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Project Manager:	Luke McKinnon

Description	Amount
Pittwater Road - REF For professional services rendered from 26/03/2010 to 4/05/2010.	

Project management	$300.00
Literature and Database Review	$160.00
Field Survey	$600.00
Data Entry and Plant Identification	$300.00
Mapping	$220.00
Impact Assessment	$1,800.00
Ecological Report Preparation	$600.00
Technical Review	$360.00
Final Report	$600.00
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Total	$5,140.00
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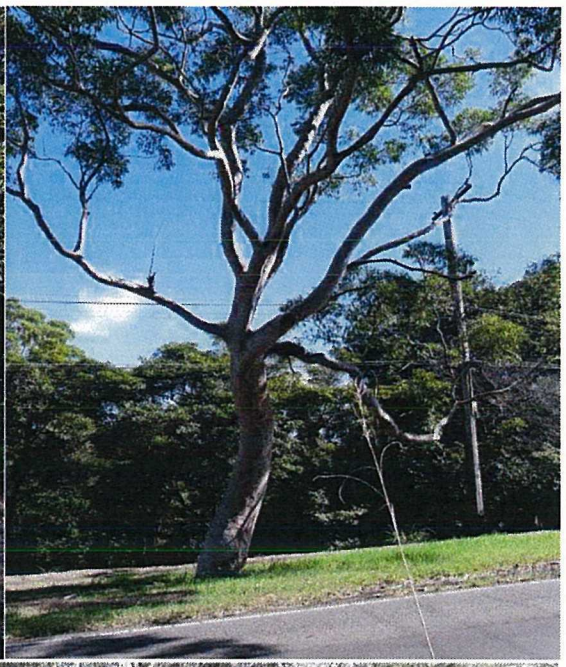
Pittwater Road Cycleway, EAST RYDE

Flora and Fauna Assessment and Assessment of Significance FINAL

Prepared for
City of Ryde



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Pittwater Road Cycleway, East Ryde

Flora and Fauna Assessment and Assessment of Significance

PREPARED FOR	City of Ryde
PROJECT NO	10SUTECO-0035
DATE	April 2010

DOCUMENT TRACKING

ITEM	DETAIL
Project Name	Pittwater Road Cycleway, East Ryde - Flora and Fauna Assessment and Assessment of Significance
Project Number	10-SUTECO-0035
File location	
Prepared by	Lucas McKinnon
Approved by	Rob Mezzatesta
Status	Final
Version Number	1.0
Last saved on	30 April 2010

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EXECUTIVE SUMMARY

This report describes a flora and fauna assessment carried out at Pittwater Road, East Ryde, 30th March 2010, to determine potential direct and indirect environmental impacts at the site of proposed realignment of the road and cycleway. The area of proposed work is approximately 500m in length, and will constitute the removal of four mature Eucalypt trees, along with various exotic flora found in the lawns below these trees. The works will increase the hard surface area at the site and consequently the intensity of the runoff during heavy rainfall, this will be channelled through an upgrading of the stormwater runoff infrastructure. The drainage point for the majority of this stormwater is Martins Creek, to the north of Bronhill Road, approximately 50m of Pittwater Road will drain into Kitty's Creek.

Kitty's Creek drains into an area of mangrove vegetation, which also maintains a small degraded patch of a Coastal Saltmarsh / Swamp Oak Floodplain Forest complex, these vegetation communities are listed under the *Threatened Species Conservation Act 1995* (TSC Act) as endangered ecological communities. The impact of the proposed works on these communities was assessed under an Assessment of Significance, under s5A of the *Environmental Planning and Assessment Act 1979*. Given the small patch size, low diversity of flora species, the presence of large areas of these communities in the area and the likely minimal increase in runoff from the site, it was considered that there will be no significant impact on these communities.

The literature and database review undertaken for this report found 23 threatened fauna, 16 threatened flora, 0 threatened populations and 8 migratory species listed under the TSC Act and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that were likely to occur at the site or were found within 10k of the site. An assessment of the likelihood of occurrence of these species found that none were likely to be affected by the proposed works.

It is recognised that the proposed works will remove four large Eucalypt trees. Given the large amount of surrounding extant vegetation, the removal of these trees is not considered likely to interfere with the movement, roosting or nesting of non-threatened arboreal fauna in the area.

There is also potential for increased run-off into Kitty's Creek, due to an increase in the hard surface area. This potential increase in run-off is proposed to be ameliorated with the installation of rock-lined sedimentation ponds.

Recommendations to alleviate any further potential environmental impacts are provided at Section 4.

1 INTRODUCTION

1.1 UNDERSTANDING OF THE PROJECT

Eco Logical Australia understands that a flora and fauna assessment is required over an area of approximately 500m along Pittwater Road, between Carramar Avenue and Bronhill Road, East. This encompasses the area of expected direct and indirect environmental impacts, and is hereafter referred to as 'the site' (Figure 1). The works are understood to be required as part of proposed realignment of Pittwater Road including:

- demolition of existing pavements, replacement of sub-base materials and relaying new road pavement;
- construction of a widened carriageway to accommodate two vehicular lanes and bikeway lanes on both sides of the carriageway;
- construction of kerb and gutters;
- removal of four trees within the road reserve;
- replanting of trees along the western portion of the road reserve;
- general landscaping; and
- construction of permanent sediment and water control devices at drainage discharge points.

The works will be undertaken within the road reserve and will include formalising the existing stormwater infrastructure, which will potentially impact upon Coastal Saltmarsh in the drainage area, an endangered ecological community listed under the *Threatened Species Conservation Act 1995.* Accordingly, Council requires that an Assessment of Significance under Section 5A of the *Environmental Planning and Assessment Act 1979* (also referred to as a '7-part test') be undertaken to determine the impact of the proposed works on this community. A site assessment will also need to take into account the likelihood of any other threatened flora, fauna and populations that may occur in the area.

Figure 1: Site of proposed works for the realignment of Pittwater Road, between Carramar Ave and Bronhill Road (highlighted in blue) (Courtesy: City of Ryde).

1.2 DESKTOP LITERATURE AND DATABASE REVIEW

Searches of the Atlas of NSW Wildlife and EPBC Protected Matters Search Tool were conducted on the 30th March 2010. These searches returned threatened and migratory species that have previously been recorded within a 10km radius from the centre of the study area. The searches utilised a central point of -33.85652 latitude and 151.08794 longitude. The results of both searches were combined and an assessment of the likelihood of occurrence for each species made (Appendix C).

Vegetation mapping relevant to the area was investigated for the presence of any threatened ecological communities (critically endangered, endangered and vulnerable), as listed under the *Threatened Species Conservation Act 1995* or the *Environmental Protection and Biodiversity Conservation Act 1999*. The relevant vegetation mapping used was the Western Sydney Vegetation Mapping datasets (Tozer, 2003). Two vegetation communities were identified at and in the near vicinity of the site, Sandstone Ridgetop Woodland and Mangrove/Saltmarsh Complex. Further vegetation in the vicinity of the site was not classified. Mangroves are protected under the *Fisheries Management Act 1994*, and Coastal Saltmarsh is listed as an EEC under the TSC Act 1995.

A review of current legislation relevant to the proposed works at the site was also undertaken, the results of this search are presented in Section 1.3.

1.3 LEGISLATIVE REQUIREMENTS

1.3.1 Environment Protection and Biodiversity Conservation Act 1999

The activity is permissible under this legislation. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a national scheme for protecting the environment and conserving biodiversity values. Approval from the Commonwealth Environment Minister is required under the EPBC Act if the action (which can include a project, development, undertaking or activity) will, or is likely to, have a significant impact on matters considered to be of national environmental significance (NES matters). NES matters relevant to this proposal include species and ecological communities that are listed under the Act. The EPBC Act does not define significant impact but identifies matters that are necessary to take into consideration. Thirteen fauna species, 14 flora species and 8 migratory species listed under EPBC Act were identified during the desktop search (see Appendix C). Although 8 migratory species have been recorded in proximity of the study site at certain times of the year they are not considered to be significantly affected by the proposal. There are no recorded observations of nesting or breeding in the vicinity.

1.3.2 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for NSW, providing a framework for the overall environmental planning and assessment of development proposals. Evaluation of this proposal is to be undertaken in accordance with Part 4, Section 79C of the Act along with Part 5 relating to environmental impact assessment and threatened species.

1.3.3 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) sets out provisions for planning and assessment of impacts on threatened species, populations and ecological communities. An Assessment of Significance (7 part test) in accordance with Section 94 of this Act (and S79C, EP&A Act) has been prepared for those species, populations and ecological communities which were found to be present, considered likely, or with the potential, to occur at the site (Appendix A).

1.3.4 Fisheries Management Act 1994 (FM Act)

The *Fisheries Management Act 1994* sets out provisions for planning and assessment of impacts on aquatic threatened species, populations and ecological communities. Under Part 7 of the FM Act, a public authority must have regard to any gazetted Habitat Protection Plan prepared under the Act. Under the FM Act a section 205 permit is required to harm marine vegetation on public water land or aquaculture lease or the foreshore of such land. Under Sections 200 and 201 of the Act, Ministerial consent is required for reclamation works carried out by a local government authority.

Mangrove trees are considered marine vegetation for the purposes of this Act. There will be no harm to the marine vegetation from the proposed works.

2 SITE INSPECTION

On Friday the 9th of April, 2010, Tammy Haslehurst, Senior Ecologist, and Andrew Whitford, Ecologist, Eco Logical Australia, attended the site at Pittwater Road, East Ryde, in the City of Ryde LGA. A traverse of the area of direct environmental impacts was undertaken and an assessment made of any potential impacts.

2.1 FLORA AND FAUNA ASSESSMENT

2.1.1 Flora

The flora occurring in the direct impact area along the roadside was recorded and targeted searches for any threatened species were also made. An assessment of the vegetation below the drainage outlet was also undertaken to verify the presence of the EEC, Coastal Saltmarsh and to clarify any ambiguities in the vegetation map. The vegetation in the vicinity of the Coastal Saltmarsh was assessed for cover abundance using a Braun-Blanquet scale (1 - 4a = <5%; 4b = 5-25%; 5 = 26-50%; 6 = 51-75%; 7 = 76-100%). The following species were recorded, and separated with reference to their location at the site:

Table 1: List of flora found during the site inspection along the area of direct impact and below the drainage outlet.

Scientific name	Common name	Road reserve west	Adjacent vegetation	Road reserve east	Saltmarsh (east)	Kitty's Creek (west)
Acacia mearnsii	Black Wattle	x	x			
*Ageratina adenophora**	Crofton Weed			x		
*Alternanthera denticulata**	Alligator Weed				2	
Angophora costata	Smooth-barked Apple	x	x			
*Atriplex prostrata**					1	
Avicennia marina	Grey Mangrove				6	
*Bidens pilosa**	Cobblers Pegs			x		
Calochlaena dubia	Soft Bracken		x			
Casuarina glauca	Swamp Oak				2	x
*Chamaesyce hirta**	Asthma Weed			x		
*Cinnamomum camphora**	Camphor Laurel		x			
Clematis aristata	Old Man's Beard		x			
Commelina cyaenea	Native Wandering Jew		x		3	
*Conyza bonariensis**	Fleabane			x		

Scientific name	Common name	Road reserve west	Adjacent vegetation	Road reserve east	Saltmarsh (east)	Kitty's Creek (west)
*Cotoneaster sp.**	Cotoneaster			x		
Cynodon dactylon	Couch	x				
Cyperus eragrostis				x		
Dianella caurelea				x		
Dichelache sp.	Plumegrass					x
Dicksonia antarctica	Tree Fern		x			
*Ehrharta erecta**	Panic Veldt Grass			x		
Entolasia stricta				x		
*Eragrostis curvula**	African Lovegrass			x		
Eucalyptus acmenioides		x		x		
Eucalyptus resinifera		x				
Glochidion ferdinandi	Cheese Tree		x			
Homalanthus populifolius	Bleeding Heart		x			
*Hydrocotlye bonariensis**	Pennywort				2	
*Hypochaeris radicata**	Catsear	x				
Imperata cylindrica	Blady Grass			x		
Kunzea ambigua	Tick Bush			x		
*Lantana camara**	Lantana			x		x
Lepidosperma filiforme					3	
*Ligustrum lucidum**	Large-leaved Privet					x
*Ligustrum sinense**	Small-leaved Privet			x		x
Lomandra longifolia	Spiny-headed Mat Rush			x		
Microlaena stipoides	Weeping Grass		x			
*Ochna serrulata**	Ochna			x		
Oplismenus sp.	Basket Grass		x			
Oxalis sp.				x		
*Paspalum dilatum**	Paspalum	x		x		
*Paspalum urvellei**	Vasey Grass			x		
*Petrorhagia nanteuilii**	Proliferous Pink	x				
Pittoporum undulatum	Sweet Pittosporum		x	x		
Pratia purpurascens	White Root		x			
*Senna pendula**	Senna			x		x
*Setaria gracilis**				x		
Sida rhombifolia	Paddy's Lucerne			x		
Sporobolus virginicus	Saltwater Couch				5	
*Taraxicum officianale**	Dandelion	x				
Tetragonia tetragonioides	Warrigal Spinach				1	

Scientific name	Common name	Road reserve west	Adjacent vegetation	Road reserve east	Saltmarsh (east)	Kitty's Creek (west)
Typha orientalis	Cumbungi				4b	
*Unknown exotic herb**					4b	

(* denotes exotic species; shaded species flagged for removal along Pittwater Road)

Opportunistic fauna sightings were made during the site inspection, all observations were noted and are tabled below.

Table 2: Opportunistic fauna sighted during site inspection.

Common name	Scientific Name
Australian Magpie	*Gymnorhina tibicen*
Australian Raven	*Corvus coronoides*
Noisy Miner	*Manorina melanocephala*

2.1.2Fauna Habitat Assessment

A fauna habitat assessment was undertaken at the site of direct impacts and below the drainage outlet in the area of the mangrove and saltmarsh vegetation to verify the presence of important fauna habitat features such as hollow-bearing trees, potential nesting or roosting sites, waterbodies, winter flowering eucalypts, intertidal mudflats and mangroves.

There were no hollow bearing trees noted at the site or in close proximity, the most significant faunal habitat feature is that of the riverine environment of the Lane Cove River and the mangrove vegetation.

2.1.3Threatened Ecological Communities (TEC)

The field inspection found that within the greater mangrove area below Kitty's Creek (south-east of the site) there was a small area of saltmarsh vegetation coexisting with some Grey Mangrove and Swamp Oak trees. Though Coastal Saltmarsh is predominantly a treeless vegetation community and there were few Swamp Oak trees present in the area, it is considered prudent to assess this area as potential remnants of the endangered ecological communities, Coastal Saltmarsh and Swamp Oak Floodplain Forest of the North Coast, Sydney Basin and South East Corner Bioregions, as they occur on the Coastal Floodplain and are known to form intergrade communities (NSW Scientific Committee 2004a, 2004b, Appendix B). As such, any potential impacts were assessed under an Assessment of Significance, s5A, EP&A Act (consisting of a '7-part test'; Appendix A).

2.1.4Threatened Species and/or Populations

Searches of the *Atlas of NSW Wildlife* and *EPBC Protected Matters Report* within a 10km radius of the site revealed records for: 16 species of threatened flora, 23 species of threatened fauna and 8 migratory fauna species.

Appendix C lists these species, their status under state and federal legislation, describes their habitat requirements and predicts their 'likelihood of occurrence' within the study area, with regard to their known distribution and available habitat within the study area, using the following criteria:

- "yes" = the species was or has been observed on the site
- "likely" = a medium to high probability that a species uses the site
- "potential" = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- "unlikely" = a very low to low probability that a species uses the site
- "no" = habitat on site and in the vicinity is unsuitable for the species.

Of these records it was considered that the occurrence of 5 were 'potentially' present, 5 were 'unlikely' to occur, and the remainder were considered to have 'no' suitable habitat on site. An assessment of these records is provided in Section 3.4. None of these species were recorded during the site visit.

2.2 MAPPING

Figure 2 presents the distribution of vegetation communities as mapped by Tozer (2003).

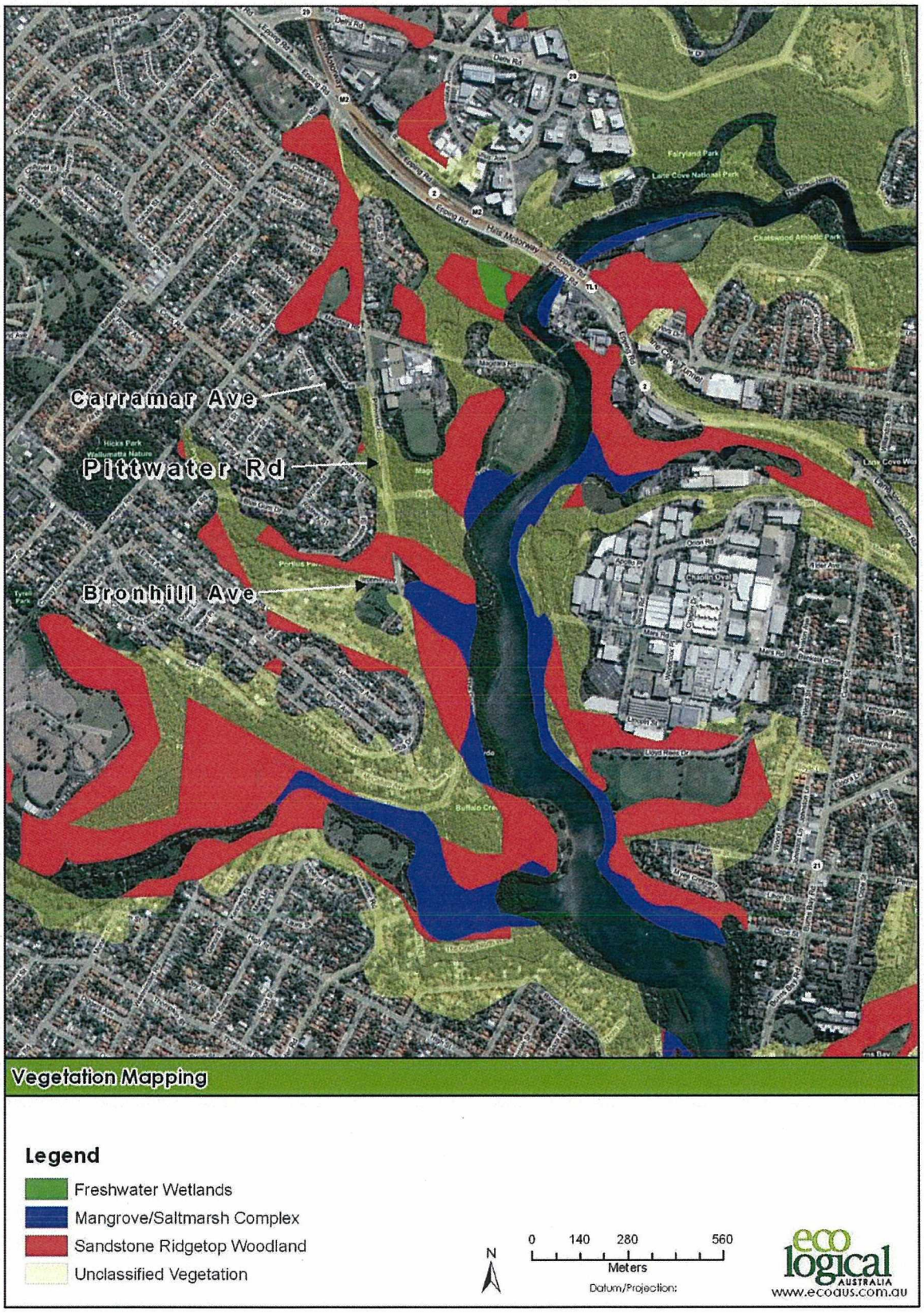

Figure 2: Vegetation communities in the area surrounding the proposal site.

3 IMPACT ASSESSMENT

A flora and fauna assessment at Pittwater Road and in the drainage area at Kitty's Creek was undertaken to determine the potential direct and indirect environmental impacts at the site. The findings of this assessment are outlined below.

3.1 FLORA AND FAUNA ASSESSMENT

Of the flora recorded at the site, no significant species (i.e. ROTAP, threatened or locally significant species) were found to occur on site.

There were no significant fauna recordings during the site assessment, all species sighted are considered common in the area.

It is recognised that the proposed works will remove four large Eucalypt trees. Given the large amount of surrounding extant vegetation, the removal of these trees is not considered likely to interfere with the movement, roosting or nesting of non-threatened arboreal fauna in the area.

3.2 HABITAT ASSESSMENT

A traverse of the site was undertaken to identify any significant habitat features such as hollow-bearing trees, potential nesting or roosting sites, waterbodies, winter flowering eucalypts and/or intertidal flats and mangroves. A number of large Eucalypts were noted at the site and adjacent to the site, four of these have been flagged for removal. These trees were not noted to be hollow bearing. They are all summer flowering species.

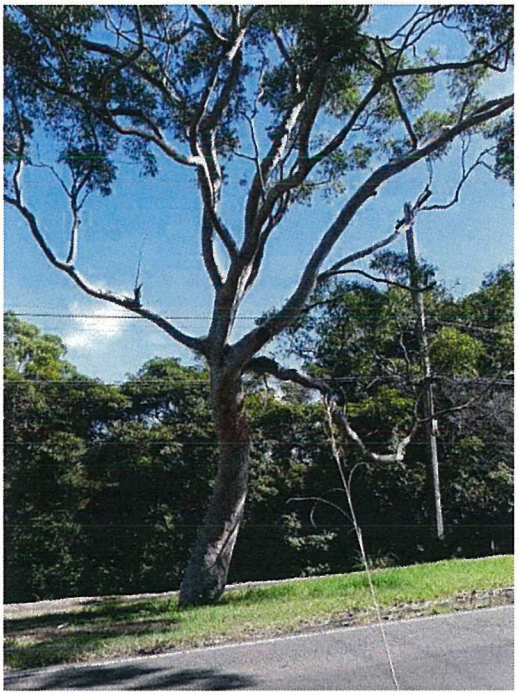

Figure 3: Smooth-barked Apple (*Angophora costata*), flagged for removal along Pittwater Road

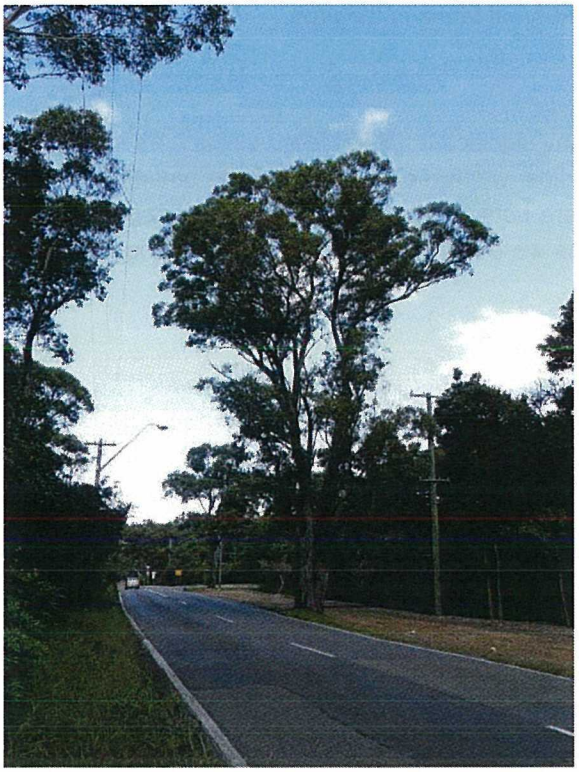

Figure 4: White Mahogany (*Eucalyptus acmenoides*), flagged for removal along Pittwater Road.

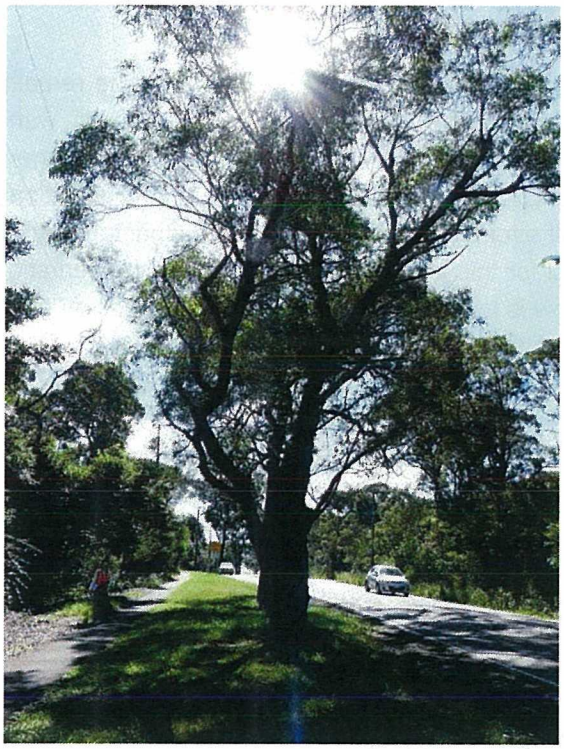

Figure 5: White Mahogany (*Eucalyptus acmenoides*), flagged for removal along Pittwater Road.

Figure 6: White Mahogany (*Eucalyptus acmenoides*), flagged for removal along Pittwater Road.

3.3 THREATENED ECOLOGICAL COMMUNITIES

The majority of the site currently drains into Martin's Creek to the west of the site, with the remainder draining to Kitty's creek near Bronhill Ave, which drains into a large area of mangroves with an intergrade area of Coastal Saltmarsh and Swamp Oak Floodplain Forest. The increase in drainage due to the increased hard surface area above Kitty's Creek, will potentially lead to higher concentrations of water being drained into the creek during high rainfall events and consequently the Coastal Saltmarsh and Swamp Oak Floodplain Forest. There is potential for this to increase erosion and sedimentation in the drainage areas. This potential increase in waterflow is to be ameliorated with the installation of rock-lined sedimentation basins in order to delay flows into Kitty's Creek.

The area of EEC is very small, with a 20 x 20m quadrat (0.04ha) vegetation survey identifying >50% of the area maintained Grey Mangrove. The remainder of the area was dominated by Saltwater Couch (*Sporobulus virginicus*), with a small amount of Swamp Oak (*Casuarina glauca*) in the canopy with some herbaceous weeds and Cumbungi.

The potential impact on the community was assessed with an Assessment of Significance ('7-part test'; Appendix A). Any potential impacts on the community from an increase in flow intensity were not considered to be significant.

Figure 7: Coastal Saltmarsh / Swamp Oak Floodplain Forest intergrade community found adjacent to mangrove community below Kitty's Creek, Pittwater Road, East Ryde.

3.4 THREATENED SPECIES AND/OR POPULATIONS

Of the threatened species recorded within 10km of the site, the following species (below) were considered to potentially occur or be unlikely to occur within the near vicinity of the site. It was not considered that any of these species would be impacted upon by the proposed activity due to the nature of the work and the small impact area; as such, Assessments of Significance (s5A, EP&A Act; '7-part test') were not required. Following is a justification of a likelihood of the presence / absence of these species.

Table 3: THREATENED FAUNA – Consideration of potential presence / absence

Scientific name	Common name	Potential presence	Reasoning
Pandion haliaetus	Osprey	UNLIKELY	Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde and Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground, on sea cliffs or in trees (Olsen 1995). It is possible that this species could pass through the area in search of prey, though it is unlikely to inhabit the area the disturbed and highly developed nature of the surrounding environment.
Ninox strenua	Powerful Owl	UNLIKELY	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus and Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000). There are recent records of Powerful Owl in nearby bushland in the vicinity of the site, though a targeted search of the immediate impact area found no hollow bearing trees of sufficient size to accommodate this species. Although this species has been seen in the area, the proposed action will not remove any hollow bearing trees, which could potentially impact upon future nesting hollows or current food resources, and as such will not impact directly on the species if it does return to the area.
Miniopterus orianae oceanensis	Eastern Bent-wing Bat	POTENTIAL	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages in the evening above and below the tree canopy on small insects (AMBS 1995,

Scientific name	Common name	Potential presence	Reasoning
			Dwyer 1995, Dwyer 1981). If this species is present in the vicinity of the site, it is not likely to be impacted upon by the proposed activity which will take place outside of foraging hours and will not impact upon any potential habitat for the species.
Mormopterus norfolkensis	Eastern Freetail-bat	POTENTIAL	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures). If this species is present in the vicinity of the site, it is not likely to be impacted upon by the proposed activity which will take place outside of foraging hours and will not impact upon any potential habitat for the species.
Pteropus poliocephalus	Grey-headed Flying-Fox	POTENTIAL	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998). If this species is present in the vicinity of the site, it is not likely to be impacted upon by the proposed activity which will take place outside of foraging hours, though the removal of the large Eucalypts along Pittwater Road may be a possible roosting and food resource, though this not a limited resource in the area with a large proportion of bushland nearby. Whilst there is potential for this species to occur, the proposed action will not impact upon this species.

Table 4: MIGRATORY SPECIES – Consideration of potential presence / absence in vicinity of the site

Scientific name	Common name	Potential presence	Reasoning
Haliaeetus leucogaster	White-bellied Sea-Eagle	POTENTIAL	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant and Higgins 1993). It is possible that this species could pass through the area in search of prey, though it is unlikely to inhabit the area the disturbed and highly developed nature of the surrounding environment
Hirundapus caudacutu	White-throated Needletail	POTENTIAL	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant and Higgins 1993; Simpson and Day 1999). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant and Higgins 1993). There is potential for this species to migrate through or use the watercourse in the vicinity of the site, where there is ample vegetation for roosting. It is not likely to be impacted upon by the proposed activity.
Merops ornatus	Rainbow Bee-eater	UNLIKELY	There is potential for this species to migrate through or use the watercourse in the vicinity of the site or use the mature Eucalypts marked for removal at the site as roosting habitat, though it is not likely to be impacted upon by the proposed activity due to the large number of other Eucalypts in the area.

4 RECOMMENDATIONS

It is recognised that the proposed works will remove four large Eucalypt trees and potentially increase run-off into Kitty's Creek. To alleviate potential impacts of the proposal, the following recommendations should be adhered to:

- The removal of vegetation should be undertaken to the minimum extent necessary to undertake the works;
- All care should be taken to avoid root damage to large Eucalypts found adjacent to the site of proposed works;
- Sedimentation fencing should be utilised where there is potential for sediment run-off into the Lane Cove River during and post construction works;
- Exposed soils should be stabilised to limit soil movement;
- All effort should be taken to ensure the engineered structures associated with the improved stormwater drainage slow water flow sufficiently, such as the rock-lined sedimentation ponds, to avoid any erosion and sedimentation issues below Kitty's Creek.

5 CONCLUSIONS

The flora and fauna assessment of the site found no significant impacts were likely due to the proposed actions. No threatened flora, fauna or populations or migratory species were considered likely to use the site and none were observed during the site inspection.

The proposed stormwater infrastructure will continue to drain into a small intergrade area of two endangered ecological communities, Coastal Saltmarsh and Swamp Oak Floodplain Forest. The impacts of the proposed works on this intergrade community were assessed with an Assessment of Significance (7 part test; Appendix A). The impacts were not considered to be significant.

A number of recommendations were provided that should be implemented to avoid any potential environmental impacts in Section 4.

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Appendix A: Assessment of Significance (7-part test): Swamp Oak Floodplain Forest and Coastal Saltmarsh Complex

The Assessment of Significance (7-part test) is applied to species, populations and ecological communities listed on Schedules 1, 1A and 2 of the TSC Act and Schedules 4, 4A and 5 of the *Fisheries Management Act 1994*. The assessment sets out 7 factors, which when considered, allow proponents to undertake a qualitative analysis of the likely impacts of an action and to determine whether further assessment is required via a Species Impact Statement (SIS). All factors must be considered and an overall conclusion made based on all factors in combination. An SIS is required if, through application of the 7-part test, an action is considered likely to have a significant impact on a threatened species, population or ecological community.

The current proposal will potentially indirectly impact upon the endangered ecological communities, Swamp Oak Floodplain Forest and Coastal Saltmarsh, which occur below the drainage outlet of the proposed works as an intergrade community. Below is an Assessment of Significance to address any potential impacts to the community.

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 the risk of extinction.**

Swamp Oak Floodplain Forest is listed as an endangered ecological community, not as a threatened species.

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.**

Swamp Oak Floodplain Forest is listed as an endangered ecological community, not as an endangered population.

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.

Ecological communities are defined under the *Threatened Species Conservation Act 1995* as: *'An assemblage of species in a particular area'.*

The *particular area* of Swamp Oak Floodplain Forest and Coastal Saltmarsh is the coastal floodplain of NSW, which is defined as, 'level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less'. The occurrence of this community 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' (NSW Scientific Committee, 2004).

The *assemblage of species* that characterise Swamp Oak Floodplain Forest are a dense to sparse canopy of Swamp Oak (*Casuarina glauca*) north from Bermagui, with Swamp Paperbark (*Melaleuca ericifolia*) taking over as the dominant canopy species as the community proceeds south from Sydney. Other subordinate trees including *Acmena smithii* (Lilly Pilly), *Glochidion* spp. (Cheese Tree) and *Melaleuca* spp. (paperbarks) may be present, but this community is often found in pure stands with the presence of salt tolerant understorey species such as *Baumea juncea, Juncus kraussii, Phragmites australis, Selliera radicans* and the occurrences of vines such as, *Parsonsia straminea, Geitonoplesium cymosum* and *Stephania japonica* var. *discolour* (a full list of characteristic species of this community is found in the Final Determination of the Scientific Committee, see Appendix B).

The *assemblage of species* that characterise Coastal Saltmarsh varies with elevation. *Sarcocornia quinqueflora* dominates at lower, and hence more frequently flooded, levels than *Sporobolus virginicus* which dominates the mid saltmarsh, while *Juncus kraussii* and *Baumea juncea* are upper saltmarsh species. The more comprehensive list of the species characteristic of Coastal Saltmarsh is found in Appendix C).

Species common of both Coastal Saltmarsh and Swamp Oak Floodplain Forest were recorded at the site and as such they are assessed here as an intergrade community.

The site of direct impact is located at Pittwater Road, East Ryde, and not on the Coastal Floodplain, though the proposed works will potentially increase the flow of water into Kitty's Creek which flows onto the Coastal Floodplain where these communities are present. Whilst the proposed works will not increase the amount of water that will flow into the creek (and hence into the EECs), the area of surface run-off will increase with the addition of further hard surface areas in the form of the cycle and road ways. This will have the effect of increasing flows at peak times due to the removal of vegetated areas that allow for the infiltration of water and slowing down of the flow rate. This water has the potential to increase erosion and sedimentation in the drainage area due to the higher velocity the volume of water during periods of high rainfall. Saltmarsh communities are particularly vulnerable to slight changes in sea level and elevation, and are currently experiencing decline in their distribution due to sedimentation from urban runoff and sea level rise associated with Anthropogenic Climate Change, also listed as a Key Threatening Process under the TSC Act.

The area of EEC at the site is quite small, with a 20 x 20m vegetation survey quadrat identifying the area as having >50% Grey Mangrove present. The 0.04ha area maintains only 11 flora species with 3 of these being exotics. This is considered to be quite a low diversity of species considering this data

was collected at the intergrade point of three vegetation communities, i.e. River Mangrove, Coastal Saltmarsh and Swamp Oak Floodplain Forest.

It is not considered that a potential increase in flows from the proposed road upgrade will act to further degrade the site, though the increased intensity of the water flow may potentially increase erosion and sedimentation at the site. Council has proposed the installation of rock-lined sedimentation basins at the headwalls of surface run-off pipes in order to slow the velocity of run-off into these areas.

There are many healthy examples of this community along the Lane Cove River (for example, Buffalos Creek Reserve), that are well equipped to serve the important ecological function that is provided by Coastal Saltmarsh and its intergrade communities.

The proposed actions will not involve the removal or modification any vegetation in the EEC. It is considered *unlikely* that the proposed action will substantially or adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

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

ii. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

iii. 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

iv. 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,

There is no habitat to be removed by the proposed actions.

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

No critical habitat of this community has been identified by the Director-General of the National Parks & Wildlife Service on the Register of Critical Habitat.

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

No recovery plan or threat abatement plans are currently in place for Swamp-oak Floodplain Forest.

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 action constitutes a key threatening process as listed under Schedule 3 of the *Threatened Species Conservation Act 1995*, that process is: Clearing of native vegetation.

Conclusion:

It is noted that the proposed action is listed as a key threatening process, that being: 'clearing of native vegetation', though this clearing will not occur within the EECs. The site adjoins some quite large

vegetation remnants, and as such will not constitute the removal of significant habitat or resources for native wildlife.

The runoff that is associated with the increased hard surface area will potentially increase the concentration of flows into Kitty's Creek during large rain events, which has the potential to increase erosion and sedimentation in the communities. Council has proposed the installation of rock-lined sedimentation basins at the headwalls of surface run-off pipes in order to slow the velocity of run-off into these areas.

Given the small size of the site; the low diversity of species at the site of the EEC; the large extant vegetation remnants in the near vicinity of the site; and the proposed engineering works to ameliorate any potential increase in water flows below the site; it is considered the proposed activities *will not significantly* impact upon this community.

Appendix B: Final Determinations

SWAMP OAK FLOODPLAIN FOREST

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community 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. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Oak Floodplain Forest generally occurs below 20 m (rarely above 10 m) elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees. Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Swamp Oak Floodplain Forest is primarily determined by the frequency and duration of waterlogging and the level of salinity in the groundwater. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acmena smithii
Alternanthera denticulata
Blechnum indicum
Carex appressa
Centella asiatica
Crinum pedunculatum
Cynodon dactylon
Entolasia marginata
Flagellaria indica
Geitonoplesium cymosum
Glochidion sumatranum
Imperata cylindrica var. *major*
Juncus kraussii subsp. *australiensis*
Juncus usitatus
Lomandra longifolia
Maundia triglochinoides
Melaleuca ericifolia
Melaleuca styphelioides
Alphitonia excelsa
Baumea juncea
Callistemon salignus
Casuarina glauca
Commelina cyanea
Cupaniopsis anacardioides
Dianella caerulea
Enydra fluctuans
Gahnia clarkei
Glochidion ferdinandi
Hypolepis muelleri
Isolepis inundata
Juncus planifolius
Lobelia alata
Lophostemon suaveolens
Melaleuca alternifolia
Melaleuca quinquenervia
Myoporum acuminatum

Oplismenus imbecillis
Persicaria decipiens
Phragmites australis
Smilax australis
Viola banksii

Parsonsia straminea
Persicaria strigosa
Selliera radicans
Stephania japonica var. *discolor*

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Clarence, Macleay, Hastings, Manning, Hunter, Hawkesbury, Shoalhaven and Moruya Rivers.

4. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions has a dense to sparse tree layer in which *Casuarina glauca* (Swamp Oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (Lilly Pilly), *Glochidion* spp. (Cheese Trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui (Keith and Bedward 1999). The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea* (Common Silkpod), *Geitonoplesium cymosum* (Scrambling Lily) and *Stephania japonica* var. *discolor* (Snake Vine), a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica* (Pennywort), *Commelina cyanea, Persicaria decipiens* (Slender Knotweed) and *Viola banksii*; graminoids such as *Carex appressa* (Tussock Sedge), *Gahnia clarkei* (a saw-sedge), *Lomandra longifolia* (Spiny-headed Mat-rush), *Oplismenus imbecillis*; and the fern *Hypolepis muelleri* (Batswing Fern). On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea, Juncus kraussii* subsp. *australiensis* (Sea Rush), *Phragmites australis* (Common Reed), *Selliera radicans* and other saltmarsh species. The composition and structure of the understorey is also influenced by grazing history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

5. Unlike most other coastal floodplain communities, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions are not a significant habitat for waterbirds (Goodrick 1970). However, they do sometimes provide food resources for the Glossy Black Cockatoo (*Calyptorhynchus lathami lathami*), and Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) (Marchant and Higgins 1990). The fauna

of Swamp Oak Floodplain Forest also includes the Squirrel Glider (*Petaurus norfolcensis*) and several species of frogs in the families Myobatrachidae (southern frogs) and Hylidae (tree frogs).

6. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Swamp Oak Floodplain Forest from other endangered ecological communities on the coastal floodplains include: its dominance by a tree canopy of either *Casuarina glauca* or, more rarely, *Melaleuca ericifolia* with or without subordinate tree species; the relatively low abundance of *Eucalyptus* species; and the prominent groundcover of forbs and graminoids. It generally occupies low-lying parts of floodplains, alluvial flats, drainage lines, lake margins and fringes of estuaries; habitats where flooding is periodic and soils show some influence of saline ground water. This latter habitat feature sets it apart from other floodplain communities.

7. Swamp Oak Floodplain Forest may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, Subtropical Floodplain Forest of the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-Flat Forest in the Sydney Basin bioregion), Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion) and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, in less saline habitats, Swamp Oak Floodplain Forest may adjoin or intergrade with several other endangered ecological communities including River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions and Subtropical Floodplain Forest of the NSW North Coast bioregion. The most saline forms of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions may adjoin or intergrade with Coastal Saltmarsh of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices (e.g. Johnston *et al.* 2003). The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. This community includes 'Sheoak Swamps' in the general coastal wetlands classification of Goodrick (1970). In the Tweed valley lowlands, this community includes '*Casuarina glauca* tall to very tall open to closed forest' (F10) of Pressey and Griffith (1992) and parts of the 'Floodplain Wetland Complex' (FL) that include *Casuarina glauca* with *Melaleuca* spp. (Pressey and Griffith 1992). In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas mapped as 'Forest Ecosystem 143, Swamp Oak', fall within this community. In the lower Hunter valley, 'Swamp Oak - Rushland Forest' (map unit 40) and 'Swamp Oak Sedge Forest' (map unit 41) of NPWS (2000) fall within this community. On the Cumberland Plain, 'Riparian Woodland' (map unit 5) of Tozer (2003) and parts of 'Alluvial Woodland' (map unit 11) dominated by *Casuarina glauca* (Tozer 2003) are included within this community, while those parts of Benson's (1992) 'River Flat Forest' (map unit 9f) dominated by *C. glauca* also fall within this community, as do parts of the 'River-flat forests' of Benson and Howell (1990) and Benson et al. (1996) that are dominated by *C. glauca*. On the Illawarra Plain, 'Coastal Swamp Oak Forest' (map unit 36) of NPWS (2002) occurs within this community. In the Comprehensive Regional Assessment of southern New South Wales (Thomas *et al.* 2000), this community includes 'Coastal Wet Heath Swamp Forest' (forest ecosystem 24), 'South Coast Swamp Forest' complex (forest ecosystem 25) and those parts of 'Ecotonal Coastal Swamp Forest' (forest ecosystem 27) dominated by *Casuarina glauca*. In the Sydney - South Coast region, this community includes parts

of 'Floodplain Swamp Forest' (map unit 105) dominated by *Casuarina glauca*, 'Estuarine Fringe Forest' (map unit 106) and 'Estuarine Creek Flat Scrub' (map unit 107) of Tindall *et al.* (2004). In the Eden region, this community includes 'Estuarine Wetland Scrub' (map unit 63) of Keith and Bedward (1999) and parts of 'Floodplain Wetlands' (map unit 60) that include *Casuarina glauca* or *Melaleuca ericifolia* (Keith and Bedward 1999). Swamp Oak Floodplain Forest South East Corner is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of Swamp Oak Floodplain Forest within and beyond these surveyed areas.

9. The extent of the Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Swamp Oak Floodplain Forest, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Swamp Oak Floodplain Forest is likely to be considerably smaller and is likely to represent much less than 30% of its original range. Major occurrences include: less than 350 ha on the Tweed lowlands in 1985 (Pressey and Griffith 1992); less than 650 ha on the lower Clarence floodplain in 1982 (Pressey 1989a); less than 400 ha on the lower Macleay floodplain in 1983 (Pressey 1989b); less than 3200 ha in the lower Hunter - central Hunter region in the 1990s (NPWS 2000); less than 5200 ha in the Sydney - South Coast region in the mid 1990s (Tindall *et al.* 2004), including up to 4700 ha on the Cumberland Plain in 1998 (Tozer 2003) and less than 250 ha on the Illawarra Plain in 2001 (NPWS 2002); and less than 1000 ha in the Eden region in 1990 (Keith and Bedward 1999).

10. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Swamp Oak Floodplain Forests in other parts of the NSW North Coast bioregion (Pressey 1989a, 1989b, NPWS 1999). In the lower Hunter - central coast region, less than 30-40% was estimated to have remained during the 1990s (NPWS 2000), while approximately 13% remained on the Cumberland Plain in 1998 (Tozer 2003). In the Sydney - South Coast region, less than 20% was estimated to remain in the mid 1990s (Tindall *et al.* 2004), in the Eden region about 30% was estimated to remain during the 1990s (Keith and Bedward 1999).

11. Land clearing continues to threaten Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Pressey 1989a, b; Pressey and Griffith 1992), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils' and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999, Johnson *et al.* 2003). Anthropogenic climate change may also threaten Swamp Oak Floodplain Forest if sea levels rise as predicted or if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change and High frequency fire are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Large areas of habitat formerly occupied by Swamp Oak Floodplain Forest have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). By the early 1900s, drainage unions or trusts were formed on the major floodplains to enable adjacent landholders to arrange for co-ordinated drainage systems, which were designed and constructed by the NSW Department of Public Works. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* and *Casuarina glauca* into open floodplain swamps has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al.* 2003, Stevenson 2003). There have also been anecdotal reports of recruitment by *Casuarina glauca* in pastures during extended dry periods, though not necessarily by other components of the community. These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston *et al.* 2003). Alteration of tidal flows may have lead to decreased soil salinity and localised expansion of *Casuarina glauca* into areas that previously supported Coastal Saltmarsh or mangroves (Stevenson 2003).

13. Very few examples of Swamp Oak Floodplain Forest remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Swamp Oak Floodplain Forest include *Araujia sericiflora* (moth plant), *Asparagus asparagoides* (bridal creeper), *Baccharis halimifolia* (groundsel bush), *Cyperus eragrostis* (umbrella sedge), *Cinnamomum camphora* (camphor laurel), *Conyza* spp. (fleabanes), *Hydrocotyle bonariensis* (American pennywort), *Ipomoea cairica*, *I. purpurea* and *I. indica* (morning glories), *Lantana camara*, *Paspalum dilatatum* (paspalum), *Pennisetum clandestinum* (kikuyu) *Rubus fruticosis* agg. (blackberries), *Solanum pseudocapsicum* (Madeira winter cherry), *S. nigrum* (black-berry nightshade), *Tradescantia fluminensis* (wandering jew) and *Verbena bonariensis* (purpletop), (Tozer 2003, Keith and Scott 2005). In general, remaining examples of Swamp Oak Floodplain Forest from the most saline environments are in better condition, while those from less saline habitats are generally more degraded.

14. Small areas of Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Stotts Island, Ukerebagh, Tuckean, Pambalong, Wamberal, Towra Point and Cullendulla Creek Nature Reserves and Bongil Bongil, Myall Lakes and Conjola National Parks. These occurrences are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. In addition, wetlands within protected areas are exposed to hydrological changes that were, and continue to be initiated outside their boundaries. Some areas of Swamp Oak Floodplain Forest are protected by State Environmental Planning Policy 14, although this has not always precluded impacts on wetlands from the development of major infrastructure.

15. Given the dynamic hydrological relationship between Swamp Oak Floodplain Forest, Coastal Saltmarsh and other endangered ecological communities on coastal floodplains, future management of water and tidal flows may result in the expansion of some communities at the expense of others. Proposals for the restoration of natural hydrological regimes and for the rehabilitation of acid sulfate soils may also result in changes to the distribution and composition of floodplain communities. Co-ordinated planning and management approaches across whole catchments will be required to address and resolve priorities between different management objectives.

16. In view of the above the Scientific Committee is of the opinion that Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam

Chairperson

Scientific Committee

Proposed Gazettal date: 17/12/04

Exhibition period: 17/12/04 - 28/01/05

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COASTAL SALTMARSH

Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast. Coastal saltmarsh has been recorded from sites along the NSW coast. (NSW North Coast, Sydney Basin and South East Corner Bioregions).

2. Characteristic vascular plant species of Coastal Saltmarsh are:

Baumea juncea	*Isolepis nodosa*
Juncus kraussii	*Samolus repens*
Sarcocornia quinqueflora	*Selliera radicans*
Sporobolus virginicus	*Suaeda australis*
Triglochin striata	*Zoysia macrantha*

The total list of species is larger, with many species present in low abundance or at few sites. A more extensive list of species is provided by Adam *et al.* (1988). The sediment surface may support a diversity of both micro-algae and macro-algae.

3. Communities with similar floristic composition, but with a different fauna, are found supratidally on exposed headlands (Adam *et al.* 1988). These headland communities and those of inland saline areas are not included within this Determination of the Coastal Saltmarsh Ecological Community.

4. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions provide habitat for a diverse invertebrate fauna, which includes both marine (crabs and molluscs) and terrestrial (insects and spiders) elements. During tidal flooding a number of fish species utilise saltmarsh habitats. Grazing by macropods may occur between tidal events. Some coastal saltmarshes provide important high tide roosts for migratory wading birds, and a range of other birds also utilise coastal saltmarsh as habitat. Diversity of macrofauna in mangrove forests adjacent to saltmarsh has been found to be greater than in mangroves that do not border saltmarsh (Yerman & Ross 2004)

5. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is frequently found as a zone landward of mangrove stands. Occasional scattered mature *Avicennia marina* trees occur through

saltmarsh at some sites, and *Avicennia* (and less frequently *Aegiceras corniculatum*) seedlings may occur throughout saltmarsh. In brackish areas dense stands of tall reeds (*Phragmites australis*, *Bulboschoenus* spp., *Schoenoplectus* spp., *Typha* spp.) may occur as part of the community.

6. West *et al.* (1985) estimated the total area of coastal saltmarsh in NSW was approximately 5700 hectares distributed in fragmented patches mostly less than 100 hectares. Since this estimate, further reduction and fragmentation have occurred.

7. Species composition within Coastal Saltmarsh varies with elevation. *Sarcocornia quinqueflora* dominates at lower, and hence more frequently flooded, levels than *Sporobolus virginicus* which dominates the mid saltmarsh, while *Juncus kraussii* and *Baumea juncea* are upper saltmarsh species. There is also geographic variation, with much more extensive stands of *Sporobolus virginicus* being found in northern NSW, and conversely more extensive *Sarcocornia quinqueflora* stands in the south. Coastal Saltmarsh in southern NSW is generally more species rich than further north, with *Austrostipa stipoides*, *Gahnia filum*, *Limonium australe* and *Sclerostegia arbuscula* forming a characteristic southern suite of species. A number of other species with restricted distribution in Coastal Saltmarsh include *Distichlis distichophylla* (endangered), *Halosarcia pergranulata* subsp. *pergranulata, Wilsonia backhousei* (vulnerable) and *Wilsonia rotundifolia* (endangered).

8. Saltmarshes are globally threatened, and many of the threatening processes identified by Adam (2002) operate in NSW including infilling, modified tidal flow, weed invasion, damage by domestic and feral animals, human disturbance, altered fire regimes and climate change.

9. Historically, substantial areas of saltmarsh have been infilled for roads and aerodromes and for residential, recreational, waste disposal, industrial and agricultural purposes. With increased recognition of the ecological value of saltmarshes, the threat of further large-scale reclamation is less, but smaller scale infilling still occurs (Harty and Cheng 2003).

10. Patterns of tidal flow have been restricted by artificial structures in many NSW saltmarshes (Williams and Watford 1997), while discharge of stormwater alters salinity regimes, increases nutrient levels and facilitates the spread of *Phragmites* and weeds.

11. In recent decades there has been widespread invasion of saltmarsh in southeast Australia by mangroves (Mitchell and Adam 1989, Saintilan and Williams 1999, 2000). The factors driving mangrove invasion are still unclear. The mangrove invasion limits the use of saltmarshes by birds that would normally make use of this habitat and has been a factor in their decline (Saintilan 2003, Straw 1999, 2000).

12. A large number of weed species occur in NSW saltmarshes (Adam 1981, Adam *et al.* 1988). In terms of change to the community structure and function, the most serious weed is *Juncus acutus*; other major weeds include *Baccharis halimifolia, Cortaderia selloana* and *Hydrocotyle bonariensis*. The upper saltmarsh zone may be dominated by introduced annuals or shortlived perennials, including *Parapholis incurva, Plantago coronopus* and *Polypogon monspeliensis*.

13. Damage to saltmarshes by recreational vehicles, including four wheel drives, is widespread, and deep wheel ruts persist for many years even after exclusion of vehicles. Use of BMX and mountain bikes is increasing, and even saltmarshes within conservation reserves have been seriously damaged (Adam 2002).

14. Grazing and trampling by domestic stock and feral herbivores occurs at a number of sites. Stock grazing has been shown to substantially change the vegetation composition and structure (Adam 1990), while on muddy substrates trampling can cause loss of plant cover and modify drainage patterns.

15. Saltmarshes have frequently been used for casual rubbish dumping and are at risk from waterborne pollution - including oil and chemical spills, both from shipping and road accidents, and catchment runoff of nutrients and agricultural chemicals.

16. Upper saltmarsh stands dominated by *Juncus kraussii* and *Baumea juncea* have high flammable fuel loads. While the natural incidence of fire in saltmarshes is likely to have been low, a number of saltmarshes have been burnt in recent years. The recovery of these sites is relatively slow and the long-term impacts of burning are uncertain.

17. Global warming and increased relative sea level are likely to pose an increasing threat to the survival of many areas of Coastal Saltmarsh (Adam 2002, Hughes 2003).

18. Coastal Saltmarsh occurs in a number of conservation reserves including the Ramsar listed sites at Towra Point and Kooragang Island Nature Reserves. Reserve status, however, does not confer protection from mangrove and weed invasion, recreational vehicles, pollution, fire or sea level rise without active management.

19. In view of the above the Scientific Committee is of the opinion that the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate.

Dr Lesley Hughes
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Scientific Committee

Proposed Gazettal date: 04/06/04
Exhibition period: 04/06/04 - 16/07/04

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Appendix C: Flora and Fauna Likelihood of Occurrence

Summary of initial assessment to determine the likelihood of occurrence of threatened species, populations and ecological communities in the proposal site. An assessment of likelihood of occurrence was made for threatened identified from the database search. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the proposal site, results of the field survey and professional judgement. The terms for likelihood of occurrence are defined below:

- "yes" = the species was or has been observed on the site
- "likely" = a medium to high probability that a species uses the site
- "potential" = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- "unlikely" = a very low to low probability that a species uses the site
- "no" = habitat on site and in the vicinity is unsuitable for the species.

THREATENED FLORA SPECIES AND POPULATIONS

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Acacia bynoeana	Bynoe's Wattle	E1	V	The species is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra (DECC 2007). It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels (DECC 2007). The species seems to prefer open and sometimes slightly disturbed sites (DECC 2007). Characteristic overstorey species include: *Corymbia gummifera*, *Eucalyptus haemastoma*, *E. gummifera, E. parramattensis*, *E. sclerophylla*, *Banksia serrata* and *Angophora bakeri.* Shrubs often associated with the species include *B. spinulosa*, *B. serrata, A. oxycedrus*, *A. myrtifolia* and *Kunzea* spp. (Winning 1992; James 1997). It flowers from September to March and fruits mature in November.	No
Acacia pubescens		V	V	Associated with on Cumberland Plains Woodlands, Shale / Gravel Forest and Shale / Sandstone Transition Forest. Clay soils, often with ironstone gravel (NPWS 1997, Benson and McDougall 1996).	No
Bothriochloa biloba	Lobed Blue-grass	-	V	Grows in woodland on poorer soils (Harden 1994). Flowers in summer. NSW subdivisions: NC, CC, NT, NWS, CWS, NWP, SWP. Other Australian states: Qld. No longer listed as vulnerable on NSW TSC Act.	No
Callistemon linearifolius	Netted Bottlebrush	V	-	Grows in dry sclerophyll forest on the coast and adjacent ranges (DECC 2007). *C. linearifolius* has been recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (DECC 2007).	No

Cryptostylis hunteriana	*Leafless Tongue Orchid*	V	V	It is known from a range of vegetation communities including swamp-heath and woodland (DECC 2007). The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*) (DECC 2007). Bell (2001) has identified Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland as potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (DECC 2007; Bell 2001).	No
Darwinia biflora		V	V	Erect or spreading shrub to 80cm high. Associated with habitats where weathered shale capped ridges intergrade with Hawkesbury Sandstone, where soils have a higher clay content (NPWS 1999, NPWS 1997, Harden 1993).	No
Deyeuxia appressa		E	E	Associated with wet ground (Harden 1994). Known from a single historical record made in 1930 (NPWS 2002).	No
Epacris purpurascens var *purpurascens*		V	-	Sydney Sandstone Gully Forest and wet heath with strong clay influences (NPWS 1997). Recorded between Gosford in the north to Avon Dam in the south. Found in a range of habitats, but most have a strong shale soil influence. Killed by fire and re-establishes from soil stored seed (DECC 2007). The species also occurs in riparian zones draining into Sydney Sandstone Gully Forest, shale	No
				lenses within sandstone habitats and colluvial areas overlying or adjoiningsandstone or tertiary alluvium.	
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Associated with shallow sandy soils bordering coastal heath with other stunted or mallee eucalypts, often in areas with restricted drainage and in areas with laterite influenced soils, thought to be associated with proximity to shale (DECC 2007). Flowering is irregular and has been recorded throughout the year (DECC 2007).	No
Haloragodendron lucasii		E	E	Associated with low woodland on sheltered slopes near creeks on moist loamy sand on bench below small sandstone cliff lines, with continuous seepage (Benson and McDougall 1997).	No

Melaleuca biconvexa	Biconvex Paperbark	V	V	Associated with damp habitats, such as Coastal Narrabeen Moist Forest, Riparian Melaleuca Swamp Woodland (LMCC 2001). This species may occur in dense stands forming a narrow strip adjacent to watercourses, in association with other *Melaleuca* species or as an understorey species in wet forest (NSW Scientific Committee 1998). Flowering occurs over just 3-4 weeks in September and October (DECC 2007).	No
Melaleuca deanei	Deane's Paperbark	V	V	Found in heath on sandstone (DECC 2007), and also associated with woodland on broad ridge tops and slopes on sandy loam and lateritic soils (Benson and McDougall 1998).	No
Pimelea curviflora var curviflora		V	-	Associated with the Duffys Forest Community, shale lenses on ridges in Hawkesbury sandstone geology (Pittwater Council 2000).	No
Pimelea spicata		E1	E	In western Sydney, it occurs on an undulating topography of well structured clay soils, derived from Wianamatta shale (DEC 2004). It is associated with Cumberland Plains Woodland (CPW), in open woodland and grassland often in moist depressions or near creek lines (*Ibid.*). Has been located in disturbed areas that would have previously supported CPW (*Ibid.*).	No
Prostanthera marifolia		E	E4	Occurs on deeply weathered clay-loam soils associated with ironstone and scattered shale lenses, a soil type which only occurs on ridge tops and has been extensively urbanised (DECC 2008).	No
Tetratheca glandulosa		V	V	Associated with ridgetop woodland habits on yellow earths (Travers Morgan 1991) also in sandy or rocky heath and scrub (NPWS 1997). Often associated with sandstone / shale interface where soils have a stronger clay influence (NPWS 1997). Flowers July to November.	No
Disclaimer: Data extracted from the Atlas of NSW Wildlife and EPBC Act Protected Matters Report are only indicative and cannot be considered a comprehensive inventory. TSC Act = *Threatened Species Conservation Act 1995*; EPBC Act = *Environmental Protection and Biodiversity Conservation Act 1999*.					

E = Endangered; E2 = Endangered Population; E4: Presumed extinct; V = Vulnerable

THREATENED FAUNA SPECIES AND POPULATIONS

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
FROGS					
Heleioporus australiacus	Giant Burrowing Frog	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest (Ehmann 1997). Associated with semi-permanent to ephemeral sand or rock based streams (Ehmann 1997), where the soil is soft and sandy so that burrows can be constructed (Environment Australia 2000).	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Litoria aurea	Green and Golden Bell Frog	E1	V	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DECC 2007). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DECC 2007). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–Typha sp. and spikerushes–Eleocharis sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 1993). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (Gambusia holbrooki) (DECC 2007).	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Mixophyes balbus	Stuttering Frog	E	V	A variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest (DECC 2007) that are generally characterised by deep leaf litter or thick cover from understorey vegetation (Ehmann 1997). Breeding habitats are streams and occasionally springs. Not known from streams disturbed by humans (Ehmann 1997) or still water environments (NSW Scientific Committee 2002).	No
Mixophyes iteratus	Giant Barred Frog	E	E	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest, wet sclerophyll forests and swamp sclerophyll forest (DECC 2007; Ehmann 1997). This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997). This species is not known from riparian vegetation disturbed by humans (NSW Scientific Committee 1999). During breeding eggs are kicked up onto an overhanging bank or the streams edge (DECC 2007).	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Pseudophryne australis	Red-crowned Toadlet	V	-	Red-crowned Toadlets are found in steep escarpment areas and plateaus, as well as low undulating ranges with benched outcroppings on Triassic sandstones of the Sydney Basin (DECC 2007). Within these geological formations, this species mainly occupies the upper parts of ridges, usually being restricted to within about 100 metres of the ridgetop. However they may also occur on plateaus or more level rock platforms along the ridgetop (DECC 2007). Associated with open forest to coastal heath (Ehmann 1997). Utilises small ephemeral drainage lines which feed water from the top of the ridge to the perennial creeks below for breeding, and are not usually found in the vicinity of permanent water (Ehmann 1997). Breeding sites are often characterised by clay-derived soils and generally found below the first sandstone escarpment in the talus slope (NPWS 1997).	No
REPTILES					

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Typical sites consist of exposed sandstone outcrops and benching where the vegetation is predominantly woodland, open woodland and/or heath on Triassic sandstone of the Sydney Basin (DECC 2007). They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer (Webb & Shine 1998b). Some of the canopy tree species found to regularly co-occur at known sites include *Corymbia eximia, C. gummifera, Eucalyptus sieberi, E. punctata* and *E.piperita* (DECC 2007).	Unlikely
DIURNAL BIRDS					
Burhinus grallarius	Bush Stone-curlew	E1	-	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins 1993). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed in lightly disturbed.	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Callocephalon fimbriatum	Gang-gang Cockatoo	V - E2	-	During summer in dense, tall, wet forests of mountains and gullies, alpine woodlands (Morcombe 2004). In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages (Shields & Chrome 1992). They sometimes inhabit woodland, farms and suburbs in autumn/winter (Simpson & Day 2004).	Unlikely
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Intact drier forest types with less rugged landscapes are preferred (DECC 2007). Nests in large trees with large hollows (Environment Australia 2000).	Unlikely
Charadrius mongolus	Lesser Sand Plover	V	-	Favours coastal areas including beaches, mudflats and mangroves where they forage (DECC 2007). They may be seen roosting during high tide on sandy beaches or rocky shores (DECC 2007).	No

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Ephippiorhynchus asiaticus	Black-necked Stork	E1	-	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DECC 2007).	Unlikely
Glossopsitta pusilla	Little Lorikeet	V	-	In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands White Box *Eucalyptus albens* and Yellow Box *E. melliodora* are particularly important food sources for pollen and nectar respectively.	Unlikely

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Lathamus discolor	Swift Parrot	E1	E	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts (Blakers et al. 1984; Schodde and Tidemann 1986; Forshaw and Cooper 1981). Hence, in this region, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as Swamp Mahogany (Eucalyptus robusta), Spotted Gum (Corymbia maculata), Red Bloodwood (C. gummifera), Mugga Ironbark (E. sideroxylon), and White Box (E. albens) (DECC 2007).	Unlikely
Pandion haliaetus	Osprey	V	-	Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde and Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground, on sea cliffs or in trees (Olsen 1995). Osprey generally prefer emergent trees, often dead or partly dead with a broken off crown (Olsen 1995).	Unlikely
NOCTURNAL BIRDS					
Ninox strenua	Powerful Owl	V	-	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Unlikely
MAMMALS (EXCLUDING BATS)					

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Dasyurus maculatus	Spotted-tailed Quoll	V	-	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECC 2007j), more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECC 2007). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	No
Dasyurus maculatus maculatus	Spotted-tailed Quoll (SE Mainland Population)	-	E		
Isoodon obesulus	Southern Brown Bandicoot	E	E	This species is associated with heath, coastal scrub, heathy forests (Menkhorst & Knight 2004), shrubland and woodland on well drained soils. This species is thought to display a preference for newly regenerating heathland and other areas prone to fire (Menkhorst & Seebeck 1990).	Unlikely
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	No
Potorous tridactylus	Long-nosed Potoroo	V	-	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	No
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE Mainland Population)	-	V		
MAMMALS (BATS)					

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; DECC 2007).	No
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	Unlikely
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Potential
E = Endangered; E2 = Endangered Population; V = Vulnerable; M = Migratory.					

MIGRATORY SPECIES LISTED UNDER THE EPBC ACT

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Haliaeetus leucogaster	White-bellied Sea-Eagle	—	M	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1993).	Unlikely
Hirundapus caudacutus	White-throated Needletail	—	M	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1993; Simpson & Day 1999). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1993).	Unlikely
Merops ornatus	Rainbow Bee-eater	—	M	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March, some occasionally present April to May (Pizzey and Doyle 1988). Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (*ibid*). Nest is a chamber at the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (*ibid*).	Unlikely
Monarcha melanopsis	Black-faced Monarch	—	M	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	No
Myiagra cyanoleuca	Satin Flycatcher	—	M	Associated with drier eucalypt forests, absent from rainforests (Blakers et al. 1984), wetter, denser forests, often at high elevations (Simpson & Day 2004).	No
Rhipidura rufifrons	Rufous Fantail	—	M	The Rufous Fantail is a summer breeding migrant to southeastern Australia (Morcombe, 2004). The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation (Morcombe, 2004). Open country may be used by the Rufous Fantail during migration (Morcombe, 2004).	No
MIGRATORY WETLAND SPECIES LISTED UNDER EPBC ACT					
Ardea alba	Great Egret	—	M	The Great Egret is common and widespread in Australia (McKilligan, 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats (McKilligan, 2005).	Potential

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
Ardea ibis	Cattle Egret	—	M	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan, 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan, 2005).	No
Disclaimer: Data extracted from the Atlas of NSW Wildlife and EPBC Act Protected Matters Report are only indicative and cannot be considered a comprehensive inventory. 'Migratory marine species' and 'listed marine species' listed on the EPBC Act have not been included in this table, since they are considered unlikely to occur within the study area due to the absence of marine habitat. Shorebirds have also been excluded as there is no shorebird habitat at the site.					

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