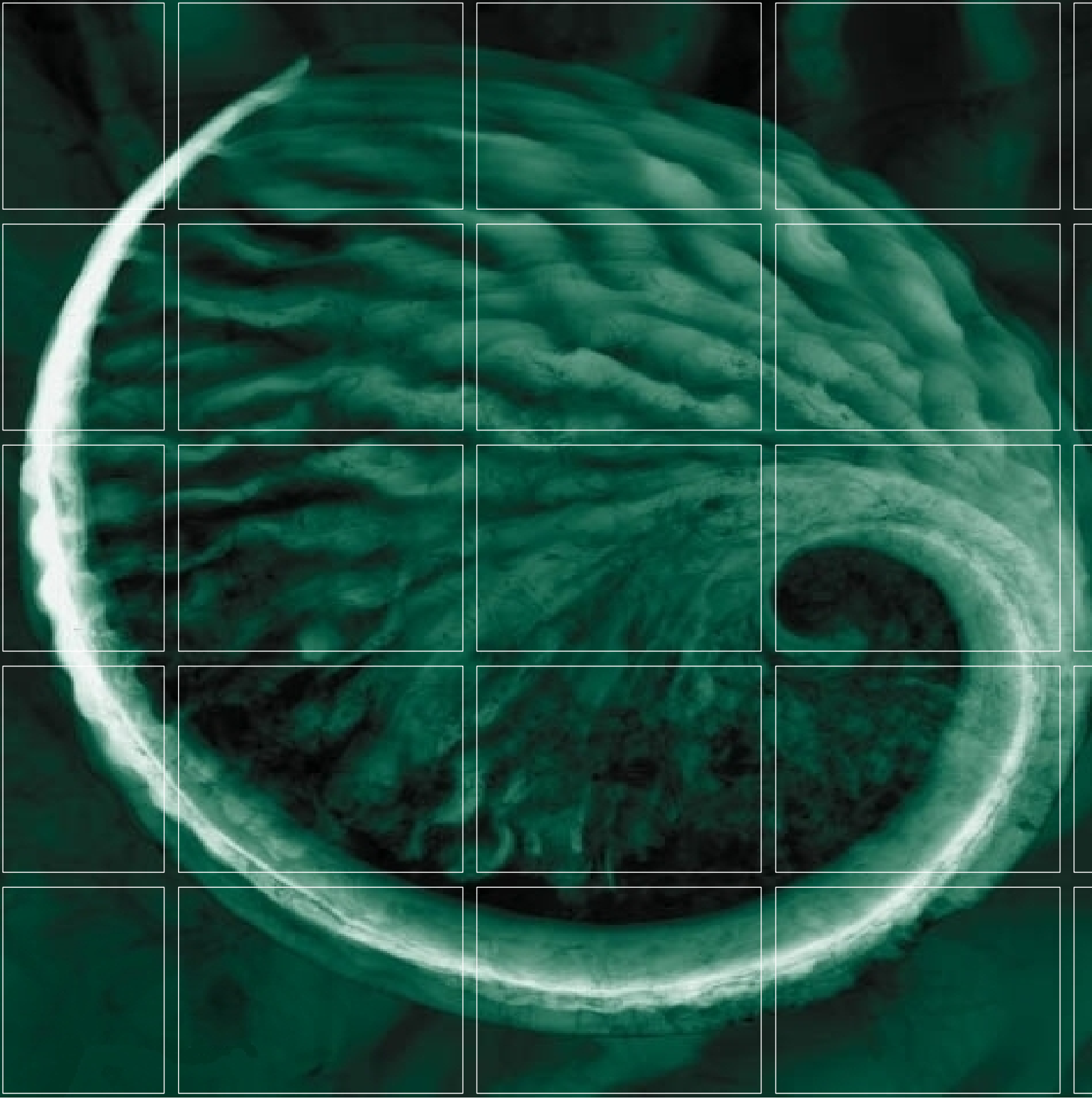
ANNEX P

Ecological Assessment Report



Fern Bay Seaside Village
Ecology Assessment Report

Aspen Group Pty Ltd

February 2009

0063154 Ecology Final 1

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Environmental Resources Management Australia Pty Ltd Quality System

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1 INTRODUCTION

1.1 BACKGROUND TO THE PROPOSED FERN BAY SEASIDE VILLAGE

Environmental Resources Management Australia Pty Ltd (ERM) have been engaged by Aspen Group Pty Ltd to prepare an Environmental Assessment Report pursuant to Part 3A of the *Environmental Planning and Assessment Act 1979* (EP & A). The EAR has been prepared to accompany the application for project approval for a residential subdivision consisting of 713 lots called 'Fern Bay Seaside Village'.

Part of the 'Fern Bay Seaside Village' has an existing approval from the Land and Environment Court in 1997 and is currently under construction. In addition, the NSW Minister of Planning approved a Master Plan for the Fern Bay Estate residential subdivision pursuant to State Environmental Planning Policy No.71 – Coastal Protection on 8 August 2006. The Project Plan application is consistent with the Master Plan approval. While there have been minor changes to the lot structure the overall footprint and layout has not been altered. This report has been prepared to ensure fulfilment of the requirements of a Part 3A application.

The site is described as Lot 3, DP 270466 Nelson Bay Road, Fern Bay and is within the Port Stephens local government area. The site is approximately 205 hectares in area and comprises 16.4 hectares zoned 1 (a) Rural Agriculture, 136.4 hectares zoned 2 (a) Residential, and 52.2 hectares zoned 7 (a) Environmental Protection under Port Stephens Local Environmental Plan (LEP) 2000.

The project is described as a community title subdivision which contains the following components:

- a subdivision of 713 residential allotments with four of these lots having the potential for further subdivision into approximately 94 integrated housing lots;
- various areas of recreational and open space are proposed which will include children's playgrounds, formal parks, a Cultural Heritage Reserve, open space for both passive and active recreation, stormwater management, fire and pedestrian trails and ecological corridors;
- a community centre is proposed within an area of open space;
- conservation is proposed through the retention of large areas of natural vegetation within the site to be managed by the Community Association and also the management of the adjoining Worimi Regional Park to the south through an offset compensation package which has been negotiated with the Department of Environment and Climate Change; and
- a commercial outlet or convenience store in the southeast of the site.

1.2 ECOLOGICAL ASSESSMENT BACKGROUND

Fern Bay Seaside Village is immediately adjacent to Nelson Bay Road, midway between Stockton Beach and Fullerton Cove. The site forms part of a local corridor of native vegetation and active dunes that extends along the coastal dune system of the Stockton Bight. The vegetated dunes typically support dry sclerophyll forest with swamp forest and/or heath associated with dunal swales. Large sections of the Stockton Bight coastal dune system are now protected within the Worimi Conservation Lands which include the Worimi Regional Park, Worimi National Park and Worimi State Conservation Area. In a regional context, the site is part of a corridor that links the Tomago coastal plain with the Lower Hunter plain, then west to the Sugarloaf Range. While not part of the proposed Watagans Ranges to Port Stephens reserve through Hexham Swamp identified in the Draft Lower Hunter Regional Conservation Plan (DEC 2006), the site is continuous with this reserve through the regional corridor.

Ecological investigations have occurred within the Fern Bay Seaside Village site and surrounding area since 1992. Ecological investigations undertaken at that time included:

- Clements A M, Rodd A N, Lim I, Clulow J and Hoye G (1992) Flora and Fauna Report part of the Environment Assessment of Fern Bay, New South Wales. This report provided broad vegetation description and mapping for the Fern Bay Seaside Village site and two parcels of land to the south and east. Fauna investigations identified a number of species assessed as threatened under the current listing including the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Greater Broad-nosed Bat (*Scoteanax rueppelli*).

Part of the site has approval for a 208 lot residential subdivision granted in September 1997. Ecological investigations undertaken at that time included:

- Gunninah Environmental Consultants (1996 revised 1997). Fauna and Flora Assessment Proposed Residential Development, Nelson Bay Road, Fern Bay. Investigations identified the threatened Squirrel Glider (*Petaurus norfolcensis*) on site. This report provided an eight part test of significance established in Section 5A of the EP&A Act of the impact of the proposed development.

Stages 1 and 2 of the approved subdivision have been constructed and released for sale in 2006 and 2007.

In preparation of the Master Plan Study for the proposed Fern Bay Seaside Village, ERM have undertaken ecological investigations on this site from 2002 to 2005. The field investigations and assessments for the Master Plan Study concentrated on the development footprint external to the approved subdivision.

The results of these assessments are provided in the following reports:

- Fern Bay Seaside Village Master Plan Study Ecological Assessment Report (ERM 2004) which assessed the impact of the proposed residential subdivision on 25 threatened species. This assessment concluded that the proposed subdivision had the potential to have a significant impact on a local population of the Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat and Squirrel Glider;

- Fern Bay Estate Master Plan Study Species Impact Statement (SIS) (ERM 2005a). The findings of this report form the basis for this assessment. This report is also provided as an annexure to this Environmental Assessment Report;

- Fern Bay Estate Master Plan Study Response to the Port Stephens Comprehensive Koala Plan of Management (ERM 2005b). This report assessed Koala habitat as defined by the Comprehensive Koala Plan of Management and is also provided as an annexure to this Environmental Assessment Report;

- Fern Bay Estate Master Plan Study Assessment of Matters of National Environmental Significance (ERM 2005c) provided an assessment of the impact of the proposal on Matters of National Environmental Significance as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* in particular threatened species and migratory birds. This report is also provided as an annexure to this Environmental Assessment Report; and

- Fern Bay Estate Master Plan Study Aquatic Assessment Report (ERM 2005d) considered the impact of the proposal on aquatic habitat and threatened fauna as defined under the *Fisheries Management Act 1994*. The report identified that intermittent aquatic habitat on site is not permanently connected to the Hunter River and therefore do not provide suitable habitat for aquatic species (ERM 2005d).

The SIS identified a total of 37 threatened species and one endangered ecological community potentially affected by the proposed development. The SIS assessed the impact of the proposal on these species and concluded that the proposed development has the potential to affect a number of threatened species and communities. The Masked Owl, Powerful Owl, Hoary Wattled Bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat and Squirrel Glider are considered most likely to be impacted by the proposal, as local populations are present and depend on habitats in the subject site for their long-term viability (ERM 2005a). The endangered ecological community known as 'Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions' occurs within the site (ERM 2005a).

The most significant impact will be the loss of habitat and habitat resources such as hollow-bearing trees and winter-flowering trees (ERM 2005a). However, the proposed design strategically conserves habitat for affected species and communities within ecological corridors and in areas that will maintain connectivity to surrounding land. Management of native vegetation on site will involve the rehabilitation of disturbed areas and management of the bush fire regime in order to increase floristic diversity in the area (ERM 2005a). Management of the community lands (zoned 7a) and reserves will be in keeping with the Community Lands Environmental Management Plan prepared for this development (ERM 2009).

The proposed residential subdivision (excluding the approved residential subdivision over part of the site) as defined in the approved Master Plan and adopted in the current Project Plan assessment will result in the disturbance and removal of approximately 70 hectares of existing vegetation. Approximately 107 hectares of existing vegetation (52% of the site) is proposed to be retained.

1.3 PURPOSE OF THE ADDENDUM REPORT

This report adopts the findings of the assessments undertaken for the Fern Bay Estate Master Plan as listed in *Section 1.2* and expands the assessment findings to:

- consider revisions to legislation in particular additions to threatened species schedules in the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*;
- address offset compensation package as agreed in the Master Plan;
- and address the Director-General requirements for the Project Plan approval as stated below:
    - outline measures for the conservation of flora and fauna and their habitats within the meaning of the *Threatened Species Conservation Act 1995* having regard to the Draft Guidelines for Threatened Species Assessment (DEC DPI, 2005) and in accordance with the Fern Bay Estate approved Master Plan No MP 20-4-2005;
    - address the requirements of State Environmental Planning Policy No 44-Koala Habitat Protection and the Port Stephens Council Comprehensive Koala Plan of Management; and
    - assess the impact of the proposal on groundwater dependent ecosystems (swamp forest and wet heath), and assess the need for appropriate buffer zone(s) to be placed around groundwater dependent ecosystems.

Throughout this ecological assessment, 'development' refers to the Fern Bay Seaside Village residential development.

2 METHODOLOGY

2.1 LITERATURE REVIEW

The methodology adopted for the Environmental Assessment included a literature review and summation of findings of previous assessment reports. Reports identified in *Section 1.2* were reviewed to provide details of field survey methodology and effort and survey results. Reports prepared for other nearby proposals (ERM 2006) were also reviewed to identify additional records of threatened species.

A search of the DECC Wildlife Atlas database, including Rare or Threatened Australian Plants (ROTAP) was conducted for all recent records of threatened flora and fauna within the locality and to update data presented in the Master Plan Study reports. This search revealed the presence of several threatened species within a 10 kilometre radius of the site. One additional species was found within 10 kilometres being the Long-nosed Potoroo (*Potorous tridactylus*).

A search of the on-line database maintained by the Commonwealth Department of the Environment and Water Resources (DEWR) was completed for a 10 kilometre radius of the site, to identify the presence of nationally listed threatened and migratory species in the locality.

All flora and fauna database records within the locality were plotted using a geographic information system and any additional threatened species were analysed to determine the likelihood that threatened flora and fauna could occur within habitats in the study area.

2.2 FIELD INVESTIGATIONS

Flora and fauna investigations have been undertaken on the site since 1992 for the rezoning application Clements and Associates (1992) and Gunninah (1996, 1997, 2002). Survey sites from these investigations are shown on *Annex A: Figure A.1*. Field investigations undertaken by ERM between 2002 and 2005 in the development of the Master Plan studies (ERM 2004, 2005a, 2005b, 2005c) targeted threatened species. Survey methodology and effort for the Master Plan studies is summarised in *Table 2.1* and shown in *Annex A: Figure A.2* and *Annex A: Figure A.3*.

The vegetation descriptions have been reviewed against the regional vegetation description in the Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) (NPWS 2000). This assessment provides a general description of the vegetation communities characterising the site.

Since lodgement of the Master Plan, additional targeted surveys have been conducted in the Fern Bay Seaside Village and in the adjoining Worimi Regional Park (previously Ministerial Part 11 land) to the south of the subdivision for the putative hybrid of the threatened *Eucalyptus parramattensis* subsp *decadens*.

The surveys targeted areas supporting the *E. parramattensis* subsp *decadens* hybrid as identified in the SIS (ERM 2005a) and Bell (2006) in particular dune swales and wet heath. Detailed searches (approximately 30 person hours) were undertaken using the random meander technique over two days (22nd and 24th January 2007). Survey routes are shown in *Annex A*: *Figure A.4.* Individuals and/or groups were marked using hand held Geographic Positioning System (GPS) - navigation system WGS 84 format. Within each clump, the mature trunks were marked as individual specimens and any other stems in the immediate area (ie within one to two metres) identified as part of the single specimen arising from the same root structure. It should be noted that the number of clumps in the population was based on the visibility from each waypoint (ie approximately 20 metres).

Table 2.1 Survey Effort, ERM 2002 to 2005

Survey Type (Species Targeted)	Vegetation Community	Survey Effort	Date
Flora survey	swamp forest[1]	4 quadrats (replicated)	13 and 14 January 2005
	dry sclerophyll open forest	3 quadrats (replicated)	13 and 14 January 2005
	wet heath	2 quadrats (replicated)	13 and 14 January 2005
Targeted flora surveys:			
• Leafless Tongue Orchid	swamp forest/dry sclerophyll open forest	random meander transect	19 November 2002
• Rough Doubletail	dry sclerophyll open forest	random meander transect	July 2002, 25 August 2004
• Sand Doubletail	dry sclerophyll open forest	random meander transect	10 September 2004
• *Eucalyptus parramattensis* subsp. *decadens* and Netted Bottlebrush	dry sclerophyll open forest/wet heath	random meander transect	18 January 2005
• Heath Wrinklewort	dry sclerophyll open forest	random meander transect	18 January 2005
• Dwarf Kerrawang	swamp forest	4 quadrats (replicated)	13 and 14 January 2005
• swamp sclerophyll forest[1]	swamp forest	4 quadrats (replicated)	13 and 14 January 2005
Koala habitat assessment	swamp forest/wet heath	6 quadrats	28 May 2004
Koala spot assessment	swamp forest	4 sites (80 swamp mahogany searched)	21 May 2004
Squirrel Glider habitat assessment	swamp forest/dry sclerophyll open forest/wet heath	5 sites/5 by 1 ha quadrats	14 and 15 February 2005
Elliott B type trapping (Squirrel Glider, Brush-tailed Phascogale)	dry sclerophyll open forest/swamp forest	375 trap nights	11 – 15 February 2002
	dry sclerophyll open forest	60 trap nights	3 – 5 September 2002
	swamp forest/dry sclerophyll open forest/wet heath	150 trap nights	14 – 18 February 2005
Call playback (owls, Squirrel Glider, Koala)	dry sclerophyll open forest/swamp forest	2 sites/2.3 hours	3 – 5 September 2002
Call playback (owls)	dry sclerophyll open forest/swamp forest	3 sites/2.5 hours	24 and 31 January, 15 February 2005
Spotlighting (all nocturnal fauna)[2]	dry sclerophyll open forest/swamp forest/wet heath	2 transects/10.5 hours	3 – 5 September 2002
	dry sclerophyll open forest/swamp forest/wet heath	2 transects/9.2 hours	24 and 31 January, 15 February 2005
	dry sclerophyll open forest/swamp forest/wet heath	4 sites/4.6 hours	14 and 16 February 2005

Survey Type (Species Targeted)	Vegetation Community	Survey Effort	Date
Stagwatching (arboreal fauna)	dry sclerophyll open forest/swamp forest	2 sites/2.0 hours	14 and 16 February 2005
Anabat detection (microchiropteran bats) hand-held unit	dry sclerophyll open forest/swamp forest	3 sites/12.8 hours	3 – 5 September 2002
	dry sclerophyll open forest/swamp forest/wet heath	1 site, 1 transect/2.8 hours	24 January 2005
Anabat detection (microchiropteran bats) delay-switch unit	dry sclerophyll open forest/swamp forest/wet heath	4 sites/8 Anabat nights	14 – 17 February 2005
Harp trapping (microchiropteran bats)	dry sclerophyll open forest/swamp forest/wet heath	5 sites/10 harp nights	14 – 17 February 2005
Call playback (Wallum Froglet)	swamp forest	4 sites/3.0 hours	22 and 29 June, 1 July 2004
Tadpole searches (Green-thighed Frog)	swamp forest	4 sites/2.2 hours	21 February 2005
Habitat and tadpole searches (Green and Golden Bell Frog)	swamp forest	4 sites/2.2 hours	21 February 2005
Point call census (nectivorous birds)	swamp forest/wet heath	5 sites/5.0 hours	9, 10 and 23 June 2004
Point call census/chewed *Allocasuarina* cone search (woodland birds)	dry sclerophyll open forest/wet heath	30 sites/10.0 hours	1, 2, 3, 5, 6 and 7 February 2005
Call playback/point call census (frugivorous birds)	swamp forest	4 sites/4.2 hours	1, 2, 3 and 5 February 2005
Point call census/nest search (raptors)	dry sclerophyll open forest/swamp forest/wet heath	34 sites/14.2 hours	1, 2, 3, 5, 6 and 7 February 2005
Elliott A type trapping (small ground mammals)	dry sclerophyll open forest/swamp forest/wet heath	4 transects/320 trap nights	24 – 28 January 2005
Hair tubes (Spotted-tailed Quoll, Brush-tailed Phascogale, small ground mammals)	dry sclerophyll open forest/swamp forest/wet heath	4 transects/400 funnel nights	24 – 28 January 2005

1 = endangered ecological community
2 = spotlighting and stagwatching hours are person hours

3 SURVEY RESULTS

3.1 VEGETATION AND FAUNA HABITATS

The Fern Bay Seaside Village is situated at the boundary of the North Coast Biogeographic Region and the Sydney Basin (division occurs at the Hunter River) Biogeographic Region. Similarly it is located in the North Coast botanical subdivision with the Central Coast botanical subdivision to the south of the Hunter River.

The site is dominated by Quaternary sands and does not contain any naturally occurring outcrops (Matthei 1995). The Stockton Bight is a dune barrier system composed of an inner barrier of Pleistocene age and an outer barrier of Holocene age that are separated by a low-lying swampy area referred to as the inter-barrier depression (Roy and Thom 1981, Thom *et al* 1992). The transgression of dunes across the site has resulted in a series of prominent ridges and distinct sandy knolls, parallel to the shore line. Soils on site consist of a narrow topsoil layer of silty sand over a sand layer with a thickness that varies from 13 to 27 metres that overlays sandy clay. The soils are underlain by rock at a depth of approximately 60 metres.

Flora species identified during previous investigations are listed in *Annex B: Table B.1*. A total of 74 fauna species were recorded including one megachiropeteran bat, 12 microchiropteran bats, seven other mammals, 50 birds, two reptiles and two amphibians (see *Table B.2*).

The site is characterised by three main vegetation communities (see *Figure A.5*) and corresponding fauna habitats. The dunes support Coastal Sand Apple-Blackbutt Forest. The dune swale support wet heath community with Swamp Mahogany-Paperbark Forest in poorly drained swales near Nelson Bay Road. The endangered ecological community 'Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions' is present in the swamp forest on site where it adjoins Nelson Bay Road.

3.1.1 *Coastal Sand Apple-Blackbutt Forest*

The eastern half of the site has been mapped as Coastal Sand Apple–Blackbutt Forest, which occurs principally on Holocene sands. This community dominates the vegetated dunes of the Stockton Bight and is well represented in conservation reserves within the Lower Hunter and Central Coast region and the North Coast bioregion.

The canopy within this community is typically dominated by Smooth-barked Apple (*Angophora costata*) and Blackbutt (*Eucalyptus pilularis*) with occasional Red Bloodwood (*Corymbia gummifera*) and *Banksia serrata*. Structurally it is an open forest with a moderately open shrubby understorey and open

groundcover of grasses (in particular Blady Grass (*Imperata cylindrica*) and Kangaroo Grass (*Themeda australis*)) and Bracken Fern (*Pteridium esculentum*). Common shrub species include *Dillwynia retorta*, *Acacia ulicifolia*, *Acacia longifolia*, *Platysace lanceolata* and *Ricinocarpos pinifolius* (ERM 2005a).

This community has been regularly subjected to fire, at least once every five years and often more frequently (ERM 2005a). There are numerous four wheel drive tracks and associated with these is rubbish dumping and Bitou Bush (*Chrysanthemoides monilifera* subsp *rotundata*) infestations.

The dry sclerophyll forest supports a variety of fauna habitats including abundant tree hollows, flowering plants, fallen logs, and ground cover such as grasses and Bracken Fern. The sandy substrate enables small terrestrial animals to easily create burrows. There is no bush rock or rock platform habitats.

3.1.2 Swamp Mahogany–Paperbark Forest

Swamp Mahogany–Paperbark forest occupies low lying areas along Nelson Bay Road. The swamp forest is dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*), Swamp Mahogany (*Eucalyptus robusta*), Swamp Oak (*Casuarina glauca)* and Cabbage Tree Palm (*Livistona australis*). The canopy density is 70 percent or greater and there is a sparse mid-storey of occasional Broad-leaved Paperbark. The ground cover is sparse, often inundated and dominated by Swamp Water Fern (*Blechnum indicum*), Jointed Twigrush (*Baumea articulata*) and Saw Sedge (*Gahnia clarkei*). In the western corner of the site Swamp Oak and Broad-leaved Paperbark with a sparse to absent understorey dominate the swamp forest.

In the Lower Hunter and Central Coast region Swamp Mahogany–Paperbark forest has been identified as a regionally significant vegetation community that has been heavily cleared with an estimated 71% of its projected pre European distribution cleared (LHCC Councils 2003). Parts of this community were assessed as representative of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community (see *Figure A.5*).

The Swamp Mahogany provides a valuable winter foraging resource for Squirrel Gliders and winter migratory birds, while its foliage is a preferred feed source for Koalas (see Section *3.1.4*). Cabbage Tree Palms and other rainforest plants provide a foraging resource for frugivorous birds and the Grey-headed Flying-fox. The ephemeral wetlands provide habitat for a number of frogs in particular the Wallum Froglet (*Crinia tinnula*).

3.1.3 Wet Heath

The wet heath is characterised by a dense lower shrub strata with occasional emergent Swamp Mahogany, Red Bloodwood and Old Man Banksia. This

community corresponds to the wet heath community identified by Clements *et al* (1992). Wet heath species such as *Melaleuca nodosa* and *Restio tetraphyllus* dominate the community.

This community corresponds to the LHCCREMS mapping unit of Tomago sand swamp woodland/heath (NPWS 2000). This community is considered to have high conservation significance given restricted distribution and previous clearing. The Tomago sand swamp woodland is identified as a regionally significant vegetation community that has been heavily cleared with an estimated 18% of its projected pre European distribution remaining and is also a specialised community of restricted distribution with a total extant distribution of 287 hectares (LHCC Councils 2003). While Tomago Sand Swamp Heath has not been heavily cleared with 90% of its projected pre European distribution remaining (LHCC Councils 2003) and this is possibly attributed to its distribution being largely within the Tomago sandbeds.

The wet heath has little to no fauna habitat in the form of tree hollows however the dense cover and diversity of shrub and grass species provide habitat and protection for birds, small mammals and reptiles. Emergent Swamp Mahogany trees provide a foraging resource for Squirrel Gliders, Koalas and winter migratory species. There are no permanent or ephemeral wetlands suitable for frogs in this habitat.

3.1.4 Koala Habitat

An assessment of Koala Habitat was provided in a number of the Master Plan studies in particular the response to Response to the Port Stephens Comprehensive Koala Plan of Management (ERM 2005b). The following is a summary of the findings in that report.

The Port Stephens Council CKPoM identified Fern Bay Seaside Village as predominantly supplementary habitat, with an area of preferred Koala habitat (Port Stephens Council 2001) corresponding with the Swamp Mahogany–Paperbark Forest mapped by Lower Hunter Central Coast Regional Environment Management Strategy (LHCCREMS) (NPWS, 2000). The CKPoM mapping also includes a 50 metre buffer over supplementary around this preferred habitat, and a link over supplementary that connects the preferred habitat in the study area to preferred Koala habitat at Newcastle Golf Course to the southwest of the subdivision. Accordingly, a Koala habitat assessment was undertaken in accordance with Appendix 6 of the CKPoM. In addition, Koala spot assessment was conducted in the study area to assess the level of current Koala activity (ERM 2005b).

The Koala habitat assessment undertaken by ERM (2005b) identified the areas mapped as swamp forest and wet heath in the study area as *potential* Koala habitat as defined by State Environmental Planning Policy No 44 – Koala Habitat Assessment (SEPP 44) as more than 15% of trees in the upper and lower canopy strata of these vegetation communities are Swamp Mahogany (*Eucalyptus robusta*) (see *Table 3.1*). Both of these habitats are also preferred

Koala habitat as defined in the CKPoM, as Swamp Mahogany represent more than 10% of trees.

Table 3.1 Koala Habitat Assessment

Tree Species	Upper strata		Lower strata		Total	
	No.	%	No.	%	No.	%
Swamp forest:						
Angophora costata	2	3	0	0	2	3
*Eucalyptus robusta**	23	41	0	0	23	34*
Livistona australis	9	16	7	63	16	24
Melaleuca quinquenervia	17	30	0	0	17	25
Melaleuca styphelioides	4	7	4	36	8	12
Wet heath:						
Angophora costata	1	6	2	9	3	8
Banksia serrata	9	60	11	50	20	54
*Eucalyptus robusta**	5	33	9	40	14	37*

1. * preferred koala feed tree species in Port Stephens LGA.
2. swamp forest and wet heath are *potential* koala habitat (ie *Eucalyptus robusta* is greater than 15% of the total species).

The Coastal Sand Apple-Blackbutt Forest is identified as supplementary Koala habitat. In keeping with the CKPoM a minimum 50 metre habitat buffer over supplementary habitat is identified around the areas of preferred Koala habitat. Further habitat linking areas were identified between proximate areas of preferred Koala habitat to further enhance Koala habitat. Koala habitat map for the Fern Bay Seaside Village is provided in *Figure A.6*.

Subsequent searches for Koala faecal pellets within one metre of the base of the Swamp Mahogany trees did not find any evidence of koala usage in these areas. Therefore, although the swamp forest and wet heath support *potential* Koala habitat, the two vegetation communities do not support *core* Koala habitat as defined by SEPP 44. This conclusion is also supported by the lack of recent (post-1992) records of Koalas in the study area and the fact that Gunninah Consultants (1996 revised 1997, 2002) and ERM (2004, 2005a, 2005b) did not find any evidence of Koala usage in the study area. There have been no records of Koalas on the adjoining Boral property (ERM, 2006).

3.2 THREATENED SPECIES

Affected species and ecological community that were recorded in the site (see *Figure A.5*) during flora and fauna surveys conducted by ERM for the SIS (ERM 2005a) include:

- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions;
- *Eucalyptus parramattensis* subsp *decadens* hybrid;
- Wallum Froglet (*Crinia tinnula*);
- Hoary Wattled Bat (*Chalinolobus nigrogriseus*);

- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Little Bentwing-bat (*Miniopterus australis*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Powerful Owl (*Ninox strenua*); and
- Squirrel Glider (*Petaurus norfolcensis*).

A roost tree of the Powerful Owl was identified in September 2002 in swamp forest (ERM 2005a). In surveys in January 2005 an individual responded to call playback in this area.

Earlier investigations on the site and surrounding lands identified a number of other threatened species including the Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-Bellied Sheathtail-bat (*Saccolaimus flaviventris*), *Diuris praecox* and the Masked Owl (*Tyto novaehollandiae*). In addition to the threatened species recently recorded on site *Diuris arenaria* (Sand Doubletail) was considered to have a high likelihood of occurrence. There was also an unconfirmed record from a nearby resident of a Koala (*Phascolarctos cinereus*) and a road kill record in November 1989 reported in Clements *et al* (1992). However there has been no record on this site reported in either Clements *et al* (1992), Gunninah (1996, 1997) or ERM (2004, 2005a, 2005b) or on the adjoining land holdings (ERM 2006) since that time. Though it is noted that potential habitat exists for the Koala in this area.

A total of 37 potentially affected species and one affected ecological community were assessed in the SIS (ERM, 2005a). These species are listed in *Annex B: Table B*.3. The Director-General Requirements for the SIS (ERM, 2005a) listed species and ecological communities to be considered for inclusion in the SIS and this list was refined to identify species that may be affected by the proposal (affected species) based on the results of database searches, vegetation mapping, habitat assessment, and flora and fauna surveys including targeted surveys, conducted by ERM and other consultants (ERM, 2005a).

No additional threatened species were identified in the DECC database search of the locality since the 2005 DECC (formerly DEC) database search. Two additional EPBC listed species *Litoria littlejohni* and *Merops ornatus* (Rainbow bee-eater) were identified from the Commonwealth online protected matters search tool. Neither of these species is considered likely to occur on site due to unsuitable habitat. An Assessment of Matters of National Environmental Significance was prepared by ERM (2005c) that addressed the other species identified under the EPBC Act as likely to occur within 10 km of the site.

Results from the targeted surveys in 2006 (ERM 2007) are shown in *Figure A*.6. The field investigations identified a total of 20 clumps of *Eucalyptus parramattensis* subsp *decadens* in Worimi Regional Park in addition to three

already marked by Bell (2006). Two clumps were identified in Fern Bay Seaside Village in addition to the four previously recorded (see *Figure A.6*).

The multi-stemmed nature of the tree and resprouting in response to recent frequent fires in the Worimi Regional Park, hindered identification of the number of individuals for each record. The estimated size of the population in the local area is 74 of which approximately seven individuals were recorded in the Fern Bay Seaside Village and 67 individuals in the Worimi Regional Park. The number of individuals in the Worimi Regional Park may also be an underestimate as the habitat has been burnt a number of times in the last year and juveniles may have been overlooked. The records in the Fern Bay Seaside Village have not been affected by fires in the recent past (last fire approximately 2000).

Further taxonomic investigations were undertaken by DECC in June 2008. Flowering specimens of the hybrid of *Eucalyptus parramattensis* subsp *decadens* collected in Worimi Regional Park have been identified as *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* (ERM 2009b). While this species is not listed as threatened under State or Commonwealth legislation it is considered to have a very high conservation value.

4 IMPACT EVALUATION AND MITIGATION

4.1 IMPACT EVALUATION

The impacts of the proposed residential subdivision were assessed in detail in ERM (2004) and in the SIS (ERM 2005a). This section summarises the finding of the previous reports while *Section 4.2* identifies measures to avoid, mitigate and offset these impacts.

The main ecological impacts are the loss of habitat, loss of wet heath habitat and fragmentation of habitats in the local and regional context. Other impacts associated with residential development include impacts from road traffic, increased runoff associated with impervious surfaces, rubbish dumping, predation by domestic and feral animals, weed dispersal, changes in fire frequency.

The proposed residential subdivision (excluding the approved residential subdivision over part of the site) will result in the disturbance/removal of approximately 70 hectares of existing vegetation (see *Table 4.1*). Development will occur in stages and it is anticipated that this may take up to 10 years.

In addition, 30 hectares of vegetation has already been approved to be cleared under the existing development consent that applies over part of the site. However the area of approved clearance has been reduced to 22.8 hectares to provide for the 200 metre wide wildlife corridor.

Table 4.1 Estimated Vegetation Clearance

Vegetation community	Total area of native vegetation in land holding	Vegetation to be removed by approved subdivision	Vegetation to be removed by Project Plan	Area to be conserved
Coastal Sand Apple-Blackbutt Forest	130.5 ha	15.5 ha	45.5 ha	69.5 ha
Swamp Forest	43.5 ha	3.3 ha	9.7 ha	30.5 ha
Wet Heath	26 ha	4 ha	15 ha	7 ha
Total	**200 ha**	**22.8 ha**	**70.2 ha**	**107 ha**

1. Sources: ERM 2005a.

Associated with the loss of vegetation community is a loss of fauna habitats in particular a reduction in availability of tree hollow habitat resource.

Approximately 107 hectares of existing vegetation (52% of the site) is proposed to be retained. The majority of the retained vegetation occurs within the 200 metre wide ecological corridor between Nelson Bay Road and the proposed development. The corridor will be dissected by two access roads each approximately 20 metres wide. These are not anticipated to isolate habitats along the corridor as the majority of the threatened species are highly mobile and in the case of the Squirrel Glider, a 20 metre barrier is not a barrier

to dispersal. An additional 2.45 hectares of Coastal Sand Apple Blackbutt forest outside of the development footprint will be disturbed for cut and fill to construct the infiltration basins and conveyance swales. These areas will be rehabilitated with endemic species.

The Project Plan development will result in the direct loss of approximately 9.7 hectares of swamp forest and 15 hectares of wet heath which represent groundwater dependent ecosystems within the site. Previous groundwater investigations of the Fern Bay site identified that the majority of rainwater is infiltrated through the sand into the unconfined aquifer (see Section 7.9 of the Environmental Assessment Report) with minimal stormwater runoff to low lying areas (swamp forest) near Nelson Bay Road or to the perched wetlands associated with the wet heath (Urban Water Cycle Solutions 2007).

With development there will be an increase in impervious areas and potentially increased surface runoff volumes and peak discharges from residential areas to the stormwater receiving environment. This will potentially alter flows into naturally low lying areas retained within the reserves and wildlife corridor. The Water Sensitive Urban Design (WSUD) proposed for the subdivision aims to provide for increased infiltration of surface flows and treatment of runoff to reduce pollutants such as total nitrogen, total phosphorus and total suspended solids. This is achieved through bio-retention swales within road reserves, gross pollutant traps and infiltration basins (see Section 7.9 of the EAR). The subdivision does not rely on piping of stormwater as the emphasis is on infiltration of water and nutrients within the development footprint. Infiltration high in the catchment, before flows reach the swamp forest, is in keeping with the current water cycle on site.

The WSUD system entails overland flow paths which may lead to increased water flows associated with a 1 to 100 year rainfall event to the low lying swamp forest (see Plan 10 of 18 in Annex B of the EAR). This will result in periods of increased stormwater runoff volume and peak discharges in three areas of the swamp forest as identified in Plan 10 of Annex B of the EAR. It is assumed that during peak flow (storm events) nutrient and fine sediment removal in the bio-retention swales may not be as effective as during low flow periods however during these events the nutrients are expected to be more diluted and swamp soils are generally highly effective at removing nitrogen.

The swamp forest near Nelson Bay Road is characterised by a sparse cover of sedges and reeds and is generally inundated with standing water for extended periods. Prolonged periods of elevated water levels may result in alterations to floristics of these communities and weed invasion however this is expected to occur infrequently (associated with a 1 to 100 year rainfall event). For the majority of the time infiltration of water and nutrients higher in the catchment will replicate existing water cycle conditions.

The Fern Bay Estate Species Impact Statement identifies 37 threatened species and one endangered ecological community as likely to be impacted by the development (2005a). Of these threatened species and ecological

communities, seven fauna species are considered most likely to be impacted by the proposal given that local populations are present and depend on habitats located in the development areas for long term viability. These species are: Masked Owl, Powerful Owl, Hoary Wattled Bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat and Squirrel Glider.

The SIS concluded that the retention of approximately 54% of the estimated number of habitat trees and retention of movement corridors in the study area will ensure the long-term viability of the Squirrel Glider population, which is a flagship species for the conservation of threatened species in the study area and wider locality. The conclusion assumes that no development (with the exception of the access roads) will occur within the ecological corridor.

An assessment of the impact of the proposal on Matters of National Environmental Significance is provided under a separate cover (ERM 2005c). This assessed the impact on the following threatened species: *Diuris praecox*, *Rulingia prostrata*, *Eucalyptus parramattensis* subps *decadens*, Swift Parrot, Regent Honeyeater, Large-eared Pied Bat, Spotted-tailed Quoll and Grey-headed Flying-fox (see *Section 4.5.1* of ERM 2005c). It also considered the impact on migratory species including the Swift Parrot, Regent Honeyeater, White-throated Needletail, Black-faced Monarch, Satin Flycatcher and White-bellied Sea-eagle (see *Section 4.5.2* of ERM 2005c). The report concluded that a local population of threatened species or migratory birds would not be significantly impacted by the proposed development and that no further assessment under the EPBC Act is warranted.

Since completion of these assessment further investigations have identified approximately 20 clumps of *E. parramattensis* subsp *decadens* x *E. robusta* and estimated population size of approximately 74 trees have been identified in the immediate locality (ERM 2007). Of these only seven trees occur within the Fern Bay Seaside Village development area and will be directly impacted by the proposed subdivision. The majority of the population occurs within Worimi Regional Park and will not be impacted directly by the project. A number of species specific management measures (in particular weeds, rubbish dumping and fire management) have been identified within the Worimi Regional Park Vegetation Management Plan with the aim of reducing threatening processes thereby enhancing habitat value of the area for this species (ERM 2009b).

Other impacts from residential development that are discussed in more detail in Chapter 6 of the SIS (ERM 2005a) include:

- increased risk of road kills associated with the main roads traversing the wildlife corridor;
- rubbish dumping in retained vegetation adjoining the development resulting in smothering of vegetation, potential contamination and/or weed invasion;

- alterations to fire regime. This may be positive in that fire frequency may reduce with management of hazard and may be reduced risk of arson with management of access to adjoining lands;
- predation by feral animals such as dogs, cats and red foxes currently occurs and though there is a risk of predation from domestic pets there is an opportunity to reduce feral animals incidence; and
- weeds are currently a problem and development may facilitate spread of existing weeds while providing opportunities for new weeds in particular garden escapees.

The Ecological Assessment (ERM 2004) and Section 6.2.12 of the SIS (ERM 2005a) considered the operation of and impacts of a number of key threatening processes including:

- clearing of native vegetation;
- high fire frequency resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- invasion of native plant communities by exotic perennial grasses;
- invasion of native plant communities by Bitou Bush;
- predation by the fox;
- predation by the feral cat;
- predation by the plague minnow;
- competition and grazing by the feral European rabbit;
- competition from feral honeybees; and
- removal of dead wood and trees.

Since that time a number of other threatening processes that may operate have been added to Schedule 3 of TSC Act including:

- invasion and establishment of exotic vines and scramblers; and
- invasion and establishment of Lantana (*Lantana camara*); and
- loss of hollow-bearing trees.

Impacts associated with these invasive species are similar to those identified for exotic perennial grasses and Bitou Bush. Lantana and Morning Glory are an existing problem in particular associated with Nelson Bay Road and the adjoining areas of swamp forest (ERM 2009a). Development may provide for spread of these species and other exotic vines and scramblers. The swamp forest and endangered ecological community in particular would be susceptible to establishment of these species and the resultant alteration to the canopy and groundcover from smothering of native vegetation.

Hollow-bearing trees were recognised at the survey design stage (see Section 4.7.6 of the SIS) as a significant habitat resource for a number of species in particular the powerful owl, hollow-dependent bats and the Squirrel Glider.

From the survey effort an average density of hollow-bearing trees was estimated for the site. It was estimated that approximately 495 potential hollow-bearing trees will be cleared. However, approximately 777 potential roost trees or 54% of the estimated number of hollow-bearing trees will be retained (see Section 5.6.2 and Table 5.4 of the SIS for further discussion).

The final determination by the NSW Scientific Committee established that loss of hollow-bearing trees is a key threatening process for species reliant on this habitat. Of the 40 threatened species identified in the determination five birds and eight mammals were identified as potentially affected by the proposed development (see *Table B.3*).

While not listed as a key threatening process at the time of writing, the loss of hollow-bearing trees was recognised in Section 6.2.1, Section 6.3.10, Section 6.3.17 and Section 6.3.18 of the SIS as a significant impact for hollow-dependent species known and or likely to occur on site. Impact mitigation measures included the retention of habitat on site in the wildlife corridor, reserves and the corridor between the proposed subdivision and the active dunes will ensure that hollow-bearing trees are available as a habitat resource for dependent species. Management of these areas is anticipated to reduce the incidence of wild fires that may protect a proportion of this habitat resource, in particular hollows in standing dead trees. Conversely this may reduce recruitment of hollows. Pre-clearance inspections of hollow-bearing trees will be undertaken by suitably qualified wildlife personnel and modified clearance of hollow-bearing trees will be implemented to reduce incidence of death of individual animals.

The loss of hollow-bearing trees was also recognised in the subsequent consultation process between the applicant and approval authority during approval of the Master Plan in development of a conservation offset package.

4.2 MITIGATION MEASURES

A number of measures have been incorporated into the design of the residential subdivision footprint to either avoid or mitigate ecological impacts and species specific impacts including:

- restriction of development to the residential 2(a) zone;
- retaining a minimum 200 metre ecological corridor along the northern boundary of the site. This area will provide a movement corridor for fauna through swamp forest and will prevent threatened species becoming isolated from the currently interconnecting areas of the habitat to the south and to the north. Approval for this corridor will override the existing development consent for residential development thereby enabling retention for biodiversity values;
- protection of large areas of preferred Koala habitat and habitat buffers within the wildlife corridor. This not only minimises impact on Koala

habitat but will also minimise impact through providing a buffering to the swamp forest habitat;

- retaining an ecological corridor along the eastern boundary of the site to provide a movement corridor for fauna through dry sclerophyll open forest and swamp sclerophyll forest;
- avoiding disturbance within 100 metres of the identified Powerful Owl roost tree;
- design and planting in bio-retention swales in road reserves to trap runoff and provide a buffer to the neighbouring vegetation; and
- the majority of retained vegetation is zoned or will be zoned 7(a) Environment Protection and 1(a) Rural Agriculture.

Various management initiatives are also proposed to minimise impacts on fauna and flora within Fern Bay Seaside Village. Management of vegetation and fauna within the environmental protection zoned land and reserves will be in keeping with the Community Lands Environmental Management Plan (ERM 2009a) that accompanies this Project Plan application (see Annex V of the EAR). Management initiatives include, amongst others:

- community title subdivision to ensure that a high standard of amenity and environmental protection is maintained. Community title also provides a forum for overseeing management of retained vegetation within reserves and the wildlife corridor, and education of residents to reduce indirect impacts through control of pets, discouraging rubbish and garden refuge dumping;
- implementation of measures to reduce weeds in the retained vegetation as identified in the Community Lands Environmental Management Plan (ERM 2009a);
- management of risk of bush fire spread to retained vegetation through provision of defendable space in asset protection zones and perimeter roads. The perimeter roads may also reduce incidence of rubbish dumping over back fences as the interface with retained vegetation is a public space managed under Community Title; and
- pre-clearance inspections and implementation of tree clearing procedure for hollow-bearing trees whereby individuals are encouraged to abandon habitat trees through clearing of all non-habitat trees around the hollow-bearing tree first, then no clearing for a period of time before felling the hollow-bearing tree. A suitably qualified wildlife professional will be on site during felling of the hollow-bearing tree. Any individuals recovered during tree felling will be released into adjoining habitat on site. These procedures are discussed in more detail in the Community Lands Environmental Management Plan (ERM 2009a) which forms part of this Project Plan application.

It should be noted that the SIS did not support development of a formal translocation proposal for individuals or a colony of the Squirrel Glider. Tree clearing procedures outlined above, aim to provide the opportunity for

individuals to abandon habitat trees prior to clearing to reduce the risk of injury or death of individuals. Prior to clearance of each stage, indirect impacts associated with edge effects of the development, in particular noise, may result in the abandonment of nest sites close to the development footprint.

With reduction in available habitat over the life of the development (up to 10 years) there may be loss of displaced individuals through competition for remaining hollows. Connectivity between retained vegetation on site and adjoining areas will provide for dispersal of individuals.

As identified in the Community Lands Environmental Management Plan microhabitat features such as hollow logs and branches may be removed from the development area and placed within reserves and open space on site. The need for this measure will be reviewed at each stage of the development with consideration given to the habitat features available in adjoining areas.

As part of the Master Plan approval an agreement was reached that the loss of habitat trees (hollow-bearing trees) and the wet heath would be compensated through preparation and support of a Vegetation Management Plan (VMP) for the Worimi Regional Park land (previously Ministerial Part 11 land) to the south of the subdivision for a period of 20 years. A copy of the VMP prepared by ERM (2009b) is provided as part of the Environmental Assessment Report package for this proposal.

The VMP (ERM 2009b) outlines measures to improve the condition of wet heath and overall management of the land by removing identified waste and weed occurrences and regenerating or restricting access to certain tracks. It also discussed proposal for the formalisation of a four wheel drive access to Stockton Beach. Through weed management, waste removal and closure of tracks the adverse impacts on the habitat value of the areas of wet heath and dry sclerophyll forest in the Worimi Regional Park will be reduced. Extension of the preliminary principles of bush fire management and pest management identified in the VMP through implementation of the broader plans currently being developed by DECC for the Worimi Conservation Lands will further enhance habitat values through management of bush fire frequency and pest species management.

Management of the hybrid individuals of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* in the Worimi Regional Park is also outlined in the Vegetation Management Plan for Worimi Regional Park (ERM 2009b). This includes protection of individuals from management of indirect impacts or threatening processes associated with implementation of the weed management program and the construction of the formalised four wheel drive track.

5 *CONCLUSION*

Fern Bay Seaside Village is located in a large remnant of coastal forest in the Stockton Bight dune system and adjoins the floodplain of the Hunter River. The site supports swamp forest, dry sclerophyll open forest and wet heath community that supports habitat for a range of threatened species and one endangered ecological community. The most significant impact will be the loss of 70 hectares of habitat and loss of habitat resources such as hollow-bearing trees and winter-flowering trees. The development plan conserves 107 hectares of habitat for affected species and communities within the ecological corridor and in areas that will maintain connectivity around the proposed development.

The NSW Minister of Planning approved a Master Plan for development of the Fern Bay Seaside Village pursuant to State Environmental Planning Policy No.71 – Coastal Protection on 8 August 2006. While there have been minor changes to the lot structure the overall footprint and layout has not been altered for the Project Plan application. This Project Plan application under Part 3A of the *Environmental Planning and Assessment Act 1979* is consistent with, and adopts the consent conditions of, the approved Master Plan. This is demonstrated through development of the Vegetation Management Plan for the adjoining Worimi Regional Park as part of the conservation offset package. This addendum report has been prepared to ensure fulfilment of the requirements of a Part 3A application.

REFERENCES

Bell, S.A.J. (2006) ***Eucalyptus parramattensis* subsp. *decadens*: Status, Distribution and Habitat** for Department of Environment and Conservation.

Clements A M, Rodd A N, Lim I, Clulow J and Hoye G (1992) Flora and Fauna *Report*: part of the **Environment Assessment of Fern Bay, New South Wales**. Prepared for Port Stephens Shire Council. Anne Clements & Associates Pty Ltd, North Sydney.

CRA Unit, National Parks and Wildlife Service (2000) **Vegetation Survey, Classification and Mapping. Lower Hunter and Central Coast Region**. Version 1.2. For the Lower Hunter and Central Coast Regional Environment Management Strategy.

Department of Environment and Conservation Department of Primary Industries (2005) **Draft Guidelines for Threatened Species Assessment.**

Department of Environment and Conservation (DEC) (2006) **Lower Hunter Regional Conservation Plan (draft)**. Department of Environment and Conservation NSW, Coffs Harbour.

Environmental Resources Management Australia Pty Ltd (ERM) (2005a) **Fern Bay Estate Master Plan Study *Species Impact Statement*** Winten Property Group and Continental Venture Capital Limited.

Environmental Resources Management Australia Pty Ltd (ERM) (2005b) **Fern Bay Estate Master Plan Study *Response to the Port Stephens Comprehensive Koala Plan of Management.*** Winten Property Group and Continental Venture Capital Limited.

Environmental Resources Management Australia Pty Ltd (ERM) (2005c) **Fern Bay Estate Master Plan Study *Assessment of Matters of National Environmental Significance Report.*** Winten Property Group and Continental Venture Capital Limited.

Environmental Resources Management Australia Pty Ltd (ERM) (2005d) **Fern Bay Estate Master Plan Study *Aquatic Assessment Report.*** Winten Property Group and Continental Venture Capital Limited.

Environmental Resources Management Australia Pty Ltd (ERM) (2006) **Lots 1 & 2 DP1006399 and Lot 3 DP664552 Nelson Bay Road, Fern Bay Rezoning Report for Boral**.

Environmental Resources Management Australia Pty Ltd (ERM) (2009a) **Fern Bay Seaside Village Community Lands Environmental Management Plan.** Aspen Group.

Environmental Resources Management Australia Pty Ltd (ERM) (2009b) **Fern Bay Seaside Village Offset Package: Worimi Regional Park Vegetation Management Plan** Aspen Group Ltd.

Gunninah Environmental Consultants (1996 revised 1997) **Fauna and Flora Assessment, Proposed Residential Development, Nelson Bay Road, Fern Bay**.

Lower Hunter & Central Coast Councils (LHCC) (2003) **Lower Hunter & Central Coast Regional Biodiversity Conservation Strategy. Briefing Notes - Results of Regional Conservation Assessment for the Lower Hunter and Central Coast**. Updated August 2003.

Matthei, L.E. (1995) **Soil Landscapes of the Newcastle 1:100 000 Sheet, Report and Map**. Department of Land and Water Conservation, Sydney.

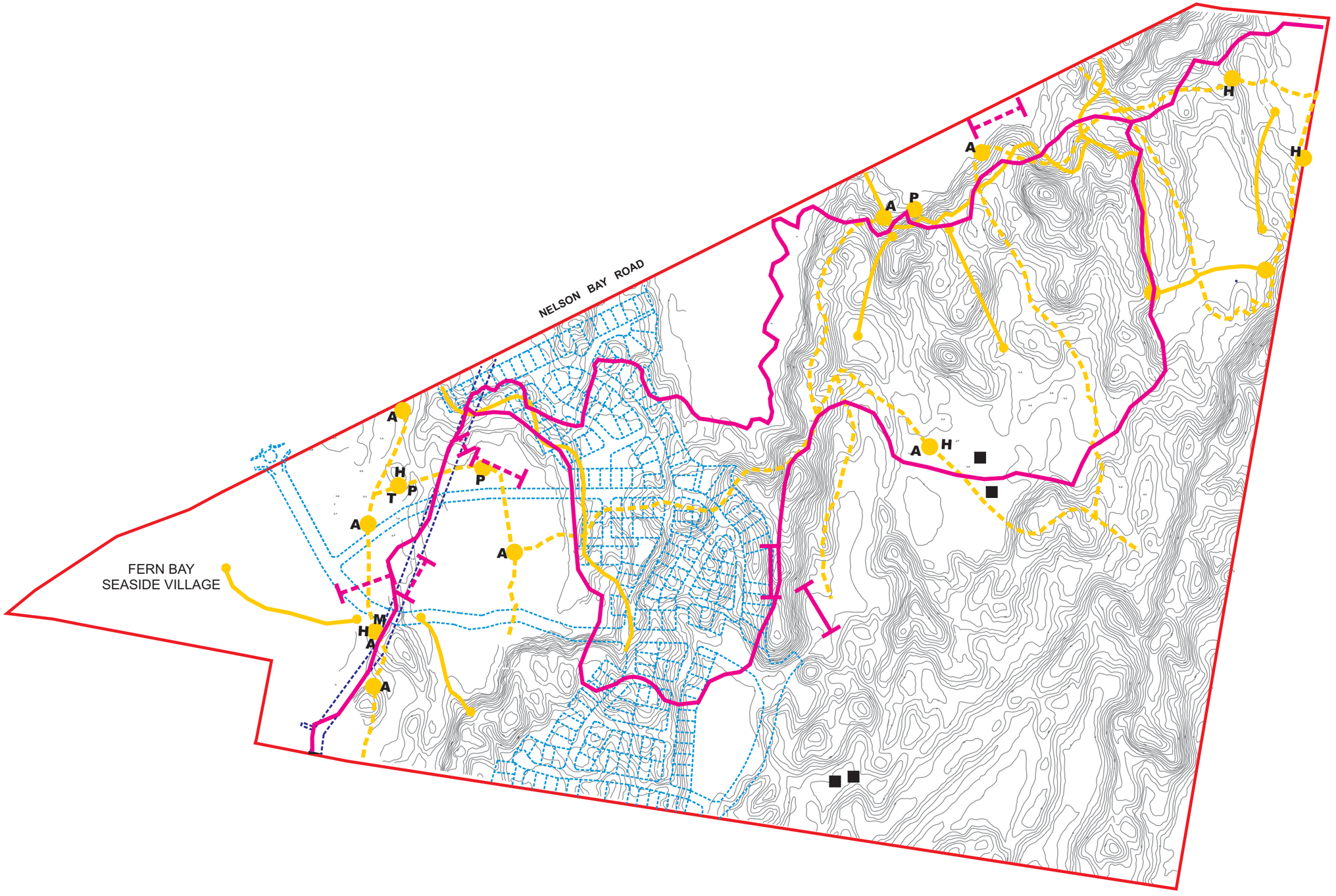
Port Stephens Council (2001) **Port Stephens Council Comprehensive Koala Plan of Management (CKPoM), June 2001**. Prepared by Port Stephens Council with the Australian Koala Foundation.

Roy, P. S., and Thom, B. G. (1981) **Late quaternary marine deposition in New South Wales and Southern Queensland – an evolutionary model** Journal of the Geological Society of Australia 28(3): 471-490.

Thom, B. G., Stephens, M., Ly, C. K., Roy, P. S., Bowman, G. M. and Hesp, P. A. (1992) **Coastal Geomorphology and Quaternary Geology of the Port Stephens-Myall Lakes Area** Australian National University Canberra.

Annex A

Figures



Legend

- Fern Bay Seaside Village
- Spotlight Transect
  Anne Clements & Associates (1992)
- Vegetation Transect
  Anne Clements & Associates (1992)
- Trap Lines - Gunninah Environmental Consultants (1996)
- Spotlight Transect - Gunninah Environmental Consultants (1996)
- H Harp Trap - Gunninah Environmental Consultants (1996)
- P Pitfall Trap - Gunninah Environmental Consultants (1996)
- T Hair Tubes - Gunninah Environmental Consultants (1996)
- M Mist Nets - Gunninah Environmental Consultants (1996)
- A Anabat Recorders - Gunninah Environmental Consultants (1996)
- ■ *Eucalyptus parramattensis* subsp. *decadens* (Bell 2006)
- Approved Subdivision

Figure A1

Survey Effort Other Studies

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_03		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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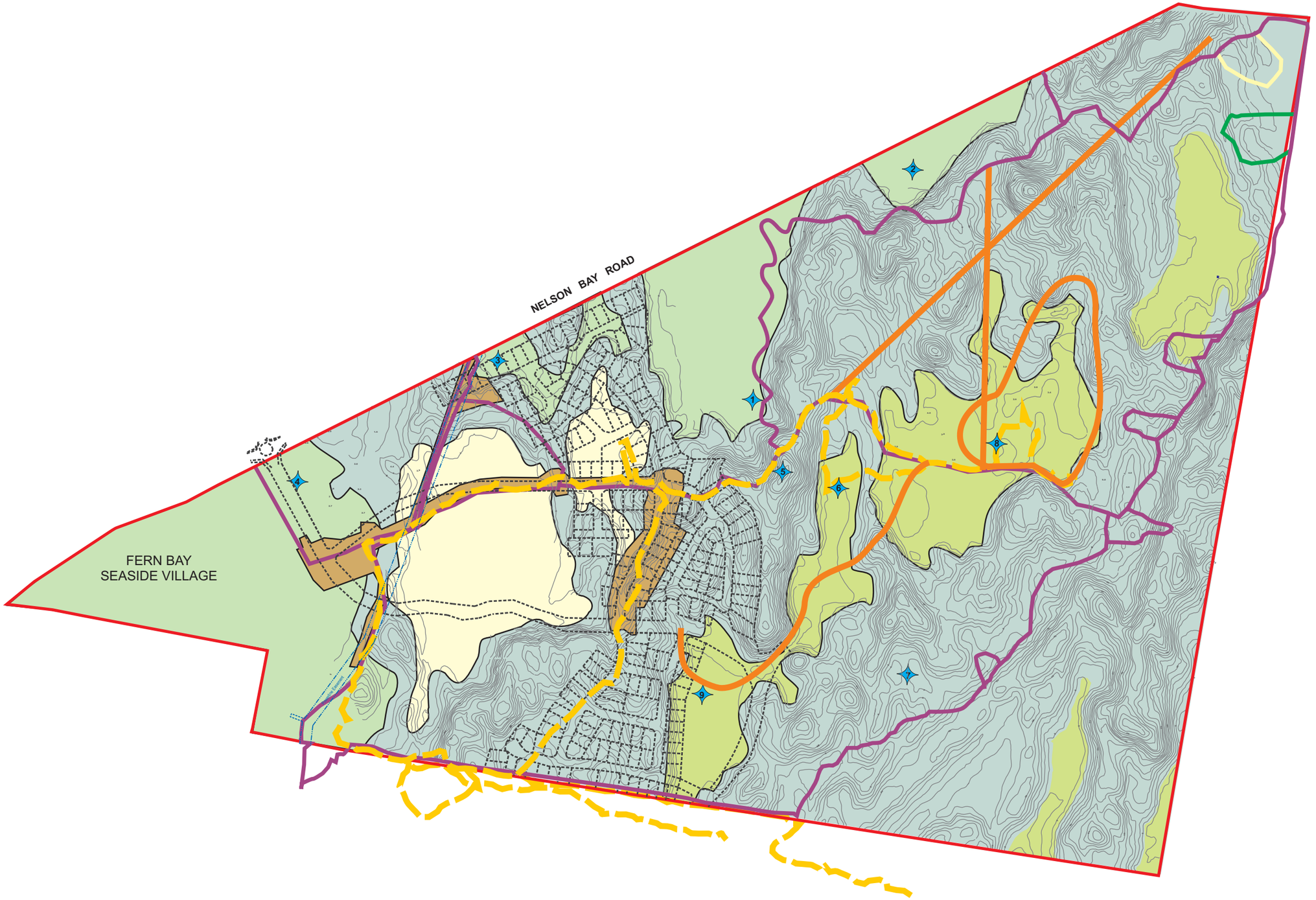
ERM



Legend

- Fern Bay Seaside Village
- Orchid Survey Location (ERM 2002)
- Orchid Survey Location (ERM 2004)
- Threatened Flora Transect (ERM 2005)
- Flora Survey Quadrats
- Cleared Vegetation
- Swamp Mahogany - Paperbark Forest
- Coastal Sand Apple Blackbutt Forest
- Wet Heath - Tomago Sand Swamp Woodland
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregion
- Approved Subdivision

Figure A2

Flora Survey Effort in the Study Area

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_03		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
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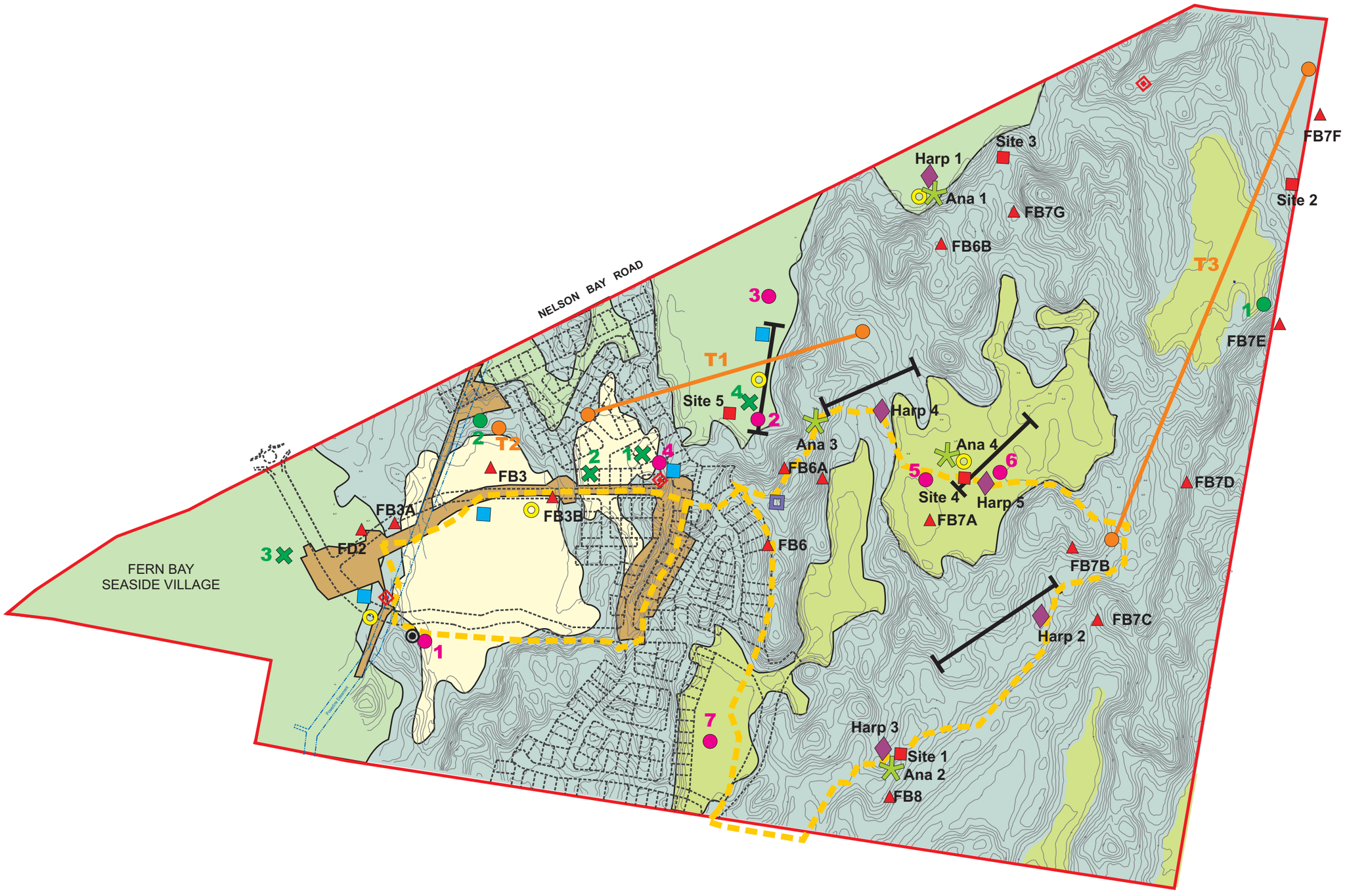

Legend

- Fern Bay Seaside Village
- Cleared Vegetation
- Swamp Mahogany - Paperbark Forest
- Coastal Sand Apple Blackbutt Forest
- Wet Heath - Tomago Sand Swamp Woodland
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregion
- 6 Koala Habitat Assessment and Faecal Pellet Search
- 2 Nocturnal Call Playback
- T1 Spotlighting and Anabat Detection Transects
- Wallum Froglet Survey Site
- Swift Parrot/Regent Honeyeater Survey Site
- 3 Frog Survey Site (ERM 2005)
- Owl Call Playback Location (ERM 2005)
- Cage Trap Location (ERM 2005)
- Powerful Owl Observed (ERM 2005)
- Hairfunnel and Elliot Trapping Transect (ERM 2005)
- Fauna Survey Locations (ERM 2005)
- Harp3 Harp Trap Survey Location (Forest Fauna Surveys 2005)
- Ana3 Anabat Survey Location (Forest Fauna Surveys 2005)
- Site 5 Squirrel Glider Survey Location (Forest Fauna Surveys 2005)
- FB3 Bird Survey Site (Ekerlogic 2005)
- Approved Subdivision

Figure A3

Fauna Survey Effort (ERM 2005a)

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_05		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	TW
Source:	-		
Scale:	Refer to Scale Bar		

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ERM

Legend

- Fern Bay Seaside Village
- Worimi Regional Park
- Survey Coverage

FERN BAY
SEASIDE VILLAGE

NELSON BAY ROAD

NEWCASTLE
GOLF
CLUB

FERN
BAY

POPPY ENGEL
ROAD
MAGELLE CT

TASMAN
SEA

Figure A4

Survey Coverage *Eucalyptus parramattensis* subsp. *decadens* hybrid Locations

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_01		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
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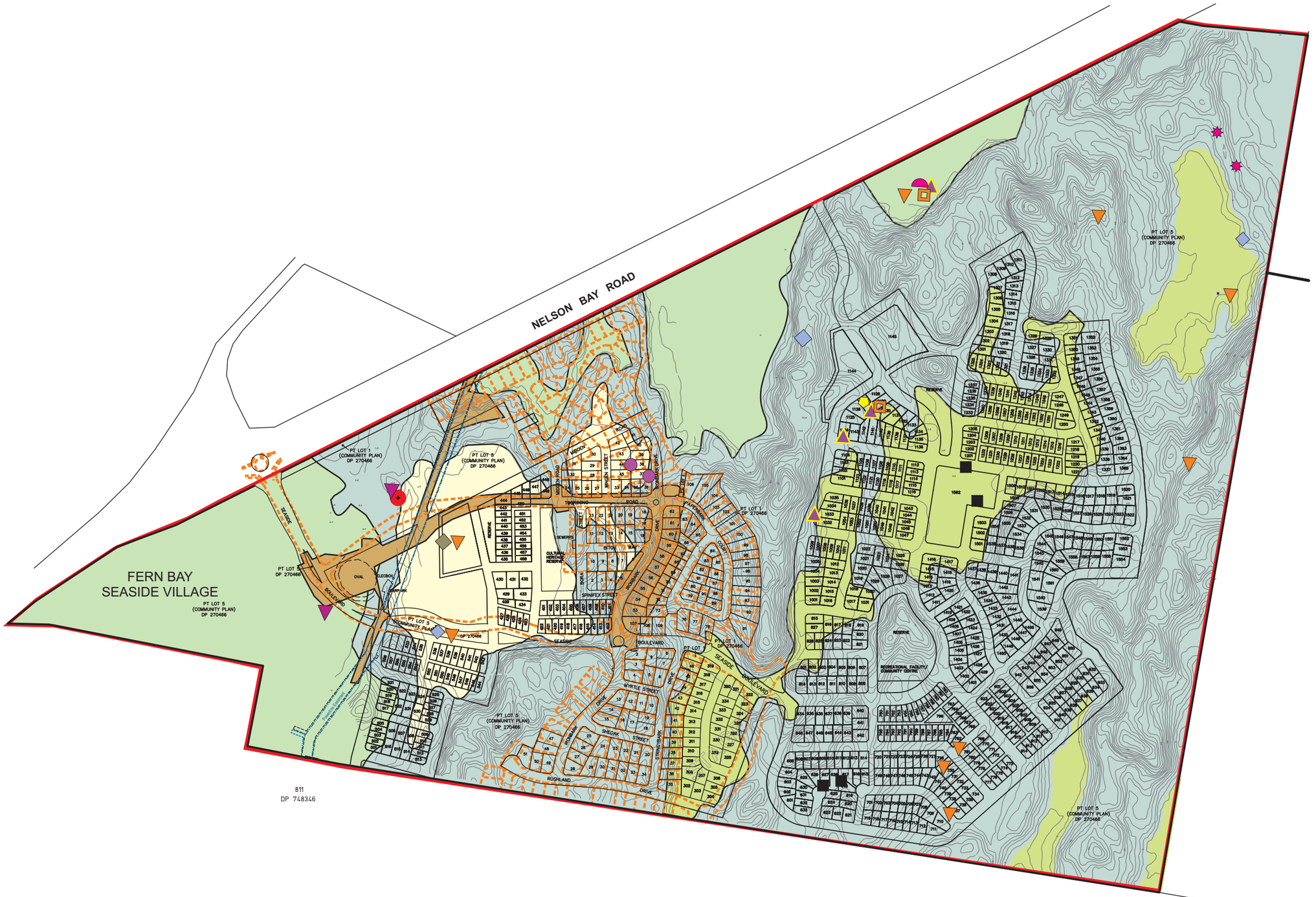

Legend

- Fern Bay Seaside Village
- Cleared Vegetation
- Swamp Mahogany - Paperbark Forest
- Coastal Sand Apple Blackbutt Forest
- Wet Heath - Tomago Sand Swamp Woodland
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregion
- 1(a) 1(a) Rural Agriculture Zone
- 2(a) 2(a) Residential Zone
- 7(a) 7(a) Environment Protection Zone
- Powerful Owl Roost Tree

Threatened Species

- Powerful Owl
- Masked Owl
- Squirrel Glider
- Grey-headed Flying-fox
- *Diuris praecox*
- Greater Broad-nosed Bat
- Eastern Bentwing-bat
- Little Bentwing-bat
- Hoary Wattled Bat
- Wallum Froglet
- *Eucalyptus parramattensis* subsp. *decadens E.robusta*
- Approved Subdivision
- Approved Master Plan Footprint

Figure A5

Vegetation Communities and Threatened Species in the Study Area

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_05		
Date:	10/2/2009	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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NELSON BAY ROAD

FERN BAY
SEASIDE VILLAGE

NEWCASTLE
GOLF
CLUB

FERN
BAY

POPPLEWELL ROAD

MAGEE CL

TASMAN
SEA

Legend

- Fern Bay Seaside Village
- Worimi Regional Park
- *Eucalyptus parramattensis* subsp. *decadens E.robusta* (Bell 2006)
- *Eucalyptus parramattensis* subsp. *decadens E.robusta* Additional Records (ERM 2007)

Figure A6

Potential *Eucalyptus parramattensis* subsp. *decadens E.robusta* hybrid locations

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_02		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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ERM

NELSON BAY ROAD

FERN BAY
SEASIDE VILLAGE

Legend

- Fern Bay Seaside Village
- Cleared Vegetation
- Preferred Koala habitat
- Supplementary Koala Habitat
- 50m Habitat Buffer over Supplementary
- Habitat Linking Area over Supplementary
- Approved Subdivision

Figure A7

Koala Habitat in the Study Area

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_ecol_07		
Date:	10/02/09	Drawing size:	A3
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Source:	-		
Scale:	Refer to Scale Bar		

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ERM

Annex B

Flora and Fauna Records

Table B.1 Flora Species List (ERM, 2005a)

Scientific Name	Common Name
AIZOACEAE	
Carpobrotus glaucescens	Pig Face
AMARYLLIDACEAE	
Crinum pedunculatum	
APIACEAE	
Actinotus helianthi	Flannel Flower
#*Centella asiatica*	
*#*Hydrocotyle bonariensis*	Pennywort
Platysace ericoides	
Platysace lanceolata	
APOCYNACEAE	
#*Parsonsia straminea*	Monkey Rope
ARECACEAE	
#*Livistona australis*	Cabbage Tree Palm
ASCLEPIADACEAE	
Marsdenia rostrata	
ASTERACEAE	
Chrysanthemoides monilifera subsp. *rotundata*	Bitou Bush
Senecio hispidulus	
BIGONIACEAE	
Pandorea pandorana	Wonga Wonga Vine
BLECHNACEAE	
#*Blechnum indicum*	
CAMPANULACEAE	
Wahlenbergia gracilis	
CASUARINACEAE	
#*Allocasuarina littoralis*	Black She-Oak
Allocasuarina torulosa	Forest She-Oak
#*Casuarina glauca*	Swamp She-Oak
COMMELINACEAE	
Commelina cyanea	
CONVOLVULACEAE	
Calystegia marginata	
CYPERACEAE	
#*Baumea articulata*	
#*Carex appressa*	
Cyperus sp.	
#*Gahnia clarkei*	
Schoenus ericetorum	
DENNSTAEDTIACEAE	
Histiopterus incisa	Batswing Fern
#*Pteridium esculentum*	Bracken
DICKSONIACEAE	
#*Calochlaena dubia*	False Bracken
DILLENIACEAE	
Hibbertia fasciculata	
Hibbertia linearis	
ELEOCARPACEAE	
Elaeocarpus obovatus	Blueberry Ash
EPACRIDACEAE	
Brachyloma daphnoides	
Monotoca elliptica	
Monotoca scoparia	
EUPHORBIACEAE	

Scientific Name	Common Name
Amperea xiphoclada	Broom Spurge
#*Breynia oblongifolia*	Breynia
#*Glochidion ferdinandi*	Cheese Tree
#*Omalanthus populifolius*	Bleeding Heart
Ricinocarpos pinifolius	Wedding Bush
FABACEAE - FABOIDEAE	
Aotus ericoides	Aotus
Bossiaea heterophylla	
Bossiaea rhombifolia	
Desmodium varians	
Dillwynia retorta var. *retorta*	Heathy Parrot Pea
Glycine microphylla	
Glycine tabacina	
Gompholobium latifolium	Broad-Leaf Wedge-Pea
Hardenbergia violacea	False Sarsaparilla
Indigophora australis	
Jacksonia scoparia	Dogwood
Kennedia rubicunda	Dusky Coral Pea
FABACEAE - MIMOSOIDEAE	
#*Acacia irrorata*	
#*Acacia longifolia*	Sydney Golden Wattle
Acacia suaveolens	
Acacia ulicifolia	Prickly Moses
HALORAGACEAE	
Gonocarpus teucrioides	Germander Raspwort
LAURACEAE	
Cassytha pubescens	Common Devils Twine
Endiandra sieberi	Corkwood
LILIACEAE	
Tricoryne elatior	Yellow Rush-Lily
LOBELIACEAE	
#*Pratia purpurascens*	White Root
LOMANDRACEAE	
#*Lomandra longifolia*	Spiny-Headed Mat-Rush
MENISPERMACEAE	
#*Stephania japonica* var. *discolor*	Snake Vine
MENYANTHACEAE	
#*Villarsia exaltata*	Erect Marsh-Flower
MORACEAE	
Maclura cochinchinensis	Cockspur Thorn
MYRSINACEAE	
Rapanea variabilis	
MYRTACEAE	
#*Acmena smithii*	Lilly Pilly
Angophora costata	Smooth-Barked Apple
Calytrix tetragona	
Corymbia gummifera	Red Bloodwood
Eucalyptus pilularis	Blackbutt
#*Eucalyptus robusta*	Swamp Mahogany
Leptospermum laevigatum	Coast Tea-Tree
#*Leptospermum polygalifolium*	Lemon-Scented Tea-Tree
Leptospermum trinervium	
#*Melaleuca linariifolia*	
Melaleuca nodosa	
#*Melaleuca quinquenervia*	Broad-Leaved Paperbark
#*Melaleuca sieberi*	
#*Melaleuca styphelioides*	Prickly-Leaved Paperbark

Scientific Name	Common Name
OLEAECEAE	
Notelaea longifolia	
PHILESIACEAE	
Eustrephus latifolius	Wombat Berry
Genitonoplesium cymesum	
PHORMIACEAE	
#*Dianella caerulea* var. *producta*	
PITTOSPORACEAE	
Billardiera scandens	Apple Berry
POACEAE	
#*Entolasia marginata*	
#*Entolasia stricta*	
Eragrostis benthamii	
#*Imperata cylindrica* var. *major*	Blady Grass
Isachne globosa	
Microlaena stipoides	
#*Oplismenus aemulus*	
#*Phragmites australis*	Common Reed
#*Themeda australis*	Kangaroo Grass
POLYGALACEAE	
Comesperma ericinum	Heath Milkwort
POLYGONACEAE	
Persicaria strigosa	
POLYPODIACEAE	
Pyrossia rupestris	
PROTEACEAE	
Banksia serrata	Old Man Banksia
Conospermum ellipticum	
Persoonia levis	Smooth Geebung
RANUNCULACEAE	
Clematis aristata	
RESTIONACEAE	
Restio tetraphyllus	Cord Rush
RHAMNACEAE	
Alphitonia excelsa	Red Ash
Pomaderris sp.	
ROSACEAE	
Rubus parvifolius	
RUBIACEAE	
Pomax umbellata	Pomax
RUTACEAE	
Zieria smithii	
SAPINDACEAE	
Cupaniopsis anarchardioides	Tuckeroo
SMILACACEAE	
Smilax australis	
Smilax glyciphylla	
TYPHACEAE	
Typha orientalis	Bullrush
VERBENACEAE	
Clerodendrum tomentosum	
**Lantana camara*	Lantana
VIOLACEAE	
#*Viola hederaceae*	
VITACEAE	
Cayratia clematidea	

1. * Introduced species

	Scientific Name	Common Name
2.	# Species indicative of 'Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions'	

Table B.2 Fauna Species List (ERM, 2005a)

Scientific Name	Common Name
Frogs	
Crinia tinnula[V]	Wallum Froglet
Limnodynastes peronii	Striped Marsh Frog
Reptiles	
Egernia major	Land Mullet
Varanus varius	Lace Monitor
Birds	
Gymnorhina tibicen	Australian Magpie
Corvus coronoides	Australian Raven
Geopelia humeralis	Bar-Shouldered Dove
Coracina novaehollandiae	Black-Faced Cuckoo Shrike
Coturnix ypsilophora	Brown Quail
Acanthiza pusilla	Brown Thornbill
Melithreptus brevirostris	Brown-Headed Honeyeater
Coracina tenuirostris	Cicadabird
Eudynamys scolopacea	Common Koel
Platycercus eximius	Eastern Rosella
Acanthorhynchus tenuirostris	Eastern Spinebill
Psophodes olivaceus	Eastern Whipbird
Eopsaltria griseogularis	Eastern Yellow Robin
Lichenostomus fuscus	Fuscous Honeyeater
Pachycephala pectoralis	Golden Whistler
Cracticus torquatus	Grey Butcherbird
Rhipidura fuliginosa	Grey Fantail
Accipiter novaehollandiae	Grey Goshawk
Colluricincla harmonica	Grey Shrike-Thrush
Dacelo novaeguineae	Laughing Kookaburra
Myiagra rubecula	Leaden Flycatcher
Meliphaga lewinii	Lewins Honeyeater
Anthochaera chrysoptera	Little Wattlebird
Dicaeum hirundinaceum	Mistletoebird
Philemon corniculatus	Noisy Friarbird
Cracticus nigrogularis	Pied Butcherbird
Neochmia temporalis	Red-Browed Finch
Rhipidura rufifrons	Rufous Fantail
Pachycephala rufiventris	Rufous Whistler
Zosterops lateralis	Silvereye
Dicrurus bracteatus	Spangled Drongo
Pardalotus punctatus	Spotted Pardalote
Pardalotus striatus	Striated Pardalote
Cacatua galerita	Sulphur-Crested Cockatoo
Malurus cyaneus	Superb Fairy-Wren
Malurus lamberti	Variegated Fairy-Wren
Sericornis frontalis	White-Browed Scrubwren
Phylidonyris nigra	White-Cheeked Honeyeater
Melithreptus lunatus	White-Naped Honeyeater
Gerygone olivacea	White-Throated Gerygone
Cormobates leucophaeus	White-Throated Treecreeper
Lichenostomus chrysops	Yellow-Faced Honeyeater
Gerygone mouki	Brown Gerygone

Scientific Name	Common Name
Ninox strenua[V]	Powerful Owl
Acanthiza lineata	Striated Thornbill
Anthochaera chrysoptera	Brush Wattlebird
Myzomela sanguinolenta	Scarlet Honeyeater
Chrysococcyx lucidus	Shining-Bronze Cuckoo
Acanthiza nana	Yellow Thornbill
Strepera graculina	Pied Currawong
Mammals	
Chalinolobus gouldii	Gould's Wattled Bat
Chalinolobus morio	Chocolate Wattled Bat
Chalinolobus nigrogriseus	Hoary Wattled Bat
Miniopterus australis[V]	Little Bentwing-Bat
Miniopterus schreibersii oceanensis[V]	Eastern Bentwing-Bat
Mormopterus sp. 2	Little Freetail-Bat
Nyctophilus sp.	Long-Eared Bat
Nyctophilus geoffreyi	Lesser Long-Eared Bat
Petaurus norfolcensis[V]	Squirrel Glider
Pseudocheirus peregrinus	Common Ringtail Possum
Trichosurus vulpecula	Common Brushtail Possum
Pteropus poliocephalus[V]	Grey-Headed Flying-Fox
Antechinus stuartii	Brown Antechinus
Rattus fuscipes	Bush Rat
*Rattus rattus**	Black Rat
Rattus lutreolus	Swamp Rat
Scoteanax rueppellii[V]	Greater Broad-Nosed Bat
Scoteanax orion	Eastern Broad-Nosed Bat
Scotorepens sp.	Broad-Nosed Bat
Vespadelus vulturnus	Little Forest Bat

1. Compilation of fauna recorded in study area by ERM 2002 to 2005 and Forest Fauna Surveys Pty Ltd 2005.
2. V = Vulnerable under the TSC Act
3. * Introduced species

Table B.3 Identification of Affected Species (ERM, 2005a)

Name	TSC Act	Preferred Habitat	Likelihood of Occurrence
Hollow-dependent Birds			
Glossy Black-Cockatoo *Calyptorhynchus lathamii*	V	Eucalypt woodlands and forests where *Allocasuarina*/ *Casuarina* are abundant in the understorey and mature trees provide large nesting hollows[1]. Rarely recorded far from preferred food resource[1].	Low to moderate. Preferred foraging resource (*Allocasuarina* spp.)[3] scarce in study area. Nesting habitat (large tree hollows) available, however rarely recorded far from preferred food resource[3]. **Potentially affected species.**
Barking Owl *Ninox connivens*	V	Open woodlands and dry open forests, nesting in the crown of mature trees[2].	Low to moderate likelihood based on habitat available but no records. **Potentially affected species.**
Powerful Owl *Ninox strenua*	V	Wet and dry sclerophyll forests, nesting (large tree hollows) and roosting in dense forest areas or dense gullies.	High. Roost tree present in study area. Local records, suitable foraging and nesting habitat also present in the study area. **Potentially affected species.**
Masked Owl *Tyto novaehollandiae*	V	Dry sclerophyll forest and woodland with a low sparse understorey, foraging in open or partly cleared land. Roosting and nest sites large tree hollows in sheltered aspects.	High. Recorded in study area. Suitable foraging and nesting habitat present. **Potentially affected species.**
Other Birds			
Bush Stone-Curlew *Burhinus grallarius*	E	Lightly timbered open forest or woodland with a ground cover of short or sparse grass and few, or no shrubs. Occasionally in mangroves and saltmarsh where fringed by *Casuarina* thickets[3]. High fire frequency further reduces habitat suitability.	Low. Local records however preferred habitat (lightly timbered open forest or woodland with a ground cover of short sparse grass and few, or no shrubs[3]) absent from study area. High fire frequency further reduces habitat suitability.
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	V	Forest, woodlands and scrubs with fallen branches[4].	Moderate. Recorded in the study area and suitable habitat is present. **Potentially affected species.**
Swift Parrot *Lathamus discolor*	E	Migratory species frequenting eucalypt forest and woodland[5], following winter flowering eucalypts (eg swamp mahogany). Breeds in Tasmania.	Moderate. Suitable foraging habitat identified in the study area (swamp mahogany in swamp forest). **Potentially affected species.**
Square-Tailed Kite *Lophoictinia*	V	Heathlands, woodlands, forests[4].	Moderate. Recorded in the locality and suitable foraging and nesting

Name	TSC Act	Preferred Habitat	Likelihood of Occurrence
isura			habitat is present in the study area. **Potentially affected species.**
Osprey *Pandion haliaetus*	V	Forages over water; nests in large dead tree[6].	Moderate. Suitable foraging habitat (brackish or salt waterbody)[6] over Stockton Bight and Fullerton Cove. Nest site is commonly a tall tree, usually dead. Potential nest sites available. **Potentially affected species.**
Grey-crowned Babbler (eastern subspecies) *Pomatostomus temporalis temporalis*	V	Open forests, woodlands, scrublands[4].	Moderate. Recorded in the study area and suitable habitat is present. **Potentially affected species.**
Wompoo Fruit-dove *Ptilinopus magnificus*	V	Rainforest[4].	Moderate. Few local records, preferred habitat generally absent in the study area, although some rainforest elements are present. **Potentially affected species.**
Rose-crowned Fruit-dove *Ptilinopus regina*	V	Rainforest[4].	Moderate. Few local records. **Potentially affected species.**
Superb Fruit-dove *Ptilinopus superbus*	V	Rainforest, mangrove, eucalypt forest[4].	Moderate. Few local records. Lives in rainforest but will feed in mangroves or eucalypt forest[4]. Rainforest generally absent from the study area, although some rainforest elements are present. **Potentially affected species.**
Regent Honeyeater *Xanthomyza Phrygia*	E	Nomadic species following rich sources of nectar, primarily winter flowering species (eg swamp mahogany in coastal areas).	Moderate. Suitable foraging habitat identified in the study area (swamp mahogany in swamp forest). **Potentially affected species.**
Cave Roosting Bats			
Large-eared Pied Bat *Chalinolobus dwyeri*	V	Roost by day in caves and mine tunnels.	Low to moderate likelihood of foraging. No roost sites present. Foraging habitat available. **Potentially affected species.**
Little Bentwing-bat *Miniopterus australis*	V	Roosts in caves, old mines, stormwater channels; forages in forested areas below the canopy.	Moderate to High. No suitable roost habitat. Foraging habitat available. **Potentially affected species.**
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*	V	Roosts in caves, old mines, stormwater channels; forages in forested areas above the canopy.	High. Recorded in the study area. Suitable foraging habitat. No roost sites identified or likely to be present. **Potentially affected species.**
Large-Footed Myotis *Myotis adversus*	V	Roosts in caves, tunnels, under bridges & dense vegetation. Forage over nearby lakes, rivers, large streams.	Moderate to High. No suitable roost habitat. Foraging habitat available. **Potentially affected species.**

Name	TSC Act	Preferred Habitat	Likelihood of Occurrence
Hollow-dependent Mammals			
Hoary Wattled Bat *Chalinolobus nigrogriseus*	V	A range of habitats including open forest and woodland, coastal scrub, sand dunes, grasslands and floodplains.	Low to moderate. No regional records although potential habitat available. **Potentially affected species.**
Spotted-tailed Quoll *Dasyurus maculates*	V	Wide range of forested habitats including rainforest, open forest, coastal heath, riparian forest. Nests in rock caves, hollow logs or tree hollows.	Moderate to high. Local records and potential habitat available. **Potentially affected species.**
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V	Sclerophyll forests where they roost in tree hollows.	Moderate. No local records, although potential foraging habitat is present in the study area. **Potentially affected species.**
Eastern Freetail-bat *Mormopterus norfolkensis*	V	Dry eucalypt forest and woodland where they roost in tree hollows.	High. Recorded in the study area. Potential roost sites and foraging habitat identified throughout the study area. **Potentially affected species.**
Squirrel Glider *Petaurus norfolcensis*	V	Dry sclerophyll forest and remnant woodland containing mature or mixed aged stands with gum-barked and winter flowering trees, and mature *Acacia* species. Nests socially in tree hollows.	High. Recorded in the study area. Potential den sites and foraging habitat identified throughout the study area. **Potentially affected species.**
Brush-tailed Phascogale *Phascogale tapoatafa*	V	Largely arboreal, prefers open dry forest with little groundcover on ridges up to 600m altitude. Common trees inhabited include box, stringybark, ironbark and blackbutt.	Moderate. No local records, although recorded in the locality. Potential habitat is present in the study area. **Potentially affected species.**
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	V	Tree hollows, abandoned nests of sugar gliders (*Petaurus breviceps*), animal burrows for roosting; almost all habitats including forest and woodland for foraging.	High. Recorded in the study area. Habitat available however low number of local records. **Potentially affected species.**
Greater Broad-nosed Bat *Scoteanax rueppellii*	V	Moist river and creek system of the ranges, roosting in tree hollows.	High. Recorded in the study area. Arboreal roosting habitat and foraging habitat available. **Potentially affected species.**
Other mammals			
Koala *Phascolarctos cinereus*	V	Forests typically on high nutrient soils characterised by presence of preferred feed trees. In Port Stephens area preferred feed trees are *Eucalyptus tereticornis*, *E. robusta*, *E. parramattensis* subsp. *decadens*[7]. Numerous records for the Port Stephens area, in particular Tomago Sandbeds and Tilligerry Peninsula.	High. Recorded in the study area. No local records in past decade. Preferred koala habitat identified in study area, although no activity recorded. **Potentially affected species.**

Name	TSC Act	Preferred Habitat	Likelihood of Occurrence
Long-nosed Potoroo *Potorous tridactylus*	V	Coastal wallum. Requires dense cover for shelter and adjacent, more open foraging areas.	Low. Some suitable habitat is present but species is not known from the Port Stephens and Newcastle regions.
Eastern Chestnut Mouse *Pseudomys gracilicaudatus*	V	Dense wet heathland on sand with thick sedges and grasses, nesting in dry grassy areas above or just below the ground[8].	Low. No known local records. Suitable habitat (dense wet heathland on sand with thick sedges and grasses)[8] absent.
Grey-Headed Flying-Fox *Pteropus poliocephalus*	V	Megachiropteran bat forages on fruits, blossom and nectar of eucalypts. In early summer roosts in large groups (camps) in forests or mangroves.	High. Potential foraging resource available (swamp mahogany, Banksia, paperbarks). Camp site at Fullerton Cove. **Potentially affected species.**
Frogs			
Wallum Froglet *Crinia tinnula*	V	Acid paperbark swamps, wallum sedgelands, wet heath and swamp forest[9].	Moderate to high. Suitable habitat within swamp mahogany – paperbark forest. Recorded in swamp forest in the approved subdivision. **Potentially affected species.**
Green And Golden Bell Frog *Litoria aurea*	E	Swamps, lagoons, streams and ponds with tall emergent vegetation such as *Typha* spp.[9]. Occupied ponds usually occur within 100 m of occupied ponds.	Low to moderate. Suitable permanent pond with tall emergent vegetation and ephemeral wetlands present. Nearest records are Kooragang Island and Medowie. **Potentially affected species.**
Green-Thighed Frog *Litoria brevipalmata*	V	Temporary ponds in woodland, coastal heath, rainforest and adjacent cleared areas.	Low to moderate. Suitable habitat is present in the study area. No records in the locality. Nearest record is Karuah. **Potentially affected species.**
Flora			
Netted Bottlebrush *Callistemon linearifolius*	V	Red flowering bottlebrush growing in dry sclerophyll forest on coast and adjacent ranges from Georges River to Nelson Bay[10].	Low to moderate likelihood of occurring in open forest. Nearest record is Salamander Bay. **Potentially affected species.**
Leafless Tongue Orchid *Cryptostylis hunteriana*	V	Terrestrial orchid grows in coastal swamp heath on sandy soil, eucalypt woodland, swamp fringes to bare hillsides in tall forest, with *Blandfordia nobilis*, *Cryptostylis erecta* and *Cryptostylis subulata*[11].	Low to moderate. Records in Port Stephens area restricted to volcanic hills, although potential habitat is present in the study area. **Potentially affected species.**
Sand Doubletail *Diuris arenaria*	V	Coastal heath forest and woodland dominated by *Corymbia gummifera* and *Angophora* sp. with a grassy or bracken understorey[12].	High. Preferred habitat present in the study area. **Potentially affected species.**

Name	TSC Act	Preferred Habitat	Likelihood of Occurrence
Rough Doubletail *Diuris praecox*	V	Grassy open areas within near-coastal open forest on sand hills and slopes[13], including easements where there is less competition for light.	High. Recorded along Nelson Bay Road in the northeast corner of study area. Suitable habitat present in the study area. **Potentially affected species.**
Camfield's Stringybark *Eucalyptus camfieldii*	V	Coastal shrub heath on sandy soils on sandstone, often of restricted drainage[14]. Restricted to coastal sand wallum woodland – heath.	Low. Preferred habitats absent from the study area.
Eucalyptus parramattensis subsp. *decadens*	V	Low woodland on sandy soil, often on Tomago sand swamp woodland. Recorded from swamp forest fringes in Salamander Bay area.	Moderate. Preferred habitat and vegetation community present in the study area. Hybrid species (*E. parramattensis* subsp *decadens* x *E. robusta*) recorded in the study area. **Potentially affected species.**
Dwarf Kerrawang *Rulingia prostrate*	E	Locally recorded from Tomago sandbeds in scribbly gum open forest at ecotone with swamp mahogany.	Moderate. Some potential to be present within swamp forest in the study area. **Potentially affected species.**
Heath Wrinklewort *Rutidosis heterogama*	V	Heath, often along disturbed roadsides in coastal districts[15]. Local records at Kurri Kurri in dry sclerophyll forest and woodland in Kurri sand swamp woodland and lower Hunter spotted gum ironbark forest[16].	Low to moderate likelihood of occurring in dry sclerophyll forest and wet heath. **Potentially affected species.**.
Endangered Ecological Communities			
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	E	Humic clay loams and sandy loams on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains[17].	High. Swamp forest adjacent to Nelson Bay Road is contiguous with the Fullerton Cove floodplain. Soil is sandy loam and many plant species occur in the swamp forest that characterises this community. **Potentially affected ecological community.**

Status in NSW as per Schedules 1 and 2 of TSC Act: E = Endangered; V = Vulnerable.

1 = Clout (1989). 2 = Davey (1993). 3 = Marchant & Higgins (1993). 4 = Marchant & Higgins (1990). 5 = Blakers et al (1984). 6 = Clancy (1991). 7 = Port Stephens Council (2001). 8 = Fox (1991). 9 = Cogger (1992). 10 = Spencer and Lumley (2002). 11 = Leigh et al (1984). 12 = Jones, D. L. (1999). 13 = Jones, D. L. (1991). 14 = Hill (2002). 15 = Harden (1992a). 16 = Hunter Catchment Management Trust (2004). 17 = NPWS (2004).

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