Paclib Management Pty Limited

Masterplan Ecological Assessment for the Former Pasminco Cockle Creek Smelter Site



August 2009

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Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Paclib Pty Limited

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1.0 Introduction

Paclib Pty Limited is preparing a Masterplan to guide the redevelopment of the former Pasminco Cockle Creek Smelter site (Pasminco) to support a mixture of residential, industrial and commercial land uses. The Pasminco site is located at Boolaroo, in northern Lake Macquarie (**Figure 1.1**), approximately 150 kilometres north of Sydney. Lead smelting began at Pasminco in 1897 with operations ceasing in September 2003. The long history of industrial land use and contamination has resulted in significant alteration to the ecology of the site and as a result vegetation communities and fauna habitats are highly disturbed.

A large proportion of Pasminco is currently subject to a remediation order (RO) issued under the *Contaminated Land Management Act 1997*. The RO was issued by the Environmental Protection Authority (EPA) (now part of the Department of Environment and Climate Change (DECC)) as the dust, surface water and groundwater leaving the site were considered to provide a human health and environmental hazard (Fitzwalter 2006) (**Figure 1.1**). A Remediation Environmental Management Plan has been prepared (Fitzwalter 2007) to guide the remediation of the site.

Umwelt (Australia) Pty Limited (Umwelt) has been commissioned to prepare an assessment of the ecological characteristics of the site and the impact of the proposed redevelopment on identified ecological features.

Five rezoning and subdivision applications have been made to Lake Macquarie City Council (LMCC), each of which contained significant ecological survey and assessment. This report draws from each of these surveys to identify the ecological values of the Pasminco site (refer to **Section 2.0**) and provide an assessment of the impact of the proposed development detailed in the Masterplan (Paclib 2008) and shown in **Figure 1.2**.

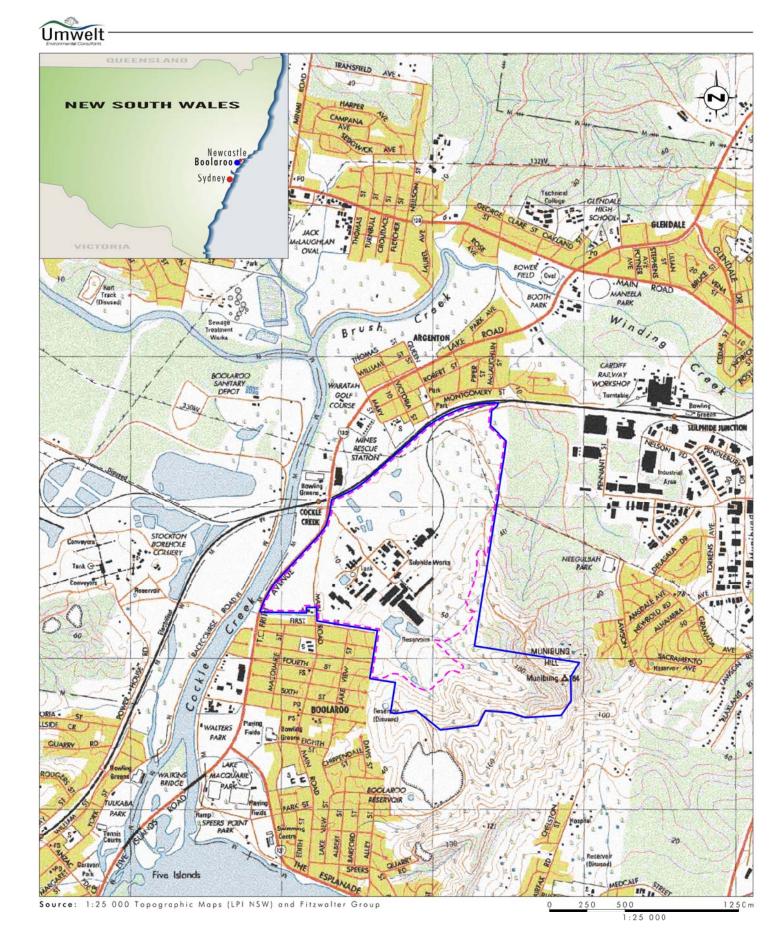
1.1 Study Area

This ecological assessment refers to the Pasminco Cockle Creek Smelter and Incitec site (the study area) as shown on **Figure 1.1**. The study area comprises approximately 212 hectares of former industrial and buffer land.

1.2 Objectives

The objectives of the ecological assessment are to:

- record the flora and fauna species occurring within the study area;
- identify any threatened flora and fauna, listed under Schedules 1 and 2 of the NSW Threatened Species Conservation Act 1995 (TSC Act) and also under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act);
- assess the impact that the proposed development is likely to have on the ecological characteristics of the study area; and
- formulate impact mitigation measures (where necessary) to reduce the impact of the proposed development on the ecological values of the study area.

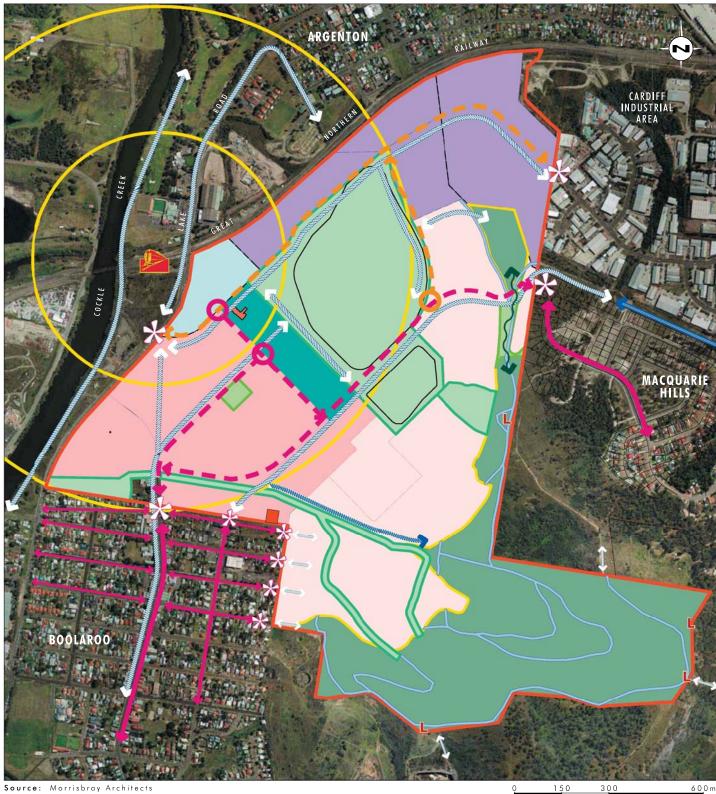


Legend Pasminco Cockle Creek Smelter Site (Study Area) Lemediation Boundary

FIGURE 1.1

Locality Plan





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Legend

Pasminco Cockle Creek Smelter Site (Study Area) **Residentia**l Proposed Road Intersection Proposed Industrial Main Road /Link **Fesidential (Urban Living)** Proposed Residential Main Road /Link Light Industrial Potential Pedestrian / Cycleway Link Mixed use / Redevelopment Existing Pedestrian / Cycleway Link Urban Centre FIGURE 1.2 Proposed Ridge Vegetation Regeneration link Cointainment Cells & Riparian links Cockle Creek Train Station Munibung Hill Reserve & Angophora Inopina reserve **Proposed Development** Major Site Access / Egress Points 朱 Parks Fire trails (pedestrian connectivity)

2.0 Literature Review

A number of relevant previous studies have been conducted on or adjacent to the Pasminco property. These are briefly discussed in the following sections.

2.1 Previous Ecological Assessments in the Local Area

2.1.1 Statement of Effect on Threatened Flora and Fauna for a Proposed Subdivision at Pasminco Cockle Creek Smelter, Boolaroo NSW (Wildthing 2002)

Wildthing (2002) undertook an ecological assessment for the construction of a proposed electricity substation on approximately four hectares, which would have resulted in the clearing of less than 2 hectares of vegetation. One vegetation community, Disturbed Open Woodland, was mapped. The threatened tree Charmhaven apple (*Angophora inopina*) was identified, as well as an intergrade between this species and the more common rough-barked apple (*Angophora floribunda*). No threatened fauna species were identified or considered likely to occur. An eight part test prepared under the *Environmental Planning and Assessment Act 1979* (EP&A Act) suggested that there was unlikely to be a significant impact on threatened species as a result of the development.

2.1.2 Flora and Fauna Impact Assessment for the Proposed Subdivision of the Initial Stages and Species Impact Statement for the Proposed Subdivision of the Final Stages of the Macquarie Park Estate of the Macquarie Park Estate, Lot 117 DP 846847, (Ecotone 2002, 2003a)

Ecotone (2002) undertook a flora and fauna assessment of a proposed 20 hectare residential development to the east of Munibung Hill, adjoining the Pasminco property. The development was found to require the removal of most vegetation on site. Two threatened fauna species were found on site, but no threatened flora species. Three vegetation communities were mapped. Despite Ecotone (2002) indicating that a species impact statement (SIS) was unlikely to be required, an SIS was prepared in the following year (Ecotone 2003a). The SIS found that by utilising the proposed mitigation measures, the viability of the local threatened squirrel glider (*Petaurus norfolcensis*) population may improve. It was proposed that LMCC take over ownership of the proposed environmental protection area based on the preparation of a five year bushland management strategy.

2.1.3 Flora and Fauna Impact Assessment for a Proposed Wetland at Aruma Place, Cardiff (Ecotone 2003b)

Ecotone (2003b) undertook an assessment for a proposed constructed wetland at Aruma Place, adjacent to the site. The land currently comprises a stormwater retarding basin. The impact assessment found that no threatened flora species were recorded or were expected to occur. The threatened eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) was recorded utilising foraging habitat. The report concluded that the proposed wetland would have no significant adverse impact on any flora or fauna species, and that the proposed development could in fact enhance habitat for many species.

2.2 Previous Ecological Assessments in the Study Area

2.2.1 Preliminary Analysis and Issues Paper: Flora and Fauna. Pasminco Cockle Creek Smelter Site (Umwelt 2004)

A literature review and brief fauna survey was conducted to determine the likely ecological constraints to the future development of the Pasminco property. The survey recorded one threatened flora species (*Angophora inopina*) and one threatened fauna species (the grey-headed flying-fox, *Pteropus poliocephalus*), while potential habitat for a number of other threatened flora and fauna species was identified. The report considered that no threatened species would be likely to constrain future development opportunities on the site, as the habitat present was of low quality.

2.2.2 Ecological Assessment for Proposed Development at Former Pasminco Cockle Creek Smelter Site, Boolaroo – Cardiff Industrial Estate (Umwelt 2005a)

Umwelt (2005a) undertook an ecological assessment for a proposed industrial development on the former Pasminco Cockle Creek Smelter Site as an extension to the Cardiff Industrial Estate. This study identified one threatened flora species, *Angophora inopina*, on the site. In addition, an intergrade between this species and the more common rough-barked apple (*Angophora floribunda*) was recorded, although the legal status of this hybrid was not defined under legislation. No other threatened flora species were considered likely to occur in the study area. No threatened fauna species were identified or considered likely to occur on the site. Development of this site was not considered likely to significantly impact threatened species.

2.2.3 Ecological Assessment for Proposed Development at Former Pasminco Smelter Site, Boolaroo – Triangle Paddock (Umwelt 2005b)

A flora and fauna assessment was conducted by Umwelt (2005b) for the proposed rezoning for future residential uses on the former Pasminco Cockle Creek Smelter site, at the intersection of Lake Road and Main Road, Boolaroo. No threatened flora and fauna species were identified or considered likely to occur on this site. Considering the high level of previous disturbance of this site and the highly degraded flora and fauna habitat, proposed development of this site was considered unlikely to significantly impact on threatened flora and fauna.

2.2.4 Ecological Assessment for Proposed Rezoning at Former Pasminco Cockle Creek Smelter Site, Boolaroo – Residential Extension to First and Second Streets (Umwelt 2005c)

Umwelt (2005c) undertook a flora and fauna assessment for the proposed rezoning for residential uses of the former Pasminco Cockle Creek Smelter site for an extension to First and Second Streets, Boolaroo. The survey effort for this study was directed towards the small part of the study site that was proposed for rezoning, while the remainder of the site was only briefly inspected as no development was proposed in these areas. No threatened flora species were recorded or considered likely to occur on this site. Two threatened fauna species, the grey-headed flying-fox (*Pteropus poliocephalus*) and the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), were recorded. The proposed rezoning was considered unlikely to significantly impact the two threatened species due to the small area to be impacted, the marginal condition of the habitat and the highly mobile nature of the species.

2.2.5 Ecological Assessment for Proposed Subdivision and Rezoning at Former Pasminco Cockle Creek Smelter Site – Rail Employment Zone (Umwelt 2005d)

Umwelt (2005d) undertook a flora and fauna assessment for the subdivision and rezoning of approximately 8.2 hectares of the Rail Employment Zone on the former Pasminco Cockle Creek Smelter site. The threatened Charmhaven apple (*Angophora inopina*) was targeted during field surveys, however expert identification verified that all individuals sampled from the three stands present were *Angophora inopina* – *A. floribunda* hybrids. It was not known whether the *A. inopina* hybrid is protected under the TSC or EPBC Acts, or the application of the legislation to this hybrid, however for the purposes of the report, a precautionary approach was taken and the taxon was considered to be a threatened species. No threatened fauna species, endangered populations or Endangered Ecological Communities (EECs) were recorded during field surveys. The proposed subdivision and rezoning was considered unlikely to impact on the Charmhaven apple based on regional distribution, population and threat status information.

2.2.6 Ecological Assessment for Proposed Subdivision and Rezoning at Former Pasminco Cockle Creek Smelter Site – Main Entry Precinct (Umwelt 2006)

Umwelt (2006) undertook a flora and fauna assessment for the subdivision and rezoning of approximately 15.4 hectares of the former Pasminco Cockle Creek Smelter site to form a proposed Main Entry Precinct. The proposed development was considered unlikely to have any significant impact on present vegetation communities, due to a long history of high-level disturbance at the site. No threatened flora species, endangered populations or EECs were identified on the site, or considered likely to occur. No threatened fauna species were identified on the site or, due to the highly disturbed nature of the habitat, considered likely to use the site beyond marginal foraging habitat. The proposed subdivision and rezoning was considered unlikely to significantly impact any potentially occurring threatened species.

3.0 Survey Methodology

3.1 Database Searches

Searches of the DECC Atlas of NSW Wildlife Database and the Department of Environment, Water, Heritage and the Arts (DEWHA) Protected Matters Database were undertaken prior to all field surveys undertaken by Umwelt to identify threatened flora or fauna species, endangered populations and EECs previously recorded within a 10 kilometre radius of the site. All surveys targeted those species listed on the database search results as well as other threatened species known or considered likely to occur in the local area.

3.2 Flora Survey

A total of eight flora surveys have been undertaken across the study area, including four systematic plot-based surveys and additional qualitative flora transects used to confirm vegetation community boundaries and target threatened species. The timing of surveys has resulted in effective coverage across the site and a comprehensive flora species list is provided in **Appendix 1**.

3.2.1 Systematic Plot-based Survey

Four flora surveys were undertaken in November 2004 with eleven 20 metre by 20 metre quadrats surveyed (**Figure 3.1**). All species occurring within the quadrats were recorded, along with an estimate of cover abundance using the standardised Braun Blanquet system. Any species that could not be identified on site were collected, pressed and dried for later identification. Some species were forwarded to the National Herbarium of NSW for further verification. In addition to the formal vegetation plots, general observations of the vegetation were made, including the level of disturbance, vegetation community maturity, erosion and density of weed infestation.

3.2.2 Targeted Threatened Fauna Transects

Threatened flora species considered to potentially occur were specifically targeted during the walking transects. A total of 13 walking transects were undertaken in June and December 2005 to assess the structural and floristic components of vegetation communities. The walking transects were also used to ground-truth existing vegetation mapping for the site, to clearly define community boundaries and to assess the level of disturbance, erosion and density of weed species. Adjacent areas were also briefly inspected to assist in vegetation mapping and to determine the level of vegetation connectivity between them and the study areas.

Angophora inopina was targeted during surveys and its location across the study area was recorded and mapped using a Global Positioning System (GPS).

3.2.3 Targeted Angophora inopina Surveys

Angophora inopina was targeted during all the flora surveys undertaken within the study area. At each Angophora tree, measurements were undertaken to determine whether the individual was the threatened Angophora inopina, Angophora inopina—floribunda intergrade or the common Angophora floribunda (or where there was a clump of 15 or more individuals a number of sample individuals were chosen).

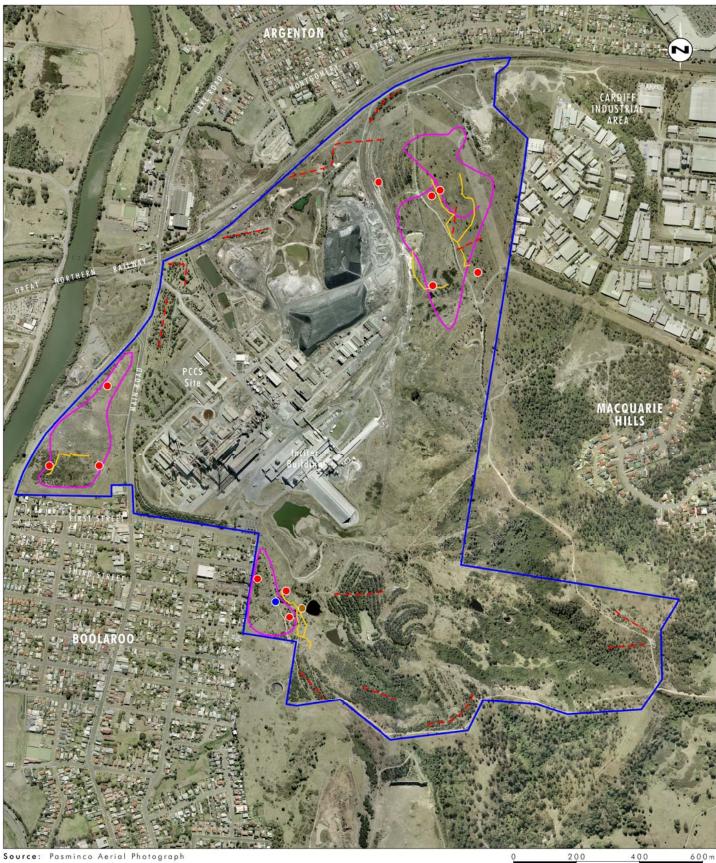
The measurements were based on Table 1: Differentiation between Angophora inopina and Angophora floribunda in Bell (2001), and comprised:

- the length and width of the adult leaves;
- the length of the leaf petioles;
- the length of the peduncles;
- the length of the pedicels;
- the length and diameter of the fruit; and
- the shape of the fruit.

The Angophora individuals were then classed into three different age classes, being:

- juvenile (those species which are not at an age of likely seed production);
- immature (those species which can produce seed and are generally between one and three metres in height); and





Legend

Pasminco Cockle Creek Smelter Site (Study Area)
 Avifauna, Reptile and Amphibian Transect
 Flora Transect

- Trap Position
 Call Playback
- .
- Anabat Echolocation Detector Vegetation Quadrat Location •

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• mature (those species which can produce seed and are generally between three and eight metres in height).

This age class system was devised in the field for ease of classification and distinction, and to further assist in determining the likely ecological significance of *Angophora* spp. in the study area.

3.3 Fauna Survey

3.3.1 Timing

Multiple fauna surveys have been undertaken across the study area with winter, spring and summer surveys ensuring appropriate seasonal coverage. Surveys were conducted in November and December 2004 with additional surveys in June 2005 and February 2007. An additional site inspection was undertaken in November 2007. Surveys included call playback sessions for the nocturnal species listed in **Table 3.1**.

Nocturnal Call Playback Species		
Petaurus norfolcensis	squirrel glider	
Petaurus australis	yellow-bellied glider	
Phascolarctos cinereus	koala	
Ninox connivens	barking owl	
Tyto tenebricosa	sooty owl	
Ninox strenua	powerful owl	
Crinia tinnula	wallum froglet	
Mixophyes balbus	stuttering frog	
Litoria aurea	green & golden bell frog	
Heleioporus australicus	giant burrowing frog	

3.3.2 Birds

Bird surveys were undertaken in all habitat types at various times of the day, primarily in early to mid morning and mid to late afternoon. Bird searches were undertaken by two observers for a minimum of 60 minutes. Opportunistic observations were recorded during all other aspects of the field survey, particularly during flora transects. Bird species were identified from characteristic calls and by observation using 10 × 60 binoculars.

A total of 10 person hours of dedicated diurnal bird survey were undertaken in the study area.

Threatened owl calls were broadcast at two sites (**Figure 3.1**) using a 10 watt directional loud hailer and all nocturnal call playback sessions were undertaken within the first hour after dusk. Call playback sessions commenced with a quiet listening period of approximately five minutes. Each species call was played for a minimum of four minutes followed by a listening period of two minutes before the beginning of the next species call. Calls of the powerful owl (*Ninox strenua*), masked owl (*Tyto novaehollandiae*) and sooty owl (*Tyto tenebricosa*) were included in the survey (**Table 3.1**).

3.3.3 Reptiles

A total of three person hours of reptile survey has been undertaken in the study area. Reptiles were searched for under rocks, logs, rubbish, loose bark on trees and amongst ground cover. Reptiles were further surveyed via opportunistic sightings during all other survey activities across the site.

3.3.4 Amphibians

A total of three person hours of amphibian survey has been undertaken in the study area. Threatened amphibian species were targeted by call playback with a list of threatened frog species targeted included in **Table 3.1**. Areas of standing water were targeted for amphibian species. Amphibians were further surveyed via opportunistic sightings during all other survey activities across the site.

3.3.5 Mammals

A range of techniques were used during fauna surveys to specifically target mammal species. In addition, mammal tracks, scats, scratches and signs were recorded during reptile and diurnal avifauna surveys and opportunistic sightings of mammal species were recorded during all survey activities.

3.3.5.1 Trapping

A variety of different types of traps were used during the surveys across the study area targeting a wide range of mammal species. The trapping methods used across the study area are detailed below. **Figure 3.1** shows the locations of all fauna trapping sites.

Terrestrial Elliot Traps

Terrestrial Elliot A traps baited with a mixture of rolled oats and peanut butter were set approximately 20 metres apart. All terrestrial Elliot trap lines were positioned amongst habitat features such as logs, fallen bark, rocks and ground cover where applicable. They were covered with a plastic bag to prevent rain entering and lined with leaves, grass or tissue paper to provide insulation for captured animals. All terrestrial Elliot traps were positioned to avoid overheating in early morning sunlight, and were tilted towards the front to prevent rain from entering the plastic bag covering the trap.

A total of 120 terrestrial Elliot trap nights have been completed across the study area.

Arboreal Elliot B Traps

Arboreal Elliot B traps baited with a mixture of rolled oats, peanut butter and honey were set on platforms three to four metres above the ground on suitable large tree trunks approximately 20 metres apart. Large trees with hollows were targeted as trap sites, although traps were also set on trees without hollows. The tree trunk and trap entrance were sprayed with a honey and water mixture to aid in attracting arboreal mammals. All Elliot traps were covered with a plastic bag to prevent rain entering and lined with woollen wadding to provide insulation for captured animals. Each trap was positioned to prevent overheating in early morning sunlight.

A total of 20 arboreal Elliot B trap nights were completed across the study area.

Hair Funnels

Hair funnels were set across the study area. Half of the traps were baited with tinned cat food (fish flavour) and the other half with a rolled oats and peanut butter mixture. All terrestrial hair funnels and tubes were positioned amongst habitat features such as logs, fallen bark, rocks and ground cover. All hair funnels were set for 10 consecutive nights. All hair samples were identified by Barbara Triggs (a recognised expert in this field) of Dead Finish, Victoria.

A total of 300 hair funnel sampling nights have been completed across the study area.

3.3.5.2 Spotlighting

An equivalent of 2.5 person hours of spotlighting has been undertaken across the study area using standard 30 watt Lightforce spotlight.

3.3.5.3 Mammal Call Playback

Nocturnal mammal call playbacks of potentially occurring threatened species were played during the first hour after dark (6.00 pm – 7.00 pm). **Table 3.1** lists the mammal species targeted during surveys. Threatened mammal calls were broadcast at two sites (**Figure 3.1**) using a 10 watt directional loud hailer and all nocturnal call playback sessions were undertaken within the first hour after dusk. Call playback sessions commenced with a quiet listening period of approximately five minutes. Each species call was played for a minimum of four minutes followed by a listening period of two minutes before the beginning of the next species call.

3.3.5.4 Micro-bat Survey

Two Anabat echolocation surveys were undertaken in the study area. These surveys were completed for a minimum of 45 minutes. The Anabat echolocation recorder was placed in a backpack, positioned vertically and given a clear view of the sky. All walking transects were completed within the first two hours after dusk.

All Anabat detector recordings were analysed by Glenn Hoye (a recognised expert in the field) of Fly by Night Surveys Pty Limited.

3.3.6 Habitat Assessment

An assessment of fauna habitat has been conducted across the study area. The habitats identified were then correlated with the specific requirements of species known or considered likely to occur within the area in order to determine which species may utilise the site for a part of their life cycle (e.g. nesting, roosting, foraging). Important habitat features that were searched for included:

- hollow-bearing trees;
- rocky outcrops;
- swamp, riverine and wet soak areas;
- density of shrub and ground layer;
- canopy cover;

- mistletoe;
- fallen logs and rocks;
- leaf litter;
- decorticating bark;
- winter flowering species; and
- stags.

Information collected during the habitat assessment was also used to determine the likelihood of threatened species utilising the site.

4.0 Flora Survey Results

4.1 Flora Species

A total of 147 flora species have been recorded within the study area, of which 57 (38.7 per cent) are introduced species. One significant species, the threatened Charmhaven apple (*Angophora inopina*) has been recorded (refer to **Figure 4.1**).

Flowering plants comprised 143 of the total number of species (monocots 37 and dicots 106), with four fern species recorded.

The most abundant plant families recorded were Fabaceae (peas and wattles) – 26 species Poaceae (grasses) – 24 species; Myrtaceae (myrtles and eucalypts) – 24 species and Asteraceae (daisies) – 10 species.

Overall, the floristic diversity of the study area is regarded as moderate. The overall number of plant species recorded is likely to be affected by the industrial history and bushland regeneration activities within the study area. The floristic diversity recorded within the study area is likely to be representative of similar disturbed woodlands and derived grasslands occurring in industrial landscapes across Lake Macquarie.

A flora species list for the study area is included as **Appendix 1**.

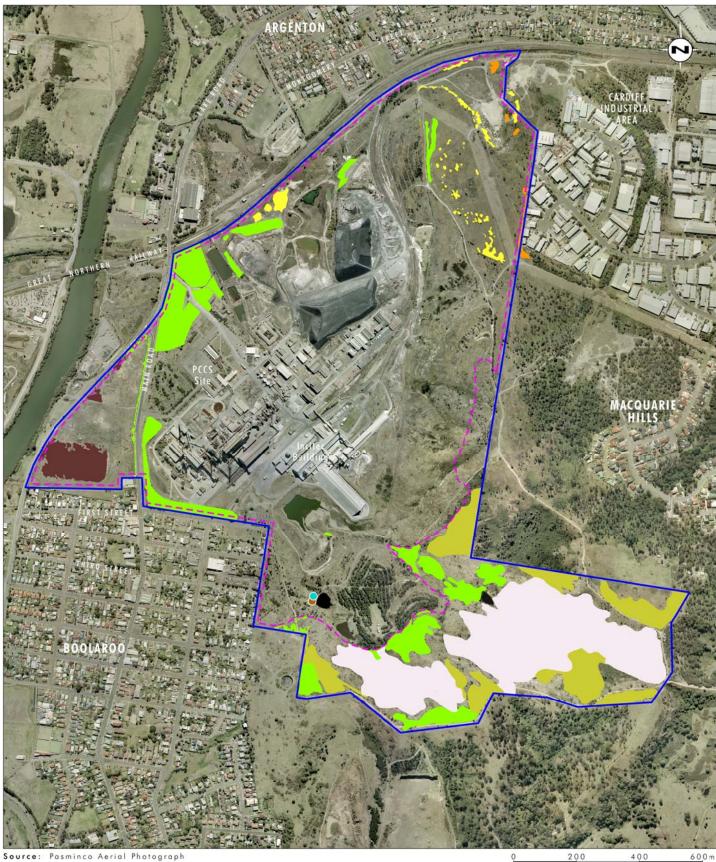
4.2 Vegetation Communities

Vegetation communities recorded in the study area are shown on **Figure 4.1**. All vegetation within the remediation boundary will be removed as part of the remediation of the site. Some of the vegetation shown on the aerial photo base of **Figure 4.1** has already been removed as part of this process.

4.2.1 Angophora inopina – Angophora floribunda Open Woodland

Within the remnants of *Angophora inopina* - *Angophora floribunda* Open Woodland there is an absence of a continuous canopy stratum, with only a scattered distribution of mostly young, regenerating canopy trees present. The dominant canopy species occurring are rough-barked apple (*Angophora floribunda*), the threatened Charmhaven apple (*Angophora inopina*) and intergrades between both of these species. Specimens sent to the





Source: Pasminco Aerial Photograph

Legend

Pasminco Cockle Creek Smelter Site t== Remediation Boundary Moist Shrubland Coastal Foothills Spotted Gum-Ironbark Forest Coast Narrabeen Moist Forest Regenerating and Planted Open Woodland Angophora inopina — Angophora floribunda Open Woodland Angophora floribunda and A costata Open Woodland

Eastern Bentwing-bat Grey-headed Flying Fox

FIGURE 4.1

Vegetation Communities and Threatened Species

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National Herbarium of NSW revealed that a complex pattern of hybridisation is present at the site, and no distinct pattern to the distribution of each *Angophora* species, or their intergrade, is evident. Within this community, black sheoak (*Allocasuarina littoralis*) and narrow-leaved bottlebrush (*Callistemon linearis*) occur in very isolated patches. Many of these are regenerating plants which have not reached maturity.

The understorey of this community consists primarily of native and introduced grasses, such as couch (Cynodon dactylon), kikuyu (Pennisetum clandestinum), kangaroo grass (Themeda australis), shorthair plumegrass (Dichelachne micrantha), slender pigeon grass (Setaria gracilis). perennial ryegrass (Lolium perenne) and whisky arass (Andropogon virginicus). Several small herbs are also present, including, blue flax lily (Dianella revoluta), slender rice flower (Pimelea linifolia subsp. linifolia), scarlet pimpernel (Anagalis arvensis), common centaury (Centaurium tenuiflorum) and dandelion (Taraxacum officinale).

In general, this vegetation community is highly modified at this site, and is dominated by very sparsely occurring *Angophora* trees, which have regenerated on the site over the past 5 to 30 years.

4.2.2 Angophora floribunda – Angophora costata Open Woodland

This vegetation community, which occurs on disturbed sites adjacent to the existing Cardiff Industrial Estate, is very similar to the *Angophora inopina* - *Angophora floribunda* Open Woodland in that its groundcover is dominated by similar species, with an abundance of weeds. However, the very sparse tree canopy supports both rough-barked apple (*Angophora floribunda*) and smooth-barked apple (*Angophora costata*). No specimens of the Charmhaven apple (*Angophora inopina*) were located in this community.

4.2.3 Derived Grassland

Derived grassland occurs across the study area in areas that have not been mapped on **Figure 4.1** as one of the woodland, forest or shrubland communities. This community consists of a sparse to dense groundcover, with both shrub and canopy strata being absent. Common native flora species recorded include shorthair plumegrass (*Dichelachne micrantha*), wiry panic (*Entolasia stricta*) and blady grass (*Imperata cylindrica var. major*), couch (*Cynodon dactylon*), kangaroo grass (*Themeda australis*), barbed wire grass (*Cymbopogon refractus*) and love creeper (*Glycine stenophita*).

Commonly recorded introduced plants include kikuyu (*Pennisetum clandestinum*), red natal grass (*Melinus repens*), Patersons curse (*Sida rhombifolia*), plantain (*Plantago lanceolata*), *Briza subaristata*, flaxleaf fleabane (*Conyza sumatrensis*), dandelion (*Hypochaeris radicata*), paspalum (*Paspalum dilatatum*), white clover (*Trifolium repens*), mugwort (*Artemisia verlotorum*), twiggy mullein (*Verbascum virgatum*) and proliferous pink (*Petrorhagia velutina*).

Scattered trees occur throughout this community and include spotted gum (*Corymbia maculata*) and the threatened tree Charmhaven apple (*Angophora inopina*). Three dams occur within this vegetation community and support fringing vegetation comprising common reed (*Phragmites australis*) and broad-leaved cumbungi (*Typha orientalis*).

Areas within the remediation boundary have been cleared of all vegetation and topsoil in accordance with the Remediation Environmental Management Plan (Fitzwalter 2007). These areas have been seeded with sterile cover crops for stabilisation purposes. For the purposes

of vegetation community mapping these areas have been included as part of the derived grassland community.

4.2.4 Moist Shrubland

A small moist soak area was identified in the study area. This area is characterised by species such as broad-leaved paperbark (*Melaleuca quinquinervia*), *Melaleuca linearifolia*, common reed (*Typha orientalis*), common rush (*Juncus ?usitatus*), and couch (*Cynodon dactylon*). A large number of introduced species also occur in this community, including crofton weed (*Ageratina adenophora*), purple top (*Verbena bonariensis*), curled dock (*Rumex crispus*), flaxleaf fleabane (*Conyza sumatrensis*), paspalum (*Paspalum quadrifarium*) and *Briza subaristata*.

4.2.5 Coastal Foothills Spotted Ironbark Forest

This community is a moderately tall open forest dominated by spotted gum (*Corymbia maculate*) and one or a number of ironbark species, particularly *E. siderophloia*, grey ironbark (*E. paniculata*) or broad-leaved ironbark (*E. fibrosa*). Common associate trees include white mahogany (*E. acmenoides*), bastard white mahogany (*E. umbra*) and turpentine (*Syncarpia glomulifera*). Forest oak (*Allocasuarina torulosa*) often dominates the upper mid-storey. Shrub layers are generally open, with species such as narrow-leaved geebung (*Persoonia linearis*), *Polysicas sambucifolius*, coffee bush (*Breynia oblongifolia*) and gorse bitter pea (*Daviesia ulicifolia*). The groundcover is usually dominated by common grasses such as blady grass (*Imperata cylindrica* var. *major*), *Entolasia stricta*, kangaroo grass (*Themeda australis*) and weeping grass (*Microlaena stipoides* var. *stipoides*).

4.2.6 Coast Narrabeen Moist Forest

This vegetation community is a tall moist open forest structure identified by the presence of turpentine (*Syncarpia glomulifera*) in association with Dean's blue gum (*E. deanii*), Sydney blue gum (*E. saligna*), white mahogany (*E. acmenoides*) and blackbutt (*E. pilularis*). A characteristic feature of this community is the presence of a mesic understorey dominated by warm temperate rainforest species such as *Cryptocarya microneura*, *Rhodamnia rubescens* and *Synoum glandulosum*. Doodia aspera, giant maidenhair (*Adiantum formosum*) and *Blechnum cartilegineum* are common ferns of the groundcover. Other lower stratum species include herbs such as *Pseuderanthemum variabile* and basket grass (*Oplismenus imbecillis*), as well as climbers such as sarsaparilla (*Smilax australis*) and *Dioscorea transversa*.

4.2.7 Regenerating and Planted Open Woodland

The study area contains significant areas dominated by planted and regenerating tree and shrub species which make up an open woodland community (**Figure 4.1**).

This community consists of mostly native trees and shrubs that were planted within the last 12 years. The understorey of this community consists of native and introduced grasses and herbs which are mown on a regular basis. A variety of species are present and some of the more common species include spotted gum (*Corymbia maculata*), broad-leaved paperbark (*Melaleuca quinquenervia*), swamp oak (*Casuarina glauca*), Sydney golden wattle (*Acacia longifolia*), sweet pittosporum (*Pittosporum undulatum*) and the introduced species oleander (*Nerium oleander*). Due to the immaturity of some of the eucalypt species present and the absence of fruits due to the regular mowing regime of the understorey, many could not be accurately identified. The eucalypt species that may be present on the site, based on planting records, include broad-leaved white mahogany (*E. robusta*), forest red gum (*E. tereticornis*), grey gum (*E. punctata*), grey ironbark (*E. paniculata*), Syndey blue gum (*E. saligna*), red ironbark (*E. fibrosa*), blue-leaved

stringybark (*E. agglomerata*), white stringybark (*E. globoidea*), scribbly gum (*E. haemastoma*), silvertop ash (*E. sieberi*), blackbutt (*E. pilularis*) and grey box (*E. moluccana*).

4.3 Threatened Flora Species, Populations and EECs

Threatened flora species known to, or considered likely to occur within 10 kilometres of the study area are listed in Table 1 of **Appendix 2**. No potential habitat for these or any other threatened flora species, excepting *Angophora inopina*, is considered to occur within the study area.

The study area does not provide habitat for any endangered populations or EECs.

Charmhaven apple (*Angophora inopina*), listed as vulnerable under both the TSC Act and the EPBC Act, was recorded within the study area, as identified on **Figure 4.1**.

5.0 Fauna Survey Results

5.1 Habitat Assessment

The assessment of terrestrial fauna habitat identified a range of habitat characteristics which contribute to the distribution, abundance and diversity of terrestrial fauna within the study area. Several general fauna habitat types are located within the study area. The broad habitat types recorded within the study area consisted of woodland, grassland and aquatic habitats.

5.1.1 Woodland Habitat

Woodland is scattered across the study area with mature, middle-aged and regenerating trees occurring at different densities. The eucalypt species present within this habitat type provide seasonal foraging resources for a number of nectarivorous bird species and mammals, as well as insectivorous birds. The eucalypt species present within this habitat also provide a nesting resource for small birds (such as the grey fantail, *Rhipidura fuliginosa*) and larger birds of prey (such as the black-shouldered kite *Elanus notatus*). No hollow bearing trees were recorded in the study area which limits the potential for a range of arboreal fauna to occur. The shrub layer within this habitat type ranges from scarce to medium density, providing shelter for a number of small woodland birds. Scattered logs and rocks within the woodland habitat type provide refuge and foraging habitat for reptiles and amphibians. The grassy understorey provides foraging habitat for macropods and for omnivorous birds such as the Australian magpie (*Gymnorhina tibicen*).

5.1.2 Grassland Habitat

The grassland habitat type occurs widely across the study area, providing habitat for a variety of native fauna species. This habitat type is the most extensive in the study area, comprising approximately 76 per cent of the study area. The large areas of open grassland provide a foraging resource for macropods and a hunting resource for micro-bats. Small mammals, such as antechinus (*Antechinus* spp.), have foraging habitat as well as refuge habitat within the dense grass layers. This habitat type also provides foraging and refuge habitat for a number of reptile species and amphibians.

5.1.3 Aquatic Habitat

The aquatic habitat type is provided in the form of dams. There are a number of dams located within the study area, and these provide a water source for native fauna. The dams also provide a foraging and refuge resource for a number of amphibian species, particularly in those dams where fringing vegetation is present.

A list of all fauna species recorded in the study area is provided in **Appendix 3**.

5.2 Fauna Survey Results

5.2.1 Birds

Thirty-four bird species were identified in the study area. Some of the species identified included the Australian grebe (*Tachybaptus novaehollandiae*), brown goshawk (*Accipiter fasciatus*), black-faced cuckoo shrike (*Coracina novaehollandiae*) and mistletoebird (*Dicaeum hirundinaceum*). No threatened avifauna species were identified in the study area.

5.2.2 Reptiles

The eastern bearded dragon (*Pogona barbata*), eastern blue-tongued lizard (*Tiliqua scincoides*) and grass skink (*Lampropholis delicata*) were identified during herpetological searches along with a number of individual skinks between 100 and 150 millimetres snout-vent length that were sighted but not captured or identified. No threatened reptile species were identified.

5.2.3 Amphibians

A total of six frog species have been recorded in the study area. Three amphibian species, the brown froglet (*Crinia signifera*), spotted marsh frog (*Limnodynates tasmaniensis*) and smooth toadlet (*Uperoliea leavigata*) were identified in the wet reedy areas in the north of the study area. Five amphibian species, the brown froglet (*Crinia signifera*), stripped marsh frog (*Limnodynates peronii*), smooth toadlet (*Uperoliea leavigata*), green reed frog (*Litoria fallax*) and broad-palmed frog (*L. latopalmata*) were identified at dams in the southern portion of the study area. No threatened amphibian species were identified in the study area.

5.2.4 Mammals

Six native and four introduced mammal species have been identified in the study area. The long-nosed bandicoot (*Perameles nasuta*) was identified from hair funnel analysis and the white-striped mastiff bat (*Nyctinomus australis*) was heard flying over head during nocturnal surveys. The introduced house mouse (*Mus musculus*) and black rat (*Rattus rattus*) were trapped in terrestrial Elliot traps. The introduced fox (*Vulpes vulpes*) was identified during spotlighting and the introduced rabbit (*Oryctolagus cuniculus*) was identified from skeletal analysis.

A single threatened grey-headed flying-fox (*Pteropus poliocephalus*) landed briefly in an acacia tree before leaving the site. Three micro-bat species were identified using an anabat echolocation detector: the threatened eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), Goulds wattled bat (*Chalinolobus gouldii*) and large forest bat (*Vespadelus darlingtoni*).

5.3 Threatened Fauna Species and Endangered Populations

The threatened grey-headed flying-fox and eastern bent-wing bat were recorded in the study area. Additional threatened fauna species have been recorded in habitats within a 10 kilometre radius of the study area (DECC Atlas of NSW Wildlife Database and DEWHA Protected Matters Database). The threatened species recorded on these two databases are listed in Table 2, **Appendix 2**, which also includes an assessment of the potential for each of these species to occur in the study area.

6.0 Impact Assessment

The proposed redevelopment of the Pasminco site will include the development of residential, industrial and commercial precincts as shown on **Figure 1.2**. The ecological impacts associated with the redevelopment of the site have been assessed previously as part of the approved rezoning and subdivision applications detailed in **Section 2.2**. There are no additional impacts associated with the redevelopment proposed in the Masterplan. This section compiles and summarises the impacts associated with the development.

6.1 Impact on Flora Species and Vegetation Communities

All vegetation communities occurring within the remediation boundary shown on **Figure 1.1** are approved for removal as part of the remediation of the site. There will be no additional clearing as part of the redevelopment of the site. One threatened or significant flora species was recorded – *Angophora inopina*.

The proposed development will not result in a significant loss of floristic diversity as the species recorded in the study area are known to occur widely across the Lake Macquarie and lower Hunter area.

6.2 Impact on Fauna Species and Habitats

The proposed development will not result in the loss additional areas of fauna habitat above that already approved as part of the remediation process.

The study area is located in a region that has been subject to a long history of industrial processing. This has led to the current condition where the vegetation of the region is highly fragmented and disturbed. Furthermore, many such fragments consist mainly of regenerating canopy species with little diversity in the understorey.

The fauna habitats of the study area are consistent with the regional trends of highly modified urban and industrial environments which generally lack significant fauna habitat values. The loss of fauna habitat is not considered significant in a local or regional context.

The proposed development will not result in an adverse impact on the fauna habitats or species which occur in the vegetated areas of the study area proposed for open space and environment protection.

6.3 Threatened Species, Populations and EECs

One threatened flora species, *Angophora inopina*, was recorded on the site. Other threatened flora species that are known to occur in the local area (listed in Table 1 of **Appendix 2**), were not recorded on the site, and based on the habitat present, are not considered likely to occur. **Figure 4.1** shows the location of confirmed records of *Angophora inopina*, *Angophora floribunda* and their intergrade.

Angophora inopina is listed as a vulnerable species under both the TSC Act and the EPBC Act. It was discovered at Charmhaven in the mid 1990s, and was only formally described in 1997 (Hill 1997). It is a small to large tree (to 8 metres), often multi-stemmed and with persistent shortly fibrous bark (Hill 1997).

Although it was originally thought to have a very restricted distribution between Charmhaven and Wyee on the Central Coast (Hill 1997), recent studies, in particular Bell (2001) indicated that it occurs over a wider area between Charmhaven and Toronto, with a disjunct population near Karuah. It is also known to occur between Argenton and Barnsley (S Bell pers. comm. 2004). Pure forms of this species have been recorded from the Wallarah catchment in the south and north to the Toronto area.

Habitat for this species typically occurs on the shallow sandy soils of the Narrabeen Group, on exposed ridges and slopes with westerly or northerly aspect. It has also been recorded on shallow alluvial soils of this geological type, in upper catchments and in embedded clay soil lenses with sandstone (Bell 2001). This species is known to naturally hybridise with *A. floribunda*, particularly around major drainage lines (Bell 2001). Field observations suggest flowering periods mainly between mid-December and mid-January, with sporadic flowering during other times (Bell 2001).

Samples identified by the National Herbarium of NSW show that at least three specimens recorded from the site are pure *Angophora inopina*, while a further nine specimens are an intergrade between this species and the more common *Angophora floribunda*. Observations indicate that the majority of the vegetation community present on the site consists of the intergrade.

There is no available guideline indicating how hybrid or intergrade specimens are treated under the TSC Act, nor the EPBC Act. As a precautionary approach, intergrades recorded on the site are regarded as significant specimens, and are considered in the same manner as a threatened species.

It is estimated that about 350 to 400 trees are present in the study area. Several other subpopulations of unknown size are known from outside of the PCCS site in the local area (S Bell pers. comm. 2004), which are likely to include several hundred more individuals.

The Masterplan includes an area of environmental protection zoning located to protect the vast proportion of the *Angophora inopina/Intergrade* population in the study area. The designation of the Angophora Reserve in accordance with the Management Plan for *Angophora inopina* (Umwelt 2007) will ensure that the species is not significantly impacted as a result of the proposed redevelopment of the site. Further detail regarding the *Angophora* Reserve is provided in **Section 7.0** and **Figure 7.1**.

The proposed development will not significantly impact on the grey-headed flying-fox and eastern bentwing-bat identified in the study area due to the relatively small area to be impacted, marginal condition of the study area as foraging habitat and the highly mobile nature of both species. It is not expected that any other threatened fauna species would use

the habitats of the study area beyond marginal foraging habitat or as a resting point during rare dispersal or movement patterns.

6.3.1.1 SEPP 44 Assessment

The Masterplan for the Pasminco site is subject to assessment under State Environmental Planning Policy (SEPP) No. 44 (Koala Habitat Protection) as it lies in a local government area (LGA) listed in Schedule 1 of the policy. SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas (*Phascolarctos cinereus*), to ensure permanent free-living populations over their present range and to reverse the current trend of population decline. Any development application in an identified LGA, affecting land one hectare or greater, including adjoining lands on the same holding, must be assessed under the policy.

Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential koala habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 constitutes 15 per cent or more of the total number of trees in the upper or lower strata of the tree component. If potential koala habitat is present, the area must be further assessed to determine if the land is core koala habitat.

The species listed in Schedule 2 of the policy are identified in **Table 6.1**.

Scientific Name	Common Name
Eucalyptus tereticornis	forest red gum
Eucalyptus microcorys	tallowwood
Eucalyptus punctata	grey gum
Eucalyptus viminalis	ribbon or manna gum
Eucalyptus camaldulensis	river red gum
Eucalyptus haemastoma	broad-leaved scribbly gum
Eucalyptus signata	scribbly gum
Eucalyptus albens	white box
Eucalyptus populnea	bimble box or poplar box
Eucalyptus robusta	swamp mahogany

Table 6.1 - Species of Eucalypt Listed in Schedule 2 of SEPP 44

The vegetation communities of the study area were assessed according to this Schedule, and it was found that *Eucalyptus tereticornis* was recorded within the study area. This species is not likely to comprise 15 per cent of overstorey species within the survey area, which indicates that the study area does not contain potential koala habitat.

The study area is not considered to provide potential koala habitat and therefore further assessment under SEPP 44 is not required.

6.4 LMCC Native Vegetation and Corridors Study

The Lake Macquarie Native Vegetation and Corridors Map (LMCC 2003) was examined to determine whether the proposed development area was contained within an identified ecological corridor. The proposed development area does not lie within an identified ecological corridor, and vegetation within the study area is not mapped as native vegetation.

7.0 Impact Mitigation and Monitoring

Specific impact mitigation measures for the ongoing protection and management of *Angophora inopina* have been documented in previously prepared rezoning and subdivision applications (Umwelt 2005a, b, c and d, 2006, 2007) and in the Management Plan for *Angophora inopina* (Umwelt 2008). A wide range of impact mitigation measures are not considered necessary for the protection and management of the ecological values of the study area as there will be no vegetation removed in addition to that approved under the Remediation Management Plan.

7.1 Angophora inopina

An Angophora inopina reserve has been dedicated as part of the rezoning of part of the Pasminco site. The Reserve is approximately 2.8 hectares and contains approximately 235 *Angophora inopina* individuals which represents 57 per cent of the species known to occur in the study area. The location of the Angophora Reserve is shown on **Figure 7.1**.

7.2 Management Plan for *Angophora inopina*

A Management Plan for *Angophora inopina* (Umwelt 2007) has been prepared to guide the ongoing management of *Angophora inopina* within the Angophora Reserve outlined in **Section 7.1**. The management plan covers a range of management strategies and details the monitoring requirements for the species and the Angophora Reserve.

The overall aim of the management plan is to ensure that the Angophora Reserve returns to an open woodland structure dominated by native trees, shrubs and groundcovers that is viable in the long term.

The objectives of this *Angophora inopina* Management Plan are to identify and address management issues to:

- ensure the long term security and viability of Angophora inopina within the Angophora Reserve;
- ensure appropriate and effective management of Angophora inopina within the Angophora Reserve; and
- devise management strategies to minimise the current and likely future threats to Angophora inopina within the Angophora Reserve.

The Management Plan for Angophora inopina (Umwelt 2008) is included as Appendix 5.

7.3 Riparian Buffer Zones

During environmental engineering works undertaken for the proposed rezoning of Lot 1 DP 523781, consultation was undertaken with the then Department of Infrastructure, Planning and Natural Resources (DIPNR) (now the Department of Planning) in relation to the required offset of residential development from watercourses on the site. DIPNR stated that a 10 metre riparian buffer was required from the top of bank for all upstream tributaries and that this riparian buffer was to be vegetated with native species (refer to Umwelt 2005d).





internet internet interograph

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Legend Pasminco Cockle Creek Smelter Site (Study Area) ZZZZ Angophora inopina Reserve

FIGURE 7.1 Location of *Angophora inopina* Reserve Riparian areas are identified on **Figure 1.2**. Revegetation works are required in areas which are not currently vegetated and should consist of the species listed in **Appendix 6**. The species have been selected based on the riparian associations known to occur in the local area and should include species from all strata to provide ecological complexity in the riparian zone. As the drainage lines are high order streams and are not expected to retain water for long periods of time, it is considered most appropriate to make the riparian zone vegetation consistent with surrounding vegetation communities, in particular Coastal Narabeen Moist Forest.

7.4 Other Strategies to Enhance the Ecological Values of the Study Area

The following strategies should be incorporated into the masterplan to aid in the enhancement of ecological values in the study area:

- locally occurring native species should be used in all landscape planting and open space areas;
- stormwater treatment ponds should be planted with locally occurring native aquatic and fringing vegetation to provide amphibian habitat;
- stormwater treatment ponds should be designed to provide amphibian, reptile and bird habitat including areas of deep water, shallow verges and rocky outcrops; and
- interpretive signage adjacent to stormwater treatment ponds and landscaping areas should be constructed to provide information relating to the ecological values of the Pasminco site and local area.

8.0 Conclusion

The redevelopment of the former Pasminco site to include residential, commercial, industrial and environmental protection precincts is not expected to result in a significant loss of ecological value form the Boolaroo local area and the redevelopment of the site will not significantly impact threatened species recorded or considered likely to occur within the study area. A species impact statement is not required for the proposed development.

The proposed redevelopment will not significantly impact any threatened or migratory species listed under the EPBC Act and referral to the Commonwealth Minister for the Environment is not required.

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APPENDIX 1

Flora Species List

Appendix 1 – Flora Species List

The following list was developed from surveys of the Study Area described in **Section 3.0** of the main report. It includes all species of vascular plants observed on the Study Area during fieldwork. Not all species are readily detected at any one time of the year, therefore the list will not necessarily include all plant species likely to occur in the Study Area. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

- sp. specimens that are identified to genus level only;
- ? specimens for which identification was uncertain;
- prob. specimens for which identification was considered highly likely but not definite;
- poss. specimens for which identification was considered likely but not definite;

The following abbreviations or symbols are used in the list:

- asterisk (*) denotes species not indigenous to the Study Area;
- subsp. subspecies;
- var. variety;
- f. forma; and
- X hybrid.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Wheeler et al. (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2007), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Family (Sub-family)	Scientific Name	Common Name	
Filicopsida (Ferns)			
Adiantaceae	Cheilanthes distans	bristly cloak fern	
Dennstaedtiaceae	Pteridium esculentum	common bracken	
Dicksoniaceae	Calochlaena dubia	soft bracken fern	
Adiantaceae	Cheilanthes distans	bristly cloak fern	
Magnoliopsida (flowering pla	nts) – Liliidae (Monocots)		
Commelinaceae	*Tradescantia fluminensis	wandering Jew	
Cyperaceae	Gahnia ?clarkei	a saw-sedge	
Cyperaceae	Gahnia sieberi		
Juncaceae	Juncus sp.		
Juncaceae	*Juncus acutus subsp. acutus	sharp rush	
Juncaceae	Juncus usitatus	common rush	
Liliaceae	*Lilium formosanum	tiger lily, Formosan lily	
Lomandraceae	Lomandra longifolia	spiny-headed mat-rush	
Lomandraceae	Lomandra ?multiflora	many-flowered mat-rush	
Phormiaceae	Dianella revoluta	blue flax lily	
Phormiaceae	Dianella caerulea	blue flax-lily	
Poaceae	*Andropogon virginicus	whisky grass	
Poaceae	*Briza subaristata		
Poaceae	Imperata cylindrica var. major	blady grass	
Poaceae	Capillipedium spicigerum	scented-top grass	
Poaceae	* Chloris gayana	Rhodes grass	
Poaceae	Chloris ventricosa	tall chloris	
Poaceae	*Cortaderia sp.	pampas grass	
Poaceae	*Hyparrhenia hirta	Coolatai grass	
Poaceae	*Lolium perenne	perennial ryegrass	
Poaceae	*Melinus repens	red Natal grass	
Poaceae	*Setaria gracilis	slender pigeon grass	
Poaceae	*Stenotaphrum secundatum	buffalo grass	
Poaceae	*Paspalum quadrifarium	paspalum	
Poaceae	*Paspalum dilatatum	paspalum	
Poaceae	*Pennisetum clandestinum	kikuyu	
Poaceae	*Rhynchelytrum repens		
Poaceae	Aristida ramosa	three-awn wiregrass	
Poaceae	Cynodon dactylon	common couch	
Poaceae	Cymbopogon refractus	barbed-wire grass	
Poaceae	Phragmites australis	common reed	
Poaceae	Dichelachne micrantha	shorthair plumegrass	
Poaceae	Entolasia stricta	wiry panic	
Poaceae	Imperata cylindrica var. major	blady grass	
Poaceae	Lachnagrostis aemula	blowngrass	
Poaceae	Themeda australis	kangaroo grass	
Xanthorrhoeaceae	Xanthorrhoea sp.		
Magnoliopsida (flowering plants) – Magnoliidae (Dicots)			
Apiaceae	*Foeniculum vulgare	fennel	

Family (Sub-family)	Scientific Name	Common Name
Apiaceae	*Hydrocotle bonariensis	pennywort
Apocynaceae	*Nerium oleander	oleander
Asteraceae	*Artemisia verlotorum	mugwort
Asteraceae	*Conyza sumatrensis	tall fleabane
Asteraceae	*Ageratina adenophora	crofton weed
Asteraceae	*Bidens pilosa	cobbler's pegs
Asteraceae	*Sida rhombifolia	Paterson's curse
Asteraceae	*Conyza bonariensis	flaxleaf fleabane
Asteraceae	*Correopsis lanceolata	coreopsis
Asteraceae	Taraxacum officinale	dandelion
Asteraceae	*Onopordum acanthium	Scotch thistle
Asteraceae	*Senecio madagascariensis	fireweed
Caryophyllaceae	*Petrorhagia velutina	proliferous pink
Caryophyllaceae	*Silene gallica var. gallica	French catchfly
Casuarinaceae	Allocasuarina littoralis	black she-oak
Casuarinaceae	Allocasuarina torulosa	forest oak
Casuarinaceae	Casuarina glauca	swamp oak
Convolvulaceae	Polymeria calycina	
Convolvulaceae	*Impomoea indica	blue morning glory
Euphorbiaceae	*Ricinus communis	castor oil plant
Fabaceae	Kennedia rubicunda	dusky coral pea
Fabaceae	*Trifolium arvense	haresfoot clover
Fabaceae	*Trifolium campestre	hop clover
Fabaceae	Acacia ulicifolia	prickly Moses wattle
Fabaceae	Bossiaea stephensonii	-
Fabaceae	Dillwynia retorta subsp. peduncularis	-
Fabaceae	Glycine stenophita	a love creeper
Fabaceae	Glycine tabacina	a love creeper
Fabaceae	Hardenbergia violacea	false sarsaparilla
Fabaceae	Pultenaea retusa	-
Fabaceae	*Vicia sativa subsp. sativa	common vetch
Fabaceae	Acacia myrtifolia	myrtle wattle
Fabaceae	*Acacia saligna	golden wreath wattle
Fabaceae (Faboideae)	*Trifolium hirtum	rose clover
Fabaceae (Faboideae)	*Trifolium repens	white clover
Fabaceae (Mimiosoideae)	Acacia binervia	coast myall
Fabaceae (Mimosoideae)	Acacia decurrens	black wattle
Fabaceae (Mimosoideae)	Acacia falcata	sickle wattle
Fabaceae (Mimosoideae)	Acacia floribunda	white sally
Fabaceae (Mimosoideae)	Acacia deanei	green wattle
Fabaceae (Mimosoideae)	Acacia decora	western golden wattle
Fabaceae (Mimosoideae)	Acacia myrtifolia	red-stemmed wattle
Fabaceae (Mimosoideae)	Acacia parramattensis	Sydney green wattle
Fabaceae (Mimosoideae)	Acacia irrorata subsp. irrorata	green wattle
Fabaceae (Mimosoideae)	Acacia longifolia var. longifolia	Sydney golden wattle

Family (Sub-family)	Scientific Name	Common Name
Fabaceae (Mimosoideae)	*Acacia sophorae	coastal wattle
Gentianaceae	Centaurium spicatum	spike centaury
Gentianaceae	*Centaurium tenuiflorum	common centaury
Haloragaceae	Gonocarpus tetragynus	
Lamiaceae	Westringia sp.	
Lauraceae	Cassytha pubescens	devil's twine
Lauraceae	*Cinnamomum camphora	camphor laurel
Malvaceae	Hibiscus sp.	a hibiscus
Malvaceae	*Modiola caroliniana	redflower mallow
Malvaceae	*Sida rhombifolia	Paddy's lucerne
Myrtaceae	Acmena smithii	lilly pilly
Myrtaceae	Angophora floribunda	rough-barked apple
Myrtaceae	Angophora costata	smooth-barked apple
Myrtaceae	Angophora inopina	Charmhaven apple
Myrtaceae	Angophora inopina—floribunda	
Myrtaceae	Callistemon citrinus	crimson bottlebrush
Myrtaceae	Callistemon linearis	narrow-leaved bottlebrush
Myrtaceae	Eucalyptus sp.	
Myrtaceae	Corymbia gummifera	red bloodwood
Myrtaceae	Corymbia maculata	spotted gum
Myrtaceae	*Eucalyptus elata	river peppermint
Myrtaceae	Leptospermum trinervium	flaky-barked tea tree
Myrtaceae	*Melaleuca armillaris	bracelet honey-myrtle
Myrtaceae	Melaleuca nodosa	ball honeymyrtle
Myrtaceae	Melaleuca linearifolia	-
Myrtaceae	*Lophostemon confertus	brush box
Myrtaceae	Leptospermum polygalifolium	
Myrtaceae	Kunzea ambigua	tick bush
Myrtaceae	Corymbia maculata	spotted gum
Myrtaceae	Eucalyptus tereticornis	forest red gum
Myrtaceae	Melaleuca armillaris subsp. armillaris	
Myrtaceae	Melaleuca ericifolia	swamp paperbark
Myrtaceae	Melaleuca quinquenervia	broad-leaved paperbark
Myrtaceae	Melaleuca styphelioides	prickly-leaved paperbark
Oleaceae	Notelaea ovata	-
Oleaceae	Notelaea longifolia	large mock-olive
Oxalidaceae	Oxalis exilis	a wood sorrel
Phytolaccaceae	*Phytolacca octandra	inkweed
Pittosporaceae	Pittosporum sp.	
Plantaginaceae	*Plantago lanceolata	plantain, lamb's tongues
Polygonaceae	*Rumex ?pulcher	fiddle dock
Polygonaceae	*Rumex crispus	curled dock
Primulaceae	*Anagallis arvensis	scarlet pimpernel
Proteaceae	Banksia ericifolia	heath-leaved banksia
Rosaceae	Rubus discolor	blackberry

Family (Sub-family)	Scientific Name	Common Name
Rosaceae	*Rubus fruticosus sp. agg.	blackberry complex
Scrophulariaceae	*Verbascum virgatum	twiggy mullein
Solanaceae	*Solanum mauritianum	wild tobacco bush
Solanaceae	*Solanum nigrum	black-berry nightshade
Thymeliaceae	Pimelea linifolia subsp. linifolia	rice flower
Typhaceae	Phragmites australis	common reed
Typhaceae	Typha orientalis	broad-leaved cumbungi
Verbenaceae	*Verbena bonariensis	purpletop
Verbenaceae	*Lantana camara	lantana
Verbenaceae	*Verbena rigida	creeping verbena, veined verbena

APPENDIX 2

Assessment of Significance under the EP&A Act

Appendix 2 – Assessment of Significance under the EP&A Act for the Pasminco Cockle Creek Smelter Site

Threatened species, endangered populations, and endangered ecological communities (EECs) recorded during surveys of the Pasminco Cockle Creek Smelter Site are listed in **Tables 1** and **2**, which also include the results of the searches of the DECC Atlas of NSW Wildlife and DEWR Protected Matters Database for a 10 kilometre radius of the study area.

Tables 1 and **2** contain an assessment as to whether there may be an impact on any recorded or potentially occurring threatened species, populations or EECs as a result of the development proposed in the masterplan. The specific impacts of the proposed development are described in Section 6.1. A seven part test of significance was prepared in accordance with the requirements of the EP&A Act for each threatened species, population or EEC for which there is the potential for impact as a result of the proposed development.

An assessment of significance for species listed under the Commonwealth EPBC Act which have potential to be impacted by the proposed development is provided in Appendix 4.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact	7 Part Test Required?
black-eyed Susan <i>Tetratheca juncea</i>	V (TSC) V (EPBC)	Open forest, woodland, heathland and moist forest, with shrub understorey and grassy groundcover, on low nutrient soils. Generally prefers well drained slopes (often south-facing) and ridges, occasionally occurs in gullies.	This species was not recorded in the study area and there is no potential habitat for this species in the study area.	No
Newcastle doubletail <i>Diuris praecox</i>	V (EPBC) V (TSCA)	Small terrestrial orchid with yellow flowers found on hills and slopes of coastal and near-coastal dry sclerophyll forests. Flowers July to early September. Currently know distribution is from Ourimbah to Nelson Bay. Recorded in Glenrock State Recreation Area.	Due to the highly disturbed nature of the study area and the large number of introduced species present, it is not considered that the site provides suitable habitat for <i>Diuris praecox</i> .	No
magenta lillypilly Syzygium paniculatum	V (EPBC) V (TSCA)	A small to medium tree, mostly 3-8 metres high with dark dense foliage. The species grows in subtropical and littoral rainforests on sandy soils or stabilised dunes near the sea. Occurs in widely separated localities between Bulahdelah and Jervis Bay (Harden 2002).	The moist rainforest environments in which this species occur do not occur within the study area. As such, potential habitat for this species does not occur.	No
heart-leaved stringybark <i>Eucalyptus</i> <i>camfieldii</i>	V (EPBC) V (TSCA)	Tree or mallee to 10 metres high, but often less. Rare and localised, in coastal scrub heath on sandy soils on sandstone, often of restricted drainage, from Gosford to Royal National Park.	The study area lacks the sandstone derived soils in which this species typically occurs. This species was not recorded during surveys and it is not considered that this species is likely to occur in the study area.	No

Table 1 - Threatened Flora Assessment

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact	7 Part Test Required?
Bynoes wattle <i>Acacia bynoeana</i>	V (EPBC) E (TSC)	Occurs mainly in heath and dry sclerophyll forest on sandy soils (Kodela and Harden 2002), and appears to prefer open and sometimes slightly disturbed sites such as road edges and recently burnt areas (DECC 2007).	This species has not been recorded in the study area. No habitat is present in the study site due to a lack of preferred habitat attributes.	No
Parramatta red gum <i>Eucalyptus</i> <i>parramattensis</i> subsp. <i>deccadens</i>	V (EPBC) V (TSC)	Typically grows on deep, low-nutrient sands, often subject to periodic inundation (DECC 2007). Occurs in dry sclerophyll woodland with a dry heath understorey and also as an emergent in dry or wet heathland (DECC 2007).	The typical habitat for this species is not present within the study area. This species has not been recorded and is considered unlikely to occur.	No.
small-flower grevillea Grevillea parviflora subsp. parviflora	V (EPBC) V (TSC)	Occurs in heath and shrubby woodland to open forest (DECC 2007), on sandy or light clay soils, usually over thin shales (Makinson 2002). The species is found over a range of altitudes, and can occur in open and slightly disturbed areas (DECC 2007).	This species has not been recorded and is not considered likely to occur. There is no potential for impact on this species.	no
leafless tongue orchid <i>Cryptostylis</i> <i>hunteriana</i>	V (EPBC) V (TSC)	Favours moist soils on the flat coastal plains. Occupies swamp heath, but may occupy sclerophyll forest and woodland, often on sandy soils (Weston 1993a). Typically found in communities containing <i>Eucalyptus</i> <i>haemastoma, E. capitellata</i> and <i>Corymbia gummifera.</i>	This species has not been recorded and potential habitat has not been identified. There is no potential for impact on this species.	no.
Charmhaven apple <i>Angophora</i> <i>inopina</i>	V (EPBC) V (TSC)	Typically occurs on the shallow sandy soils of the Narrabeen Group, on exposed ridges and slopes with a westerly or northerly aspect. It has also been recorded on shallow alluvial soils of this geological type, in upper catchments and in embedded clay soil lenses with sandstone (Bell 2001).	This species has been recorded in the study area. Further assessment is provided below.	Yes
River Flat Eucalypt Forest	EEC (TSC)	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains (NSW Scientific Committee 2005a).	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No.
Lower Hunter Spotted Gum - Ironbark Forest	EEC (TSC)	The Lower Hunter Spotted gum – Ironbark Forest EEC occurs in the central to lower Hunter Valley, principally on Permian geology.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact	7 Part Test Required?
Swamp Oak Floodplain Forest	EEC (TSC)	This EEC is associated with grey- black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No.
Quorrobolong Scribbly Gum Woodland	EEC (TSC)	This EEC occurs on a residual sand deposit overlying the Permian clay sediments in the Hunter Valley.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No.
Swamp Sclerophyll Forest	EEC (TSC)	This EEC is associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No.
Freshwater Wetlands on Coastal Floodplains	EEC (TSC)	This EEC is associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No.
Hunter Lowland Red Gum Forest	EEC (TSC)	Occurs on gentle slopes arising from depressions and drainage flats on permian sediments of the Hunter Valley floor.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC (EPBC)	This ecological community occurs in areas where rainfall is between 400 and 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 metres to 1200 metres.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No
weeping myall (<i>Acacia pendula</i>) in the Hunter Catchment	EP (TSC)	Grows on major river floodplains on heavy clay soils, sometimes as the dominant species and forming low open woodlands. Within the Hunter catchment it typically occurs on heavy soils, sometimes at the margins of small floodplains, but also in more undulating locations remote from floodplains, such as at Jerrys Plains.	This EEC does not occur within the study area. There is no potential for an impact on this EEC.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact	7 Part Test Required?
tiger orchid (<i>Cymbidium</i> <i>canaliculatum</i>) in the Hunter Catchment	EP (TSC)	This species occurs within dry sclerophyll forests and woodlands of tablelands and western slopes, growing in hollows of trees. It is usually found occurring singly or as a single clump, typically between two and six metres above the ground.	This endangered population does not occur within the study area. There is no potential for an impact on this endangered population.	No.

Key:

TSC = Threatened Species Conservation Act 1995 EPBC Act = Environment Protection and Biodiversity Conservation Act 1999 E = EndangeredV = Vulnerable EP = endangered population EEC = Endangered Ecological Community CEEC = Critically Endangered Ecological Community

Table 2 - Threatened Fauna Assessment

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
giant burrowing frog Heleioporus australiacus	V (TSC) V (EPBC)	This species prefers woodland and heath in Hawkesbury sandstone ridge-top habitat and broader upland valleys. In particular, it is found in small headwater creek lines and slow flowing or intermittent creek lines (DECC 2007).	There is no potential for this species to occur due to the absence of suitable sandstone habitats. There is no potential for an impact on this species.	No.
stuttering frog <i>Mixophyes balbus</i> E (TSC)	V (EPBC)	This species is found near streams in rainforest and wet, tall open forest in the foothills and escarpments (DECC 2007). Occurs along the east coast from southern Queensland to north- east Victoria, on the eastern side of the Great Dividing Range (DECC 2007).	No habitat is present on site for this species due to the lack of preferred habitat attributes (i.e. sub- tropical rainforest). There is no potential for an impact on this species.	No.
wallum froglet <i>Crinia tinnula</i>	V (TSCA)	The wallum froglet is restricted to coastal areas of southern Queensland and Northern NSW (Cogger 2000). In this range, the species is thought to be confined to acid paperbark swamps in 'Wallum Country'. Wallum referring to heath, scrub and woodland on sand dunes and sand planes between Fraser Island and Sydney (Robinson 1993). The wallum froglet is a late winter breeder.	Suitable habitats have not been recorded in the study area and therefore there is no potential habitat for this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
giant barred frog <i>Mixophyes iteratus</i>	E (TSC) E (EPBC)	This species forages and lives amongst deep, damp leaf litter in rainforest, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 metres (DECC 2007). Breeds in shallow, flowing rocky streams (DECC 2007).	The rainforest or wet sclerophyll vegetation preferred by this species is not present within the study area. There is no potential for an impact on this species.	No.
green and golden bell frog <i>Litoria aurea</i>	E (TSC) V (EPBC)	Occurs among vegetation in permanent water bodies (Cogger 1994), particularly where bullrush (<i>Typha</i> spp.) and spikerush (<i>Eleocharis</i> spp.) occur (DECC 2007). Known to occur in degraded water bodies such as brick-pits and industrial sites (DECC 2007).	The dams within the study area are not expected to provide habitat for this species. There is no potential for an impact on this species.	No.
green-thighed frog <i>Litoria brevipalmata</i>	V (TSC) *	Occurs in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain (DECC 2007). Breeding occurs around grassy semi-permanent ponds and flood-prone grassy areas (DECC 2007).	There is no potential for this species to occur within the study area due to a lack of preferred habitat. There is no potential for an impact on this species.	No.
Littlejohn's tree frog Litoria littlejohni	V (TSC) V (EPBC)	Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops (DECC 2007). Prefers wet forest margins for breeding.	There is no potential for this species to occur within the study area due to the absence of permanent rocky streams. There is no potential for an impact on this species.	No.
broad-headed snake Hoplocephalus bungaroides	E (TSC) V (EPBC)	This species appears to prefer sites where exposed sandstone outcrops and benches occur, particularly in woodland and heath vegetation. It is often found sheltering under rock crevices (winter) and tree hollows (summer) (DECC 2007).	The study area does not contain typical sandstone outcrop habitat preferred by this species, nor does it contain typical vegetation preferred by this snake. There is no potential for an impact on this species.	No.
painted snipe Rostratula benghalensis australis	E (TSC) V (EPBC)	Occurs in ephemeral and permanent wetlands where there is a cover of vegetation. Such areas may include shallows and margins of wetlands, dams, sewage ponds, wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub and open timber (Pizzey & Knight 1997).	The study area does not contain suitable aquatic habitats required by this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
freckled duck Stictonetta naevosa	V (TSC)	The freckled duck is endemic to southeastern and southwestern Australia, however may occur as vagrants elsewhere (NPWS 1999f). Inhabits large well-vegetated swamps, moving to lakes in dry periods (Pizzey and Knight 1997). Prefers plankton rich wetland types, large open lakes and their shores, creeks, farm dams, sewage ponds and floodwaters (Marchant & Higgins 1990). Breeds Sep- Dec, mostly in irregularly flooded lignum swamps in western NSW (Pizzey & Knight 1997). Filters sediments of wetland fringes for algae, seeds, small invertebrates, crustaceans, zooplankton, worms, insects, small fish etc. (NPWS 1999f).	The study area does not contain suitable aquatic habitats required by this species. There is no potential for an impact on this species.	No.
black-breasted buzzard Hamirostra melanosternon	V (TSC)	Habitat varies, however often includes wooded and open habitats, especially riverine woodlands (Debus 2001). Often recorded in dry open country, arid areas and savannah woodlands (Hollands 2003). This species is recorded from the majority of the mainland, except	The study area does not provide potential habitat for this species. There is no potential for an impact on this species.	No.
		for high rainfall areas of the south and south east (Debus 2001).		
black bittern <i>Ixobrychus flavicollis</i>	V (TSCA)	This species has a wide range extending from southern NSW, to Cape York and along the north cost to the Kimberley (NPWS 1999c). Habitat includes terrestrial and ephemeral wetland, with dense vegetation and permanent water (NPWS 1999c). Nests in trees nearby (Garnett & Crowley 2000). Feeds at dusk, roosting by day in dense vegetation or reeds (NPWS 1999c). Generally solitary, breeding from Dec to March (NPWS 1999c).	The study area does not contain vegetated aquatic habitats required by this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
Australasian bittern <i>Botaurus poiciloptilus</i>	V (TSCA)	This bittern has a recorded distribution from southern QLD to TAS and across NSW and VIC to eastern SA (NPWS 1999d). There is an isolated population in WA (Garnett & Crowley 2000). In NSW, this species is recorded along the coast, as well as wetlands of the Murrumbidgee and Lachlan Rivers. It is frequently recorded in the Murray- Darling Basin (NPWS 1999d). This species prefers shallow, brackish or freshwater swamps with dense vegetation (Garnett & Crowley 2000). Will also use dense saltmarsh vegetation in estuaries and flooded grasslands (NPWS 1999d). Roosts by day, in dense reeds on the ground. Pairs occupy territories (Garnett & Crowley 2000).	The study area does not contain vegetated aquatic habitats required by this species. There is no potential for an impact on this species.	No.
magpie goose Anseranas semipalmata	V (TSCA)	The magpie goose is widespread throughout coastal northern and eastern Australia (Pringle 1985). Favoured habitat includes large seasonal wetlands, well vegetated dams with sedges/rushes, wet grasslands and floodplains (Pizzey & Knight 1997). Thousands of magpie geese congregate in these habitats to feed on aquatic vegetation. A cup-shaped nest is built in a secluded place on a mound of floating/trampled down vegetation. Breeding occurs February to June (Pringle 1985).	The study area does not contain vegetated aquatic habitats required by this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
blue-billed duck <i>Oxyura australis</i>	V (TSCA)	Endemic to Australia, the blue- billed duck occurs in the south- west and south-east of the continent (NPWS 1999e). Large flocks of this species are seen on large, open freshwater dams and lakes in the colder months (Autumn/Winter). Prefers well- vegetated freshwater swamps, large dams and lakes at other times (NPWS 1999e). Breeding occurs in Sep-Mar (Pizzey & Knight 1997) with nests built in dense vegetation, supported by Cumbungi or other plant species. Primarily feeds on aquatic insects, however seeds, buds, stems, leaves and fruit of emergent vegetation may also form part of their diet (NPWS 1999e).	The study area does not contain vegetated aquatic habitats required by this species. There is no potential for an impact on this species.	No.
sooty tern <i>Sterna fuscata</i>	V (TSCA)	In Australia, occurs widely across tropics with occasional sightings on the west and east coasts from Perth in WA to Bermagui in southern NSW. Breeding colonies have been recorded on Lord Howe Island and Norfolk Island. Pelagic species, breeding on coral cays, atolls, sandbanks, cliffs and other rocky areas. Nests in large colonies, often with the Common Noddy. Nests are usually shallow scrapes on sand, shingle, rock or grass or under low vegetation.	The study area does not contain the coastal habitats required by this species. There is no potential for an impact on this species.	No.
wompoo fruit-dove <i>Ptilinopus magnificus</i>	V (TSCA)	The wompoo fruit-dove occurs in tropical and sub-tropical rainforests of eastern Australia. The Lower Hunter represents the southern-most extent of its range. While rainforest is the preferred habitat, this species may occupy monsoon forest, adjacent eucalypt forest and fruiting trees on scrubby creeks (Pizzey & Knight 1997). The diet consists of succulent rainforest fruits taken from the canopy. Rarely feeds on fruits from the forest floor. Breeding occurs from October to February. A flimsy nest is built on a leafy horizontal branch, usually above water (Pizzey & Knight 1997).	The study area does not contain suitable fruiting species required by this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
superb fruit-dove <i>Ptilinopus superbus</i>	V (TSCA)	The superb fruit-dove occurs along the east coast of Australia. Typical habitat includes rainforest, scrubs, mangroves, and wooded stream margins. Feeds in Lantana thickets, on figs, pittosporums, lilly pillies, blackberry, palms and laurels (Pizzey & Knight 1997). The superb fruit-dove breeds from September to January, building a flimsy twig nest among branches or in a tree fork (Pizzey & Knight 1997). This species is typically found alone or in pairs, however may be found in groups on a fruiting tree.	The study area does not contain suitable fruiting species required by this species. There is no potential for an impact on this species.	No.
rose-crowned fruit- dove <i>Ptilinopus regina</i>	V (TSCA)	The rose-crowned fruit-dove is associated with rainforests, monsoon forest, vine scrubs, adjacent eucalypt forests and woodlands (Pizzey & Knight 1997). Also occupies swamp woodlands, mangroves, berry or fruit-bearing trees in public and private gardens. The Hunter River is the accepted southern extremity for the species. The species breeds from October to April. The nest is typically flimsy, and is built on a leafy horizontal branch or palm frond among dense vegetation. The nest is usually 2-10 metres high and often over a stream (Pizzey & Knight 1997).	The study area does not contain suitable fruiting species required by this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
hooded robin (southeast form) <i>Melanodryas</i> <i>cucullata cucullata</i>	V (TSCA)	The hooded robin occurs from central QLD to Spencer Gulf, SA. Found throughout NSW (NPWS 2004e). Occupies a range of habitats including eucalypt woodland, acacia shrubland, open forest (NPWS 2004e), mallee, casuarina, cypress pine, mulga and banksia dominated coastal scrubs (Pizzey & Knight 1997). This species requires a large home range, estimated at 18 hectares (NPWS 2004e). Forages on the ground for insects. Breeding occurs Jul-Dec. Eggs are laid in a cup-shaped nest of bark, grass, and other organic matter. The nest placed on stumps, in tree cavities, or on a horizontal fork/branch (Pizzey & Knight 1997).	Typical foraging resources for this species are not present in the study area. There is no potential for an impact on this species.	No.
black-necked stork Ephippiorhynchus asiaticus	E (TSC)	In eastern Australia the black- necked stork has been recorded from Victoria in the south and inland to the Macquarie Marshes and Griffith (NPWS 2004c). The range of this species has declined to the north and east since European colonisation and the number of individuals has significantly declined on the southern and western limits of its range (NPWS 2004c). Disturbance, wetland modification and powerlines are considered the main threats to the survival of this species (NPWS 2004c).	No habitat is present in the study area for this species due to a lack of preferred habitat attributes (i.e. wetlands). There is no potential for an impact on this species.	No
osprey Pandion haliaetus	V (TSCA)	The osprey is found in a range of coastal habitats including estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs, stacks. Breeding occurs from April to July (Pizzey & Knight 1997). The nest is made from sticks, seaweed and rope, with more material added to the nest each year (Sainty <i>et al.</i> 2000).	The study area does not contain the coastal and estuarine habitats required by this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
pied oystercatcher Haematopus longirostris	V (TSCA)	The pied oystercatcher occurs over the entire Australian coastline (Australian Museum 2004). Occupies a variety of habitats including sandy/shelly/pebbly beaches, sandspits/sandbars, tidal mudflats, coastal islands, brackish or saline wetlands, grassy paddocks and golf courses near the coast. The birds breed from August to January, building a shallow scrape in the sand on an open beach or among low growth behind the beach (Pizzey & Knight 1997). Forages in mud with their long beak for bivalve molluscs, worms, crustaceans and insects (Australian Museum 2004).	The study area does not contain the coastal or aquatic habitats required by this species. There is no potential for an impact on this species.	No.
square-tailed kite <i>Lophoictinia isura</i>	V (TSC)	Recorded from a variety of timbered habitats, showing preference for timbered watercourses. Occupies hunting ranges of more than 100km ² . Breeding occurs between July and February and nests are generally near watercourses.	The study area does not contain potential foraging and nesting habitat for this species. There is no potential for an impact on this species.	No.
comb-crested jacana Irediparra gallinacea	V (TSC)	Requires well vegetated, permanent wetland habitats with floating or emergent vegetation, in particular water-lilies. Feeds primarily on invertebrates and some vegetation. Breeds in spring and summer in NSW, in a nest of wet, floating vegetation.	The study area does not contain areas of vegetated aquatic habitats with floating vegetation required by this species. There is no potential for an impact on this species.	No.
red goshawk Erythrotriorchis radiatus	E (TSC) V (EPBC)	In NSW, preferred habitat is mixed tropical rainforest Melaleuca Swamp Forest and Open Eucalypt forest along coastal rivers, often in rugged terrain (DECC 2007). Prefers mosaic vegetation types; hunts along the ecotones (NPWS 2002). Habitats are generally close to permanent bodies of freshwater, nest sites being only up to 1 kilometre away from such water bodies.	The study area does not contain potential habitat for this species. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
glossy black- cockatoo <i>Calyptorhynchus</i> <i>lathami</i>	V (TSC)	This species is distributed along the east coast of Australia from west VIC to Rockhampton QLD (NPWS 1999h). Preferred habitat includes She-oaks (<i>Allocasuarina</i> spp.) woodlands, open sclerophyll forests, and timbered watercourses (Pizzey & Knight 1997). Typically found in areas of low soil nutrients. Nest consists of a layer of woodchips in a large hollow, often high above the ground. Feed almost entirely on she-oak seeds, however may occasionally feed on wood-boring insect larvae. Breeding time is Mar-Aug, nests being a layer of woodchips in a large hollow (Pizzey & Knight 1997). Generally occur in small flocks, with usually no more than 10 individuals.	Typical foraging resources for this species are absent from the study area. There is no potential for an impact on this species.	No.
gang gang Cockatoo Callocephalon fimbriatum	V (TSC)	In summer, it occupies tall montane forests and woodlands (DECC 2007), and may also occur in sub-alpine woodland and occasionally in temperate rainforests (DECC 2007). In winter, it occurs at lower altitudes in drier, open eucalypt forests/woodlands, or in dry forest in coastal areas (DECC 2007). May undertake nomadic or seasonal movements.	There is no potential habitat for this species within the study area. There is no potential for an impact on this species.	No.
swift parrot <i>Lathamus discolor</i>	E (TSC) E (EPBC)	Often visits box-ironbark forests, feeding on nectar and lerp (Garnett & Crowley 2000). In NSW, typical feed species include mugga ironbark, grey box, swamp mahogany, spotted gum, red bloodwood, narrow-leaved red ironbark, forest red gum and yellow box (Swift Parrot Recovery Team 2001).	Typical foraging and nesting resources for the swift parrot are not present in the study area. There is no potential for an impact on this species.	No.
regent honeyeater Xanthomyza phrygia	E (TSC) E (EPBC)	Semi-nomadic, generally occurs in temperate eucalypt woodlands and open forests, commonly recorded from box-ironbark eucalypt associations, wet lowland coastal forests dominated by swamp mahogany, spotted gum and riverine <i>Casuarina</i> woodlands (DECC 2007).	Typical foraging and nesting resources for the regent honeyeater are not present in the study area. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
turquoise parrot <i>Neophema pulchella</i>	V (TSC)	The turquoise parrot occupies a variety of habitats, primarily eucalypt woodland and open forest near open water and forested hills. Also found in coastal heath, pasture, roadsides and orchards (Pizzey & Knight 1997).	Typical foraging and nesting resources for the turquoise parrot are not present in the study area. There is no potential for an impact on this species.	No.
powerful owl <i>Ninox strenua</i>	V (TSC)	The powerful owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest (Garnett and Crowley 2000). The powerful owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation. Occurs mostly on the coastal side of the Great Dividing Range, from south western Victoria to Bowen in Queensland (Garnett & Crowley 2000).	Typical foraging and nesting resources for this species are not present in the study area. There is no potential for an impact on this species.	No.
sooty owl Tyto tenebricosa	V (TSCA)	The sooty owl is an ecological specialist with a poor recovery potential. Its range covers a narrow strip of eastern Australia. Preferred habitat includes dry, subtropical and warm temperate rainforest and sclerophyll forest from 200-1000 m ASL (NEFA 2004). Favours forest in gullies with a sheltered aspect, with a tall, dense understorey layer. The sooty owl is a remarkable hunter, with main prey items being ring-tailed possum and sugar glider. May move to drier forest to hunt. Other small mammals are also taken. This species nests on decayed debris in tree hollows up to 30 metres above the ground (Pizzey & Knight 1997). There are a few records of this species nesting in caves.	Typical foraging and nesting resources for the sooty owl are not present in the study area. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
barking owl <i>Ninox connivens</i>	V (TSC)	Habitat for this species includes dry forests and woodlands (Kavanagh 2002), often in association with hydrological features such as rivers and swamps (Taylor et al. 2002). Large hollows are required for breeding.	Typical foraging and nesting resources for the barking owl are not present in the study area. There is no potential for an impact on this species.	No.
masked owl <i>Tyto novaehollandiae</i>	V (TSC)	Generally recorded from open forest habitat with sparse mid- storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land (Kavanagh 2004).	Typical foraging resources for this species are not present in the study area. There is no potential for an impact on this species.	No.
brown treecreeper (eastern subsp.) <i>Climacteris picumnus</i> <i>victoriae</i>	V (TSC)	Typical habitat for this species includes drier forests, woodlands, scrubs, with fallen branches; river red gums on watercourses and around lake-shores; paddocks with standing dead timber; and margins of denser wooded areas (Pizzey & Knight 1997). This species prefers areas without dense understorey (DECC 2007).	Typical habitat for this species is not present within the study area. There is no potential for an impact on this species.	No.
black-chinned honeyeater (eastern subsp.) <i>Melithreptus gularis</i> gularis	V (TSC)	In NSW, it is mainly found in woodlands with annual rainfall of 400-700mm containing box- ironbark associations and river red gum (Garnett & Crowley 2000). It is also known from drier coastal woodlands of the Cumberland Plain, Western Sydney and in the Hunter, Richmond and Clarence valleys (DECC 2007).	Typical foraging and nesting resources for this species are not present in the study area. There is no potential for an impact on this species.	No.
speckled warbler Pyrrholaemus saggitata	V (TSC)	In NSW, occupies eucalypt and cypress woodlands, generally on the western slopes of the Great Dividing Range. Inhabits woodlands with a grassy understorey, leaf litter and shrub cover, often on ridges or gullies (Garnett & Crowley 2000).	Typical foraging resources for this species are not present in the study area. There is no potential for an impact on this species.	No.
grey-crowned babbler (eastern form) <i>Pomatostomus</i> <i>temporalis temporalis</i>	V (TSC)	Habitat for this species includes open forest and woodland, acacia scrubland and adjoining open areas (Garnett & Crowley 2000).	Typical foraging resources for this species are not present in the study area. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
diamond firetail <i>Stagonopleura</i> <i>guttata</i>	V (TSC)	Habitat includes a range of eucalypt-dominated communities with a grassy understorey, including woodland, forest and mallee (Garnett & Crowley 2000). Populations appear unable to persist where remnants are less than 200 hectares in area (DECC 2007).	Typical foraging resources for this species are not present in the study area. There is no potential for an impact on this species.	No.
spotted-tailed quoll Dasyurus maculatus maculatus	V (TSC) E (EPBC)	Highly varied habitat, ranging from sclerophyll forest, woodlands, coastal heathlands and rainforests. Records exist from open country, grazing lands and rocky outcrops (DECC 2007). Suitable den sites including hollow logs, tree hollows, rocky outcrops or caves are necessary (DECC 2007).	Typical foraging and nesting resources for the spotted-tailed quoll are not present in the study area. There is no potential for an impact on this species.	No.
koala Phascolarctos cinereus	V (TSC)	This species inhabits eucalypt forest and woodland. Known to feed on a large number of eucalypt and non-eucalypt species, however tends to specialise on a small number in different areas (DECC 2007).	The study area does not provide potential koala habitat as defined by SEPP 44. There is no potential for an impact on this species.	No.
yellow-bellied glider Petaurus australis	V (TSC)	Generally found at low population densities in habitat that is patchily distributed (DECC 2007). Prefers tall, mature sclerophyll forests in regions of high rainfall particularly where hollows and year-round food resources are abundant (DECC 2007).	The study arae does not support potential habitat for this species. There is no potential for an impact on this species.	No.
squirrel glider <i>Petaurus norfolcensis</i>	V (TSC)	Generally inhabits dry sclerophyll forest and woodland (Suckling 2002). Preferred foraging habitat contains a regenerating understorey of eucalypts, wattles and flowering shrubs. Winter flowering species such as red ironbark, spotted gum and coast banksia are particularly important when other food sources are limited (NSW Scientific Committee 2000).	Typical foraging and nesting resources for the squirrel glider are not present in the study area. There is no potential for an impact on this species.	No.
long-nosed potoroo Potorous tridactylus	V (TSC) V (EPBC)	Occupies a variety of habitats from coastal heath to dry or wet sclerophyll forest. Restricted to areas with rainfall greater than 760 mm per year (Strahan 1995) and it prefers habitats with a dense ground cover and light, sandy soils.	Potential habitat for the long-nosed potoroo does not occur in the study area. There is no potential for an impact on this species.	No.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
brush-tailed rock- wallaby <i>Petrogale penicillata</i>	E (TSC) V (EPBC)	This species occupies rocky escarpments, outcrops and cliffs showing a preference for complex structures with fissures, caves and ledges facing north (DECC 2007). Forage in or adjacent to rocky areas (DECC 2007).	Suitable rocky areas required by the brush- tailed rock-wallaby are absent from the study area. There is no potential for an impact on this species.	No.
grey-headed flying- fox <i>Pteropus</i> <i>poliocephalus</i>	V (TSC) V (EPBC)	This species feeds on a variety of flowering and fruiting plants, including native figs and palms, blossoms from eucalypts, angophoras, tea-trees and banksias (Tidemann 2002). Camps sites are usually formed in gullies, usually in vegetation with a dense canopy and not far from water (Tidemann 2002).	This species was recorded in the study area. Further assessment is provided below.	Yes.
eastern freetail-bat Mormopterus norfolkensis	V (TSC)	Occurs mostly in dry eucalypt forest and woodland. Also recorded over a rocky river in rainforest and wet sclerophyll forest (Churchill 1998). Generally roosts in tree hollows, but may use man-made structures (Churchill 1998).	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.
eastern bentwing-bat Miniopterus schreibersii oceanensis	V (TSC)	Habitat varies widely, from rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grasslands (Churchill 1998). Requires caves for roosting and maternity sites.	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.
yellow-bellied sheathtail bat <i>Saccolaimus</i> <i>flaviventris</i>	V (TSCA)	This species is wide ranging throughout tropical Australia, with records extending into south eastern areas (Churchill 1998). Has been recorded from a wide variety of habitats, from wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and deserts (Churchill 1998). In eucalypt forests, this species forages above the canopy, however ventures lower when in open country (Strahan 1995). This species is generally solitary, however may form small groups around spring (Churchill 1998). Roosting is generally recorded from tree hollows. A single young is born between December and March (Churchill 1998).	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
eastern false pipistrelle Falsistrellus tasmaniensis	V (TSC)	Habitat includes sclerophyll forest from the Great Dividing Range to the coast. It appears to prefer wet habitats, with trees over 20 metres high (Churchill 1998). It generally roosts in tree hollows or trunks, in groups of 6 – 36, but is occasionally recorded from caves or buildings (Churchill 1998).	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.
little bentwing-bat Miniopterus australis	V (TSC)	Habitat includes wet and dry sclerophyll forest, rainforest, dense coastal banksia scrub, and <i>Melaleuca</i> swamps. Cave- dwelling, often sharing roosts with the eastern bentwing-bat (<i>Miniopterus scheribersii</i> oceanensis). Sometimes roost in tree hollows. Forages for small insects beneath the canopy of densely vegetated habitats. May depend on a large colony for the high temperatures required to rear the young. May hibernate over winter in southern parts of their range.	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.
large-eared pied bat Chalinolobus dwyeri	V (TSC) V (EPBC)	Generally found in a variety of drier habitats, including the dry sclerophyll forests and woodlands, however probably tolerates a wide range of habitats (Hoye & Dwyer 2002). Tends to roost in the twilight zones of mines and caves (Churchill 1998).	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.
large-footed myotis <i>Myotis adversis</i>	V (TSC)	Occurs in most habitat types providing they are near to water (Richards 1995). Commonly cave-dwelling, however it is also recorded from tree hollows, dense vegetation, bridges, mines and drains (Churchill 1998).	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.

Species	Legal Status	Specific Habitat	Potential to Occur/Potential for Impact?	7 Part Test Required?
greater broad-nosed bat <i>Scoteanax rueppellii</i>	V (TSC)	The greater broad-nosed bat appears to prefer moist environments such as moist gullies in coastal forests, or rainforest. They have also been found in gullies associated with wet and dry sclerophyll forests and open woodland. It roosts in hollows in tree trunks and branches and has also been found to roost in the roofs of old buildings.	Potential foraging resources for this species are present in the study area. Further assessment is provided below.	Yes.
Hastings River mouse <i>Pseudomys oralis</i>	E (TSC) E (EPBC)	This species inhabits a variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs (DECC 2007). Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops (DECC 2007).	There is no potential habitat for this species within the study area. There is no potential for an impact on this species.	No.

From Tables 1 and 2, those species requiring further assessment are:

- Charmhaven apple (Angophora inopina);
- eastern freetail-bat (Mormopterus norfolkensis);
- grey-headed flying-fox (Pteropus poliocephalus);
- yellow-bellied sheathtail-bat (Saccolaimus flaviventris);
- greater broad-nosed bat (Scoteanax rueppellii);
- eastern bentwing-bat (Miniopteris schreibersii oceanensis);
- little bentwing-bat (*Miniopterus australis*);
- large-footed myotis (*Myotis adversus*);
- eastern false pipistrelle (Falsistrellus tasmaniensis); and
- large-eared pied bat (Chalinolobus dwyeri).

Below is a seven part test of significance for each of the species that have been recorded or are considered likely to occur in the study area. This assessment has been prepared in accordance with Section 5A of the EP&A Act.

1.0 Charmhaven Apple (Angophora inopina)

This species has a very limited distribution originally thought to be between Charmhaven and Wyee on the Central Coast, but more recently (Bell 2001) confirmed as between Charmhaven and Karuah. It is a tree to 8 metres tall, often multi-stemmed with shortly fibrous bark persistent throughout (Hill 1997). The species occurs in open sclerophyll woodlands of *Eucalyptus haemastoma* and *Corymbia gummifera* with some *E. capitellata* and a dense understorey on deep white sandstone soils over sandstone, often with some gravelly laterite (Hill 1997).

In the study area both *Angophora inopina* and its intergrade *Angophora inopina- floribunda* were identifed. Only the former species is listed under the TSC Act 1995. It is uncertain as to whether or not the intergrade would be covered by Schedule 2 of the TSC Act 1995, and therefore be considered to be a threatened species. However, for the purposes of this seven part test and the flora and fauna impact assessment, it is considered a threatened species.

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The proposed development may result in the loss of approximately 175 individual trees. Approximately 235 trees will be conserved in the Angophora Reserve (refer to Section 7.0) and further stands of this species are known to occur between Argenton and Barnsley (S. Bell *pers. comm.* 2004).

Based on the expanded distribution recently recognised for this species, and the dedication of the *Angophora* reserve as part of the masterplan, the proposed development is unlikely to disrupt the life cycle of the species such that a viable population is likely to be placed at risk of extinction.

 b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

A significant area of known habitat of *Angophora inopina*, or its intergrade with *Angophora floribunda*, will not be modified or removed by the proposed development.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

The proposed development will not result in an area of known habitat becoming isolated from currently interconnecting or proximate areas. The proposed development would see the protection of a reserve where *Angophora inopina* could persist, and areas where it could regenerate. The species has shown a remarkable ability to regenerate in and colonise the highly disturbed environment on the site.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The species is known to occur between Charmhaven in the south and Karuah in the north. The Pasminco site is not considered to be crucial for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected by the proposed development.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

2.0 Eastern Freetail-bat (Mormopterus norfolkensis)

The eastern freetail-bat has a distribution ranging along the east coast of New South Wales from south of Sydney north into south east Queensland, near Brisbane (Churchill 1998). Most records are from dry eucalypt forest and woodland east of the Great Dividing Range. Generally only solitary animals are recorded (Allison & Hoye 1995). Eastern freetail-bats generally roost in tree hollows, however have been recorded from roofs, under bark and the metal caps of telegraph poles (Churchill 1998). They generally forage above the forest canopy, over water and also on the ground.

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The study area is considered to comprise potential habitat for this species however, there is no breeding or roosting habitat for this species within the site due to a lack of hollow-bearing

trees. Disused buildings may provide potential breeding or roosting habitat. Given the highly modified nature of the study area, the lack of suitable hollows on the site and the remote chance of occurrence, it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

 b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified in the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal. It is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor and no individuals of this species were identified. Based on the small areas of marginal habitat to be affected, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

This species occurs widely throughout New South Wales and therefore the study area is not considered important to the long-term survival of the species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

3.0 Grey-headed Flying-fox (*Pteropus poliocephalus*)

The grey-headed flying fox is a large flying fox that forages on a variety of flowering and fruiting plants, and is consequently responsible for the seed dispersal of many rainforest species. It feeds on plants such as native figs and palms, banksias and eucalypts. Roost sites or 'camps' are located within gullies, typically not far from water, usually in vegetation with a dense canopy. Roost sites are important as these are the places where mating, birth and rearing of young occurs, in addition to providing daytime refuge from predators (Tidemann 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The woodland and open grassland areas provide only marginal foraging habitat for the greyheaded flying-fox. The grey-headed flying fox was recorded in the study area and is also commonly known to occur in the Lake Macquarie area. Given the highly modified nature of the study area and marginal foraging habitat quality it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

 b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

d) in relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

Known habitat for this species was identified in the study area. The amount of potential habitat for this species within the study area is minor. Based on the small areas of marginal habitat to be affected, it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposed development.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

Known habitat for this species was identified in the study area. The amount of habitat within the site is minor. Based on the small areas of marginal habitat to be affected, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

This species occurs widely throughout New South Wales and therefore the study area is not considered important to the long-term survival of the species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

4.0 Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris)

The yellow-bellied sheathtail bat is wide ranging throughout tropical Australia, with records extending into south eastern areas (Churchill 1998). This species has been recorded from a wide variety of habitats, from wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and deserts (Churchill 1998). In eucalypt forests, this species forages above the canopy, however ventures closer to the ground when in open country (Richards 1995a). This species is generally solitary, however may form small groups around

spring (Churchill 1998). Roosting is generally recorded from tree hollows. A single young is born between December and March (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The study area is considered to comprise potential habitat for this species however, there is no breeding or roosting habitat for this species within the site due to a lack of hollow-bearing trees. Disused buildings may provide potential breeding or roosting habitat. Given the highly modified nature of the study area, the lack of suitable hollows on the site and the remote chance of occurrence, it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

d) in relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified at the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal at best it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within these areas is considered marginal at best, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The yellow-bellied sheathtail bat is a wide ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

5.0 Greater Broad-nosed Bat (Scoteanax rueppellii)

The greater broad-nosed bat has a distribution ranging from the Atherton Tablelands in Queensland to southern New South Wales (Churchill 1998). Habitat for this species occurs in moist gullies and river systems draining the Great Dividing Range, as well as a variety of woodland, forest and rainforest vegetation types (Hoye & Richards 1995). This species has not been recorded above 500 metres in altitude. Greater broad-nosed bats have been recorded roosting in hollow tree trunks and branches, as well as old buildings (Churchill 1998). A single young is born in January (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The study area is considered to comprise potential habitat for this species however, there is no breeding or roosting habitat for this species within the site due to a lack of hollow-bearing trees. . Given the highly modified nature of the study area, the lack of suitable hollows on the site and the remote chance of occurrence, it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

 b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified at the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal at best it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within these areas is considered marginal at best, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The greater broad-nosed bat is a wide ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process. The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

6.0 Eastern Bentwing-bat (Miniopterus scheibersii oceanensis)

The eastern bentwing-bat has an eastern distribution from Cape York, south along the coastal side of the Great Dividing Range, and into the southern tip of South Australia (Churchill 1998). Habitat ranges widely from rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grasslands (Churchill 1998). It is a cave-dwelling species, congregating in maternity caves for breeding and later dispersing to satellite caves, generally within 300 kilometres (Churchill 1998). This species hibernates over winter in southern parts of their range (Churchill 1998). The eastern bentwing-bat will roost communally with similar species such as the little bentwing-bat. They have been recorded roosting in a variety of man-made structures including buildings and culverts (Dwyer 1995b). A single young is born in December (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

This species was recorded in the study area. The study area is considered to provide marginal foraging habitat and breeding or roosting habitat was not identified within the study area. Given the highly modified nature of the area it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

Known habitat for this species was identified in the study area. The amount of foraging habitat within the study area is minor. Based on the small areas of marginal habitat to be

affected, it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

Known habitat for this species was identified in the study area. The amount of foraging habitat within the study area is minor. Based on the small areas of marginal habitat to be affected, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this wide-ranging species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The eastern bentwing bat is a wide ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

7.0 Little Bentwing-bat (*Miniopterus australis*)

The little bentwing-bat occurs from Cape York to northern New South Wales, where it is confined to subtropical areas (Dwyer 1995a). Habitat for this species includes well-timbered areas of rainforest, wet and dry sclerophyll forest, *Melaleuca* swamps and coastal forests (Churchill 1998). This is a cave-dwelling species, congregating in maternity colonies in summer and dispersing over winter (Churchill 1998). This species will hibernate over winter in the southern parts of their range (Churchill 1998). Little bentwing-bats are often found roosting with the eastern bentwing-bat (Dwyer 1995a). A single young is born in December (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

This species was not recorded in the study area. The study area is considered to provide marginal foraging habitat and breeding or roosting habitat was not identified within the study

area. Given the highly modified nature of the area it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified at the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal at best it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within these areas is considered marginal at best, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The little bentwing bat is a wide ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

8.0 Large-footed Myotis (*Myotis adversis*)

The large-footed myotis is a coastal species, ranging from the Kimberley region in the Northern Territory to South Australia (Churchill 1998). This species will occur in most habitat types providing they are near to water (Richards 1995b). It is commonly cave-dwelling, however roosting has been recorded from tree hollows, dense vegetation, bridges, mines and constructed drains (Churchill 1998). When breeding, this species may roost in small groups, with males defending a territory and a harem of females (Richards 1995b). A single young is born in November – December (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

Dams within the study area provide potential habitat for the large-footed Myotis, however potential roosting habitat was not identified. As the potential habitat in the study area is considered marginal, it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or

Not applicable.

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

d) in relation to the habitat of a threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified at the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal at best it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within these areas is considered marginal at best, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The large-footed myotis is a wide ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

9.0 Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

The eastern false pipistrelle has a range from south eastern Queensland, south through New South Wales and Victoria, and into Tasmania (Churchill 1998). Habitat for this species includes sclerophyll forest from the Great Dividing Range running east to the coast, however it is thought to be more common at cool elevations (Phillips 2002). Eastern false pipistrelles appear to prefer wet habitats, with trees generally over 20 metres high (Churchill 1998).

Pipistrelles generally roost in tree hollows or trunks, in groups of 6 - 36, and they are occasionally recorded from caves and buildings (Churchill 1998). This species appears to hibernate over winter in southern parts of its range (Phillips 1995). A single young is born in December (Churchill 1998). The eastern false pipistrelle feeds on various species of invertebrates (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

Dams within the study area provide potential habitat for this species, however potential roosting habitat was not identified. As the potential habitat in the study area is considered marginal, it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or

Not applicable.

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified at the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal at best it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the

habitat within these areas is considered marginal at best, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The eastern false pipistrelle is a wide-ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

10.0 Large-eared Pied Bat (Chalinolobus dwyeri)

The large-eared pied bat has a distribution ranging from south western Queensland to New South Wales from coastal areas to the western slopes of the Great Dividing Range (Churchill 1998). This species is generally found in a variety of drier habitats, including dry sclerophyll forests and woodlands, however it probably tolerates a wide range of habitat types (Hoye & Dwyer 1995). This species tends to roost in the twilight zones of mines and caves, generally in colonies or common groups (Churchill 1998). Females give birth (generally to twins) in November (Churchill 1998).

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

Dams within the study area provide potential habitat for the large-eared pied bat, however potential roosting habitat was not identified. As the potential habitat in the study area is considered marginal, it is considered unlikely that the life cycle of this species will be disrupted such that a viable local population of this species will be placed at risk of extinction.

 b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction; Not applicable.

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or

Not applicable.

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Not applicable.

- d) in relation to the habitat of a threatened species, population or ecological community:
 - i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No known habitat for this species was identified at the study area. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within the area is considered marginal at best it is considered that a significant area of known habitat for this species will not be removed or modified as a result of the proposal.

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and

No known habitat for this species was identified on the site. The amount of potential habitat within the site is minor. Given that no individuals of this species were identified and the habitat within these areas is considered marginal at best, it is considered that an area of known habitat is not likely to become isolated from currently interconnecting or proximate areas for this species.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The large-eared pied bat is a wide ranging species and therefore the potential habitat from with the study area is not considered important for the long-term survival of this species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of declared critical habitat will be affected.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

A recovery plan for this species has not been prepared.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development will require the removal of some vegetation, so it is classed as the Key Threatening Process 'Clearing of Native Vegetation'. This may also include 'Removal of Dead Wood and Dead Trees'.

Conclusion

The proposed development of the Pasminco site will not result in a significant impact on any threatened species, populations or EECs recorded or potentially occurring within the Pasminco Cockle Creek Former Smelter Site. A Species Impact Statement is not required.

APPENDIX 3

Fauna Species List

Appendix 3 - Fauna Species List

Legend

3-		
Ρ	-	Probable identification by Fly By Night Bat Surveys Pty Ltd
Po	-	Possible identification by Fly By Night Bat Surveys Pty Ltd
V	-	Listed as Vulnerable under the Threatened Species Conservation Act 1995
Х	-	Recorded by Umwelt (Australia) Pty Limited during November 2004 field survey
*	-	Denotes an introduced species

FAMILY	SCIENTIFIC NAME	COMMON NAME
BIRDS		
Accipitridae	Haliastur sphenurus	whistling kite
Accipitridae	Accipiter novaehollandiae	grey goshawk
Accipitridae	Accipiter fasciatus	brown goshawk
Artamidae	Cracticus torquatus	grey butcherbird
Artamidae	Cracticus nigrogularis	pied butcherbird
Artamidae	Gymnorhina tibicen	Australian magpie
Artamidae	Strepera graculina	pied currawong
Campephagidae	Coracina novaehollandiae	black-faced cuckoo-shrike
Centropodidae	Centropus phasianinus	pheasant coucal
Charadriidae	Vanellus miles	masked lapwing
Columbidae	Streptopelia chinensis	spotted turtle-dove
Columbidae	Columba liura	rock dove
Corvidae	Corvus coronoides	Australian raven
Cuculidae	Eudynamis scolopacea	common koel
Dicaeidae	Dicaeum hirundinaceum	mistletoebird
Dicruridae	Grallina cyanoleuca	magpie-lark
Halcyonidae	Dacelo novaeguineae	laughing kookaburra
Hirundinidae	Hirundo ariel	fairy martin
Hirundinidae	Hirundo neoxena	welcome swallow
Maluridae	Malurus cyaneus	superb fairy-wren
Meliphagidae	Lichenostomus chrysops	yellow-faced honeyeater
Meliphagidae	Anthochaera chrysoptera	little wattlebird
Passeridae	Neochmia temporalis	red-browed finch
Passeridae	Lonchura castaneothorax	chestnut-breasted mannikin
Phalacrocoracidae	Phalacrocorax varius	pied cormorant
Phalacrocoracidae	Phalacrocorax sulcirostris	little black cormorant
Phalacrocoracidae	Phalacrocorax carbo	great cormorant
Podicipedidae	Tachybaptus novaehollandiae	Australasian grebe
Sturnidae	*Acridotheres tristis	common mynah
Sturnidae	*Sturnus vulgaris	common starling
Sylviidae	Cisticola exilis	golden-headed cisticola
Phasianidae	Coturnix sp.	quail
Zosteropidae	Zosterops lateralis	silvereye
Pelecanidae	Pelecanus conspicillatus	Australian pelican
AMPHIBIANS		
Myobatrachidae	Crinia signifera	brown froglet
Myobatrachidae	Limnodynastes tasmaniensis	spotted marsh frog

FAMILY	SCIENTIFIC NAME	COMMON NAME
Myobatrachidae	Uperoleia laevigata	smooth toadlet
Myobatrachidae	Limnodynastes peronii	striped marsh frog
Hylidae	Litoria fallax	green reed frog, dwarf tree frog
Hylidae	Litoria latopalmata	broad-palmed frog
REPTILES		
Scincidae	Lampropholis delicata	grass skink
Scincidae	Tiliqua scincoides	eastern blue-tongued lizard
Agamidae	Pogona barbata	eastern bearded dragon
MAMMALS		
Canidae	* Vulpes vulpes	fox
Leporidae	*Oryctolagus cuniculus	rabbit
Molossidae	Nyctinomus australis	white-striped freetail-bat
Muridae	*Mus musculus	house mouse
Muridae	*Rattus rattus	black rat
Peramelidae	Perameles nasuta	long-nosed bandicoot
Pteropodidae	Pteropus poliocephalus	grey-headed flying-fox
Vespertilionidae	Miniopterus schreibersii	eastern bentwing-bat
Vespertilionidae	Chalinolobus gouldii	Gould's wattled bat
Vespertilionidae	Vespadelus darlingtoni	large forest bat

APPENDIX 4

Assessment of Significance under the EPBC Act

Appendix 4 – Assessment of Significance under the *Environmental* Protection and Biodiversity Conservation Act 1999

A search of the EPBC Protected Matters database (25 October 2007) identified 1 EEC, 21 threatened species (discounting marine species) and 7 terrestrial migratory species (discounting marine species) known to occur, or considered likely to occur, on the basis of habitat modelling, within 10 kilometres of the site. These threatened flora and fauna species are included in Tables 1 and 2 of Appendix 2, and migratory species recorded in the study area are listed in Appendix 3. None of the eight flora species listed on the EPBC Database are likely to occur within the study area. Potential habitat for two of the 11 EPBC Database listed fauna species is present: the grey-headed flying fox and large-eared pied bat both listed as vulnerable under the EPBC Act. A single grey-headed flying-fox was identified within the site. The site is not considered to support any significant foraging resources for any of the EPBC listed migratory bird species recorded in the study area.

The aim of this assessment is to determine whether the proposed development is likely to have a significant impact on any of these threatened and migratory species.

Under the EPBC Act 1999, an 'important population' is one that is necessary for the species' long-term survival and recovery. This may include populations that are:

- key source 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.

It is not considered that the single grey-headed flying-fox forms part of an important population of this species. There are many records for this species within a 10 kilometre radius of the site, and it is considered unlikely that this individual is part of a key population for breeding or dispersal, population necessary for maintaining genetic diversity, or a population at the limit of the species range.

Grey-headed flying-fox - Assessment of Significance

An action has, will have, or is likely to have a significant impact on threatened or migratory species if it does, will, or is likely to:

• lead to a long-term decrease in the size of an important population of a species;

A single grey-headed flying-fox was identified within the study area. This individual was observed to land within an area of immature eucalypts. This individual does not constitute an important population of the species, nor is it likely to be part of an important population of the species. It is considered that the vegetation within the study area would form marginal foraging habitat at best for this species. No camps were present within the site, nor is it likely that large numbers would use the site for foraging. It is possible that the individual was using the area as a stop-over during dispersal. The proposed development will not lead to a long-term decrease in the size of an important population of an identified threatened or migratory species.

• reduce the area of occupancy of an important population, or;

A single grey-headed flying-fox was identified within the study area. This individual was observed to land within an area of immature eucalypts. This individual does not constitute an

important population of the species, nor is it likely to be part of an important population of the species. Despite this, the proposed development will impact a small area of marginal foraging habitat. This will not reduce the area of occupancy of an important population of this specie.

• fragment an existing important population into two or more populations, or;

There are no important populations of this species within the study area. The proposed development will not fragment an existing important population into two or more populations.

• adversely affect habitat critical to the survival of a species, or;

The habitats occurring within the study area provide marginal habitat at best, and do not form critical habitat which is essential to the survival of the grey-headed flying-fox.

• disrupt the breeding cycle of an important population, or;

The study area does not support important breeding habitat for the grey-headed flying-fox. The proposed development is not expected to disrupt the breeding cycle of an important population of this species.

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

Based on a habitat assessment undertaken for the study area, it is not considered to be quality habitat for the grey-headed flying-fox. The area contains only immature eucalypt species, unlikely to provide suitable foraging habitat. The modification of such marginal foraging habitat is not expected to be significant to the extent that a species is likely to decline.

• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat, or;

The proposed development is not expected to result in the introduction of any non-endemic species which may be detrimental to any vulnerable species or their habitat.

• interferes substantially with the recovery of the species.

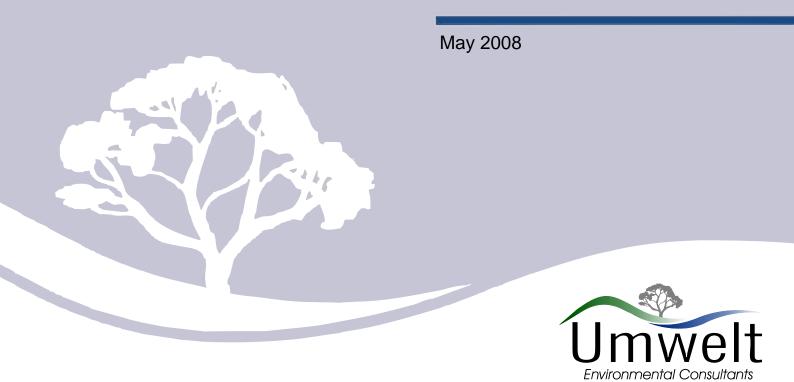
The proposed development will not result in the loss of important habitat for the grey-headed flying-fox, and is not expected to substantially interfere with the recovery of any threatened species potentially occurring on the site.

APPENDIX 5

Management Plan for Angophora inopina (Umwelt 2007)

Fitzwalter Group

Revised Management Plan for Angophora inopina Reserve at the Former Pasminco Cockle Creek Smelter Site, Boolaroo



Revised Management Plan for Angophora inopina Reserve at the Former Pasminco Cockle Creek Smelter Site, Boolaroo

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Fitzwalter Group

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APPENDICES

- 1 Flora Species List
- 2 Habitat Management Advice (Bell 2008)

1.0 Introduction

The former Pasminco Cockle Creek Smelter (PCCS) site is situated near Boolaroo approximately 150 kilometres north of Sydney (**Figure 1.1**). Within the PCCS site an area was proposed for industrial subdivision as an extension to Cardiff Industrial Park, known as Cardiff West Estate (**Figure 1.2**). This Management Plan refers to approximately 2.7 hectares of land which will be established to reserve the threatened tree *Angophora inopina* and its intergrade *Angophora inopina*—*floribunda* located within the area proposed for industrial subdivision, hereafter referred to as the 'Angophora Reserve' (**Figure 1.2**). This document is a revision of the first Management Plan prepared for the reserve (Umwelt 2007) and reflects modifications to the reserve boundary and also changes to the management approaches that have come about through the evolution of the project. The area to which this management plan refers is shown on **Figure 1.3**.

1.1 Background

Umwelt (Australia) Pty Limited (Umwelt) prepared an Ecological Assessment in 2005 for the proposed Cardiff Industrial Park development (Umwelt 2005a). During the survey of the study area, the threatened tree *Angophora inopina* and its intergrade *Angophora inopina* — *floribunda* were identified. Due to the potential impacts of the proposed development on this threatened species, Umwelt (2005a) recommended that the likely loss of *Angophora inopina* and its intergrade should be offset through the establishment of a reserve in an area in which this species is present.

The reserve boundary proposed by Umwelt (2005a) was amended by Fitzwalter Group prior to the preparation of the first Management Plan for the Angophora Reserve (Umwelt 2007a), to include further areas to the east and south-east of the original proposed reserve. The Angophora Reserve boundary has since been further modified, the changes being the contraction of the north boundary and a new vehicle access road traversing the southern section of the reserve. The current reserve boundary including the proposed road route is shown on **Figure 1.2**, and is hereafter referred to as the 'Angophora Reserve'. This Plan of Management refers only to the management of the Angophora Reserve, excluding the proposed road route shown on **Figure 1.2**.

It is intended that PCCS manages the Reserve for 5 years at which point it will be dedicated it to Lake Macquarie City Council. This intention is currently subject to agreement from Lake Macquarie City Council. The proposed rezoning of the Angophora Reserve will preclude other developments within the reserve aside from those required for the effective conservation management of its ecological values.

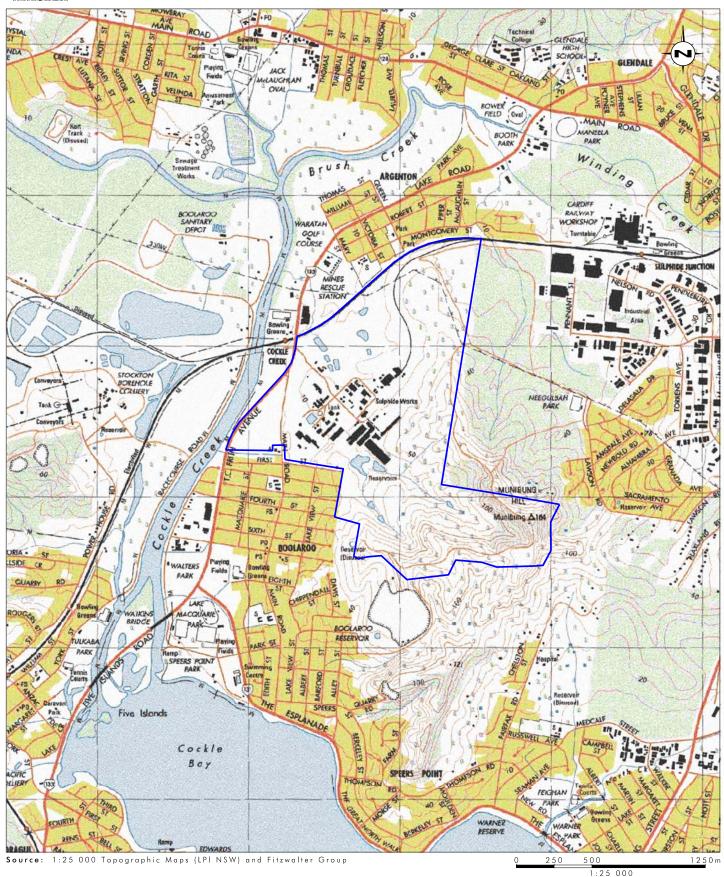
1.2 Aim and Management Objectives

The overall aim of the Management Plan is to establish appropriate management actions which will ensure that the population of *Angophora inopina* within the Angophora Reserve is protected in the long term. This Management Plan not only aims to protect the population of *Angophora inopina* as it currently exists, but also to establish means by which the habitats can be enhanced, such as through regeneration of a native vegetation community within the Angophora Reserve.

The objectives of this Angophora inopina Management Plan are to:

• document current knowledge in relation to the *Angophora inopina* population within the Angophora Reserve;

Umwelt



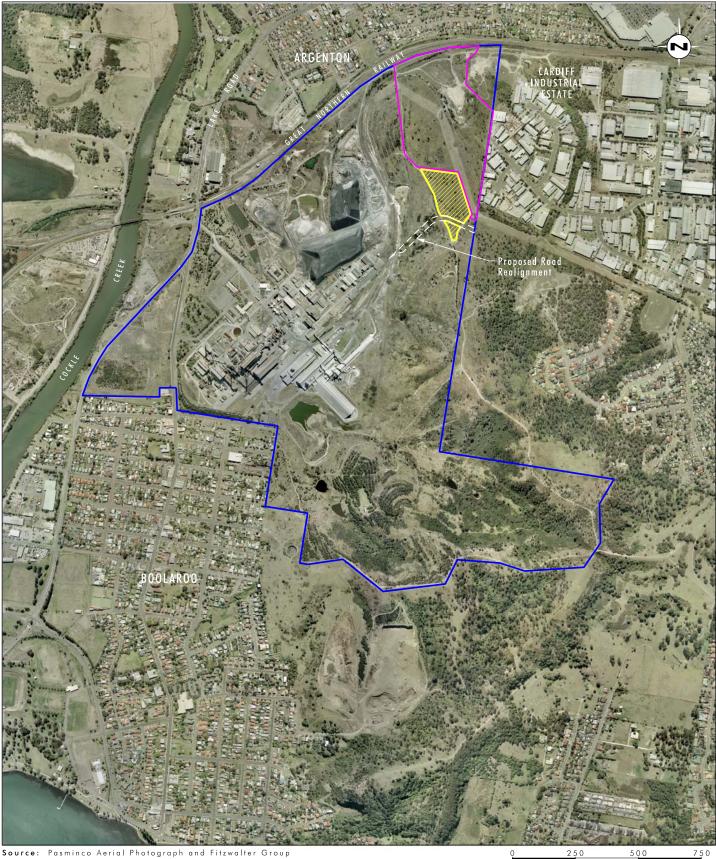
Legend

– Pasminco Cockle Creek Smelter Site

FIGURE 1.1

Location of Pasminco Cockle Creek Smelter Site

Umwelt



Source: Pasminco Aerial Photograph and Fitzwalter Group

Legend



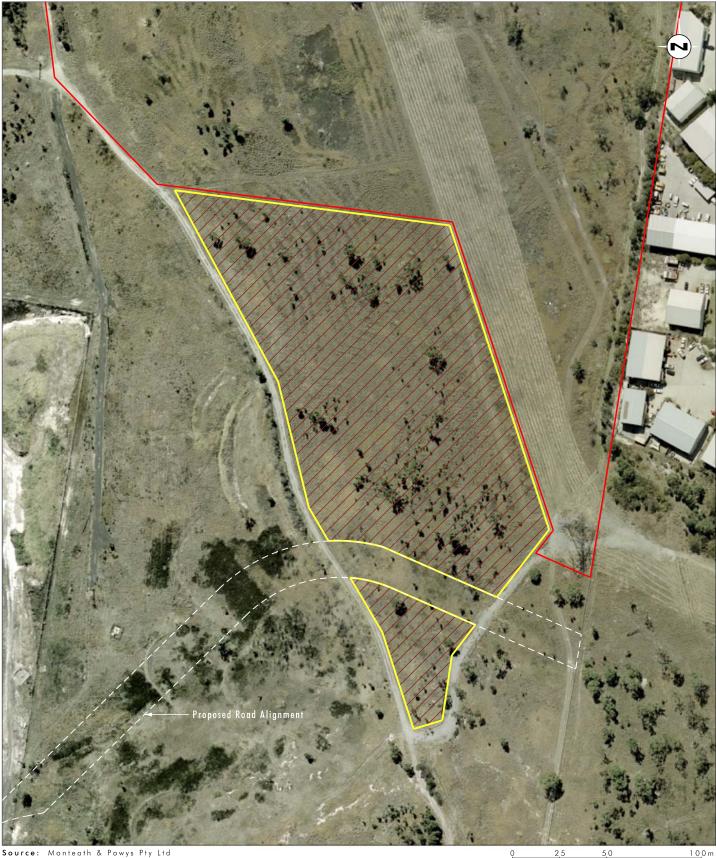
Posminco Cockle Creek Smelter Site Site Boundary for proposed Cardiff West Estate Subdivision Angophora Reserve (current recognised boundary)

FIGURE 1.2

Angophora Reserve Boundary and Proposed Extension to Cardiff Industrial Estate

1:15 000





Source: Monteath & Powys Pty Ltd

Legend

Cardiff West Estate Site Area covered by Management Plan Angophora Reserve (current boundary)

FIGURE 1.3

Area covered by Management Plan

1:2000

- ensure the long term security and viability of *Angophora inopina* within the Angophora Reserve through appropriate and effective management actions;
- devise management strategies to minimise the current and likely future threats to *Angophora inopina* within the Angophora Reserve;
- identify actions required to regenerate a natural and self-sustaining vegetation community within the Angophora Reserve that is compatible with the surrounding landscape; and
- to develop an appropriate monitoring program for the Angophora Reserve.

2.0 Existing Environment

2.1 Pasminco Cockle Creek Smelter Site

The vegetation of the PCCS site was covered by broad scale mapping undertaken as part of the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (House 2003). Previous surveys undertaken by Umwelt (2005a, 2005b, 2005c, 2005d) also mapped the vegetation communities occurring within the PCCS site. The combined vegetation community mapping of the PCCS site is shown on **Figure 2.1**.

Ten vegetation communities occur within the PCCS site comprising Eucalyptus Plantings; *Angophora inopina – Angophora floribunda* Open Woodland; *Angophora inopina – Angophora costata* Open Woodland (as described in Umwelt 2005a); Planted Open Woodland; Derived Grassland (as described in Umwelt 2005b); Moist Shrubland; Planted Shrubs and Trees (as described in Umwelt 2005c); Coastal Foothills Spotted Gum – Ironbark Forest; Coastal Sheltered Apple – Peppermint Forest and Coastal Plains Smooth-barked Apple Woodland (as described in Umwelt 2005d). The results of all previous surveys within the PCCS Site have now been integrated into the Master Plan prepared for the site (Umwelt 2008).

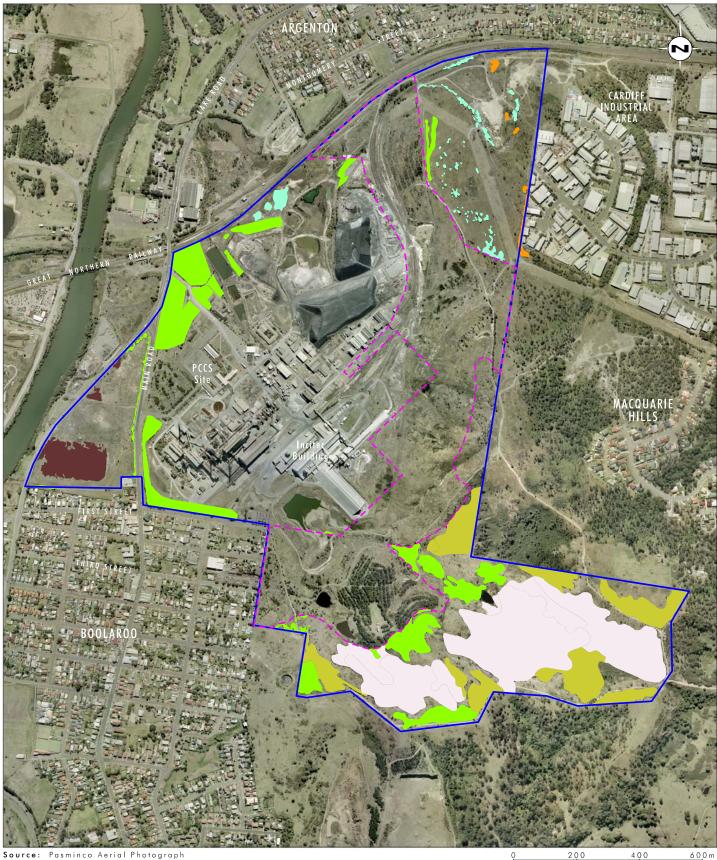
2.2 Angophora Reserve

The 2.7 hectare Angophora Reserve contains two vegetation communities, Derived Grassland (as described in Umwelt 2005b) and *Angophora inopina – floribunda* Open Woodland (as described in Umwelt 2005a) (**Figure 2.1**). The Derived Grassland occurs on all areas that have not been assigned any vegetation community on **Figure 2.1** (excluding dams and infrastructure areas). A list of all flora species recorded within the Angophora Reserve to date is included in **Appendix 1**.

Within the Angophora Reserve, the derived grassland is dominated by the opportunistic species blady grass (*Imperata cylindrica* var. *major*), the dense growth of which has resulted in a very low species diversity within the Reserve. Other species recorded within the Derived Grassland include kangaroo grass (*Themeda australis*), saw sedge (*Gahnia* sp.) and the introduced Formosan lilly (*Lilium formosanum*) and paspalum (*Paspalum dilatatum*).

The Angophora inopina – floribunda Open Woodland is dominated by Angophora inopina and its intergrades. Within this community, the shrubs narrow-leaved bottlebrush (*Callistemon linearis*) and mock olive (*Notelaea longifolia*) occur in very isolated patches. In some locations within the PCCS site, the understorey consists of native grasses, including kangaroo grass (*Themeda australis*) and shorthair plume grass (*Dichelachne micrantha*) and introduced grasses including whisky grass (*Andropogon virginicus*), slender pigeon grass (*Setaria gracilis*) and perennial ryegrass (*Lolium perenne*). However, within the Angophora





Source: Pasminco Aerial Photograph

Legend Pasminco Cockle Creek Smelter Site Remediation Boundary Moist Shrubland 🔲 Coastal Foothills Spotted Gum-Ironbark Forest Coast Narrabeen Moist Forest Coust warrabeen worst rotest
 Regenerating and Planted Open Woodland
 Angophora inopina — Angophora floribunda Open Woodland
 Angophora floribunda and A costata Open Woodland

1:12 000

FIGURE 2.1

Vegetation Communities within the Pasminco Cockle Creek Smelter Site

Reserve, the understorey comprises a species composition consistent with that of the Derived Grassland community described above, being heavily dominated by blady grass (*Imperata cylindrica* var. *major*).

Bell (2008) regarded it likely that the Angophora Reserve would have previously supported a vegetation community similar to that of the Coastal Plains Smooth-Barked Apple Woodland (MU 30 in NPWS 2000 (mapping) and house 2003 (vegetation community descriptions)) prior to its disturbance. This community is widespread within the local area and is generally characterised by a canopy of smooth-barked apple (*Angophora costata*) and red bloodwood (*Corymbia gummifera*) and any combination of other canopy species such as Sydney peppermint (*Eucalyptus piperita*), broad-leaved white mahogany (*Eucalyptus umbra*) and brown stringybark (*Eucalyptus capitellata*). The community supports a dry, shrubby midstorey, which may include species such as black she-oak (*Allocasuarina littoralis*), redstemmed wattle (*Acacia myrtifolia*), lemon-scented tea-tree (*Leptospermum polygalifolium*), *Dillwynia retorta* and hairy bush pea (*Pultenaea villosa*). The understorey typically comprises a dense cover of native grasses and other herbs such as wiry panic (*Entolasia stricta*), kangaroo grass (*Themeda australis*) and threeawn speargrass (*Aristida vagans*).

3.0 *Angophora inopina* – Ecology and Conservation Status

Angophora inopina is a small to large tree, up to eight metres high, and is often multistemmed with fibrous bark (Department of Environment and Climate Change (DECC) 2008) (**Plate 1** and **Plate 2**). The flowering season appears to be between mid-December and mid-January, but flowering is generally poor and sporadic (DECC 2008, Hill 1991). It is a member of the Angophora bakeri complex, which also includes Angophora crassifolia, A. paludosa and A. exul (DECC 2008, Hill 1997). None of these related species are known from the same area as Angophora inopina, although A. bakeri does occur sporadically in the ranges to the west, and also near Kurri Kurri in the lower Hunter Valley (Bell 2001). Angophora inopina is a long-lived, resprouting species which can regenerate after disturbance through the development of an extensive lignotuber (Bell 2008).

Angophora inopina is endemic to the Central Coast region of NSW (DECC 2008), centred predominantly on the Gorokan, Doyalson and Wyee soil landscapes (Bell 2008). The known northern limit is near Karuah where a disjunct population occurs; to the south populations generally extend from Toronto to Charmhaven, with the main population occurring between Charmhaven and Morisset (DECC 2008). Approximately 1500 hectares of habitat in which this species occurs has been mapped, excluding the disjunct Karuah populations (Bell 2008).

Angophora inopina occurs most frequently in four main vegetation communities:

- 1) Eucalyptus haemastoma Corymbia gummifera Angophora inopina woodland/ forest;
- 2) Hakea teretifolia Banksia oblongifolia wet heath;
- 3) Eucalyptus resinifera Melaleuca sieberi Angophora inopina sedge woodland; and
- 4) Eucalyptus capitellata Corymbia gummifera Angophora inopina woodland/forest (DECC 2008).

Angophora inopina is listed as Vulnerable in NSW on Part 1, Schedule 2 of the *Threatened* Species Conservation Act 1995 (TSC Act). Angophora inopina is also listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). There is no available guideline indicating how specimens of Angophora inopina





PLATE 1 Mature and juvenile Angophora inopina within the Angophora Reserve



PLATE 2 Mixed age class stand of *Angophora inopina* within the Angophora Reserve shows the dense ground cover of blady grass (*Imperata cylindrica* var. *major*)

- Angophora floribunda intergrade are treated under the NSW TSC Act, nor the Commonwealth EPBC Act. As a precautionary approach, intergrades recorded within the PCCS Site, including in the Angophora Reserve, are regarded as significant specimens, and in terms of their conservation status, are treated in the same manner as pure Angophora inopina.

4.0 Ecological Characteristics of the PCCS Angophora Reserve Population

Surveys within the PCCS Site undertaken for the Environmental Assessment (Umwelt 2005a) identified *Angophora inopina* at several locations; these are shown on **Figure 2.1**. A targeted survey was undertaken on 4 October 2006 by Umwelt (2006) to identify the number of individuals of *Angophora inopina* and *Angophora inopina*—floribunda located within both the Angophora Reserve and a contamination remediation area which occurs to the north of the Angophora Reserve. The surveys revealed that the trees present within this remediation area were predominantly *Angophora inopina* – floribunda intergrades. The results of this survey contributed to determining whether any specific actions needed to be implemented (such as seed collection and supplementary planting), as a result of the loss of the species from the remediation area.

Detailed survey and mapping of each individual *Angophora inopina* or *Angophora inopina* – *floribunda* within the Angophora Reserve has since been undertaken by Umwelt for the purposes of this Management Plan. All individual *Angophora* trees (excluding *Angophora costata*) were marked with a metal tree tag labelled with a unique number, their location recorded with a hand-held global positioning system (GPS), and details such as tree height, diameter at breast height (DBH) and health were recorded for each tree. **Figure 4.1** shows the location, species and age class of all *Angophora* trees within the Angophora Reserve. For the purposes of this mapping, the trees were categorised in accordance with the four age classes defined in **Table 4.1**.

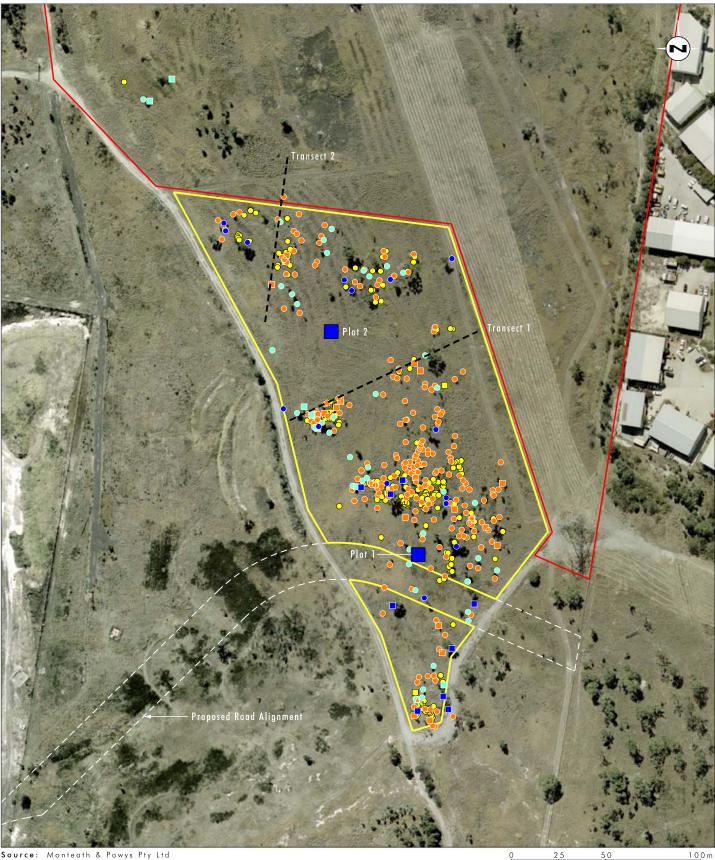
Age Class	DBH Range	Height Range
Class 1	<4 cm	<2 metres
Class 2	4-15 cm	2-4 metres
Class 3	15-20 cm	4-7 metres
Class 4	>20 cm	>7 metres

DBH = diameter at breast height

A total of 530 individual trees were mapped as a result of this survey, of which 469 are Angophora inopina, 60 are Angophora inopina – floribunda intergrades and one is Angophora floribunda. There is likely to be more pure Angophora floribunda present within the Angophora Reserve, however it is difficult to separate specimens of this species from specimens of the intergrade in the field. Therefore, based on the application of the precautionarv principle, the majority of trees displaying characteristics of Angophora floribunda were treated as the intergrade.

Figure 4.1 demonstrates that *Angophora inopina* occurs widely throughout the entire Angophora Reserve, with concentrated patches in several locations. The distribution of age classes is fairly even across the reserve with trees of age class 2 being most predominant. The distribution of individual trees within each age class is presented in **Table 4.2**. There are relatively few trees of age class 4, which are trees of greatest maturity. There are numerous





Source: Monteath & Powys Pty Ltd

Legend

- Cardiff West Estate Site Angophora Reserve (current boundary) Plot location — — Transect location

- Angophora floribunda
 Angophora inopina
 Angophora floribunda-inopina intergrade

1:2000

FIGURE 4.1

Location of *Angophora inopina* within the Angophora Reserve

concentrated patches of age class 1 trees, showing that there is a significant amount of natural regeneration of the *Angophora inopina* occurring. This is predominantly through lignotuber growth, however there is also evidence of seedling recruitment.

Age Class	Angophora inopina	Angophora inopina – floribunda	Angophora floribunda	Total
1	180	15	-	195
2	232	28	-	260
3	42	8	-	50
4	15	9	1	25
TOTAL	469	60	1	530

 Table 4.2 - Results of Age-class Assessment of Individual Trees Surveyed

Table 4.3 shows that the dominant health class of the trees within the Angophora Reserve was 'slightly stressed' for both *Angophora inopina* and *Angophora inopina* – *floribunda*. Comparatively low numbers of trees were stressed, near dead or dead. The stress to the trees observed predominantly comprised dieback of epicormic growth on the trunk and, much less frequently, insect attack to the leaves. The leaves of many individuals were yellowing, however this is a typical characteristic of this species generally.

Table 4.3 - Results of Health	Category Assessment	of Individual Trees Surveyed

Health Category	Angophora inopina	Angophora inopina – floribunda	Angophora floribunda	Total
Healthy	121	15	1	137
Slightly stressed	301	33	-	334
Stressed	40	8	-	48
Near dead	5	1	-	6
Dead	2	3	-	5
TOTAL	469	60	1	530

The Flora and Fauna Master Plan for the PCCS Site (Umwelt 2008) identifies a number of areas of vegetated open space and riparian corridors within the PCCS Site. Fitzwalter have advised Umwelt that the Master Plan for future site development includes a corridor for open space commencing at the southern tip of the Reserve and connecting to Munibung Hills, in accordance with Council's objectives. This connection will further enhance the conservation values of the Angophora Reserve in the long term. This corridor will tentatively link the Angophora Reserve with some of these areas to the south-east and the south-west. There will, however, be a separation of approximately 200 metres between the Angophora Reserve and these open space areas (separated by residential areas). This will provide some limitations to the movement of less mobile fauna species and flora species with restricted dispersal mechanisms.

However, the connectivity between the Angophora Reserve and the open space areas will provide benefits such as genetic transfer between some flora species, and will assist mobile fauna species such as birds and bats to migrate between habitat remnants. There is some potential for ground dwelling reptiles and mammals and arboreal mammals to move between

remnants, however this would determined or limited by the density of vegetation within the residential areas which are planned to be situated among the remnants.

5.0 Ecological Management Strategy

In order to achieve the objectives of the Angophora Reserve identified in **Section 1.2**, action will, or may be required in six key areas. These are discussed in **Sections 5.1** to **5.6**. Regular monitoring (see **Section 6.0**) will be required to ensure that the management actions are achieving the desired objectives. Some specific habitat management advice was sought from Stephen Bell, a botanist with particular expertise and experience in the conservation management of *Angophora inopina*. The report provided by Bell (2008) is included in **Appendix 2**. All management actions described in the following sections are consistent with the recommendations provided by Bell (2008). The areas to which this management plan relates are shown on **Figure 1.3**.

5.1 Regeneration

The following sections relate to the regeneration of individuals of *Angophora inopina* and also regeneration of an appropriate vegetation community within the Angophora Reserve.

5.1.1 Regeneration of *Angophora inopina*

During the inspection of the Angophora Reserve by Umwelt ecologists on 4 October 2006, it was evident that natural regeneration of *Angophora inopina* was occurring with a large number of juvenile plants emerging. *Angophora inopina* is lignotuberous, allowing vegetative regrowth to occur following disturbance. Anecdotal evidence suggests that flowering is generally postponed following disturbances (such as fire), while vegetative recovery occurs (Bell 2001).

Given that natural regeneration of the species is currently occurring, assisted management with the use of fencing (Section 5.3), weed control (Section 5.4) and the exclusion of fire (Section 5.6) should help to ensure that the natural regeneration of *Angophora inopina* in the reserve continues. Should monitoring of the Angophora Reserve (Section 6.0) show that regeneration of *Angophora inopina* is inadequate, then supplementary planting or additional management actions may be required (refer to Sections 5.2 and 6.0).

5.1.2 Regeneration of Natural Vegetation Community

While the regeneration of *Angophora inopina* is important, the re-establishment of a native vegetation community resembling that in which it would have previously occurred is also important. Currently, the vegetation within the Angophora Reserve is very species poor and is dominated by colonising native species and introduced species. The vegetation structure is also highly modified from what would be expected to occur in a natural vegetation community supporting *Angophora inopina*. It is suggested in **Section 4.0** and in Bell (2008) that the Angophora Reserve would have previously supported Coastal Plains Smooth-Barked Apple Woodland.

It is recommended that the objective of the revegetation of the Angophora Reserve be to establish a self-sustaining vegetation community that is consistent with examples of the Coastal Plains Smooth-Barked Apple Woodland that occur within the local area. Bell (2008) recommends that a natural ecosystem will not return to the Angophora Reserve without active management.

The key recommendations put forward by Bell (2008) for the regeneration of the Angophora Reserve are the management of the invasive blady grass (*Imperata cylindrica* var. *major*) as well as replanting of the site with native species which are known to occur within local examples of the Coastal Plains Smooth-Barked Apple Woodland community. Specific management techniques for the integrated control of blady grass (*Imperata cylindrica* var. *major*) within the Angophora Reserve are provided in Bell (2008). These recommendations are summarised below:

- initial cool burn or slashing within the Angophora Reserve to remove above ground biomass;
- apply glyphosate herbicide* when young shoots re-emerge;
- densely plant ground, shrub and tree species; and
- follow-up herbicide application over subsequent years as required.

*Herbicide application should be undertaken by a professional operator with appropriate experience in bush regeneration techniques in areas supporting threatened species. Extreme care should be taken to avoid spray drift onto any native plants, in particular *Angophora inopina*.

These techniques will also provide some control of other weed species occurring in the reserve, thus giving the native plantings the opportunity to establish.

In relation to the planting of native species within the Angophora Reserve, Bell (2008) provides a list of suggested species and ideal planting density. This is included in **Appendix 2**. As many species from this list that can be obtained should be used for the regeneration of the Angophora Reserve. It is strongly recommended that this list is adhered to, and that no other species be supplemented unless advice from a suitably qualified ecologist is sought. The use of tubestock is recommended as the most primary means of re-establishing native plant cover within the Angophora Reserve. All tubestock should be protected from native and feral animal grazing through the use of tree guards. Plantings should be undertaken by an appropriately trained person who has an understanding of native vegetation community composition to ensure that the planting densities and layout reflect a natural ecosystem as closely as possible. Direct seeding is not considered appropriate due to the dense ground cover of competitive species (in particular *Imperata cylindrica* var. *major*) which would competed strongly with and likely inhibit the germination of any seedlings.

5.2 Seed Collection and Propagation of *Angophora inopina*

Resprouting of established individuals following disturbance is the primary method of maintenance of stands of *Angophora inopina*, while recruitment and expansion of the species occurs only through seed dispersal (Bell 2001). As discussed in **Section 4.1**, the adequacy of the existing and future natural regeneration should be assessed during ongoing monitoring of the reserve. If natural regeneration does not appear satisfactory in order to meet the management objectives, supplementary planting of *Angophora inopina* may be necessary. Greenhouse experiments show that germination in *Angophora inopina* occurs quite freely (Bell 2001). Germination rates of 72 per cent have been obtained using smoke water on a commercial propagation mix (Bell 2001).

If supplementary planting is required then seed for propagation must be collected from the *Angophora inopina* individuals occurring within the Angophora Reserve. It is recommended that seed only be collected from pure *Angophora inopina* individuals to ensure the protection

of the genetic integrity of the stand within the Angophora Reserve. The seed collection and propagation procedure should be developed by a suitably qualified authority and any plantings should be undertaken by qualified persons.

5.3 Fencing/Access Control and Signage

The Angophora Reserve should be appropriately fenced to restrict vehicle movement and limit pedestrian access as well as to exclude feral animal species such as rabbits (refer to **Section 5.5**). This will enable *Angophora inopina* to continue to regenerate and colonise other parts of the reserve, facilitate regeneration of native species, and protect any plantings of native species. A perimeter road occurs on the western edge of the Angophora Reserve. A locked gate should be placed across this road to restrict vehicle movement. A key to this locked gate should be provided to any appropriate emergency services, such as the local Rural Fire Service, in case of emergencies. This road will help allow access to the Angophora Reserve for monitoring, weed control and revegetation purposes, and for any bushfire emergencies, and should be maintained for these reasons. Signs should be erected on the fence surrounding the Angophora Reserve detailing the importance and purpose of the conservation reserve.

It is recommended that the perimeter fence be removed approximately 5 years from commencement of regeneration efforts within the Angophora Reserve. It is envisaged that once a dense cover of native shrub and understorey species is established, this will help to restrict access, largely negating the need for the fence. The removal of the fence at a later date will ensure that native fauna species can disperse more freely between the Angophora Reserve and nearby vegetated remnants. Future monitoring of the reserve (discussed in **Section 6.0**), should assess whether an appropriate cover of vegetation has established to enable the fence to be removed. Depending on the final layout of the development of the PCCS Site, it may not be appropriate to remove the fence. If it is found that dispersing fauna would be placed at risk of vehicle collision through the necessity to cross roads, it may be recommended that the fence remain in place.

The fence should not be removed if it is deemed that there will be any adverse impacts on the reserve relating to future surrounding land uses that cannot be foreseen at the time of preparation of this Management Plan.

5.4 Weed Management

Table 5.1 lists those weed species previously recorded in the Angophora Reserve (Umwelt 2007b, Umwelt in prep.) which have some potential threat to the biodiversity of the Angophora Reserve.

Common Name	Scientific Name			
crofton weed	Ageratina adenophora			
blady grass	#Imperata cylindrica var. major			
Formosan lilly	Lilium formosanum			
paspalum	Paspalum dilatatum			
kikuyu	Pennisetum clandestinum			
buffalo grass	Stenotaphrum secundatum			
purple top	Verbena bonariensis			
creeping verbena	Verbena rigida			

Table 5.1 - Weed Species in the Vicinity of the Angophora Reserve

Note #: Although not an introduced species, blady grass (*Imperata cylindrica* var. *major*) is recognised as the most significant current threat to the natural recruitment of native species and survival of planted species. In the context of the Angophora Reserve, it is regarded as a weed species. Management recommendations for blady grass (*Imperata cylindrica* var. *major*) are provided in Section 5.1.2.

The present abundance of some weed species may be limiting opportunities for *Angophora inopina* seedling establishment and development, which may lead to the gradual degradation of habitat (Bell 2001). Aside from blady grass (*Imperata cylindrica* var. *major*), there are currently no weed species that currently require active management within the Angophora Reserve. The extent of weed species within the reserve should be monitored and the weed management actions adopted appropriately in response to any outbreaks.

Crofton weed (*Ageratina adenophora*) (listed in **Table 4.1**), is a declared noxious weed in the Lake Macquarie local government area (in which the Angophora Reserve occurs). Crofton weed is listed under Schedule 4 of the *Noxious Weeds Act 1993* and has a weed control class of 4. The control objective for weed control class 4 is to minimise the negative impact of those plants on the economy, community or environment of NSW (DPI 2005). The low density of crofton weed within the Angophora Reserve means that it does not require management action. However, in the event that future monitoring identifies a significant increase in this species' abundance, appropriate management actions should be devised and implemented.

Weed control methods should be matched with good land management practices to obtain the best result. Kirkpatrick and Gilfedder (1999) suggest that the following issues be considered when selecting a weed control method:

- degree of infestation;
- native plants present and how they should be protected;
- presence of soil erosion;
- likelihood of prolific regeneration of the weeds from seed; and
- ability of the weeds to resprout from their roots.

Due to the small size of the Angophora Reserve and sensitivities due to the presence of *Angophora inopina*, the management of weed species should be preferably undertaken through mechanical removal of plants. Hand-pulling is labour intensive but a very effective

method for reducing the size of weed populations. Herbicide application may be appropriate in situations where the infestation is large, however should only be undertaken by an appropriately trained person to ensure that there is no adverse impact on native species, in particular *Angophora inopina*. For example, herbicide control has been recommended for the control of the invasive blady grass (*Imperata cylindrica* var. *major*) within the Angophora Reserve due to the extent of the infestation.

Consideration should be given to the establishment of a local Landcare group as this will contribute to the long-term follow-up management of weed species within the Angophora Reserve, as well as giving local residents ownership and responsibility over the reserve. The commitment and contribution of such groups will greatly enhance the long-term viability of the Angophora Reserve.

The extent of the weed species within the Angophora Reserve should be monitored (**Section 6.0**) to evaluate the threat of the weeds on the general health of the *Angophora inopina* population.

5.5 Feral Fauna Management

Fauna surveys undertaken by Umwelt (2005a) identified a number of introduced species, which were considered to be common on the PCCS site. These species comprised the black rat (*Rattus rattus*), house mouse (*Mus musculus*), rabbit (*Oryctolagus cuniculus*) and fox (*Vulpes vulpes*).

There is some anecdotal evidence suggesting that grazing and trampling by animals, and in particular domestic cows (*Bos taurus*) and goats (*Capra hircus*), can have a negative impact on *Angophora inopina* (Bell 2001). The feral animals recorded to date within the PCCS site are not considered to be a threat to *Angophora inopina*. However, on-going monitoring (refer to **Section 6.0**) should examine the effect that rabbit grazing may have upon *Angophora inopina* seedlings.

In order to limit the possible grazing impacts of rabbits from the Angophora Reserve, the perimeter fence will be appropriate for the exclusion of this species (refer to **Section 5.3**). This will minimise the impacts on any plantings within the Angophora Reserve. As described in **Section 5.1.2**, the use of tree guards around tubestock plantings is also recommended to reduce the impacts of grazing by both native and feral animals.

In the event that monitoring reveals that feral animal grazing is impacting on the recruitment of *Angophora inopina* or any other native plantings within the Angophora Reserve, further management actions should be implemented.

5.6 Bushfire Management

Angophora inopina resprouts following fire, as with most species in the Myrtaceae family (Bell 2001). Depending on fire intensity, this resprouting can be via epicormic shoots on trunks, or from the submerged lignotuber (Bell 2001). Almost the entire known habitat for *Angophora inopina* occurs in a fire prone environment. Surveys have shown that this species persists in regularly fired areas through resprouting, although high fire frequencies do limit flowering and seed set (Bell 2001). *Angophora inopina* has been recorded in areas which have been recently burnt (<12 months), as well as areas not suffering a burn for >25 years (Bell 2001). The majority of land on which *Angophora inopina* persists are subject to burns (either through arson or controlled burning) every two to five years (Bell 2001).

Regular fire has been identified as a threat to the long-=term survival of this species (Bell 2001).

Conservation of *Angophora inopina* requires that both natural and prescribed fire intensity and frequency be managed to ensure the long term preservation of populations (Bell 2001). However, a lack of scientific knowledge makes it difficult to balance the benefits and costs of fire on *Angophora inopina* (Bell 2001). For the specific management of *Angophora inopina* in the Angophora Reserve, a precautionary approach to prescribed or hazard reduction burning is recommended due to the current limited knowledge of this species' response to fire. It is recommended that the Angophora Reserve remains a fire free zone until it can be considered likely, through monitoring (see **Section 6.0**), that this population can survive a severe fire event.

5.7 **Topsoil Application**

Previously, discussion has been given to the need for application of topsoil to the Angophora Reserve to assist in the regeneration of *Angophora inopina*. It is recommended (and endorsed by Bell 2008) that application of topsoil is not necessary for the successful regeneration of the Angophora Reserve. Bell (2008) identifies that there is currently sufficient soil cover to enable appropriate understorey development, although it is shallow in some areas. Bell (2008) also recognises that additional management issues may arise should externally sourced topsoil be applied, such as increased erosion (and subsequent sedimentation) as well as introduction of exotic plant species.

6.0 Monitoring

6.1 Introduction

The monitoring program for the Angophora Reserve will consist of a baseline survey at the commencement of the program, followed by a vegetation survey using vegetation quadrats and photo monitoring within the *Angophora inopina* open woodland over a period of five years. After five years the need for future monitoring should be assessed.

6.2 Objective

The objective of the monitoring program will be to determine if there is any improvement or deterioration in *Angophora inopina* habitat within the Angophora Reserve area and, where necessary, provide management recommendations to achieve further improvements in ecological management.

6.3 Baseline Monitoring Survey

A baseline survey was undertaken within the Angophora Reserve in January 2007 (Umwelt 2007b). The detailed methods employed for the baseline monitoring are described in the baseline monitoring report (Umwelt 2007b). A subsequent monitoring survey was undertaken in February 2008 (Umwelt in prep.), following the same methods. The location of the two transects and two plots are shown on **Figure 4.1**.

6.3.1 Monitoring Methods

The methods of the monitoring program are systematic yet repeatable. The key methods were the establishment and survey of two permanently marked 1,024m² nested quadrats and the establishment and survey of two permanently marked 100m long transects. The nested quadrats allow systematic survey of the floristic composition and structural diversity, while the transects focus on the collation of information on individual *Angophora inopina* trees, in particular their height, DBH, health and evidence of recruitment. The nested quadrats were sampled using systematic, repeatable techniques, including the Modified Braun-Blanquet Cover-abundance method, to ensure the data collected are comparable from year to year and are as little affected by observer bias as possible. This allows a comparison of flora species diversity and abundance over time.

Within each quadrat or transect, the following aspects were assessed:

- native and introduced species diversity and abundance;
- incidence of weeds and feral animals;
- evidence of natural regeneration of *Angophora inopina* and whether supplementary planting of this species needs to be undertaken;
- signs of damage to the Angophora Reserve through vandalism or pollution;
- the adequacy of fencing and signage; and
- any signs and levels of impacts of fire.

All four survey sites were permanently marked in each corner with a metal stake to enable them to be relocated in subsequent monitoring events. The location of Plot 2, documented in Umwelt (2007b) was relocated for the 2008 monitoring (Umwelt in prep.) due to boundary modifications. The new location of Plot 2 is shown on **Figure 4.1**. There have since been further modifications that require Plot 2 to be relocated. It is proposed that a new plot be established during the next monitoring survey. All subsequent monitoring surveys should be undertaken by suitably qualified and experienced ecologists.

Photo monitoring points were established within each of the permanent monitoring quadrats. Photo monitoring will assist in recording observable changes to the Angophora Reserve over time. Photo monitoring will be undertaken from each corner of the monitoring plot or transect, and the bearings of each photograph will be recorded.

6.3.2 Monitoring Schedule

The monitoring program should continue using the same methods as those employed for the baseline surveys (Umwelt 2007b) for five years with the number and frequency of the monitoring surveys to be reassessed after each monitoring event. Umwelt (2007a) proposed six-monthly monitoring of the Angophora Reserve for the first 12 months, commencing from the baseline monitoring survey. Due to unforeseen modifications to the boundary of the Angophora Reserve, the 2007 six monthly monitoring was not able to be undertaken. As such, the six monthly monitoring should commence from the February 2008 monitoring, with the next survey to be scheduled for August 2008 and again in February 2009. Based on the outcomes of the second six-monthly programs are required or whether the monitoring can continue on an annual basis. Based on the above recommendations, a summary of the schedule of monitoring within the Angophora Reserve is outlined in **Table 6.1**.

Year	Monitoring Event	Comments		
Summer 2007	Baseline monitoring survey	Completed.		
Summer 2008	Year 1 monitoring survey	Completed February 2008.		
Winter 2008	Six monthly monitoring survey	-		
Summer 2009	Year 2/six monthly monitoring survey	Frequency of monitoring to be reviewed.		
Summer 2010	Year 3 monitoring survey	Timing subject to outcomes of previous monitoring.		
Summer 2011	Year 4 monitoring survey	Timing subject to outcomes of previous monitoring.		
Summer 2012	Year 5 monitoring survey	Timing subject to outcomes of previous monitoring. Assess need for future monitoring surveys.		

Table 6.1 - Monitoring Schedule

7.0 Reporting Requirements

The monitoring process should be documented in six-monthly reports and then annual reports. The reports should include the following details:

- Methods;
- Results and Discussion;
- Conclusions; and
- Recommendations.

Reports should be prepared and submitted to Fitzwalter Pty Ltd within two months of each monitoring event. A copy of these reports may be forwarded on to Lake Macquarie City Council for their review and consideration at the discretion of Fitzwalter Pty Limited.

8.0 Adaptive Management

A strong positive feedback loop between monitoring and adaptive management will be necessary. The successful management of the ecological components of the Angophora Reserve will be dependent upon appropriate responsiveness to any new ecological data that may arise through the ecological monitoring of the Angophora Reserve. This will enable a flexible approach to the management requirements, allowing ongoing feedback and continual refinement and improvement of the management strategy.

9.0 Conclusions

A total of 530 Angophora inopina or Angophora inopina – floribunda trees have been recorded within the Angophora Reserve, and there is substantial evidence of natural recruitment. The natural recruitment of Angophora inopina within the Angophora Reserve negates the need for any seeding or planting of this species at present. The outcomes of

future monitoring of the site should recommend any necessary actions if the natural recruitment is found to be declining.

The reconstruction of a natural vegetation community within the Angophora Reserve requires active management. The target vegetation community is Coastal Plains Smooth-Barked Apple Woodland, of which *Angophora inopina* will be a component of the canopy and mid – stratum. The key actions required for the reconstruction of this community is the control of blady grass (*Imperata cylindrica* var. *major*) and the planting of locally occurring native species from the recommended list provided by Bell (2003). Other management issues that need to be addressed as detailed above include fencing, access control and signage, weed control and bushfire management. The ongoing monitoring program that has been established will be used to assess the success or otherwise of management actions implemented, as well as to identify further management actions required as new issues arise.

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APPENDIX 1

Flora Species List

Appendix 1 – Flora Species List

The following list was developed from surveys of the Angophora Reserve, including Umwelt (2007a), Umwelt (in prep.) and Bell (2008).

The list includes all species of vascular plants observed on the Angophora Reserve during these surveys. Not all species are readily detected at any one time of the year, therefore the list will not necessarily include all plant species likely to occur in the Angophora Reserve. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

- sp. specimens that are identified to genus level only;
- ? specimens for which identification was uncertain;
- prob. specimens for which identification was considered highly likely but not definite; and
- poss. specimens for which identification was considered likely but not definite.

The following abbreviations or symbols are used in the list:

asterisk (*) denotes species not indigenous to the study area;

- subsp. subspecies;
- var. variety;
- f. forma; and
- X hybrid.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Wheeler et al. (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2006-2008), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Family	Scientific Name	Common Name	Umwelt (2007a)	Umwelt (in prep.)	Bell (2008)
Filicopsida (Ferns)					
Adiantaceae	Cheilanthes distans	bristly cloak fern	Х		
Dennstaedtiaceae	Pteridium esculentum	bracken	Х		Х
Dicksoniaceae	Calochlaena dubia	false bracken fern		Х	
Magnoliopsida (Floweri	ng Plants) - Liliidae (Monocots)				
Commelinaceae	Commelina cyanea	native wandering Jew		Х	
Cyperaceae	Carex inversa	knob sedge		Х	
Cyperaceae	Fimbristylis dichotoma	common fridge-sedge		Х	
Cyperaceae	Gahnia radula	saw sedge			Х
Cyperaceae	Gahnia sp.	a saw sedge	Х		
Juncaceae	*Juncus acutus	sharp rush		Х	
Juncaceae	*Juncus cognatus				х
Juncaceae	Juncus sp.		Х	Х	
Juncacae	Juncus usitatus	common rush		Х	
Liliaceae	*Lilium formosanum	tiger lily	Х	Х	Х
Lomandraceae	Lomandra multiflora	many-flowered mat-rush	x		
Phormiaceae	Dianella caerulea	blue flax-lily	Х		
Phormiaceae	Dianella caerulea var. caerulea	blue flax-lily		Х	
Phormiaceae	Dianella revoluta var. revoluta				x
Phormiaceae	Dianella sp.			Х	
Poaceae	Capillipedium spicigerum	scented-top grass	X	Х	
Poaceae	Cynodon dactylon	common couch	Х	Х	Х
Poaceae	Dichelachne micrantha	shorthair plumegrass		Х	
Poaceae	Imperata cylindrica var. major	blady grass	х	х	x
Poaceae	*Paspalum dilatatum	paspalum	Х	Х	Х

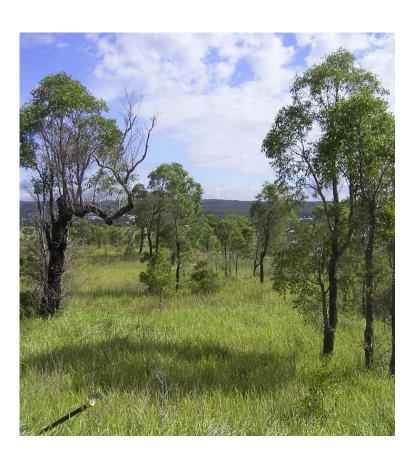
Family	Scientific Name	Common Name	Umwelt (2007a)	Umwelt (in prep.)	Bell (2008)
Magnoliopsida (Flowering	Plants) - Liliidae (Monocots)				
Poaceae	*Pennisetum clandestinum	kikuyu grass			Х
Poaceae	*Setaria gracilis	slender pigeon grass	Х	Х	
Poaceae	*Sorghum halepense	Johnson grass			Х
Poaceae	*Stenotaphrum secundatum	buffalo grass	х		
Poaceae	Themeda australis	kangaroo grass	Х	Х	Х
Xanthorrhoeaceae	Xanthorrhoea latifolia subsp. latifolia				x
Xanthorrhoeaceae	Xanthorrhoea sp.		Х	Х	
Magnoliopsida (Flowering	Plants) - Magnoliidae (Dicots)				
Asteraceae	*Ageratina adenophora	crofton weed		Х	Х
Asteraceae	*Bidens pilosa	cobblers pegs			Х
Asteraceae	*Conyza bonariensis	flaxleaf fleabane		Х	Х
Asteraceae	*Conyza sp.			Х	
Asteraceae	*Conyza sumatrensis	tall fleabane	Х	Х	
Asteraceae	*Taraxacum officinale	dandelion	Х	Х	Х
Euphorbiaceae	Glochidion ferdinandi var. ferdinandi	cheese tree			х
Fabaceae (Faboideae)	*Trifolium hirtum	rose clover	х		
Fabaceae (Faboideae)	*Trifolium repens	white clover	х		х
Fabaceae (Mimosoideae)	Acacia falcata	sickle wattle			х
Fabaceae (Mimosoideae)	Acacia longifolia subsp. longifolia	Sydney golden wattle			Х
Fabaceae (Mimosoideae)	Acacia myrtifolia	red-stemmed wattle			х
Gentianaceae	Centaurium spicatum	spike centaury	Х	Х	
Loranthaceae	Dendrophthoe vitellina				Х

Family	Scientific Name	Common Name	Umwelt (2007a)	Umwelt (in prep.)	Bell (2008)
Magnoliopsida (Floweri	ng Plants) - Magnoliidae (Dicots)				
•• /					X
Myrtaceae	Angophora costata	Sydney red/rusty gum	X		Х
Myrtaceae	Angophora floribunda	rough-barked apple	X	X	
Myrtaceae	Angophora inopina	Charmhaven apple	X	Х	Х
Myrtaceae	Angophora floribunda - inopina		х	Х	
Myrtaceae	Callistemon linearis	narrow-leaved bottlebrush	х	Х	x
Myrtaceae	Corymbia maculata	spotted gum		Х	Х
Myrtaceae	Eucalyptus resinifera subsp. resinifera	red mahogany			x
Myrtaceae	Eucalyptus sp. (juvenile)		Х	Х	
Myrtaceae	Eucalyptus tereticornis	forest red gum			Х
Myrtaceae	Leptospermum polygalifolium	lemon-scented tea-tre	x		
Oleaceae	Notelaea longifolia	large mock-olive	Х		
Oleaceae	Notelaea longifolia forma longifolia	large mock-olive		х	x
Plantaginaceae	*Plantago lanceolata	lambs tongues	Х	Х	Х
Primulaceae	*Anagallis arvensis	scarlet/blue pimpernel	х	Х	
Rosaceae	*Rubus fruticosus sp. agg.	blackberry complex	Х		
Scrophulariaceae	*Verbascum virgatum	twiggy mullein	Х	Х	
Scrophulariaceae	Verbascum sp.				Х
Verbenaceae	*Lantana camara	lantana			Х
Verbenaceae	*Verbena bonariensis	purpletop	Х	Х	Х
Verbenaceae	*Verbena rigida	veined verbena	Х	Х	
Verbenaceae	*Verbena rigida var. rigida	veined verbena		Х	Х

APPENDIX 2

Habitat Management Advice (Bell 2008)

Habitat Management Advice for *Angophora Reserve*, Pasminco Cockle Creek Smelter, Lake Macquarie



Report to

Fitzwalter Group 633 Harris St Ultimo NSW 2007



February 2008

Stephen A.J. Bell



Eastcoast Flora Survey PO Box 216 Kotara Fair NSW 2289

Habitat Management Advice for Angophora Reserve, Pasminco Cockle Creek Smelter, Lake Macquarie.

Report to Fitzwalter Group

Stephen A.J. Bell

February 2008

Summary

An inspection has been made of Angophora Reserve on the Pasminco site at Cockle Creek, with the aim of providing information that may be used for the management of this reserve. Based on remnant vegetation present both on the site and in nearby locations, it is likely that Coastal Plains Smooth-barked Apple Woodland once covered the site, and a list of suitable understorey plants and their planting densities has been provided. However, it is suggested that the dense swards of Blady Grass (*Imperata cylindrica* var. *major*) be controlled initially, with the long-term aim that shading by the developing understorey will reduce the vigour of this species. The existing density of *Angophora inopina* plants is consistent with other natural populations elsewhere, and additional propagation or replanting of specimens is not considered necessary given the existence already of a soil profile, and the potential that additional weed propagules may be introduced to the site.

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Acknowledgements

Thanks to Max Elliott, Dee Murdoch and John Simpson for discussions on rehabilitation and weed control.

1.0 Background

The Fitzwalter Group have requested information relating to the rehabilitation of Angophora Reserve, on the Pasminco Cockle Creek Smelter (PCCS) site at Boolaroo in Lake Macquarie. Angophora Reserve has been established solely for the protection of *Angophora inopina*, a small tree that is listed as Vulnerable on the NSW *Threatened Species Conservation Act 1995*.

Currently, Angophora Reserve consists of scattered plants of *Angophora inopina* over a grassy understorey of few native species and some weeds. For future rehabilitation of the site, the following information is being sought:

- appropriate understorey vegetation that could be co-planted with the *A.inopina* including the density of this planting;
- any possible management to be applied to the *A.inopina* (let it re-seed naturally or collect seeds from other areas for planting in the Angophora Reserve);
- possibilities for relocating juvenile trees from other areas within the Pasminco Site for replanting in the Angophora Reserve;
- advice regarding the value or benefit of adding either 25mm or 50mm of porous sandy (or other) topsoil to enhance the Angophora Reserve soil bank.

This report outlines the suggested actions required to rehabilitate Angophora Reserve, and to enhance the habitat for *Angophora inopina*.

2.0 The Study Area

For over 100 years the lead smelting process has occurred within the Pasminco Cockle Creek Smelter vicinity, including the site of Angophora Reserve. Historical photographs show that the native vegetation on the hills behind the smelter were ringbarked and felled as early as 1903 (Anon, no date), if not earlier (Figure 1). In 1939, this area was still devoid of native vegetation (Figure 2). The lead smelter ceased operations in September 2003, and remediation of the site and an exit strategy began.

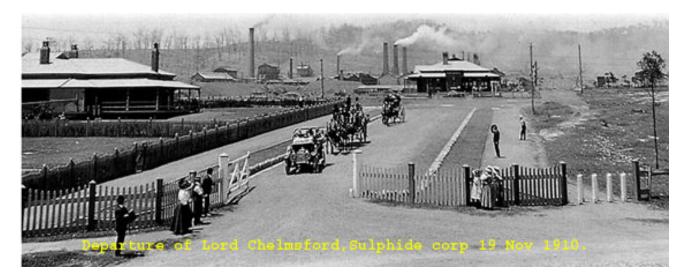


Figure 1 Entrance to the Pasminco site in 1910. Note the bare hills with ringbarked trees in the background. (Source: *One Last Look: Memories of the Pasminco Smelter*)



Figure 2 Aerial view of the Pasminco site in 1939. Angophora Reserve is in the middle distance at the left. (Source: *One Last Look: Memories of the Pasminco Smelter*)

Angophora Reserve lies on the north-western slope of Munibung Hill in Lake Macquarie LGA, at the rear of the former PCCS (Figure 3). It occupies 2.7ha of land, which has been previously cleared for grazing and has been subjected to fallout from the lead smelting process for over 100 years. The site currently supports scattered small trees of *Angophora inopina* over an understorey dominated by grasses.

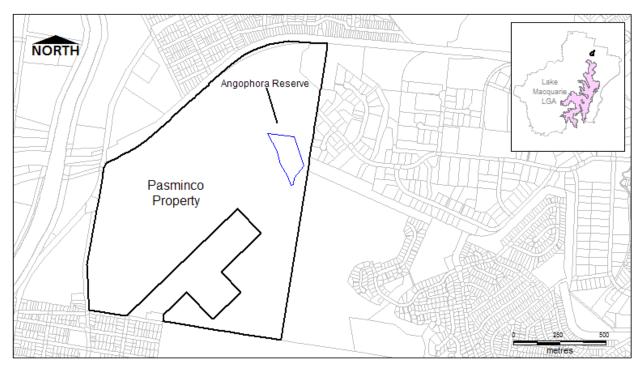


Figure 3 Location of the area of investigation, Angophora Reserve.

3.0 Angophora inopina

General Description

Angophora inopina is long-lived, small tree to 8m in height, often multi-stemmed, and with persistent shortly fibrous bark throughout (Tierney 2004). It occurs from the Bulahdelah area on the North Coast to the Warnervale area on the Central Coast, a geographical range of ~120km. Adult leaves are moderately glossy, coriaceous, mid-green, opposite, discolourous and paler beneath, lanceolate to broad-lanceolate, acute, 4-11cm long, and 0.8-2.6cm wide. Petioles are robust, flattened, and 0.5-0.8cm in length. The inflorescence is compound and terminal, with unit umbellasters 3 to 7-flowered. Peduncles are setose, terete, and 3-17mm long. Mature buds are setose, ribbed, globular to pyriform, 5-7mm long, and 5-7mm diameter. Fruits are setose, vaguely ribbed, cup shaped to pyriform, more or less truncate, usually 3-locular, 11-15mm long, and 9-12mm in diameter. Valves are broadly triangular, obtuse, enclosed and steeply raised (Hill 1997).

Conservation Status

Angophora inopina is currently listed as Vulnerable in NSW on Part 1, Schedule 2 of the *NSW Threatened Species Conservation Act 1995.* The species is also listed as Vulnerable on the schedules of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999*, and hence is protected under Commonwealth legislation. When describing the species, Hill (1997) suggested a conservation risk code of 2R-, following the criteria of Briggs and Leigh (1996). This code indicates that *Angophora inopina* is a rare species with a geographical range of less than 100km, but with insufficient information on reservation status. Following more recent work on this species, this code should now be revised to 2RCi to reflect representation of small populations (<1000 plants, but considered inadequate) within Lake Macquarie State Conservation Area, Wallaroo and Karuah Nature Reserve's (Bell 1998; Leonard 2001; Bell 2002). In the future event that Crown lands around Morisset (where significant populations are known) become included in National Parks estate, the conservation risk code for this species may change to adequate conservation (2RCa).

Taxonomic History

Historically, *Angophora inopina* had gone unnoticed within botanical circles, probably having previously been regarded as *Angophora floribunda*. In 1995, specimens of an unknown *Angophora* were collected from the grounds of Vales Point Power Station near Doyalson, and relayed to the National Herbarium in Sydney for identification (Bell 1995). Subsequently, additional collections provided the impetus for formal description of the species, culminating in the publication of Hill (1997).

Angophora inopina is a member of the *A. bakeri* C Hall complex, which also includes *A. crassifolia, A. paludosa* and *A. exul.* It may be distinguished within that group by the broad, coriaceous leaves with short, broad petioles. It is most similar to *A. crassifolia,* from which it is distinguished by the broader leaves (lower length: breadth ratio) with shorter petioles (lower blade: petiole ratio) (Hill 1997). None of these three similar species are known from the same area as *A. inopina,* although *A. bakeri* does occur sporadically in the ranges to the west, and also near Kurri Kurri in the lower Hunter Valley. *A. crassifolia* occurs in Ku-ringgai Chase and Garigal National Parks south of the Hawkesbury River (Briggs & Leigh 1996), while *A. exul* is restricted to a small portion of the Northern Tablelands well to the north.

Ecology and Habitat

Tierney (2004) has examined the pollination and germination requirements in this species, concluding that population structure is significant in determining the ability of the population to respond to recruitment clues. *Angophora inopina* is a long-lived, resprouting species enabling it to respond to disturbance through the development of an extensive lignotuber. The known habitat for this species on the Central Coast has been documented in Bell (2004). In this region, *Angophora inopina* occurs within three broad habitat types, centred mainly on the Gorokan, Doyalson and Wyong soil landscapes. Most stands are evident within open woodland/ forest vegetation where *Eucalyptus haemastoma, Corymbia gummifera*, and *Eucalyptus capitellata* dominate with *Angophora inopina*. Other populations occur in wet-dry heath, and swamp forest environments where sedge species are characteristic. These habitat types together occupy over 4,200ha in the region (NPWS 2000), with approximately 1,500ha of occupied habitat supporting the species (Bell 2004).

Presence in the Region

Research conducted on this species in the Sydney Basin bioregion indicates that the Morisset area represents the centre of distribution of the species, which extends from Warnervale in the south, to as far north as Karuah, and Bulahdelah (Bell 2004). Some populations around the major drainage lines (eg: Dora Creek, Cockle Creek) also display hybrid characteristics with the closely related *Angophora floribunda*, which occurs more commonly on deeper alluvial soils.

Within the bioregion, approximately 1500ha of occupied habitat supporting *Angophora inopina* has been mapped, excluding populations in the Karuah area (Bell 2004). Representation within secure conservation reserves includes Lake Macquarie State Conservation Area (Bell 1998), and Karuah and Wallaroo Nature Reserves (Bell 2002).

4.0 Methods

The PCCS and nearby areas were visited on 6 February 2008. Angophora Reserve was inspected on foot and a plant species list compiled to assist with profiling the original habitat. Lands to the immediate south-east at the rear of the Macquarie Hills housing estate were also inspected for native plant species. In addition, a similar stand of remnant bushland supporting *Angophora inopina* was examined near Edgeworth (~2km to the north-west), to provide additional co-occurring plant species, although that site occurs at lower elevation and potentially supports a different suite of species.

The three aims of the site inspections were to gather information on:

- the diversity of native plant species remaining within Angophora Reserve;
- the original habitat that may have once occurred on the Pasminco site; and
- any management issues apparent that may impact on rehabilitation of the Reserve.

5.0 Results

Species Diversity

In total, only eighteen native species were noted from Angophora Reserve, with diversity impacted upon severely by the density of one native grass species (*Imperata cylindrica* var. *major*). Appendix 1 shows all plant species recorded within the Angophora reserve and nearby sites. It is likely that repeated fire events or slashing have promoted dense growth of *Imperata cylindrica*.

Original Habitat

Based on the remnant native trees and understorey plants in the immediate vicinity of the Reserve, it is likely that Coastal Plains Smooth-barked Apple Woodland (MU30 in NPWS 2000) formerly covered the site, which is consistent with remnant vegetation in the adjacent Cardiff Industrial Estate and Macquarie Hills housing estate. Tree species such as *Angophora inopina, Angophora costata, Eucalyptus resinifera* and *Eucalyptus umbra*, together with the shrubs *Dillwynia retorta, Acacia myrtifolia, Callistemon linearis, Acacia longifolia, Acacia falcata* and *Leptospermum polygalifolium* are consistent with MU30. Although dominated by *Imperata cylindrica* var. *major*, the ground layer within Angophora Reserve also supports species expected from this vegetation type, such as *Xanthorrhoea latifolia* subsp. *latifolia, Themeda australis* and *Gahnia radula*.

Management Issues

The field inspection of Angophora Reserve revealed a severe infestation of Blady Grass (*Imperata cylindrica* var. *major*) across the site, which has hampered any regeneration by other native species. This dominance by Blady Grass is no doubt in response to previous clearing and regular burning or slashing of the site.

Several weed species are also present (eg: *Cynodon dactylon, Ageratina adenophora, Verbena bonariensis, Conyza bonariensis*), together with other invasive natives such as *Gahnia radula*. Apart from the presence in parts of the native shrub *Callistemon linearis*, the mid storey is virtually non-existent. Given the density of *Imperata cylindrica* var. *major*, there are few other native ground layer species, and those that are present are in low numbers. Importantly, however, some species (eg *Xanthorrhoea latifolia* subsp. *latifolia*, *Acacia myrtifolia*) are present which provide strong clues to the original vegetation type present.

Prior to any attempts to revegetate, it will be necessary to deal with the weed species present on the site, including the dense swards of Blady Grass, which in this situation has become highly invasive. Suggestions in this regard are made in Section 7.0.

6.0 Discussion

Reconstruction of Original Habitat

As can be appreciated, it is difficult to reconstruct a habitat that has been locally extinct for over 100 years, with a view to protecting a Vulnerable plant species in its original context. However, remnant vegetation that has managed to regenerate on the site and nearby areas provides clues to the original composition. With little doubt, it is likely that the original vegetation of the hills and slopes supporting Angophora Reserve and surrounds once comprised the Coastal Plains Smooth-barked Apple Woodland (NPWS 2000). This vegetation community is relatively widespread in Lake Macquarie, and is characterised by *Angophora costata, Corymbia gummifera, Eucalyptus resinifera* and *Eucalyptus umbra*, and in places *Angophora inopina*.

It is uncertain whether or not *Angophora inopina* was originally as dominant on the site as it is today, given the extensive lignotuber that this species produces, and consequently its ability to continually respond to the removal of aerial stems (such as felling and slashing) through vigorous resprouting. Although lignotuber development has been shown in some of the other co-dominant eucalypts in this community (eg: *Corymbia gummifera*: Mullette 1978), this rarely occurs and is often a response to environmental stress. It is possible that *Angophora costata, Eucalyptus resinifera, Corymbia gummifera* and *Eucalyptus umbra* may have been eradicated through continual felling and slashing, while *Angophora inopina* repeatedly resprouted due to its superior lignotuber.

On the Central Coast, three common habitat types for *Angophora inopina* have been documented (Bell 2004). By far the most common habitat supporting this species is the *Eucalyptus haemastoma* Woodland/ Forest, which equates to the Coastal Plains Scribbly Gum Woodland of NPWS (2000). The other two habitats outlined occupy more restricted distributions, occurring as wet heath or in sedge-dominated drainage lines. Habitat present on and near the Pasminco site is not represented by any of these three habitat types, probably due to a lack of data at the time that study was done. Consequently, the Coastal Plains Smooth-barked Apple Woodland represents a new habitat type for *Angophora inopina* on the Central Coast.

Rehabilitation of Angophora Reserve

Angophora Reserve, in its current state, will not return to a natural ecosystem without active management. The ground layer vegetation is nearly exclusively dominated by Blady Grass (*Imperata cylindrica* var. *major*), which has severely impacted upon the natural revegetation of the site. Problems of rehabilitation in areas dominated by Blady Grass have been reported from many parts of the world (eg: Chikoye & Ekeleme 2001; Brewer & Cralle 2003). It is likely that a period of 8-10 years of integrated management will be required, during which time the density and cover of Blady Grass should reduce, while at the same time replanted tree and understorey species become established. Management of other weed species may also be required during this period.

From the list of native plant species recorded at or near to the Reserve (Appendix 1), those included in Table 1 are considered appropriate for inclusion in revegetation plans for Angophora Reserve. A suggested planting density has also been included in the table.

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Layer	Species	Density (plants/10m ²)	Comment
Trees	Angophora inopina Angophora costata Eucalyptus resinifera Corymbia gummifera Eucalyptus umbra	- 0.5 0.5 0.5 0.5	already present in sufficient amounts
Shrubs	Acacia falcata Acacia myrtifolia Acacia longifolia Allocasuarina littoralis Callistemon linearis Daviesia ulicifolia Dillwynia retorta Epacris pulchella Leptospermum polygalifoliun Pultenaea villosa	2 2 1 0.5 - 2 3 2 m 1 2	already present in sufficient amounts difficult to propagate
Grasses	Aristida ramosa Aristida vagans Entolasia stricta Eragrostis brownii Panicum simile Themeda australis	3 2 2 4 2 10	
Forbs	Phyllanthus hirtellus	3	
Sedges	Dianella caerulea Lomandra multiflora Lomandra confertifolia Ptilothrix deusta Xanthorhhoea latifolia	1 1 1 3 1	
Vines	Kennedia rubicunda Hardenbergia violaceae	0.5 0.5	
Ferns	Cheilanthes sieberi	2	

Table 1 Suggested planting composition and density, Angophora Reserve.

Topsoil Application

Provided the existing cover of Blady Grass can be reduced in biomass (see below), it is considered unnecessary to topsoil the site to improve revegetation. The existing site still maintains a soil cover sufficient for understorey development, although in places this layer does appear shallow. The addition of additional topsoil may also pose an erosion problem during rainfall events, and may introduce exotic plant propagules to the site depending on topsoil origin.

Blady Grass Control

Although a native species, Blady grass is never an overly dominant species in a healthy ecosystem, and is considered in this context as a weed. The eradication of Blady Grass from the Reserve represents the first hurdle to be overcome in the rehabilitation process. This is not an easy task, and requires a persistent approach of integrated management. Chikoye (2003) has summarised the reviews of Brook (1989), Townson (1991), and Terry *et al.* (1997), and states that the key objective of any management strategy should be the destruction of rhizomes, which are the main organs by which the weed spreads. In the long term, the ideal strategy for Angophora Reserve would be the re-establishment of shrub and tree layers so that shading will reduce the competitiveness of Blady Grass.

Chikoye (2003) summarises the following control techniques for Blady Grass:

- 1. **Fire prevention/control** Fire prevention or control is an important factor for *I. cylindrica*dominated grasslands because it hastens the rate of natural succession to secondary forest that would eventually shade and suppress the weed. Preventing the start of wildfires and the suppression of those that start can reduce burning.
- 2. **Slashing/cutting** Slashing followed by burning is a common practice for clearing the foliage of *I. cylindrica* on arable farms before tillage or sowing. To be effective and exhaust carbohydrate reserves in the rhizome, slashing must be repeated at frequent intervals. For example, Soerjani (1970) suggested an interval of two weeks over a period of three years. Repeated slashing also induces flowering and hence can facilitate the spread of the weed. Slashing should be integrated with other options to reduce the amount of labour required.
- 3. **Pressing/Flattening** Pressing is accomplished by bending the culms (stems) of *I. cylindrica* at ground level. If the stems are tall (1m or more), their own weight helps keep the grass flattened (Terry *et al.* 1997). In the middle belt of Nigeria, farmers bend the foliage of *I. cylindrica* at the beginning of the rainy season immediately followed by shallow tillage where soil is placed over the stems to keep them flattened. Tillage is carried out four weeks later, to completely cover the foliage and rhizomes. Regrowth of *I. cylindrica* after flattening is 20-60 percent lower than after slashing and it is cheaper and faster than slashing. It reduces the fire risk and facilitates the establishment of cover crops. Pressing can be done using planks, logs or drums (Friday *et al.* 1999).
- 4. Tillage Tillage, if not preceded by slashing or burning, has the role of knocking-down the foliage as well as damaging the rhizomes and preventing their regrowth into new shoots by fragmentation, desiccation, and deep burial. Tillage should be to a depth of about 30-40 cm, since most rhizomes are found above this depth. Rhizomes should be broken into the shortest fragments possible and buried as deeply as possible. The disadvantages of using tillage to control *I. cylindrica* are that it takes a long time to get acceptable control, it has be repeated several times, and it is expensive and may promote soil erosion (Townson, 1991; Terry *et al.* 1997).
- 5. Chemical control Herbicides are quicker, cost-effective, and disturb the soil less where erosion may be of concern (Townson, 1991). Several herbicides have been tested alone or in mixtures for the control of *I. cylindrica*. A few of these have shown poor-to-good control, depending on the rate of application, climate, and soil type. Repeated or sequential applications are usually necessary to have good control of *I. cylindrica*. Imazapyr and glyphosate appear to be the most promising herbicides for *I. cylindrica* control because of their ability to translocate to the underground rhizomes. Imazapyr at 0.5 -1.0 kg/ha and glyphosate at 1.0-1.8 kg/ha provide good control lasting up to 12 months, depending on soil type, application rate, and environmental conditions (Udensi *et al.* 1999; Terry *et al.* 1997). The long-lasting soil activity of imazapyr may be good in plantations but not in arable farming where it inhibits the establishment of arable crops. Glyphosate is the mostly widely used chemical for *I. cylindrica* control worldwide. After glyphosate application, supplementary weeding is still required in the crop to control shoots that escape the initial pre-planting application.

For Angophora Reserve, it is suggested that an integrated approach be adopted for the control of Blady Grass. This may involve an initial cool burn across the area to remove above ground biomass (slashing may also be a suitable alternative to fire in this case, and may be preferable). On re-emergence, application of glyphosate herbicide initially, followed by planting of designated ground, shrub and tree species. Follow-up spot application of herbicide will also be required over the ensuing years while understorey vegetation develops. The ultimate aim will be to shade out the Blady Grass so that it occurs only occasionally within the Reserve.

Control of Other Weeds

Although several other weed species are present within the Reserve (Appendix 1), few of these are likely to require intensive and ongoing treatment. Formosa Lily (*Lilium formosanum*) is widespread in the hills around

Pasminco, and is only apparent from January to February when flowering. Some of these plants are present within the Reserve, and may require treatment ('cut-and-paste') prior to fruiting each year. Other woody weeds such as Crofton Weed (*Ageratina adenophora*) and Lantana (*Lantana camara*) will require spot-control, while shading created through understorey development will reduce the impact of other grassy and herbaceous weeds. However, given that the Reserve is surrounded by cleared and disturbed lands, weeds are likely to be an ongoing problem requiring management.

7.0 Conclusions

In respect to the initial aims of the project, the following responses have been provided:

• <u>Provide appropriate understorey vegetation that could be co-planted with the *A.inopina* including the density of this planting</u>

A list of appropriate species has been identified (Table 1) based on nearby remnant vegetation supporting *Angophora inopina*, thought to represent the original vegetation community Coastal Plains Smooth-barked Apple Woodland (NPWS 2000).

• <u>Comment on possible management to be applied to the *A.inopina* (let it re-seed naturally or collect seeds from other areas for planting in the Angophora Reserve)</u>

Angophora inopina freely seeds and produces viable seed (Tierney 2004). Consequently, there is little need for additional propagation and planting of this species within the Reserve.

 <u>Comment on possibilities for relocating juvenile trees from other areas within the Pasminco Site for</u> <u>replanting in the Angophora Reserve</u>

The current density of *Angophora inopina* within the Reserve mirrors naturally occurring populations elsewhere. There is no need for additional replanting of juvenile plants to boost the population.

 <u>Advise of the value or benefit of adding either 25mm or 50mm of porous sandy (or other) topsoil to</u> <u>enhance the Angophora Reserve soil bank</u>

The addition of 25-50mm of sandy topsoil is not considered necessary for the re-establishment of understorey vegetation within the Reserve. There is an existing soil profile on the site sufficient for the development of understorey vegetation.

Other suggestions for remediation of the site include:

- Eradication or reduction in biomass of Blady Grass from the site, either through slashing or burning (cool fire), followed by herbicide application on re-emergence, and then planting out of shrub and ground layer vegetation.
- Spot herbicide application of weed species using standard weed control techniques, including spottreatment of Blady Grass infestations until shading occurs through understorey development, possibly over several years.
- Apart form an initial burn to reduce existing biomass and allow a start to weed control, fire should be excluded from the site for the forseeable future, to enable development of an understorey and to prevent repeated dominance of Blady Grass.

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Family	Species	Angophora R	Macq. Hills
Adiantaceae	Cheilanthes sieberi subsp. sieberi		Y
Dennstaedtiaceae	Pteridium esculentum	Y	Y
Araliaceae	Polyscias sambucifolia subsp. A		Y
Asteraceae	* Ageratina adenophora	Y	
	* Bidens pilosa	Y	Y
	* Conyza bonariensis	Y	
	* Taraxacum officinale	Y	Y
Casuarinaceae	Allocasuarina littoralis		Y
Epacridaceae	Epacris pulchella		Y
Euphorbiaceae	Glochidion ferdinandi var. ferdinandi	Y	Y
Fabaceae (Faboideae)	* Trifolium repens	Y	
	Daviesia ulicifolia subsp. ulicifolia		Y
	Dillwynia retorta species complex		Y
	Hardenbergia violacea		Y
	Kennedia rubicunda		Y
	Pultenaea villosa		Y
Fabaceae (Mimosoideae)	Acacia falcata	Y	Y
	Acacia longifolia subsp. longifolia	Y	Y
	Acacia myrtifolia	Y	Y
	Acacia ulicifolia		Y
Loranthaceae	Dendrophthoe vitellina	Y	Y
Myrtaceae	Angophora costata	Y	Y
	Angophora inopina	Y	Y
	Callistemon linearis	Y	Y
	Corymbia gummifera		Y
	Corymbia maculata	Y	
	Eucalyptus punctata		Y
	Eucalyptus resinifera subsp. resinifera	Y	Y
	Eucalyptus tereticornis	Y	
	Eucalyptus umbra		Y
	Leptospermum polygalifolium subsp. cismontanum		Y
Oleaceae	Notelaea longifolia forma longifolia	Y	Y
Plantaginaceae	* Plantago lanceolata	Y	Y
Proteaceae Persoonia linearis			

9.0 Appendix 1 – List of Species within the Reserve

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Scrophulariaceae	* Verbascum spp.	Y	Y	
Verbenaceae	* Lantana camara	Y		
	* Verbena bonariensis	Y	Y	
	* Verbena rigida var. rigida	Y		
Anthericaceae	Tricoryne elatior		Y	
Cuperaceae	Gahnia radula	Y	Y	
Cyperaceae	Ptilothrix deusta	I	Y	
			I	
Doryanthaceae	Doryanthes excelsa		Y	
Juncaceae	* Juncus cognatus	Y	Y	
Liliaceae	* Lilium formosanum	Y	Y	
Lomandraceae	Lomandra confertifolia subsp. pallida		Y	
	Lomandra filiformis subsp. filiformis		Y	
	Lomandra multiflora subsp. multiflora		Y	
Phormiaceae	Dianella caerulea var. assera		Y	
	Dianella revoluta var. revoluta	Y		
Poaceae	* Cynodon dactylon	Y	Y	
	* Paspalum dilatatum	Y		
	* Pennisetum clandestinum	Y		
	* Sorghum halepense	Y	Y	
	Aristida ramosa		Y	
	Aristida vagans		Y	
	Eragrostis brownii		Y	
	Imperata cylindrica var. major	Y	Y	
	Panicum effusum		Y	
	Panicum simile		Y	
	Themeda australis	Y	Y	
Xanthorrhoeaceae	Xanthorrhoea latifolia subsp. latifolia	Y	Y	

APPENDIX 6

Recommended Species for Riparian Zone Revegetation

Appendix Six – Recommended Species for Riparian Zone Revegetation

The following species list has been adapted from the vegetation community profile for Coastal Narabeen Moist Forest, as described in the Lower Hunter and Central Coast Regional Environmental Management Strategy (NSW NPWS 2000).

Coastal Narabeen Moist Forest is a tall moist open forest community characterised by the presence of *Syncarpia glomulifera* in association with *Eucalyptus deanei, E. saligna, E. acmenoides* and *E. pilularis*. Mesic species dominate the understorey including *Cryptocarya microneura, Rhodamnia rubescens* and *Synoum glandulosum*. Ferns such as *Doodia aspera, Adiantum formosum* and *Blechnum cartilegineum* characterise the species of the forest floor. Herbs including *Pseuderanthemum variabile, Oplismenus imbecillis* are found along with a diversity of climbers of which most common are *Smilax australis* and *Dioscorea transversa* (NSW NPWS 2000). Coastal Narabeen Moist Forest has been mapped in drainage lines at Pasminco as part of this project.

Common names have been sourced from *PlantNET*, the online database of the Sydney Royal Botanic Gardens.

Species	Common Name			
Tallest Stratum				
Syncarpia glomulifera	turpentine			
Eucalyptus saligna	Sydney blue gum			
Eucalyptus acmenoides	white mahogany			
Eucalyptus deanei	mountain blue gum			
Eucalyptus pilularis	blackbutt			
Angophora floribunda	rough-barked apple			
Eucalyptus paniculata subsp. paniculata	grey ironbark			
Eucalyptus siderophloia	grey ironbark			
Corymbia maculata	spotted gum			
Eucalyptus punctata	grey gum			
Eucalyptus propinqua	small-fruited grey gum			
Upper Mid-stratum				
Cryptocarya microneura	murrogun			
Rhodamnia rubescens	scrub turpentine			
Synoum glandulosum	scentless rosewood			
Allocasuarina torulosa	forest oak			
Glochidion ferdinandi	cheese tree			
Guioa semiglauca				
Acmena smithii	lilly pilly			
Livistona australis	cabbage tree palm			
Lower Mid-stratum				
Gymnostachys anceps	settlers flax			

Table 1 - Species R	Recommended for	Planting in R	Riparian Zones	at Pasminco
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Table 1 - Species Recommended for Planting in Riparian Zones at Pasminco (cont)

Species	Common Name
Eupomatia laurina	bolwarra
Astrotricha latifolia	
Lowest Stratum (<1m)	
Pseuderanthemum variabile	pastel flower
Doodia aspera	prickly rasp fern
Oplismenus imbecillis	basket grass
Hibbertia dentata	trailing guinea flower
Adiantum formosum	giant maidenhair
Blechnum cartilagineum	gristle fern
Calochlaena dubia	rainbow fern
Entolasia stricta	wiry panic
Teucrium corymbosum	forest germander
Dennstaedtia davallioides	lacy ground fern

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