areas of DSF D and perhaps Dune Scrub, but limited leaf litter in the latter, plus long history of habitat disturbance over general area considered likely to have excluded potential to occur. Unlikely to occur given lack of local records and disturbance history of the subject land.
Stephen's Banded Snake (*Hoplocephalus stephensii)*	Inhabits variety of habitats over large tracts including dry rainforest, sub-tropical rainforest, wet and dry sclerophyll, rocky outcrops (especially granite and sandstone) - requires close proximity to variety of vegetation formations. Nocturnal and primarily arboreal - sheltering under decorticating bark, within tree scars, hollows, logs, rock crevices and slabs. Active predator of variety of vertebrates including geckos, skinks, frogs, small mammals, bats, birds	Not recorded on site, property or in locality. In broad structural terms the property (including the site) contains some vegetation communities that may be potentially suitable (predominantly the dry sclerophyll forest). However the subject land has been subject to an extensive disturbance history and habitats are largely isolated. Not detected on the subject land (though extremely difficult to detect) or in the locality. Very low to unlikely potential to occur due to disturbance history and lack of local records.
Pale-Headed Snake (*Hoplocephalus bitorquatus*)	Wet and dry sclerophyll, preferring those with *Callitrus* spp, riparian vegetation, and occasionally rainforest. Terrestrial and semi-arboreal predator of small vertebrates (mainly lizards and frogs, small mammals and probably co-habitating bats). Shelters under decorticating bark and within hollows especially close to watercourses.	As for Stephen's Banded Snake.
Wallum Froglet (*Crinia tinnula)*	Predominantly confined to acidic paperbark swamps of coastal areas (Cogger 1992). Also found in wet heathland and Melaleuca sedgelands. Recorded breeding in flooded pasture adjacent to paperbark swamp (Berrigan 2002a).	Recorded in disturbed wetland and drain on property

Giant Barred Frog (*Mixophyes iteratus)*	Moist hardwood forest, Antarctic Beech and rainforest near flowing streams. May also occur in coastal riverine rainforest and riparian vegetation. Forages in areas adjacent to riparian zones. Males call from under leaf litter or rocks by flowing streams. Eggs laid at streamside to await washing into stream by rainfall.	Not recorded on site, property or in locality. No suitable habitat on site or property. Very unlikely to occur.
Barred Frog *(M. balbus)*	Found in wet forest usually above 100m, predominantly near slow-flowing mountain streams. Also found in moist gullies within areas of dry forest, where it may utilise very small, hardly flowing trickles of water (Tyler 1997).	As for *M. iteratus*. Very unlikely to occur.
Green and Golden Bell Frog (*Litoria aurea*)	Found in large permanent swamps and ponds where no Plague Minnow (*Gambusia affinis)* and little macro-algae. Requires emergent vegetation, grass tussocks or rocks for shelter. May use disturbed sites opportunistically - may depend on seral stages. Eats insects and other frogs.	Not recorded on site, property or in locality – nearest records near northern end of Lake Innes NR. Some broadly suitable potential habitat in dams on property but infested with Plague Minnow and subject to high predation by waterfowl.. Given the disturbance history of the subject land, the rarity of this species in the region and the failure to detect it in three separate surveys it is considered a unlikely occurrence.
Green Thighed Frog (*Litoria brevipalmata*)	Poorly known. Found in range of habitats such as warm temperate open forest, rainforest, and forestry dams in dry, open forest, dry sclerophyll forest with swamp forest drainage lines; breeding aggregations around oxbow lakes, ditches, flooded paddocks, overflows and grassy semi-permanent ponds. Males call only for few days after Spring and early Summer rains. Possibly a lowland forest ground-dweller.	Occurring in the locality but not on the study site or property. At times habitat generalist requirements suggest property (including the site) may offer some at least structurally suitable habitat for this species. However the potential for this species to occur is limited by the disturbance history and the failure to detect it in targeted searches in three separate surveys. Unlikely chance of occurrence.
Olongburra Sedge Frog (*Litoria olongburensis*)	Apparently restricted to marshes and swamps with emergent vegetation, and often associated with tannin-stained, acidic water.	Not recorded on site, property or in locality. Some marginal potential habitat in disturbed sedgeland and wetland, and low lying plains on property, however not detected by 3 surveys and very few records south of Coffs Harbour. Given the disturbance history of the subject land and the rarity of this species in the region it is considered an unlikely occurrence.

APPENDIX 2: THREATENED SPECIES PROFILES

A2.1 Preliminary Information

A scale used by the author to indicate the likelihood of the species to potentially occur in the habitat on the study sites (if they have not been recorded in the locality) is as follows:

- *unlikely* (<1% probability) - no potentially suitable habitat; too disturbed; or habitat is very poor. No or few records in region or records/site very isolated eg by pastoral land, urbanisation, etc.

- *low* (1-10%)- few minor areas of potential habitat; highly modified site/habitat; or few habitat parameters present, but others absent or relatively insignificant (sub-optimum habitat). Usually very few records in locality.

- *fair* (11-25%) - some significant areas of potential habitat, but some habitat parameters limited. Potential for occasional foraging eg from nearby more optimal areas or known habitat. Records at least within 10-15km radius of site.

- *good* (26-50%) - significant abundance of habitat parameters/areas of habitat, and more locally eg adjacent. Potential part of larger territory, but probably unable to support breeding in isolation. Recorded within 10km in similar habitat/environs.

- *Moderate* (51-75%) - quite good potentially suitable habitat on and adjacent to the site, and/or good quality and abundance of some vital habitat parameters. Records within <10km, or adjacent to site, or adjacent to high quality habitat where species likely to occur.

- *high* (>75%) - very good to optimum habitat occurring on or adjacent to the site (support breeding pair or population). Recorded within 5-10km of site in same or similar habitat.

A.2.2 Ecological Profiles and Extent of Local Populations

EASTERN FREETAIL BAT (*Mormopterus norfolkensis*)
GREATER BROAD-NOSED BAT (*Scoteanax rueppellii*)
YELLOW-BELLIED SHEATHTAIL BAT (*Saccolaimus flaviventris*)
SOUTHERN MYOTIS (*Myotis macropus*)

ECOLOGICAL PROFILE:

(a) Eastern Freetail Bat:

Specific habitat requirements of the Eastern Freetail Bat (hereon abbreviated to EFB) 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).

(b) Greater Broad-Nosed Bat

In NSW, this bat occurs in habitats generally below 500m altitude, ranging from woodland to moist and dry eucalypt forest, and rainforest, with a preference for moist gullies in mature coastal forest or rainforest on the eastern side of the Great Dividing Range (Churchill 1998, Smith *et al* 1995). It mostly roosts and nests in tree hollows in trunks and branches but will use old buildings. It generally forages at a height of 3-6m in rainforest but prefers the edges/ecotones between woodland,

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cleared land and riparian forest ie along gullies, creeks and small rivers (NPWS 1994b, Hoye and Richards 1995, Richards 1991, Smith *et al* 1995). It requires a sparse understorey to forage on large insects (moths, beetles and chafers) and small vertebrates possibly including other bats.

This consultant has recorded this species foraging on the edge of recently underscrubbed dry sclerophyll forest at Arakoon (Berrigan 2000c) and on the edge of rural-residential land and forest near Harrington (Berrigan 2001f).

(c) Yellow-Bellied Sheathtail Bat:

The ecology of this species is poorly known. Found in almost all habitats, particularly wet and dry sclerophyll forests and woodlands below 500m altitude, and also open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts mainly in tree hollows, but also under bark, under roof eaves and in other artificial structures. Found also in abandoned Sugar Glider nests, and in northern parts of its range cracks in clay and animal burrows.

Fast flying species, believed to forage above the canopy or closer to the ground in open areas. Insectivorous - known to prey on grasshoppers, chafers and shield bugs.

Found in southern half of its range mainly January to June, with a patchy distribution. May migrate to occupy southern area during warmer months. Usually solitary, but found in groups of up to 10 (commonly 2-6) in late Winter to Spring, and may be territorial. Breeds twice early-late Summer (AMBS 1995a, Richards 1991, Smith et al 1995, Churchill 1998).

(d) Southern Myotis (formerly the Fishing Bat/Large-Footed Mouse-Eared Bat - *M. adversus*):

This highly social species (hereon referred to as SM) lives in colonies usually ranging from 10 to 15 but may occur in hundreds. Usually roosts in caves, mines and tunnels but also tree hollows, buildings, stormwater drains, bridges, and within dense foliage (i.e. *Pandanus*) in the tropical part of their range. Roosts are usually selected close to water. Riparian corridors are considered important.

Found in most habitat types near water eg mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red gum woodland. Key habitats are lagoons, lakes, streams, rivers and other water bodies and their banks. Prefers riparian habitat over 500m in length. Foraging is generally along or above streams and large still water bodies for small fish and aquatic insects, but also an aerial forager. Prey includes moths, beetles, crickets, cockroaches, flies and water insects (eg water-boatmen, mayflies and water-striders), and small fish. Seldom encountered more than a few hundred metres from their foraging habitat (Churchill 1998, Smith *et al* 1995).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

The property contained a number of hollow bearing trees in the forest remnants and the Pastoral Woodland which may be suitable as at least temporary roost sites for the GBNB, EFB, YBSB and the SM. However, there are no caves, cliffs or overhangs on or directly adjacent the 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 during non-breeding stages (eg the Bent-Wing Bats). Buildings on the property may offer temporary roost sites for the above species. It is possible that some hollows on the property may be structurally suitable for breeding roosts for some of these species however the limited abundance of this key habitat component suggests competition between and within species is likely to be high especially with common woodland birds in the Pastoral Woodland (observed to be dominated by birds).

Potential foraging habitat for the YBSB, EFB, CBWB, GBNB and the LBWB (which was detected on the site) existed on the margin between the forests and cleared grazing land, over the limited areas of continuous canopy, and in the open woodland where these species could forage for insects. The SM may potentially occur on the property opportunistically foraging over the dams (especially the large ones) and along Duchess Gully.

Given the ecology of the subject species and their mobility (given above), the local population of any of these species would extend well beyond the confines of the site and property.

JABIRU/BLACK-NECKED STORK (*Ephippiorhynchus asiaticus*)

ECOLOGICAL PROFILE:

The Jabiru inhabits riverine swamps, large permanent pools, coastal wetlands and estuaries, but also uses brackish or saline habitats, mangroves and artificial habitats such as farm dams and sewage ponds. It forages for small invertebrates, frogs, fish,

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reptiles and small mammals. It may establish in a location for several years, but can travel widely to favourable habitats (Smith, 1995, DEC 2005a).

The Jabiru nests in large stick platforms in live or dead trees in secluded swamps often overhanging water (Lindsey 1992). In NSW, eggs are laid in August-November (DEC 2005a). Most breeding occurs in north Qld and the Northern Territory, and it occurs elsewhere as a vagrant during non-breeding season (July-February), it generally frequents the same areas. The Jabiru may occur singly, in pairs or small groups (up to 18 recorded) (Smith et al 1995). The NSW population in 1965 was estimated to be only 37-43 individuals.

Critical habitat components include the aquatic food base, water quality and roost and nest trees. Disturbance of feeding by livestock may be less critical than an adequate food supply (RAOU, quoted in Smith *et al* 1995).

HABITAT ON SITE AND EXTENT OF LOCAL POPULATION:

This species was not recorded on the property by this or previous surveys but has been recorded in the locality at several locations including a breeding record in the northeast of Queens Lake (Mr Andy Marshall NPWS pers. comm.). Potential habitat is considered to constitute the two small dams and to a lesser extent the two large dams (limited by the steep sides). In wetter years, perhaps some sections of the pasture may be used for opportunistic foraging.

Overall the property offers potential habitat which may be used as part of the Jabiru's non-breeding range over the LGA depending on seasonal conditions. The property is not considered to have sufficient habitat or reliability of food resources to support breeding, as well as being prone to a high human presence which could lead to disturbance of breeding. Hence it is considered a low to fair potential occurrence on the property.

GLOSSY BLACK COCKATOO (*Calyptorhynchus lathamii*)

ECOLOGICAL PROFILE:

The Glossy Black Cockatoo (hereon referred to as GBC) typically occurs in dry to moist sclerophyll forest (often on low nutrient soils) containing its preferred forage species – it has a restricted diet of large-coned Casuarina and Allocasuarina (*A. littoralis* and *A. torulosa* are the preferred coastal species) (NPWS 2005). Food trees generally have large cone crops (eg >200 cones) and young cones (easier to open and the seeds have higher protein content). Cones are not selected on size but on number of seeds per cone (to maximise foraging effort efficiency), thus a tree with a large crop is not necessarily a preferred food tree (Clout 1989). Trees may require at least 10 years of growth before being potentially utilised (Mt King Ecological Surveys 1993b) though small trees under 3m tall may be used (personal observations).

This species lives in loose groups (pairs disassociate for breeding and return with young to group) ranging from 2-20 individuals, occupying a permanent area (range over 100km), following the fruiting pattern of its preferred food tree species (some pairs have been recorded searching over 40km for suitable food trees).

An Autumn to Winter breeder, perhaps linked to the phenology of its food, it requires nesting hollows, around the mid canopy, in dead limbs or trunks approximately 18cm in diameter with very wide bottoms, usually in dead trees (Smith *et al* 1995, Schodde and Tideman 1990, NPWS 1999), and often amongst the largest trees in a relative stand (Gibbons and Lindenmayer 2002). Bird numbers may possibly be limited by nest site availability (Mt King Ecological Surveys 1993b). European honeybees have been recorded killing nestlings, and may render hollows unusable (Garnett *et al* 1999, Gibbons and Lindenmayer 2002), while other species which have extended their range eg Galahs, may compete for nest sites (Garnett *et al* 1999, Gibbons and Lindenmayer 2002).

Preference for tracts of undisturbed or minimally disturbed woodland (State Forests 1995). Coastal groups generally smaller than inland groups (Smith *et al* 1995).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

Potential habitat for this species essentially consists of a small stand of Black Oaks along part of the western boundary adjacent to Ocean Drive within a stand of mixed forest mapped as Dry Sclerophyll/Swamp Forest. Some trees also occur in the DSF D in the southeast. No evidence of feeding was found on the property and no birds were observed despite numerous local records (eg Darkheart 2006h, 2004q, DECC 2008a, Bionet 2008)

A few hollows in Forest Red Gums in pastoral woodland on the property had some marginal structural potential to provide nest sites for this species, though trunk diameter of host trees suggested internal dimensions may not be sufficient. Current use of

hollows by common woodland birds including Galahs further indicated the very low potential for these hollows to be selected by the GBC.

Overall, the property is considered to offer only a relatively minute area of potential foraging habitat forming a marginal part of the local population's local range which would at least include large areas of known habitat in nearby Queens Lake State Forest/State Conservation Area (Darkheart 2006h, DECC 2008a, Bionet 2008) and large area of private land (eg Darkheart 2004q).

SWIFT PARROT (*Lathumus discolour*)

ECOLOGICAL PROFILE:

This bird lives in eucalypt forests and woodlands, particularly box-ironbark, and feeds primarily on mostly on pollen and nectar of Winter flowering eucalypts, but also feeds on fruit, seeds, lerps and insect larvae (Schode and Tideman 1990, Brereton 1996, Garnett and Crowley 2000). Preferred sites have high soil fertility and large trees with large nectar production; often along drainage lines, or in isolated or small rural or urban remnants (Emison *et al* 1987, Tzaros 1996 and 1997. Favoured species are *E. robusta, Corymbia gummifera, E. globulus, E. sideroxylon, E. leucoxylon, E. labens, E. ovata, C. maculata, Banksia serrata* and *B. integrifolia*

This species only breeds in Tasmania (mostly along the southeastern coast, within 8km of the coastline). Nesting occurs in hollow bearing trees usually away from foraging sites.

Post-breeding (from about January), the species disperses throughout Tasmania and the mainland (Autumn onwards) from southeast South Australia (to the Adelaide Plains), along the coast and inland slopes of the Great Dividing Range, up to southeast Queensland (Duaringa and Chinchilla). Non-breeding birds are highly mobile, with movements varying between years (some sites are used repeatedly). Mainland sites usage varies year to year, probably also due to nectar availability (Wilson and Bennet 1999). Migrants return in Spring, forming flocks (Brereton 1996). The species is usually found on the mainland from March to September (Smith *et al* 1995).

The Swift Parrot is predicted to occur over 860 000km^2 (medium confidence), with only about 4000km^2 occupied and decreasing (low confidence). There are estimated to be about 1300-2000 breeding pairs: decreasing (Birds Australia 2002, Garnett and Crowley 2000).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

The DECC (2008a) Atlas of Wildlife has a record of this species possibly (exact location depends on the precision of the data) in the northern end of the property. Habitat on the site consists of Forest Red Gum scattered over the pastoral woodland. This extends outside the site onto the property, with other potential habitat available via Swamp Mahogany in the swamp forest. White Banksia on other parts of the property may also offer potential habitat. Overall, these resources offer a relatively minute area of potential foraging habitat (depending on flowering incidence) for this widely nomadic species as part of its non-breeding range. Locally, more abundant habitat occurs to the west in nearby Queens Lake State Forest/State Conservation Area (Darkheart 2006h), Lake Innes Nature Reserve (NPWS 1994a) and large area of private land (eg Darkheart 2004q). Occurrence on the property thus would be as opportunistic foraging forays of a few individuals as part of its seasonal nomadic movements, with occurrence on the property subject to competition and aggressive encounters with common woodland birds such as Lorikeets and the Noisy Miner which were also present.

POWERFUL OWL (*Ninox strenua*)
BARKING OWL (*N. connivens*)
MASKED OWL (*Tyto novaehollandiae*)

ECOLOGICAL PROFILE:

(a) **Powerful Owl**:

Australian population is possibly about 7000 breeding birds (stable) classed as Least Concern under The Action Plan for Australian Birds (Garnett and Crowley 2000). The Powerful Owl attains its greatest relative abundance in northeastern NSW (Kavanagh 2000b).

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The Powerful Owl (hereon abbreviated to PO) inhabits open *Eucalypt, Casuarina* or *Callitris* pine forest and woodland, and may forage along the forest's edge, although it may prefer gullies in coastal forests (below 1500m ASL), but is generally found where prey densities and roost densities are sufficiently high. It has also been recorded breeding and foraging successfully within forests and woodlands within metropolitan areas of large cities provided suitable prey species and nesting cavities are available, however, is sensitive to disturbance of nests and thus has lower breeding success (Cooke *et al* 2000). Hence overall, it is regarded as a habitat generalist (Kavanagh 2000b).

The PO preys opportunistically on large arboreal mammals such as the Yellow-Bellied Glider, Sugar/Squirrel Gliders, Common-Ringtail Possum, Greater Glider (high populations of the latter species is often linked with the occurrence of the PO) and even smaller Koalas, supplemented with terrestrial mammals (eg rats, bandicoots and juvenile wallabies), birds (eg galahs, currawongs, rosellas, lorikeets, cockatoos), fruit bats (especially if camps are nearby) and even insects (eg Christmas Beetles and large Ghost Moths), depending on abundance of prey (eg other species may be taken where mammals populations are low, though this is seen as less sustainable) (Debus *et al* 1994, Soderquist *et al* 2000, Kavanagh 2000a). Birds tend to be taken in more fragmented habitats where density and abundance of arboreal prey is lower (Kavanagh 2000a). The PO requires the equivalent of a small possum every two nights to maintain physiological demands (Garnett 1993, Schodde and Tideman 1990). Hunting may be concentrated in part of the territory for some time, resulting in local declines in abundance and diversity (Kavanagh 1988), but also sees the entire home range being used regularly (Soderquist *et al* 2000).

The PO is sedentary, and solitary or in pairs occupying permanent territories of 300-5000ha (average 800-1000ha), depending on the quality of habitat (Debus 1995, Soderquist *et al* 2000, Kavanagh 2000b). Favoured roosts are on a branch within dense foliage of a tall understorey or sub-storey tree in moist, tall forest, rainforest or open forest. Recorded roost species include Forest Oak (*Allocasuarina torulosa*), Lilly Pilly *(Acmena smithii*), *Leptospermum* spp, *Acacia* spp. and Turpentine (*Syncarpia glomulifera*). The PO has also been recorded roosting in pine plantations near eucalypt forest.

Nests are usually located in large (30 to >150cm DBH, average 77-180cm DBH; with minimum 10cm wide apertures), deep (1-3m) hollows in trunks of trees, or horizontal and sloping spouts, 9-37m above ground (Debus 1995, Kavanagh 1997). These trees are often the largest and oldest tree (150-500 years) within a forest patch (eg an emergent), and are generally located at the head of a minor drainage line or upslope of streams (Soderquist *et al* 2000, Smith *et al* 1995, Gibbons and Lindenmayer 2002).

Breeding mainly occurs in Winter (Kavanagh 2000a), and nest fidelity is usually high, though some pairs have been recorded selecting new sites on average every two years (Kavanagh 2000b). Two eggs are laid per year, with most pairs able to raise at least one young (Kavanagh 2000b). Siblicide is not unknown.

(b) Barking Owl:

The Barking Owl (hereon abbreviated to BO) shows a preference for more open country ie savannah woodland, woodland, as well as forest. It is widespread on the foothills and coastal plain, to the inland slopes and plains, and rare or absent in dense, wet forests on the eastern fall of the Great Dividing Range. It has been recorded roosting in rainforest, but prefers to forage in more open country including farmland. Its preferred habitat is usually dominated by eucalypts and paperbarks (NPWS 2003b), and has even been recorded in remnants of forests and woodland, and in tree copses on farmland, in towns and golf courses. Roosts are normally in dense foliage of large trees (including rainforest species) such as streamside gallery forests, River She-Oak, Casuarinas, Allocasuarinas, eucalypts, Angophoras and Acacias. Roosts are not necessarily hidden (NPWS 2003d).

Nesting occurs in hollow trees, mainly eucalypts or paperbarks, usually near watercourses or wetlands. Nest is a large open hollow often vertical or sloping in a trunk or spout of a live or dead tree, 2-35m above ground, with an opening of 20-46cm and depth of 20-300cm. Breeding is in permanent territories, and is strictly seasonal with eggs laid in late Winter or Spring (August-October in NSW). Fledglings are seen with their parents about October to January, and disperse at the end of Summer (NPWS 2003d).

Population densities are not well known for the species, though some studies have recorded breeding pairs spaced <1-10km apart. Large territories (probably at least 200ha, but more likely up to 6000ha) are maintained with territorial calls at dusk and dawn.

Least nocturnal of Australian owls, hunting before dusk for small to medium prey such as birds, large insects and mammals. Tends to eat more birds than other forest owls and takes rosellas, starlings and magpies, with a concentration on mammals during breeding and Winter; and often a lot more insects post-breeding in warmer months. Common prey include rabbits, hares, smaller marsupials, possums, Sugar Gliders, Squirrel Gliders, Brushtailed Phascogale, rats mice, and a variety of birds (NPWS 2003d).

(c) The Masked Owl:

Southern Australia subspecies estimated to number about 7000 breeding birds (stable), and is classed as Near Threatened under *The Action Plan for Australian Birds* (Garnett and Crowley 2000). The Masked Owl attains its greatest relative abundance in northeastern NSW (Kavanagh 2000b).

The Masked Owl (hereon abbreviated to MO) prefers eucalypt forest and woodland with a sparse understorey, and appears to require partial clearing/open areas or forest edges for foraging, hence it is regarded as habitat generalist (Kavanagh 2000b). They also inhabit more open areas eg farmland. It appears to avoid wetter and denser forest (Kavanagh 2000a) and is least common in forested environments with a denser understorey and/or dense groundcover, including early stages of forest regrowth (Kavanagh 2000b).

The MO is solitary, and sedentary, occupying a large permanent territory about 500-1000ha/5-10km^2 (average 800-1200ha) (Debus 1995, Kavanagh 2000b). It preys closer to the ground than the other owls, and appears to be more of a specialised predator on small terrestrial, scansorial (climbing) and arboreal mammals in the 200-600g range (eg rats, antechinuses, Sugar Gliders, Common Ringtails, bandicoots and rabbits), birds (eg Tawny Frogmouth Owl), domestic poultry and even insects (Garnett 1993, Schodde and Tideman 1990, Debus 1995, Mt King 1993, Kavanagh 2000). The Masked Owl appears to predate more on introduced species in highly disturbed environments, and native species in more natural habitats (Kavanagh 2000).

The MO roosts in tree hollows in eucalypts, and also in Lilly Pilly's and some rainforest trees, dense foliage (infrequent), caves and crevices. Nests are located in tree hollows or cliffs. Tree hollow nests are generally in vertical trunk or spout hollows 10-30m high, 0.5-5m deep and 0.5m wide, in or near eucalypt forest or woodland (Debus 1995). Selected trees are usually 100-191cm DBH (Kavanagh 1997).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

Overall, the general property with its mix of habitats from pasture to forest is considered to offer limited potential for foraging and temporary roosting of these birds which have all been recorded in agricultural woodlands and similar habitats to that on the property and in the general area (DEC 2008b, Smith *et al* 1995, Debus 1995, NPWS 2003d, Garnett 1993, Schodde and Tideman 1990, Debus 1995, Mt King 1993, Kavanagh 2000a, 2000b, Cooke *et al* 2000). Prey diversity and abundance is limited due to the constraints of the property (eg majority it pasture and retained forest is fragmented, isolated and mostly regrowth). Given the species' large home range and dietary requirements, as well as extent of forest to the west and further north and south, the property at most may only lie on the marginal fringe of the large territory of a pair of these species. Both the MO and PO have been recorded within 1km of the property (Darkheart 2004q, Mrs Penny Marshall BHPA pers. comm., DECC 2008a, Bionet 2008), hence these species in particularly have some low to marginally fair potential to occur on the property using it for opportunistic foraging forays.

The property is not considered to offer any suitable nest sites as while some tree hollows may have suitable opening apertures, internal dimensions suggested by trunk diameter is considered likely to be insufficient.

Given the territory size of these species, low quality habitat on the property and their ecology, the local population would extend well beyond the confines of the property.

OSPREY (*Pandion haliaetus*)

ECOLOGICAL PROFILE:

The Osprey is coastally distributed, occurring singly or in dispersed pairs in territories along the coastline with active nests usually more than 1km apart. It feeds almost exclusively on fish, commonly Mullet or Bream in relatively clear water. Optimal habitat is shallow water with sufficient fish of 25-35cm length and nearby structures suitable for vantage points, feeding platforms and nest sites (Clancy 1991, DEC 2005a).

Ospreys rarely feed on the ground and utilise feeding perches near feeding grounds and also near the nest. Tall dead trees may also be used as vantage points (Clancy 1991). Nests are located in tall usually dead trees, but occasionally live trees, artificial structures, rock ledges, cliff faces, rocky foreshores and islands within 1-2km of water, but rarely adjacent. Preferred tree locations are exposed positions (to prevailing winds which reduce thermal loads) with easy access and good visibility. Preferred stick sources are *Melaleuca quinquenervia* and *Casuarina glauca*, and a sufficient presence of such material in adjacent swamp forest or other stands of vegetation may be a limiting factor in nest site selection. Breeding extends from

March to November and may be linked to the migration of Sea Mullet which enter NSW in May-June. Eggs incubate in 35 days and young fledge at 9 weeks. Nests are used in successive years. Nests are actively defended from other raptors and potential nest raiders eg Crows and Kookaburras. Also locally nomadic and capable of travelling long distances to access suitable feeding and nesting grounds (Clancy 1991, DEC 2005a, Smith *et al* 1995).

In the Port Macquarie NPWS district (which includes Hat Head National Park), some 47 nest sites and minimum of 86 birds are known to exist (NPWS pers. comm. 1999).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

Potential habitat on the property consists of the two large dams and Duchess Gully. All of these habitats contain potential prey species of this raptor, but given its ecological requirements, extent of habitat on the property relative to the locality, would only form a minute portion of the territory of one pair of birds.

No nests occurs on the property though Forest Red Gums in the pastoral woodland offer some structural potential. Nesting is considered a very low potential probability given presence of a Whistling Kite nest in this area.

SQUARE-TAILED KITE (*Lophoictinia isura*)

ECOLOGICAL PROFILE:

The Square-Tailed Kite (hereon referred to as STK) has an Australian population size of approximately 7000 breeding pairs (low reliability) and stable (low reliability), and it is classed as Least Concern in The Action Plan for Australian Birds (Garnett and Crowley 2000).

It typically inhabits coastal forested and wooded areas primarily within 250km of coast and rarely inland along wooded watercourses and in central Australia (Blakers *et al* 1984, Debus and Czechura 1989). Often associated with ridge and gully forests, STK usually prefers open eucalypt forest and woodland and will forage in open country or partially cleared pastoral country. It is never abundant anywhere, occurring as solitary birds or dispersed pairs. The STK has a marked preference for continuous stands of open forest/woodland. It may forage over mallee, heath and shrubs, and in wooded urban areas particularly if passerine birds present.

The STK is a specialist hunter of passerine birds, especially honeyeaters and nestlings, but also takes eggs, reptiles, rabbits and insects. It prefers to take prey from the outer foliage of the canopy; hunting in the morning and afternoon.
The home range of a pair is reportedly at least 100km^2 with ranges up to 1700km^2 being reported (AMBS 1996, Garnett 1993, State Forests 1995, NPWS 2000).

Nests are constructed in mature, living trees in the fork or large horizontal limb of a tall eucalypt or angophora within forest, often near water. Breeding occurs in July to February (Debus and Czechura 1989). In southeast and southwest Australia, there is a recorded seasonal dispersal of this species north in the Winter and south in the Summer. This is more pronounced in the southwest (State Forests 1995).

In recent years, breeding has been recorded in Kempsey-Wauchope Forestry Management Area and at Port Macquarie, where it is also known to tolerate human activity, even when nesting (Bischoff *et al* 2000). The STK may be adapting to well-vegetated outer fringes of cities in northern NSW, feeding on the plentiful introduced and native passerine birds there (Debus 1998).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

A single bird has been observed foraging by this consultant over the southern end of the property in recent years. Given the ecology of the species, the property would only form a fraction of the home range of the local pair which may be based (as suggested by the nesting record) in Port Macquarie. As most of the property is open pasture, foraging is generally limited to the remnants of forest which were not noted to be particularly abundant with prey species, though seasonal abundance would vary.

WOMPOO FRUIT-DOVE (*Ptilinopus magnificus*)

ECOLOGICAL PROFILE:

Recorded from large, undisturbed tracts of sub-tropical rainforest, dry rainforest, littoral rainforest, warm temperate rainforest and wet sclerophyll forests with a rainforest mid-storey. Occasionally in monsoon forest, tall open forest, open woodlands and

vine thickets near rainforest (Marchant and Higgins 1993). This species demonstrates a preference for undisturbed or less disturbed moist forest and rainforest (Lindsey 1992). The Wompoo Fruit Dove is essentially restricted to central and northeastern NSW (Recher *et al* 1995).

Feeds almost entirely on fruit, foraging primarily high in canopy. Relatively sedentary to locally nomadic with dispersal over a local area according to fruiting pattern of preferred species (figs, native tamarind, myrtles, laurels, lily pillys, Bangalow Palm, White Cedar, *Smilax australis*, oliveberry and pigeonberry trees). Favoured species include: *Ficus macrophylla, F. fraseri. F. rubiginosa, F. watkinsiana,* Wild Tobacco (*Solanum maritianum*), *Acronychia oblongifolia, Neolitsea dealbata* and *Cissus antarctica* (Recher *et al* 1995).

Breeding habitat is dense rainforest, with timing according to fruiting patterns (generally July-September). Nest a flimsy platform of vine tendrils located on slender horizontal branches in the dense rainforest canopy, generally below 10m and as low as 2m above ground.

The NSW population probably exceeds 7000 birds (Recher *et a*l 1995). The extent of the local population would be those individuals who use the locality as a seasonal forage resource.

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

This bird was observed by chance in 2003 as a small group flying along the dune vegetation to littoral rainforest near Middle Head, and as a single bird roosting opportunistically in the western dry sclerophyll. The property has no rainforest or littoral rainforest, with only a small area of mixed wet sclerophyll regrowth along the upper limits of Duchess Gully. This area is not considered likely to attract this bird to forage due to its limited extent and high exposure to predators. This and the ecology of the species readily indicates the property has no substantial value to the species and the local population extends well beyond its confines.

SQUIRREL GLIDER (*Petaurus norfolcensis*)

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).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

This species was not recorded on the property despite suitable habitat in the southeast dry sclerophyll particularly. This species has been recorded to the southeast in the adjacent STP grounds (Biolink 2003) and thus is considered likely to use the southeast dry sclerophyll for foraging and denning in tree hollows as part of a wider home range of a local colony. Its use of habitat on the remainder of the property is considered significantly unlikely given fragmentation and isolation of other potentially suitable habitat (eg Paperbark/Swamp Mahogany swamp forest in the centre) and the poor condition of such habitat (eg lack of understorey or range of foraging resources). Given this, the southeast dry sclerophyll and adjacent Paperbark/Swamp Mahogany swamp forest is considered the only area likely to be used as part of a colony's wider range which obviously extends beyond the property. This species has also been recorded in tentatively connected habitat in northeast Bonny Hills (Darkheart 2005a, 2005b) and these colonies are considered likely to exchange genetic information with the colony which may facilitate the southeast dry sclerophyll and swamp forest from the STP.

BLUE BILLED DUCK (*Oxyura australis*)

ECOLOGICAL PROFILE:

The Blue-Billed Duck (BBD) breeds in the Murray-Darling Basin, with non-breeding occurrences (mainly immature birds) using large, deep, open freshwater dams, rivers and lakes throughout the Basin and on the coast (NPWS 1999, DEC 2006b, Marchant and Higgins 1990, Smith *et al* 1995). It has also been recorded in sewage treatment ponds and also estuarine waterbodies during non-breeding seasons, and will readily use newly flooded areas (NPWS 1999, Marchant and Higgins 1990). It prefers clear, still, deep, well-vegetated (eg *Typhus* spp) freshwater wetlands with firmer substrates where it feeds on aquatic insects as well as various invertebrates, seeds, bulbs, stems and leaves (NPWS 1999, Marchant and Higgins 1990, DEC 2006b, Smith *et al* 1995).

HABITAT ON PROPERTY/SITE AND EXTENT OF LOCAL POPULATION:

This rarely recorded bird is considered a low potential occurrence in the large dams on the property which offer a large area of deep water though with limited vegetation. Given a record of this species in the Port Macquarie STP and the size of the dams on the property, there is a small chance a few birds could opportunistically use this habitat as part of their non-breeding range. A subsequently detailed in part (a), the creation of a 10.72ha wetland may increase the potential for this seasonally nomadic bird to occur in the area.

BLACK BITTERN (*Ixobrychus flavicollis*)
AUSTRALASIAN BITTERN (*Botaurus poiciloptilus*)

ECOLOGICAL PROFILE:

(a) **Black Bittern**:

Australia-wide, estimated to be about 20 000 breeding birds (decreasing), within 3 sub-populations, with the largest about 19 500. Classed as Least Concern under The Action Plan for Australian Birds (Garnett and Crowley 2000).

This solitary, seldom seen and characteristically shy bird inhabits terrestrial, fresh and estuarine wetlands, usually with permanent water and dense vegetation, and estuaries, watercourses, billabongs and pools. Other general habitats with permanent water (eg rivers and creeks) such as rainforest, swamp forests, riparian strips, woodland, mangroves and flooded grassland may also be used (Marchant and Higgins 1990).

The bird forages on reptiles, fish, frogs/tadpoles and invertebrates including molluscs, crustaceans and insects (including aquatic larvae). Birds often rest in denser waterside vegetation (eg trees or reeds) during the day, and forage at night, dusk or during the day, (Marchant and Higgins 1990, Readers Digest 1990).

The bird can be either nomadic or sedentary depending on the quality of habitat and seasonal conditions (eg drought) (Ecotone Ecological Consultants 1998).

Breeding is presumed to be from December to March, when birds pair up. Nests constructed of twigs may be located on a tree branch overhanging water, or on reeds (Marchant and Higgins 1990, Readers Digest 1990, personal observations).

(b) **Australasian Bittern**:

Australia-wide, estimated to be about 2500 breeding birds (low reliability estimate; trend is decreasing), within 3 sub-populations, with the largest about 1000. Classed as Vulnerable under The Action Plan for Australian Birds (Garnett and Crowley 2000).

The Australasian Bittern is also cryptic and seldom seen. It has narrower habitat preferences than the Black Bittern, being mainly found in shallow, vegetated freshwater or brackish swamps. Occurrences and hence detectability increases in wetter seasons where more ephemeral habitats and peak breeding may occur (Garnett and Crowley 2000, Readers Digest 1990).

This bird is solitary, generally hunting at night by wading up to knee deep in water or the waters edge. Prey includes amphibians, fish, crustaceans, snails, small terrestrial mammals (eg mice) and various insects (Garnett and Crowley 2000, Readers Digest 1990). Pairs occupy territories, though each bird may have its own foraging territory, throughout which it will build roosting pads under brakes of reeds (Garnett and Crowley 2000, Readers Digest 1990). The latter may be identified by pellets of indigestible material (Readers Digest 1990).

Breeding occurs from October-January. Breeding males vocalise with a booming call. Nest may be either a trampled mat of reeds and rushes (Readers Digest 1990), a well-constructed cup (Garnett and Crowley 2000) usually over water in dense cover (Readers Digest 1990), or a branch overhanging water (personal observations). Females incubate and hatch the young unaided, and there is some suggestion of polygyny (Readers Digest 1990).

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

Potential habitat for these species on the property is considered to constitute the estuarine sections of Duchess Gully, most of which occurs downstream. The large dams are considered marginal due to limited cover and roosting potential but could be used for foraging forays as part of their wider range. Given the limited habitat on the property and ecological requirements of the species, the local population of these species would extend well beyond the property.

EASTERN BLOSSOM BAT (*Syconycteris australis*)

ECOLOGICAL PROFILE:

The Eastern Blossom Bat (hereon referred to as EBB) is a small solitary bat that is an ecological specialist. Important habitat components for the EBB are suitable roosts in rainforest or swamp forest and nearby foraging resources in heath or swamp forest (Law 1993).

It appears to be dependent on a continuous supply of nectar and pollen (Law 1993, Smith *et al* 1995) and it enters daily torpor if it has not fed and the temperature falls below 26^0C (Churchill 1998). The EBB feeds largely in heathland and swamp forest, foraging for pollen and nectar, usually from *Banksia* but also from *Callistemon salignus* and Pink Bloodwood (Smith *et al* 1995). In northern New South Wales the CBB has a foraging area of about 4-13ha, which it utilises continuously and it appears to defend the food resource from other bats (Churchill 1998).

The EBB roosts in rainforest or swamp forest adjacent to or near (50m-4km) the foraging resource (Churchill 1998). They roost individually amongst large leaves in the canopy or subcanopy, utilising the same area of forest, but often changing roost sites daily according to weather conditions (Smith *et al* 1995).

Females give birth in Spring and possibly again in Autumn (Smith *et al* 1995, Churchill 1998). Lactation lasts approximately 3 months.

HABITAT ON SITE/PROPERTY AND EXTENT OF LOCAL POPULATION:

The EBB has not been recorded on the property but was not specifically targeted. It has been recorded roosting in the nearby littoral rainforest (Parker 2002), and while the most optimum habitat is likely to occur north of Lake Cathie in Lake Innes Nature Reserve and south of Bonny Hills in Queens Lake Nature Reserve, it may occur opportunistically on the property using limited resources such as Bloodwoods, Blackbutts, Swamp Mahogany, Forest Red Gum and White Banksia as part of its seasonally nomadic foraging range. Given the ecology of the species and limitations of the property, the local population would extend well beyond the property.

APPENDIX 3: Plant Species List

Table 13: Plant species list

COMMON NAME	SCIENTIFIC NAME
Canopy Trees	
Swamp Oak	*Casuarina glauca*
Forest Red Gum	*Eucalyptus tereticornis*
Swamp Mahogany	*Eucalyptus robusta*
Northern Grey Ironbark	*Eucalyptus siderophloia*
Small-Fruited Grey Gum	*Eucalyptus propinqua*
Tallowwood	*Eucalyptus microcorys*
Brush Box	*Lophostemon confertus*
Coast Blackbutt	*Eucalyptus pilularis*
Grey Ironbark	*Eucalyptus siderophloia*
Broad-Leaved White Mahogany	*Eucalyptus umbra*
Needlebark Stringybark	*Eucalyptus planchoniana*
Red Mahogany	*Eucalyptus resinifera*
Lemon Scented Gum	*Corymbia citriodora*
Sydney Blue Gum	*Eucalyptus salignus*
Moreton Bay Fig	*Ficus macrophylla*
Broad Leaved Paperbark	*Melaleuca quinquenervia*
Spotted Gum	*Corymbia maculata*
Pink Bloodwood	*Corymbia intermedia*
Understorey Trees	
Hickory Wattle	*Acacia implexa*
Willow Bottlebrush	*Callistemon salignus*
Willow-Leaved Hakea	*Hakea salicifolia*
Coastal Banksia	*Banksia integrifolia*
Cheese Tree	*Glochidion ferdinandi*
Boobialla	*Myoporum acuminatum*
Prickly-Leaved Paperbark	*Melaleuca styphelioides*
Narrow-Leaved Melaleuca	*M. linariifolia*
Old Man Banksia	*Banksia serrata*
Blueberry Ash	*Elaeocarpus reticulatus*
Lilly Pilly	*Acmena smithii*
Satinwood	*Phebalium squaneum*
Hard Quandong	*Elaeocarpus obovatus*
Common Acronychia	*Acronychia oblongifolia*
Coastal Tea Tree	*Leptospermum laevigatum*
Cherry Ballart	*Exocarpus cupressiformis*
Black Oak	*Allocasuarina littoralis*
Broombush	*Monotoca scoparia*
Brush Muttonwood	*Rapanea howittiana*

Shrubs	
Wallum Bottlebrush	*Callistemon pachyphyllus*
Coastal Tea Tree	*Leptospermum laevigatum*
Narrow-Leaved Melaleuca	*Melaleuca linariifolia*
Swamp Banksia	*Banksia robur*
Bush Candles	*B. spinulosa var collina*
Heath Banksia	*Banksia ericifolia var. macrantha*
Wallum Beard Heath	*Leucopogon lanceolatus*
Prickly Beared Heath	*Leucopogon juniperinus*
Native Broom	*Viminaria juncea*
Handsome Flat Pea	*Platylobium formosum*
Wallum Heath	*Epacris pulchella*
Lantana	**Lantana camara*
Bitou Bush*	*Chrysanthemoides monilifera*
Sydney Golden Wattle	*Acacia longifolia*
Sickle Wattle	*A. falcata*
Sweet Wattle	*A. suaveolens*
Palm Lily	*Cordyline stricta*
-	*Boronia pinnata*
Orange Thorn	*Citriobatus pauciflorus*
Sieber's Paperbark	*Melaleuca sieberi*
Ball Honey Myrtle	*Melaleuca nodosa*
Wilkiea	*Wilkiea huegeliana*
Mock Olive	*Notelaea longifolia*
Slender Tea Tree	*Leptospermum polygalifolium*
Rough Pittosporum	*Pittosporum revolutum*
Common Pittosporum	*P. undulatum*
-	*Pomaderris ligustrina*
Native Raspberry	*Rubus parviflorus*
Crinklebush	*Lomatia salicifolia*
Dogwood	*Jacksonia scoparia*
Geebung	*Persoonia levis*
Coffee Bush	*Breynia oblongifolia*
Graceful Bush Pea	*Pultenaea flexilis*
-	*Pultenaea retusa*
-	*P. villosa*
Common Acronychia	*Acronychia oblongifolia*
Grass Tree	*Xanthorrhoea spp*

Grasses	
Whisky Grass*	**Andropogon virginicus*
Rhodes Grass*	**Chloris gayana*
-	*Dichanthium sericeum*
Forest Hedgehog Grass	*Echinopogon ovatus*
Bordered Panic*	*Entolasia marginata*
-	*Ischaemum australe*
Brown Lovegrass*	*Eragrostris brownii*
Basket Grass	*Oplismenus aemulus*
Bladey Grass	*Imperata cylindrica*
Weeping Grass	*Microlaena stipoides*
Carpet Grass*	**Axonopus fissifolius*
Parramatta Grass*	**Sporobolus indicus*
Broad-Leaved Paspalum*	**Paspalum wettsteinii*
Torpedo Grass*	*Panicun repens*
Red Natal Grass*	*Melinis repens*
Kangaroo Grass	*Themeda australis*
Sedges, Rushes, Wetland Plants	
Spiny Headed Matrush	*Lomandra longifolia*
Many-Flowered Matrush	*Lomandra multiflora subsp. multiflora*
-	*Juncus polyanthemus*
-	*J. continuus*
Jointed Twig-Rush	*Baumea* articulate
Frogsmouth	*Philydrum lanuginosum*
Water Lily	*Nymphaea violacea*
-	*J. cognatus*
-	*Baumea juncea*
-	*Fimbristylus dichotoma*
-	*Selaginella uliginosa*
Saw Sedge	*Gahnia clarkei*
A Saw Sedge	*G. aspera*
-	*Cyperus polystachyos*
-	*Isolepis nodusus*
-	*Restio tetraphyllus ssp*
Giant Spikerush	*Eleocharis equisetina*
Common Spikerush	*E. acuta*
Water Ribbons	*Triglochin procerum*
-	*Carex appressa*
Sedge	*Carex sp.*

Groundcovers	
-	*Desmodium rhytidophyllum*
Plantain*	**Plantago lanceolata*
Flax Lily	*Dianella caerulea*
Kidney Weed	*Dichondra repens*
Pomax	*Pomax umbellata*
Kurnell Curse*	**Hydrocotyle bonariensis*
Pouched Coral Fern	*Gleichenia dicarpa*
Pennywort	*Centella asiatica*
Buttercup	*Ranunculus lappaceus*
-	*Senecio diaschides*
Whiteroot	*Pratia purpurascens*
-	*Goodenia paniculata*
Bat's Wing Fern	*Histiopteris incisa*
Common Groundfern	*Hypolepsis muelleri*
Rasp Fern	*Doodia aspera*
Leafy Purple Flag	*Patersonia glabrata*
Fireweed*	*Senecio madagascariensis*
-	*Histiopterus incisa*
-	*Blechnum indicum*
Violet	*Viola hederacea*
Bindii*	**Soliva sessilis*
Bracken Fern	*Pteridium esculentum*
False Bracken Fern	*Calochlaena dubia*
White Clover	**Trifolium repens*
Cats Ear	**Hypochaeris radicata*
Farmers Friend*	**Biden pilosa*
Parasites and Epiphytes	
Devils Twine	*Cassytha glabella*
Mistletoe	*Amyema pendulum*
Snake-Flower Orchid	*Cymbidium suave*
Lianas, Scramblers and Twiners	
Wombat Berry	*Eustrephus latifolius*
-	*Glycine spp*
Love Creeper	*Glycine microphylla*
False Sarsaparilla	*Hardenbergia violacea*
Jasmine Morinda	*Morinda jasminoides*
White Passionflower*	**Passiflora subpeltata*
Austral Smilax	*Smilax australis*
Native Sarsaparilla	*Smilax glyciphylla*
Common Marsdenia	*Marsdenia rostrata*
Monkey Rope	*Parsonsia straminea*
Molucca Bramble	*Rubus moluccanus var. trilobus*
Native Bramble	*Rubus parvifolius*
Kangaroo Grape	*Cissus antarctica*

APPENDIX 4: Site Photos

Series 1: View from western edge of wetland to northwest filling area.

Series 2: View of wetland and filling area from west to northeast from the depression contain Wallum Frolgets in 2006

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Photos A1 and A2: Shrubs in mid-ground indicate southwest drain where Common Planigale was recorded in 2003.

Left photo: Sample of habitat in which Wallum Froglet has survived slashing in 2006. These sedges are <15cm high. Note layer of detritus. This was moist when dug.

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